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ORBCOMM
Serial Interface Specification

E80050015 – Revision F

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PREFACE

1. This publication provides all the specifications for the ORBCOMM Serial Interface.
2. To obtain information relative to this or other ORBCOMM documents, send an Email to: DOCUMENT_CONTROL@ORBCOMM.COM.

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Chapter 1 Overview

What's New

This version of the Serial Interface Specification represents a change in direction for the Subscriber Communicators (SCs). In an effort to support lower SC prices, ORBCOMM intends to eliminate requirements for any functionality that are not frequently used. In addition, ORBCOMM wishes to promote a new, more robust serial packet retry mechanism and a more consistent status and configuration mechanism.

Consequently, after March 1, 2000, ORBCOMM will no longer require SC's to implement Doppler-based position determination and Byte Mode. NOTE: should an SC Manufacturer elect to implement Doppler-based position determination or Byte Mode, the implementation shall adhere to the specifications described herein.

In addition, all SC's Type-Approved after August 1, 1999 shall implement the following new functionality:

1. Additional *status_code* values for the LINK LEVEL ACK packet that indicate rejection of a packet (see Table 3.1);
2. A new serial packet retry mechanism to correct a deficiency in the original method (see Section 2.4.1); and
3. A consistent mechanism for evaluating the SC's status and specifying it's configuration:
   a) Creation of a new GET PARAMETER packet (Table 3.20);
   b) Creation of a new SET PARAMETER packet (Table 3.21);
   c) Creation of a new PARAMETER RESPONSE packet (Table 3.22); and
   d) Definition of additional, generally-useful, configuration parameters.

Finally, in order to promote the standardization of Command Mode interfaces, this specification introduces an AT-style Command Mode whose implementation is optional. Note however, that if an SC manufacturer elects to implement *any* Command Mode interface, the AT-style format, as described in Section 2.3, shall be implemented. Additional manufacturer-specific Command Mode variations may also be implemented if desired.

1.1 Scope

This document describes the protocol for the serial interface between ORBCOMM-certified SCs and Data Terminal Equipment (DTE). The intent is to provide an acceptable interface to every possible data communications application suitable for the ORBCOMM System, and to standardize the interface so that an SC can be used for many different applications.

The document is divided into four chapters and nine appendices, which are summarized below:

Chapter 1 OVERVIEW defines the document scope, presents text conventions, provides terminology clarifications, and lists related documentation.

Chapter 2 PROTOCOL DESCRIPTION provides an introduction to the SC protocol, and describes three modes of interface to the SC, the SCs position determination functionality, and the internal parameters that affect the SC's operation.

Chapter 3 PACKET DESCRIPTIONS & PACKET DESCRIPTION NOTES defines the packets exchanged between the SC and the DTE that controls it.

Chapter 4 EXAMPLES presents ladder diagrams that detail the response of the SC and the ORBCOMM Network to each Serial Interface packet.

Appendix A SC PARAMETERS lists internal SC parameters accessible via protocol mode.

Appendix B BYTE MODE presents a flow chart that illustrates Byte Mode operation.

Appendix C COMMAND MODE API lists the commands supported by the AT-style Command Mode interface.

Appendix D S-REGISTERS identifies the S-Registers used to access SC status and control information via the AT-style Command Mode interface.

Appendix E NETWORK CAPABILITIES discusses the four basic formats of exchanging data over the ORBCOMM Network.

Appendix F FLETCHER CHECKSUM provides C source code implementing the Fletcher encoding and decoding functionality.

Appendix G LATITUDE & LONGITUDE CONVERSION illustrates the process of converting between ORBCOMM position format and Geodetic position format.

Appendix H SATELLITE ELEMENT SET FORMAT DESCRIPTION defines format of the Satellite Element Set used in the ORBCOMM Network.

Appendix I GLOSSARY OF TERMS & ACRONYMS provides a list of all acronyms used in this document.

1.2 Text Conventions

This document uses the following text conventions:

Phrases that identify packets described in the *ORBCOMM Subscriber Communicator Air Interface Specification* (document A80TD0009 - Revision B) appear in SMALL CAPS.

THE **BOLD SMALL CAPS** font identifies ORBCOMM serial interface packets, as enumerated in Chapter 3 of this document.

Text appearing in *italicized* type indicates configuration parameters, which are described in Appendix A.

Parameters within Air Interface or Serial Interface packets appear in ***boldface italicized*** type.

1.3 Terminology Clarifications

This document uses the following terminology:

"SC-Originated messages"

This term refers to "inbound" transferred data—i.e., data that originates from SCs and travels to the Satellites and the ORBCOMM System.

"SC-Terminated messages"

This term refers to "outbound" transferred data—i.e., data that transfers from the ORBCOMM System and Satellites to SCs.

"message"

(lower case "m").This is a generic term that refers to any subscriber data that passes through the ORBCOMM System.

"Message" (upper case "M")

This term refers to a specific type of subscriber data that passes over the ORBCOMM System.

1.4 Related Documentation

The following documents provide background information on the ORBCOMM System and provide information on the SC's communication with Satellites:

ORBCOMM System Overview (document no. A80TD0008).

ORBCOMM Subscriber Communicator Air Interface Specification (document no. A80TD0009).

Chapter 2 PROTOCOL DESCRIPTION

In this document, the generic descriptions “data terminal” and “data terminal equipment” (DTE) refer to the device connected to the SC, and not to the SC itself. Also, the term “message handler agent” (MHA) refers to the process in the DTE which manages the sending and receiving of messages via the SC.

There are three distinct modes of the SC serial interface: Protocol Mode – which must be implemented by all SCs – and two optional interfaces: Byte Mode and Command Mode. Byte Mode enables DTEs that can only generate data bytes without a header, length field, or checksum to use the ORBCOMM Network. Byte Mode is described in Section *2.2* and Appendix B. Command Mode utilizes a command interpreter designed to enable configuration modification and viewing by a technician and to facilitate simple message exchanges. This protocol is defined in Section 2.3 and Appendices C and D.

Generally speaking, Protocol Mode is the most common mode of operation, in which the protocol described in Section 2.1 and Chapter 3 is active. At power-up the SC will operate in either Protocol, Byte, or Command Mode, depending on the setting of its internal *ops_mode* parameter. Users shall also be able to enter Command Mode by entering a sequence of five non-printable characters. The choice of these characters is left to the SC manufacturers. Good design practice will return the user to Protocol Mode automatically after a period of inactivity.

2.1 Protocol Mode

The packets exchanged by the SC and DTE are specified in Chapter 3. All packets contain a header byte to enable the receiver to synchronize to the packet boundaries. Packets transmitted by the DTE shall contain a header byte of 0x85; a header byte of 0x05 indicates the packet was transmitted by the SC. The only exception to this is the new packet retry mechanism discussed at the end of Section 2.4.1. All packets also contain a unique packet type identifier and a length field. The protocol also mandates the use of two Fletcher checksum bytes to detect errors in the packet bytes. This checksum is calculated over all packet bytes. The least-significant bit of the least-significant byte is transmitted first. The bytes of a packet are generally transmitted without an inter-character delay—the start bit of the next byte immediately follows the stop bit of the previous byte.

Protocol Mode provides more functionality than may be required for some applications. In those cases, the DTE need only implement a subset of the described packets/protocol. It is the intention of ORBCOMM, however, to require that all SCs support the full functionality of the protocol, except in the case when the SC is not equipped with position determination capability or an RS-232 port. As previously stated, this will enable an SC to be employed in many different applications.

The SC will queue messages, reports and GlobalGrams from the DTE on a priority basis, to be sent either in a polled or SC-Originated mode. The DTE may track the acknowledgment

of each Message, Report, or GlobalGram it generates by specifying a unique reference number in each of these packets. Once the SC's internal message buffer is full, additional messages, reports, or GlobalGrams from the DTE are discarded and an **ACK** packet is sent with ***status_code*** = 1 (see Section 2.4 and Table 3.1). The message capacity of SC is limited by its available message queue memory.

If the SC is not storing messages or reports received from the DTE, reception of the POLL COMMAND will result in transmission of a **SYSTEM ANNOUNCEMENT** packet to the DTE (see Figure 4.14). Otherwise, the first queued message or report from the DTE that satisfies the requested response (indicated by the ***control_code***) in the POLL COMMAND will be removed from the queue and sent to the ORBCOMM Gateway. If no messages from the DTE in the queue satisfy the request, a **SYSTEM ANNOUNCEMENT** packet will be sent to the DTE.

The SC will also queue SC-Terminated messages, commands, and GlobalGrams until the DTE is ready to accept them, as signaled by the activation of DTR or de-activation of RTS. If the SC's internal buffer is full, the SC transmits a SUBSCRIBER RECEIVER READY packet to the ORBCOMM Gateway–with the ***control_code*** = 1, NOT ready to receive–in response to SC-TERMINATED ASSIGNMENT packets.

Manufacturers may implement application-specific packets of their own design. The packet types must range from 30 to 255. Packet types 20 through 29 are reserved for future protocol mode use. The manufacturer-defined packets must adhere to the specification format for the header (bytes 0 - 4) and checksum bytes.

2.2 Byte Mode

NOTE: ORBCOMM will not require SCs to implement Byte Mode after March 1, 2000.

Byte Mode exists for DTEs that only generate data bytes without a header, length field, or checksum. Byte Mode is configurable to allow SC-Originated Messages, Reports, or GlobalGrams to be generated using a time-based or count-based trigger, or both. Details are presented in the configuration parameters description (Appendix A) and in a flow chart (Appendix B).

The DTE's data bytes are stored in SC memory, then encapsulated into an SC-Originated report, message, or GlobalGram. When triggered by a byte count maximum, timer expiration, or ASCII Start-Of-Message/End-Of-Message (SOM/EOM) characters received from the DTE, the SC fills-in the remaining fields of the SC-Originated Message/Report/GlobalGram using the values of ***def_polled, def_ack_level, def_rep_or_ind, def_msg_or_ind, def_priority, def_msg_body_type,*** and ***def_serv_type***. The Message/Report/GlobalGram is then sent to the ORBCOMM Gateway/Satellite, or remains queued until the SC is polled by the ORBCOMM Gateway, based on the value of the ***def_polled*** parameter.

In the SC-Terminated direction, the DTE receives only the SC-Terminated command, message, or GlobalGram bytes without the usual header (i.e., ***retry_count, gwy_id, subject_ind,***

msg_body_type, gwy_dgram_ref_num, or_ind) information, length field, checksum, etc. If configured for SOM/EOM behavior, the SOM character will precede and EOM character will follow the Command, Message, or GlobalGram bytes. Note that the activation of this mode prevents the use of any of the Protocol Mode packets described in this document by the DTE or SC.

2.3 Command Mode

This section specifies a Command Mode interface whose implementation is interface is optional; however should an SC manufacturer elect to implement a Command Mode interface, it must function exactly as described in this section. SC Manufacturers may implement additional, proprietary Command Modes at their discretion.

The development of this AT-style Command Mode interface was motivated by a desire to provide a familiar user interface to novice developers and users. The primary goal of this interface is to standardize the mechanism for configuring the SC's operating parameters. A secondary goal is to provide a simple, user-friendly interface for sending and receiving messages over the ORBCOMM network.

After considering what format best suited the needs of the target audience, ORBCOMM elected to design this interface around the Hayes AT protocol. One obvious problem with this approach is the fundamental differences between a packet-switched network such as ORBCOMM and the circuit-switched Public Switched Telephone Network (PSTN) for which the AT protocol was designed. Given these differences, the standard AT commands cannot be implemented directly. ORBCOMM's approach was to modify a subset of the standard AT command interface to accommodate the characteristics of the ORBCOMM Network, resulting in an AT-style interface with the much of the same look and feel as the standard circuit-switched AT command interface. Future specifications may enhance this AT-style command interface to provide more functionality, comparable to that provided through the Protocol Mode interface.

The following section defines the structure of the command line and response strings. Appendix C defines the commands supported by the SC while Appendix D specifies the mechanism for accessing and setting the SC's internal parameters (S-Registers).

When specifying the format of the strings exchanged by the DTE and SC, the following conventions are used: character strings enclosed within < > indicate an ASCII text element or command. Strings enclosed within [ ] indicate optional ASCII text elements that are not needed with every command line.

2.3.1 Command Line Structure

When interpreting AT-style command strings, the SC shall not distinguish between ASCII text strings of upper case, lower case, or a mixture of both. In addition, an SC implementing the AT-style Command interface must have the ability to accept a minimum of 80 command line characters.

The structure of an SC command line is:

AT[<Command>][<Data>]<CR>

The SC shall interpret the ASCII characters "AT" as the command line header. This character string initiates a new command line and acts as the anchor for the synchronization of the remaining bytes in the command line.

The SC shall accept up to two ASCII characters within the **[<Command>]** field. In most cases, the **[<Command>]** will contain only one ASCII character. The commands supported by this interface are listed and described in Appendix C.

The [<**Data**>] field associated with each command varies. See Appendix C for more details.

An ASCII CR (0x0D) signifies the end of a command-line.

2.3.2 Response Code Structure

Responses Codes shall be generated by the SC to inform the DTE of any relevant information and the execution status of a DTE-generated command. Response Code strings shall be limited to 40 characters in length and will be terminated by an ASCII CR (0x0D) and LF (0x0A). The structure of a Response Code string is:

[<Response>]<CR><LF>

This AT-style Command Interface defines two types of Response Codes: Final and Unsolicited. The SC shall transmit a Final Response Code after execution of a command from the DTE. The Final Response Code indicates whether or not the command line followed the specified format and whether or not the command was successfully executed. There are two Final Response Codes, the strings OK and ERROR. OK indicates that the command line structure is correct and that the SC has completed execution of the command. ERROR signifies that the command line structure was not properly formatted or that the command cannot be executed in the current operational mode.

An Unsolicited Response Code indicates the occurrence of an event not directly associated with the issuance of a command by the DTE.

An example that an Unsolicited Response Code is received is when entering Online Messaging mode via the ATD command. In this case, the SC will not send a Final Response Code until the DTE requests a departure from online messaging mode using the escape sequence +++. This sequence would appear as follows:

DTE: ATDM<CR>

SC: CONNECT GWY<CR><LF>

After transmitting the message body data to the SC, the DTE would transmit the escape sequence to re-enter command mode.

DTE: +++<CR>

SC: OK<CR><LF>

After entering Online Messaging mode (using `ATDM`), a `CONNECT GWY` response from the SC indicates reception of a downlink from a satellite that is connected to the desired Gateway as identified by S-Register 53. The `CONNECT SAT` signifies that the SC has locked onto a downlink from a satellite that is not connected to the desired Gateway. `NO CONNECT` is returned when the SC cannot lock onto a downlink from any satellite.

2.4 Link Layer

It is expected that the DTE will be co-located with the SC, or at least within 50 feet (15 meters), which is the typical RS-232 cable length specification. This distance can be extended to 200 feet (61 meters) with high-grade cable, or even farther with RS-232 line drivers. The transmission reliability provided by this high-quality low-error-rate link enables simplification of the serial link protocol—long messages need not be broken into multiple packets before being transferred between the SC and DTE.

Consequently, the protocols between the SC and the DTE are half-duplex (i.e., a packet must be acknowledged by the recipient before another can be sent), thereby enabling simple software flow control. Furthermore, the protocol is designed exclusively for point-to-point links–only one DTE and one SC can be connected to the serial link.

Since communications in Byte Mode are inherently unidirectional, there is no Link Layer interaction between the DTE and the SC. ORBCOMM expects Command Mode to be used almost exclusively in an online, human-interactive context, so no Link Layer control mechanism was deemed necessary. Consequently, this section describes the Link Layer methodology that is exclusive to Protocol Mode.

Protocol Mode requires only one control packet–the Link Layer Acknowledgment, or **ACK** packet. It is used to acknowledge the reception of "information packets" (see Chapter 3.1, Packet Descriptions). Error-free packets are acknowledged by responding with an **ACK** packet with a ***status_code*** of 0. If, however, the received information packet is in error (e.g., bad checksum), the packet receiver will transmit an **ACK** packet with a non-zero ***status_code*** (see Table 3.1).

If the application does not require or cannot support link layer acknowledgment, the SC can be configured with ***ser_max_retries = 0*** and ***abort_response = 0.*** In this case, the SC will make only one attempt to send an information packet to the DTE, and the lack of an **ACK** from the DTE will not generate a serial port failure indication (abort report).

2.4.1 Invalid Packets

Though the serial link between the DTE and SC is expected to be very reliable, there are two mechanisms for handling scrambled packets. The first mechanism, which has been described in previous versions of this specification and is implemented in all SCs available as of the date of the release of this specification, defines the fifth byte of each packet as a *retry_count* field that indicates how many times the packet has been transmitted. When the packet originator receives an **ACK** packet with a non-zero ***status_code***, or fails to receive an **ACK** packet at all, it transmits the corresponding information packet again, after incrementing the ***retry_count*** field of the re-transmitted packet. A packet with a non-zero

retry_count indicates to the recipient that the information packet is a duplicate of a previously received information packet. The receiver then re-sends the appropriate **ACK** packet, and discards the second information packet if the packet has been processed previously. If the receiver observes the ***retry_count*** drop to zero or decrease, it should assume that a new packet has been received.

Unfortunately, there is a flaw in this mechanism that can result in lost messages when communications between the DTE and the SC are not reliable.

> **EXAMPLE:** Initially the DTE sends a message to the SC (msg 1, retry = 0). The SC receives the message and acknowledges it. Next, the DTE sends a new message (msg 2). In the event the SC does not receive message 2 (e.g., electrical noise, transients, etc.), it will not respond to the DTE with an **ACK** packet. After the DTE times-out, it retransmits message 2 with a retry count of 1. The SC receives this packet and **ACK**s it, but discards the packet, incorrectly believing it to be a retransmission of message 1. Having received an **ACK** for message 2, the DTE believes the packet was accepted and therefore does not re-send it.

The fundamental cause of this problem is the inability of the SC to distinguish between the scenario in which a new message from the DTE is lost and the case in which the DTE fails to receive one of the SC's **ACK**s. To address this problem, ORBCOMM has developed an alternate mechanism for handling packet errors.

This revised error handling mechanism redefines the ***retry_count*** field of the Serial Interface packets (byte four) to represent a packet sequence number (***pkt_seq_num***), with the packet sender selecting a unique value for each distinct message. Retransmissions of packets rejected by the recipient or not acknowledged retain the ***pkt_seq_num*** of the original packet. Messages from the DTE having the same ***pkt_seq_num*** are processed only once. A newly-defined ***status_code*** in the **ACK** packet indicates that the packet being acknowledged was a duplicate and was therefore discarded.

> **NOTE:** The SC must save the ***pkt_seq_num*** of the most-recently received message from the DTE. To insure correct processing of the first DTE message, the SC must initialize the ***pkt_seq_num*** parameter to an invalid message number.

To achieve backwards compatibility with the original protocol, packets whose fifth byte is to be interpreted as a ***pkt_seq_num*** instead of a ***retry_count*** shall begin with a packet header byte of 0x86 (for packets from the DTE to the SC) or 0x06 (packets transmitted from the SC to the DTE).

If an SC has implemented the new parameter access scheme described in Appendix A, DTE software can determine whether or not the SC supports this enhanced retry processing mechanism by reading the *ser_spec_rev* parameter. For SCs that do not support the new parameter access scheme, DTE software can send packets with a header byte of 0x86 to the SC. If the SC supports the new retry handling scheme, these packets will be processed as expected. If the SC does not support the new retry mechanism, it will not recognize the packet header byte (0x86 instead 0x85) and will not respond to the DTE. If the SC repeatedly fails to acknowledge the packet, the DTE can assume that the SC does not support the enhanced retry handling mechanism.

Until the SC receives a packet from the DTE with a packet header byte of 0x86, it will assume that the DTE software does not support the new retry mechanism. The SC will, therefore, send packets to the DTE with a packet header byte of 0x85 and a fifth byte that indicates the packet's retry count. Once the SC receives a packet with a header byte of 0x86 it will implement the new retry scheme in all subsequent communications with the DTE.

2.4.2 DTE Failure Notification

To enable detection of DTE failure, the SC implements a response timeout mechanism. After transmitting a packet to the DTE, the SC will set a timer for *ser_pkt_timeout* seconds. As stated above, the DTE should always respond to packets transmitted by the SC with an **ACK** packet, regardless of the received packet type or presence of errors within the packet. Should the DTE fail to respond within *ser_pkt_timeout* seconds, the SC will re-transmit the packet, increment a DTE response failure count, and re-start the response timer. The SC can be configured to send an abort report to the customer's application hub after *ser_max_retry* DTE response timeouts. More information on these parameters is provided in Appendix A.

If communication with the DTE has failed, communication with the DTE should still be attempted. The only consequence of the failure is the transmission of the abort report and the removal of the failed packet from SC memory.

2.5 Physical Layer

While the protocols described in this Chapter are independent of the actual method used for communicating the data bits, all SCs built so far have implemented an RS-232 asynchronous serial link, which is described below. Should application developers require a parallel, synchronous, or PCMCIA interface to the SC, the development and documentation of these interfaces will be the responsibility of the SC manufacturers.

The SC's serial interface shall adhere to the RS-232C specification, except for permitting the use of a DB-9 connector instead of a DB-25. The SC interface shall be of the Data Communications Equipment (DCE) type, while the device controlling the SC is to be wired as a DTE. This specification requires that every SC support the asynchronous version of RS-232C using a 9- or 25-pin connector. Those SCs providing a 25-pin connector could choose to implement the synchronous version of RS-232. Additional configuration parameters not currently defined would be required in order for the user to select between asynchronous and synchronous operation.

RS-232 flow control may be used to prevent data overruns. This implies manipulation of the Data Terminal Ready (DTR) and Request-To-Send (RTS) lines by the DTE and the Data Set Ready (DSR) and Clear-To-Send (CTS) lines by DCE (SC). The RS-232 protocol is described in numerous publications and therefore is not described here. The serial configuration parameters (Appendix A) enable the SC to be configured to support a wide range of DTE configurations.

Applications that require extremely low power and long battery life may benefit from the use of alternative serial interface voltage levels. In this mode, the bi-polar voltage levels of the RS-232 specification would be replaced with the indigenous voltages of the SC digital circuitry (TTL, CMOS, or GaAs 3-volt technology). Although RS-232 signal levels are mandated by this specification, ORBCOMM acknowledges that the ability to remove the relatively inefficient RS-232 voltage regulator and line driver circuits may be required in some applications. ORBCOMM will consider waiving the requirement for RS-232 levels on a case-by-case basis.

2.5.1 Connector

Figure 2.1 displays the pin designations and signal directions. The following list identifies the SC serial interface. Some of the signals have specific meaning within the ORBCOMM application. Not all signals will be used by every application. To simplify selection of DTEs, ORBCOMM will consider waiving the requirements for all signals but Ground, Transmitted Data, and Received Data.

Data Terminal Ready (DTR)

The DTR signal may be configured for differing responsibilities via the *ob_flow_ctrl* and *pwr_down_mode* configuration parameters (Appendix A). It may be used to enable the DTE to command a low-power mode within the SC–the DTE simply deactivates DTR and the SC will power-down non-essential components. The transition of DTR from inactive to active will result in the awakening of the SC. The SC can otherwise ignore DTR, or it can be used for flow control.

Request-To-Send (RTS) & Clear-To-Send (CTS)

Manipulation of RTS and CTS may be required for reliable full-duplex operation; however if half-duplex is configured, then implementation of these two signals is optional. CTS can be used for flow control by the SC by itself, however half-duplex operation should provide sufficient flow control when the messages are not large.

Carrier Detect (CD)

The SC activates CD whenever it is locked onto the Satellite downlink and is receiving GATEWAY INFORMATION, DOWNLINK CHANNEL INFORMATION and UPLINK CHANNEL INFORMATION packets.

Data Set Ready (DSR)

DSR is activated whenever the SC is powered. DSR can also be configured for flow control responsibilities, or to indicate queued SC-Terminated messages.

Signal Ground (GD)

Signal ground assures a common ground reference between the SC and the DTE.

Transmitted Data (TxD)

TxD conveys serial data from the DTE to the SC.

Received Data (RxD)

RxD conveys serial data from the SC to the DTE.

Voltage levels are standard RS-232C levels:

"0" = "active" = +5 to +15 VDC
"1" = "inactive" = -5 to -15 VDC

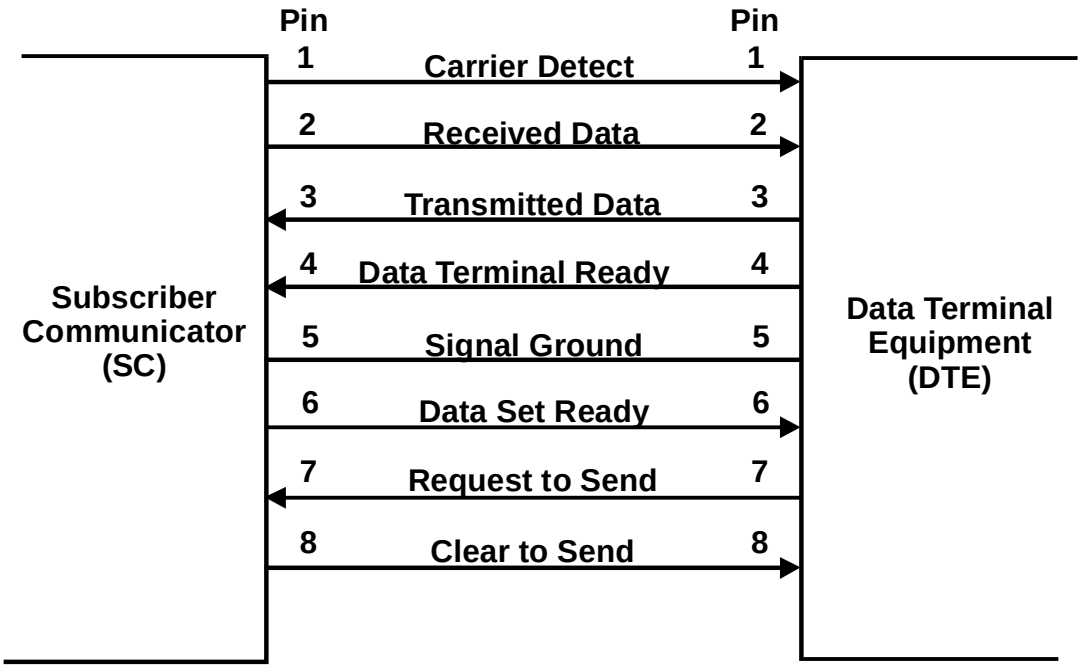


Figure 2.1 RS-232 Connector Specification

2.6 Configuration

To support the widest variety of applications, the SC's operational parameters must be configurable. The AT-style Command Mode interface supports this functionality by associating the SC's operating parameters with Hayes-like S-Registers and supporting command strings to read and write the S-Registers. The mapping of S-Registers to parameters is described in Appendix D.

In previous versions of this Serial Interface specification, not all of the SC's parameters were accessible via Protocol Mode and there was no consistent mechanism for accessing those parameters that were. This specification addresses these issues by aggregating all of the DTE-accessible parameters and status into a table. Protocol Mode DTE's can access the SC's operating parameters and internal status via the newly-defined `GET PARAMETER`, `SET PARAMETER`, and `PARAMETER RESPONSE` packets (Tables 3.20, 3.21, and 3.22). These packets reference parameters and status information in the table via

indexes that correspond to the parameters' locations within the table. Appendix A presents the parameters and status data that are accessible in this manner, their corresponding indexes, and their pre-set factory default values and ranges. (The factory default values listed in the table are recommended settings. Each SC manufacturer may assign different values.)

Two sets of these parameters exist within the SC–one fixed set which contains the pre-set factory defaults, and a second set which can be customized for the application. Both sets must be stored in non-volatile memory. Only one set is active at any time, and the active set must be re-selected automatically following a cycling of power. It may be necessary to restore the pre-set factory defaults if the configuration becomes unknown and the SC becomes inaccessible through the serial link. The implementation of this functionality is left to the SC manufacturers.

2.7 Position Determination Algorithm

NOTE: ORBCOMM will not require SCs to implement Doppler-Based Position Determination Mode after March 1, 2000.

The Protocol Mode allows for the DTE to control the position determination capability of the SC. The packets are described in Tables 3.15 and 3.16. Following the successful calculation of SC position, the SC automatically returns a **POSITION STATUS** packet to the DTE. A POSITION REPORT is not automatically sent to the ORBCOMM Gateway. The application can initiate this action, however, through the **COMMUNICATIONS COMMAND** packet (see Table 3.3) or can send an **SC-ORIGINATED POSITION REPORT** packet to the SC.

Chapter 3 PACKET DESCRIPTIONS & PACKET DESCRIPTION NOTES

3.1 Packet Descriptions

LINK LEVEL ACKNOWLEDGMENT

	7 6 5 4 3 2 1 0	
0	0x05/0x85 or 0x06/0x86	packet header byte (0x05/0x06: SC ->DTE, 0x85/0x86: DTE -> SC)
1	0x01	packet type
2	0x07	packet length, starting with byte 0, includes checksum
3	0x00	
4	status_code	identifies reason for error if any (see below)
5	Check Byte 0	Fletcher Checksum
6	Check Byte 1	

status_code descriptions:

0 = no error

1 = buffer unavailable - wait 30 seconds then send again

2 = packet rejected, invalid checksum

3 = packet rejected, invalid parameter

4 = packet rejected, size exceeds queue capacity

5 = packet rejected, ill-formed

6 = packet rejected, unrecognized packet type

7 = packet rejected, duplicate packet sequence number

Table 3.1 - Link Level Acknowledgment

CONFIGURATION COMMAND

	7 6 5 4 3 2 1 0	
0	0x85/0x86	packet header byte
1	0x02	packet type
2	0x14	packet length, starting with byte 0, includes checksum
3	0x00	
4	retry_count/pkt_seq_num	number of times this packet has been re-sent/pkt seq num
5	*pin code byte 0*	personal identifcation number, used as a security measure (min = 0, max = 9999)
6	*pin code byte 1*	
7	*pin code byte 2*	
8	*pin code byte 3*	
9	*desired_gwy_id*	instructs SC to acquire Satellite having this ORBCOMM Gateway
10	*def_polled*	SC-Originated: polled by ORBCOMM Gateway or initiated by SC (see Section 3.2, note 1)
11	*def_ack_level*	default acknowledgement level (see Section 3.2, note 3)
12	*def_rep_or_ind*	default OR indicator for Reports (see Section 3.2, note 4)
13	*def_msg_or_ind*	default OR indicator for messages (see Section 3.2, note 4)
14	*def_priority*	default priority level (see Section 3.2, note 5)
15	*def_msg_body_type*	default body type for messages (see Section 3.2, note 6)
16	*def_serv_type*	default service type for Reports (see Section 3.2, note 2)
17	*gwy_search_mode*	method for searching for downlinks (see Appendix A)
18	Check Byte 0	Fletcher Checksum
19	Check Byte 1	

Table 3.2 – Configuration Command

COMMUNICATIONS COMMAND

	7 6 5 4 3 2 1 0	
0	0x85/0x86	packet header byte
1	0x03	packet type
2	0x0d	packet length, starting with byte 0, includes checksum
3	0x00	
4	retry_count/pkt_seq_num	number of times this packet has been re-sent/pkt seq num
5	*type_code*	type of action requested (see below)
6	*value byte 0*	generic value pertinent to type of action requested (used with *type_code*: 4, 5, 7, 8, 10-15, 18, & 25)
7	*value byte 1*	
8	*value byte 2*	
9	*value byte 3*	
10	*gwy_id*	destination ORBCOMM Gateway (used with *type_code*: 0, 1, 3, 5-15, 23)
11	Check Byte 0	Fletcher Checksum
12	Check Byte 1	

type_code Definitions:

0 = request all SC-Terminated messages/commands queued in ORBCOMM Gateway

1 = request all SC-Terminated messages/commands queued in ORBCOMM Gateway of size no greater than 150 bytes

2 = request all GlobalGrams queued in satellite

3 = request O/R indicator addresses (Section 3.2, note 4)

4 = request status of SC-Originated message/report/GlobalGram identified by MHA message reference number in value field

5 = request status of SC-Originated message/report identified by ORBCOMM Gateway message reference number in value field

6 = request list of subjects of messages queued in ORBCOMM Gateway

7 = request a single SC-Terminated message, identified by index in list of subjects, indicated in the value field. (Index value is inferred from position of message subject relative to other message subjects, starting with value 1. List of subjects ob tained from previous transmission of SC communications command with *type_code* = 6)

8 = delete a single SC-Terminated message, identified by index in list of subjects, indicated in the value field (see type_code =7 above)

9 = request registration with ORBCOMM Gateway

10 - 15 = generic functions (see Section 3.2, note 15)

16 = request status packet

17 = clear active message being transferred (either SC-Originated or SC-Terminated) between SC and ORBCOMM Gateway

18 = clear SC-Originated message identified by *mha_ref_num* in *value* field

19 = clear all messages in SC-Originated queue

20 = clear all messages in SC-Terminated queue

21 = perform self-test (internal check of memory, modem, etc.)

22 = perform local loop-back test (Dummy packet sent internally through SC - nothing transmitted to Satellite)

23 = perform loop-back test with ORBCOMM Gateway (SC sends Report with O/R indicator = 0, ORBCOMM Gateway sends Command with first 5 Report bytes)

24 = power down until DTR transitions from inactive to active

25 = power down for *value* seconds

26 = power down for at least *value* seconds, then awaken with the rise of the next satellite pass

27 = Send position report to ORBCOMM Gateway

28 = send orbital elements as an SC-Terminated message (NASA 2-line format, Appendix *) to the DTE.

29 = force SC to next known downlink in system

48 and above = SC Manufacturer defined

Table 3.3 Communications Command

SYSTEM ANNOUNCEMENT

	7 6 5 4 3 2 1 0	
0	0x05/0x06	packet header byte
1	0x04	packet type
2	0x0a	packet length, starting with byte 0, includes checksum
3	0x00	
4	retry_count/pkt_seq_num	number of times this packet has been re-sent/pkt sequence number
5	*announce_code*	system provided information
6	*gwy_id*	originating ORBCOMM Gateway (not applicable for announce code 2)
7	*dest_or_ind*	destination OR indicator (must be used in response to poll if report, see below)
8	Check Byte 0	Fletcher Checksum
9	Check Byte 1	

announce_code Definitions:

0 = calculate position estimate then send SC-Originated Position Report (for DTE equipped with position estimation capability, i.e. GPS)

1 = send one report

2 = not used

3 = not used

4 = send one SC-Originated message

5 = send one SC-Originated message or report

6 = send pre-defined O/R addresses

7 = not used

8 = not used

9 - 15 generic functions (see Section 3.2, note 15)

16 and above = SC manufacturer defined (see Section 3.2, note 15):

- *dest_or_ind (used as destination for response of poll)*
- *dest_or_ind = 0 has no effect, should be ignored*
- *If a report is polled and dest_or_ind is non-zero, the dest_or_ind must be used as the or_ind in the report.*
- *If a message is polled and dest_or_ind is non-zero, this dest_or_ind must be included in the responding message, if any.*

Table 3.4 System Announcement

STATUS

	7 6 5 4 3 2 1 0	
0	0x05/0x06	packet header byte
1	0x05	packet type
2	length byte 0	packet length, starting with byte 0, includes checksum
3	length byte 1	
4	retry_count/pkt_seq_num	number of times this packet has been re-sent/pkt sequence number
5	*state*	state of SC, message transport processes (see below)
6	*st_diag_code*	diagnostic code from self test, etc. (see below)
7	*active_mha_msg_ref*	MHA # of message being transferred (0xff = no message)
8	*sat_in_view*	current *satellite_#* (0 if no Satellite in view)
9	*gwy_quan*	quantity of ORBCOMM Gateways currently connected to this satellite
	gwy_id_0	list of ORBCOMM Gateway's and the minimum priority of a message acceptable to the respective ORBCOMM Gateway. Messages of lower priority must not be sent until the congestion clears
	min_pri_gwy_0	
	.	
	gwy_id_i-1	
	min_pri_gwy_i-1	
10+2i	*queued_ob_msgs*	number of SC-Terminated messages in SC memory
11+2i	*queued_ib_msgs*	number of SC-Originated messages in SC memory
12+2i	*week_byte_0*	UTC time week, with week #0 starting January 6, 1980 (value corresponds to time of next synchronization segment)
13+2i	*week_byte_1*	
14+2i	*time_byte_0*	24 bit integer representing the number of seconds since 00:00:00 UTC (resets midnight Sunday)
15+2i	*time_byte_1*	
16+2i	*time_byte_2*	
17+2i	*total_sats*	total number of satellites in system
18+2i	*stored_sats*	number of stored Satellite orbital elements
19+2i	*check_errs*	number of downlink packets with bad checksums since last status packet
20+2i	Check Byte 0	Fletcher Checksum
21+2i	Check Byte 1	

Table 3.5 Status

SC-ORIGINATED MESSAGE

	7 6 5 4 3 2 1 0	
0	0x85/0x86	packet header byte
1	0x06	packet type
2	length byte 0	packet length, starting with byte 0, includes checksum
3	length byte 1	
4	retry_count/pkt_seq_num	number of times this packet has been re-sent/pkt sequence number
5	*gwy_id*	destination ORBCOMM Gateway ID
6	*polled*	SC-Originated: polled by ORBCOMM Gateway or initiated by SC (see Section 3.2, note 1)
7	*ack_level*	acknowledgment level (see Section 3.2, note 3)
8	*priority*	message priority (see Section 3.2, note 5)
9	*msg_body_type*	message body type (see Section 3.2, note 6)
10	*mha_ref_num*	DTE assigned, used to identify among multiple messages
11	*rcpnt_quan*	number of recipients for this message
12	*subject_ind*	1=message contains a subject; 0=no subject (see Section 3.2, note 11)
	rcpnt_addr_0 byte 0	null terminated recipient address strings and/or recipient indicators (see Section 3.2, notes 10,11)
	rcpnt_addr_6 byte i-1	
	subj byte 0	null-terminated message subject (see Section 3.2, note 11) (max length = 80 characters)
	subj byte j-1	
	msg body byte 0	message body (max length determined by SC message queue size) NOTE: for message body types 0 (text) and 15 (externally-defined), a one-byte Data Type is inserted before the actual message body (see Section 3.2, notes 6 and 11)
	msg body byte k-1	
	Check Byte 0	Fletcher Checksum
14+i+j+k	Check Byte 1	

Table 3.6 SC-Originated Message

SC-ORIGINATED DEFAULT MESSAGE

	7 6 5 4 3 2 1 0	
0	0x85/0x86	packet header byte
1	0x07	packet type
2	length byte 0	packet length, starting with byte 0, includes checksum
3	length byte 1	
4	*retry_count/pkt_seq_num*	number of times this packet has been re-sent/packet sequence number
5	*mha_ref_num*	Used to uniquely identify messages
	msg body byte 0	message body
	.	
	.	
	msg body byte k-1	
	Check Byte 0	Fletcher Checksum
7+k	Check Byte 1	

NOTES:

1. The active configuration values are used for destination ORBCOMM Gateway (*desired_gwy_id*), acknowledgment level (*def_ack_level*), O/R indicator (*def_or_ind*), polled (*def_polled*), priority (*def_priority*), and body type (*def_msg_body_type*).
2. If the *def_msg_body_type* is 0 or 15, the SC must insert the appropriate single byte parameter before msg body byte 0. See the description of *def_msg_body_type* in the Appendix A.

Table 3.7 SC-Originated Default Message

SC-ORIGINATED REPORT

	7 6 5 4 3 2 1 0	
0	0x85/0x86	packet header byte
1	0x08	packet type
2	0x12	packet length, starting with byte 0, includes checksum
3	0x00	
4	retry_count/pkt_seq_num	number of times this packet has been re-sent/packet sequence number
5	*gwy_id*	destination ORBCOMM Gateway ID
6	*polled*	SC-Originated: polled by ORBCOMM Gateway or initiated by SC (see Section 3.2, note 1)
7	*serv_type*	Service Type (see Section 3.2, note 2)
8	*or_ind*	originator/recipient indicator, only values 0-3 (see Section 3.2, note 4)
9	*mha_ref_num*	DTE assigned, used to uniquely identify messages
10	user data byte 0	user data
11	user data byte 1	
12	user data byte 2	
13	user data byte 3	
14	user data byte 4	
15	user data byte 5	
16	Check Byte 0	Fletcher Checksum
17	Check Byte 1	

Table 3.8 SC-Originated Report

SC-ORIGINATED DEFAULT REPORT

	7 6 5 4 3 2 1 0	
0	0x85/0x86	packet header byte
1	0x09	packet type
2	0x0e	packet length, starting with byte 0, includes checksum
3	0x00	
4	*retry_count/pkt_seq_num*	number of times this packet has been re-sent/packet sequence number
5	*mha_ref_num*	DTE assigned, used to uniquely identify messages
6	user data byte 0	user data
7	user data byte 1	
8	user data byte 2	
9	user data byte 3	
10	user data byte 4	
11	user data byte 5	
12	Check Byte 0	Fletcher Checksum
13	Check Byte 1	

NOTE:The active values in the SC configuration are used for Polled (*def_polled*), Service Type (*def_serv_type*), and O/ R indicator (*def_or_ind*).

Table 3.9 SC-Originated Default Report

SC-ORIGINATED GLOBALGRAM

	7 6 5 4 3 2 1 0	
0	0x85/0x86	packet header byte
1	0x0a	packet type
2	length byte 0	packet length, starting with byte 0, includes checksum
3	length byte 1	
4	*retry_count/pkt_seq_num*	number of times this packet has been re-sent/packet sequence number
5	*gwy_id*	destination ORBCOMM Gateway ID
6	*mha_ref_num*	Used to identify among multiple messages, returned in ACK
7	*or_ind*	originator/recipient indicator (see Section 3.2, note 4)
	user data byte 0	User data (max = 229)
	user data byte 1	
	user data byte 2	
	.	
	.	
	user data byte i-1	
8+i	Check Byte 0	Fletcher Checksum
9+i	Check Byte 1	

NOTE: SYSTEM RESPONSE packet is always sent to DTE to indicate success or failure of transmission to Satellite.

Table 3.10 SC-Originated GlobalGram

SYSTEM RESPONSE

	7 6 5 4 3 2 1 0	
0	0x05/0x06	packet header byte
1	0x0b	packet type
2	0x0f	packet length, starting with byte 0, includes checksum
3	0x00	
4	*retry_count/pkt_seq_num*	number of times this packet has been re-sent/packet sequence number
5	*origin*	type of originator of this acknowledgment (see Section3.2, note 7)
6	*origin_id*	Id of originator, either *sat_id* or *gwy_id*
7	*status*	status of message transfer or message enquiry (see Section 3.2, notes 8,15)
8	*diag_code*	diagnostic code (see Section 3.2, notes 9,15)
9	*mha_ref_num*	DTE assigned, used to uniquely identify messages
10	*gwy_ref_num* byte 0	ORBCOMM Gateway assigned, used for delivery confirmation (see Section 3.2, note 15) (0xffff = not applicable)
11	*gwy_ref_num* byte 1	
12	*ack_mask*	which recipients apply to this ack (see Section 3.2, note 12)
13	Check Byte 0	Fletcher Checksum
14	Check Byte 1	

origin code definitions:

- if origin = 0 (satellite), *mha_ref_num* is valid, *gwy_ref_num* is not valid
- if origin = 1 (ORBCOMM Gateway), both *mha_ref_num* and *gwy_ref_num* are valid
- if origin = 2 (recipient), *mha_ref_num* is not valid, *gwy_ref_num* is valid
- if origin = 3 (SC), *mha_ref_num* is valid, *gwy_ref_num* is not valid

Table 3.11 System Response

SC-TERMINATED MESSAGE

	7 6 5 4 3 2 1 0	
0	0x05/0x06	packet header byte
1	0x0c	packet type
2	length byte 0	packet length, starting with byte 0, includes checksum
3	length byte 1	
4	*retry_count/pkt_seq_num*	number of times this packet has been re-sent/packet sequence number
5	*gwy_id*	originating ORBCOMM Gateway ID
6	*subject_ind*	1 = message contains a subject; 0=no subject (see Section 3.2, note 11)
7	*msg_body_type*	message body type (see Section 3.2, note 6)
8	*or_quan*	number of recipients + one originator (see Section 3.2, notes 10,11)
	or_addr_0 byte 0	originator address or indicator and list of recipient addresses and/or indicators (see Section 3.2, notes 10,11)
	.	
	.	
	or_addr_7 byte i-1	
	subj byte 0	null-terminated message subject (see Section 3.2, note 11) (max length = 80 characters)
	.	
	.	
	subj byte j-1	
	msg body byte 0	message body (max length determined by SC message queue size)
	.	
	.	
	msg body byte k-1	
	Check Byte 0	Fletcher Checksum
10+i+j+k	Check Byte 1	

Table 3.12 SC Terminated Message

SC-TERMINATED USER COMMAND

	7 6 5 4 3 2 1 0	
0	0x05/0x06	packet header byte
1	0x0d	packet type
2	0x0d	packet length, starting with byte 0, includes checksum
3	0x00	
4	*retry_count/pkt_seq_num*	number of times this packet has been re-sent/packet sequence number
5	*gwy_id*	ORBCOMM Gateway ID
6	user data byte 0	User data
7	user data byte 1	
8	user data byte 2	
9	user data byte 3	
10	user data byte 4	
11	Check Byte 0	Fletcher Checksum
12	Check Byte 1	

Table 3.13 SC-Terminated User Command

SC-TERMINATED GLOBALGRAM

	7 6 5 4 3 2 1 0	
0	0x05/0x06	packet header byte
1	0x0e	packet type
2	length byte 0	packet length, starting with byte 0, includes checksum
3	length byte 1	
4	*retry_count/pkt_seq_num*	number of times this packet has been re-sent/packet sequence number
5	*gwy_id*	ORBCOMM Gateway ID
6	*gwy_dgram_ref_num*	Used to identify among multiple GlobalGrams (assigned by ORBCOMM Gateway)
7	*or_ind*	Originator/Recipient Indicator (see Section 3.2, note 4)
	user data byte 0	User data (max length = 182)
	user data byte 1	
	user data byte 2	
	.	
	.	
	user data byte i-1	
8+i	Check Byte 0	Fletcher Checksum
9+i	Check Byte 1	

Table 3.14 SC-Terminated GlobalGram

POSITION DETERMINATION COMMAND

	7 6 5 4 3 2 1 0	
0	0x85	packet header byte
1	0x0f	packet type
2	0x08	packet length, starting with byte 0, includes checksum
3	0x00	
4	*retry_count/pkt_seq_num*	number of times this packet has been re-sent/pkt sequence number
5	*type_code*	type of action requested
6	Check Byte 0	Fletcher Checksum
7	Check Byte 1	

type_code Definitions:

0 = send SC position status

1 = start process using no initial position information

2 = start process using current position as starting point

3 = stop position determination process

Table 3.15 - Position Determination Command

POSITION STATUS

	7 6 5 4 3 2 1 0	
0	0x05	packet header byte
1	0x10	packet type
2	0x12	packet length, starting with byte 0, includes checksum
3	0x00	
4	*retry_count/pkt_seq_num*	number of times this packet has been re-sent/pkt sequence number
5	*pos_calc_active*	state of position determination process (1=active, 0=inactive)
6	*quality_ind*	indication of position estimate accuracy (0 = GPS; 1 = good Doppler -> 15=poor Doppler)
7	*pass_quan*	number of consecutive Satellite passes for this estimate
8	age byte 0	age of lat and lon estimate in minutes (max = 65535 minutes)
9	age byte 1	
10	*lat_code* byte 0	coded geodetic latitude - 0: north pole, 0x0fffff: south pole. resolution: 1.2 meters.
11	*lat_code* byte 1	
12	*lat_code* byte 2	
13	*lon_code* byte 0	coded geodetic longitude - 0: Greenwich Meridian, increasing in eastern direction. resolution: 2.4 meters.
14	*lon_code* byte 1	
15	*lon_code* byte 2	
16	Check Byte 0	Fletcher Checksum
17	Check Byte 1	

pos*_calc_active:*

0 = the position determination facility is idle

1 = the position determination facility is currently attempting to estimate SC position

Table 3.16 Position Status

SC-ORIGINATED POSITION REPORT

	7 6 5 4 3 2 1 0	
0	0x85/0x86	packet header byte
1	0x11	packet type
2	0x0e	packet length, starting with byte 0, includes checksum
3	0x00	
4	*retry_count/pkt_seq_num*	number of times this packet has been re-sent/packet sequence number
5	*mha_ref_num*	DTE assigned, used to identify among multiple messages
6	*lat_code* byte 0	coded geodetic latitude - 0: North Pole, 0x0fffffff: South Pole. Resolution: 2.4 meters.
7	*lat_code* byte 1	
8	*lat_code* byte 2	
9	*lon_code* byte 0	coded geodetic longtitude - 0: Greenwich Meridian, increasing in eastern direction. Resolution: 2.4 meters.
10	*lon_code* byte 1	
11	*lon_code* byte 2	
12	Check Byte 0	Fletcher Checksum
13	Check Byte 1	

NOTE: The active values in the SC configuration are used for Service Type (*def_serv_type*), and O/R indicator (*def_or_ind*). The polling parameter (*def_poll*) is ignored for this report. The report is always sent immediately.

Table 3.17 SC-Originated Position Report

SC-ORIGINATED ENHANCED GLOBALGRAM

	7 6 5 4 3 2 1 0	
0	0x85/0x86	packet header byte
1	0x0a	packet type
2	length byte 0	packet length, starting with byte 0, includes checksum
3	length byte 1	
4	*retry_count/pkt_seq_num*	number of times this packet has been re-sent/packet sequence number
5	*gwy_id*	destination ORBCOMM Gateway ID
6	*mha_ref_num*	DTE assigned, used to identify among multiple messages
7	MUST BE 0	required for backwards compatibility
8	priority	message priority (see Section 3.2, note 5)
9	*msg_body_type*	message body type (see Section 3.2, note 6)
10	*rcpnt_quan*	number of recipients for this message
11	*subject_ind*	1=message contains a subject; 0=no subject (see Section 3.2, note 11)
	rcpnt_addr_0 byte 0	null terminated recipient address strings and/or recipient indicators (see Section 3.2, notes 10,11)
	.	
	.	
	rcpnt_addr_6 byte i-1	
	subj byte 0	null-terminated message subject (see Section 3.2, note 11) (max length = 80 characters)
	.	
	.	
	subj byte j-1	
	msg body byte 0	message body
	.	
	msg body byte k-1	
	Check Byte 0	Fletcher Checksum
13+i+j+k	Check Byte 1	

NOTES:

1. The SC must be provisioned in the Gateway for text, binary, or enhanced GlobalGram operation.
2. The maximum length of combined recipients, subject, terminations and message body is 225.
3. This packet is not currently supported in the ORBCOMM Mesage Switch. It is scheduled for implementation TBD.

Table 3.18 SC-Originated Enhanced GlobalGram

SC-TERMINATED ENHANCED GLOBALGRAM

	7 6 5 4 3 2 1 0	
0	0x05/0x06	packet header byte
1	0x0e	packet type
2	length byte 0	packet length, starting with byte 0, includes checksum
3	length byte 1	
4	*retry_count/pkt_seq_num*	number of times this packet has been re-sent/packet sequence number
5	*gwy_id*	originating ORBCOMM Gateway ID
6	*gwy_dgram_ref_num*	Used to identify among multiple GlobalGrams (assigned by ORBCOMM Gateway)
7	MUST BE 0	required for backwards compatibility
8	*subject_ind*	1=message contains a subject; 0=no subject (see Section 3.2, note 11)
9	*msg_body_type*	message body type (see Section 3.2, note 6)
10	*or_quan*	number of recipients + one originator (see Section 3.2, notes 10,11)
	or_addr_0 byte 0	originator address or indicator and list of recipient addresses and/or OR indicators (see Section 3.2, notes 10,11)
	or_addr_7 byte i-1	
	subj byte 0	null-terminated message subject (see Section 3.2, note 11) (max length = 80 characters)
	.	
	.	
	subj byte j-1	
	msg body byte 0	message body
	msg body byte k-1	
	Check Byte 0	Fletcher Checksum
12+i+j+k	Check Byte 1	

NOTES:

1. The SC must be provisioned in the Gateway for text, binary, or enhanced GlobalGram operation.
2. The maximum length of combined recipients, subject, terminations and message body is 179.
3. This packet is not currently supported in the ORBCOMM Mesage Switch. It is scheduled for implementation TBD.

Table 3.19 SC-Terminated Enhanced GlobalGram

GET PARAMETER

	7 6 5 4 3 2 1 0	
0	0x85/0x86	packet header byte
1	0x12	packet type
2	0x08	packet length, starting with byte 0, includes checksum
3	0x00	
4	*retry_count/pkt_seq_num*	number of times this packet has been re-sent/packet sequence number
5	*parameter_num*	number of parameter whose value should be returned, see Appendix A
6	Check Byte 0	Fletcher Checksum
7	Check Byte 1	

Table 3.20 Get Parameter

SET PARAMETER

	7 6 5 4 3 2 1 0	
0	0x85/0x86	packet header byte
1	0x13	packet type
2	length byte 0	packet length, starting with byte 0, includes checksum
3	length byte 1	
4	*retry_count/pkt_seq_num*	number of times this packet has been re-sent/ packet sequence number
5	*parameter_num*	number of parameter whose value should be returned, see Appendix A
6	parameter value byte count	number of parameter value bytes specified (n)
7	parameter value byte 0	one or more hexadecimal bytes indicating the desired value of the specified parameter, value byte 0 is LSB
	parameter value byte 1	
7+n	parameter value byte n-1	
8+n	Check Byte 0	Fletcher Checksum
9+n	Check Byte 1	

Table 3.21 Set Parameter

PARAMETER RESPONSE

	7 6 5 4 3 2 1 0	
0	0x05/0x06	packet header byte
1	0x14	packet type
2	length byte 0	packet length, starting with byte 0, includes checksum
3	length byte 1	
4	*retry_count/pkt_seq_num*	number of times this packet has been re-sent/packet sequence number
5	*status*	status of get or set parameter request to which this refers (see below)
5	*parameter_num*	number of parameter referenced, see Appendix A
6	parameter value byte count	number of parameter value bytes returned (n)
7	parameter value byte 0	one or more hexadecimal bytes indicating the value of the specified parameter, value byte 0 is LSB
	parameter value byte 1	
7+n	parameter value byte n-1	
8+n	Check Byte 0	Fletcher Checksum
9+n	Check Byte 1	

Table 3.22 Parameter Response

NOTE: the PARAMETER RESPONSE packet is returned in response to GET and SET PARAMETER packets. If *status* = 0 and byte 7 = 0, (responding to a GET PARAMETER command) the value of byte 7 specifies the number of parameter value bytes returned between byte 7 and the checksum.

status:

0: parameter returned (GET PARAMETER) or parameter value changed (SET PARAMETER)

1: specified parameter number not supported

2: access denied (SET PARAMETER)

3: specified parameter number out of range

4: specified value out of bounds (SET PARAMETER)

SATELLITE STATE VECTOR

	7 6 5 4 3 2 1 0	
0	0x05/0x06	packet header byte
1	0x15	packet type
2	0x17	packet length, starting with byte 0, includes checksum
3	0x00	
4	*retry_count/pkt_seq_num*	number of times this packet has been re-sent/packet sequence number
5	*sat_id*	ID of satellite to which this data pertains
6	X nibbles 1,0	20 bit integer, LSB =8 meters for a 1000 km ortibtal altitude Coordinates are ECEF. Decoding: tmp = (X nibbles 1,0) + 256*(X nibbles 3,2) + 256*256* (X nibble 4) X = [(2*tmp*MAX_R_SAT)/VAL_20_BITS-MAX_R_SAT]/1000 where:MAX_R_SAT = 8378155 VAL_20_BITS = 1048576
7	X nibbles 3,2	
8	Y nibble 0 | X nibble 4	
9	Y nibbles 2,1	
10	Y nibbles 4,3	
11	Z nibbles 1, 0	
12	Z nibbles 3,2	
13	X_DOT nibble 0 | Z nibble 4	20 bit integer, LSB =0.0143 meters/sec for a 750 km ortibtal altitude Decoding: tmp = (X_DOT nibbles 1,0) + 256*(X_DOT nibbles 3,2) + 256*256* (X_DOT nibble 4) X_DOT = [(2*tmp*MAX_V_SAT)/VAL_20_BITS-MAX_R_SAT]/1000 where:MAX_V_SAT = 7700
14	X_DOT nibbles 2,1	
15	X_DOT nibbles 4,3	
16	Y_DOT nibbles 1,0	
17	Y_DOT nibbles 3,2	
18	Z_DOT nib 0 | Y_DOT nib 4	
19	Z_DOT nibbles 2,1	
20	Z_DOT nibbles 4,3	
21	Check Byte 0	Fletcher Checksum
22	Check Byte 1	

Sent to DTE when *send_pass_predict* = 1

Table 3.23 Satellite State Vector

SATELLITE ORBITAL ELEMENTS

	7 6 5 4 3 2 1 0	
0	0x05/0x06	packet header byte
1	0x16	packet type
2	0x10	packet length, starting with byte 0, includes checksum
3	0x00	
4	*retry_count/pkt_seq_num*	number of times this packet has been re-sent/packet sequence number
5	*plane_id*	Identifies the satellite plane
6	*sat_id*	ID of satellite to which this data pertains
7	mean_anom 0	Mean Anomaly for this satellite (other elements taken from Plane Orbital Elements set) 0 = 0 degrees, 0xffffff = 360 degrees Mean Anomaly = {[mean_anom0 + mean_anom1*0xff + mean_anom2*0xffff + mean_anom3*0xffffff]/0xffffffff*2*pi}
8	mean_anom 1	
9	mean_anom 2	
10	mean_motion 0	(mean_motion - MIN_MOTION)/MAX_MOTION*0xffffffffff
11	mean_motion 1	
12	mean_motion 2	
13	mean_motion 3	
14	Check Byte 0	Fletcher Checksum
15	Check Byte 1	

Sent to DTE when *send_pass_predict* = 1

Table 3.24 Satellite Orbital Elements

SATELLITE PLANE ORBITAL ELEMENTS

	7 6 5 4 3 2 1 0	
0	0x05/0x06	packet header byte
1	0x17	packet type
2	0x1c	packet length, starting with byte 0, includes checksum
3	0x00	
4	*retry_count/pkt_seq_num*	number of times this packet has been re-sent/packet sequence number
5	*plane_id*	Identifies satellite plane
6	epoch byte 0	epoch time (milliseconds since 1/1/93, good for 35 years)
7	epoch byte 1	
8	epoch byte 2	
9	epoch byte 3	
10	epoch byte 4	
11	inclin byte 0	resolution: 1/26 second 0->0x7fffff: prograde, 0x7fffff->0xffffff, retrograde, increasing torwards -90 (polar = 0x7fffff) inclination = {[inclin 0 + 0xff*inclin 1 + 0xffffff*inclin 2)]/oxffffff}* pi
12	inclin byte 1	
13	inclin byte 2	
14	raan byte 0	Right ascension of ascending node, resolution = 1/13 second 0= 0 degrees, 0xffffff = 360 degrees raan ={[raan0 + 0xff*raan1 + 0xffff*raan2]/0xffffff}*pi
15	raan byte 1	
16	raan byte 2	
17	eccent byte 0	Eccentricity = [eccen 0 + eccen1*0xff)*0xffff]*0.1
18	eccent byte 1	
19	perigee byte 0	Argument of Perigee
20	perigee byte 1	
21	sat_quan	Total number of satellites in the system
22	decay byte 0	decay = (decay0 + 0xff*decay1)/0xffff revs/day
23	decay byte 1	
24	orbit_num byte 0	Number of complete orbits since epoch
25	orbit_num byte 1	
26	Check Byte 0	Fletcher Checksum
27	Check Byte 1	

Sent to DTE when *send_pass_predict* = 1

Table 3.25 Satellite Plane Orbital Elements

3.2 Packet Description Notes

1. Polling of SC-Originated Messages/Reports

0 = SC initiates transfer immediately

1 = Messages/reports are queued in SC, awaiting poll from ORBCOMM Gateway

2. Service Type (a combination of ACK level and priority for space efficiency)

NOTE**:** While the service types preceded by an asterisk are not currently implemented by the ORBCOMM Network, they are Reserved for Future Use and must be supported by the SC.

0 = Normal priority, no acknowledgment expected

*1 = Normal priority, only non-delivery to ORBCOMM Gateway acknowledged - acknowledgement generated by SC based on lack of communication with satellite or ORBCOMM Message Switch (OMS)

2 = Normal priority, delivery to ORBCOMM Gateway acknowledged

*3 = Normal priority, only non-delivery to recipient acknowledged (from X.400 MTA, via Internet, acknowledgment comes from Simple Mail Transfer Protocol (SMTP) Gateway)

4 = Normal priority, delivery to recipient acknowledged

5 = Same as 0, but indicates report sent in response to poll from ORBCOMM Gateway

*6 = Same as 1, but indicates report sent in response to poll from ORBCOMM Gateway

7 = Same as 2, but indicates report sent in response to poll from ORBCOMM Gateway

*8 = Same as 3, but indicates report sent in response to poll from ORBCOMM Gateway

9 = Same as 4, but indicates report sent in response to poll from ORBCOMM Gateway

10 = Special delivery priority, no acknowledgment expected

*11 = Special delivery priority, only non-delivery to ORBCOMM Gateway acknowledged

*12 = Special delivery priority, delivery to ORBCOMM Gateway acknowledged

*13 = Special delivery priority, only non-delivery to recipient acknowledged

*14 = Special delivery priority, delivery to recipient acknowledged

*15 = Cancel previous special delivery report (acknowledgment of delivery or non-delivery to recipient)

3. Acknowledgment level

NOTE: While the acknowledgment levels preceded by an asterisk are not currently implemented by the ORBCOMM Network, they are Reserved for Future Use and must be supported by the SC.

0 = No acknowledgment expected

1 = Only non-delivery to ORBCOMM Gateway acknowledged

2 = Delivery to ORBCOMM Gateway acknowledged

3 = Only non-delivery to recipient acknowledged

4 = Delivery to recipient acknowledged

4. **Valid Originator/Recipient Indicator Values**

0 = For SC-Terminated: Null address; For SC-Originated: self (loop back test).

1-8 = User pre-defined in ORBCOMM Gateway database

9-15 = System pre-defined in ORBCOMM Gateway database

NOTE: Reports support only OR Indicator values 0-3.

5. **Priority Level**

NOTE**:** Due to the low level of loading of the network, there is currently no effective difference in delivery as a function of priority.

0 = Non-urgent (lowest priority)

1 = Normal

2 = Urgent

3 = Special delivery (SC-Originated only, highest priority)

6. **Message body type (1988 X.400 specification)**

Most of the X.400 defined body types defined on the next page have two components: data type parameters and the data itself. The data type parameters comprise a sequence of information items that describe what the information object in the data component represents. They are typically format and control descriptors. The data component is the information object itself. The data type parameters precede the data within the user data field of the message packet (bytes 13 through the Fletcher checksum), and generally consist of a single byte each.

The Externally Defined message body type enables X.400 service providers to carry unique and unusual message types. This category contains the body types unique to the ORBCOMM System.

NOTE: While the message body types preceded by an asterisk are not currently implemented by the ORBCOMM network, they are Reserved for Future Use and must be supported by the SC.

0 = IA5TEXT (one single byte data type parameter: 5=ia5; 2=ita2 (telex) character set in message body.

* 1 = not used (formerly telex)

* 2 = Voice (under study by CCITT)

* 3 = G3 Facsimile

* 4 = G4 Class 1 Facsimile

* 5 = Teletex

* 6 = Videotex

* 7 = Nationally Defined

* 8 = Encrypted (under study by CCITT)

* 9 = Message (a message inside of a message)

* 10 = not used (formerly "simple formattable text")

* 11 = Mixed Mode

* 12 = not used

* 13 = not used

14 = Bilaterally Defined (binary data)

15 = Externally Defined (one single byte data type parameter) as defined below:

Data Type Parameter Byte:

0 = Text-to-Facsimile (SC-Originated Only). The initial portion of the body type contains a null-terminated telephone number. The next portion contains a null-terminated character string which is presented on the facsimile cover page immediately following the "ATTENTION:" header. (If nothing is desired in this field, then only a null must be used as a place holder). The remaining portion of the message body becomes the body of the facsimile.

1 = Text-to-Voice (SC-Originated Only). The initial portion of the body type contains a null-terminated telephone number. The next portion contains a null-terminated character string which is the name of the individual to be contacted. The remaining portion of the message body is read over the phone by customer service operators.

2 = Pre-defined O/R Addresses (For the SC-Originated, the addresses for O/R indicators 1-8 are placed in order, null-terminated, into an SC-Originated message. For the SC-Terminated, the addresses for O/R indicators 1-15 are placed in order, null-terminated, into an SC-Terminated message).

3 = Date, Originator, and Subject for each SC-Terminated message queued in the ORBCOMM Gateway for this SC. Each attribute (originator, date, and subject) of the message is null-terminated. Non-existent attributes are identified by a single null.

4 = Sets of orbital elements in NASA 2-line format (as specified in Appendix H).

International Alphabet Number 5 (IA5) Table

	--Control Codes--							
	0	1	2	3	4	5	6	7
0	Null	TC7 (DLE)	Space	0	@	P	‘	p
1	TC1 (SOH)	DC1	!	1	A	Q	a	q
2	TC2	DC2	“	2	B	R	b	r
3	TC3 (ETX)	DC3	#	3	C	S	c	s
4	TC4 (EOT)	DC4	($)	4	D	T	d	t
5	TC5 (ENQ)	TC8 (NAK)	%	5	E	U	e	u
6	TC6 (ACK)	TC9 (SYN)	&	6	F	V	f	v
7	BELL	TC10 (ETB)	‘	7	G	W	g	w
8	FE0 (BS)	CAN	(	8	H	X	h	x
9	FE1 (HT)	EM	)	9	I	Y	i	y
A	FE2 (LF)	SUB	*	:	J	Z	j	z
B	FE3 (VT)	ESC	+	;	K	[	k	{
C	FE4 (FF)	IS4 (FS)	,	<	L	\	l	|
D	FE5 (CR)	IS3 (GS)	-	=	M	]	m	}
E	SO	IS2 (RS)	.	>	N	^	n	~
F	SI	IS1 (US)	/	?	O	_	o	DEL

Notes:

IA5 is defined for values 0x00 through 0x7F. If a message or GlobalGram is sent as IA5, each character value must be in this range. Behavior outside this range (i.e. 0x7F to 0xFF) must be determined. The

names of some of the control characters between IA5 and ASCII are different. The ASCII name is shown in parentheses for these cases.

Hex 0x42 is the international currency symbol. The ASCII equivalent is the "$".

Table 3.26 International Alphabet Number 5 (IA5)

7. **Message/Report/GlobalGram Acknowledgment Origin**

0 = Satellite (GlobalGram only).

1 = ORBCOMM Gateway (SC-Originated message and report only).

2 = recipient (SC-Originated message and report only).

3 = SC (abnormal conditions)

8. **Status of message transfer (1988 X.400 specification + ORBCOMM)**

0 transfer failure

1 = unable to transfer

2 = conversion not performed

3 = reserved for future use

4 = reserved for future use

5 = reserved for future use

6 = reserved for future use

7 = reserved for future use

8 = reserved for future use

9 = reserved for future use

10 = transfer attempt failed but message has been re-queued and will be attempted again

11 = Response to COMMUNICATIONS COMMAND

12 = status unknown

13 = no acknowledgment from recipient at this time - please wait

14 = message aborted by user

15 = Message was received by indicated acknowledgment originator

9. **Message transfer diagnostic codes (1988 X.400 specification + ORBCOMM)**

0 = unrecognized originator/recipient name

1 = ambiguous originator/recipient name

2 = MTA congestion

3 = loop detected

4 = recipient unavailable

5 = transfer time-out

6 = body type not supported

7 = content too long

8 = convert impractical

9 = convert prohibited

10 = convert not registered

11 = invalid parameter

12-100= reserved for future use

101 = SC ID not registered

102 = PIN code not valid

103 = requested ORBCOMM Gateway could not be found in any Satellite downlink

104 = insufficient message priority (ORBCOMM Gateway may be congested)

105 = satellite not responding (uplink may be congested)

106 = SC access restriction

107 = SC registration has expired

108 = SC-Originated message already exists in ORBCOMM Gateway

109 = no active session, or SC-Originated message number error

110 = error occurred in ORBCOMM Gateway while saving message to non-volatile memory

111 = database error occurred in ORBCOMM Gateway

112 = no additional diagnostic information indicated

113 = maximum retries attempted

114 = GlobalGram is not permitted at this time

115 = no Satellite in view at this time

116 = position report currently not available, but starting calculation

117 = no position determination capability

118 = GlobalGram size exceeded

119 = no SC-Terminated messages/commands queued in ORBCOMM Gateway

120 = no SC-Terminated messages/commands queued in ORBCOMM Gateway of size less than 150 bytes

121 = no GlobalGrams queued in current satellite

122 = requested message deleted

123 = no stored Satellite orbital elements

124 = registration request received, please wait

125 = registration granted by ORBCOMM Gateway

126 = registration rejected by ORBCOMM Gateway

127 = maximum number of GlobalGrams (16) stored in current satellite

128 = invalid range of one or more fields

129-140 = reserved for future use

141 and above = reserved for generic function diagnostic codes (see note 15)

10. **Parsing and Filling of Originator/Recipient Addresses**

The recipients of an SC-Originated message, and the originator and recipients of an SC-Terminated message are carried by the packet according to the following rules:

a. An O/R address must be a ASCII character string which adheres to the X.400 standard syntax. A 0h, 80h, or 90h follows the last character of the string to indicate that the O/ R address identifies a primary, blind, or copied recipient, respectively.

b. An O/R indicator must be a number between 0 and 15, occupying one byte in the packet. The upper nibble is set to zero, 8, or 9 to indicate that the O/R address identifies a primary, blind, or copied recipient, respectively.

c. O/R addresses and O/R indicators are placed sequentially in the packet, without the use of length fields.

d. For the SC-Terminated message, the first O/R address or indicator identifies the originator. (An O/R indicator value of 0 indicates that the originator address is not being sent. This case occurs when the originator cannot be matched to any of the 14 originator addresses, but the SC user has specified that he/she does not want the X.400 address of the originator or the copied recipients transmitted with any message.

   Each byte is billed to the subscriber.) The remaining addresses or indicators are the copied recipients (up to a total of 6 in this case) Note that there is never a blind recipient filled into an SC-Terminated message.

e. The maximum O/R address length is 128 characters (null included).

f. The maximum quantity of O/R addresses and/or O/R indicators per message is seven.

g. An SC-Originated message must have at least one O/R address or O/R indicator, however an SC-Terminated message may have none.

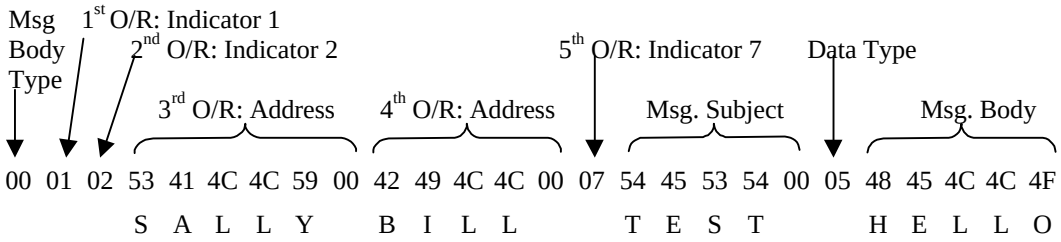
h. For the SC-Originated message, an O/R indicator of 0 indicates a request for a message loopback; the ORBCOMM Gateway sends the received message back to the SC. If the SC-Originated message is a report, the first five bytes of the report are placed into a User Command (with no acknowledgment expected).

11. **Additional Contents within an SC-Originated or SC-Terminated Message**

SC-Terminated and SC-Originated messages may contain a body type parameter, a subject and up to seven O/R indicators and/or addresses, in addition to the normal message body. If specified, the body type parameter is inserted before any other field, followed by the O/R indicators and/or addresses, followed by the subject (a null-terminated ASCII string), followed by the actual message body. The presence of the subject, the message body type (which may require a data type parameter) and the quantity of O/R indicators and/or addresses is revealed by the contents field of the SC-TERMINATED ASSIGNMENT or REQUEST FOR SC-ORIGINATED MESSAGE TRANSMISSION packet that preceded the message.

In the following example of an SC-Terminated message, the text message (the message body type = 0 and data type parameter = 5) has a subject "TEST", a message body "HELLO", an originator revealed by O/R indicator 1, and four primary recipients identified by O/R indicator 2, null-terminated O/R address "SALLY", null-terminated O/R address "BILL", and O/R indicator 7. These bytes would be present in the SC-Terminated message, carried in one or more packets. The value of the SC-Terminated assignment contents field is 13 decimal.

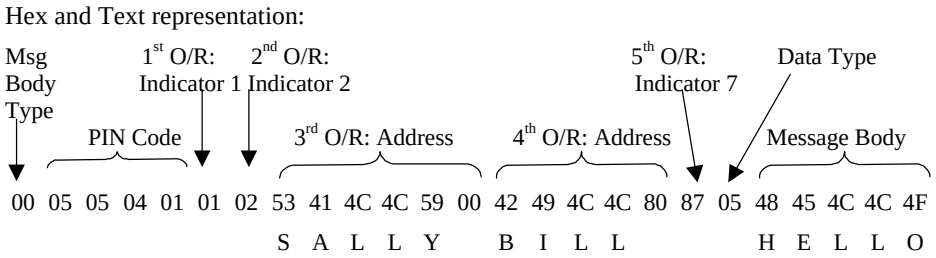
Hex and Text representation:



An SC-Originated message may contain a body type parameter, a PIN code, a subject and up to seven O/R indicators and/or addresses, in addition to the normal message body. The body type parameter is inserted first, followed by the four-byte PIN code, and the O/R indicators and/or the O/R addresses. This string is followed by the subject (a null- terminated ASCII string), which in turn, is followed by the actual message body. The ORBCOMM Gateway can request that the SC supply its PIN code via the

control field of the SC-ORIGINATED ASSIGNMENT packet (see Note 13). The presence of a subject and the quantity of O/R indicators and/or addresses is revealed by the REQUEST FOR SC- ORIGINATED MESSAGE TRANSMISSION contents field. The message body type also is revealed in the REQUEST FOR SC-ORIGINATED MESSAGE TRANSMISSION packet. If the type specified in byte 12 implies a data type parameter within the message itself, the ORBCOMM Gateway will expect this value as the first byte of the user data (bytes 13 through the Fletcher checksum) of the SC-ORIGINATED MESSAGE PACKET.

In the following example of an SC-Originated message, the message includes a PIN code, a message body "HELLO", five recipients identified by O/R indicator 1 (primary), O/R indicator 2 (primary), null-terminated O/R address "SALLY" (primary), null-terminated O/R address "BILL" (blind), and O/R indicator 7 (blind). These bytes would be present in the SC-ORIGINATED MESSAGE PACKET user data fields (bytes 13 through the Fletcher checksum), carried in one or more packets. The value of the REQUEST FOR SC-ORIGINATED MESSAGE TRANSMISSION contents field is 5 decimal, and bit 7 of the REQUEST FOR SC- ORIGINATED MESSAGE TRANSMISSION control field is set.



12. **Acknowledgment of SC-Originated Messages**

The SC-ORIGINATED MESSAGE RECIPIENT ACKNOWLEDGMENT packet is transmitted to the SC after the ORBCOMM Gateway has received indication of a successful or unsuccessful transfer for each recipient. It is used for both SC-Originated messages and SC-Originated reports, but not for GlobalGrams. The ORBCOMM Gateway sets bits in the ***ack_mask*** field to indicate to which of the original message recipients (up to seven) this acknowledgment applies. Each bit corresponds to one of the O/R indicators and/or O/R address of the original message, starting with bit 0 (SC-ORIGINATED REPORT will always use bit 0). Multiple SC-ORIGINATED MESSAGE RECIPIENT ACKNOWLEDGMENT packets may be sent to an SC. For example, if a SUBSCRIBER MESSAGE ENQUIRY is received at the ORBCOMM Gateway for a message that had seven recipients, but only four acknowledgments have been received, the ***ack_mask*** will have the appropriate four bits set, and ***status_code*** =15. The remaining three acknowledgments will be indicated later by subsequent SC-ORIGINATED MESSAGE RECIPIENT ACKNOWLEDGMENT packet(s), whenever the acknowledgment or negative acknowledgment is received from the recipients at the ORBCOMM Gateway.

Since notification of message delivery failure may take up to 24 hours over the PDN (up to five days from the Internet!), the SC should not wait for the SC-ORIGINATED MESSAGE RECIPIENT ACKNOWLEDGMENT packet after sending the message to the ORBCOMM Gateway. If it is not received after some unacceptable period, the user (or MHA) may generate a COMMUNICATIONS COMMAND, with ***type_code*** = 5. The SC will then generate a SUBSCRIBER MESSAGE ENQUIRY packet with ***control_code*** = 5. If the ***status_code*** of the SC-ORIGINATED MESSAGE RECIPIENT ACKNOWLEDGMENT packet is not equal to 15, then the SC must generate a SUBSCRIBER SCKNOWLEDGMENT packet. The SC must not send a SUBSCRIBER ACKNOWLEDGMENT if the ***status_code*** = 15.

The SESSION CLEAR and REPORT ACKNOWLEDGMENT packets only indicate successful transmission to the ORBCOMM Gateway, for SC-Originated messages and SC-Originated reports, respectively. They do not imply successful transmission to the recipient(s). The Satellite transmits an SC-ORIGINATED GLOBALGRAM ACKNOWLEDGMENT packet upon receiving a GlobalGram from the SC. There is no packet that explicitly indicates that the GlobalGram has reached the ORBCOMM Gateway. The recipient of the GlobalGram should generate an SC-Terminated GlobalGram to indicate successful reception of the SC-Originated GlobalGram, if that is desired.

In detail, if the SC-ORIGINATED REPORT is sent using ***serv_type*** = 3, 4, 8, 9, 13, or 14, then the ORBCOMM Gateway will return a two-byte reference number assigned by the ORBCOMM Gateway to the SC using the REPORT ACKNOWLEDGMENT packet. The SC then sends a **SYSTEM RESPONSE** packet to the DTE, with the ***originator_code*** = 1 (ORBCOMM Gateway), and the ***gwy_ref_num*** specifying the reference number assigned by the ORBCOMM Gateway assigned reference number. The DTE then knows that the message has reached the ORBCOMM Gateway and is now on its way to the recipient.

Once the ORBCOMM Gateway receives indication of the recipient's reception of the report, it sends an SC-ORIGINATED MESSAGE RECIPIENT ACKNOWLEDGMENT packet to the SC, which in turn sends another SYSTEM RESPONSE packet to the DTE (with ***originator_code*** = 2). If the recipient did not get the report, the ORBCOMM Gateway sends the SC-ORIGINATED MESSAGE RECIPIENT ACKNOWLEDGMENT packet with the appropriate status and diagnostic code. The ORBCOMM Gateway sends the first SC-ORIGINATED MESSAGE RECIPIENT ACKNOWLEDGMENT packet when indications of reception or failed reception have been received from all recipients. If the SC receive it, the DTE user can choose to send a COMMUNICATIONS COMMAND, with ***type_code*** = 5, and with the ***gwy_ref_num*** valid (***mha_ref_num*** is no longer used once the message has been acknowledged by the ORBCOMM Gateway). The SC then sends a SUBSCRIBER MESSAGE ENQUIRY to the ORBCOMM Gateway, which then sends the SC-ORIGINATED MESSAGE RECIPIENT ACKNOWLEDGMENT packet. (The state of all pending and failed message transfers is recorded in the ORBCOMM Gateway.)

If an SC-Originated message is sent using ***ack_level*** = 3 or 4, the same sequence of packet transmissions occurs as described above for the report. However, if multiple recipients are included in the message, then the ***ack_mask*** field of the SC-ORIGINATED

MESSAGE RECIPIENT ACKNOWLEDGMENT identifies the recipients in which the status (and possibly diagnostic, if there is a transfer failure) codes apply.

13. **PIN Code Handling**

The PIN code is an extra measure of protection against theft of services using a stolen or cloned SC. It is not normally required for message transmission. The following paragraphs describe its use in the SC-Originated and SC-Terminated directions.

In the SC-Terminated direction, the SUBSCRIBER RECEIVER READY packet sent to the ORBCOMM Gateway from the SC must contain the valid PIN code. The PIN code is stored in the SC but can be updated from the DTE or the application task. If the PIN code does not match the value stored in the ORBCOMM Gateway, the SC receives a SESSION CLEAR packet with the appropriate diagnostic and status codes.

In the SC-Originated direction, the ***control_code*** of the SC-ORIGINATED ASSIGNMENT packet specifies the inclusion of the PIN code in the message, if so provisioned. The SC must then insert the four PIN code bytes according to the details provided in Note 11.

14. **Serial Interface/API Communications Command Handling**

The response to the COMMUNICATIONS COMMAND varies depending on the requested action. Each response is described in the table below. (When referring to a particular value of a diagnostic code, 'X' represents any of the values described in Note 9).

Type Code	Desired Response [serial pkt(s) sent to DTE, other than Link Layer Ack which is always sent immediately]	Abnormal Response [serial pkt(s) sent to DTE, other than Link Layer Ack which is always sent immediately]
0	SC-Terminated message(s) or System Response (***origin*** = 1, ***status*** = 11, ***diagnostic*** = 119)	System Response (***origin*** = 3, ***status*** = 11, ***diagnostic*** < > 119)
1	short SC-Terminated message(s) or System Response (***origin*** = 1, ***status*** = 11, ***diagnostic*** = 120)	System Response (***origin*** = 3, ***status*** = 11, ***diagnostic*** < > 120)
2	SC-Terminated GlobalGram(s) or System Response (***origin*** = 0, ***status*** = 11, ***diagnostic*** = 121)	System Response (***origin*** = 3, ***status*** = 11, ***diagnostic*** < > 121)
3	SC-Terminated message containing O/R addresses (see note 6)	System Response (***origin*** = 3, ***status*** = 11, ***diagnostic*** = X)
4	System Response (***origin*** = 3, ***status*** = 15, ***diagnostic*** = 112)	System Response (***origin*** = 3, ***status*** = 12, ***diagnostic*** = 112 or 109)
5	System Response (***origin*** = 2, ***status*** = 15, ***diagnostic*** = 112) (also see note 12)	System Response (***origin*** = 2, ***status*** = 11, ***diagnostic*** = X)
6	SC-Terminated message containing list of originator, time, and subject for each message (see note 6) or System Response (***origin*** = 1, ***status*** = 11, ***diagnostic*** = 119)	System Response (***origin*** = 3, ***status*** = 11, ***diagnostic*** < > 119)

Type Code	Desired Response [serial pkt(s) sent to DTE, other than Link Layer Ack which is always sent immediately]	Abnormal Response [serial pkt(s) sent to DTE, other than Link Layer Ack which is always sent immediately]
7	one SC-Terminated message	System Response (***origin*** = 3, ***status*** = 11, ***diagnostic*** = X)
8	System Response (***origin*** = 1, ***status*** = 11, ***diagnostic*** = 122)	System Response (***origin*** = 3, ***status*** = 11, ***diagnostic*** < > 122)
9	System Response (***origin*** = 1, ***status*** = 11, ***diagnostic*** = 124 or 125 or 126)	System Response (***origin*** = 3, ***status*** = 11, ***diagnostic*** = X)
10-15	System Response (***origin*** = 1, see note 15 for other fields)	System Response (***origin*** = 3, ***status*** = 11, ***diagnostic*** = X)
16	*Status* Packet	N/A
17	No packet sent. DTE can request *Status* Packet if desired.	If *Status* Packet requested, state = 0 means no additional message being transmitted or received. Otherwise, new message is being transmitted or received
18		System Response (***origin*** = 3, ***status*** = 11, ***diagnostic*** = 109)
19		Not Applicable
20		Not Applicable
21	*Status* Packet (*state* = 0, *status_diag_code* = 0)	*Status* Packet with *st_diag_code* reveals failure
22	*Status* Packet (*state* = 0, *status_diag_code* = 0)	*Status* Packet with *st_diag_code* reveals failure
23	*Status* Packet (*state* = 0, *status_diag_code* = 0)	*Status* Packet with *st_diag_code* reveals failure
24	No packet sent. SC powers down immediately.	Not Applicable
25		
26		
27	If def_serv_type is not 0 or 10, SC sends System Response indicating success according to description in note 12	If *def_serv_type* is not 0 or 10, SC sends System Response indicating failure according to description in note 12
28	SC-Terminated Message with Orbital Elements, message body type 15,4	System Response (***origin*** = 1, ***status*** = 11, ***diagnostic*** = 123)
29	No packet sent. Change to the next down link channel	Not Applicable

Table 3.27 Communication Command Responses to Type Code Inputs

15. **Preservation of Future System Capabilities using Generic Functions**

Unused values of some fields of the COMMUNICATIONS COMMAND, SYSTEM ANNOUNCEMENT, and SYSTEM RESPONSE packets have been specified as generic

functions in order to enable the SC to support future system capabilities without code modification. This will hopefully enable the support of applications not envisioned at this time. The packets involved include the following:

POLLING COMMAND (ORBCOMM Gateway to SC)

SYSTEM ANNOUNCEMENT (SC to DTE)

SUBSCRIBER MESSAGE ENQUIRY (SC to ORBCOMM Gateway)

COMMUNICATIONS COMMAND (DTE to SC)

SYSTEM COMMAND (ORBCOMM Gateway to SC)

SYSTEM RESPONSE (SC to DTE)

a. POLLING COMMAND & SYSTEM ANNOUNCEMENT

b. POLLING COMMAND *control_codes* and SYSTEM ANNOUNCEMENT codes not yet specified include codes 9-15 (future system use) and 16 and above (SC manufacturer defined). If the SC receives a POLLING COMMAND with these values, it performs the following functions:

   i. Copies the POLLING COMMAND control field into the SYSTEM ANNOUNCEMENT *announce_code* field.
   ii. Copies the POLLING COMMAND *gwy_id* field into the SYSTEM ANNOUNCEMENT *gwy_id* field.
   iii. Copies the POLLING COMMAND *dest_or_ind* field into the SYSTEM ANNOUNCEMENT *dest_or_ind* field.
   iv. Sends the SYSTEM ANNOUNCEMENT to the DTE/MHA.
   v. Sends a SUBSCRIBER ACKNOWLEDGMENT packet to the ORBCOMM Gateway

c. SUBSCRIBER MESSAGE ENQUIRY & COMMUNICATIONS COMMAND

SUBSCRIBER MESSAGE ENQUIRY *control_codes* and COMMUNICATIONS COMMAND *type_codes* not yet specified include codes 10-15. If the SC receives a COMMUNICATIONS COMMAND with these values, it performs the following functions:

   i. Copies the COMMUNICATIONS COMMAND *type_code* field into the SUBSCRIBER MESSAGE ENQUIRY *control_code* field.
   ii. Copies the COMMUNICATIONS COMMAND *gwy_id* field into the SUBSCRIBER MESSAGE ENQUIRY *gwy_id* field.
   iii. Copies the COMMUNICATIONS COMMAND *value* field (byte 0 and byte 1) into the SUBSCRIBER MESSAGE ENQUIRY message reference field.
   iv. Copies the PIN value into the SUBSCRIBER MESSAGE ENQUIRY PIN field.
   v. Repeatedly sends the SUBSCRIBER MESSAGE ENQUIRY packet to the designated ORBCOMM Gateway until maximum retries is exceeded (determined from the value of *ul_max_retries* in the Read/Write Configuration Parameters) or

until a SYSTEM COMMAND is received from the designated ORBCOMM Gateway having a *control_code* value of 32. The SC then sends a SYSTEM RESPONSE to the DTE/ MHA according to the procedure listed below under SYSTEM COMMAND and SYSTEM RESPONSE.

d. SYSTEM COMMAND & SYSTEM RESPONSE

SYSTEM COMMAND *control_code* = 32 indicates a Generic Function. If the SC receives a SYSTEM COMMAND with this value, it performs the following functions:

i. Copies byte 6 of the SYSTEM COMMAND into the SYSTEM RESPONSE status field.

ii. Copies byte 7 of the SYSTEM COMMAND into the SYSTEM RESPONSE *diag_code* field.

iii. Copies bytes 8 and 9 of the SYSTEM COMMAND into the SYSTEM RESPONSE *gwy_ref_num* field (bytes 0 and 1 respectively).

iv. Sets SYSTEM RESPONSE *origin_field* = 1 (ORBCOMM Gateway).

v. Copies the SYSTEM COMMAND *gwy_id* field into the SYSTEM RESPONSE *origin_id* field.

vi. Sets SYSTEM RESPONSE *mha_ref_num* = 0xff and *ack_mask* = 0.

vii. Sends the SYSTEM RESPONSE packet to the DTE/MHA.

viii. Sends SUBSCRIBER ACKNOWLEDGMENT PACKET to the ORBCOMM Gateway.

Chapter 4 SERIAL INTERFACE PACKET EXAMPLES

Consistent with the expression that "one picture is worth a thousand words," this Chapter presents ladder diagrams illustrating how each of the Serial Interface packets is used. While the resulting interaction between the SC and the satellite, and between the satellite and the GCC are arguably outside the scope of this Serial Interface Specification, the context this information provides is invaluable, particularly to the reader newly introduced to the ORBCOMM system. Consequently, the ladder diagrams in this Chapter include packets from the Air Interface Specification and also illustrate the satellite's interaction with the GCC.

NOTE: In the following ladder diagrams, the vertical axis (time) is not to scale.

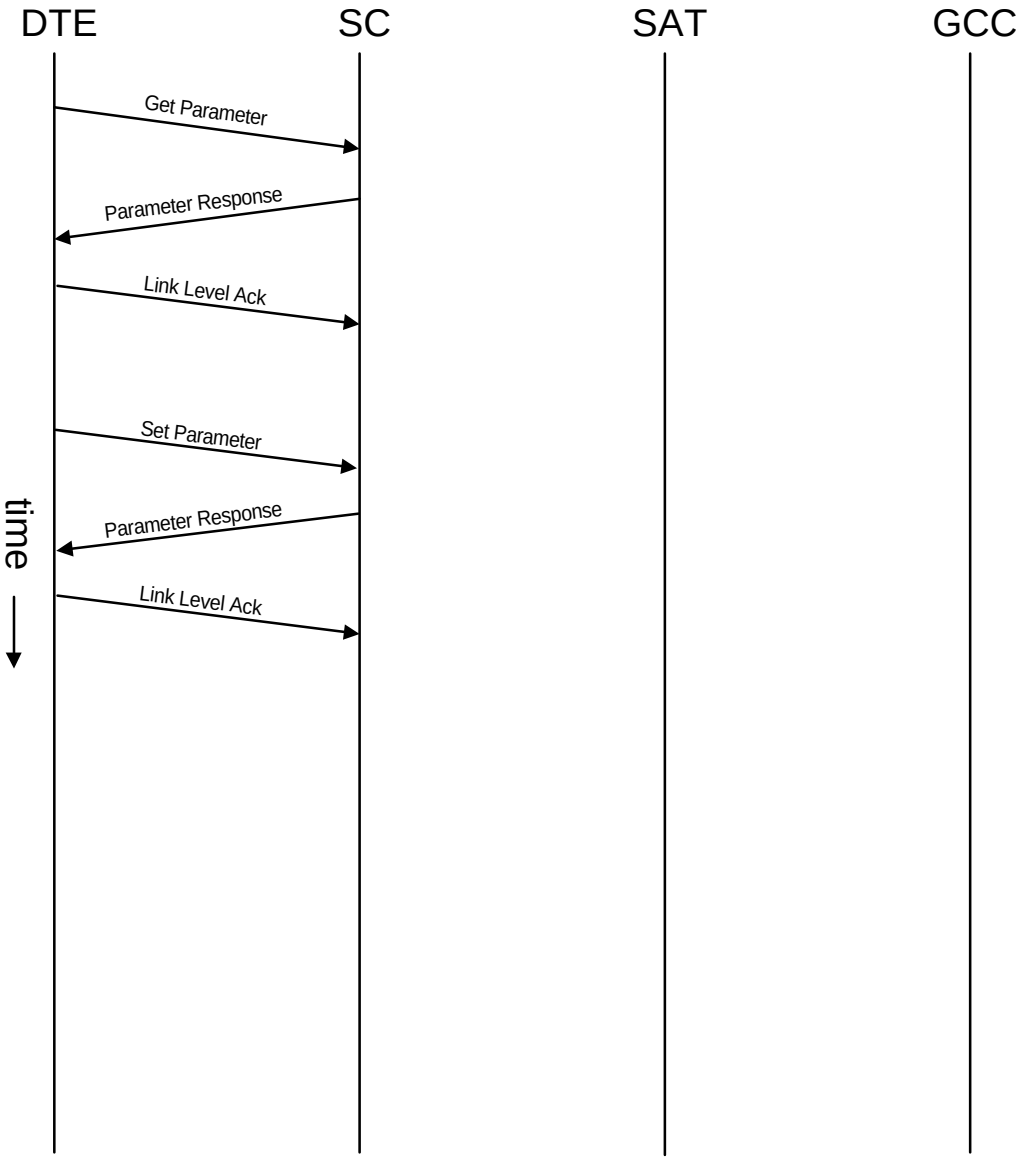


Figure 4.1 Get and Set Parameter

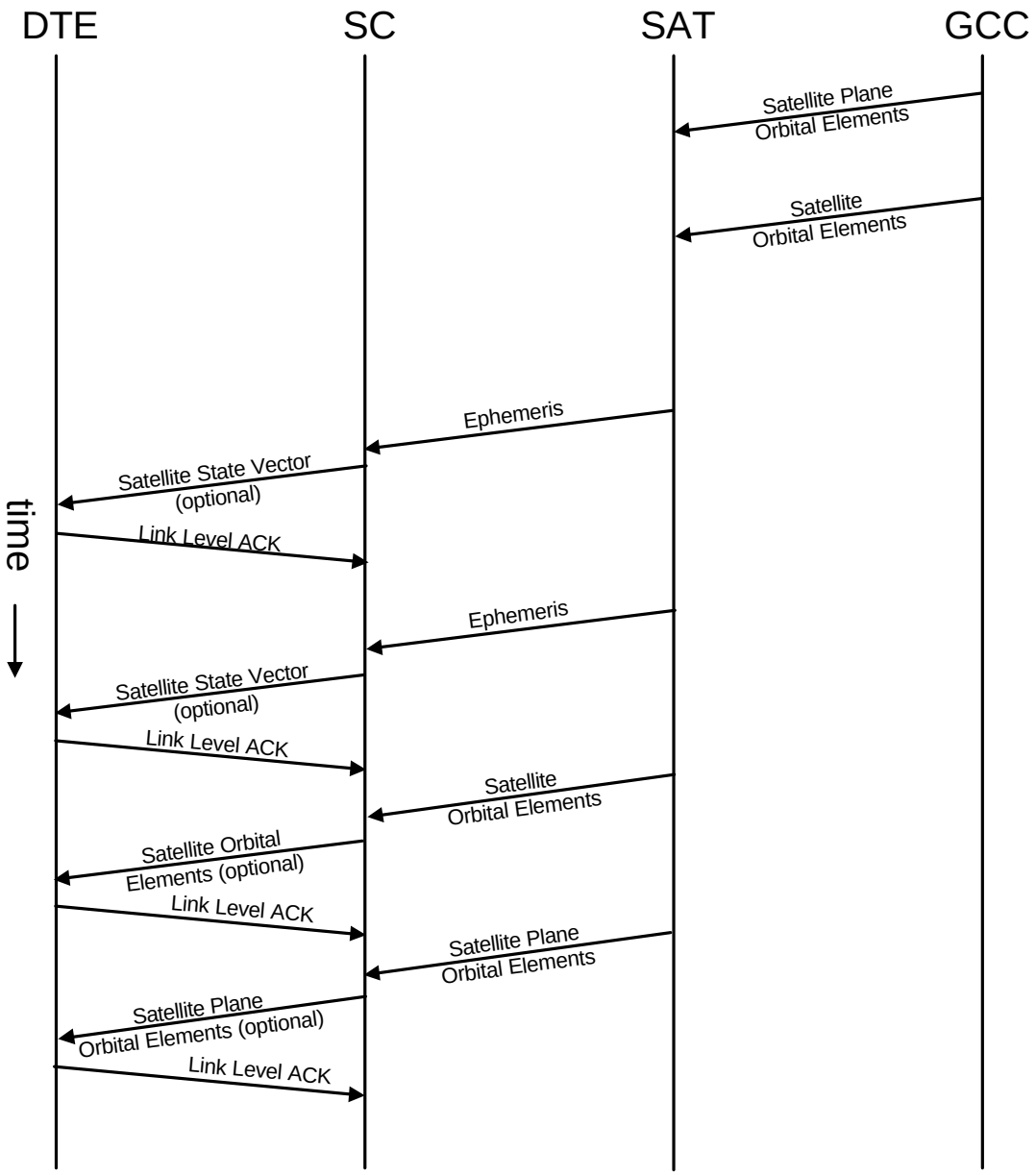


Figure 4.2 Satellite Pass Prediction Data

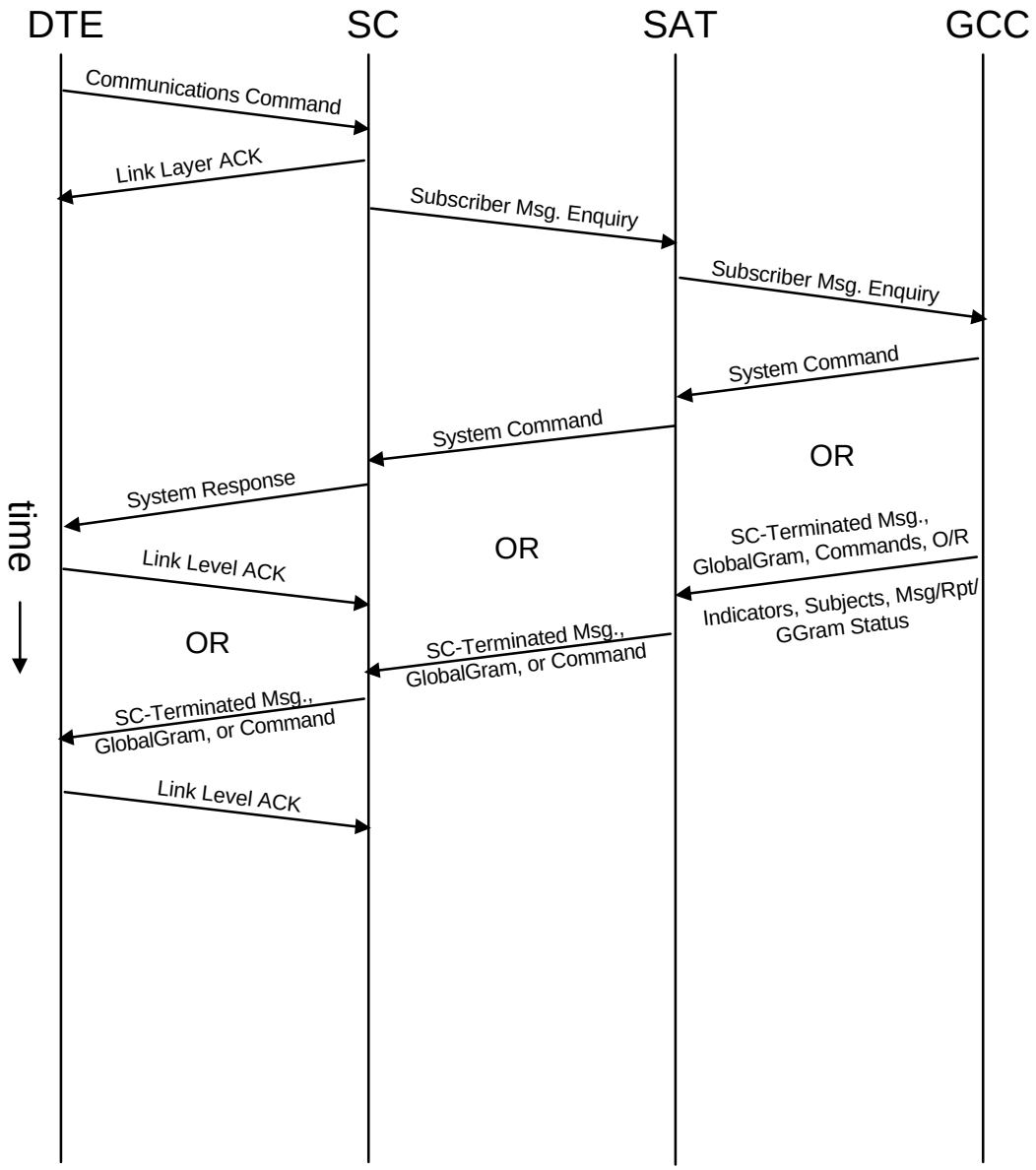


Figure 4.3 Communications Command

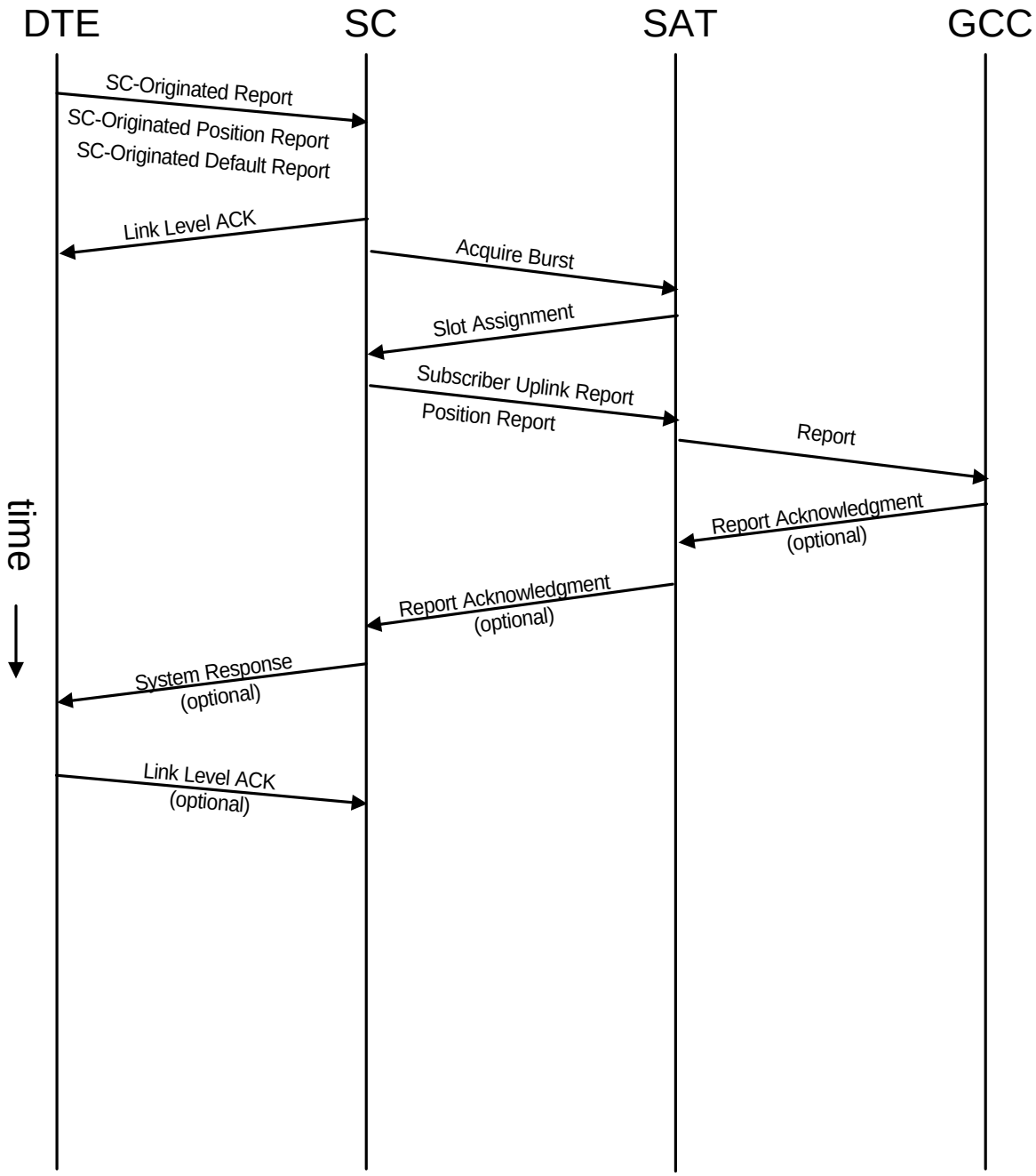


Figure 4.4 SC-Originated Report

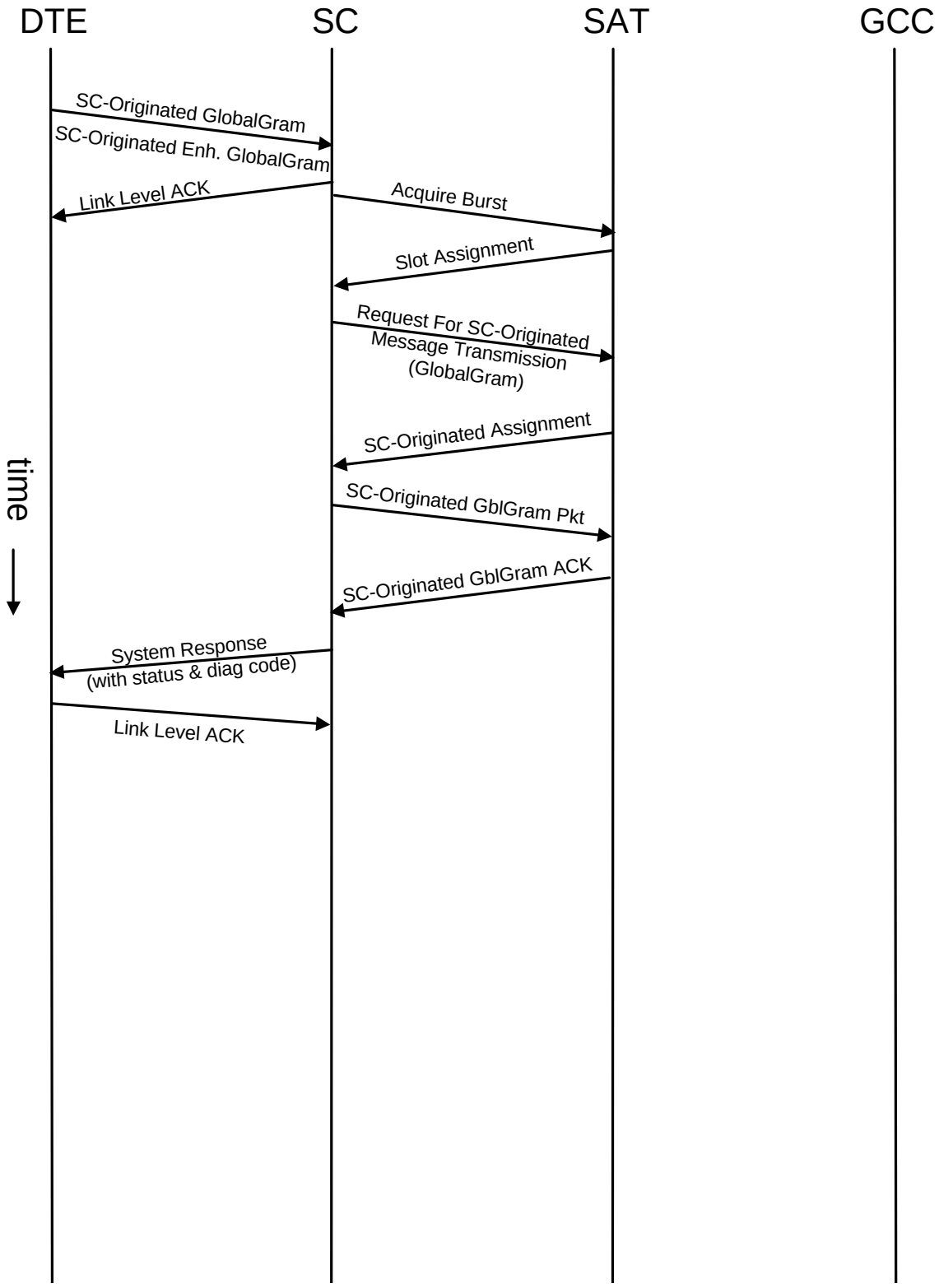


Figure 4.5 SC-Originated GlobalGram

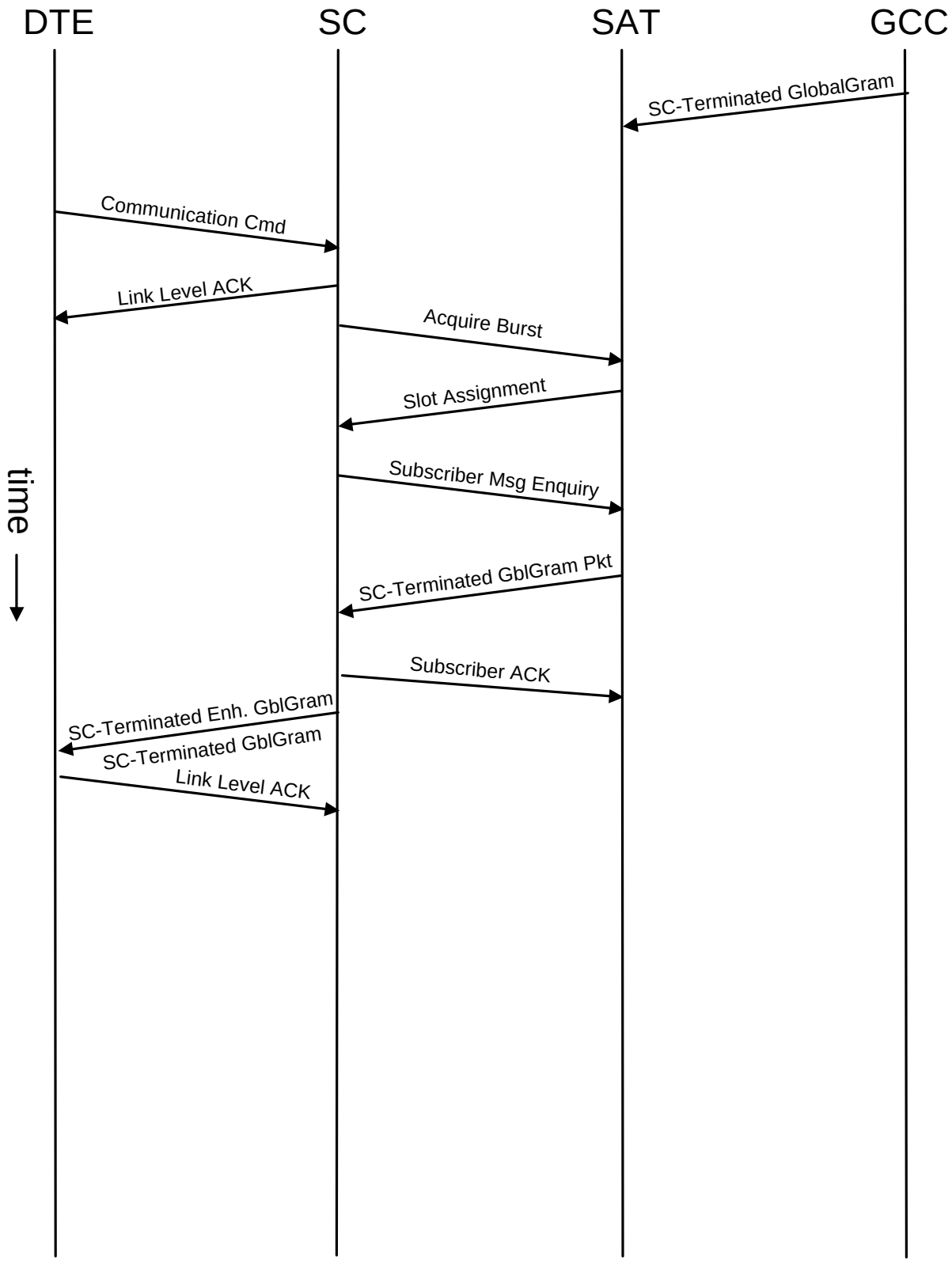


Figure 4.6 SC-Terminated GlobalGram

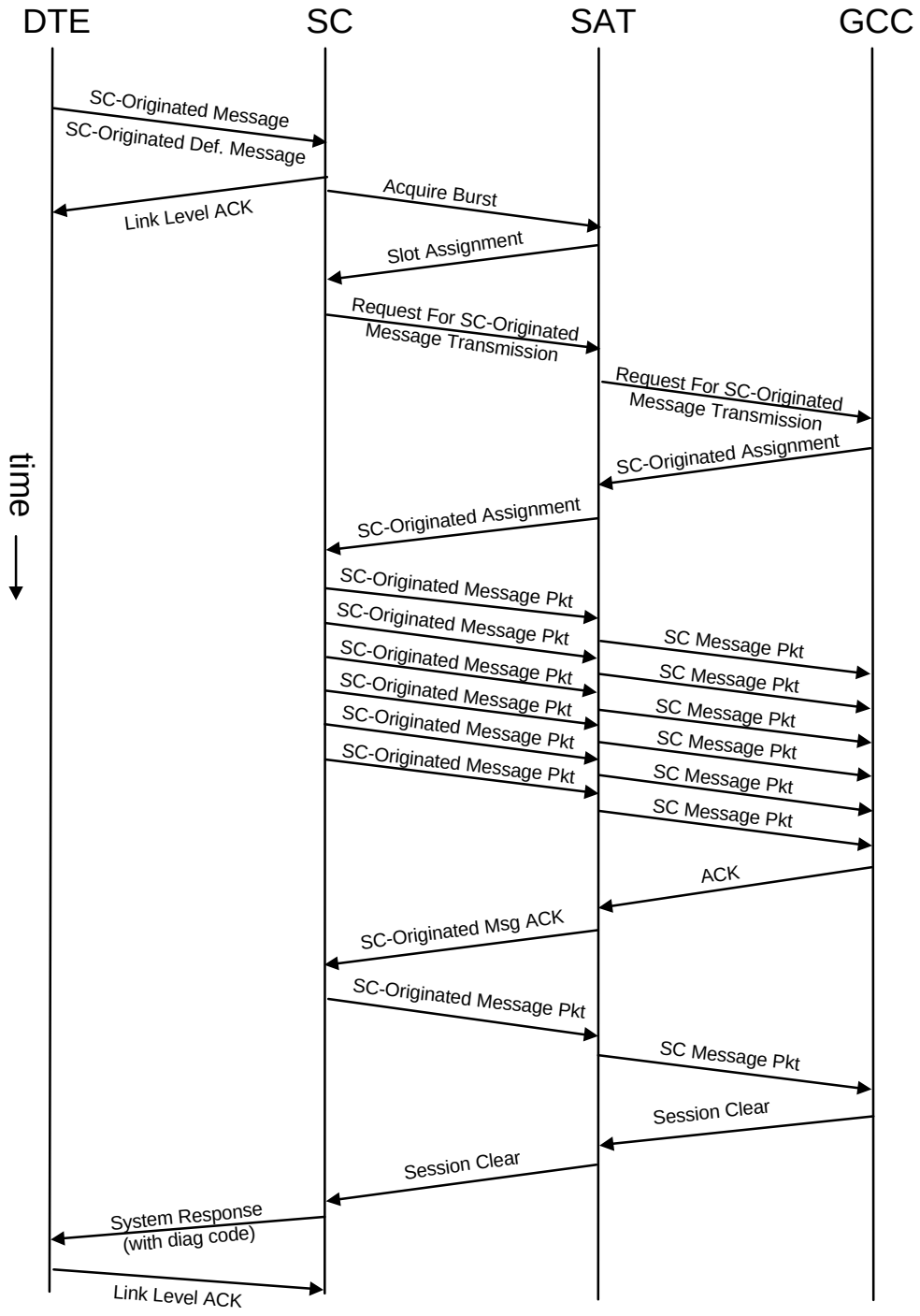


Figure 4.7 SC-Originated Message

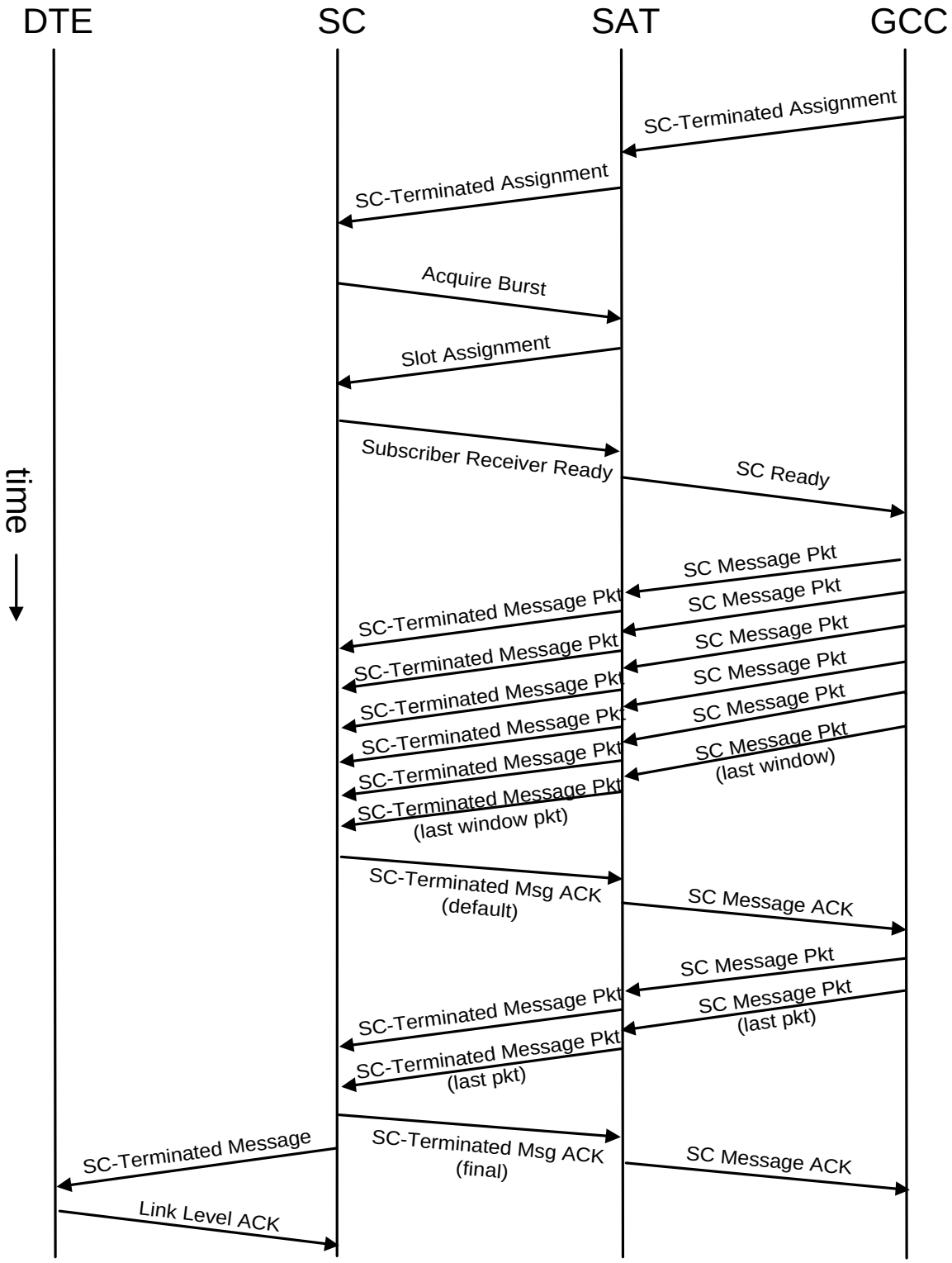


Figure 4.8 SC-Terminated Message

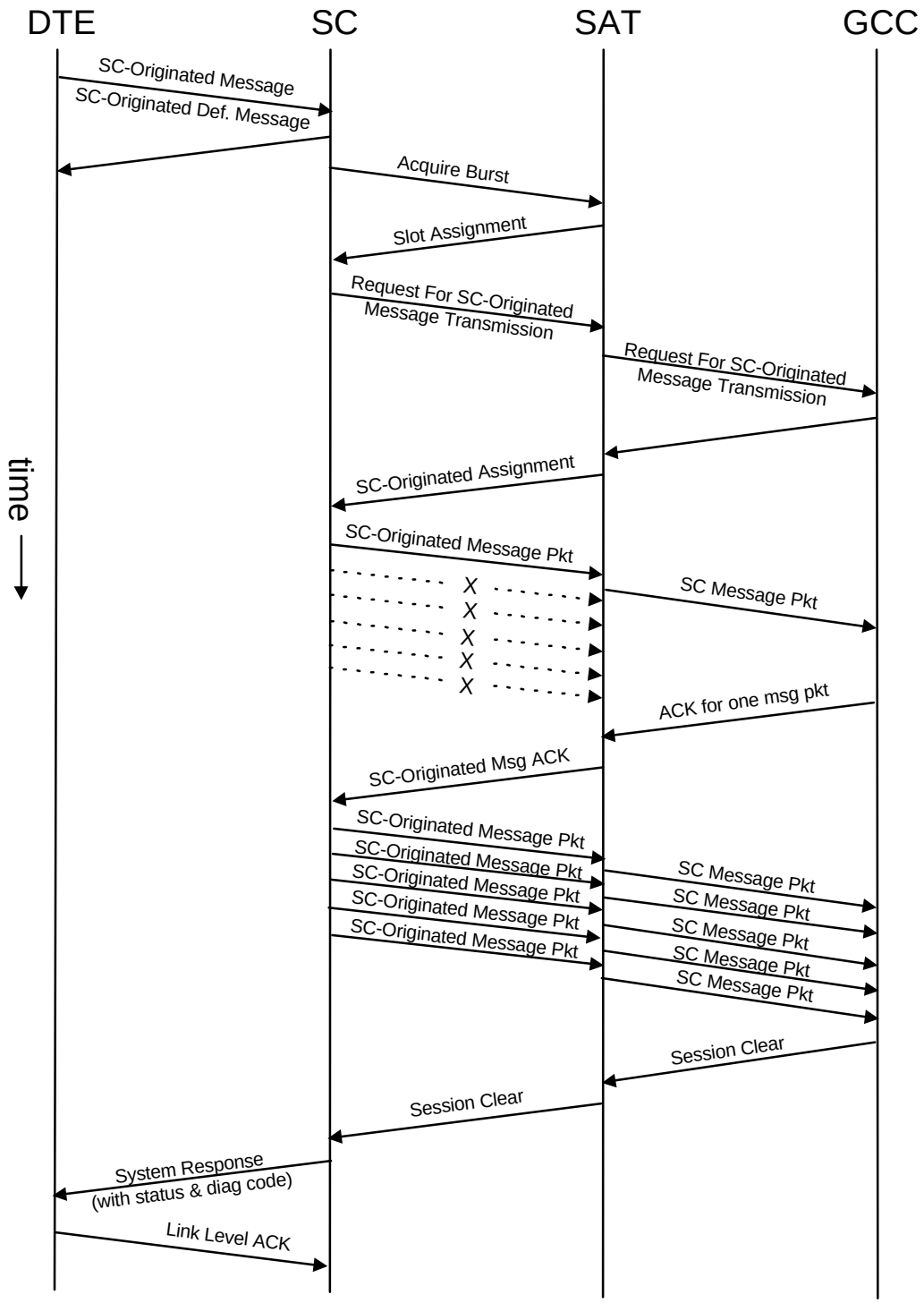


Figure 4.9 SC-Originated Message, SC Transmission Error

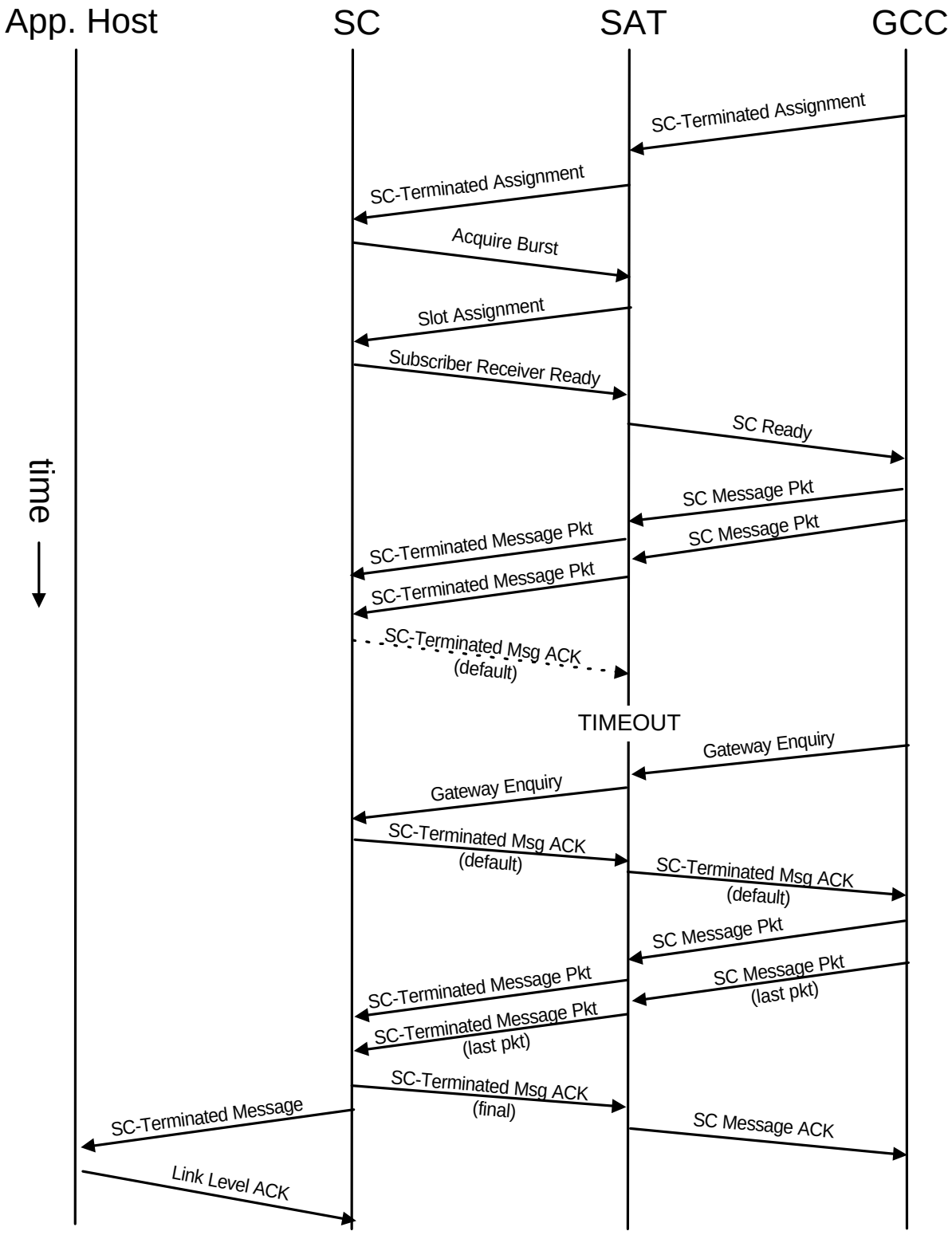


Figure 4.10 SC-Terminated Message, SC Transmisson Error

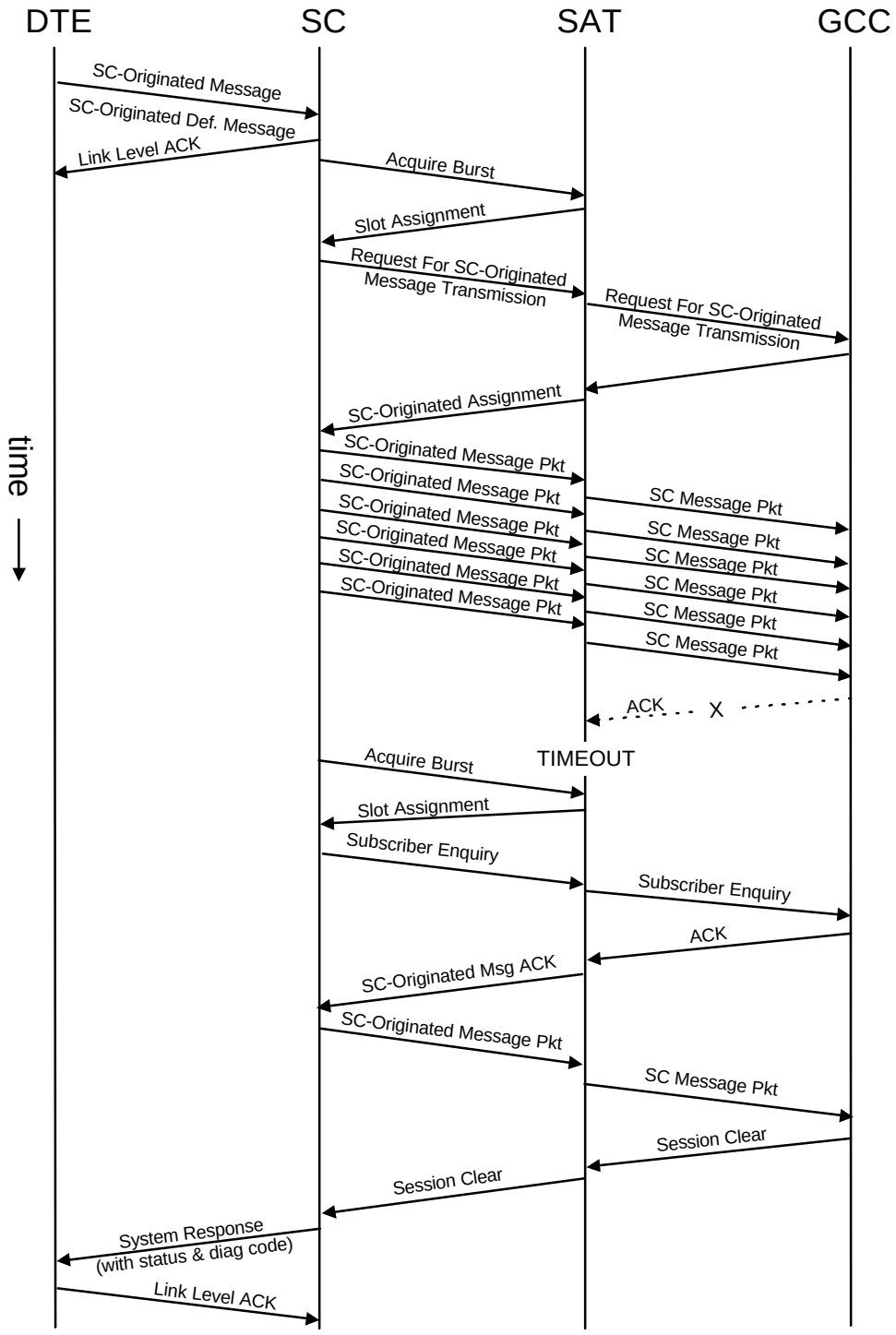


Figure 4.11 SC-Originated Message, Satellite/GCC Error

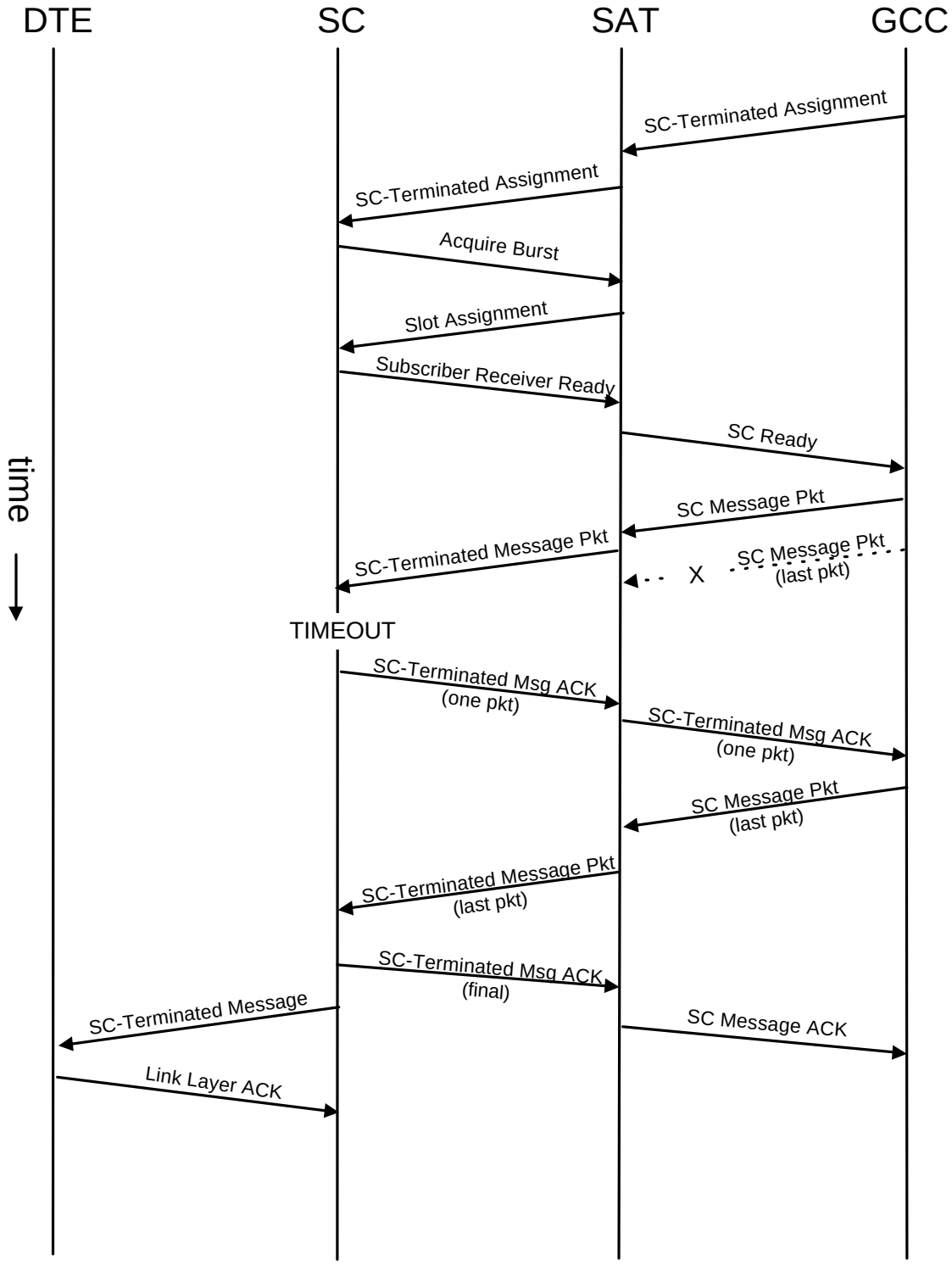
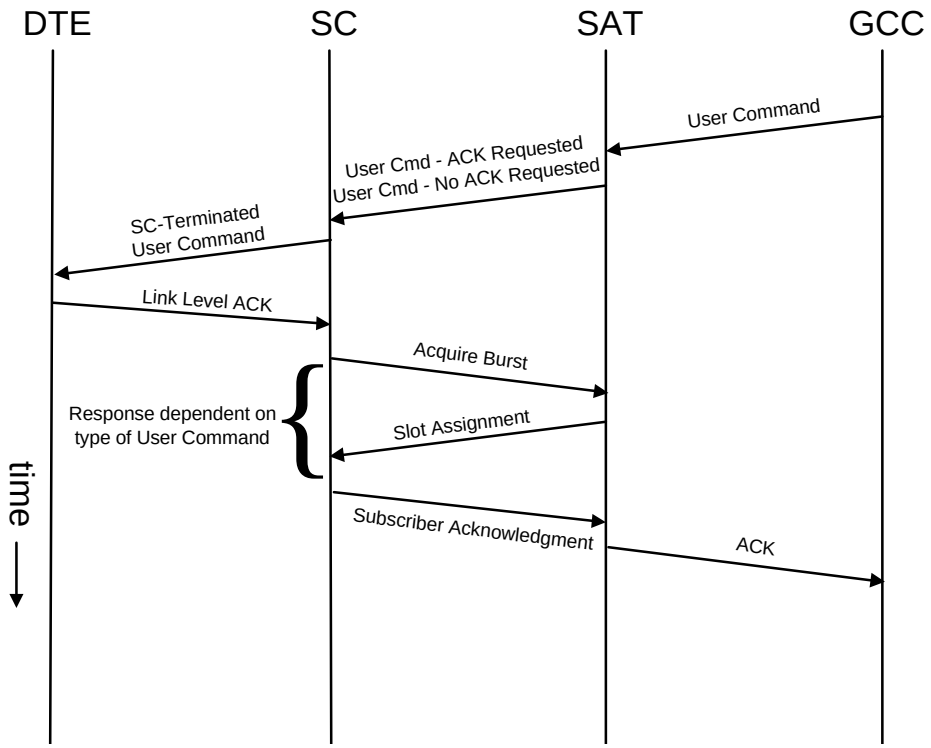


Figure 4.12 SC-Terminated Message, Satellite/GCC Transmission Error



User Command:

Will elicit a response from the application within the SC or DTE

An ACK may be requested. If not, the elicited response will signify the reception of the command.

Figure 4.13 SC-Terminated User Command

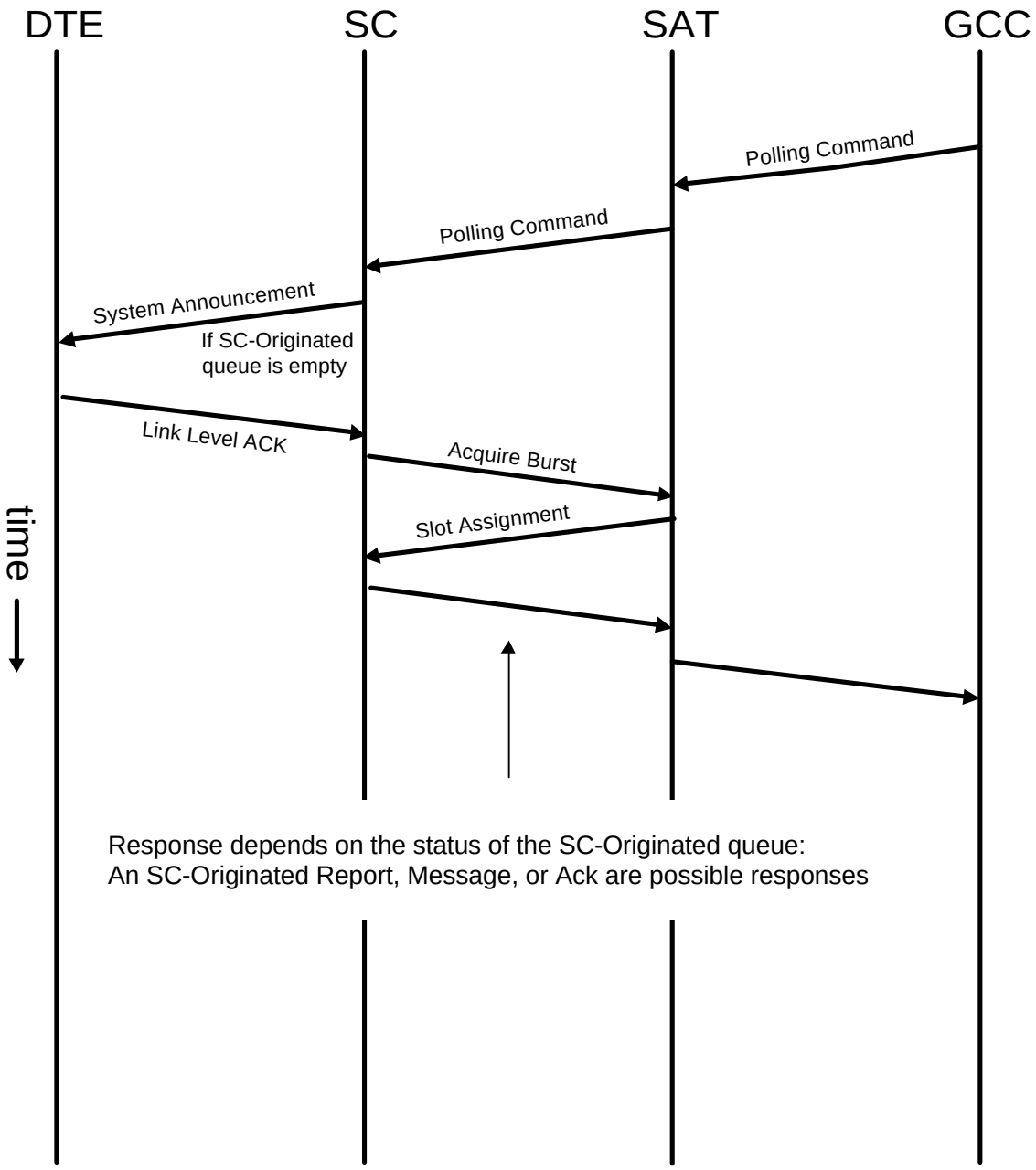


Figure 4.14 Polling by GCC

Appendix A SC Parameters

The SC Parameters listed in the following table are parameters that are available by using the SET and GET PARAMETERS.

Number	Name	Def. Value	Min Value	Max Value	DTE Access	Description
0x00	pin_code	0	0	9999	R/W	Personal Identification Number, used as a security measure
0x01	desired_gwy_id	1 (U.S.)	0	255	R/W	Instructs SC to acquire satellite connected to this ORBCOMM Gateway
0x02	def_polled	0	0	1	R/W	SC-Originated messages polled by ORBCOMM Gateway or initiated by SC (see Section 3.2, note 1)
0x03	def_ack_level	1	0	4	R/W	Default acknowledgement level for messages (see Section 3.2, note 3)
0x04	def_rep_or_ind	1	0	3	R/W	Default Report O/R Indicator (see Section 3.2, note 4)
0x05	def_msg_or_ind	1	0	15	R/W	Default Message O/R Indicator (see Section 3.2, note 4)
0x06	def_priority	0	0	3	R/W	Default Priority Level (see Section 3.2, note 5)
0x07	def_msg_body_type	14	0	15	R/W	Default Message Body Type (see Section 3.2, note 6)
0x08	def_serv_type	2	0	15	R/W	Default Service Type for reports (see Section 3.2, note 2)
0x09	gwy_search_mode	0	0	4	R/W	0=continuously search downlink band for desired GWY; 1=search band once for desired GWY, if not found then maintain lock with first discovered downlink; 2=maintain lock with first discovered downlink; 3=search band once for desired GWY, if not found, open search to include any ORBCOMM Gateway, if none found, maintain lock with first discovered downlink; 4=search band once for desired GWY, if not found, continuously search band for downlink having no ORBCOMM Gateway or desired GWY.
0x0a	ob_route	1	0	2	R/W	route outbound messages/

Number	Name	Def. Value	Min Value	Max Value	DTE Access	Description
						commands to: 0=local application task (MHA); 1=serial port; 2=both
0x0b	inactive_interval	0	0	86,400	R/W	number of seconds to power down after unsuccessfully searching for all channels in *dl_channel* list. (0 = SC stays powered)
0x0c	sc_state	0	0	9	R	SC State state of SC message transport processes (see SC *State* below)
0x0d	sc_diag_code	0	---	---	R	SC Diagnostics Result Code (see SC *Diag Code* below)
0x0e	active_mha_ref_num	0	0	255	R	Active MHA Message Reference number (255 = no message)
0x0f	sat_in_view	0	0	255	R	Number of Current Satellite In View (0 if no satellite in view)
0x10	gwy_id_list	---	---	---	R	List of IDs of ORBCOMM Gateways connected to the current satellite
0x11	min_gwy_pri_list	---	---	---	R	List of minimum acceptable message priorities for each Gateway identified in parameter 0x10, in the same order as the Gateways identified in parameter 0x10
0x12	msg_queue_size	---	---	---	R	Total size of SC message queues, in KB
0x13	sco_msg_queue_size	---	---	---	R/W	Size of SC-Originated message queue, in KB
0x14	sct_msg_queue_size	---	---	---	R/W	Size of SC-Terminated message queue, in KB
0x15	queue_ob_msgs	---	---	---	R	Number of SC-Terminated messages in queue
0x16	queued_ib_msgs	---	0	---	R	Number of SC-Originated messages in queue
0x17	week_bytes	---	---	---	R/W	UTC time week, week 0 = January 6, 1980
0x18	time_bytes	---	---	---	R/W	24-bit integer representing the number of seconds 00:00:00 UTC

Number	Name	Def. Value	Min Value	Max Value	DTE Access	Description
						last Sunday (resets 12:00 Saturday night/ Sunday morning)
0x19	total_sats	---	0	---	R	Total number of satellites in system
0x1a	stored_sats	0	0	---	R	Number of stored satellite orbital elements
0x1b	pos_calc_active	0	0	1	R/W	State of position determination process (if supported), 0: off, 1: active
0x1c	pos_age	---	---	---	R	Age of lat. and long. estimate in minutes (max. = 65535)
0x1d	lat_code	---	0	0xffffff	R/W	Coded geodetic latitude 0: North Pole, 0xffffff: South Pole
0x1e	lon_code	---	0	0xffffff	R/W	Coded geodetic longitude 0: Greenwich Median, increasing in eastern direction
0x1f	msg_requeue_opt	1	0	1	R/W	SC-Originated Requeue Options 1: requeue message/report/GlobalGram when transmission fails, 0: do not requeue, notify DTE using system response packet
0x20	poll_response_timeout	5	2	30	R/W	Poll Response Timeout number of seconds to wait for response from MHA before holding inbound messages (with *polled* set) for next poll
0x21	ser_max_retries	0	0	255	R	number of successive packet retires without receiving valid ACK before discarding the packets
0x22	ser_pkt_timeout	5	1	30	R/W	Serial Packet Timeout: number of seconds SC waits for ACK after sending last byte of a packet before resending
0x23	abort_response	0	0	1	R/W	Abort Response 0: do nothing, 1: send abort report
0x24	abort_report	---	---	---	W	Abort Report values of ncc_id, polled, serv_type, or_ind, and info

Number	Name	Def. Value	Min Value	Max Value	DTE Access	Description
						bytes 0-5 for abort report
0x25	ops_mode	0	0	2	R/W	0: Protocol mode, 1: Command Mode, 2: Byte Mode
0x26	ob_flow_ctrl	3	0	3	W	Sending packets/bytes to DTE: 0: deactivated DTR stops it; 1: activated RTS stops it; 2: either; 3: no outbound flow control
0x27	ib_flow_ctrl	3	0	3	W	To stop DTE from sending: 0: deactivate CTS; 1:deactivate DSR; 2: both; 3: no inbound flow control
0x28	DSR_treatment	0	0	1	W	1: DSR activated if one or more SC-Terminated messages queued in SC
0x29	baud_rate	4	0	5	R/W	DTE baud rate 0: 300, 1: 600, 2: 1200, 3: 2400, 4: 4800, 5: 9600
0x2a	parity_bits	0	0	2	R/W	DTE Parity 0: none, 1: odd, 2: even
0x2b	stop_bits	1	1	2	R/W	DTE stop bits
0x2c	data_bits	8	7	8	R/W	DTE data bits
0x2d	duplex	1	0	2	R/W	DTE Duplex Setting 0: half, 1: full, 2: receive only
0x2e	test_mode	0	0	3	W	Test Mode 0: normal operation, 1: echo downlink bit error rate test to DTE, 2: echo uplink to DTE 3: echo both to DTE, 4: echo DTE to uplink as reservation burst
0x2f	pwr_dwn_mode	1	0	1	W	0: receiver power controlled by DTE DTR signal; 1: receiver power controlled by *rvcr_power* parameter
0x30	active_set_id	0	0	1	R/W	active configuration set ID 0: preset factory defaults,

Number	Name	Def. Value	Min Value	Max Value	DTE Access	Description
						1: custom
0x31	serial_num	---	---	---	R	SC Serial Number
0x32	sw_version	---	---	---	R	SC Software Version
0x33	hw_version	---	---	---	R	SC Hardware Version
0x34	ser_spec_rev	'F'	'F'	---	R	SC Serial Interface Specification revision supported.
0x35	manu_id	---	00	99	R	SC Manufacturer ID 00: Panasonic, 01: Scientific Atlanta, 02: Stellar, 03: Magellan, 04: Quake, etc.
0x36	pos_det_supported	0	0	1	R	Onboard Position Determination Capability; 0: not supported 1: GPS 2: Doppler 3: Glonass
0x37	most_recent_dl	---	50	349	R	Most Recent Downlink Channel
0x38	dl_chan_list	---	50	349	R	Downlink Channel List
0x39	debug_lvl	0	0	5	R/W	Specifies level of detail of messages transmitted from debug serial port (TBD)
0x3a	rcvr_power	2	0	2	R/W	Receiver power state: 0: off, 1: listen to DL 6/16 frames, 2: on continuously
0x3b	send_pass_predict	0	1	0	W	When 1, passes Ephemeris, Satellite plane orbital elements packets to the DTE
0x3c - 0x72	RESERVED FOR FUTURE ORBCOMM USE	---	---	---	---	---
0x73	initial_pos_det	0	0	1	W	1 = Activate position determination process automatically at startup and generate position reports to *desired_gwy_id* and *def_or_ind* when quality is acceptable 0 = don't activate automatically
0x74	pos_min_quality_ind	2	0	15	R/W	minimum acceptable quality indicator of estimated position

Number	Name	Def. Value	Min Value	Max Value	DTE Access	Description
						(Doppler) if sending position report to Gateway
0x75	pos_min_data_pts	20	20	200	R/W	minimum number of Ephemeris/range rate data points required before attempting a Doppler-based position estimate
0x76	pos_max_oe_age	24	12	8760	R/W	maximum acceptable age (in hours) of orbital elements (for Doppler-based position determination)
0x77	sub_pass_percent	75	50	100	R/W	percentage of pass required before Doppler-based position estimate is attempted
0x78	max_pos_det_queue	160	0	240	R	maximum number of data points for Doppler-based position estimation, (28 bytes/data point) 0 = Doppler position determination capability disabled; fixed location; or not required for application
0x79	bmode_trigger	0	0	1	R/W	Byte Mode Only: 0 = initiate SC-Originated transfer after *bmode_lgth* bytes or after *bmode_timeout* seconds; 1 = initiate SC-Originated transfer after detection of *bmode_rx_som* and *bmode_rx_som* and *bmode_rx_eom* characters (SC searchs for *bmode_rx_som* and *bmode_rx_som* while *bmode_lgth* bytes and *bmode_timeout* handle abnormal conditions)
0x7a	bmode_timeout	0	0	604,800	R/W	Byte Mode Only: number of seconds to wait after receiving first byte before SC frames the bytes as an SC-Originated Report, Message, or GlobalGram
0x7b	bmode_lgth	6	1	sct_msg_ queue_size	R/W	Byte Mode Only: number of bytes required to trigger SC-Originated message transfer. Also used to indicate maximum buffer size in all Byte Mode configurations
0x7c	bmode_tx_som	0x02	0	0x7f	R/W	Byte Mode Only: when bmode_trigger = 1, this character precedes data bytes

Number	Name	Def. Value	Min Value	Max Value	DTE Access	Description
						sent to DTE
0x7d	bmode_tx_eom	0x03	0	0x7f	R/W	Byte Mode Only: when bmode_trigger = 1, this character concludes data bytes sent to DTE
0x7e	bmode_rx_som	0x02	0	0x7f	R/W	Byte Mode Only: when bmode_trigger = 1, this character precedes data bytes sent to SC
0x7f	bmode_rx_som	0x03	0	0x7f	R/W	Byte Mode Only: when bmode_trigger = 1, this character concludes data bytes sent to SC
0x80 - 0xff		---	---	---	---	Reserved for SC manufacturer-specific parameters

Table A.1 SC Parameters

NOTE: Parameter numbers 0 – 127 (0x0 – 0x7f) are reserved for use by ORBCOMM. Parameters 128 – 255 (0x80 – 0xff) are reserved for manufacturers' use.

SC State: (See page A-2)

0 = idle

1 = sending SC-Originated message

2 = sending SC-Originated report

3 = sending SC-Originated GlobalGram

4 = receiving SC-Terminated message

5 = receiving SC-Terminated command

6 = receiving SC-Terminated GlobalGram

7 = performing self-test

8 = performing local loop-back

9 = performing ORBCOMM Gateway loop-back test (may require a minute or two, depending on Satellite availability)

SC Diag Code: (See page A-2)

0 = no indication

1 = self-test failed, PROM CHECKSUM failed

2 = self-test failed, bad memory location

3 = local loop-back failed, modem not responding

4 = remote loop-back failed, no Satellite visible

5 = remote loop-back failed, transmitter probably bad

6 = remote loop-back failed, ORBCOMM Gateway not responding

7 = remote loop-back failed, TX/RX data does not match

20 = SC detected general failure

21 and above: Reserved for SC Manufacturers

Appendix B BYTE-MODE PROCESS FLOW DIAGRAMS

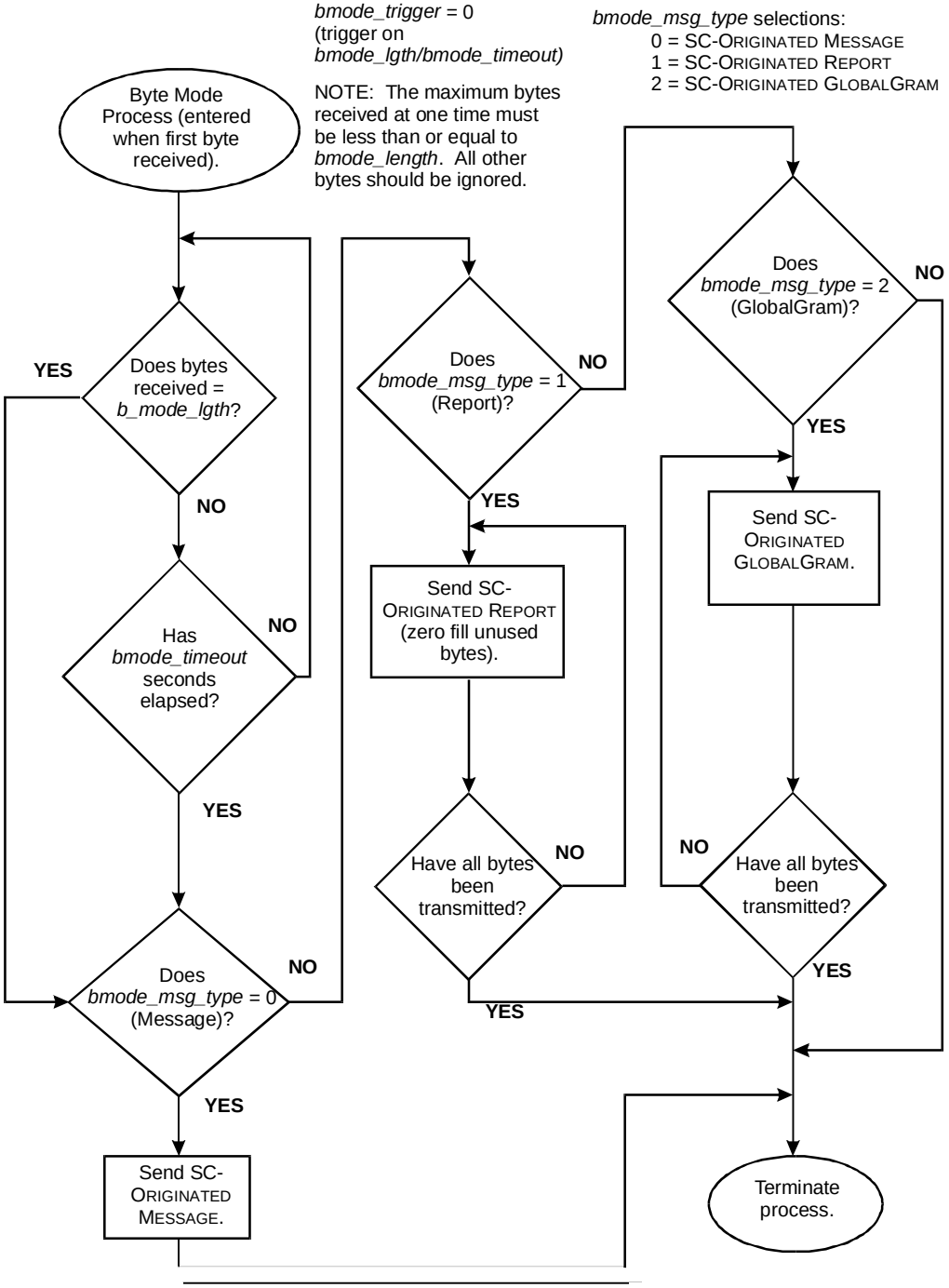


Figure B.1 – Byte Mode Process Flow Diagram for Length/Time-out Trigger

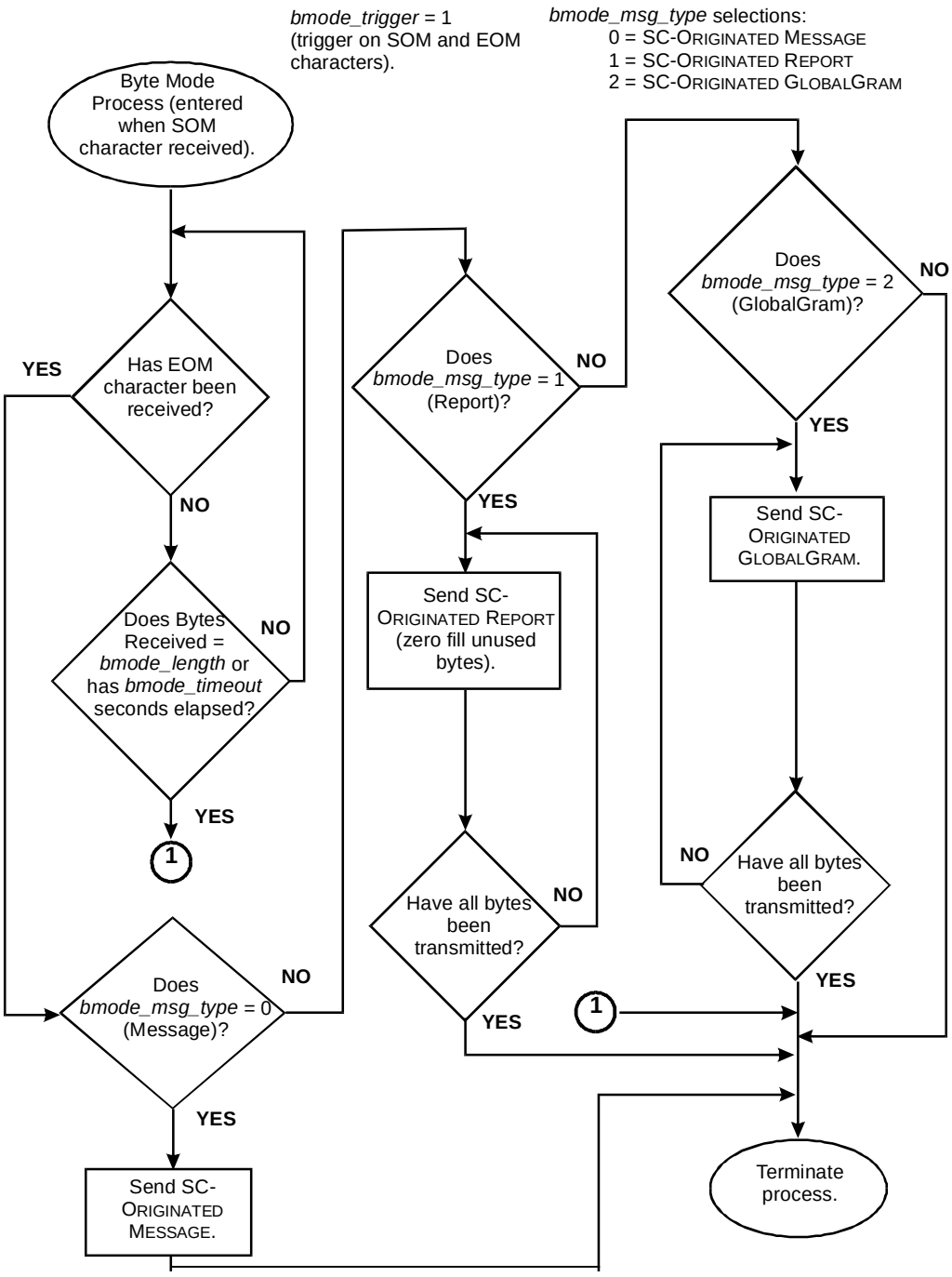


Figure B.2 – Byte Mode Process Flow Diagram for SOM & EOM Trigger

Appendix C Command Mode API

The Command Mode interface maps command strings, as closely as possible, to existing functionality in the Hayes AT command set. Although the operation of an SC varies significantly from that of a PSTN modem, there are groups of command strings that lend themselves to the expansion into this platform.

C.1 AT Command Reference

The commands referenced in Table A.1 are always appended to the command-line header AT.

Command	Command Description
AT	Attention Command
DM	Send Message/GlobalGram
EC	Command Character Echo
PO	Message Polling Query
RP	Send Position Report
SR	Read/Write S-Registers
XP	Protected Register Access Mode
&V	Display S-Register Configuration
&W	Save Current S-Register Configuration

Table C.1 AT Commands

C.2 AT Command Descriptions

Following are descriptions of each Command Mode command, listed in the order they appear in the previous table.

C.2.1 AT: Attention Command

Command Syntax	Responses	Command Description
AT	OK	Used to detect the presence of an AT Command-capable Subscriber Communicator.

The Attention command is issued by a DTE device to detect the presence of a connected SC (acting as the DCE device). If the SC supports the Command Mode interface, it will return an OK Final Response Code.

Defined Values:

None.

Associated S-Registers:

None.

C.2.2 ATDM: Send Message/GlobalGram

Command Syntax	Responses	Command Description
ATDM	**OK** **ERROR**	**Send Message/GlobalGram to the default O/R Indicator identified by S-register 133 (def_msg_or_ind).**
ATDM<xxxx>	**OK** **ERROR**	**Send Message/GlobalGram to the specified e-mail address (indicated by xxxx)**

The ATDM command is used to send a simple Message/GlobalGram to either a defined recipient indicator, or to a specified recipient address.

Upon entering this command, the SC will go into Online Messaging mode. It is then assumed that all subsequent characters sent to the SC are intended to be the Message/ GlobalGram body. The SC will continue receiving this Message/GlobalGram body data until one of the following events occurs:

1. The Inbound Message Queue is full (the size of the queue is indicated by S-Register 141);
2. There has been a 60 second delay since the last byte received; or
3. The Online Escape Character (indicated by S-Register 2) has been transmitted sequentially three times.

If the Online Escape Character sequence is entered before any valid data bytes are sent, the SC will respond with the ERROR Final Response Code and not send the message.

At this point, the SC will package the received data and send the inbound Message/GlobalGram as directed by the default messaging registers (refer to Associated S-Registers below for more detail).

Defined Values:

xxxx X.400 compliant e-mail recipient address

If ATDM is issued with no recipient address, the following applies:

1. The SC will send an SC-Originated Default Message to the recipient indicator identified by S-Register 133.

2. If the current satellite is connected to the desired gateway (identified by S-Register 53), the SC will respond to the DTE with the Unsolicited Response Code `CONNECT GWY` and the SC-Originated Default Message will be sent.
3. If the current satellite is not connected to the desired gateway, the SC will respond with the Unsolicited Response Code `CONNECT SAT` and the message will be sent as an SC-Originated Enhanced GlobalGram.
4. If there is no satellite in view, the SC will respond with the Unsolicited Response Code `NO CONNECT`, then queue the message until a satellite connected to the desired Gateway is in view.
5. If `ATDM` is issued with a recipient address, the SC will send SC-Originated Message to the specified recipient address. Items 2, 3, and 4 (above) apply.

In order to attach a subject to an SC-originated message, set register S128 to the correct text (up to 80 characters).

Unsolicited Response Codes:

```
CONNECT GWY
CONNECT SAT
NO CONNECT
```

Associated S-Registers:

120 Message Polling
123 Message Priority
124 Message Service Type
125 Message Body Type
126 Message O/R Indicator
128 Active Message Subject
145 Message Requeue Option
150 SC State

C.2.3 ATEC: Command Character Echo

Command Syntax	Responses	Command Description
ATECn	OK ERROR	Enable/Disable local serial port echoing.

The ATEC command is used to enable or disable echoing of DTE-originated data characters back to the local DTE.

Defined Values:

n = 0 Disable local echoing of characters. (default)

n = 1 Enable local echoing of characters.

Zero will be assumed if no parameter is given.

Associated S-Registers:

None.

C.2.4 ATPO: Message Polling Query

Command Syntax	Responses	Command Description
ATPO	OK ERROR	Poll SC for next available SC-Terminated Message/ Command/GlobalGram.

The ATPO command allows the DTE to poll the next available SC-Terminated Message/ GlobalGram from the SC-Terminated Message Queue. This allows the DTE to control the reception of SC-Terminated messages.

S-Register 144 (Stored SC-Terminated Messages) can be used to determine how many Messages/ Commands/GlobalGrams are available in the SC-Terminated Message Queue of the SC.

Use of this command may not be necessary if S-Register 146 (SC-Terminated Message Destination) is set to a value of 1 or 2. In this configuration, the SC will automatically transfer all SC-Terminated Messages directly to the DTE serial port as they are received.

The Command Mode interface is intended primarily to permit configuration of the S-Registers (i.e., configuration parameters) in the SC. The secondary function is to provide a simple user interface for sending and receiving messages. While in Command Mode, all SC-Terminated Messages transferred to the DTE will adhere to the following format:

GWID: m

FROM: n

COPY: x

SUBJ: y

z

where:

m: SC-Terminated message Gateway ID number

n: Originator indicator or address

x: Copied recipient inicators and/or addresses, comma separated

y: SC-Terminated Message subject (blank if default GlobablGram)

z: SC-Terminated Message body.

EXAMPLE:

GWID: 1

FROM: johndoe@bluemoon.com

COPY: janedoe@cybergal.com,2

SUBJ: Emergency Test

This is a test of the emergency broadcast system, this is only a test.

Sincerely,

John Doe

Defined Values:

None.

Associated S-Registers:

144 Stored SC-Terminated Messages

146 SC-Terminated Message Destination

C.2.5 ATRP: Send Position Report

Command Syntax	Responses	Command Description
ATRP	OK ERROR	Send inbound Position Report to a default O/R Indicator

The ATRP command should automatically initiate the Position Determination process and update the Latitude, Longitude, and the numerous position-related S-Registers. This report will be sent to the user specified in S-Register 127 (Report O/R Indicator).

Defined Values:

None

Associated S-Registers:

127	Report O/R Indicator
90	Position Calculation State
92 to 105	Refer to the Appendix B section for more detail

C.2.6 ATSR: Read/Write S-Registers

Command Syntax	Responses	Command Description
ATSRn?	**m OK or ERROR**	**Read specified S-Register value.**
ATSRn=m	**OK ERROR**	**Write value (n) to specified S-Register**

The ATSR command is used to read the value of specified S-Registers or write new values to the S-Registers.

Defined Values:

n	Any valid S-Register number. Refer to Appendix B for more information.
m	Any value within the range of the specified S-Register.

Associated S-Registers:

All non-protected S-Registers. Refer to Appendix B and the ATXP command for access to protected S-Registers.

C.2.7 ATXP: Protected Register Access

Command Syntax	Responses	Command Description
ATXPn	**OK ERROR**	**Temporarily places SC in a mode that allows operator to change protected S-Registers.**

The ATXP command is intended as a safeguard against tampering with critical protected S-Registers. Upon entry of the proper command and password, the SC sends the Final Response Code OK. The next command entered is authorized to change critical S-Register values that are protected against tampering. If an error is made in entering the next

command, Protected Register Access mode is disabled. In any case, only one protected S-Register may be changed at a time; an ATXPn command must be correctly entered for each protected S-register change.

Defined Values:

n ORBCOMM-specified 8-character password which is the same for all Subscriber Communicators of a particular manufacturer (each manufacturer will have a different password) and is only known by ORBCOMM, SC Manufacturers, and authorized Application Developers.

Associated S-Registers:

None.

C.2.8 AT&V: Display S-Registers

Command Syntax	Responses	Command Description
AT&V	<S-Register Table> OK ERROR	Displays all S-Register values (except registers labeled as System (S) or Protected (P)) in a Tab separated column table.

The AT&V command allows the user to view the current values of the S-Registers. The SC will generate a display as follows:

Figure C.1 SC Display for AT&V Command

Defined Values:

None.

Associated S-Registers:

All.

C.2.9 AT&W: Save Current S-Register Configuration

Command Syntax	Responses	Command Description
AT&Wn	OK ERROR	Write current S-Register configuration to NV memory.

The AT&W command will write the current values of the S-Registers to non-volatile memory. All S-Registers are stored, except those that are protected. Entering Protected Register Access mode before issuing this command, however, will allow all S-Registers, including those protected, to be written to NV memory.

Defined Values:

n = 1 **Save current configuration as user defined configuration 1. Currently, only one user-defined configuration is specified.**

Associated S-Registers:

All.

Appendix D S-Registers

Appendix B defines the S-Registers associated with the Command Mode interface. Most of the S-Registers are configuration parameters also defined in the Protocol Modem GET and SET PARAMETER commands (see Appendix A). The S-Registers are organized into three major groups: Local, Network, and Messaging.

The definition of each of the currently-defined S-Registers is not expected to change. Space between S-Registers has been left for future definition of new S-Registers, without affecting existing applications built on this version of the Command Mode interface specification.

Any Command Mode implementation must, at a minimum, include the S-Registers specified here. In addition to the required S-Register set, manufacturers may define and implement additional S-Registers to meet requirements unique to their particular equipment. S-Registers 200 and above are set aside for manufacturer definition. Manufacturers implementing an extended S-Register set must conform to the specified interface for reading and writing S- Register values.

Tables in the following three section define the S-Registers. Each S-Register has an associated "type" parameter which identifies the level of access permitted. Three access classes are defined:

R Read register status. The S-Register value can be read during normal operation.

W Write register status. The S-Register value can be written during normal operation.

P Protected register status. Protected mode must be entered (using the command `ATXaaaaaaaa`, where `aaaaaaa` is an 8-character password) prior to changing the value of any S-Register of this type.

Each S-Register (a.k.a., Configuration Parameter) is a assigned a valid mode. This means that the effects of write operations will only be noticed in the mode(s) defined for that S-Register. The valid serial interface modes are defined below.

AT AT Command Interface mode (As defined in this document).

PR Serial packet Protocol mode (as defined in ORBCOMM SC Serial Interface Specification).

D.1 Local S-Registers

Local S-Registers refer to the integral functionality necessary to properly communicate with the SC and set up basic interface configurations.

No.	Type	Reference	Mode	Range (Default)	Name/Description
6	R/W P	ops_mode	AT/ PR	0-1(0)	Serial Interface Operation Mode Used by the SC at power-up to determine the serial interface mode in use, regardless of what mode the SC powered- down from. Changing the value does not affect the currently active serial interface mode. 0: Protocol Mode 1: AT Command Mode
7	R/W	active_set_id	AT/ PR	0-1 (0)	Active Configuration Identifies the currently active S-Register configuration (i.e., Configuration Parameter set). Writing this parameter with a new value will automatically overwrite all saved S- Register values with the specified set, except System registers (S) and protected registers (P). 0: Factory default configuration Overwrites S-Registers with the default values identified within parentheses in this document. 1: Custom Configuration 1 Overwrites S-Registers with the specified custom configuration.
10	W P	pin_code	PR	0-9999 (0)	Personal Identification Number (PIN) Used as an extra security measure for protection against theft of services using a stolen or cloned SC. This is not required for normal messaging and is only used in the Configuration Command of Protocol Mode.
11	R	serial_num	AT/ PR	0-9, a-z, or A-Z (NA)	SC Serial Number Manufacturer specific SC serial number. Values will vary, but the size is fixed at 20 bytes (i.e., 20 ASCII characters).
12	R	sw_version	AT/ PR	0000- 9999 (NA)	SC Software Version Manufacturer-specific SC internal software version. Values will vary, but the size is fixed at 2

No.	Type	Reference	Mode	Range (Default)	Name/Description
					bytes (i.e., 4 BCD nibbles). The two upper nibbles represent a major revision level, while the 2 lower nibbles represent a minor revision level. For example, 0x0220 would correspond to version 2.20 and would be displayed on the terminal screen as 0220 (in ASCII).
13	R	hw_version	AT/ PR	0000- 9999 (NA)	SC Hardware Version Manufacturer-specific SC internal hardware version. Values will vary, but the size is fixed at 2 bytes (i.e., 4 BCD nibbles). The two upper nibbles represent a major revision level, while the 2 lower nibbles represent a minor revision level. For example, 0x0220 would correspond to version 2.20 and would be displayed on the terminal screen as 0220 (in ASCII).
14	R	ser_spec_version	AT/ PR	0000- 9999 (NA)	SC Serial Specification Version Identifies the version of the ORBCOMM Serial Interface specification that is supported by the SC. Values will vary, but the size is fixed at 2 bytes (i.e., 4 BCD nibbles). The two upper nibbles represent a major revision level, while the 2 lower nibbles represent a minor revision level. For example, 0x0220 would correspond to version 2.20.
15	R	manu_id	AT/ PR	00-05 (NA)	SC Manufacturer ID Each SC is coded with one of the following manufacturer IDs for reference. Additional manufacturer IDs may be added to the list in the future. 00: Panasonic 01: Scientific Atlanta 02: Stellar 03: Magellan 04: Torrey Sciences 05: CTI
16	R	gps_supported	AT/ PR	0-1 (0)	Onboard GPS Capability 0: Not supported 1: Available

No.	Type	Reference	Mode	Range (Default)	Name/Description
20	W	ob_flow_ctrl	AT/ PR	0-3 (3)	SC-to-DTE Data Flow Control Controls data flow from SC to DTE via hardware flow control methods. 0: Active DTR stops data flow 1: Active RTS stops data flow 2: Either 0 or 1 stops data flow 3: No SC-to-DTE flow control
21	W	ib_flow_ctrl	AT/ PR	0-3 (3)	DTE-to-SC Data Flow Control Controls data flow from DTE to SC via hardware flow control methods. 0: Inactive CTS stops data flow 1: Inactive DSR stops data flow 2: Both of the above are required to stop data flow 3: No DTE-to-SC flow control
22	W	DSR_treatment	AT/ PR	0-1 (0)	DSR Message Indicator Used to configure the activity of the SC-controlled DSR line. 0: Normal DSR treatment (DSR is activated on power-up) 1: DSR is activated only when one or more outbound message(s) are queued in the SC.
23	R/W	baud_rate	AT/ PR	0-5 (4)	Serial Interface Data Rate 0: 300 1: 600 2: 1200 3: 2400 4: 4800 5: 9600
24	R/W	parity_bits	AT/ PR	0-2 (2)	Serial Interface Parity 0: Even 1: Odd 2: None
25	R/W	stop_bits	AT/ PR	1-2 (1)	Serial Interface Stop Bits
26	R/W	data_bits	AT/ PR	6-8 (8)	Serial Interface Data Bits
27	R/W	duplex	PR	0-2 (1)	DTE Duplex Setting 0: Half 1: Full 2: Receive Only
30	W	test_mode	AT/ PR	0-4 (0)	Diagnostic Testing Mode

No.	Type	Reference	Mode	Range (Default)	Name/Description
					0: Normal Operation 1: Echo downlink Bit Error Rate test to Application Host 2: Echo uplink to App. Host 3: Echo both to App. Host 4: Echo App. Host to uplink as reservation burst
32	R/W	ser_pkt_timeout	PR	1-30 (5)	Serial Packet Timeout In Protocol mode, number of seconds the SC waits for Link Level ACK, after sending the last byte of a packet, before resending. Link Level ACK is not used in AT Command mode, so this parameter has no effect.
33	R/W	ser_max_retries	PR	0-255 (0)	Serial Packet Maximum Retries In Protocol mode, number of successive packet retries the SC should attempt without receiving a valid Link Level ACK before discarding the packets.
34	R/W	pwr_dwn_mode	AT/ PR	0-1 (1)	Power Down Mode Determines the method for entering power down mode. While powered down, any serial port activity will wake the SC. 0: Controlled by DTE DTR serial port signal Deactivating DTR puts SC in low power mode 1: Controlled by S-Registers
35	R/W	pwr_dwn_min_interval	AT/ PR	0-535600 (0)	Power Down Minimum Interval Identifies the minimum number of minutes to remain powered down before waking at the next satellite pass. Takes effect only after: a. Satellite downlink is inactive and the value of this parameter is nonzero b. At least one set of stored orbital elements exist c. If SC position is known Otherwise, register S36 (inactive_interval) takes effect.
36	R/W	inactive_interval	AT/ PR	0-86400 (0)	Power Down Inactive Interval Identifies the number of seconds to power down after unsuccessfully searching for all channels in register S63 (dl_chan_list). Used only if requirements for register S35 (pwr_dwn_min_interval) can not be met. 0: SC stays powered-up

Table D.1 Local S-Registers

D.2 Network S-Registers

Network S-Registers refer to the inherent functionality of the ORBCOMM network. These S-Registers are used to modify network and service configurations and obtain network oriented information

No.	Type	Reference	Mode	Range (Default)	Name/Description
53	R/W	desired_gwy_id	AT/PR	0-255 (1 U.S.)	Desired Gateway ID SC attempts to always try to maintain lock with a downlink from a satellite connected to this Gateway, according to register S60 (gwy_search_mode).
60	R/W	gwy_search_mode	AT/PR	0-4 (0)	Gateway Search Mode Identifies the mode which the SC should use to lock onto a downlink. 0: Continuously search downlink band for desired Gateway 1: Search downlink band once for desired Gateway, if not found, then maintain lock with first discovered downlink 2: Maintain lock with first discovered downlink 3: Search downlink band once for desired Gateway, if not found, open search to include any Gateway 4: Search downlink band once for desired Gateway, if not found, continuously search band for downlink having no Gateway or desired Gateway
61	R	gwy_id_list	AT/PR	0-255 (NA) 10 comma separated values	Satellite Gateway ID List Lists the IDs of ORBCOMM Gateways connected to the current satellite.
62	R	min_gwy_pri_list	AT/PR	0-3 (0) 10 comma separated values	Minimum Gateway Priority List List of Minimum acceptable message priorities for each Gateway identified in register S61 (gwy_id_list).

No.	Type	Reference	Mode	Range (Default)	Name/Description
63	R	dl_chan_ list	AT/PR	50-349 (NA) 24 comma separated values	Downlink Channel List Identifies up to 24 channels for SC to start satellite downlink acquisition search.
64	R	most_ recent_dl	AT/PR	50-349 (NA)	Most Recent Downlink Channel Identifies the channel number of the last (or current) downlink.
65	R	max_dl_ baud_rate	AT/PR	0-3 (0)	Maximum Downlink Rate Identifies the maximum transmission rate for the downlink. 0: 4800 bps 1: 9600 bps 2: 19200 bps 3: 38400 bps
66	W	max_ chksm_ errs	AT/PR	1-255 (60)	Downlink Checksum Errors Specifies the maximum number of downlink checksum errors allowed in register S67 (chksm_frame_count) frames before SC attempts acquisition on different downlink.
67	W	chksm_ frame_count	AT/PR	1-16 (2)	Checksum Frame Count Specifies the number of consecutive frames for checksum verification.
80	R	sat_in_ view	AT/PR	0-1 (0)	Satellite in view Identifies the number of current satellites in view. 0: No satellite in view 1: Satellite in view
81	R	total_sats	AT/PR	0-36 (NA)	Total System Satellites Identifies the total number of satellites currently operating in the ORBCOMM system.
82	R	stored_ sats	AT/PR	0-36 (NA)	Stored Orbital Elements
83	R	week_ bytes	AT/PR	0-9999 (0)	UTC Week Identifies the number of weeks since UTC time began (week ending January 6, 1980).
84	R	time_bytes	AT/PR	0-604709 (0)	UTC Time Identifies the number of seconds in the current UTC Week since 00:00:00 Sunday (resets

No.	Type	Reference	Mode	Range (Default)	Name/Description
					Saturday night/Sunday morning at midnight).
90	R	pos_calc_ active	AT/PR	0-1 (0)	Position Calculation State Identifies the state of the Position Determination Process. 0: Inactive 1: Active
103	R	pos_age	AT/PR	0-65535 (NA)	Position Estimate Age Identifies the age of the current latitude and longitude estimate in minutes.
104	R	lat_code	AT/PR	0- 16777215 (0)	Coded Geodetic Latitude 0: North pole 16777215: South Pole
105	R	lon_code	AT/PR	0- 16777215 (0)	Coded Geodetic Longitude 0: Greenwich Meridian Increasing in the Eastern direction
110	R/W	abort _reponse	PR	0-1 (0)	Abort Response 0: Do nothing 1: Send abort report
111	R/W	abort _report	PR	NA	Abort Report Stores 10 bytes which specify gwy_id, polled, serv_type, or_ind, and info_bytes 0- 5.

Table D.2 Network S-Registers

D.3 Messaging S-Registers

Messaging S-Registers refer to the functionality associated with inbound (SC-Originated) and outbound (SC-Terminated) messaging and reporting.

No.	Type	Reference	Mode	Range (Default)	Name/Description
120	R/W	def_polled	AT/PR	0-1 (0)	Message Polling Identifies the manner in which inbound (i.e., SC-Originated) messages are handled. 0: Inbound messages are sent immediately 1: Inbound messages are queued in the SC until polled by Gateway

121	R/W	poll_response_ timeout	AT/PR	2-30 (5)	MHA Reference Timeout Identifies the number of seconds the SC should await a response from the Message Handling Algorithm before holding inbound messages (with polled set) for next poll by the Gateway.
122	R/W	def_ack_level	PR	0-4 (0)	Message ACK Level Identifies the level of acknowledgment expected after sending an inbound default message. Values preceded by a * are not currently implemented by the ORBCOMM network, they are reserved for future use and must be implemented by the SC. 0: No ACK expected *1: Non-delivery to Gateway 2: Only delivery to Gateway *3: Non-delivery to recipient 4: Only delivery to recipient Acknowledgments are not sent to DTE while SC is in AT Command mode, so this parameter has no effect.
123	R/W	def_priority	AT/PR	0-3 (0)	Message Priority Identifies the level of priority for inbound default messages. 0: Non-urgent 1: Normal 2: Urgent 3: Special delivery (SC-Originated only) Due to the fact that the ORBCOMM network is currently under-utilized, there is no effective difference in message delivery as a function of priority. This may change as the network becomes more heavily utilized.
124	R/W	def_serv_type	PR	0-15 (2)	Message Service Type Identifies the message priority and acknowledgment level of inbound default messages. Values preceded by a * are not currently implemented by the ORBCOMM network, they are reserved for future use and

					must be implemented by the SC. 0: Normal priority, no ACK 1: Normal priority, only non- delivery to Gateway acknowledged 2: Normal priority, only delivery to Gateway acknowledged 3: Normal priority, only non- delivery to recipient acknowledged 4: Normal priority, only delivery to recipient acknowledged 5-15: Refer to ORBCOMM Serial Interface Specification, Section 3.2, note 2, for more information Acknowledgments are not sent to DTE while SC is in AT Command mode, so this parameter has no effect.
125	R/W	def_msg_ body_type	AT/PR	0-15 (14)	Message Body Type Identifies the body type used by SC for inbound default messages. Values preceded by a * are not currently implemented by the ORBCOMM network, they are reserved for future use and must be implemented by the SC. 0: IA5TEXT *1-13: Refer to ORBCOMM Serial Interface Specification, section 3.2, note 6, for more information 14: Bilaterally defined (binary) 15: Externally defined. Refer to ORBCOMM Serial Interface Specification, section 3.2, note 6, for more information
126	R/W	def_msg_or_ ind	AT/PR	0-15 (1)	Message O/R Indicator Identifies the Originator/Recipient address indicator used by the SC for inbound default messages. 0: SC-Terminated:Null Address, SC-Originated:self (loop back) 1-8: User predefined in Gateway database 9-15: System predefined in Gateway database

127	R/W	def_rep_or_ ind	AT/PR	0-3 (1)	Report O/R Indicator Identifies the Originator/Recipient address indicator used by the SC for inbound default reports. 0: SC-Terminated:Null Address, SC-Originated:self (loop back) 1-3: User predefined in Gateway database
128	R/W	None	AT	0-80 chars	Active Message Subject Identifies the message subject that the SC will use when sending a default message through the AT Command Interface.
140	R	msg_queue_ size	AT/PR	Min=1 Max=HW dependent	Total Message Queue Size Identifies the total message queue memory size in KB.
141	R/W	sco_msg_ queue_size	AT/PR	Min=1 Max=HW dependent	Inbound Message Queue Identifies the total SC-originated message queue size in KB of the total message queue available.
142	R/W	sct_msg_ queue_size	AT/PR	Min=1 Max=HW dependent	Outbound Message Queue Identifies the total SC-Terminated message queue size in KB of the total message queue available.
143	R	queued_ib_ msgs	AT/PR	Min=0 Max=HW dependent	Stored Inbound Messages Identifies the number of SC- Originated messages queued for transport from the SC.
144	R	queued_ob_ms gs	AT/PR	Min=0 Max=HW dependent	Stored Outbound Messages Identifies the number of SC-terminated messages queued for DTE retrieval by the SC.
145	R/W	msg_requeue_ opt	AT/PR	0-1 (1)	Inbound Message Requeue Option Identifies message requeue options for inbound (i.e., SC-Originated) messages. 0: Do not requeue Notify DTE using SYSTEM RESPONSE packet (only valid in Protocol Mode) 1: Requeue message/report/ globalgram when transmission fails
146	R/W P	ob_route	AT/PR	0-2 (1)	Outbound Message Destination Controls the automatic routing of SC-Terminated messages, commands, and globalgrams from the network.

					0: Local application task (MHA) queue 1: Serial port 2: Both of the above
150	R	sc_state	AT/PR	0-9 (0)	SC State Indicates state of the SC message transport processes. 0: Idle 1: Sending SC-Originated message 2: Sending SC-Originated report 3: Sending SC-Originated globalgram 4: Receiving SC-Terminated message 5: Receiving SC-Terminated command 6: Receiving SC-Terminated globalgram 7: Performing self test 8: Performing local loop-back 9: Performing ORBCOMM Gateway loop- back test (may take a few minutes to complete based on satellite availability)
151	R	sc_diag_code	AT/PR	0-21 (0)	SC Diagnostics Result Code Identifies the diagnostics result from the most recent self and/ or loop-back tests. 0: No indication 1: Self-test failed, PROM Checksum failure 2: Self-test failed, bad memory location 3: Local loop-back failed, modem not responding 4: Remote loop-back failed, no visible satellite 5: Remote loop-back failed, transmitter not functioning correctly 6: Remote loop-back failed, ORBCOMM Gateway not responding 7: Remote loop-back failed, TX/ RX data does not match 8-19: Reserved 20: SC detected general failure 21 and above: Reserved for SC manufacturers.
152	R	active_mha_ ref_num	AT/PR	0-255 (0)	Active MHA Reference Number Identifies the number of the last inbound message transmitted from the SC Message Handling Algorithm. This allows applications to track SC internal message accounting.

					255: No message

Table D.3 Messaging S-Registers

Appendix E NETWORK CAPABILITIES

1. **Data Report**

   SCs generate short reports consisting of one packet that are transmitted via random access. Data Reports can be originated by an SC or network requested (polled). A Data Report may be acknowledged and, if so, a re-transmission protocol is used for failed packets.

2. **Message Transfer**

   A Message refers to a longer sequence of data to be transferred to or from the SC, typically between 10 and 1000 bytes. Transfer of messages involves several more steps for reliable transfer. Messages are transferred via short packets over the satellite links. All packets are acknowledged or re-transmitted. Messages are accepted/delivered via public or private data networks. These Messages can be transferred to or from SCs. Messages from SCs can be originated at the request of the SC (random access), or at the request of the network (polled). In either case the transfer of Message packets is in a reservation (“polled”) fashion.

3. **GlobalGram**

   A GlobalGram is a single, self-contained packet sent or received by an SC when no Net-work Control Center can be accessed by the current satellite. GlobalGrams allow up to 229 user-defined bytes per packet to be sent by the SC and 182 user-defined bytes per packet to be received. This allows remote and oceanic areas to be served in a "store-and- forward" mode. A SC is only permitted to send or receive GlobalGrams when com-munication is impossible with any ORBCOMM Gateway. The GlobalGram is acknowl-edged by the Satellite and then archived in Satellite memory until the addressed ORBCOMM Gateway establishes contact with that Satellite. The Satellite will queue no more than 16 SC-Originated and 16 SC-Terminated GlobalGrams per SC at a time.

4. **Commands**

   Short commands consisting of one packet are transmitted to an SC terminal. Commands could be signals to initiate communications via other links or commands from a billing system to enable another receiver of a different service. Acknowledgment may or may not be required.

Appendix F Fletcher Checksum

```
/*
 * operator fletcher_encode
 */
fletcher_encode( buffer, count )
unsigned char* buffer;
long      count;
{
  int i;
  unsigned char c0 = 0;
  unsigned char c1 = 0;
  *( buffer + count - 1 ) = 0;
  *( buffer + count - 2 ) = 0;
  for( i = 0; i < count; i++)
  {
       c0 = c0 + *( buffer + i );
       c1 = c1 + c0;
  }
  *( buffer + count - 2 ) = c0 - c1;
  *( buffer + count - 1 ) = c1 - 2*c0;
}
/*
 * operator fletcher_decode
 */
long fletcher_decode( buffer, count )
unsigned char* buffer;
long     count;
{
  long  result = 0;
  int i;
  unsigned char c0 = 0;
  unsigned char c1 = 0;
  for( i = 0; i < count; i++)
  {
       c0 = c0 + *( buffer + i );
       c1 = c1 + c0;
  }
  return( (long)(c0 + c1) );
```

Appendix G LATITUDE & LONGITUDE CONVERSION

From ORBCOMM Codes to Geodetic:

```
long double lat, lon, lon_code, lat_code;
lat = 90. - ((unsigned long)lat_code/((double)0XFFFFFF))*180.;
lon = ((unsigned long)lon_code/((double)0XFFFFFF))*360.;
if(lon > 180.)
lon = lon - 360.;
```

From Geodetic to ORBCOMM Codes:

```
long double lat, lon, lon_code, lat_code, tmp1;
if(lon < 0/* west */
tmp1 = (lon + 360.)/360.;
else /* east */
tmp1 = lon/360.;
lon_code = (unsigned long) (tmp1 * 0x0ffffff) & 0x0ffffff;
tmp1 = -(lat - 90.)/180.;
lat_code = (unsigned long) (tmp1 * 0x0ffffff) & 0x0ffffff;
```

Appendix H SATELLITE ELEMENT SET FORMAT DESCRIPTION

The satellite ephemeris data consists of two lines in the following format (not including the two-line column "ruler"). Multiple element sets should repeat the formatting above— i.e., a two-line element set for the first satellite, followed by a two-line element set for the second satellite, etc. All element sets should be sent from the SC in the form of an SC-Originated Message. This Message should be sent with a blank ID, no ORIGINATOR and no SUBJECT. The Message body field should contain the two-lined element sets with no additional characters.

```
Column                1         2         3         4         5         6
Number:      123456789012345678901234567890123456789012345678901234567890123456789
             1 NNNNNU NNNNNAAA NNNNN.NNNNNNNN +.NNNNNNNN +NNNNN-N +NNNNN-N N NNNNN
Element
Set Format:  2 NNNNN NNN.NNNN NNN.NNNN NNNNNNN NNN.NNNN NNN.NNNN NN.NNNNNNNNNNNNN
```

EXAMPLE: Actual F2 element set as received from NASA.

```
             1         2         3         4         5         6
123456789012345678901234567890123456789012345678901234567890123456789
1 23546U 95017B   97072.53586170  .00000056  00000-0  32865-4 0 02534
2 23546 069.9776 265.2990 0013272 169.5560 190.5848 14.45508865102583
```

Format Description:

Line 1

Column	Description
01	Line Number of Element Data
02	Blank
03-07	Satellite Number (corresponds to the *satellite_#.* Zero fill all leading characters.)
08	Classification of Element Set (U = unclassified)
09	Blank
10-11	International Designator (last two digits of launch year)-**N/A**
12-14	International Designator (Launch number of the year)-**N/A**
15-17	International Designator (Piece of launch)-**N/A**
18	Blank
19-20	Epoch Year (last two digits of year)— calculated from data in SATELLITE PLANE ORBITAL ELEMENTS

Line 1 (continued)

Column	Description
21-32	Epoch (Julian Day and fractional portion of the day)— calculated from data in SATELLITE PLANE ORBITAL ELEMENTS
33	Blank
34-43	Decay from SATELLITE PLANE ORBITAL ELEMENTS.
44	Blank
45-52	Second Time Derivative of Mean Motion— **N/A**
53	Blank
54-61	BSTAR drag term if GP4 general perturbation theory was used— **N/A**
62	Blank
63	Ephemeris type— **N/A**
64	Blank
65-68	Element set number— **N/A**
69	Checksum (Modulo 10)

Line2

Column	Description
01	Line Number of Element Data
02	Blank
03-07	Satellite Number (same as above)
08	Blank
09-16	Inclination (degrees)— from SATELLITE PLANE ORBITAL ELEMENTS
17	Blank
18-25	Right Ascension of the Ascending Node (degrees)— from SATELLITE PLANE ORBITAL ELEMENTS
26	Blank
27-33	Eccentricity (decimal point assumed)— from SATELLITE PLANE ORBITAL ELEMENTS
34	Blank
35-42	Argument of Perigee (degrees)— from SATELLITE PLANE ORBITAL ELEMENTS

Line 2 (continued)

Column	Description
43	Blank
44-51	Mean Anomaly (degrees)— from SATELLITE PLANE ORBITAL ELEMENTS
52	Blank
53-63	Mean Motion (revs per day)— from SATELLITE PLANE ORBITAL ELEMENTS
64-68	Orbit number at epoch (revs) — from SATELLITE PLANE ORBITAL ELEMENTS
69	Checksum (Modulo 10)

NOTES:

1. To calculate checksum: letters, blanks, periods = 0; minus sign =1; plus sign = 2.
2. The International Designator and other complete data fields not required by the tracking algorithm are sent as blank spaces or zeros.
3. All epochs are Coordinated Universal Time (UTC).
4. In fields where there may be leading zeros, blanks cannot be substituted for those leading zeros.
5. Fields designated as **N/A** (not applicable) are not required and should be zero filled.
6. Plus signs (+) are optional.
7. Minus signs (-) are required.
8. A carriage return (CR) and a line feed (LF) must be appended to the end of each line. Column Description

Appendix I GLOSSARY OF TERMS & ACRONYMS

ACK	Acknowledgment
CMOS	Complementary Metal-Oxide Semiconductor
CR	carriage return
CTS	Clear-To-Send
DCE	Data Communications Equipment
DSR	Data Set Ready
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
ECL	Emitter Coupled Logic
GCC	Gateway Control Center
GWY	ORBCOMM Gateway
Inbound Subscriber orginated (SC-Originated) direction	The direction of a message orginating from an SC and sent to an ORBCOMM Gateway/Satellite LF line feed
MHA	Message Handler Agent
MTA	Message Transfer Agent
OMS	ORBCOMM Message Switch
Outbound Subscriber terminated (SC-Terminated) direction	The direction of a message sent from an ORBCOMM Gateway/Satellite and terminating at an SC
RTS	Request-To-Send
SC	Subscriber Communicators
SMTP	Simple Mail Transfer Protocol
TTL	Transistor-Transistor Logic
UTC	Coordinated Universal Time