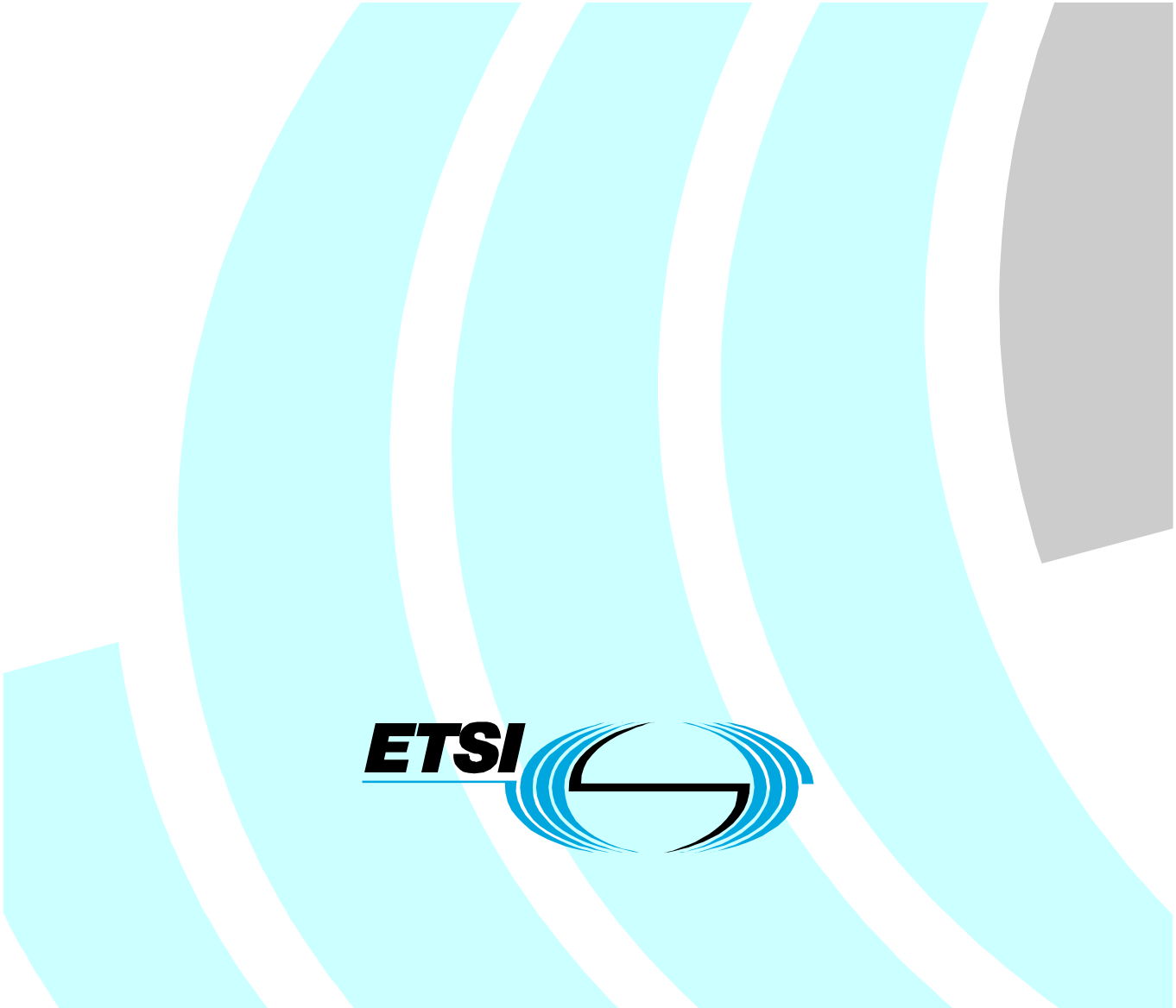
ETSI TS 102 189-3 V1.1.1 (2004-03)

Technical Specification

Satellite Earth Stations and Systems (SES);
Regenerative Satellite Mesh - A (RSM-A) air interface;
MAC/SLC layer specification;
Part 3: SLC layer



Reference
DTS/SES-00RSM-A-MAC-P3

Keywords
air interface, broadband, satellite, multimedia, IP

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://webapp.etsi.org/IPR/home.asp).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Satellite Earth Stations and Systems (SES).

The present document is part 3 of a multi-part deliverable covering Regenerative Satellite Mesh - A (RSM-A) air interface MAC/SLC layer specification, as identified below:

Part 1: "General description";

Part 2: "MAC layer";

Part 3: "SLC layer".

1 Scope

The present document defines the communication interface between a TC-SES BSM Regenerative Satellite Mesh-A (RSM-A) air interface compliant Satellite Terminal (ST) and the Security Access Module (SAM). It specifies the communication medium and the protocols for communication. This document describes how packets, received at the ST from the Network Operations Control Centre (NOCC), are routed to the SAM, how messages created originally by the ST are routed to the SAM, how message from the SAM are routed via the ST to the NOCC and how messages from the SAM are consumption by the ST.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication and/or edition number or version number) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

[1] ETSI TS 102 188-5: "Satellite Earth Stations and Systems (SES); Regenerative Satellite Mesh - A (RSM-A) air interface; Physical layer specification; Part 5: Radio transmission and reception".

[2] ETSI TS 102 188-7: "Satellite Earth Stations and Systems (SES); Regenerative Satellite Mesh - A (RSM-A) air interface; Physical layer specification; Part 7: Synchronization".

[3] ETSI TS 102 189-2: "Satellite Earth Stations and Systems (SES); Regenerative Satellite Mesh-A (RSM-A) air interface; MAC/SLC layer specification; Part 2: MAC layer".

[4] ETSI TS 102 189-1: "Satellite Earth Stations and Systems (SES); Regenerative Satellite Mesh-A (RSM-A) air interface; MAC/SLC layer specification; Part 1: General description".

[5] Universal Serial Bus Specification, revision 1.1, September 23, 1998.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

Network Operations Control Centre (NOCC):centre that controls the access of the satellite terminal to an IP network and also provides element management functions and control of the address resolution and resource management functionality

satellite payload: part of the satellite that provides air interface functions

NOTE: The satellite payload operates as a packet switch that provides direct unicast and multicast communication between STs at the link layer.

Satellite Terminal (ST): terminal that is installed in the user premises

terrestrial host: entity on which application level programs are running

NOTE: It may be connected directly to the Satellite Terminal or through one or more networks.

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ACF	Access Control Field
BA	Bandwidth Assignment
BCSTID	Bandwidth Control Satellite Terminal IDentity
BR	Bandwidth Request
BRIC	Bandwidth Request Integrity Check
IP	Internet Protocol
LSB	Least Significant Bit
MAC	Medium Access Control
Mbps	Mega-bits per second (millions of bits per second)
MSB	Most Significant Bit
NOCC	Network Operations Control Centre
RSM	Regenerative Satellite Mesh
SAM	Security Access Module
SAP	Service Access Point
SI-SAP	Satellite Independent-SAP
SLC	Satellite Link Control
SOF	Start Of Frame
ST	Satellite Terminal
TOD	Time Of Day
UDP	User Datagram Protocol
USB	Universal Serial Bus

4 General aspects

4.1 Security Access Module - functional description

The SAM is the security component of a satellite terminal. Physically it is a secure chip embedded in the terminal. The SAM contains secret key material and authenticates every RSM-A packet sent out by the terminal by generating an Access Control Field, which can be verified by other authorized components of the system. The SAM will only sign requests that are valid within the policies set forth for that particular ST. On the receive side it verifies that management messages are authentic messages from the NOCC. The set of functionality, including the ACF generation, bandwidth assignment and bandwidth request integrity checks, is called capacity protection and is introduced in TR 102 287 (see bibliography).

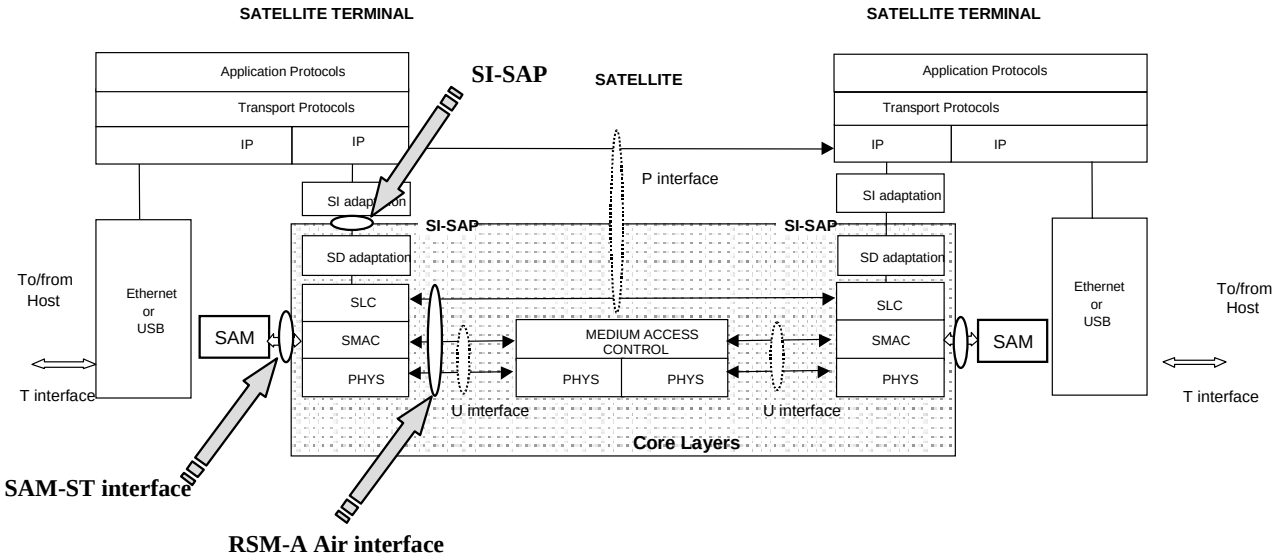


Figure 4.1: Protocol architecture and SAM-ST interface

The SAM's areas of responsibility to the RSM-A system are as follows:

- Authentication.
- Authorization protection.
- Registration.
- Usage audit.

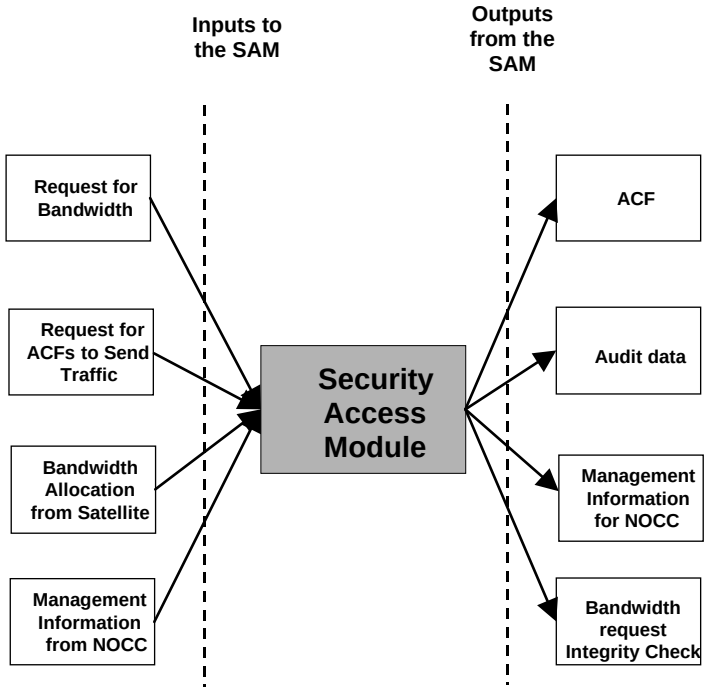


Figure 4.2: Security function interactions between the SAM and the ST

5 ST-SAM physical interface

The ST-SAM physical interface is divided into an electrical interface and a mechanical interface.

The physical/electrical interface between the ST and the SAM shall be a Universal Serial Bus (USB) revision 1.1 [5]. The SAM shall be equivalent to a "USB device" function and the ST shall be equivalent to a "USB host". The ST implementation shall not require the SAM to share this USB port with any other device or hub. The ST should suppress frame timing, i.e. should not send USB Start Of Frame (SOF) token timing packets on the USB interface.

The physical/mechanical interface may use any suitable interface. An optional mechanical description is given in annex A.

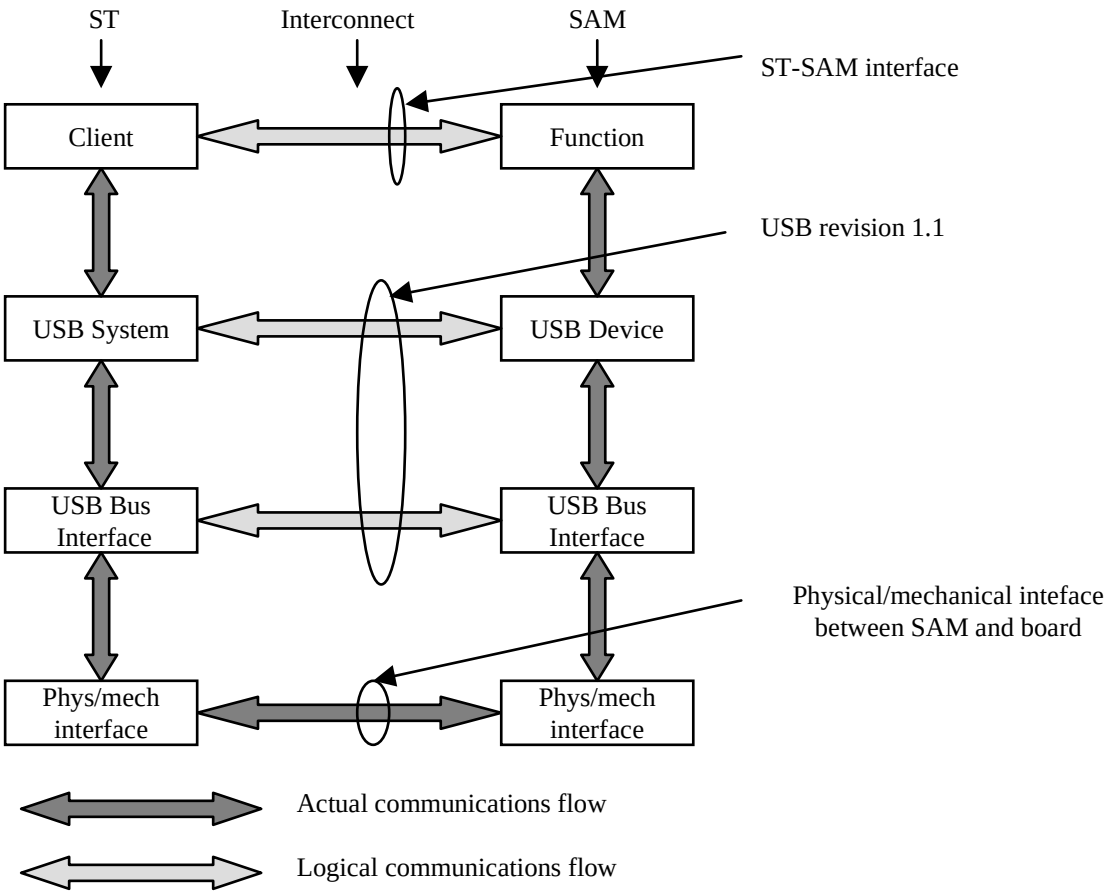


Figure 5.1: Interlayer communications model

6 Client - Function interface

6.1 Procedures

The ST and SAM shall use the messages described in the procedures below to communicate with each other. Whenever the ST sends the SAM an INDICATION message, the SAM shall always respond with either a RESPONSE message (for a successful operation) or a FAILURE message (whenever the requested operation fails) with an error code. However, the SAM does not respond to the ACF FRAME COUNT INDICATION message.

6.1.1 Health check

The ST sends the ST HEALTH CHECK INDICATION message to the SAM periodically. There is no strict requirement on the length of the period however it should be 1 second. The SAM shall respond with the ST HEALTH CHECK RESPONSE.

6.1.2 Frame count maintenance

The ST shall send the Frame count at the start of each uplink frame using the ACF creation frame count message. The SAM shall use the latest Frame Count sent by the ST to process subsequent ACF Creation Indication Messages. The Frame count field is the current 35-bit uplink frame number in TOD [39, 5] format, as specified in TS 102 188-7 [2].

The ST shall send this message to the SAM within 100 μseconds of the start of each uplink frame.

6.1.3 ACF procedure

The ST shall send packet header information to the SAM, for both of the RSM-A packets contained in the uplink block that the ST is preparing to transmit, using the ACF CREATION INDICATION message.

If the SAM approves the request, it shall respond with an ACF CREATION RESPONSE message containing the ACF field. The ST shall append this ACF to the MAC block before transmission to the satellite. The ST shall not transmit a MAC block to the satellite without an ACF field.

The SAM responds to the ST with an ACF CREATION FAILURE message if the ACF cannot be computed.

The following clause outlines the timing requirements for the ACF generation process. The timing diagram for the process is illustrated in figure 6.1.

The diagram illustrates activity on the USB interface bus between the host and the SAM, as well as the processing that is performed by the SAM. The host initiates all activity on the USB bus, and the SAM behaves as a USB device.

The process involves the following steps, and must be completed within one 16 Mbps code block period, which is 87,8 µs. Figure 6.1 shows this code block period, or epoch:

1) Transfer of data required to generate ACF from host to SAM.

2) Processing of data by the SAM to generate the ACF.

3) Extraction of the ACF data from the SAM by the host.

The process is initiated by the host at the beginning of each epoch. In figure 6.1, this occurs at 0 µs and again at 87,8 µs. The host must generate the Out Token within 1 µs of the beginning of each epoch (Icon 1). The host will then generate the Out Data packet. The SAM will receive the Out Data Packet, and acknowledge receipt to the host via an ACK message. The entire Out Data period will not exceed 17,74 µs under worst case conditions, which include a maximum number of zero insertions occurring on the USB interface (Icon 2).

Once the SAM has acknowledged receipt of the Out Data, it is allocated 47 µs to process the data, generate the ACF, and make it available in its USB FIFO (Icon 3). This point must occur no later than 65,74 µs into the epoch (Icon 4). The SAM may continue code execution after it has filled its USB FIFO at Icon 3, provided it has completed execution under interrupt prior to Icon 6. This time period may be used for functions such as statistics gathering, and is shown as Icon 10.

The host will begin initiation of the In Token 72,5 µs into the epoch period (Icon 5). The host must begin physical generation of the In Token onto the USB bus no later then 73,5 µs into the epoch period (Icon 6). In a worst case scenario, with a maximum number of zero insertions occurring during the In Data period, the In Data period will last 12,3 µs (Icon 7). This will allow the In Data period to terminate at least 2 µs prior to the end of the epoch (Icon 8). Overall, this leaves a minimum margin of 6,76 µs between the In Data being available at the SAM and the generation of the In Token.

Table 6.1 contains the timing requirements for this interface. All numbers are in microseconds.

Table 6.1

Icon	Description	Duration (µsec)		Epoch Point
		Min	Max	
1	Delay from beginning of epoch to generation of Out Token by the host	0	1	N/A
2	Out Data period	16,74	17,74	N/A
3	SAM ACF generation period		47	
4	Latest point at which SAM must have In Data available for host			65,74
5	Time point at which host will initiate In Data period			72,5
6	Latency from (5) to appearance of In Token on bus		1	
7	In Data Period	11,8	12,3	
8	End of In Data period to end of epoch	2	3,5	
9	Margin available between In Data available at SAM and initiation of In Token by host	6,76		

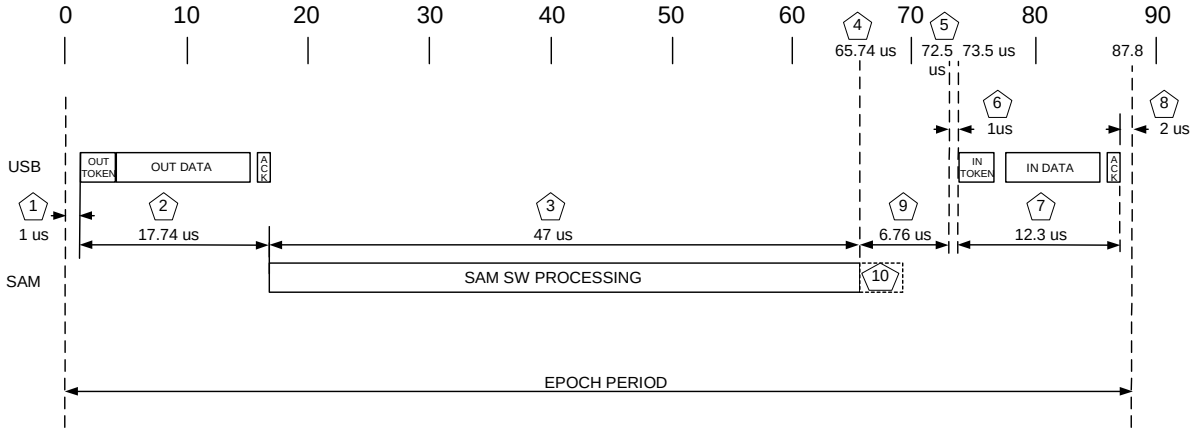


Figure 6.1: ACF timing diagram

6.1.4 Bandwidth Request procedure

The ST requests Bandwidth from the satellite based on the policies that it signed up for and received from the NOCC during the registration process. The SAM ensures that the ST adheres to these policies and therefore will not sign requests that are not within these guidelines. The SAM shall approve requests that agree with the policy permitting the ST to send a message to the satellite requesting a bandwidth allocation. The BANDWIDTH REQUEST INDICATION message contains bytes 16-63 of the air interface bandwidth request message as described in TS 102 189-2 [3].

The SAM shall return an Integrity Check code within the BANDWIDTH REQUEST RESPONSE message if the ST is permitted to request the bandwidth.

The SAM shall return a BANDWIDTH REQUEST FAILURE message to the ST with a failure code if the SAM rejects the ST's bandwidth request. The ST shall not request bandwidth from the satellite without a valid integrity code from the SAM.

6.1.5 Bandwidth Assignment procedure

The satellite shall send bandwidth assignments to the ST. The ST shall filter each assignment based on the Bandwidth Control Satellite Terminal ID (BCSTID) (as specified in TS 102 189-2 [3]) contained in each assignment and send this assignment information to the SAM using the BANDWIDTH ASSIGNMENT INDICATION message.

The SAM will use data from the BANDWIDTH ASSIGNMENT INDICATION message to subsequently determine which data packets it shall approve for transmission. Each BANDWIDTH ASSIGNMENT INDICATION message may contain up to 9 assignments.

A BANDWIDTH ASSIGNMENT RESPONSE message is sent to the ST if the bandwidth assignment indication is successful and the SAM has stored all the assignments.

If the SAM rejects all or some of the assignments, it shall send a BANDWIDTH ASSIGNMENT REJECT message to the ST.

6.1.6 Bandwidth Request and Assignment timing requirements

The following clause outlines the timing requirements for the Bandwidth Request (BR) and Bandwidth Assignment (BA) message interface with the SAM. The timing diagram for these processes is illustrated in figure 6.2.

The diagram illustrates activity on the USB interface bus between the ST host and the SAM, as well as the processing that is performed by the SAM. The host initiates all activity on the USB bus, and the SAM behaves as a USB slave. The diagram shows timing for both BA and BR cycles.

The process involves the following steps, and must be completed within one half of a 2 Mbps code block period, which equates to 220 µs. Figure 6.1 shows this ½ code block period, or epoch.

During the epoch period, the interface must be able to support either one BA transaction or one BR transaction. Each of these transactions has slightly different timing requirements. Both transactions operate using the following 3 steps:

1) Transfer of data required from host to SAM via an Out transaction.

2) Processing of data by the SAM, for either BA or BR.

3) Extraction of the response from the SAM by the host via an In transaction.

The entire process is initiated by firmware in the host at the beginning of each epoch. In figure 6.2, this occurs at 0 µs and again at 220 µs. The host must generate the Out Token within 1 µs of the beginning of each epoch (Icon 1). The host will then generate the Out Data packet. The SAM will receive the Out Data Packet, and acknowledge receipt to the host via an ACK message. The entire Out Data period will not exceed 52 µs for a BR cycle or 55 µs for a BA cycle, under worst case conditions. The worst case condition includes a maximum number of zero insertions occurring on the USB interface. These time periods are shown by Icon 2 for a BR transaction and Icon 8 for a BA transaction.

Once the SAM has acknowledged receipt of the Out Data, it is allocated 138 137 µs to process a BR message (Icon 3), or 134 µs to process a BA message (Icon 9). This processing is considered to have ended when the SAM has loaded the data to be returned to the host in its USB buffer, and has set the TX_PKT_RDY bit. This point must occur no later than 190 µs into the epoch (Icon 4) for either BA or BR transactions. The SAM may continue code execution after it has filled its USB FIFO at Icon 4, provided it has completed execution under interrupt prior to the end of the period denoted Icon 6 at 212 µs.

For either BA or BR transactions, the host firmware will begin initiation of the In Token 192 µs into the epoch period (Icon 5 and Icon 10). The host must begin physical generation of the In Token onto the USB bus within 1 µs (Icon 6). In a worst case scenario, with a maximum number of zero insertions occurring during the In Data period, the In Data period will last 20 µs and end at 213 µs into the epoch (Icon 7). This will allow the In Data period to terminate at least 7 µs prior to the end of the epoch.

Table 6.2 contains the timing requirements for this interface. All numbers are in microseconds.

Table 6.2: Bandwidth Request and Assignment interface timing requirements

Icon	Description	Duration (µsec)		Epoch Point
		Min	Max	
1	Delay from beginning of epoch to generation of Out Token by the host (BR and BA)	0	1	N/A
2	Out Transaction period, BR	46	52	N/A
3	SAM BR Processing period		137	
4	Latest point at which SAM must have In Data available for host (BR and BA)			190
5,10	Time point at which host will initiate In Transaction (BR and BA)			192
6	Latency from (5) to appearance of In Token on bus		1	
7	In Transaction Period (BR and BA)	13,7	20	
8	Out Transaction period, BA	49	55	
9	SAM BA Processing period		134	
11	Latest point at which In Token phase will complete			213

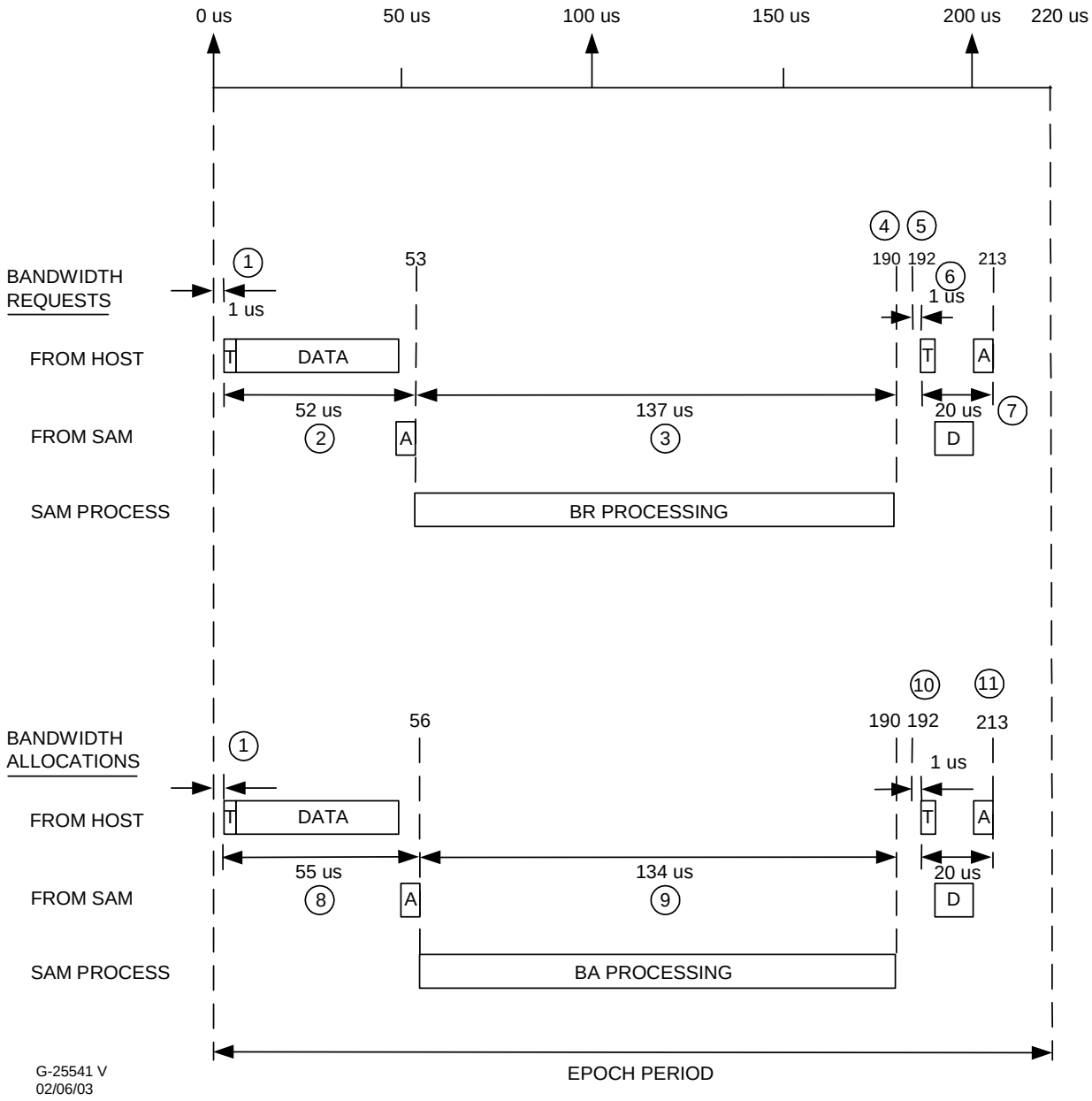


Figure 6.2: Bandwidth Request and Assignment timing diagram

6.1.7 Registration

The ST sends an ST REGISTRATION INDICATION message to the SAM to initialize the registration process. If ST is already registered, the SAM sends an ST REGISTRATION COMPLETE message to the ST informing it of the registration status. If ST is not registered, SAM initiates the registration process with the NOCC. The ST treats these messages transparently as described in clause 7, but shall use the SA-supervisory contention channel as described in TS 102 189-2 [3]. The ST shall transition from the DEREGISTERED state to the REGISTRATION INITIATED state as described in TS 102 189-1 [4].

If the registration is successful, the SAM informs the ST via the ST REGISTRATION COMPLETE message. The ST shall transition from the REGISTRATION INITIATED state to the REGISTERED state as described in TS 102 189-1 [4].

If the registration fails, the SAM shall send a ST REGISTRATION FAILURE BACKOFF message to the ST. This message contains a backoff timer value. The ST shall start the backoff timer. Upon timer expiry, the ST shall resend the ST REGISTRATION INDICATION message to the SAM.

6.1.8 De-registration

As described in TS 102 189-1 [4], the NOCC may deregister an ST. To do this, the NOCC shall send an encrypted message to the SAM/ST to deregister the ST. Upon reception of this message, the SAM shall clear the keys, registration and configuration information on the ST and send the NOCC a de-registration response as an acknowledgement. The SAM shall also inform the ST via a DE-REGISTRATION STATUS message to inform the ST that it has been de-registered. The ST shall transition from any substate of the REGISTERED state to the DEREGISTERED state as described in TS 102 189-1 [4].

7 Management messages

7.1 General

The SAM communicates to the NOCC through the ST. These messages are transparent to the ST and are always encrypted by the SAM. The NOCC sends messages to the SAM through the ST and these messages are also always encrypted. The ST shall strip the ST-SAM header from all messages received from the SAM and destined for the NOCC. The ST shall add UDP/IP headers and management protocol headers as required.

7.2 Segmentation and reassembly

Certain management messages are longer than the 64 byte limit of the USB interface. These messages are segmented as shown in figure 7.1 after the ST-SAM header is added. Each first segment is 60 bytes and both an L1 header and an H2 header are added such that the H2 header is in byte 0 and the L1 header is contained in bytes 1-3. Each middle segment is 63 bytes and only an H2 header is added such that the H2 header is in byte 0. Each last segment is 63 bytes or less and only an H2 header is added in byte 0. A first and last segment is 60 bytes or less and both an L1 and an H2 header are added such that the H2 header is in byte 0 and the L1 header is in bytes 1-3. Segments from one message shall not be combined with segments from another message.

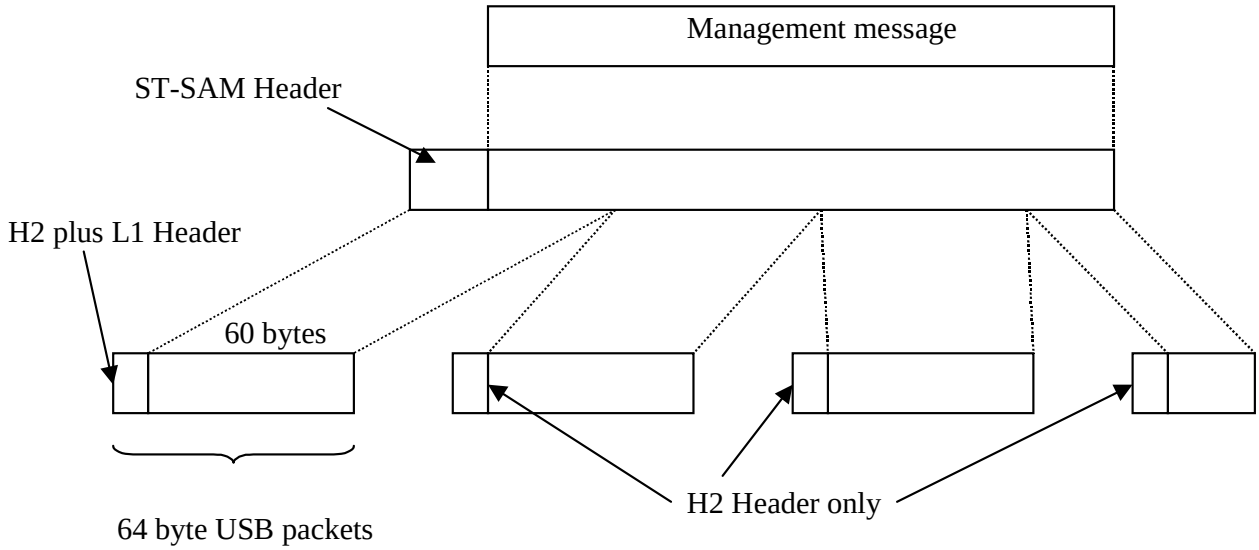


Figure 7.1: Segmentation and reassembly of management messages

8 Message formats

The ST-SAM communication shall adhere to the format defined below. This clause will describe the messages exchanged between the Satellite Terminals (ST) and the Security Access Module (SAM) and to define the rules under which they communicate.

8.1 Packet order of presentation

The order of presentation or transmission of packets on the ST-SAM interface is in consecutive byte number, starting with byte 0 (header) and ending with byte N. The transmit order of presentation of the bits within each byte of a packet is MSB first (bit 7) and LSB last (bit 0). The packets are transmitted in order as shown by the direction of transmission in figure 8.1.

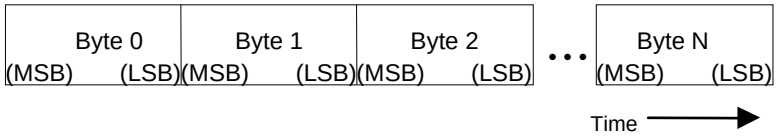


Figure 8.1: Packet byte and bit order of presentation

8.2 Order of bits within a field

The order of bits within a field shall be "big-endian" or network byte order as illustrated in figure 8.2.

(MSB) Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0	Byte
								N
				2^7	2^6	2^5	2^4	N + 1
2^3	2^2	2^1	2^0					N + 2
								N + 3

Figure 8.2: Order of bits within a field

8.3 Message types

Table 8.1 lists the message types which traverse the interface between the SAM and the ST. Only those messages which either originate at the ST and terminate at the SAM or originate at the SAM and terminate at the ST are described in this clause.

Table 8.1: Message types

Message type	Source-Destination	Msg type value
BANDWIDTH ASSIGNMENT INDICATION	ST-SAM	1
BANDWIDTH ASSIGNMENT RESPONSE	SAM-ST	2
BANDWIDTH ASSIGNMENT FAILURE	SAM-ST	3
BANDWIDTH REQUEST INDICATION	ST-SAM	4
BANDWIDTH REQUEST RESPONSE	SAM-ST	5
BANDWIDTH REQUEST FAILURE	SAM-ST	6
ACF CREATION INDICATION	ST-SAM	7
ACF CREATION RESPONSE	SAM-ST	8
ACF CREATION_FAILURE	SAM-ST	9
ACF CREATION FRAME COUNT INDICATION	ST-SAM	255
ST REGISTRATION INDICATION	ST-SAM	10
ST REGISTRATION COMPLETE	SAM-ST	15
ST REGISTRATION FAILURE BACKOFF	SAM-ST	17
SAM DEREGISTRATION STATUS	SAM-ST	21
ST HEALTH CHECK INDICATION	ST-SAM	34
ST HEALTH CHECK RESPONSE	SAM-ST	35

8.4 Error codes

The error codes are listed in table 8.2 per protocol category.

Table 8.2: Error codes

Protocol class	Error	Error code value
Generic error codes in SAM	InvalidSAMESN	1
	CorruptedMessage	2
	UnexpectedMessage	3
	InvalidIncomingMessage	7
	MessagePackUnpackError	8
	NoCurrentSessionKey	9
registration error code	NOCCAuthenticationFailure	26
	ChallengeWaitTimeout	27
	ResponseWaitTimeout	28
	NotRegistered	29
bandwidth assignment error code	BA_SessionKeysFailure	76
	BA_OutOfRange	77
	BA_InvalidSTId	78
	BA_FailedAIntegrity	79
bandwidth request error code	BR_SessionKeysFailure	101
	BR_UndefinedSTSourceID	102
	BR_InvalidRequestRate	103
	BR_InvalidRequestType	104
	BR_InvalidFrameCount	105
	BR_InvalidNumSlots	106
	BR_InvalidNumRequest	107
	BR_InvalidUplinkCellID	108
	BR_BRICGenerationFailure	109
ACF request error code	ACF_SessionKeysFailure	126
	ACF_InvalidSTSourceID	127
	ACF_InvalidDestination	128
	ACF_InvalidChannel	129
	ACF_InvalidSlot	130
	ACF_InvalidFrameNumber	131
	ACF_ContentionChannelConflict	132
	ACF_ContentionChannelUsage	133
	ACF_CONUSRequestInvalid	134
	ACF_PayloadReplicatorRequestInvalid	135
	ACF_DESComputationError	136
	ACF_InvalidHVULRequest	137
Generic error codes	RNGProcessorError	253
	OutOfSequence	254
	UnknownError	255

8.5 Message header formats

8.5.1 SAM-ST header

The ST-SAM communication will adhere to the format defined below for communications between the two entities. This SAM-ST header is attached to the each message between ST and SAM (the exceptions to this rule are the ACF Creation Indication, Response, Failure and Frame Count Indication). It appears before the SAM Security header and message data structure. The SAM-ST header is not encrypted.

(MSB) Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0	Byte
msgType								0
transID								1
msgLength								2
								3

Figure 8.3: SAM-ST header format

8.5.1.1 transID

The transID is an integer value used to identify the response to a certain message.

8.5.1.2 msgLength

The msgLength is the total length of the message (including messages that span multiple packets) excluding the SAM-ST header.

8.5.2 H2 header

All messages from the ST to the SAM and all response or failure messages from the SAM to the ST will have a H2 header at the beginning of the message.

8.5.2.1 ST -> SAM direction

The length of the H2 header is 4 bits for all messages from the ST to the SAM. The format is given in figure 8.4. Values are defined in table 8.3.

(MSB) Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0	Byte
H2 header				Spare (if L1 header is present)				0

Figure: 8.4: H2 header format ST -> SAM direction

Table 8.3: H2 header definition for ST -> SAM direction

Function	Value	Description/Comment
ACF	0000	ACF creation indication
BA	0001	Bandwidth Allocation
BR	0010	Bandwidth Request
Null 0	0011	Null Data, other data are not allowed to be written to SAM's TX_FIFO
Null 1	0100	Null Data, other data are allowed to be written to SAM's TX_FIFO
F/L 0	0101	First and Last packet, other data are not allowed to be written to SAM's TX_FIFO
F/L 1	0110	First and Last packet, other data are allowed to be written to SAM's TX_FIFO
F 0	0111	First packet, other data are not allowed to be written to SAM's TX_FIFO
F 1	1000	First packet, other data are allowed to be written to SAM's TX_FIFO
L 0	1001	Last packet, other data are not allowed to be written to SAM's TX_FIFO
L 1	1010	Last packet, other data are allowed to be written to SAM's TX_FIFO
M 0	1011	Middle packet, other data are not allowed to be written to SAM's TX_FIFO
M 1	1100	Middle packet, other data are allowed to be written to SAM's TX_FIFO
Frame Count	1101	Frame counter
reserved	1110	
reserved	1111	

8.5.2.2 SAM -> ST direction

The length of the H2 header is 8 bits for all messages from the SAM to the ST. The format is given in figure 8.5.

(MSB) Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0	Byte
C	spare		F/L		Function			0

Figure 8.5: H2 header format for the SAM -> ST direction

8.5.2.2.1 Function field

The function field specifies the message type per table 8.4.

Table 8.4: Function field definition

Function	Value
ACF Response	000
Bandwidth Allocation	001
Bandwidth Request	010
Other Data	011
Null	100
Reserved	Other values

8.5.2.2.2 F/L field

The F/L field specifies whether the packet is the first, middle or last packet of a data message per table 8.5. ACF response, Bandwidth allocation and bandwidth request messages shall always fit within one packet and the F/L field shall be coded as "11".

Table 8.5: F/L field definition

definition	Value
First packet	10
Middle packet	00
Last packet	01
First and last packet	11

8.5.2.2.3 C bit

The C bit interpretation is conditional on the value of the function field.

If the function is ACF response then C = 1 indicates ACF pass and C = 0 indicates ACF fail.

If the function is bandwidth allocation or bandwidth request then this bit is unused.

If the function is other data or null then the C bit acts as a flow control bit. If C = 1, the SAM is ready to receive more data and if the C = 0 then the SAM is not ready to received more data.

8.5.3 L1 header

The L1 header accompanies the H2 header for all messages between the ST and the SAM except the messages related to the ACF. The length of the L1 header is 3 bytes.

(MSB) Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0	Byte
spare	TMF							0
Length								1
								2

Figure 8.6: L1 header format

8.5.3.1 TMF

The TMF field is the target message FIFO address for which the message is intended in the SAM -> ST direction and the source TMF address for messages in the ST -> direction indicating to the SAM to which address the SAM response should be sent.

8.5.3.2 Length

The length field is defined as the length in bytes of the SAM- ST message plus 4 for the first H2 header and the L1 header. H2 headers prepended to any subsequent segments are not included in the length field value.

8.6 Message formats

8.6.1 ACF creation indication

The ACF CREATION INDICATION message is sent by the ST to the SAM to request an ACF code for an RSM-A packet.

L1 Header present: No

ST-SAM Header present: No

(MSB) Bit 7	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**(LSB) Bit 0**	**Byte**
H2 header				Sub-band designator				0
HVUL	Carrier designator							1
MAC header information 1								2
								3
								4
								5
								6
MAC header information 2								7
								8
								9
								10
								11
CGID index		Spare	Time slot number					12

Figure 8.7: ACF CREATION INDICATION message format

8.6.1.1 Sub-band designator

The Sub-band designator field is defined in TS 102 188-5 [1].

8.6.1.2 HVUL bit

The HVUL bit defines the MAC mode the terminal will use to transmit the packet. If the terminal is using HVUL mode, the HVUL bit = "1". If the terminal is using BoD mode, the HVUL bit = "0".

8.6.1.3 Carrier designator

The Carrier designator field is defined in TS 102 188-5 [1].

8.6.1.4 MAC header information

The MAC header information field contains the first five bytes of the 8-byte MAC packet header. The MAC-packet header is defined in TS 102 189-2 [3]. The MAC header information does not include the Source ID, see TS 102 189-2 [3].

8.6.1.5 CGID index

Instead of passing the 15 bit CGID field across the interface, the ST shall pass a two bit index field, since there are only three possible CGIDs for any transmit opportunity. The SAM already has the CGID values.

8.6.1.6 Time slot number

The Time slot number field is defined in TS 102 189-2 [3].

8.6.2 ACF creation response

The output of the Data Transmission process is an Access Control Field (ACF) code that is 4 bytes.

L1 Header Present: No

SAM-ST Header Present: No

(MSB) Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0	Byte
H2 header								0
ACF								1
								2
								3
								4

Figure 8.8: ACF CREATION RESPONSE message format

8.6.3 ACF creation failure

The SAM responses to the ST with a failure message when the ACF cannot be computed.

L1 Header Present: No

SAM-ST Header Present: No

(MSB) Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0	Byte
H2 header								0
Failure Code								1

Figure 8.9: ACF CREATION FAILURE message format

8.6.4 ACF creation frame count indication

The ST will send the Frame count (35 bits) at the beginning of each frame. The SAM will use the latest Frame Count from the ST to process subsequent ACF CREATION INDICATION Messages.

L1 Header present: No

SAM-ST Header Present: No

(MSB) Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0	Byte
H2 header				spare				0
								1
Frame Count								2
								3
								4

Figure 8.10: ACF CREATION FRAME COUNT INDICATION message format

Frame Count

The Frame count field is the current 35-bit uplink frame number in TOD [39, 5] format, see TS 102 188-7 [2].

8.6.4A ST health check indication

The ST HEALTH CHECK INDICATION message is sent by the ST to SAM to check the current registration status of ST.

L1 Header present: Yes

SAM-ST Header Present: Yes

(MSB) Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0	Byte
ACF TMF								0
BR/BA TMF								1
Other TMF								2

Figure 8.11: ST HEALTH CHECK INDICATION message format

8.6.5 ST health check response

The ST Health Check Response message is sent by the SAM to ST in response to an ST Health Check Indication.

L1 Header present: Yes

SAM-ST Header Present: Yes

(MSB) Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0	Byte
Error Code								0
								1
								2
								3
Boot SW version								4
Boot SW ICD version								5
								6
								7
								8
Operation SW version								9
Operation SW ICD version								10
								11
								12
								13
RS	CK	Spare						14

Figure 8.12: ST HEALTH CHECK RESPONSE message format

8.6.5.1 Return code

The Error Codes are defined in clause 8.4.

8.6.5.2 Boot SW version

The Boot SW Version number is a configurable parameter in the SAM.

8.6.5.3 Boot SW ICD version

The bootSwICDVersion is a configurable parameter in the SAM.

8.6.5.4 Operation SW version

The operationSwVersion is a configurable parameter in the SAM representing the operational software version. The value of this parameter is "0" if the SAM does not have operational software.

8.6.5.5 Operation SW ICD version

The operationSwIcdVersion is the SAM-NOCC interface version which the SAM supports.

8.6.5.6 RS bit

The RS bit is the registration status of the ST. If the ST is registered the value = "1" and if the ST is not registered the value = "0".

8.6.5.7 CK bit

The CK bit indicates whether or not the SAM has CP Keys. If the SAM has valid keys the value = "1" and if the SAM does not have valid keys the value = "0".

8.6.6 Bandwidth Assignment indication

The ST receives Bandwidth assignments from the satellite in a Bandwidth assignment message (see TS 102 189-2 [3]). The ST shall forward this message to the SAM for verification. The SAM will use data from the bandwidth assignments to determine which data packets it should subsequently approve for transmission. There can be up to 9 assignments per Bandwidth assignment message. However, each assignment contains a BCSTIDand an ST shall filter these messages and only send to the SAM, those assignments which are addressed to that ST.

L1 Header present: Yes

SAM-ST Header Present: Yes

<table>
<tr><th>(MSB)
Bit 7</th><th>Bit 6</th><th>Bit 5</th><th>Bit 4</th><th>Bit 3</th><th>Bit 2</th><th>Bit 1</th><th>(LSB)
Bit 0</th><th>Byte</th></tr>
<tr><td colspan="8">Uplink frame number</td><td>0</td></tr>
<tr><td colspan="8">Number of assignments</td><td>1</td></tr>
<tr><td colspan="8">IF version</td><td>2</td></tr>
<tr><td colspan="8" rowspan="9">Assignment field #1</td><td>3</td></tr>
<tr><td>4</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td></tr>
<tr><td>9</td></tr>
<tr><td>10</td></tr>
<tr><td>11</td></tr>
<tr><td colspan="8" rowspan="3">… other assignment fields
(optional)</td><td></td></tr>
<tr><td>…</td></tr>
<tr><td></td></tr>
<tr><td colspan="8" rowspan="4">TOD check</td><td>9m + 3</td></tr>
<tr><td></td></tr>
<tr><td></td></tr>
<tr><td>9m + 6</td></tr>
</table>

Figure 8.13: BANDWIDTH ASSIGNMENT INDICATION message format

8.6.6.1 Uplink frame number

The frame number field is an integer value representing the uplink frame number for which the assignments contained in the message are valid. The uplink frame number uses TOD [12, 5] format, TS 102 188-7 [2].

8.6.6.2 Number of assignments

Number of assignments contained in the message. This value cannot exceed 5.

8.6.6.3 IF version

Interface Version.

8.6.6.4 Assignment field

The assignment field is defined in TS 102 189-2 [3].

8.6.6.5 TOD check

The TOD check is contained in the bandwidth assignment message which the ST receives from the satellite.
See TS 102 189-2 [3].

8.6.7 Bandwidth Assignment response

The BANDWIDTH ALLOCATION RESPONSE message is sent to the ST if the BANDWIDTH ALLOCATION INDICATION is successful and the SAM has stored all the allocations properly. The ST is not waiting for any response from the SAM but the SAM sends the message nevertheless, to indicate that the storage of the bandwidth allocations has been successful. A NULL message is sent to the ST to complete the interface requirements.

L1 Header Present: Yes

SAM-ST Header Present: Yes

8.6.8 Bandwidth Assignment failure

The SAM sends the BANDWIDTH ASSIGNMENT FAILURE message to the ST if the SAM did not receive the Bandwidth allocations correctly. The GeneralFailureCode represents general failure code and does not attribute to any particular allocations. The AllocationFailureCode is specific to one of the five-bandwidth allocations. The index indicates which allocation has failed and the value indicates why it failed.

L1 Header Present: Yes

SAM-ST Header Present: Yes

(MSB) Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0	Byte
General error code								0
Assignment #1 error Code								1
Assignment #m error code								m

Figure 8.14: BANDWIDTH ASSIGNMENT FAILURE message format

8.6.8.1 Failure code

The General and assignment specific error codes are described in clause 8.5. The index indicates which allocation has failed and the value indicates the error code. It may be possible that one allocation may be successful and the other produces an error. An assignment error Code of zero"0" indicates that there is no failure corresponding to that assignment. The number of assignment failure codes, m, refers to the number of assignments in the corresponding BANDWIDTH ASSIGNMENT INDICATION message.

8.6.9 Bandwidth Request indication

L1 Header Present: Yes

SAM-ST Header Present: Yes

(MSB) Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0	Byte
Frame count								0
								3
Bandwidth request header								4
								9
Bandwidth request data #1								10
								15
Bandwidth request data #2								16
								21
Bandwidth request data #3								22
								27
Bandwidth request data #4								28
								33
Bandwidth request data #5								34
								39
Spare								40
								48

Figure 8.15: BANDWIDTH REQUEST INDICATION message format

8.6.9.1 Frame count

The frame count format is specified in TS 102 189-2 [3].

8.6.9.2 Bandwidth request header

The bandwidth request header format is specified in TS 102 189-2 [3].

8.6.9.3 Bandwidth request data

The bandwidth request data field format is given in TS 102 189-2 [3].

8.6.10 Bandwidth Request response

The output of the Bandwidth Request process is a Bandwidth Request Integrity Check (BRIC) code which is 4 bytes plus ST-SAM message overhead.

L1 Header Present: Yes

SAM-ST Header Present: Yes

(MSB) Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0	Byte
Integrity check								0
								1
								2
								3
ABkey	spare							4

Figure 8.16: BANDWIDTH REQUEST RESPONSE message format

8.6.10.1 Integrity check

The integrity check is a check field created by the SAM. The ST shall include this information within the bandwidth request message it transmits to the satellite. The satellite shall reject all bandwidth requests which do not have a valid integrity check field.

8.6.10.2 AB Key

The AB key bit indicates the key used to calculate the Integrity Check, A = 0, B = 1. The ST shall include this information in the bandwidth request message it transmits to the satellite.

8.6.11 Bandwidth Request Failure

This message indicates the failure code or the failure reason whenever a bandwidth request to the SAM fails to produce a Bandwidth Request Integrity Check code.

L1 Header Present: Yes

SAM-ST Header Present: Yes

(MSB) Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0	Byte
Failure Code								0

Figure 8.17: BANDWIDTH REQUEST FAILURE message format

8.6.12 ST registration indication

The ST sends this message to the SAM to initialize the registration process.

L1 Header Present: Yes

SAM-ST Header Present: Yes

(MSB) Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0	Byte
challengeResponseTimeoutValue								0
								1
registrationRequestTimeoutValue								2
								3

Figure 8.18: ST REGISTRATION INDICATION message format

8.6.12.1 challengeResponseTimeoutValue

The challengeResponseTimeoutValue is a configurable parameter.

8.6.12.2 registrationRequestTimeoutValue

The registrationRequestTimeoutValue is a configurable parameter.

8.6.13 ST registration complete

The ST REGISTRATION COMPLETE message is sent by the SAM to the ST to inform the ST that Registration is complete and was successful.

L1 Header Present: Yes

SAM-ST Header Present: Yes

(MSB) Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0	Byte
MC	Spare							0

Figure 8.19: ST REGISTRATION COMPLETE format

8.6.13.1 MC bit

The MC bit is set to "1" if the registration process completes successfully and is set to "0" if the ST is already registered.

8.6.14 ST registration failure backoff

The ST REGISTRATION FAILURE BACKOFF message is sent to the ST by the SAM upon receiving the ST Registration Failure message from the NOCC. The SAM shall forward the error code and backoff timer value sent by the NOCC.

L1 Header Present: Yes

SAM-ST Header Present: Yes

(MSB) Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0	Byte
Error Code								0
								1
								2
								3
backOffTime								4
								5
								6
								7
Reserved								8

Figure 8.20: ST REGISTRATION FAILURE BACKOFF format

8.6.14.1 Error Code

The Error Codes are defined in clause 8.4.

8.6.14.2 backOffTime

The backoff time is sent to the SAM by the NOCC in the message. It is in units of seconds and the minimum value is 0 seconds and the maximum value is 1 000 seconds.

8.6.15 SAM deregistration status

The SAM DEREGISTRATION STATUS message is sent by the SAM to the ST with the status of a de-registration command from the NOCC.

L1 Header Present: Yes

SAM-ST Header Present: Yes

(MSB) Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	(LSB) Bit 0	Byte
Error code								0
								1
								2
								3
Reserved								14

Figure 8.21: SAM DEREGISTRATION STATUS format

8.6.15.1 Error code

The Error Codes are defined in clause 8.4.

Annex A (informative): SAM pin layout

A.1 SAM pin layout

Table A.1 displays one recommended implementation of pin assignments for the SAM chip. This implementation uses the JEDEC standard 24 pin SOIC package.

Pins 1, 4 and 16 are chip ground. Pin 24 is the voltage supply for the chip. Pins 3, 6, 7, 12, 17 and 19 are signal inputs which are connected to ground. Pin 5 is the 48 MHz clock. Pins 20 and 21 are signal inputs pulled to logical level 1 (+ 5 volts). Pins 8, 9, 10, 15, 18 and 22 are signal inputs which are left open. Pins 11 and 14 are the USB differential data. Pins 2, 13 and 23 are not used.

Table A.1

GND	1		24	VCC + 5 V
Not used	2		23	Not used
GND	3		22	open
GND	4		21	+ 5 V
48 MHz	5		20	+ 5 V
GND	6		19	GND
GND	7		18	open
open	8		17	GND
open	9		16	GND
open	10		15	open
D -	11		14	D +
GND	12		13	Not used

Annex B (informative): Message flow diagrams

B.1 Successful bandwidth request/assignment/data transfer

Figure B.1 shows the message flow diagram for both the ST-Satellite interface and the ST-SAM interface for a successful data transfer. The ST-Satellite bandwidth-on-demand procedures are described in TS 102 189-2 [3]. See clauses 6.1.3, 6.1.4 and 6.1.5 for a description of the procedures associated with the ST-SAM interface.

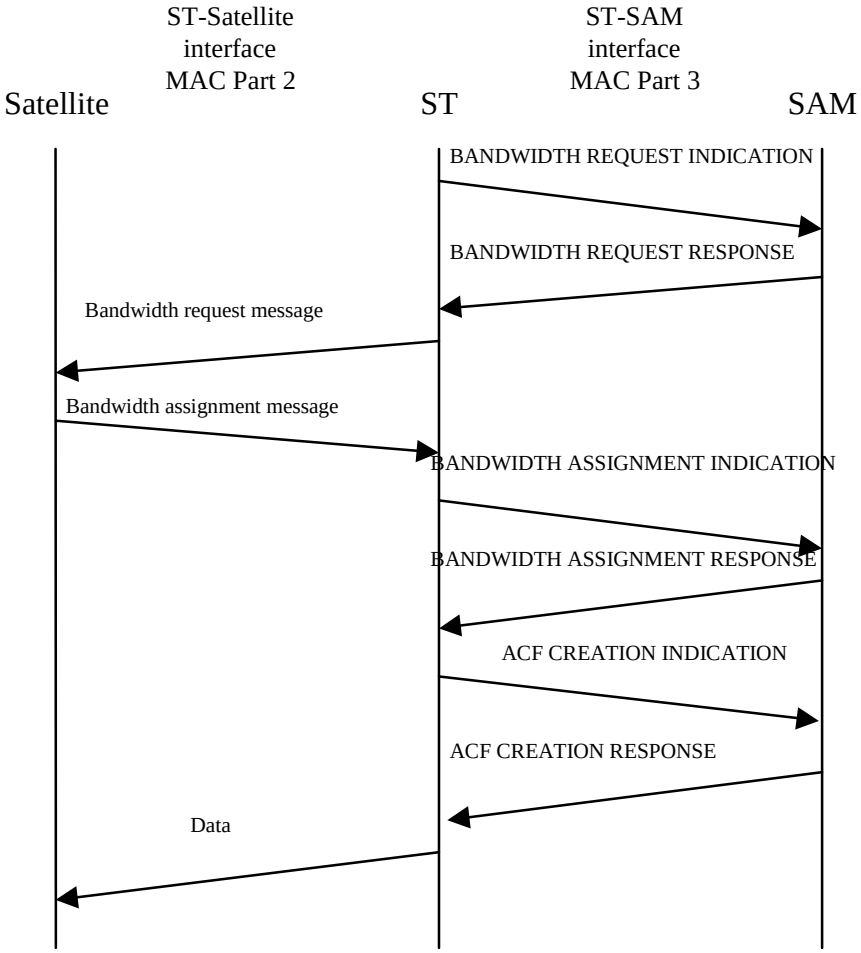


Figure B.1: Successful data transfer

B.2 Successful registration

Figure B.2 shows the message flow diagram for both the SAM-NOCC interface and the ST-SAM interface for a successful registration. See clause 6.1.8 for a description of the procedures associated with the ST-SAM interface. The SAM-NOCC procedures are outside the scope of the present document.

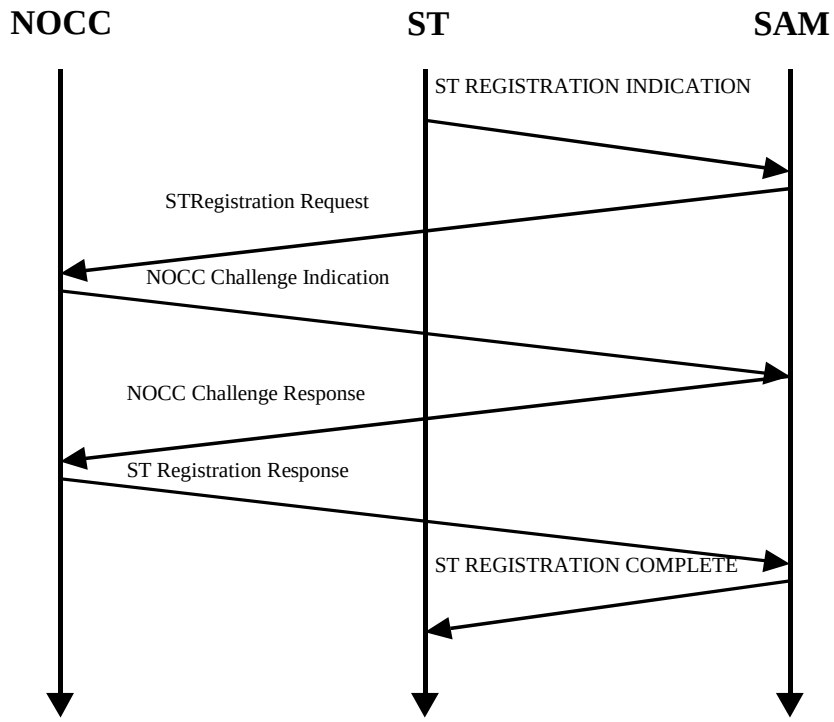


Figure B.2: Successful registration

B.3 Successful de-registration

Figure B.3 shows the message flow diagram for both the SAM-NOCC interface and the ST-SAM interface for a successful de-registration. See clause 6.1.9 for a description of the procedures associated with the ST-SAM interface. The SAM-NOCC procedures are outside the scope of the present document.

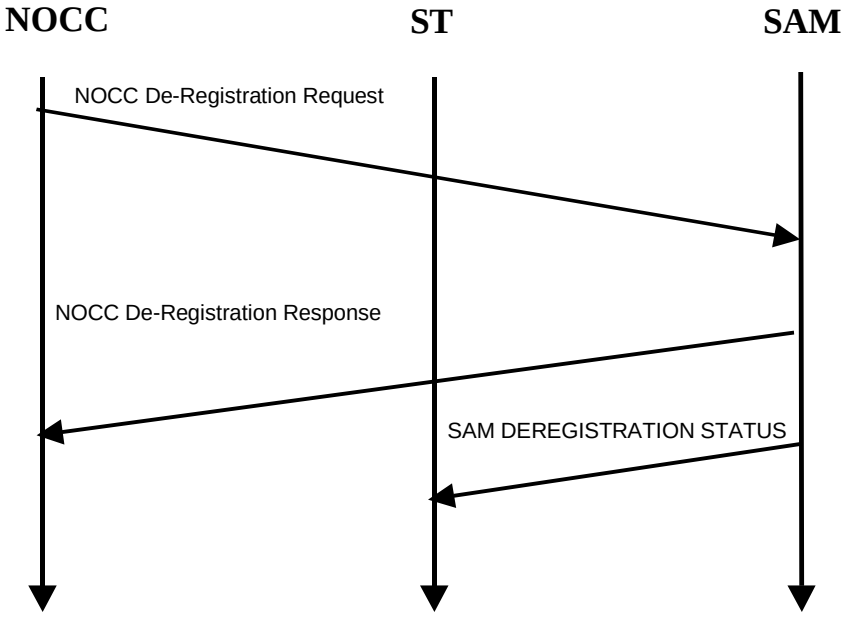


Figure B.3: Successful de-registration

Annex C (informative): Bibliography

ETSI TS 102 188-1: "Satellite Earth Stations and Systems (SES); Regenerative Satellite Mesh - A (RSM-A) air interface; Physical layer specification; Part 1: General description".

ETSI TS 102 188-2: "Satellite Earth Stations and Systems (SES); Regenerative Satellite Mesh - A (RSM-A) air interface; Physical layer specification; Part 2: Frame structure".

ETSI TS 102 188-3: "Satellite Earth Stations and Systems (SES); Regenerative Satellite Mesh - A (RSM-A) air interface; Physical layer specification; Part 3: Channel coding".

ETSI TS 102 188-4: "Satellite Earth Stations and Systems (SES); Regenerative Satellite Mesh - A (RSM-A) air interface; Physical layer specification; Part 4: Modulation".

ETSI TS 102 188-6: "Satellite Earth Stations and Systems (SES); Regenerative Satellite Mesh - A (RSM-A) air interface; Physical layer specification; Part 6: Radio link control".

ETSI TR 101 984: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia; Services and Architectures".

ETSI TR 102 287: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); IP interworking over satellite; Security Aspects."

History

Document history		
V1.1.1	March 2004	Publication