ETSI TR 103 444 V1.1.1 (2016-12)

Satellite Earth Stations and Systems (SES);
Broadband Satellite Multimedia (BSM);
Guide to Satellite Independent
Service Access Point (SI-SAP) use

Reference
DTR/SES-00403

Keywords
BSS, satellite, MSS, protocol, interface

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Sous-Préfecture de Grasse (06) N° 7803/88

Contents

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Foreword

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

Modal verbs terminology

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Executive summary

The present document summarizes the main functions of the ETSI BSM architecture, with special emphasis on the services offered by Satellite Independent Service Access Point (SI-SAP) interface to the higher protocol layers as well as the primitives defined to invoke those services. In more detail, the present document provides a guide to the use of the related ETSI BSM documentation, worked out since year 2001 and updated in year 2015, providing precise pointers to the ETSI technical specifications (TSes) and reports (TRs), where the ETSI BSM architecture functions and SI-SAP interface services are defined and specified.

The aim of the present document is illustrate the main functions of the ETSI BSM architecture and the services offered by the SI-SAP interface.

Introduction

The present document focuses on the ETSI BSM architecture which defines the main actors involved in satellite communications, including the satellite network itself, external subnetworks, and the related interfaces. In particular, the ETSI BSM architecture defines a layered architecture separating the satellite dependent (SD, physical and datalink layers according to ISO/OSI terminology) from the satellite independent (SI, network layer) by means of the Satellite Independent Service Access Point (SI-SAP) interface, which provides an hardware abstraction layer easing the implementation of cross-layer mechanisms and interoperability of multi-vendor devices.

The SI-SAP interface can be actually implemented as logical or physical interface. In the former configuration, the SI-SAP interface extends and adapts the functions already provided by the interface existing between L1 and L2 of the ISO/OSI protocol stack, hence possibly enabling new services. On the other hand, the latter configuration corresponds to the case where the SI-SAP interface is actually implemented in two physically separated elements (e.g. a user terminal and a satellite modem), whereby the defined SI-SAP services can be run by means of a dedicated message exchange protocol.

The aforementioned capabilities offered by the SI-SAP interface are defined in terms of specific services that can be requested by the SI layer to the SD layer, respectively implementing SD and SI adaptation functions (provided namely by the SDAF and SIAF modules) for this purpose. In particular, the SI-SAP services currently defined deal with control and user plane functionalities, such as data transfer, address resolution, resource reservation, multicast management, logon/logoff, and configuration of the satellite independent (SI) layer.

The present document addresses the functions offered by the ETSI BSM architecture and the services implemented by the SI-SAP interface, illustrating the main characteristics and pointing to the related ETSI BSM literature, so as to offer a standalone guidance document for satellite system designers and implementers.

1 Scope

The present document provides a guide to ETSI BSM architecture and SI-SAP interface for satellite system designers and implementers, in terms of pointers to the relevant ETSI BSM literature.

Firstly, the document addresses the functions that are offered by the ETSI BSM architecture, providing the description of the main features and pointing to the specific TSs and TRs that detail these functions. In more detail, the following functions are illustrated:

- Data transfer.
- QoS management.
- Address resolution.
- Multicast management.
- Security.
- Network integration.
- Performance management.

Secondly, the document addresses the services that are offered by the SI-SAP interface and are run between the satellite independent (SI) and satellite dependent (SD) layers. Similarly to the description of the aforementioned ETSI BSM architecture functions, illustration of the main features is provided along with the pointers to the relevant ETSI BSM documents where the SI-SAP services are defined, specified, and analysed. The considered SI-SAP interface services are:

- Logon/logoff.
- Satellite independent layer configuration.
- Address resolution.
- Resource reservation.
- Multicast group receive and transmit.
- Data transfer.

The aim of the present document is to provide a standalone guide to the ETSI BSM standardization track, which is based on several technical specifications and reports.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TS 103 275: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Common air interface specification; Satellite Independent Service Access Point (SI-SAP) interface: Services".

[i.2] ETSI TS 102 856-2: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Multi-Protocol Label Switching (MPLS) interworking over satellite; Part 2: Negotiation and management of MPLS labels and MPLS signalling with attached networks".

[i.3] ETSI TS 102 856-1: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Multi-Protocol Label Switching (MPLS) interworking over satellite Part 1: MPLS-based Functional Architecture".

[i.4] ETSI TS 102 855: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Interworking and Integration of BSM in Next Generation Networks (NGNs)".

[i.5] ETSI TR 102 676: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Performance Enhancing Proxies (PEPs)".

[i.6] ETSI TS 102 675-2: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Part 2: Performance Management Information Base".

[i.7] ETSI TS 102 675-1: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Part 1: Performance Management at the SI-SAP".

[i.8] ETSI TS 102 674: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); PIM-SM Adaptation".

[i.9] ETSI TS 102 673: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Performance Parameters".

[i.10] ETSI TS 102 672: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Management Functional Architecture".

[i.11] ETSI TR 102 467: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Transition to IPv06".

[i.12] ETSI TS 102 466: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Multicast Security Architecture".

[i.13] ETSI TS 102 465: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); General Security Architecture".

[i.14] ETSI TS 102 464: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Interworking with DiffServ QoS".

[i.15] ETSI TS 102 463: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Interworking with IntServ QoS".

[i.16] ETSI TS 102 462: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); QoS Functional Architecture".

[i.17] ETSI TS 102 461: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Multicast Source Management".

[i.18] ETSI TS 102 460: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Address Management at the SI-SAP".

[i.19] ETSI TS 102 357: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Common Air interface specification; Satellite Independent Service Access Point (SI-SAP) interface: Primitives".

[i.20] ETSI TR 102 353: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Guidelines for the Satellite Independent Service Access Point (SI-SAP)".

[i.21] ETSI TS 102 295: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM) services and architectures; BSM Traffic Classes".

[i.22] ETSI TS 102 294: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM) services and architectures; IP interworking via satellite; Multicast functional architecture".

[i.23] ETSI TS 102 293: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM) services and architectures; IP Interworking over satellite; Multicast group management; IGMP adaptation".

[i.24] ETSI TS 102 292: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM) services and architectures; Functional architecture for IP interworking with BSM networks".

[i.25] ETSI TR 102 287: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); IP Interworking over satellite; Security aspects".

[i.26] ETSI TR 102 187: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia; Overview of BSM families".

[i.27] ETSI TR 102 157: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia; IP Interworking over satellite; Performance , Availability and Quality of Service".

[i.28] ETSI TR 102 156: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia; IP interworking over satellite; Multicasting".

[i.29] ETSI TR 102 155: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia; IP interworking over satellite; Addressing and routing".

[i.30] ETSI TR 101 985: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia; IP over Satellite".

[i.31] ETSI TR 101 984: "Satellite Earth Stations and Systems (SES); Broadband Satellite Multimedia (BSM); Services and architectures".

[i.32] IETF RFC 4815: "RObust Header Compression (ROHC): Corrections and Clarifications to RFC 3095".

[i.33] IETF RFC 3261: "SIP: Session Initiation Protocol".

[i.34] IETF RFC 753: "Internet Message Protocol".

[i.35] IETF RFC 793: "Transmission Control Protocol".

[i.36] IETF RFC 768: "User Datagram Protocol".

[i.37] IETF RFC 3135: "Performance Enhancing Proxies Intended to Mitigate Link-Related Degradations".

[i.38] ISO/IEC 7498-1: "Information Technology - Open Systems Interconnection - Basic Reference Model: The Basic Model. International Standard".

[i.39] ISO/IEC 10731: "Information Technology - Open Systems Interconnection - Basic Reference Model-Conventions for the Definition of OSI Services. International Standard".

[i.40] IETF RFC 3376: "Internet Group Management Protocol, Version 3".

[i.41] IETF RFC 4601: "Protocol Independent Multicast - Sparse Mode (PIM-SM): Protocol Specification (Revised)".

[i.42] IETF RFC 2205: "Resource Reservation Protocol (RSVP) - Version 1 Functional Specification".

[i.43] IETF RFC 3031: "Multiprotocol Label Switching Architecture".

[i.44] IETF RFC 3209: "RSVP-TE Extensions to RSVP for LSP Tunnels".

[i.45] IETF RFC 2460: "Internet Protocol, Version 6 (IPv6) Specification" Deering, S. and R. Hinden.

[i.46] ETSI EN 302 307: "Digital Video Broadcasting (DVB); Second generation framing structure, channel coding and modulation systems for Broadcasting, Interactive Services, News Gathering and other broadband satellite applications (DVB-S2)".

[i.47] ETSI TS 101 545-1: "Digital Video Broadcasting (DVB); Second Generation DVB Interactive Satellite System (DVB-RCS2); Part 1: Overview and System Level specification".

3 Definitions and abbreviations

3.1 Definitions

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

architecture: abstract representation of a communications system

NOTE: Three complementary types of architecture are defined:

- Functional Architecture: the discrete functional elements of the system and the associated logical interfaces.
- Network Architecture: the discrete physical (network) elements of the system and the associated physical interfaces.
- Protocol Architecture: the protocol stacks involved in the operation of the system and the associated peering relationships.

BSM network: together with the BSM interworking and adaptation functions that are required to provide IP interfaces (i.e. layer 3 and below) to attached networks

BSM subnetwork: all the BSM network elements below the Satellite Independent Service Access Point (SI-SAP)

BSM System (BSMS): system comprising a BSM Network together with a Network Management Centre (NMC) and Network Control Centre (NCC)

NOTE: The BSM System also includes any additional elements that are required to provide the network services to the subscribers and their users.

control plane: plane that provides the control functions

NOTE: The control plane has a layered structure and performs the call control and connection control functions; it deals with the signalling necessary to set up, supervise and release calls and connections.

flow (of IP packets): traffic associated with a given connection-oriented, or connectionless, packet sequence having the same 5-tuple of source address, destination address, Source Port, Destination Port and Protocol type

forwarding: process of relaying a packet from source to destination through intermediate network segments and nodes

NOTE: The forwarding decision is based on information that is already available in the routing table. The decision on how to construct that routing table is the routing decision.

management plane: plane that provides the management functions

NOTE: The management plane provides two types of functions, namely Layer Management and plane management functions:

- Plane management functions are functions related to a system as a whole and provides coordination between all the planes. Plane management has no layered structure.
- Layer management functions are functions relating to resources and parameters residing in its protocol entities. Layer management handles the operation and maintenance (OAM) of information flows specific to the layer concerned.

network control centre: equipment at OSI Layer 2 that controls the access of terminals to a satellite network, including element management and resource management functionality

user plane: plane that has a layered structure and provides user information transfer, along with associated controls (e.g. flow control, recovery from errors, etc.)

3.2 Abbreviations

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

3GPP	3rd Generation Partnership Project
BSM	Broadband Satellite Multimedia
BSM_GID	BSM Group Identity
BSM_ID	BSM IDentifier
BSMS	BSM System
CFM	ConFirMation
DiffServ	Differentiated services
DVB-RCS2	Digital Video Broadcasting for Return Channel Satellite, 2nd generation
DVB-S2	Digital Video Broadcasting for Satellite, 2nd generation
FCAPS	Fault, Configuration, Accounting, Performance, Security
IGMP	Internet Group Membership Protocol
IMS	Internet Multimedia Subsystem
IND	INDication
IntServ	Integrated Services
IP	Internet Protocol
IPv6	Internet Protocol version 6
ISO	International Organization for Standardization
L2	Layer 2 (of the ISO/OSI protocol stack)
L3	Layer 3
MPLS	Multi-Protocol Label Switching
NCC	Network Control Centre
NGN	Next Generation Network
NMC	Network Management Centre
OSI	Open Systems Interconnection
PEP	Performance Enhancing Proxy
PIM-SM	Protocol Independent Multicast - Sparse Mode
QID	Queue Identifier
QIDSPEC	QID Specification
QoS	Quality of Service
REQ	REQuest
RES	RESponse
ROHC	Robust Header Compression
RSVP	Resource ReserVation Protocol
RSVP-TE	Resource Reservation Protocol - Traffic Engineering
SAP	Service Access Point
SD	Satellite Dependent
SDAF	Satellite Dependent Adaptation Functions
SI	Satellite Independent
SIAF	Satellite Independent Adaptation Functions
SIP	Session Initiation Protocol

SI-SAP	Satellite Independent Service Access Point
SLC	Satellite Link Control
SLS	Service Level Specification
SMAC	Satellite Medium Access Control
SPHY	Satellite Physical
TCP	Transmission Control Protocol
TR	Technical Report
TS	Technical Specification
UDP	User Datagram Protocol

4 ETSI BSM architecture background

4.1 Functional architecture

4.1.1 Main elements

The main principles of the ETSI BSM architecture [i.30] and [i.31] consist in logically separating the Satellite Independent (SI) layers (e.g. IP layer) from the Satellite Dependent (SD) layers, in order to provide an hardware-abstraction layer capable of defining efficient cross-layer mechanisms and enhancing the interoperability between devices (e.g. satellite terminals and gateways) procured by different manufacturers. This enriched set of functions is operated through the Satellite Independent - Service Access Point (SI-SAP), which actually extends the capabilities naturally offered by the Service Access Point (SAP) [i.19], defined between Layer 2 (L2) and Layer 3 (L3) of the protocol stack, according to the ISO/OSI protocol architecture terminology [i.38]. Likewise, the services primitives exchanged between SI and SD layers naturally complement and extend those defined between L3 and L2 layers. The application of such concept in a general satellite network results in the definition of the ETSI BSM architecture [i.24] superimposed to the reference satellite usually constituted by satellite terminals, gateway, satellite, Network Management Centre (NMC), and Network Control Centre (NCC). The overall ETSI BSM architecture is applicable to the different configurations that a satellite network can be implementing in terms of topology (star, mesh) and payload operation (transparent and regenerative), which are suitably casted into different BSM families [i.26].

The functional architecture comprises three main elements (depicted in figure 4.1):

- BSM Subnetwork. It is composed of the satellite network interfaces implemented in the ground network elements (e.g. satellite terminals and gateways) and the satellite in its entireness (i.e. feeder up-/down-links, user up-/down-links, and payload).
- BSM Network. It is composed of the BSM subnetwork and the rest of the satellite terminal and gateway protocol stack, including the SI-SAP interface along with the interworking functions (user and gateway side) and the network interfaces towards the outside of the BSM network.
- BSM System (BSMS). It is the composed of the BSM network, NMC and NCC. The BSM system essentially provides control and management on the entire BSM network.

NOTE: Network premises and external network can be connected to the BSM network, according to the technology implemented at the physical layer.

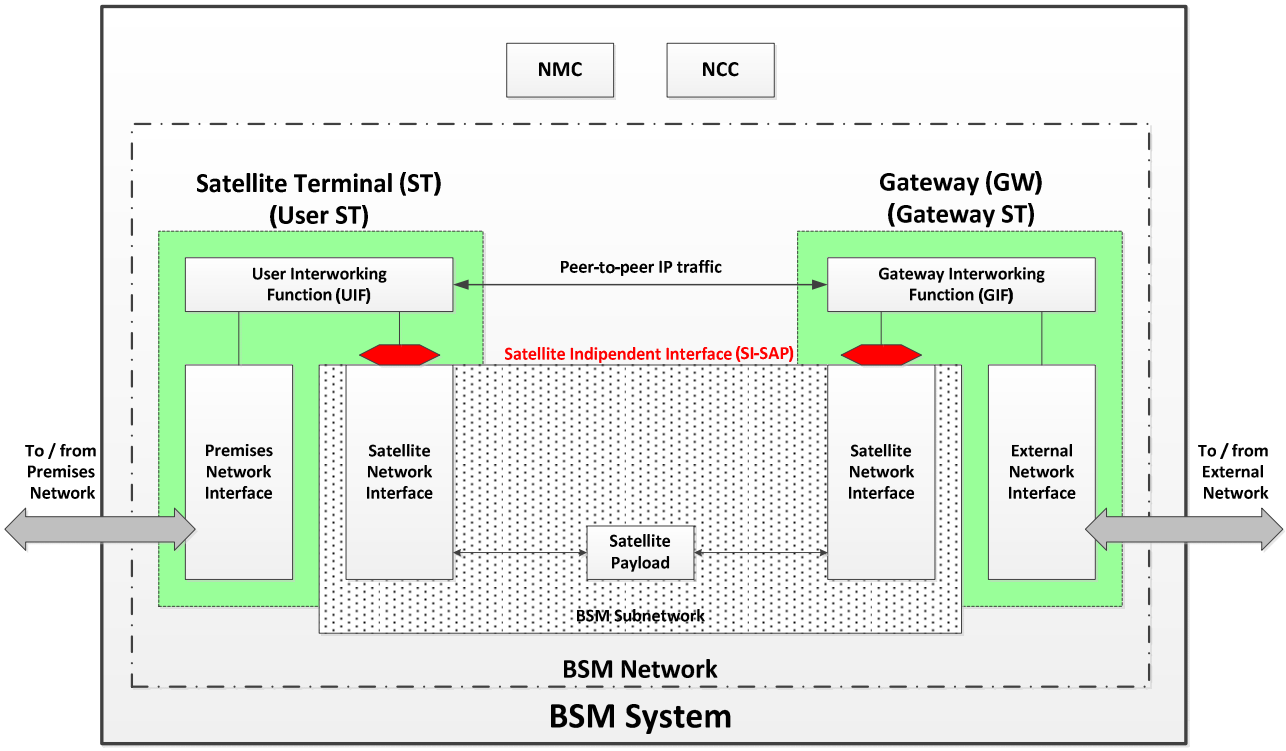

Figure 4.1: ETSI BSM Architecture Decomposition

4.1.2 Main functions

The functions offered by the ETSI BSM architecture are actually provided by SI and SD layers [i.20]. Since the ETSI BSM architecture can be considered as a superposition of traditional protocol architectures employed in nowadays telecommunication networks, the available functions are essentially the same. The main difference, instead, consists in the way they are implemented because of the intrinsic characteristics of satellite technology and the way interaction between SI and SD layers (where applicable) is performed because of the mutual role of the SI-SAP interface.

In more detail, the main functions offered by the ETSI BSM architecture, also according to the currently available ETSI BSM documentation, are the following (further detailed in clause 5):

- Data transfer.
- QoS management.
- Address resolution.
- Multicast management.
- Security.
- Network integration.
- Performance management.

The aforementioned functions can be considered as macro-functions, in that they can be further decomposed in atomic functions. In the case these atomic functions are segregated to a specific layer without any interaction with others, they can be regarded as procedures run by the protocol entity during the execution of the defined protocol service. On the contrary, if the atomic functions result in the interaction between adjacent protocol layers, they can be regarded as service primitives exchanged across the service access point (interface) defined between the two adjacent layers. As such, the atomic functions offered by the SD to the SI layer through the SI-SAP interface can be considered as SI-SAP interface service primitives.

Finally it can be also noticed that because of this relation, functions and SI-SAP interface service primitives may bring the same name. This occurs when a specific function provided by the ETSI BSM architecture actually coincides to the service that is provided by the SD to the SI layer. For instance, address resolution and data transfer functions are atomic functions that require interactions between SI and SD layers through the SI-SAP interface, hence coinciding with the corresponding SI-SAP interface services. On the other hand, multicast management (for instance) is a macro-function that is composed of several atomic functions, amongst which multicast group transmit and receive are mapped onto the corresponding services provided through the SI-SAP interface. More details about the SI-SAP interface and the related service primitives are provided in clauses 4.2 and 4.3.

4.2 SI-SAP interface

The SI-SAP interface [i.1], [i.19] and [i.20] provides a functional separation between satellite dependent (SD) and independent (SI) layers. The implementation of the SI-SAP interface actually allows keeping the implementation of SI and SD layers separated and independent, while all adaptations functions are carried out by dedicated Satellite Independent and Satellite Dependent Adaptation Functions (SIAF and SDAF modules, respectively).

In more detail, the SI layer implements the network layer of the protocol stack, whereas the protocol layers operating on top of it are considered as external layers. Considering that most of telecommunication networks implement nowadays the TCP/IP protocol suite, it can be observed that the IP [i.34] layer are actually implemented in the SI layer, whereas TCP [i.35] and UDP [i.36] protocols are considered as external layers lying on top of the SI layer (IP). Furthermore, the SI layer also implements the satellite independent adaptation functions (SIAF) module aimed at performing all necessary functions to allow SI to interwork with the SD layer.

On the other hand, the SD layer implements the lowers layer of the protocol stack: Satellite link control (SLC), Satellite medium access control (SMAC), and Satellite physical (SPHY).

The SD layer also implements the satellite dependent adaptation functions (SDAF) module aimed at performing all necessary functions to allow SD to interwork with the SI layer. In more detail, the interaction between SI and SD layers is performed by the SIAF and SDAF modules, which exchange primitives according to the service requested from the SI layer to the SD layer, through the SI-SAP interface.

The functional separation between SI and SD layer operated by the SI-SAP interface is sketched in figure 4.2.

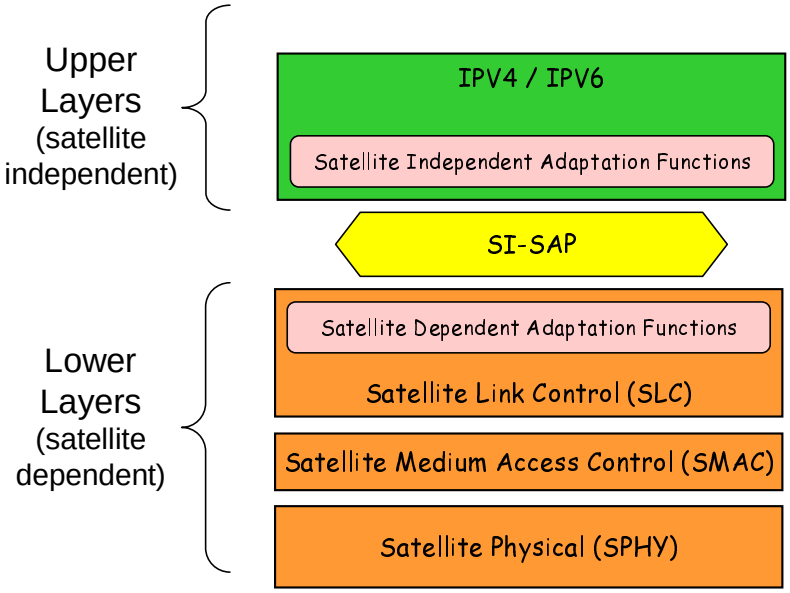

Figure 4.2: SI-SAP Interface: Separation between SI and SD Layers

4.3 SI-SAP interface primitives

4.3.1 Terminology

According to ISO/OSI terminology [i.38], primitives exchanged between layer N+1 and layer N are the implementation of services offered to layer N+1 by layer N and provided through the Service Access Point of layer N+1.

Four types of primitives are defined and also applied in the SI-SAP interface definition:

- Request (*req*). The request comes from the SAP of layer N+1 to use a given service offered by layer N. The request can be locally acknowledged or unacknowledged by layer N.
- Confirmation (*cfm*). The confirmation primitive is issued to acknowledge a request primitive received from layer N and to confirm the service request. Hence, it is issued by layer N toward layer N+1.The confirmation can be local as acknowledgment of the request or after remote confirmation from the counterpart peer.
- Indication (*ind*). The indication primitive is triggered upon unsolicited event or reception of a protocol message (data or control plane) at layer N. hence it is issued from layer N towards layer N+1. In reaction to this primitive, layer N+1 SAP can issue a response Primitive (see below).
- Response (*res*). The response primitive is triggered upon reception of protocol message or indication of unsolicited event. Hence, it is issued from layer N+1 towards layer N. The primitive is used from a peer to signal the counterpart peer about the action following the reception of an indication primitive or an external trigger (i.e. unsolicited event).

The overall ISO/OSI primitive model [i.39] is illustrated in the following, where reference to SI-SAP interface and ETSI BSM architecture is terms of SI and SD layers is given [i.19]. To this regard, layer N+1 has to be considered as the SI layer, whereas layer N is the SD layer.

The exchange of SI-SAP primitives in an ETSI BSM compliant architecture is illustrated in figure 4.3.

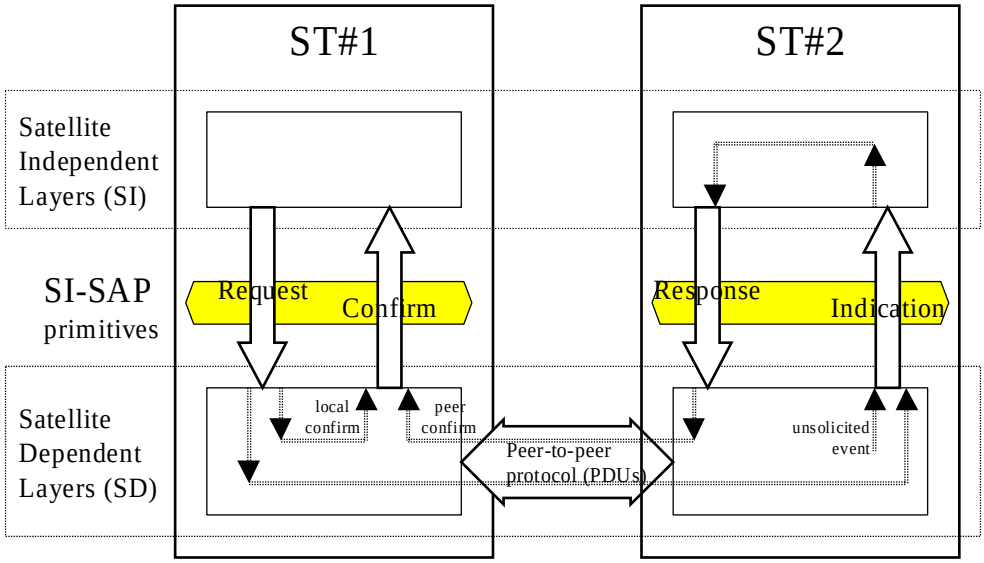

Figure 4.3: SI-SAP interface definition and service primitive exchange

SI-SAP interface primitives are denoted according the following syntax:

```
Layer-Plane-PrimitiveName-PrimitiveSemantics
```

where:

- `Layer`: It is the N+1 layer requesting a given service from layer N. As aforementioned, the involved N+1 layer is the Satellite Independent (SI) layer, whereas layer N corresponds to the Satellite Dependent (SD) one.
- `Plane`: It refers to the User (U), Control (C) or Management (M) plane.

- `PrimitiveName`: It defines the name of the primitive.
- `PrimitiveSemantics`: It defines the type of primitive according to the ISO/OSI terminology: Request (REQ), Confirmation (CFM), Response (RES) or Indication (IND), as formerly outlined.

4.3.2 Classification

The SI-SAP interface defines primitives to be exchanged between the SI and SD layers, in order to support User and Control plane (U- and C-plane namely) functionalities. Management (M-) plane functionalities are not supported by currently defined SI-SAP interface primitives, as management functions are segregated in specific protocol layers, with no interaction requested between SI and SD layers. As a result, according to the terminology introduced in clause 4.3.1, only service primitives SI-C-* and SI-U-* are defined, where '*' indicates the name and type of the reference primitives.

In particular, the primitives offered by the SI-SAP interface can be classified according to the related service, pertaining to either U- or C-planes:

- User Plane (U-plane):
  - Data transfer.
- Control Plane (C-plane):
  - Logon.
  - Logoff.
  - Satellite Independent (SI) layer configuration.
  - Address resolution.
  - Resource reservation.
  - (Multicast) group receive.
  - (Multicast) group transmit.

Details about the aforementioned services and related primitives are given in clause 6.

It can be noted that not all functions provided by the ETSI BSM architecture and summarized in clause 4.1 correspond to services for which the SI-SAP interface provides related primitives. This is due to the fact that some of those functions are exclusively provided by either SI or SD layers, with no interaction with other layers (SD or SI, mutually exclusively), hence not requiring the implementation of any SI-SAP interface primitives. For instance, this is the case of security, network integration and performance management.

5 Guide to ETSI BSM architecture functions

5.1 Overview

The present clause addresses the functions provided by the ETSI BSM architecture, as listed in clause 4.1. In particular, each function is presented at high-level in order to give indications of the main characteristics and pointing to the related ETSI BSM documentation. More details about each function are beyond the scope of the present document and the interested reader can refer to the relevant documentation hereafter provided.

Finally, the present clause concludes by providing a summary of all functions and the related ETSI BSM documents, in order to easily guide the interested readers towards the relevant literature (technical reports or specifications), which have been produced in the course of the ETSI BSM standardization activity and available up to the date when the present document has been composed.

5.2 Data transfer

The ETSI BSM architecture support both multicast (broadcast) and unicast data transfer. The function is defined to run independently of the specific topology (star or mesh satellite network) and the specific payload operations (transparent or regenerative). Nevertheless, the function can be run provided that address resolution and QoS management operations have been already performed.

5.3 QoS management

The ETSI BSM architecture provides a powerful QoS management framework, able to implement different QoS models, such as DiffServ and IntServ in an IP-based architecture, by means of a dedicated BSM class of service specification [i.21], which fits the requirements contained in the Service Level Specifications (SLS) of traffic flows. Further to this, the application of any specific QoS framework also imply specific actions in terms of resource reservation operations, hence allowing defining a powerful QoS mapping framework, necessary to map the QoS requests coming from the SI layer into request of satellite capacity reservation, performed by the SD layer.

From this perspective, it is immediate to see that the role of QoS management is quite central in the implementation of an ETSI BSM-compliant satellite network. To this end, a dedicated functional QoS architecture has been defined in order to conveniently accommodate the ETSI BSM building blocks within the functional architecture of a reference satellite network (e.g. DVB-S2/RCS2 [i.46] and [i.47] satellite network), taking into account the main characteristics of well-consolidated QoS models, such as IntServ and DiffServ. In virtue of this aspect, the overall QoS management is in fact not only limited to QoS mapping operations performed between SI and SD layers, but also regards the interaction with QoS requests possibly coming from hosts applications, by means of QoS-oriented protocols, such as SIP [i.33] and RSVP [i.42], just to cite a few.

5.4 Address resolution

The address resolution function is performed to allow the translation between SI and SD layers addresses, by taking advantage of SI-SAP interface instance addresses (i.e. BSM_ID), to achieve full independency between the technologies implemented at the SI and SD layers, respectively. Address resolution is performed for both unicast and multicast data services and success of operations is necessary to perform subsequent data transfer. In more detail, the address resolution function consists in retrieving the BSM_IDs of sources and destinations. The former is stored locally, whereas the latter can be known after the logon operation or by polling other network entities.

Further to address resolution, this function also considers the case of address change or topology modification, so that the SI layer needs to be aware of any BSM_ID changes, which is therefore notified by the SD layer to the SI layer.

5.5 Multicast management

Multicast management, as well as QoS management, is a central function in the ETSI BSM architecture, as it is closely linked to address resolution, security and data transfer. Hence, dedicated functional architectures have been proposed, by considering the typical pull- and push-paradigms used in IP-based multicast networks.

Moreover, taking IP-networking model as reference, extensions to IGMP [i.40] and PIM-SM [i.41] protocols have been also proposed. As such, multicast management requires a close interaction between SI and SD layers, in order to translate the IP multicast groups into corresponding groups at the SD layer. This is actually achieved by means of the concept of BSM_GID, which is the core element used in the mechanisms that rule the group membership dynamics. In more detail, the ETSI BSM architecture provides mechanisms to create a new multicast group as well as add (remove) members to an existing multicast group, based on the requests coming from multicast routing protocols. Moreover, it also allows ETSI BSM network elements to accept multicast group or filter them out, according to the related group membership.

5.6 Security

The ETSI BSM architecture provides security functions based on the best current practice available in the IP-based networks. Accordingly, functional architectures for unicast and multicast data communications are provided. It can be noted that, differently from the aforementioned functions, security functions do not require any specific interaction between SI and SD layer, since encryption and authentication functions (for instance) are segregated in specific layers (typically SI layers), hence not requiring any exchange of information across the ETSI BSM architecture protocol stack. As such, no SI-SAP primitives have been defined to support security functions in the ETSI BSM architecture.

5.7 Network integration

The ETSI BSM architecture provides the building blocks to integrate satellite segments with external elements, such as terrestrial networks (e.g. 3GPP-based network). To this end, a broader set of functions is provided to allow an efficient integration and to implement a modular and flexible telecommunication architecture. Four main functional areas have been identified, in which the necessary functions have been elaborated:

- NGN-interworking: The ETSI BSM architecture is integrated into the overall NGN framework, building on the IMS (Internet Multimedia Subsystem) concept, so as to interwork with the other network portions running on different technologies (e.g. 3GPP - http://www.3gpp.org/).

- End-to-end routing and multicast support. To this regard, the routing and multicast management functions defined in the ETSI BSM architecture are extended to external networks in order to achieve a full end-to-end networking concept, applied to heterogeneous network technologies. The envisaged functional architectures are based on abstract models and then extended to meet the requirements of IP technology. In particular, the architecture has been conceived for the transition towards IPv6 [i.45], especially to exploit the benefits for the convergence of addressing plans used inside and outside the satellite network. The architecture building blocks are defined for both unicast and multicast data services, hence developing the concept of end-to-end multicast (where applicable) achieved through IP multicast routing and group membership protocols.

- MPLS [i.43] support. The convergence of terrestrial and satellite networks may imply the support of MPLS technology in the ETSI BSM satellite network. In particular, update of SI-SAP interface primitives is the primary focus to see the portability of the ETSI BSM architecture basic concepts. Moreover, the architecture is designed so as to enable the transport of MPLS-related signalling (e.g. RSVP-TE [i.44]). Depending on the network integration concept, the elaborated architectures are able to allow MPLS running transparently (tunnel mode) over the ETSI BSM architecture or to implement MPLS shim layer within the ETSI BSM architecture with the necessary interactions between the SIAF and SDAF modules across the SI-SAP interface.

- Performance enhancing proxy (PEP [i.37]). The ETSI BSM architecture can also implement TCP performance enhancing functionalities (e.g. TCP accelerators, boosters), especially recommended when the architecture is operating over geostationary satellite networks. No specific design is provided for the TCP acceleration, which is an implementation matter. On the other hand, the ETSI BSM architecture is extended so as to incorporate PEP functions, in case of both plain and secure data communications. The overall architecture is framed in the context of integrated satellite and terrestrial networks, to drive the requirements of PEP functions for efficiently transporting Internet traffic over satellite.

5.8 Performance management

Performance management function is actually part of the broader network management operations performed in a telecommunication network applying the FCAPS paradigm (fault, configuration, accounting, performance, security). Accordingly, performance management is regarded in terms of monitoring and control, by leveraging on the tools already developed for terrestrial IP-based networks. To this end, a dedicated functional architecture accommodating the ETSI BSM concepts has been developed and specific performance indicators defined. In particular, the performance indicators for the SI-SAP interface have been identified in order to track the dynamics and then the performance of the ETSI BSM architecture, in terms of the SI-SAP interface primitives exchanged between SI and SD layers. Nevertheless, being such indicators located within a specific layer with no interaction with others, the network management functions related to performance management are segregated in SI and SD layers, without the need for implementing any specific SI-SAP interface primitives.

5.9 Summary

Table 5.1: Relevant bibliography for the functions provided by the ETSI BSM architecture

ETSI BSM architecture function	ETSI BSM TS reference(s)	ETSI BSM TR reference(s)
Data transfer	ETSI TS 102 292 [i.24] ETSI TS 102 357 [i.19] ETSI TS 103 275 [i.1]	ETSI TR 101 984 [i.31] ETSI TR 101 985 [i.30] ETSI TR 102 353 [i.20]
QoS management	ETSI TS 102 292 [i.24] ETSI TS 102 295 [i.21] ETSI TS 102 357 [i.19] ETSI TS 102 462 [i.16] ETSI TS 102 463 [i.15] ETSI TS 102 464 [i.14] ETSI TS 103 275 [i.1]	ETSI TR 101 985 [i.30] ETSI TR 102 157 [i.27] ETSI TR 102 353 [i.20]
Address resolution	ETSI TS 102 292 [i.24] ETSI TS 102 357 [i.19] ETSI TS 102 460 [i.18] ETSI TS 103 275 [i.1]	ETSI TR 101 985 [i.30] ETSI TR 102 155 [i.29] ETSI TR 102 353 [i.20]
Multicast management	ETSI TS 102 292 [i.24] ETSI TS 102 293 [i.23] ETSI TS 102 294 [i.22] ETSI TS 102 357 [i.19] ETSI TS 102 461 [i.17] ETSI TS 102 466 [i.12] ETSI TS 102 674 [i.8] ETSI TS 103 275 [i.1]	ETSI TR 101 985 [i.30] ETSI TR 102 156 [i.28] ETSI TR 102 353 [i.20]
Security	ETSI TS 102 465 [i.13] ETSI TS 102 466 [i.12]	ETSI TR 102 287 [i.25]
Network integration	ETSI TS 102 855 [i.4] (NGN) ETSI TS 102 856-1 [i.3] (MPLS) ETSI TS 102 856-2 [i.2] (MPLS) ETSI TS 103 275 [i.1]	ETSI TR 102 467 [i.11] (IPv6) ETSI TR 102 676 [i.5] (PEP)
Performance management	ETSI TS 102 672 [i.10] ETSI TS 102 673 [i.9] ETSI TS 102 675-1 [i.7] ETSI TS 102 675-2 [i.6]	

6 Guide to SI-SAP interface primitives

6.1 Overview

The present clause addresses the service primitives provided by the SI-SAP interface, defined within the ETSI BSM architecture, as listed in clause 4.3. In particular, each primitive is presented at high-level in order to give indications of the main characteristics and pointing to the related ETSI BSM documentation. More details (e.g. primitive specification) about each primitive are beyond the scope of the present document and the interested reader can refer to the relevant documentation hereafter pointed to.

Finally, the present clause concludes by providing a summary of all primitives and the related ETSI BSM documents, in order to easily guide the interested readers towards the relevant literature (technical reports or specifications), which have been produced in the course of the ETSI BSM standardization activity and available up to the date when the present document has been composed.

6.2 Logon/logoff

The logon/logoff services are generally performed by the physical layer of the related satellite network element (e.g. satellite terminal and gateway). As such, the related primitive is invoked from the SD layer and used to notify the SI layer about an ongoing logon/logoff event. In particular, it contains information (e.g. BSM_ID) necessary to identify the source, which triggered the event. In more detail, the logon service (and the related primitive) is invoked as soon as the logon phase is completed. On the other hand, the logoff service (and the related primitive) is invoked while the logoff procedure is being performed by the physical layer of the involved ETSI BSM network entities (i.e. satellite terminals and gateways).

The defined primitives are:

- SI-C-LOGON-IND.
- SI-C-LOGOFF-IND.

6.3 Satellite Independent (SI) layer configuration

The configuration of the SI layer is a service that is started as soon as the logon procedure is accomplished by the SD layer. The aim of this service is to provide the SI layer with the necessary information to configure the addressing plan (e.g. mapping between IP addresses and BSM_IDs) and the additional functions of higher protocol layers (e.g. ROHC [i.32], PEP [i.37] configuration, etc.). The service can be requested directly from the SI layer or through unsolicited indication generated by the SD layer. Upon successful SI layer configuration, address resolution functions can be performed.

The defined primitives are:

- SI-C-CONF-REQ.
- SI-C-CONF-CFM.
- SI-C-CONF-IND.
- SI-C-CONF-RES.

6.4 Address resolution

The address resolution service is invoked right after the logon process and is instrumental to performing data transfer. It can be invoked by the SI layer to perform the address mapping between SI and SD layers. Alternatively, the SD layer can inform the SI layer about change of the SD addressing or network topology in the form of an unsolicited indication, to which the SI layer can provide a response.

The defined primitives are:

- SI-C-AR_QUERY-REQ.
- SI-C-AR_QUERY-CFM.
- SI-C-AR_INFO-IND.
- SI-C-AR_INFO-RES.

6.5 Resource reservation

The resource reservation service can be invoked by the SI layer before starting the data transfer, in order to request the necessary satellite capacity resources to accomplish it. This service is strictly linked to overall QoS management, as it allows defining different QoS-based flow treatments, implemented according to either IntServ or DiffServ models. Three different services and related primitives are defined to deal with the different phases of resource allocation and reservation during data communication: reservation of resources, modification of a reservation, and release of resources. Furthermore a monitoring service is also provided in order to track the utilization of the satellite capacity in terms of an indication provided by the SD to the SI layer, to which a response from the SI layer can also follow. The main parameters that are used by the primitives deal with QoS provisioning and are expressed in terms of the Queue Identifier (QID), used to perform QoS mapping between SI and SD layers, and the QID specification (QIDSPEC), used to describe the Service Level Specification (SLS) of each considered traffic flow.

The defined primitives are:

- SI-C-QUEUE_OPEN-REQ.
- SI-C-QUEUE_OPEN-CFM.
- SI-C-QUEUE_MODIFY-REQ.
- SI-C-QUEUE_MODIFY-CFM.
- SI-C-QUEUE_MODIFY-IND.
- SI-C-QUEUE_MODIFY -RES.
- SI-C-QUEUE_CLOSE-REQ.
- SI-C-QUEUE_CLOSE-CFM.
- SI-C-QUEUE_CLOSE-IND.
- SI-C-QUEUE_CLOSE -RES.
- SI-C-QUEUE_STATUS-IND.
- SI-C-QUEUE_STATUS-RES.

6.6 Multicast group receive and transmit

The multicast management function provided by the ETSI BSM architecture is subdivided into two main service instances, one implemented at the transmitter side, the other at the receiver side. At the transmitter side, the service is actually invoked to build the multicast group with the BSM_GID and BSM_ID addresses, based on the interaction with the multicast routing (e.g. PIM-SM) and group management protocols (e.g. IGMP) running at the SI layer (e.g. IP layer). As such, the SI layer interacts with the SD layer to inform it about the creation of new multicast groups and to add or remove members of existing multicast groups. On the hand, the receiver side invokes the corresponding service to receive the "desired" multicast data flows and to filter out the others.

The defined primitives are:

- SI-C-MCGROUP_ADD-REQ.
- SI-C-MCGROUP_ADD-CFM.
- SI-C-MCGROUP_REMOVE-REQ.
- SI-C-MCGROUP_REMOVE-CFM.
- SI-C-RGROUP_OPEN-REQ.
- SI-C-RGROUP_OPEN-CFM.
- SI-C-RGROUP_CLOSE-REQ.

- SI-C-RGROUP_CLOSE-CFM.

6.7 Data transfer

The data transfer service is run as soon as the aforementioned services are carried out successfully, i.e. after logon phase is accomplished, address resolution and resource reservations are performed. Depending on the nature of the traffic being transferred (unicast or multicast), also multicast group receive and transmit services are invoked before the data transfer can actually starts. The data transfer service is invoked from the SI layer to request the SD layer to transmit data over the satellite air interface. Conversely, at the receiver side, the SD layer forwards data to the SI layer, in the form of an indication, as soon as data are received from the satellite air interface.

It can be also observed that data transfer primitives are the only SI-SAP interface ones that can also transport data in a payload. All the others, instead, only transport signalling information, without a data payload.

The defined primitives are:

- SI-U-UNITDATA-REQ.
- SI-U-UNITDATA-IND.

6.8 Summary

Table 6.1: Relevant bibliography for the SI-SAP interface primitives

SI-SAP interface primitives	ETSI BSM TS reference(s)	ETSI BSM TR reference(s)
Logon/logoff	ETSI TS 103 275 [i.1]	-
SI layer configuration	ETSI TS 103 275 [i.1]	-
Address resolution	ETSI TS 102 357 [i.19] ETSI TS 102 460 [i.18]	ETSI TR 102 353 [i.20]
Resource reservation	ETSI TS 102 357 [i.19] ETSI TS 102 460 [i.18] ETSI TS 102 462 [i.16] ETSI TS 102 463 [i.15] ETSI TS 102 464 [i.14]	ETSI TR 102 353 [i.20]
Multicast group receive and transmit	ETSI TS 102 293 [i.23] ETSI TS 102 294 [i.22] ETSI TS 102 357 [i.19] ETSI TS 102 461 [i.17] ETSI TS 102 674 [i.8] ETSI TS 103 275 [i.1]	ETSI TR 102 353 [i.20]
Data transfer	ETSI TS 102 357 [i.19] ETSI TS 103 275 [i.1]	ETSI TR 102 353 [i.20]

History

Document history		
V1.1.1	December 2016	Publication