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Contents

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Foreword

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

Introduction

The present document has been prepared by the TC-SES Broadband Satellite Multimedia (BSM) working group based on the recommendations from the work of STF-126 [2].

1 Scope

The present document is intended to review the standardization issues with respect to services and architectures for Broadband Satellite Multimedia (BSM). The present document builds on the following two earlier reports:

- TR 101 374-1 [1]: "Survey on Standardization Objectives for Broadband Satellite Multimedia".
- TR 101 374-2 [2]: "Standardization Objectives for Broadband Satellite Multimedia: The Standardization Scenario".

The present document discusses the standardization approach, relevant issues, actions and further work that should be undertaken within ETSI in the following areas:

- BSM reference architectures and models;
- BSM bearer services;
- BSM interfaces.

The present document is intended to assess the possible role that Broadband Satellite Multimedia systems may have, which services they can provide, which existing standards they can use and which standards should be developed. The objectives of BSM standardization are:

- to enable users to access a wide range of telecommunications services, including many that are today undefined, with particular emphasis on multi-media services and high data rates;
- to provide an efficient means of using network resources (particularly radio spectrum);
- to facilitate the provision of a high quality of service similar to that provided by fixed networks;
- to facilitate the provision of easy to use, low cost terminals.

2 References

For the purposes of this Technical Report (TR), the following references apply:

[1] ETSI TR 101 374-1: "Satellite Earth Stations and Systems (SES); Broadband satellite multimedia; Part 1: Survey on standardization objectives".

[2] ETSI TR 101 374-2: "Satellite Earth Stations and Systems (SES); Broadband satellite multimedia; Part 2: Scenario for standardization".

[3] ETSI TS 122 101 (V4.3.0): "Universal Mobile Telecommunications System (UMTS); Service aspects; Service principles (3GPP TS 22.101 version 4.3.0 Release 4)".

[4] ATM Forum: "ATM User-Network Interface (UNI) Specification", af-uni-0010.002, v3.1.

[5] ETSI TS 123 107: "Universal Mobile Telecommunications System (UMTS); Quality of Service (QoS) concept and architecture (3GPP TS 23.107 Release 5)".

[6] ETSI TR 101 865: "Satellite Earth Stations and Systems (SES); Satellite component of UMTS/IMT-2000; General aspects and principles".

3 Definitions and abbreviations

3.1 Definitions

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

broadcast: communication capability which denotes unidirectional distribution to an unspecified number of access points connected to the network

NOTE: The communication may reach any or all access points and each terminal may select which broadcast information to receive.

channel: means of unidirectional transmission of signals between two points

NOTE: Several channels may share a common transport mechanism.

connection oriented: communication method in which communication proceeds through three well-defined phases: connection establishment, data transfer, connection release

connectionless: communication method which allows the transfer of information between users without the need for connection establishment procedures

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

layer management functions: management functions (e.g. meta-signalling) relating to resources and parameters residing in its protocol entities

NOTE: Layer Management handles the Operation And Maintenance (OAM) information flows specific to the layer concerned.

management plane: plane which provides two types of functions, namely layer management and plane management functions

NOTE: Plane management has no layered structure.

multicast: communication capability which denotes unidirectional distribution from a single source access point to a number of specified destination access points

multipoint: communication configuration attribute which denotes that the communication involves more than two access points

plane management functions: management functions related to a system as a whole and provides co-ordination between all the planes

service attribute: specified characteristic of a telecommunication service

NOTE: The value(s) assigned to one or more service attributes may be used to distinguish that telecommunication service from others.

service category or service class: service offered to the users described by a set of performance parameters and their specified values, limits or ranges

NOTE: The set of parameters provides a comprehensive description of the service capability.

service component: single type of telecommunication service

NOTE: Service components are divided into speech, audio, video and data:
speech: voice telecommunication;
audio: telecommunication of sound in general;
video: telecommunication of full motion pictures, and of stills;
data: telecommunication of information-files (text, graphics, etc); and
MultiMedia (MM): combination of two or more of the above components (speech, audio, video, data), with a temporal relationship (e.g. synchronization) between at least two components.

telecommunication service: service offered by a network operator or service provider to its customers in order to satisfy a specific telecommunication requirement

NOTE: Telecommunication services are divided into two broad families: bearer services and teleservices:
bearer service: type of telecommunication service that provides the capability of transmission of signals between access points;
teleservice: type of telecommunication service that provides the complete capability, including terminal equipment functions, for communication between users according to standardized protocols and transmission capabilities established by agreement between operators

user plane: plane which has a layered structure and provides for user information flow 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:

AESA	ATM End System Addresses
ASDL	Assymetric Digital Subscriber Line
ATM	Asynchronous Transfer Mode
ATMF	ATM Forum
BE	Best Effort
BSM	Broadband Satellite Multimedia
CATV	CAble TeleVision
CLBS	ConnectionLess Bearer Service
COBS	Connection Oriented Bearer Service
CR	Constant Rate
Diffserv	Differentiated services
DL	DownLink
ES	End System
GSM	Global System for Mobile communication
HFC	Hybrid Fibre Coax
IB	InBound
ID	IDentifier
IETF	Internet Engineering Task Force
Intserv	Integrated services
IP	Internet Protocol
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
ISDN	Integrated Services Digital Network
ISP	Internet Service Provider
IWF	InterWorking Functions
LAN	Local Area Network
LMDS	Local Multipoint Distribution Service
MAC	Medium Access Control
MM	MultiMedia
MTM	Multipoint-To-Multipoint
NCC	Network Control Centre
OAM	Operation, Administration and Maintenance
OB	OutBound
OBP	On Board Processing
OSI	Open System Interconnection
PILC	Performance Implications of Link Characteristics
PSTN	Public Switched Telephone Network
PTM	Point-To-Multipoint
PTO	Public Telecommunications Operator
PTP	Point-To-Point
QoS	Quality of Service
RFC	IETF Request For Comments
RSVP	Resource reSerVation Protocol
RTTE	Radio and Telecommunications Terminal Equipment

SAF	Satellite Access Function
SAT	SATellite
SCC	Satellite Control Centre
SDAF	Satellite Dependent Adaptation Function
SGF	Satellite Gateway Function
SIAF	Satellite Independent Adaptation Function
SI-SAP	Satellite Independant Service Access Point
SLA	Service Level Agreements
SLC	Satellite Link Control
SMAC	Satellite Medium Access Control
SME	Small-to-Medium sized Enterprises
SNAL	Satellite Network Adaptation Layer
SPHY	Satellite PHYsical
ST	Satellite Terminal
TCP	Transmission Control Protocol
TOS	Type Of Service
UDP	User Datagram Protocol
UL	UpLink
UMTS	Universal Mobile Telecommunication System
VCI	Virtual Channel Identifier
VPI	Vitual Path Identifier
VR	Variable Rate
VSAT	Very Small Aperture Terminal (satellite)
WG	Working Group
WLL	Wireless Local Loop

4 Overview of BSM

4.1 Domain definitions

The scope of BSM networks is defined in terms of four basic domains: the user domain, the access domain, the core network domain and the content domain as illustrated in figure 4.1a.

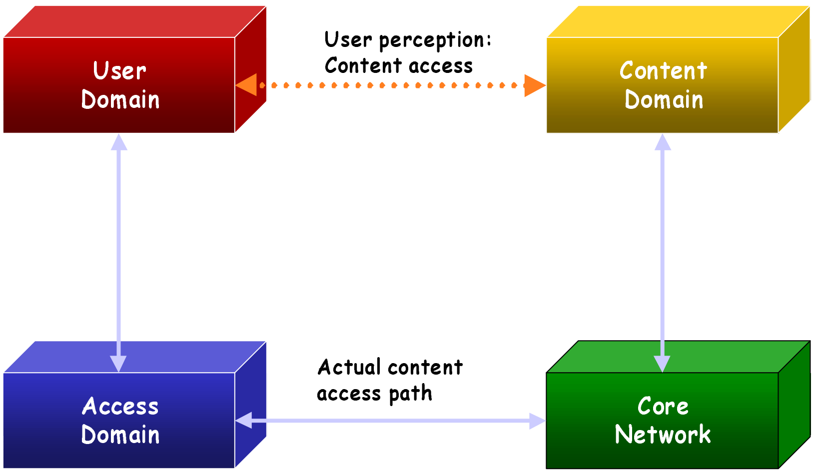

Figure 4.1a: The four domains

A BSM network can serve as part of the core network (e.g. as part of the Internet backbone) or as a high speed access network or both. In both cases, the satellite network is expected to provide a complementary role to other network technologies as illustrated in figure 4.1b; although the satellite network can provide a primary role for certain classes of users.

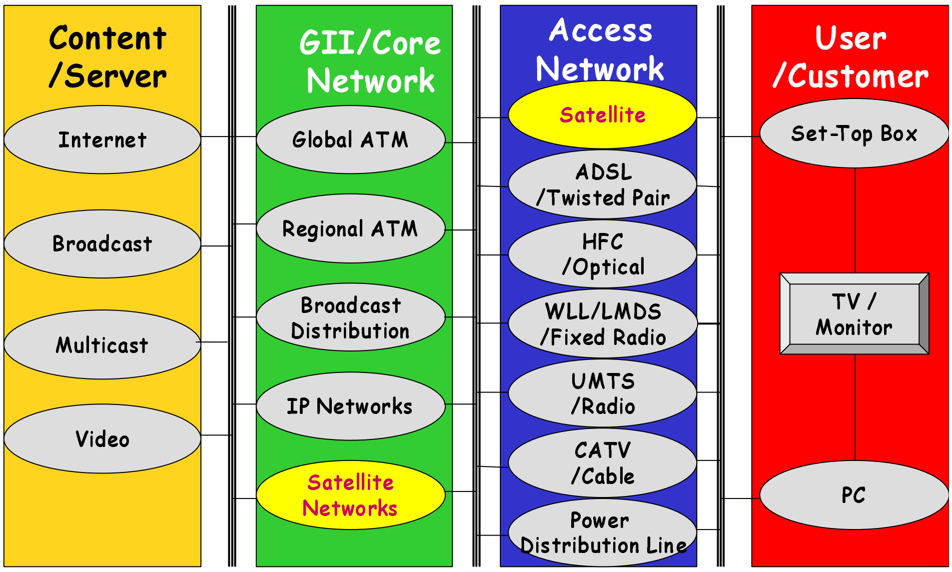

Figure 4.1b: Role of satellite networks

4.2 Satellite network scenarios

Telecommunication satellites can be used to provide broadcasting and multicasting services as well as Point-To-Point services as illustrated in figure 4.2b. In addition to international or long haul communications, this figure shows satellites being used to provide regional backbone networks and access networks, including access to added value services such as Internet applications.

Due to their natural coverage of large mass of land or ocean satellites are also used to broadcast broadband services such a Digital Video and in this case interactivity can be provided either by the satellite or though a terrestrial telecommunication infrastructure (e.g. PSTN IDSN, GSM).

A BSM network can be used in all parts of the global IP network. For the present document, we divide the global IP network into 3 parts: Core network, Distribution network and Access network as illustrated in figure 4.2a. The Distribution network is an intermediate IP subnetwork that is used to connect an access network to the Core network.

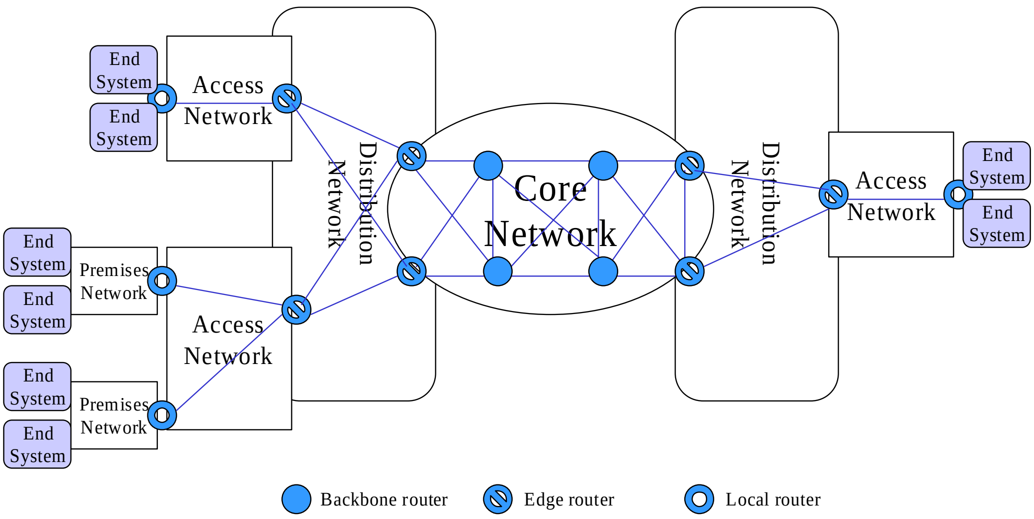

Figure 4.2a: Core network, distribution network and access network

Each of the networks defined in figure 4.2a corresponds to a different domain and these different domains are interconnected with edge routers. Different QoS mechanisms may be used within each domain and these are interworked by these edge routers. For example, the Core network may use Diffserv, whereas the Distribution network may use Intserv and the access network may use Best_Efforts.

The different types of BSM IP scenarios are summarized in table 4.2.

Table 4.2: BSM Scenarios

ACCESS NETWORK SCENARIOS	POINT-TO-POINT	MULTICAST	BROADCAST
Corporate intranet	Corporate VSAT network, i.e. site interconnections	Corporate Multicast e.g. Data distribution e.g. Video conferencing	Datacasting TV broadcast (private)
Corporate internet	Internet Access via corporate ISP or via 3rd party ISP	IP multicast RT streaming ISP caching	ISP caching
SME intranet	Small VSAT network	SME multicast	
SME internet	Internet Access via 3rd party ISP	IP multicast RT streaming ISP caching	ISP caching
Soho Residential	Internet Access via ISP Company access via VPN Internet Access via ISP	IP multicast RT streaming ISP caching IP multicast RT streaming ISP caching	ISP caching ISP caching

DISTRIBUTION NETWORK SCENARIOS	POINT-TO-POINT	MULTICAST	BROADCAST
Content to Edge	ISP to Backbone	IP multicast RT streaming Caching at ISP/Edge	TV broadcast (public)

CORE NETWORK SCENARIOS	POINT-TO-POINT	MULTICAST	BROADCAST
ISP interconnect	Trunk interconnect	N/A	N/A

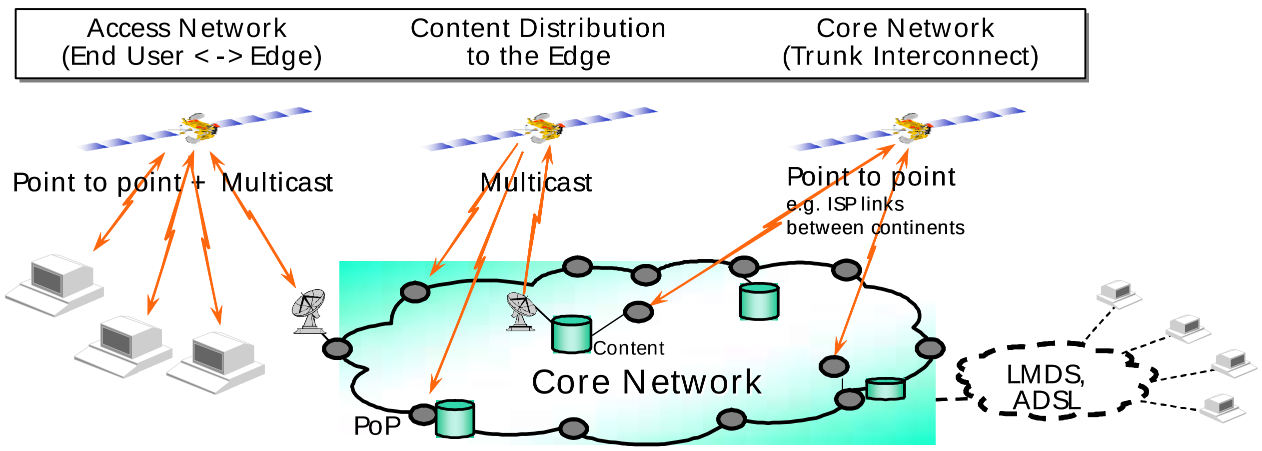

Figure 4.2b: Examples of BSM based internet services

4.3 BSM access network requirements

When used as an access system, BSM may be deployed to connect user network interfaces located in and physically fixed to customer premises, to a service node interface of a broadband core network, as follows:

- The target users are residential households, or typical Small-to-Medium sized Enterprises (SMEs).
- All BSM systems are expected to support IP.
- BSM systems may support both symmetric and asymmetric data flows.
- In general, the system will use multiple access to the radio bandwidth in order to optimize the efficiency with which multiple bursty users utilize spectrum.
- Systems may be deployed by PTOs who provide network services to the public, or private operators who use the network for their own purposes.
- BSM systems should allow both terminal interoperability and service interoperability, as defined in clause 4.5.
- BSM systems should allow for network management functions consistent with those used to manage terrestrial networks.

4.4 Satellite terminal interworking functions

BSM Satellite Terminals (STs) provide the following interworking functions:

- **Satellite Access Function** (**SAF**): the logical function that provides interworking between the BSM bearer service and an End System, either directly or via a local network (e.g. a LAN);
- **Satellite Gateway Function** (**SGF**): the logical function that provides interworking between the BSM bearer services and a core network, either directly or via a transit network.

These logical definitions only define the types of interworking function provided by a terminal. A given Satellite Terminal (ST) may provide multiple instances of both SAF and SGF functionality.

A **Satellite Access Terminal** is defined as a BSM Satellite Terminal that provides at least one instance of SAF functionality.

Similarly, a **Satellite Gateway** is defined as a BSM Satellite Terminal that provides at least one instance of SGF functionality. A Satellite Terminal with such functionality will generally be considered a Satellite Gateway, even when it also contains instances of SAF functionality.

4.5 Interoperability definitions

4.5.1 Terminal Interoperability

Terminal interoperability is defined as the ability of a Satellite Terminal (ST) designed and built according to the standards to interoperate with a BSM satellite system designed and built independently to the same standards and to provide defined services according to an "inter-operation profile" specification.

This implies that a conforming terminal could in principle be used to access more than one BSM satellite system. In addition, it shall be possible for 3rd party manufacturers to produce conforming terminals.

4.5.2 Service interoperability

Service interoperability means the ability to offer the same services over different systems.

Once protocol interoperability between networks is attained, service interoperability is dominated by the respective Service Level Agreements (SLAs) of the interoperating networks.

This implies that BSM networks should support an open service interface, in principle allowing the possibility of 3rd party service providers offering services over their networks.

4.6 Link and channel attributes

Within either a star or mesh network topology, the links can have the following attributes:

- Point-To-Point links;
- Point-To-Multipoint links;
- Multipoint-To-Multipoint links;
- Multipoint-To-Point links;
- Broadcast links.

We can define the direction of a link relative to the ST as follows:

- UpLink (UL): a link from the ST to the satellite (i.e. a link transmitted by the ST);
- DownLink (DL): a link from the satellite to the ST (i.e. a link received by the ST).

These definitions are illustrated in figure 4.6.

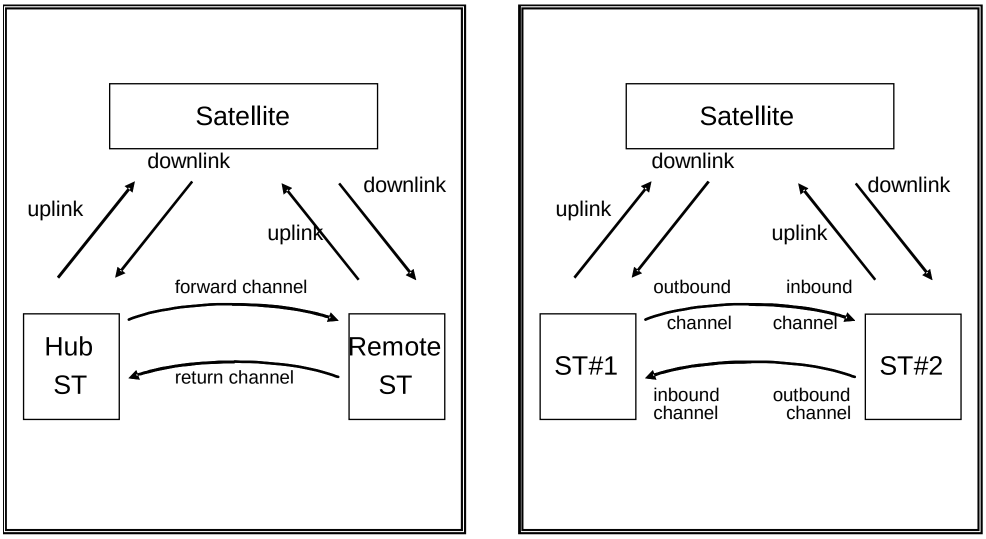

Figure 4.6: Links and channels

Channels (both logical and physical) can also be defined by reference to the network topology as illustrated in figure 4.6.

In the case of a Star topology we can define the direction of a channel as follows:

- Forward channel: a channel from the central (hub) ST to the other (remote) STs;
- Return channel: a channel from one of the other (remote) STs to the central (hub) ST.

In the case of a Mesh or Star topology we can define the direction of a channel as follows:

- OutBound channel (OB): a channel originating from the ST (i.e. the ST is the data source);
- InBound channel (IB): a channel terminating at the ST (i.e. the ST is the data sink).

NOTE: OutBound and InBound channel definitions are relative to a given ST. An OutBound channel from one ST becomes the Inbound channel at the peer ST.

5 BSM reference models

5.1 BSM roles

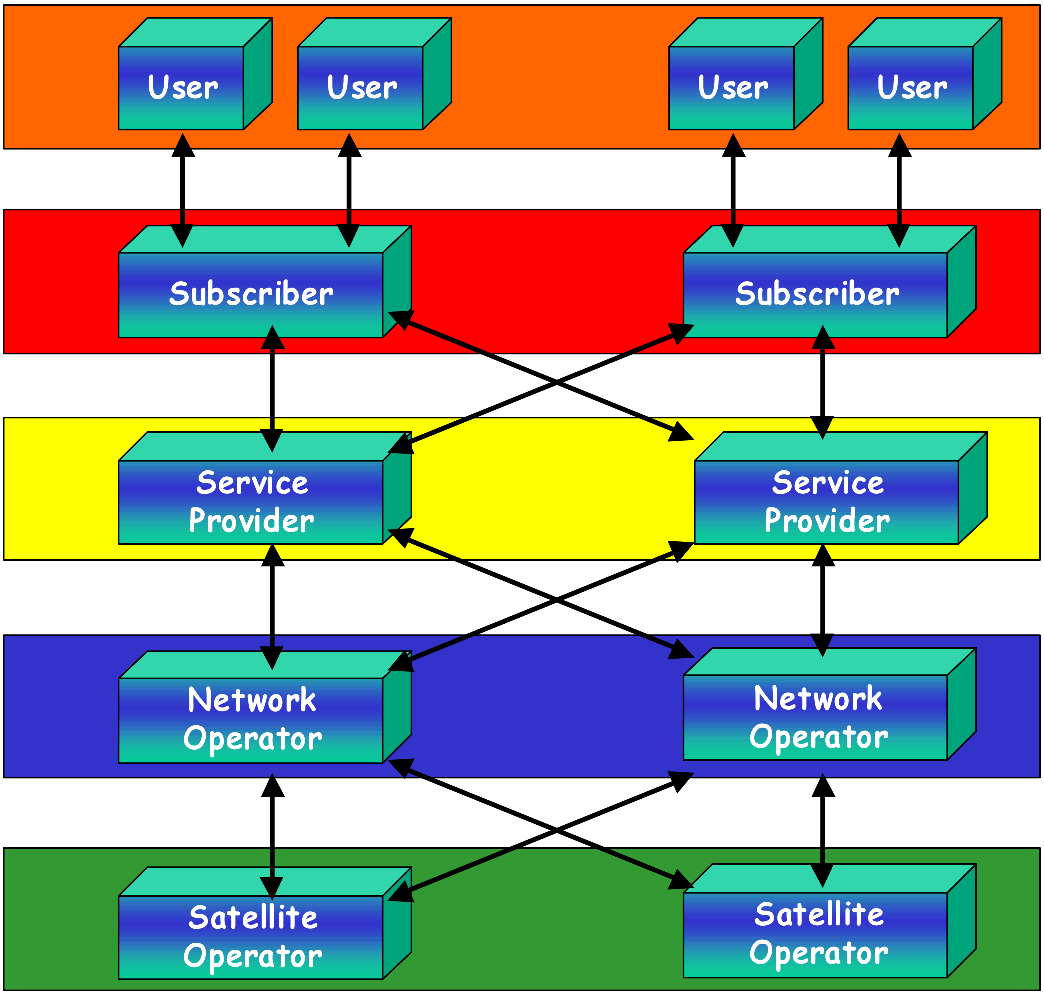

Figure 5.1: BSM roles

Figure 5.1 illustrates the different roles within a BSM network.

NOTE: This model illustrates the most general case. For some BSM networks a single entity may act in different roles at different levels. For example, a satellite operator may also be a network operator.

These roles are defined in terms of their responsibilities and their interactions as follows:

satellite operator: operator responsible for the bulk transport services of the satellites. The satellite operator provides a defined set of bulk transport services to the network operators.

network operator: operator responsible for his subset of the satellite resources. The network operator may obtain resources from multiple satellite operators and may combine these with other network resources to provide a broader network service to the service providers.

service provider: interface between the customers (i.e. the subscribers and the users) and one or more network operators. The service provider may obtain services from multiple network operators and may offer a combined service to the customers. The service provider is responsible for all aspects of the customer service from installation, to maintaining the quality of service during normal operation, to billing the customers for network usage.

subscriber: entity that enters into a service contract with the service provider. A single subscriber may support one or several users with a single contract (e.g. a large company subscriber may subscribe for services to several hundred users).

user: entity that uses the network services provided by the service provider. The user is associated with a single subscriber and the user's network usage is subject to the service agreement between that subscriber and the service provider.

5.2 BSM service capabilities

Existing systems have largely standardized the complete sets of teleservices, applications and supplementary services which they provide. As a consequence, substantial re-engineering is often required to enable new services to be provided and the market for services is largely determined by operators and standardization. This makes it more difficult for operators to differentiate their services.

BSM shall therefore standardize service capabilities and not the services themselves. Service capabilities consist of bearers defined by QoS parameters and the mechanisms needed to realise services. These mechanisms include the functionality provided by various network elements, the communication between them and the storage of associated data. Clause 5.2.2 provides a conceptual description of a service architecture and architecture requirements which aim to provide service capabilities. It is intended that these standardized capabilities should provide a defined platform which will enable the support of speech, video, multi-media, messaging, data, other teleservices, user applications and supplementary services and enable the market for services to be determined by users and home environments.

NOTE: This is based on the approach used in the 3GPP specifications [3].

5.3 Reference architectures

5.3.1 Definitions

A BSM network may support either a mesh or star topology:

- A star network topology is defined by the star arrangement of links between the Hub station (or Gateway) and multiple remote stations. A remote station can only establish a direct link with the Hub station and cannot establish a direct link to another remote station.
- A mesh network is defined by the mesh arrangement of links between the stations, where any station can link directly to any other station. The star topology can be considered as one special case of the mesh topology.

NOTE: A star topology can be used to provide mesh connectivity by establishing an indirect link between remote stations via the Hub station.

A BSM network may use either a non-regenerative or a regenerative satellite architecture:

- A non-regenerative architecture refers to a single architecture, commonly called a "bent-pipe architecture". This architecture does not terminate any layers of the air interface protocol stack in the satellite - the satellite simply transfers the signals from the user links to the feeder links transparently.
- A regenerative architecture is the range of other architectures that provide additional functionality in the satellite. In these architectures, the satellite functions terminate one or more layers of the air interface protocol stack in the satellite.

5.3.2 Detailed reference model for satellite access

A detailed reference model for satellite access is presented in figure 5.3.2a.

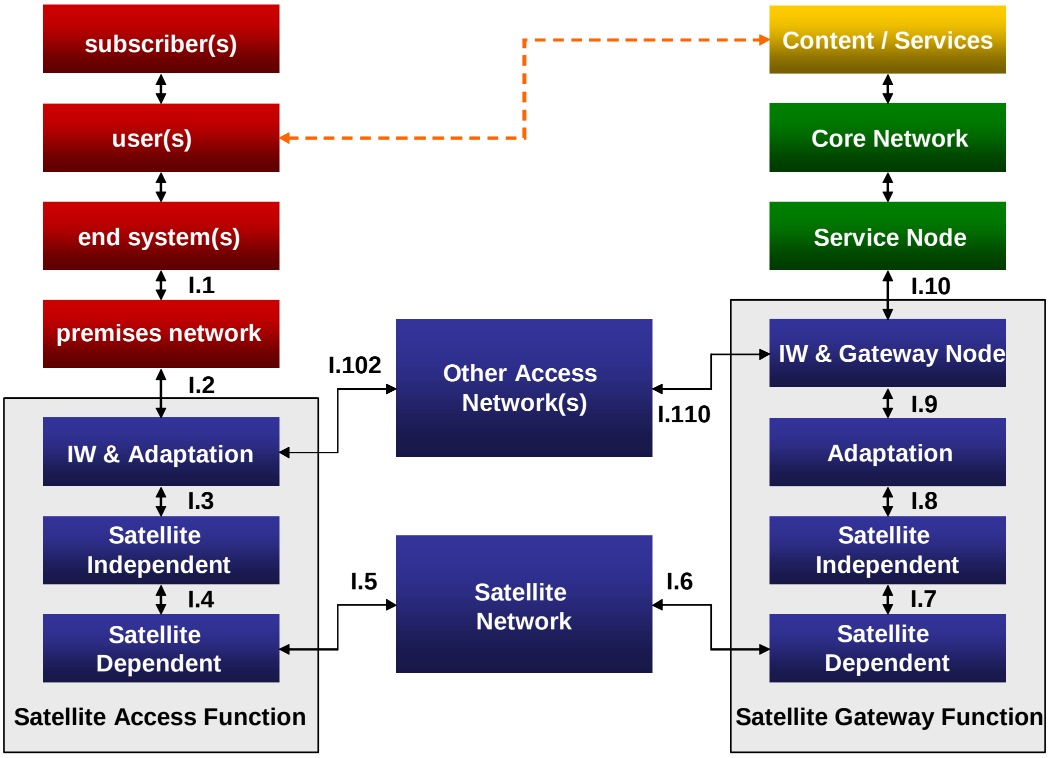

Figure 5.3.2a: Reference model of satellite access

The interfaces illustrated are described in more detail in table 5.3.2.

Table 5.3.2: Interfaces for satellite access

Ref	Interface Name	Description of interface
I.1	External Network Interface	Interface between end system and customer premises network
I.2	BSM Network Interface	External interface between satellite access function and customer premises network
I.3	BSM subnetwork service access point	Internal interface
I.4	BSM Satellite Independent Service Access Point (SI-SAP)	Internal interface
I.5	BSM Access Terminal Air Interface (see note)	Internal air interface
I.6	BSM Gateway Air Interface (see note)	Internal air interface
I.7	BSM Gateway Satellite Independent Service Access Point (SI-SAP)	Internal interface
I.8	BSM gateway subnetwork service access point	Internal interface
I.9	BSM gateway adaptation service access point	Internal interface
I.10	BSM Gateway Interface	External interface between satellite gateway function and terrestrial network
I.102	Alternative return channel Interface	External interface to return channel (may be bi-directional)
I.110	Alternative return channel gateway Interface	External interface for return channel (may be bi-directional)
NOTE: The Access Terminal air interface may be identical to the Gateway air interface.		

IWFs (InterWorking Functions) occur at two points (refer to the reference architecture model in figure 5.3.2a). One type of IWF is required to translate the internal (I.10) interface of the BSM network into network - specific interfaces of the particular core network (e.g. ATM). The other type of IWF is required to translate the internal (I.2) interface of the BSM network into external interfaces with Terminal Equipment. IWFs are logical entities and no particular physical location is implied by their position in the BSM configuration diagram.

There may be many different implementations of Broadband Satellite Multimedia systems. From a high level perspective, a BSM system will generally be composed of three segments as follows:

- User segment; comprising several types of terminals providing satellite access functions.
- Space segment; comprising one or several satellites, a Satellite Control Centre (SCC) and the associated Tele-command, Telemetry and Ranging stations.
- Operator segment; comprising one or more Network Control Centres (NCC) and satellite gateways that interconnect to a terrestrial telecommunications infrastructure (e.g. to a terrestrial core network).

NOTE 1: The SCC and NCC are omitted from figure 5.3.2a in order to focus on the User Plane access architecture.

Three simplified mappings of the reference model are identified in figure 5.3.2b: these mappings differ only in the functionality provided by the satellite terminals. For the core network and distribution network scenarios, both ends of the BSM network are provided by Gateway functions. By contrast, for the access network scenario, the user terminal side of the BSM network is associated with one or more access functions, which provide interworking for end users. In the fully meshed case, the communications link is between two terminals providing access functions.

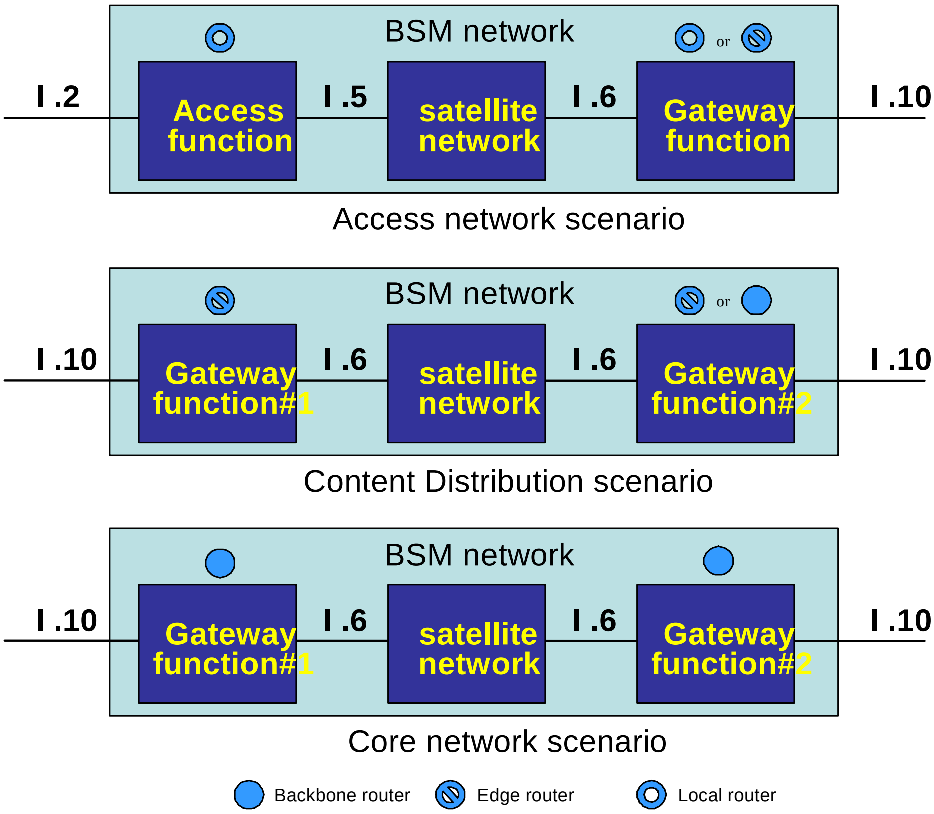

Figure 5.3.2b: Simplified reference models for BSM scenarios

NOTE 2: As shown in figure 5.3.2b, BSM networks are always defined between the I.2 and/or I.10 interfaces.

5.4 Topology examples

Examples of mesh topology and star topology are illustrated in figures 5.4a and 5.4b respectively.

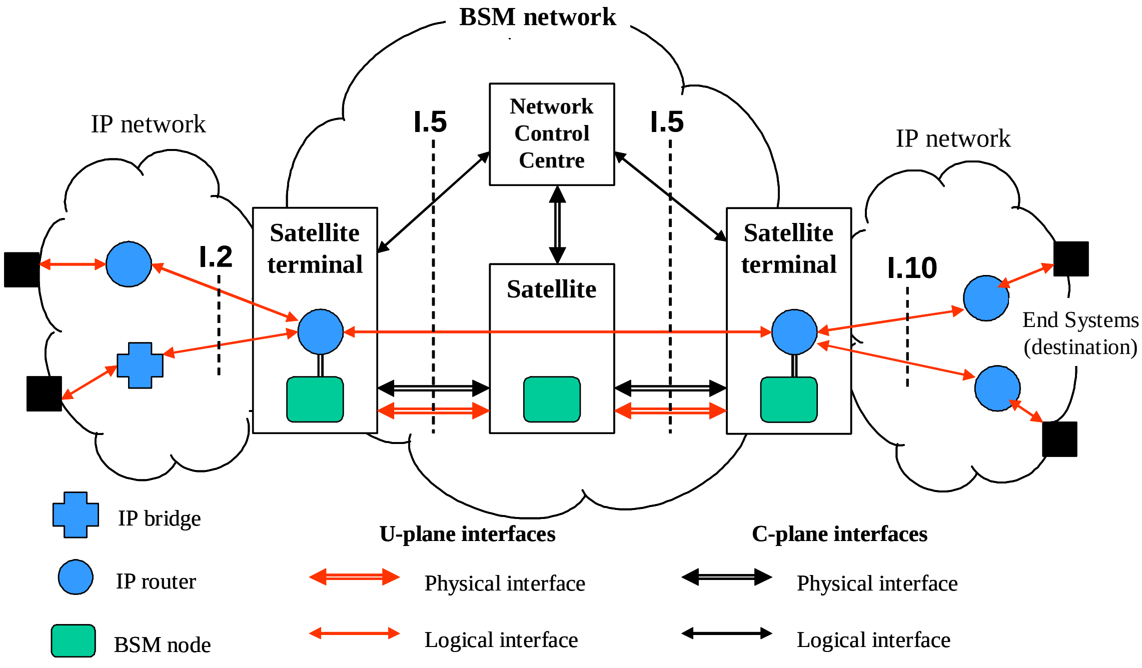

Figure 5.4a: Example of Mesh topology

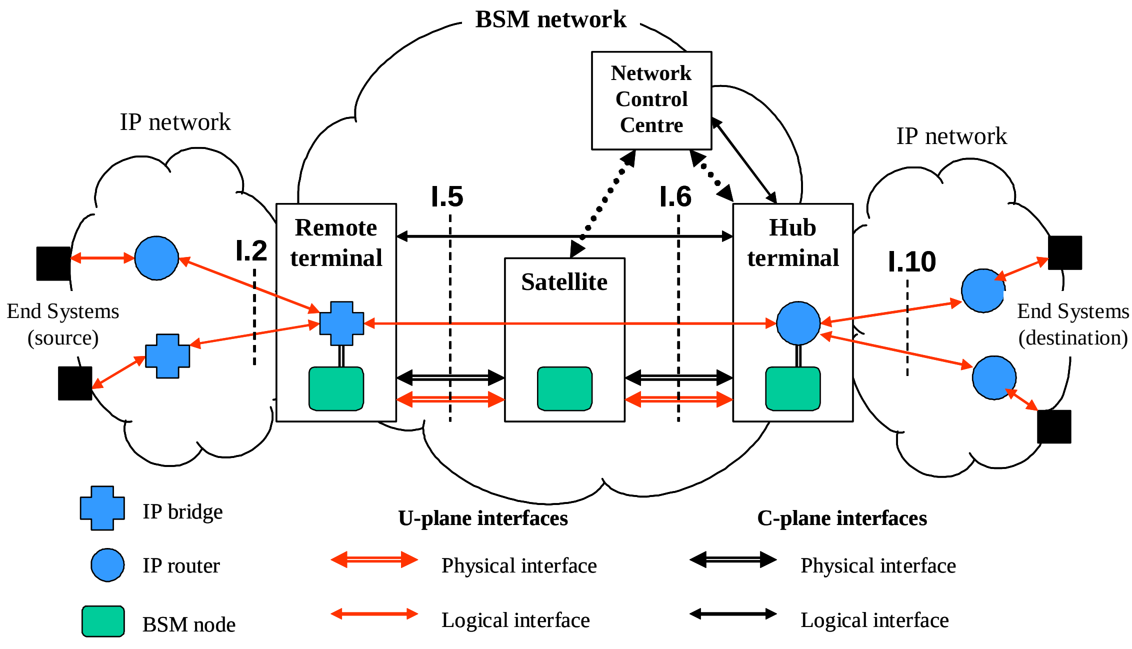

Figure 5.4b: Example of Star topology

As illustrated in figure 5.4b, the Network Control Centre (NCC) for a mesh topology is logically associated only with the hub terminal: remote terminals communicate with the NCC only indirectly via the hub terminal. As a result, the physical interface between the hub terminal and the NCC may either be direct or via the satellite. A direct interface is possible for a network where the hub terminal and the NCC are collocated.

5.5 Network interface examples

The BSM network interfaces are shown in figure 5.5. In these models the internal BSM interfaces are separated into an UpLink (UL) and a DownLink (DL).

Figure 5.5a shows the interfaces for the case of a satellite return channel and figure 5.5b shows the case where the satellite return channel at the satellite terminal (access) is removed and replaced with a bi-directional terrestrial channel that transports all of the return traffic and may also transport some of the forward traffic (e.g. time critical traffic).

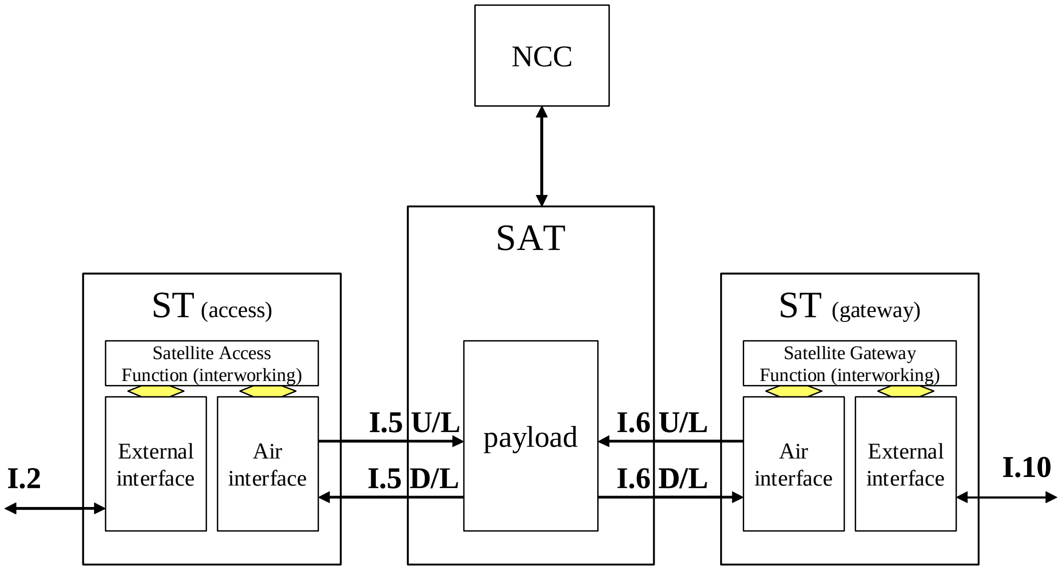

Figure 5.5a: BSM network interfaces: satellite return channel

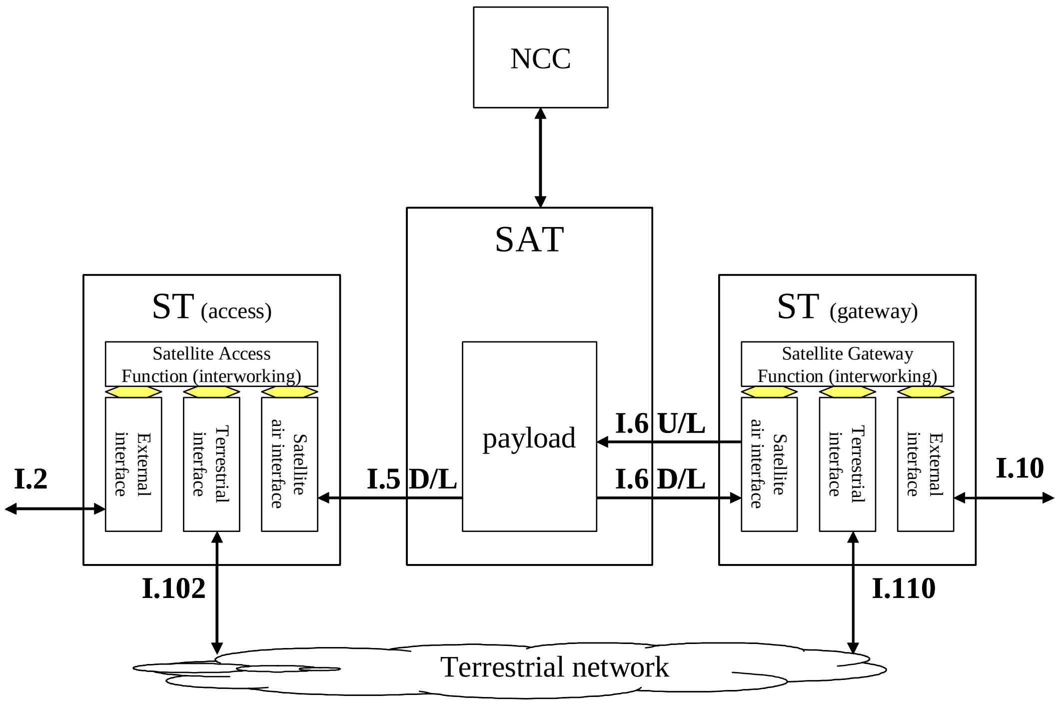

Figure 5.5b: BSM network interfaces: terrestrial return channel

5.6 Protocol architecture

5.6.1 Generic protocol architecture

The generic protocol architecture for satellite access terminal to satellites is illustrated in figure 5.6.1.

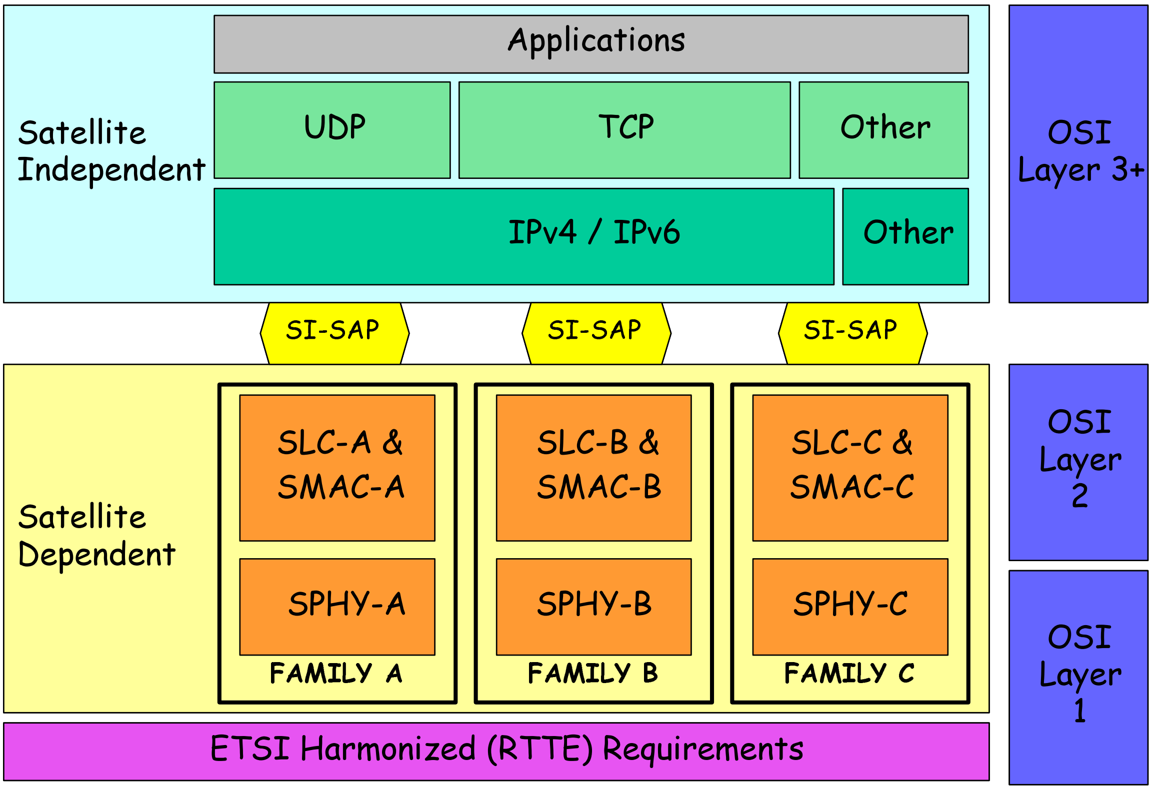

Figure 5.6.1: Generic protocol architecture

The different layers of the protocol architecture are defined in table 5.6.1.

Table 5.6.1: Main layers of a BSM air interface

Layer	Description of Layer	Comments
1	PHYSICAL LAYER	Satellite dependent layer Must conform to ETSI Harmonized Standards
2	DATA LINK LAYER Satellite Link Control (SLC) and Satellite Medium Access Control (SMAC)	Satellite dependent layer SLC and SMAC may be combined into a single layer, or may be separate sublayers
3+	IP AND HIGHER LAYERS	Defined by other standards bodies.

As shown in figure 5.6.1, a Satellite Independent interface (SI-SAP) is defined as the boundary between the lower satellite dependent layers and the upper satellite independent layers.

Below this boundary, the protocol architecture supports "families" of air interface protocols, where each family defines a complete stack of air interface protocols for the physical layer and the data link layer. Each air interface family is expected to use a combination of a SLC, SMAC and SPHY layers that are jointly optimized for a specific range of satellite architectures and/or for a range of specific traffic types.

5.6.2 Satellite Independent Service Access Point (SI-SAP)

The satellite independent service access point (SI-SAP) defines a formal interface between the satellite independent upper layers and the satellite dependent lower layers. The SI-SAP is defined as a common interface that applies to all air interface families.

The SI-SAP corresponds to the endpoints of the BSM bearer services as described in clause 5.6.3. The SI-SAP is used to define standard satellite independent bearer services and this enables ETSI and other standards bodies to define standard mappings from the higher layers to these BSM bearer services.

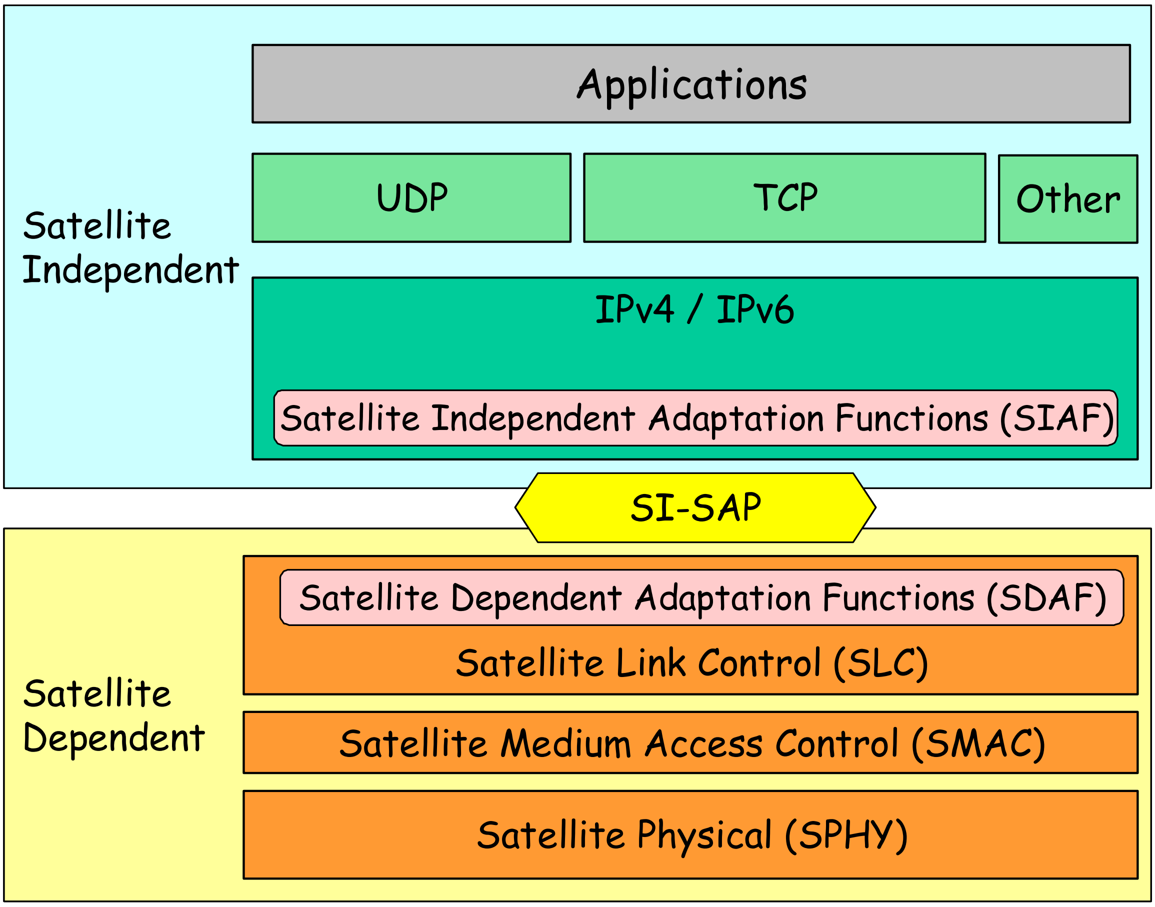

Figure 5.6.2: Satellite Independent Service Access Point (SI-SAP)

As shown in figure 5.6.2 two additional adaptation functions are defined to provide a mechanism for adapting to and from the SI-SAP BSM bearer services:

- The Satellite Independent Adaptation Functions (SIAF) operate at the bottom of Layer 3 to adapt the layer 3 protocols to and from the BSM bearer services;
- The Satellite Dependent Adaptation Functions (SDAF) operate at the top of Layer 2 to adapt the BSM bearer services to and from the native air interface services.

5.6.3 BSM bearer services

The BSM bearer services define a set of standard Layer 2 services (services from Layer 2 to Layer 3). The BSM bearer services are built on lower layer transmission bearer services as illustrated in figure 5.6.3.

The higher layer services such as TCP/IP services are in turn built on the BSM bearer services.

The BSM bearer services are defined with more details in clause 7.

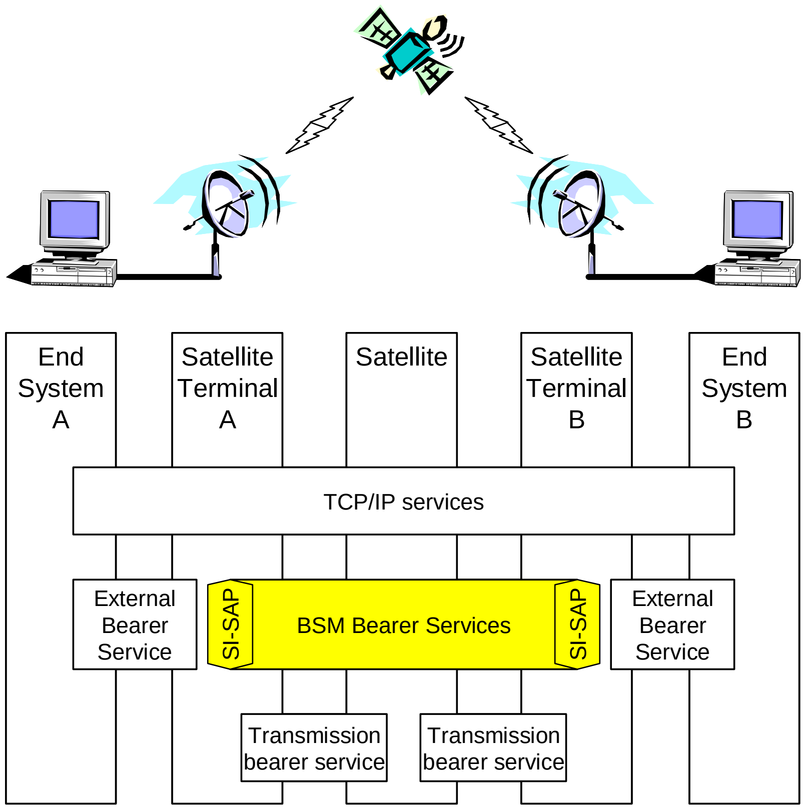

Figure 5.6.3: BSM bearer services

A BSM system will typically use a combination of different transmission bearer services (i.e. different channels) to support a range of BSM bearer services. The higher layer services (IP and above) can be mapped to different BSM bearer services depending on the particular service requirements (e.g. the quality of service and the topology required).

5.6.4 Air interface elements of service

Figure 5.6.4 illustrates the relationship between the BSM bearer services and the elements of service at the different layers of the satellite air interface.

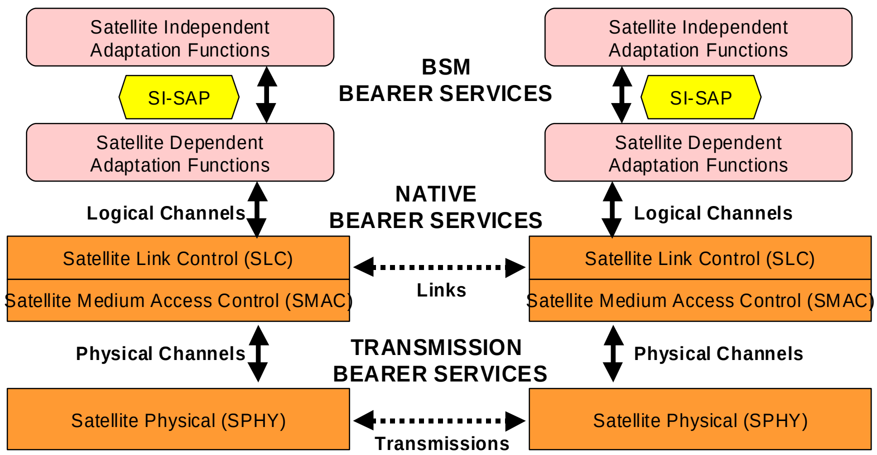

Figure 5.6.4: Air interface elements of service

The elements of services are divided into layer-to-layer elements of service and peer-to-peer elements of service.

The following layer-to-layer elements of services are defined:

- **BSM bearer services** provide the capability of transmission of signals between a pair of SI-SAP access points as defined above.
- **Logical channels** are the native services provided by the link layer protocols (i.e. a logical channel corresponds to the endpoint of a specific instance of the link layer services). The Logical Channels correspond to the Native bearer services of the air interface family (i.e. before adaptation to the BSM bearer services).
- **Physical channels** are the services provided by the physical layer protocols (i.e. a physical channel corresponds to the endpoint of a specific instance of the physical layer services). The Physical Channels correspond to the Transmission Bearer Services (as also shown in figure 5.6.3).

The following peer-to-peer elements of service are also defined:

- **A link** is defined as the peer-to-peer association at the link layer. The peer entity for the link may be either the satellite or another ST depending on payload of the satellite. A link will typically support multiple logical channels (e.g. by multiplexing).
- **A transmission** is defined as the peer-to-peer association at the physical layer.

6 General service definitions

6.1 Media components

The telecommunication services supported by involve in general one or more media components. The following types of media components are distinguished in the present document:

speech: voice telecommunication.

audio: telecommunication of sound in general.

video: telecommunication of full motion pictures, and of stills.

data: telecommunication of information-files (text, graphics, etc).

MultiMedia (MM): a combination of two or more of the above components (speech, audio, video, data), with a temporal relationship (e.g. synchronization) between at least two components.

6.2 BSM connections

A BSM connection provides a means for communication between two or more devices in, or attached to, a Broadband Satellite Multimedia telecommunication network.

In the case of IP traffic, BSM connections are referred to as "flows":

- **IP Flows (Flows)** are defined as a sequence of IP packets that are routed (end-to-end), based on the destination IP address contained in the IP header. An IP flow is a logical concept introduced to describe IP traffic at a particular node. IP packets belonging to the same flow can (and often do) travel via differing sets of nodes.
- An IP Flow may be associated with a traffic class and a path through a network using the Integrated Services (Intserv) model, in which case reservations are made using RSVP. IP networks may also support traffic classes without explicit reservation using the Differentiated services (Diffserv) model. Intserv and Diffserv are described in more detail in TR 101 865 [6], clause 8.2.
- IP Flows are identified in network nodes on the basis of information found in the IP datagram header fields (e.g. IP source and destination address, source and destination port, protocol ID, Type Of Service (TOS) field).

In case of ATM traffic, BSM connections are referred to as "virtual circuits":

- **Virtual circuits** are defined as a sequence of ATM cells that are switched identically based on a label that is unique on a link per link basis, and contained in the ATM header (i.e. the Virtual Channel Identifier (VCI) + Virtual Path Identifier (VPI)). From a network perspective, a virtual connection is an edge-to-edge service, travelling from one edge of a network to another edge.
- Virtual circuits are established by means of signalling on the basis of ATM End System Addresses (AESA) e.g. as defined by ATMF in af-uni-0010.002 [4]. Virtual connections are identified in ATM switches on the basis of the VCI/VPI.
- ATM edge devices are seldom co-located with the end hosts, and are more often co-located with IP routers.

6.3 Media components and connections

Connections are said to be mono-media, when they transport only one media component (i.e. either speech only, or audio only, or video only, or data only). Connections are said to be multi-media, when they transport a MultiMedia (MM) component.

MultiMedia (MM) services can be provided in one of two ways, as illustrated in figure 6.3:

- Using multiple parallel mono-media flows, while maintaining synchronization in the terminals.
- Using a single MultiMedia flow, while dealing with the individual media components in the terminals.

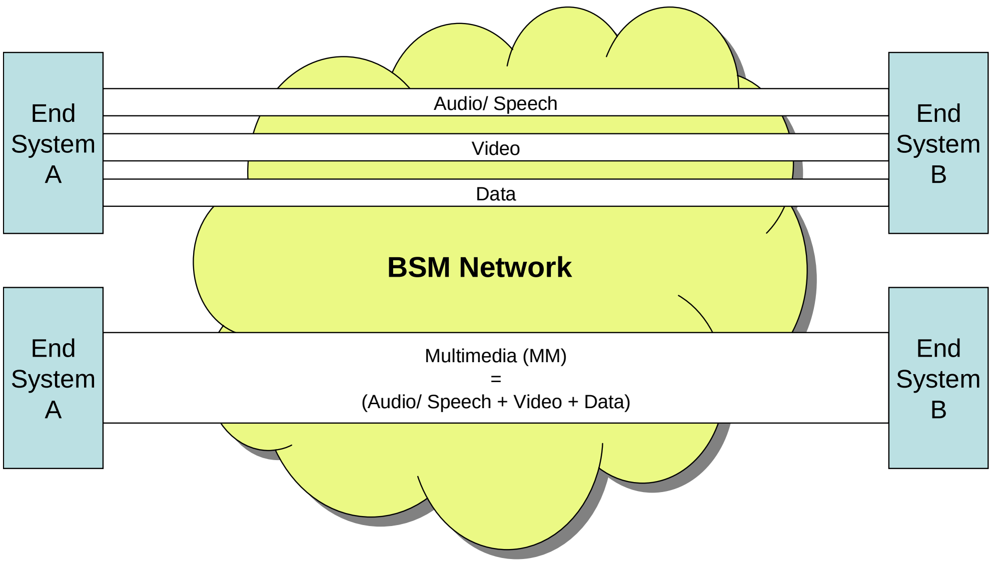

Figure 6.3: Multimedia components

6.4 Traffic classes and QoS

6.4.1 General

When defining the BSM QoS, the restrictions and limitations of the air interface have to be taken into account. It is not reasonable to define complex mechanisms as have been in fixed networks due to different error characteristics of the air interface. The QoS mechanisms provided in the BSM network have to be robust and capable of providing reasonable QoS resolution.

In this clause, we make a distinction between the terms Traffic Class and Quality of Service (QoS):

- Traffic class is a generic concept that applies at every step of the traffic flow. In other words this corresponds to the characteristics of the end-to-end service. Traffic class is defined by a set of general characteristics.

- QoS is a specific concept that applies for a particular portion of the traffic flow. A QoS class must therefore always be qualified by reference to a specific interface; for example "BSM Bearer Service QoS". QoS is typically defined by a defined set of QoS attributes.

6.4.2 Traffic classes

Four traffic classes can be distinguished in the Broadband Satellite Multimedia networks as illustrated in table 6.4.2. These are based on the traffic classes defined in TS 123 107 [5].

Table 6.4.2: BSM Traffic classes

TRAFFIC CLASS	INTENDED USAGE	EXAMPLE APPLICATIONS
Conversational	Real-time conversational traffic involving conversing entities	telephony, teleconference, videophony and videoconference, chatting, net-gaming
Streaming	Real-time streaming traffic involving the sending of information from one entity to another	audio and video broadcast, surveillance
Interactive	Near real-time interactive traffic involving retrieving of information by one entity, from another entity	web browsing
Background	Non real-time background traffic involving the sending of information from one entity to another entity	Email and file transfer

6.4.3 Traffic characteristics

Table 6.4.3 lists the four traffic classes and indicates the applicable media components, and gives an indication of the corresponding general traffic characteristics.

Table 6.4.3: Traffic characteristics

Traffic class	Components	General traffic characteristics
Conversational	Speech Audio Video Data MM	Constant Rate (CR) and Variable Rate (VR) Delay sensitive Delay variation sensitive Limited tolerance to loss/errors (depends on coding)
Streaming	Audio Video MM	Variable Rate (VR) Tolerant to delay (buffering in terminals) Delay variation sensitive (depending on buffer sizes in terminals/gateways) Limited tolerance to loss/errors (depends on coding)
Interactive	Data	Variable Rate (VR) Delay sensitive (but more tolerant than conversational) Tolerant to delay variation Loss/error sensitive
Background	Data	Best Effort (BE) Not delay sensitive Tolerant to delay variation (and more tolerant than interactive class) Loss/error sensitive

The main distinguishing factor between the four BSM traffic classes is how delay sensitive the traffic is: Conversational class is meant for traffic which is most delay sensitive while Background class is the most delay insensitive traffic class.

Conversational and Streaming classes are mainly intended to be used to carry real-time traffic flows. Conversational real-time services, like video telephony, are the most delay sensitive applications and those data streams should be carried in Conversational class.

Interactive class and Background class are mainly meant to be used by traditional Internet applications like WWW, Email, Telnet, FTP and News. Due to looser delay requirements (when compared to conversational and streaming classes) these classes may provide better error rate by means of channel coding and retransmission.

The main difference between Interactive and Background class is that Interactive class is mainly used by interactive applications, e.g. interactive Email or interactive Web browsing, while Background class is meant for background traffic, e.g. background download of Emails or background file downloading. The responsiveness of the interactive applications can be improved by separating interactive and background applications. For example, if traffic in the Interactive class is allocated a higher priority in scheduling than Background class traffic, so background applications use transmission resources only when interactive applications do not need them.

6.4.4 End to End QoS

Network Services are considered end-to-end, this means from one End System (ES) to another ES. An End-to-End Service may have a certain Quality of Service (QoS) which is provided for the user of a network service. It is the user that decides whether he is satisfied with the provided QoS or not.

On its way from one End System (ES) another ES the traffic has to pass different bearer services of a series of network(s) and the End-to-End-Service used by the ES is determined by the combination of the BSM bearer services and those External Bearer Services. As the End-to-End Service is conveyed over several networks (not only BSM) it is outside the scope of the present document.

The External Bearer Services are not further elaborated in the present document: these bearer services may be using several network services, e.g. a ES - ST Local Bearer Service, or an External Bearer Service provided by terrestrial transit networks or even another BSM Bearer Service.

6.4.5 BSM QoS

The present document focuses on the BSM Bearer Service. These are the services that the BSM network operator offers and it is these bearer services that provide the BSM QoS.

The Satellite Terminal is required to map the implied traffic class, as indicated by the class of service attributes of the external network, into a BSM bearer service with a suitable quality of service. This mapping is normally contained in the Satellite Independent Network Adaptation Layer.

A BSM bearer service includes all aspects to enable the provision of a contracted QoS. These aspects are among others the control signalling, user plane transport and QoS management functionality. The BSM bearer service architecture is depicted in figure 6.4.5. Each bearer service on a specific layer offers its individual services using services provided by the layers below.

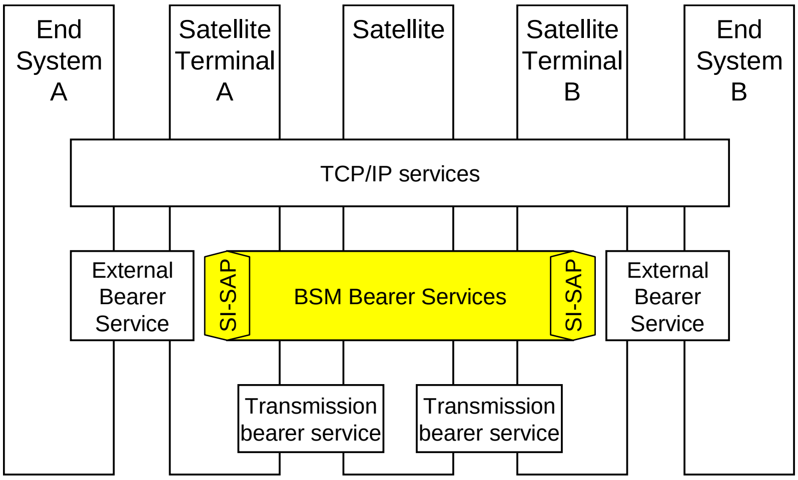

Figure 6.4.5: BSM bearer services

BSM Quality of Service is defined by reference to the BSM bearer services and the associated bearer service attributes. BSM bearer services include both ConnectionLess Bearer Services (CLBS) and Connection Oriented Bearer Services (COBS) as defined in clause 7.

A given BSM network may offer a range of BSM bearer services, and each bearer service may offer a range of QoS. The mapping of the external network services into the BSM bearer services is network specific: for a given BSM network the mapping may be dependent on non-traffic factors such as the network capabilities and the customer service contract as well as (or instead of) the traffic class. A few examples serve to illustrate the range of possible strategies:

- A BSM network may be configured to offer a specific QoS for each user. In this example, all traffic for that user would get the same aggregate class, regardless of the actual traffic content.
- A BSM network may be configured to offer a specific QoS for each traffic class. In this example, the traffic class could be implied from the external network QoS (e.g. via Diffserv PHB, see TR 101 865 [6], clause 8.2.4) or could be implied via traffic flow identifiers (e.g. the IP destination address).
- In a more general case, a BSM network could offer a mixture of these two QoS strategies.

Traffic classes in ATM can be directly related to actual network requirements for the various edge-to-edge paths, where each ATM path (as denoted by VCI/VPI pairs) is associated with a specific traffic class.

Traffic classes for IP flows may be only indirectly related to the actual network requirements. An IP flow does not usually indicate a specific requirement to the network and the edge device has to guess the traffic class of an flow. For example, using Diffserv an endhost or router may indicate a general class of service based on a user, network policy, or application type. However, this is normally related to an aggregate class of service - applying to a number of separate flows.

7 Bearer services

7.1 Definitions

7.1.1 Bearer services

Bearer services provide the capability for information transfer between access points and involve only low layer functions. These functions are sometimes referred as low layer capabilities (in reference to OSI layers). The user may choose any set of high layer protocols for his communication and the BSM bearer services do not ascertain compatibility at these layers between users.

The characterization of a bearer service is made by using a set of characteristics that distinguishes it from other bearer services. Particular values are assigned to each characteristic when a given bearer service is described and defined.

In the general case, the networks between the two access points can use different control mechanisms. In this case the bearer services of each network throughout the communication link have to be translated at the network interfaces to realize an end to end bearer service. Each network contributes to the end-to-end QoS perceived by the end-user. Therefore all of the intervening networks (between two access points) must attain service interoperability in order to support the end-to-end QoS.

7.1.2 Connectionless and connection-oriented bearer services

Connectionless bearer services refer to services which allows the transfer of information between users without the need for separate connection establishment procedures.

Connection-oriented bearer services refer to services in which communication proceeds through three well-defined phases: connection establishment, data transfer, connection release.

7.1.3 Unidirectional and bidirectional bearer services

Bearer services may be unidirectional or bidirectional as follows:

unidirectional bearer service: bearer service where data are transferred in one direction only from the source user-network interface to the destination user-network interface(s).

bidirectional bearer service: bearer service where data are transferred in both directions between the source user-network interface(s) and the destination user-network interface(s).

NOTE: A bidirectional bearer service can be realised by combining two or more unidirectional bearer services in opposite directions.

7.1.4 Bearer service symmetry

Bidirectional bearer services may be symmetric or asymmetric. For asymmetric bearer services the service may define a forward direction and a reverse direction as follows:

forward direction: dominant direction of data transfer over an asymmetric network. It corresponds to the direction with better link characteristics in terms of bandwidth, latency, error rate, etc. We term data transfer in the forward direction as a "forward transfer".

reverse direction: direction in which acknowledgements of a forward TCP transfer flow. Data transfer could also happen in this direction (and it is termed "reverse transfer"), but it is typically less voluminous than that in the forward direction.

NOTE: These definitions are adopted from the IETF PILC Working Group (PILC WG).

7.2 Bearer service configurations

7.2.1 Overview

Bearer services are defined as the edge-to-edge services provided by the BSM subnetwork. The following BSM bearer service configurations are defined:

- Point-To-Point Bearer Services
  - Point-To-Point Connectionless Bearer Service (PTP-CLBS)
  - Point-To-Point Connection-Oriented Bearer Service (PTP-COBS)
- Point-To-Multipoint Bearer Services
  - Point-To-Multipoint Connectionless Bearer Service (PTM-CLBS)
  - Point-To-MultiPoint Connection-Oriented Bearer Service (PTM-COBS)

- Multipoint-To-Multipoint Bearer Services
    - Multipoint-To-Multipoint Connectionless Bearer Service (MTM-CLBS)
- Broadcast Bearer Services
    - Broadcast Connectionless Bearer Service (BRO-CLBS)

7.2.2 Point-To-Point Bearer Services

7.2.2.1 Point-To-Point Connectionless Bearer Service (PTP-CLBS)

The Point-To-Point Connectionless Bearer Service (PTP-CLBS) is a unidirectional service in which one (or more) single packet(s) is (are) sent from a single service user "A" to a single destination user "B". Each packet is independent of the preceding and succeeding packet. This service is of the datagram type and is intended to support bursty applications.

On the radio interface PTP-CLBS may provide an acknowledged transfer mode for reliable delivery.

7.2.2.2 Point-To-Point Connection-Oriented Bearer Service (PTP-COBS)

The Point-To-Point Connection-Oriented Bearer Service (PTP-COBS) is a unidirectional service which supports connection-oriented communications over a virtual circuit connection where a series of one or more packet(s) is (are) sent from a single service user "A" to a single destination user "B". The virtual circuit provides a defined Quality of Service (QoS) which applies to all the packets. The bit rate can be approximately constant to support constant rate traffic or it can be highly variable to support variable bit rate traffic.

7.2.3 Point-To-Multipoint Bearer Services

7.2.3.1 Point-To-Multipoint Connectionless Bearer Service (PTM-CLBS)

The Point-To-Multipoint Connectionless Bearer Service (PTM-CLBS) is a unidirectional service in which one (or more) single packet(s) is (are) sent from a single service user "A" to one or more destination users "D1", "D2", …"Dn" Each packet is independent of the preceding and succeeding packet. This service is of the datagram type and is intended to support bursty applications.

On the radio interface PTM-CLBS may provide an acknowledged transfer mode for reliable delivery.

7.2.3.2 Point-to-Multipoint Connection-Oriented Bearer Service (PTM-COBS)

The Point-To-Multipoint Connection-Oriented Bearer Service is a unidirectional service which supports connection-oriented communications over virtual circuit connections where a series of one or more packets are sent from a single service user "A", called the root, to one or more destination users "D1", "D2", … "Dn", called the leafs. New leafs can join under either a root-initiated join procedure or a leaf-initiated join procedure.

7.2.4 Multipoint-To-Multipoint Bearer Services

7.2.4.1 Multipoint-To-Multipoint Connectionless Bearer Service (MTM-CLBS)

The Multipoint-To-Multipoint Connectionless Bearer Service (PTM-CLBS) is a unidirectional service in which one (or more) single packet(s) is (are) sent from any one of a defined group of service users " "C1", "C2", …"Cn" to one or more destination users "D1", "D2", …"Dn". The source group "C1", "C2", …"Cn" may overlap in whole or in part with the destination group "D1", "D2", …"Dn". Each packet is independent of the preceding and succeeding packet. This service is of the datagram type and is intended to support bursty applications.

On the radio interface MTM-CLBS may provide an acknowledged transfer mode for reliable delivery.

7.2.5 Broadcast Bearer Services

7.2.5.1 Broadcast Connectionless Bearer Service (BRO-CLBS)

The Broadcast Connectionless Bearer Service (BRO-CLBS) is a unidirectional service in which one (or more) single packet(s) is (are) sent from any one of a defined group of service users " "C1", "C2", …"Cn" to an unaddressed group of destination users. This service differs from the PTM-CLBS and MTM-CLBS services by using a broadcast address for transmission: this means that the destination group is not defined by an address contained in the source data.

NOTE: A broadcast address is typically realised by a reserved value or "all stations" address. The associated broadcast service may offer regional or other network defined groupings of terminals (e.g. to support logical private networks).

Annex A: Example protocol models

A.1 A protocol model for regenerative satellites

A protocol model for a satellite with on board processing (OBP) is illustrated in figure A.1. The SIAF provides a local mapping from the standard TCP/IP traffic into the SI-SAP in order to provide peer-to-peer transport of TCP/IP traffic between STs.

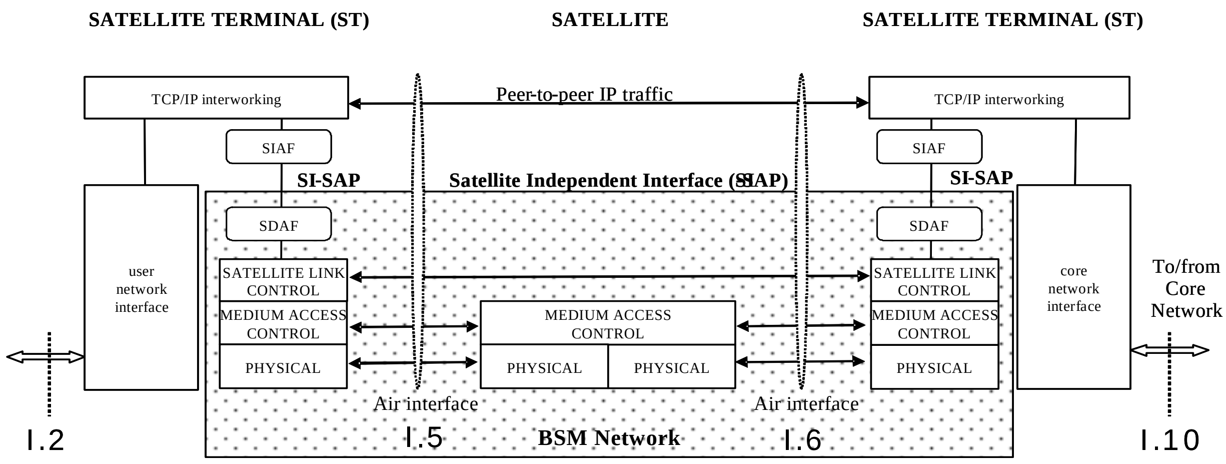

Figure A.1: Protocol model for satellite with OBP

A.2 A protocol model for non-regenerative satellites

A protocol model for a non-regenerative (transparent) satellite is illustrated in figure A.2. The SIAF provides a local mapping from the standard TCP/IP traffic into the SI-SAP in order to provide peer-to-peer transport of TCP/IP traffic between STs. In this case, no MAC layer processing is performed by the satellite.

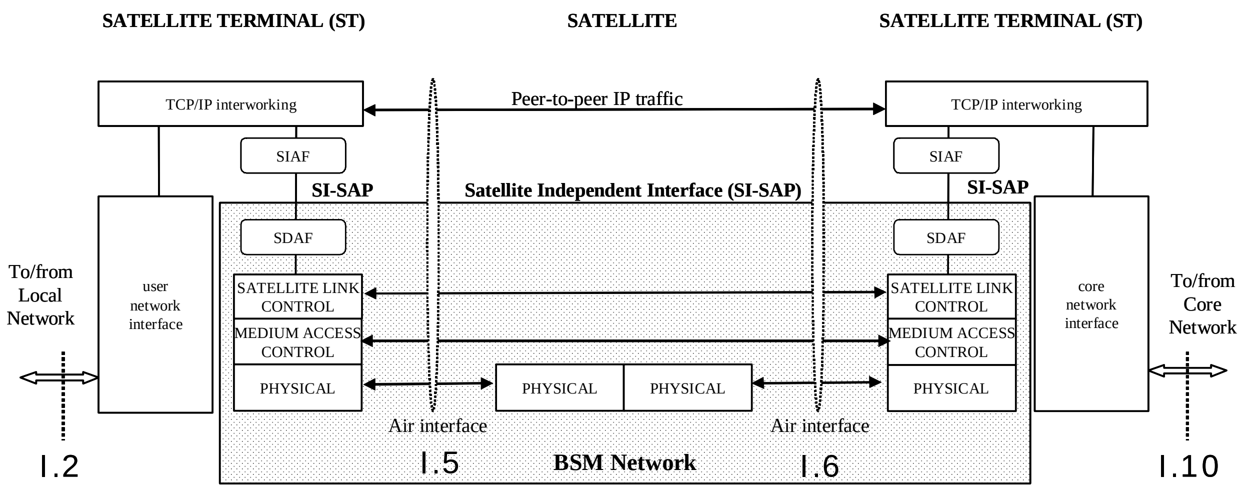

Figure A.2: Protocol model for non-regenerative satellite

History

Document history		
V1.1.1	November 2002	Publication