IST Integrated Project No 507023 – MAESTRO

D6-2.2a

SDMB System design definition file

(for Commercial System)

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Abstract:

The deliverable D6-2 – System Design Definition file - describes the system in terms of functional and physical architectures (sub-systems and interfaces) and ensures the top-level cohesion between the design work-packages activities.

This document D6-2-2a supersedes D6-2-1a

Keyword list: SDMB, Architecture

EXECUTIVE SUMMARY

This document contains deliverable D6-2 of the IST Integrated Project MAESTRO – Mobile Applications & sErvices based on Satellite and Terrestrial inteRwOrking (IST Integrated Project n° 507023).

MAESTRO project aims at studying technical implementations of innovative mobile satellite systems concepts targeting close integration & interworking with 3G and Beyond 3G mobile terrestrial networks.

MAESTRO aims at specifying & validating the most critical services, features, and functions of satellite system architectures, achieving the highest possible degree of integration with terrestrial infrastructures. It aims not only at assessing the satellite systems' technical and economical feasibility, but also at highlighting their competitive assets on the way they complement terrestrial solutions.

The work package 6 «Architecture» aims at:

- Identifying the Technical Requirements of the SDMB system
- Defining an SDMB system architecture that inter works with the 3GPP architecture and meets all system requirements,
- Defining the functions and interfaces of SDMB all sub-systems namely User Equipment, Intermediate Module Repeater, space segment, hub and service centre,
- Estimating the cost impacts of SDMB features on 3G handset and on BM-SC
- Estimating the manufacturing and installation costs associated to the intermediate repeater.
- Estimating the development cost of the hub.
- Analysing the impacts of SDMB system on the 3G mobile network.

The deliverable D6-2 – System Design Definition file - describes the system in terms of functional and physical architectures (sub-systems and interfaces) and ensures the top-level cohesion between the design work-packages activities.

The task is lead by ASP and is supported actively by all MAESTRO partners.

This document is dedicated to the architecture of the commercial system.

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DOCUMENT HISTORY

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1.1	30 April 2004	D6-2-1a Document draft
1.2	28 June 2004	D6-2-1a Revised edition for review before delivery to EC
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3.2	21 Dec 2004	Final version for delivery

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1 INTRODUCTION

1.1 Background

This document is the answer to the SDMB Technical Requirement Document. It describes the SDMB system in terms of functional, organic and physical architectures taking into account sub-system and interface definitions. If needed, the justification of an architecture choice is given.

It is one output of the task 6.2 of the Work Package 6. This document is dedicated to the commercial system and does not refer to Maestro test-bed architecture.

1.2 Fields of application

This document is applicable to the SDMB system as designed in the frame of the MAESTRO project.

1.3 Document structure

Section 2 introduces the MAESTRO documentary set

Section 3 recalls the terms, definitions, abbreviated terms and symbols

Section 4 is a general presentation of the SDMB system

Section 5 focuses on external interfaces

Section 6 describes functional architecture

Section 7 introduces the system organic/logical architecture

1.4 Document status

DRAFT

2 DOCUMENTARY REFERENCE SYSTEM

2.1 Applicable documents

Del. no.	Deliverable name
D1-1	SDMB Role Model
D1-5	Commercial Service Definition (*)
D1-6	PPDR Service Definition (*)
D1-7	Business Model Scenarios (*)
D1-8	SDMB Mission Requirements (*)
D6-1	SDMB System Technical Requirement document

(*) Not delivered yet

2.2 Applicable norms and standards

[1] 3GPP, "Repeater radio transmission and reception (FDD)", 3GPP TS 25.106

2.3 Reference documents

Del. no.	Deliverable name
D2-1.1	SDMB Physical layer – specifications
D3-1	SDMB Access Layer Definition
D4-1	Short-list of architecture options for various locations of SDMB
D5-1	Reliable Transport Layer Technical Requirement Document
D6-4	IMR specifications document
D6-5	SDMB hub specification document
D6-6	Service Centre Specification document
D6-9	Space segment specification (*)
D6-10	UE SDMB specification document of a Commercial UE product (*)

(*) Not delivered yet

2.4 Documents tree

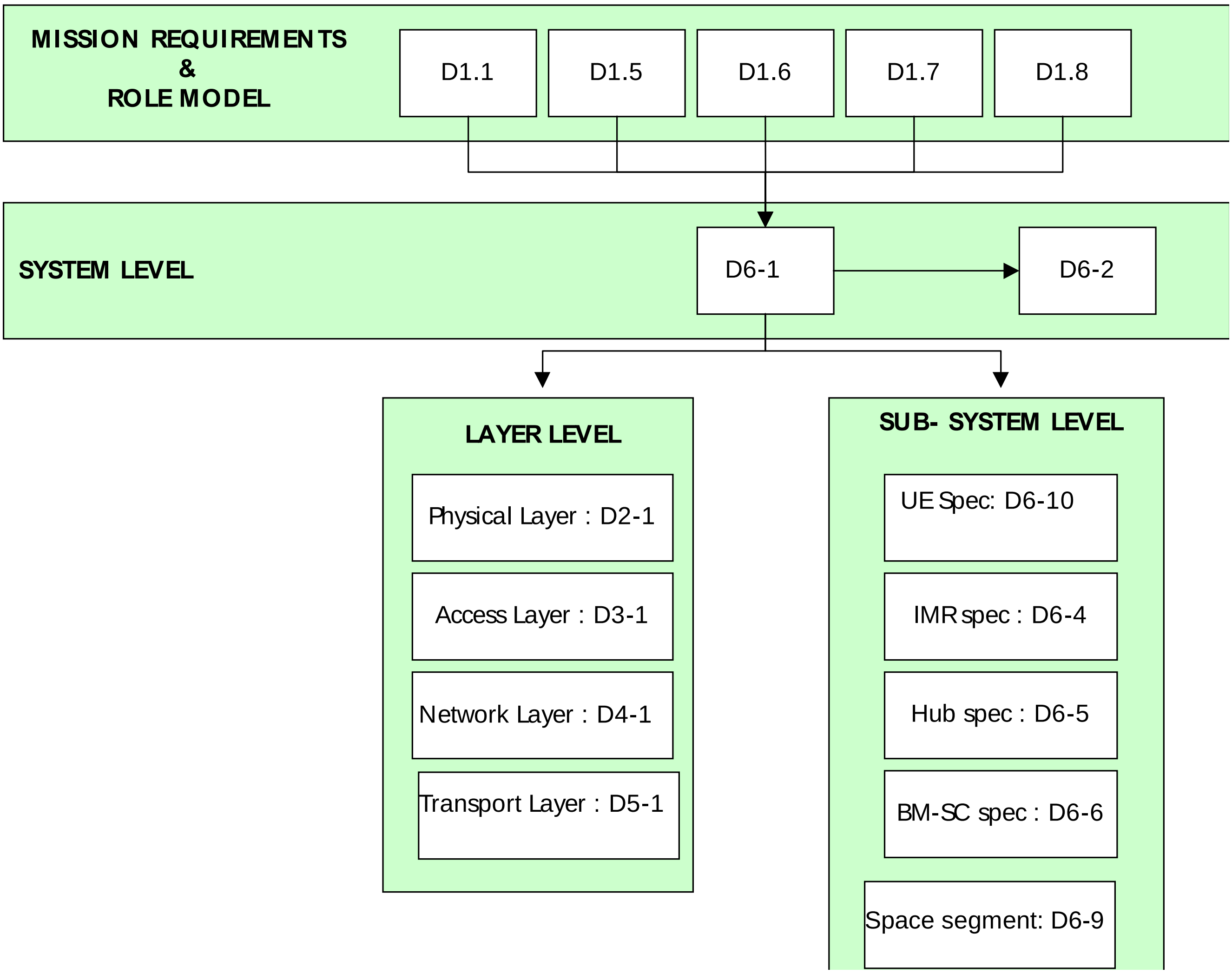


Figure 1: Maestro document tree (partial)

3 TERMS, DEFINITIONS, ABBREVIATED TERMS AND SYMBOLS

3.1 Terminology and definitions

Version
1.4

BM-SC	Means the BM-SC as defined for MBMS and including specific SDMB features
Cell	Means the Terrestrial mobile network cell
Content	File or data stream transmitted by the SDMB system and possibly (for the Download service) completed by terrestrial retransmissions
Download delivery method	A delivery method that delivers some multimedia content with loose time constraints. The service is best map on 3GPP defined background traffic class capability.
End User	The End user owns the terminal, subscribes to the MNO & Mobile Portal services
Groupcast service	A service offered to end-user allowing to send in a cost efficient way the same content to a group of users. This may include streaming or download.
SDMB service	A push service that delivers a set of Multimedia content to several recipients. The service includes information, which allows the user equipment to process the content according to the end-user's rights and terminal capabilities. The access to the service may be restricted to a certain group of users which may have to pay a fee.
Relevant content	A multimedia content which is expected to interest the end user with respect to its user preference profile.
Service area	Refers to the area where the SDMB services are available. Basically it is defined taking into account a set of satellite spots providing the European coverage.
Spot area	Corresponds to the areas covered by a satellite spot beam. There is not necessarily a service continuity between two spot areas. We assume that the same data is datacast in a spot area and it differs from the data datacast in other spot areas.
Streaming delivery method	A delivery method that delivers some multimedia content with real time constraints. It may refers to TV or radio type of services. Such service is manually activated by the end-user. Content are played as soon as received by the end-user terminal. The service is best map on 3GPP defined streaming traffic class capability.
Terrestrial mobile network	The terrestrial mobile network(s) on which the SDMB system relies.
UE	The UMTS/GSM User equipment modified to include SDMB features.
User preference profile	The description of the SDMB-content related user preferences (preferred user services) in the UE.
User service	A consistent set of contents, distributed using a given delivery method.

3.2 ABBREVIATIONS

Version 1.5

3GPP	Project
	Advanced Audio Coding
ABFN	Analogue Beam Forming Network
ACI	Adjacent Channel Interference
ACIR	Adjacent Channel Interference Ratio
ACLR	Adjacent Channel Leakage Ratio
ACS	Adjacent Channel Selectivity
ADC	Analogue to Digital Conversion
AGC	Automatic Gain Control
AGILENT	Agilent Technologies Belgium SA, Belgium (MAESTRO Partner)
AM/AM	Amplitude – Amplitude transfer function
AM/PM	Amplitude – Phase transfer function
ASC	Ascom Systec AG, Swiss (MAESTRO Partner)
ASEL	Alcatel SEL AG, Germany (MAESTRO Partner)
ASP	Alcatel Space, France
AWE	AWE Communications GMBH, Germany (MAESTRO Partner)
AWGN	Additive White Gaussian Noise
BCF	Base Common Functions
BCH	Broadcast Channel
BER	Bit Error Rate
BLER	BLock Error Rate
BM-SC	Broadcast Multicast Service Center
BS	Base Station
BT	British Telecommunications PLC, United Kingdom (MAESTRO Partner)
BYTL	Bouygues Telecom, France (MAESTRO Partner)
CBS	Cell Broadcast Service
CCI	Co-Channel Interference
CCN	Contract Change Notice
CDD	Content Delivery Descriptor
CDMA	Code Division Multiple Access
CDN	Content Delivery Network
CNP	Combined Network Planning
COTS	Commercial Off The Shelf
CPICH	Common Pilot Channel
CTCH	Common Traffic Control Channel
DL	DownLink
DMB	Digital Multimedia Broadcasting
DRM	Digital Rights Management
DSP	Digital Signal Processing
DVB	Digital Video Broadcasting
DVB-S	DVB Satellite
EC	European Commission
EIRP	Equivalent Isotropically Radiated Power
ERCOM	Ercom Engineering Reseaux Communications, France (MAESTRO Partner)
ESA	European Space Agency
ESG	Electronic Service Guide
E-TF1	E-TFI, France (MAESTRO Partner)
ETSI	European Telecommunications Standard Institute
EVM	Error Vector Magnitude
FDD	Frequency Division Duplex
FDM	Frequency Division Multiplex
FDMA	Frequency Division Multiple Access
FEC	Forward Error Correction
FHG/IIS	Fraunhofer Gesellschaft e.V., Germany (MAESTRO Partner)
FP5	5th Research Framework Program of the European Commission
FP6	6th Research Framework Program of the European Commission
FSS	Fixed Satellite Services
G/T	Figure of merit
GD	Group Delay
GEO	Geostationary Earth Orbit
GF	Gain Flatness
GFI	GFI Consulting, France (MAESTRO Partner)
GNSS	Global Navigation Satellite System
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
GUI	Graphic User Interface
GW	Gateway
HDFSS	High Density FSS
HLR	Home Location Register
HPA	High Power Amplifier

HTML	Hyper Text Markup Language
HW	Hardware
I/O	Input / Output
IBO	Input Back-Off
IMR	Intermediate Module Repeater
IMT-2000	International Mobile Telecommunications 2000
IP	Internet Protocol
IRT	Intelligent Ray Tracing
IST	Information Society & Technology
ITU	International Telecommunication Union
KO	Kick-Off
LBS	Location Based Services
LDR	Large Deployable Reflector
LMS	Land Mobile Satellite
LNA	Low Noise Amplifier
LNB	Low Noise Block
LOGICACMG	LogicaCMG UK Limited, United Kingdom (MAESTRO Partner)
LOS	Line Of Sight
LTWTA	Linearised Travelling Wave Tube Amplifier
MAC	Medium Access Control
MAESTRO	Mobile Applications & sErvices based on Satellite and Terrestrial inteRwOrking
MBMS	Multimedia Broadcast/Multicast Service
MM	MultiMedia
MMI	Man Machine Interface
MMS	Multimedia Messaging Service
MNO	Mobile Network Operator
MoDiS	IST FP5 Mobile Distribution project - MObile DIgital broadcast Satellite
MP3	Moving Picture Experts Group Layer-3 Audio (audio file format/extension)
MPA	Multi-Port Amplifier
MPC	Multi-Port Combiner
MPD	Multi-Port Divider
MPEG4	Motion Picture Experts Group 4 (Standard - Compressed Video at 64 Kbps)
MSC	Mobile Switching Centre
MSPS	Motorola Toulouse SAS, France (MAESTRO Partner)
MSS	Mobile Satellite Services
NLOS	Non Line Of Sight
Node B	UMTS Base Station
O&M	Operation and Maintenance
OBO	Output Back-Off
OMA	Open Mobile Alliance
OMC	Operation and Maintenance Center
OMUX	Output Multiplexer
PA	Power Amplifier
P-CCPCH	Primary Common Control Physical Channel
PCDE	Peak Code Domain Error
PER	Packet Error Rate
PFD	Power Flux Density
PICH	Paging Indicator Channel
PIM	Protocol Interface Module
PLMN	Public Land Mobile Network
P-SCH	Primary Synchronisation Channel
PSSP	Public Security Service Provider
PTP	See p-t-pt
p-t-p	Point to Point
PVR	Personal Video Recorder
QoS	Quality of Service
R1	MAETRO Test Bed Release 1
R2	MAETRO Test Bed Release 2
RAN	Radio Access Network
RLC	Radio Link Control
RNC	Radio Network Controller
RNPT	Radio Network Planning Tool
RNS	Radio Network Subsystem
SAP	Service Access Point
S-CCPCH	Secondary Common Control Physical Channel
SDMB	Satellite Digital Multimedia Broadcasting
S-DMB	See SDMB
SES	SES Astra, Luxembourg (MAESTRO Partner)
SF	Spreading Factor
SFN	Single Frequency Network
SGSN	Serving GPRS Support Node
SIM	Subscriber Identity Module
SMS	Short Message Service
SLA	Service Level Agreement
SPH	Space Hellas SA, Greece (MAESTRO Partner)
S-SCH	Secondary Synchronisation Channel
SSPA	Solid State Power Amplifier
S-UMTS	Satellite UMTS
SW	Software
TBC	To Be Confirmed
TBD	To Be Defined
TDD	Time Division Duplex
T-UMTS	Terrestrial UMTS
TV	Television

TWTA	Travelling Wave Tube Amplifier
UCL	University College London, United Kingdom (MAESTRO Partner)
UDCAST	Udcast, France (MAESTRO Partner)
UE	User Equipment
UMTS	Universal Mobile Telecommunications System
UNIS	The University of Surrey, United Kingdom (MAESTRO Partner)
UoB	Alma Mater Studiorum Universita Di Bologna, Italy (MAESTRO Partner)
URAN	UMTS Radio Access Network
USB	Universal Serial Bus
UT	User Terminal
UTRA	UMTS Terrestrial Radio Access
UTRAN	UMTS Terrestrial Radio Access Network
Uu	UMTS air interface
W-CDMA	Wideband Code Division Multiple Access
WH	Walsh – Hadamard
WP	Work Package
WRC	World Radio Conference
XHTML	Extensible Hypertext Markup Language
XML	eXtensible Markup Language

4 GENERAL PRESENTATION OF THE PRODUCT

Version 1.2

4.1 Perspectives of the system

In the context of a growing market toward mobile multimedia, studies led to the innovative concept of Satellite Digital Multimedia Broadcast (referred as SDMB in the rest of the document).

The SDMB satellite system aims at providing a dependable and cost effective broadcast/multicast capability for mobile services over a pan-European coverage. It makes use of 3GPP (3rd Generation Partnership Project) standardised technologies, IMT2000 satellite frequency bands and high power geostationary satellite(s) in order to accommodate low cost 3G handsets with indoor reception.

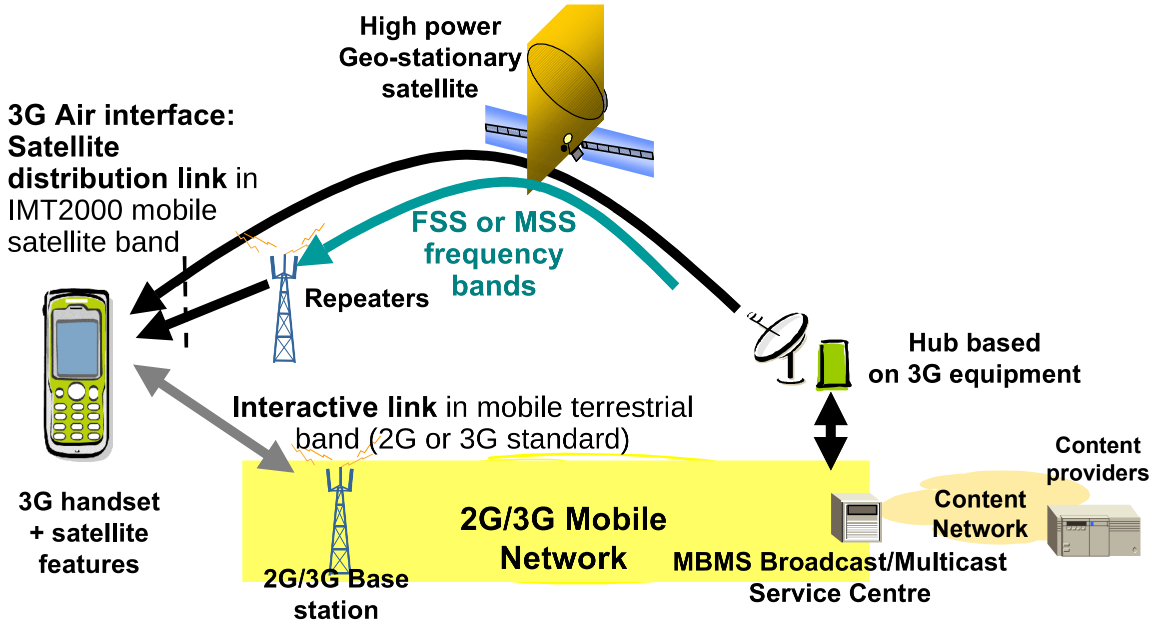


Figure 1 - SDMB system overview

4.2 Definition of the market

Mobile content business are expected to exceed by far wired Internet thanks to the flexible and proven billing capability of mobile networks. As an example, world-wide mobile Content revenues already exceeded 3B€ in 2003 mainly with mobile ring-tones.

Mobile video services are expected to be very popular and end users who are interested in video services have similar interest in viewing content provider services as generating their own content.

In addition, Media operators see real business opportunity in mobile content. Content production will be a subset of fixed programs tailored for mobile. It will mainly give priority to video services and interactivity such as on demand, voting, gambling.

In this context, there is a consensus around one to many distribution as the missing scheme in 3G network economics to deliver mobile rich content services to end users in a cost effective manner. Several initiatives aim at providing one to many distribution for 3G mobile networks. The market identified by the SDMB system is the data broadcasting towards mobile handsets, taking benefit from the natural broadcasting nature of the geostationary satellites.

The world region identified as a primary market is Europe.

Since this issue is still open, the possible nation-wide/linguistic spot beams according to market expectations are :

- Spain/Portugal,
- Italy,
- France, Belgium and Luxembourg,
- UK and Ireland,
- Germany, Switzerland, Austria and Netherlands
- and Greece.

S-DMB system is primarily designed for mass market standard commercial purpose. It also allows pre-emption of the transmission resources by authorised organisation (police, civil protection…) for providing specific services for crisis prevention and management (Public Protection and Disaster Relief Missions).

4.3 Definition of the missions of the system

The purpose of the SDMB system is to provide a distribution capacity for several mobile operators to deliver cost effective streaming and download services directly to mobile handsets over umbrella cells in both outdoor and indoor environments.

The system shall not introduce constraints on the user terminal or the consumer itself. In other words, it shall be as transparent as possible to 3G handsets with respects to cost, autonomy, form factor, aesthetics to maximise market penetration. To do that, the SDMB system is based onto the broadcast mode of MBMS.

It is assumed that at the time of deployment of the SDMB system, most mobile handsets will be able to operate on both 2G and 3G types of networks. Conversely, the 3G mobile networks will most likely be limited to urban areas. The SDMB system has then to be compatible of both 2G and 3G networks to be able to offer its services everywhere.

The SDMB system is open in the sense it has to be compatible with the end-to-end framework defined by the Open Mobile Alliance (OMA).

In addition, the system aims at complementing 2G and 3G mobile system by achieving the true anywhere and anytime challenge with a dependable infrastructure offering point to point services capability via satellite over permanent or temporary zones not covered by the terrestrial networks. This requires a satellite up-link from the user terminal.

This document is devoted to the datacast mission. The requirements associated to the direct satellite point to point mission are not analysed.

4.4 Category of users and associated characteristics

A «Role» is a subset of technical and business missions, to be taken over inside the service delivery chain. The missions assigned to a same Role are interrelated, and designed to be coherent from the organisational point of view, which includes management and quality of service objectives, information systems, processes, and technical competencies to be involved.

The SDMB role model is described in detail in D1-1 and may be summarised in the next figure:

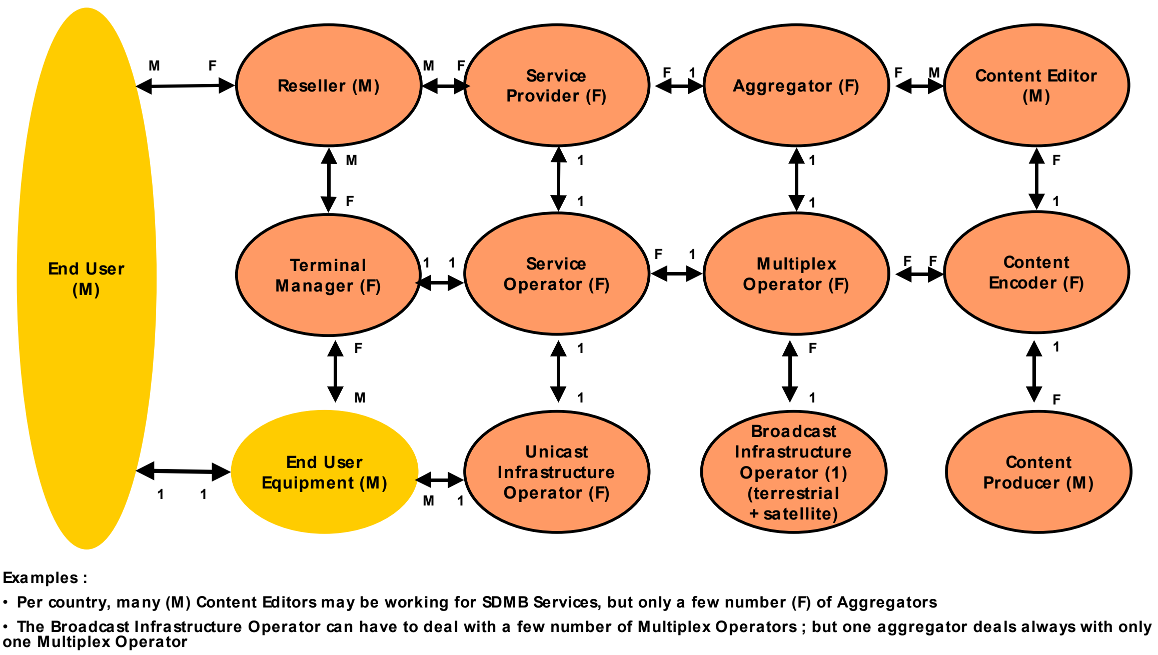


Figure 2 - SDMB Role model and cardinality per country (from D1-1)

10 main Roles have been identified in the S-DMB Service Delivery Chain :

- **Reseller, Service Provider, Aggregator and Content Editor** are part of the **«Service Design and Marketing»** upper service layer, which covers all commercial activities involved in the S-DMB system: marketing studies, service offering, sales, billing, …, from the content selection and edition, until the sales to End users,
- **Terminal Manager, Service Operator, Multiplex Operator and Content Encoder** are part of the **«Service Operation»** intermediate layer, which has to produce effective services, and to manage the technical consistency of S-DMB Service delivery technical chain. These Roles must work together to implement common standards, in order to be able to encode and carry the content that will be broadcast and to read it on the end user terminal
- **Unicast Infrastructure Operator and Broadcast Infrastructure Operator** are part of the **«Infrastructure Operation»** lower layer, which provides the communication infrastructure capacity able to carry the content to end users terminals.

The relationship between the different roles are also described in detail in D1-1 and may be summarised in the figure below:

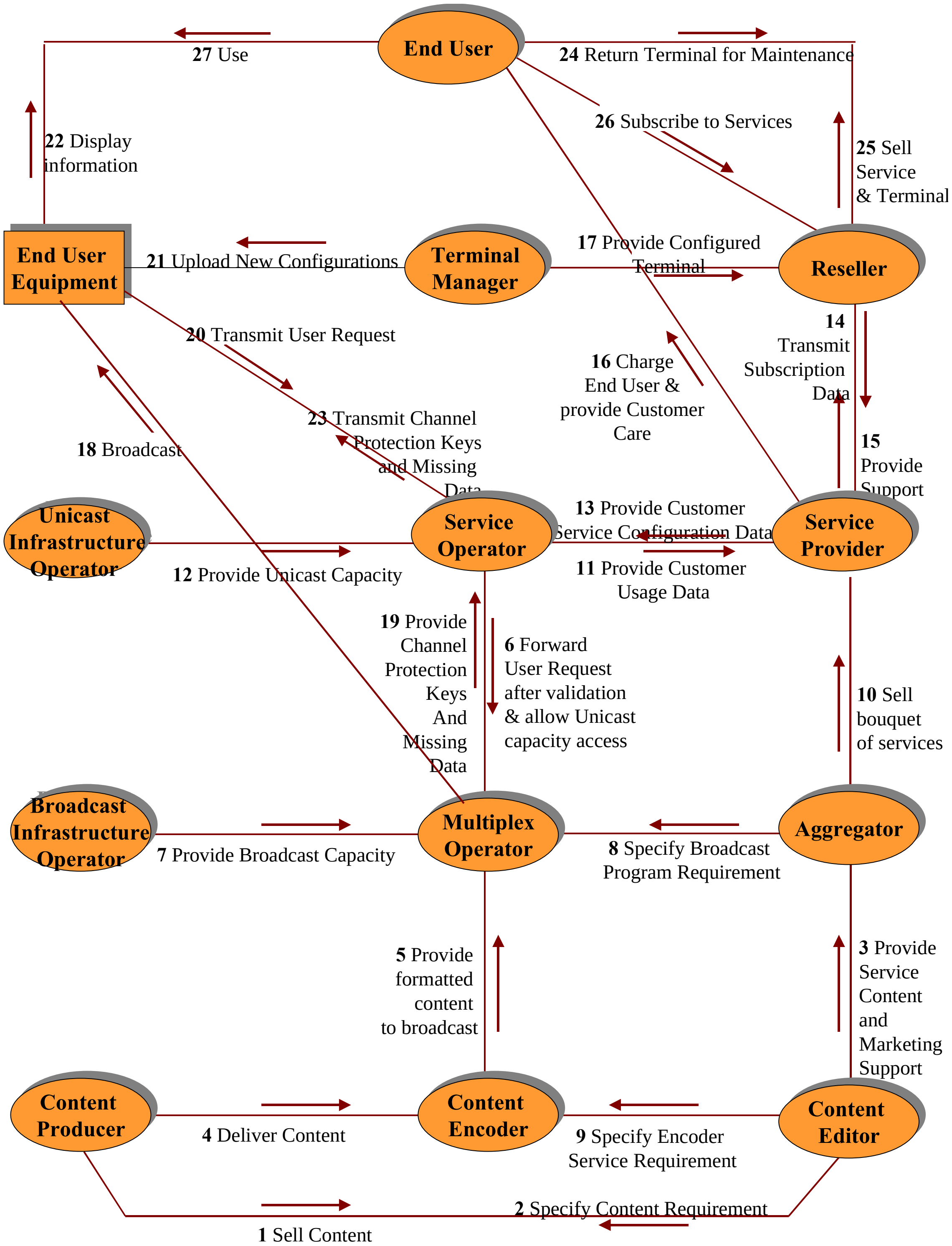


Figure 3 - SDMB Roles relationship (from D1-1)

The different roles defined in D1-1 may be assigned to different business actors (i.e. Companies), which implies the responsibility sharing between these actors.

In given market conditions, each Business Actor Model scenario tends to determine the number of actors playing the S-DMB Roles.

Different Business Actor scenarios could coexist in different countries..

It is assumed that a Role has generally to be taken in charge by one actor only, i.e. the Role responsibility can not be split; obviously, the actor in charge may delegate part of his missions to subcontractors or suppliers.

To minimise the dependencies of the system engineering with respect to the Business Actor scenarios, the stakeholders of the SDMB system are described in terms of roles and not in terms of actors.

4.5 Operating environment

4.5.1 Development context

The SDMB system encompasses

- a Satellite based infrastructure operating in the IMT2000 frequency band allocated to mobile satellite systems. This infrastructure is made of geo-stationary satellites, satellite operation centres, terrestrial repeaters and uplink earth stations.
- 3GPP UTRA FDD UTRAN standardised user equipment implementing SDMB specific features which at least includes the extension to the satellite frequency band.
- 3GPP Broadcast Multicast Service Centre implementing SDMB specific features to inter-work with the SDMB infrastructure

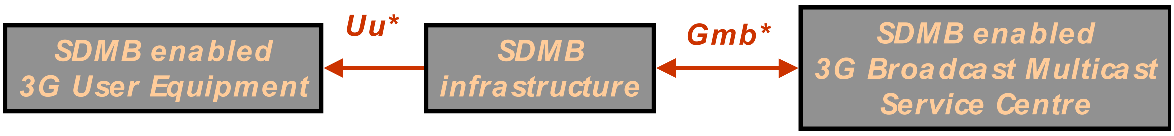


Figure 4 - SDMB system development context

The Uu and Gmb / Gi interfaces are defined in 3GPP documentation.

The Uu* is the interface between the SDMB infrastructure and the SDMB enabled 3G User Equipment. It is a wireless interface relying on the 3GPP defined Uu interface and operating in the IMT2000 frequency band allocated to mobile satellite systems. It may implement some minor modifications such as parameter range extension.

The Gmb* is the interface between the SDMB infrastructure and the SDMB enabled 3G Broadcast Multicast Service Centre. It relies on the 3GPP defined Gmb interface. It may implement some minor modifications such as parameter range extension to allow the BM-SC to take into account the SDMB datacast resources.

4.5.2 Operational context

The SDMB system provides a datacast capacity to complement mobile system of several mobile network operators. This capacity can be used to deliver cost efficient mobile IP datacast services to 3G end users.

Interaction is required to manage the services delivered, the SDMB enabled user equipment, the mobile IP datacast service subscribers and possibly some terrestrial components of the SDMB infrastructure.

This interactive link is provided by 2G or 3G mobile systems. It can be used by mobile IP datacast services requiring real time interaction.

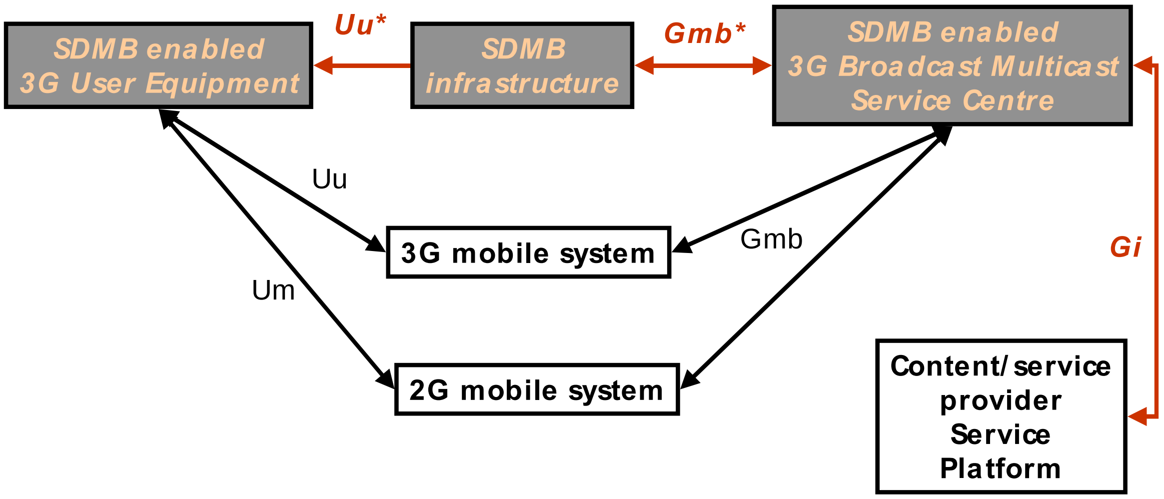


Figure 5 - SDMB system operational context

Gi is a 3GPP defined interface.

4.6 Dimensioning

The preliminary dimensioning of the SDMB system includes:

- one to three geostationary satellites that could be located in 10°E (preliminary location identified for dimensioning purpose), 15°¨W and 32.5°E.
- up to six spot areas,
- a number of hubs from one to the number of spots,
- several millions of end users.

4.7 Hypotheses

The considered UE is expected to be derived from a 3GPP UMTS/MBMS compliant UE.

The considered UE is expected to be equipped with an internal or external non-volatile memory to store relevant contents. Should the opposite occur, this kind of terminal would be able to received streamed data flow, but not to store contents.

The SDMB infrastructure relies on a terrestrial mobile network (UMTS or GPRS), which can possibly be 3GPP MBMS compliant.

5 EXTERNAL INTERFACES

Based on the following figure which illustrates the different concepts of architecture. The SDMB system is what is defined inside this document. But as SDMB is seen as complementary to existing system, the two real external interfaces are inside the US and inside the BM-SC as shown in the figure.

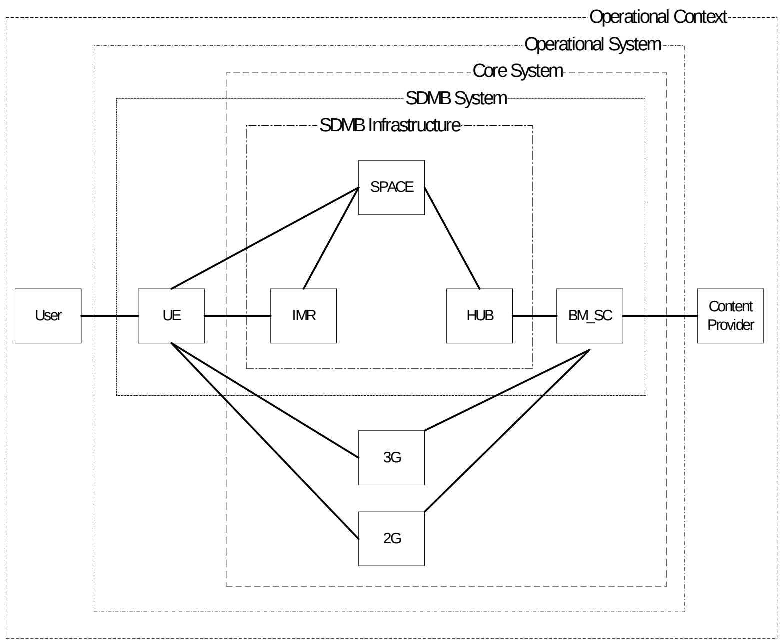


Figure 2: Architecture concepts

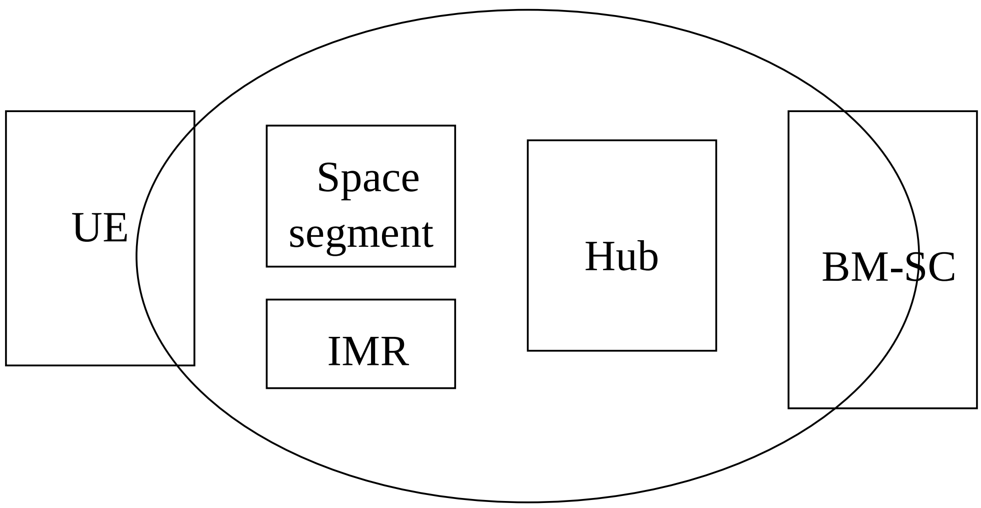


Figure 3: External interface

6 FUNCTIONAL ARCHITECTURE

6.1 Presentation of the functional architecture

The two figures below describes the breakdown of services and technical functions of the SDMB system. The Figure 4: System Layer view presents the functions using a layer view and a split between the well-known sub-systems. The Figure 5: Functional tree presents them using a functional tree.

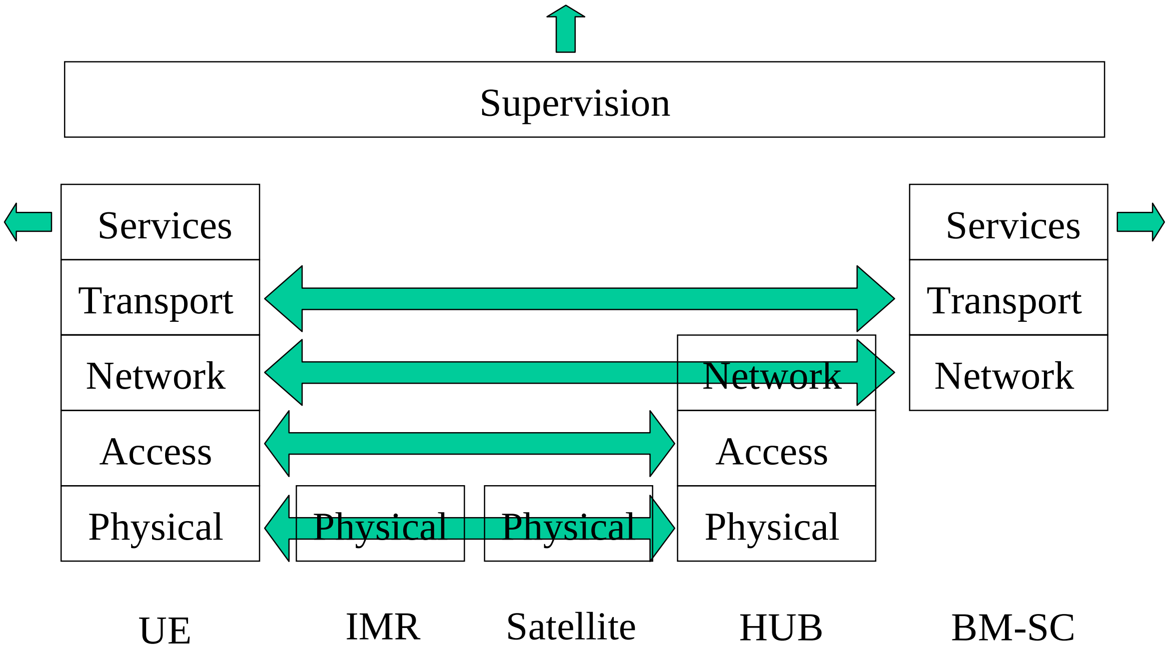


Figure 4: System Layer view

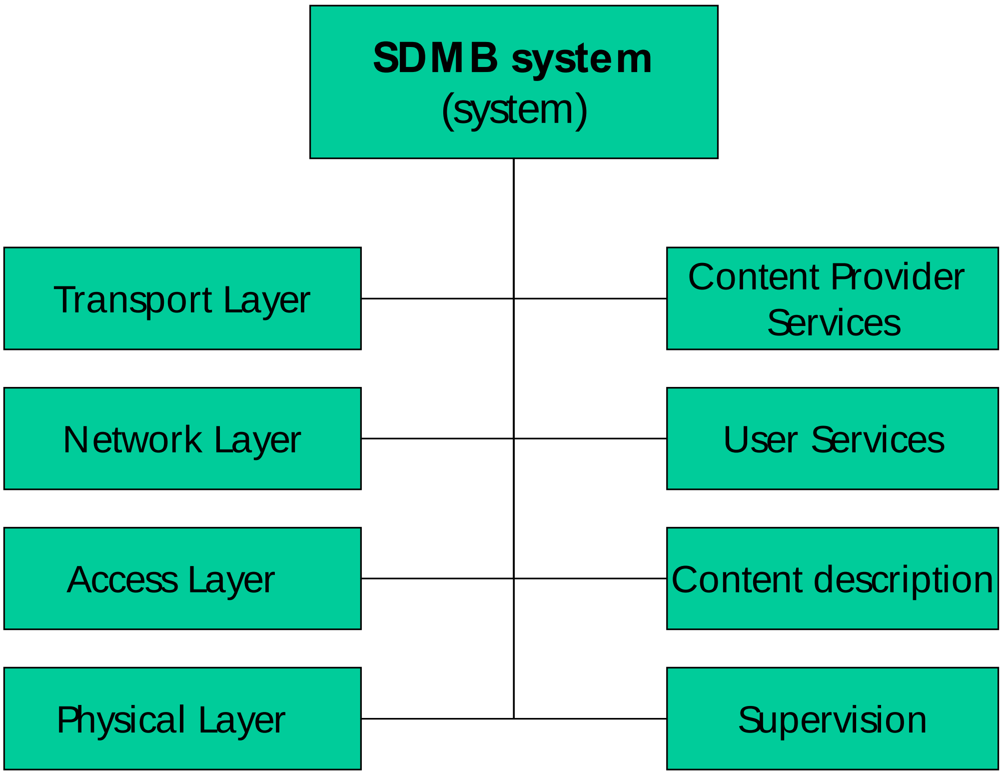


Figure 5: Functional tree

All the level 1 functions are then defined more in details, some of them are also described using level 2 functions. All the technical functions are not described but a reference to their related specification is given.

6.1.1 'Content provider services' function

- 'Broadcast data' function

It provides a point to multi-point bearer service via satellite or terrestrial network. The choice is triggered by optimised routing algorithms based on localisation, audience, QOS and data size.

- 'Provide content via unicast terrestrial service' function

Multimedia content may be retrieved by unicast connection (pull service) performed though a terrestrial mobile network (GSM, GPRS or UMTS).

The files are stored on a server for a given time. They are accessible by the users via point to point pull services (e.g. web browsing).

- 'Collect content from UE' function

Multimedia content may be sent from the terminal to a server through a terrestrial mobile network. It is then stored for subsequent broadcast.

- 'Transmit alerting messages' function

Alert messages may be broadcast to all SDMB terminals whatever the terminal user (subscriber or not)

The system is designed to ensure reception and display by all the terminals.

- Give feedback to content provider' function

Periodically or at request, the system will give statisitics about the multimedia content delivery and consumption. To achieve this goal, a number of measurements are collected at different levels.

6.1.2 'Content description' function

This function should not be studied by the MAESTRO project. It mainly deals with building the content descriptor (use of metadata and XML) and providing the multimedia program (use of Electronic Service Guide).

6.1.3 'User services' function

- 'Download' function

Multimedia content may be download in the terminal for future use (data caching). The terminal may choose to store the content in its internal memory or in an external one (SIM card/memory card).

- 'Streaming' function

Multimedia content may be streamed towards the terminal for immediate display. The end-user may choose to store or not the multimedia content.

- 'User profiling' function

The user may activate the SDMB reception and define an user profile (static or dynamic) stored in its terminal to allow selective reception.

- 'Service information' function

The terminal indicates to the user the availability of the SDMB coverage, the service availability (based on information received in the service announcement). This function may be customised by the service provider.

6.1.4 'Supervision' function

- Administration, Configuration Management, Fault Management, Performance Management.
- Centralised monitoring
- Satellite, Ground equipment (Repeater, gateway) and server are owned by different actors
- Performance measurements collected by the UE
- Performance measurements collected by the IMR
- Monitoring of the used terrestrial network and satellite capacity for charging

6.1.5 'Transport layer' function

This functions aims to complement the physical layer error detection and recovery techniques. To recover from random and bursty losses (like paging , location update, …), two techniques are applied at block level: Forward Error Correction and interleaving. To recover from long blocking periods due to deep shadowing or phone calls, two others techniques are applied: file caroussel combined with partial storing within the UE and selective retransmission of packets via terrestrial network.

For more details, refer to D5-1.

6.1.6 'Network layer' function

The Figure 6: End-to-end protocol architecture presents the SDMB end-to-end service architecture based on the one defined by 3GPP SA4.

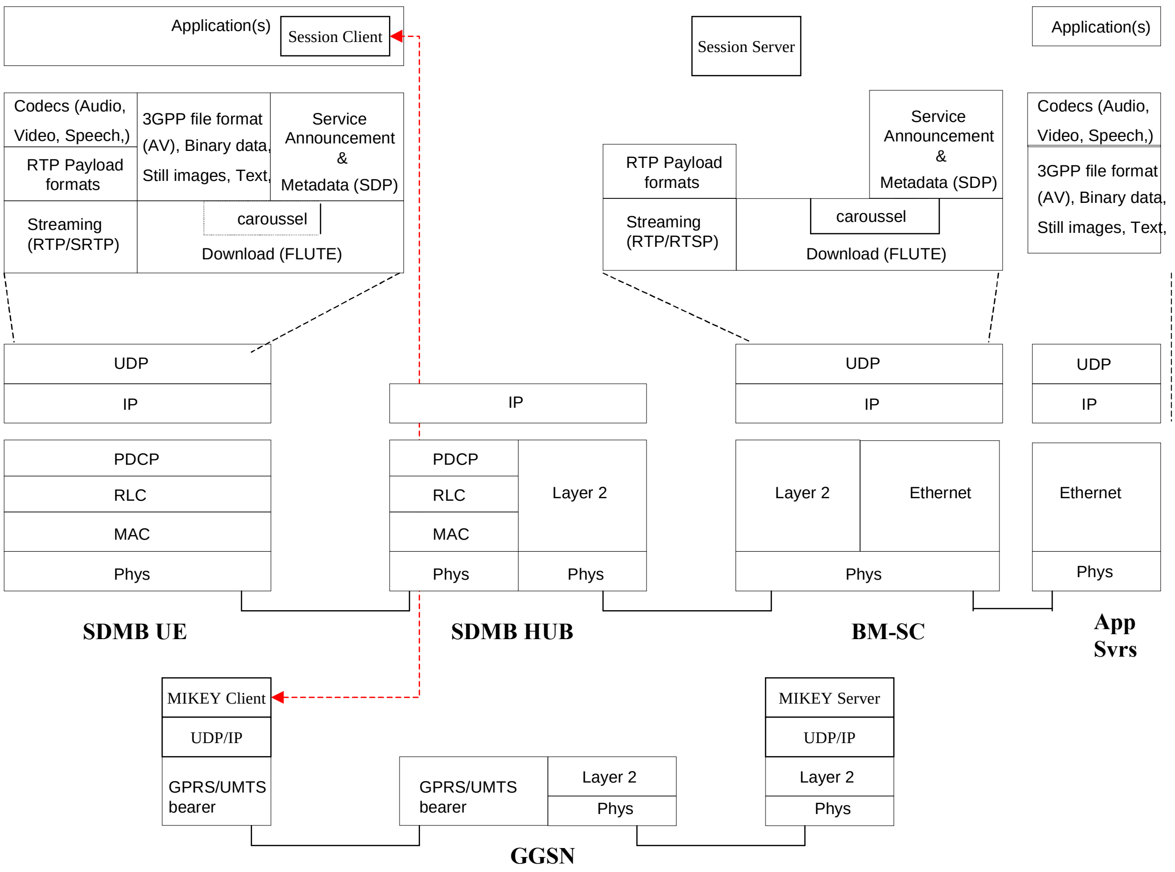


Figure 6: End-to-end protocol architecture

The network layer may be split in the following functions:

- 'Authenticate user' function

The system may if needed authenticate an user before any unicast transaction.

- 'Authorise user' function

The system may authorise or reject an user. The system may forbid the access to broadcast content to subscribers of a given mobile operator.

- 'Bill user' function

If authenticated, an user may be billed to use multimedia content. Different billing schemes may be applied:

- per subscription
- pay per act.

- 'Ciphering/deciphering' function

The broadcast data may be ciphered to provide conditional access to the system.

- 'Authenticate Content Provider' function

Two levels: at BM-SC external interface and at hub external interface.

- 'Authorise Content Provider' function

Two levels: at BM-SC external interface and at hub external interface.

- 'Bill Content Provider' function

Two levels: at BM-SC external interface and at hub external interface.

- 'Digital Rights Management' function

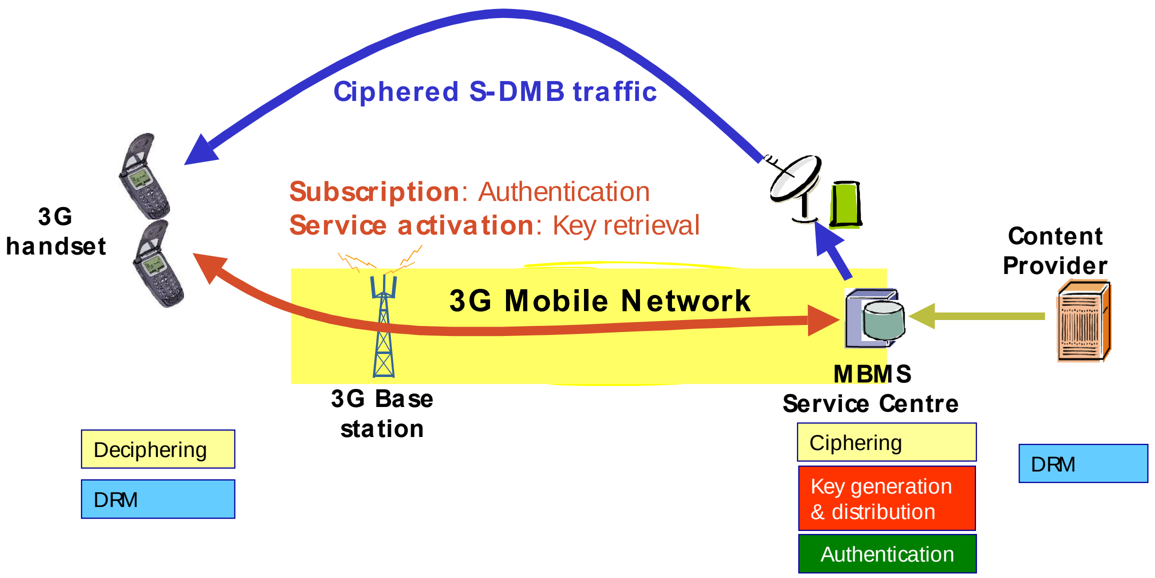


Figure 7: Security principles

For more details, refer to D4-1 and D4-3.

6.1.7 'Access layer' function

The main features of the access layer are the following:

- Maximum commonalities with the Universal Terrestrial Radio Access (UTRA) Frequency Division Duplex (FDD) WCDMA air interface. The 3GPP specifications have been the starting point for the access scheme definition. Adaptations and modifications to the satellite environment have been made where applicable.
- Given that the baseline architecture of the system is unidirectional, i.e. without a satellite return link, only the downlink direction of the WCDMA interface is of interest to SDMB.
- Due to the point-to-multipoint nature of the services, only the subset of WCDMA functionality required for the support of common/point-to-multipoint (MBMS) channels is relevant to the SDMB access scheme.

Taken into these assumptions, the relevant WCDMA channels are presented in Figure 8: Use of 3GPP channels.

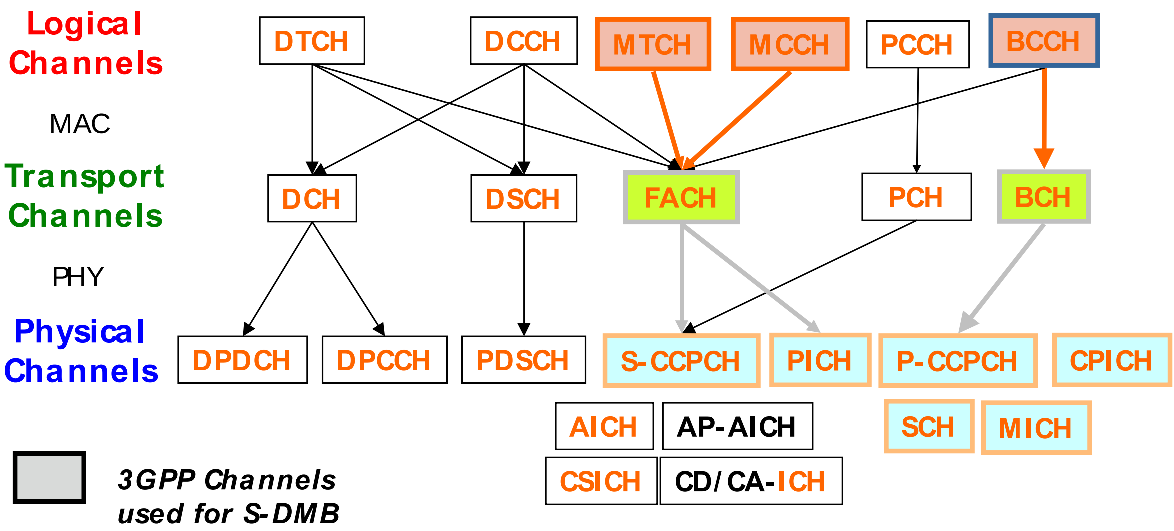


Figure 8: Use of 3GPP channels

Depending on its capabilities, the UE may be able to support full parallel mode, i.e. GSM/GPRS/UMTS idle mode and SDMB reception or only partial parallel mode, i.e. SDMB reception is interrupted to allow GSM/GPRS/UMTS idle mode activity. It is one characteristic of the access layer embedded in the UE. The Figure 9: Scheduling shows how these processes are scheduled.

For more details, refer to D3-1.

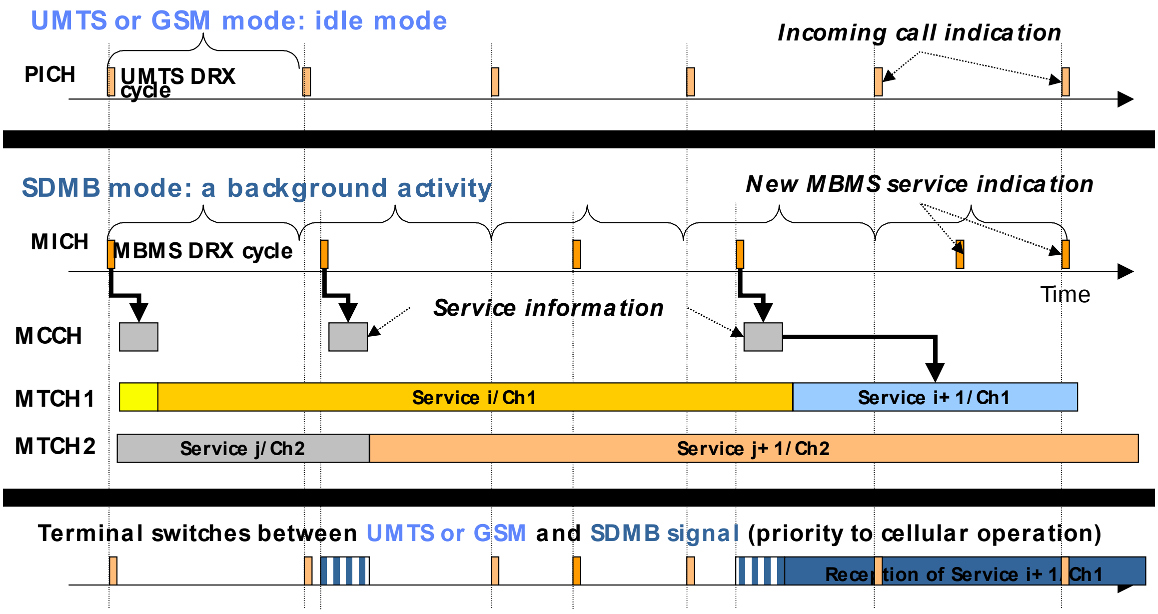


Figure 9: Scheduling

6.1.8 'Physical layer' function

The SDMB physical layer is compliant with the 3GPP physical layer as stated in the document D2-1 (Part 1). The Figure 10: SDMB channel coding, multiplexing, and mapping presents the main functions performs by the physical layer.

It is important to note that the basic SDMB principle is to receive and combine signals transmitted by a satellite and by terrestrial repeaters (IMR). This combining is performed by the UE thanks to its RAKE receiver as it is done usually in the 3G terrestrial context between multipaths.

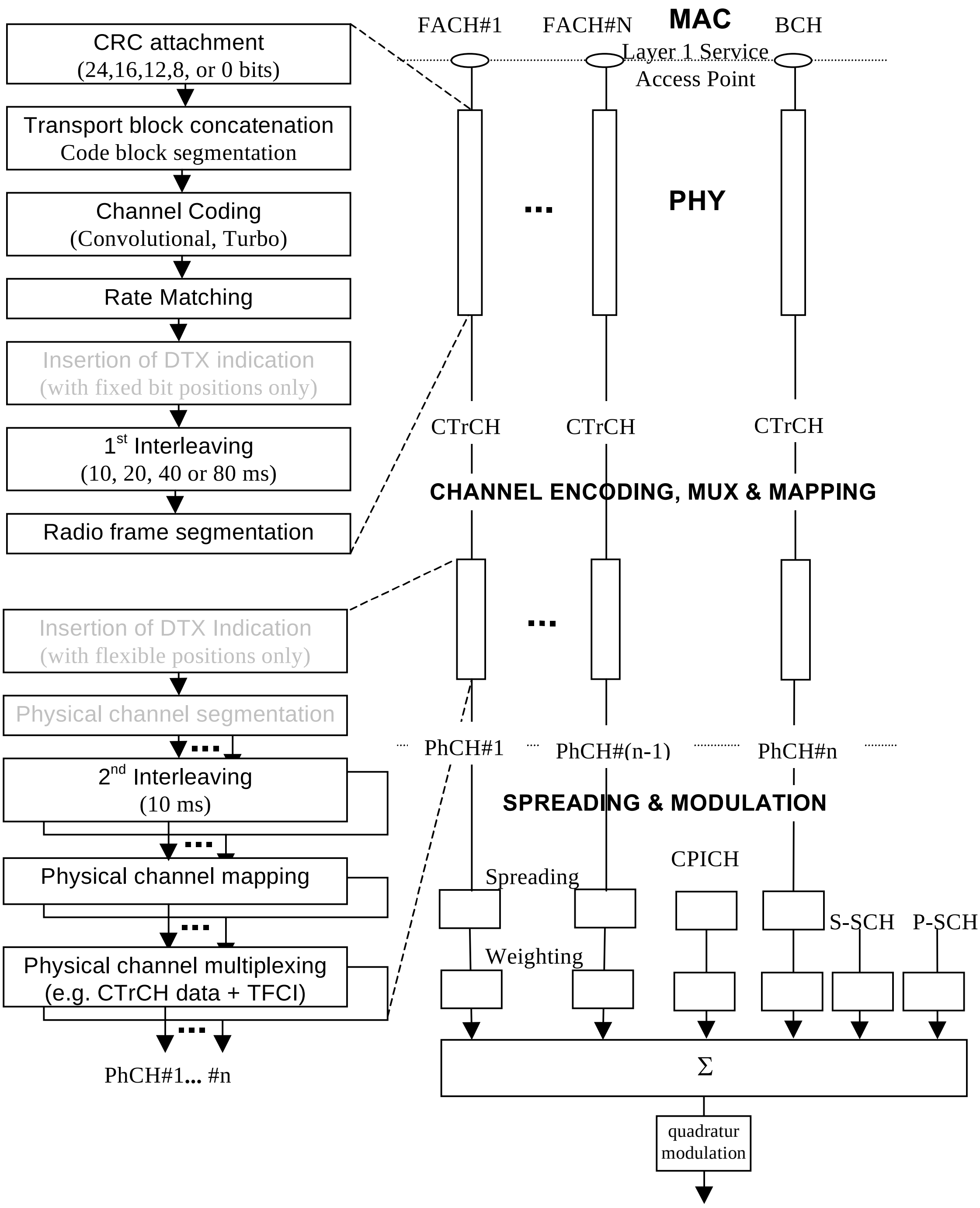


Figure 10: SDMB channel coding, multiplexing, and mapping

The Figure 11: Single Frequency Network shows how the frequencies are used inside a spot beam. For details about used frequency bands, see annex A.

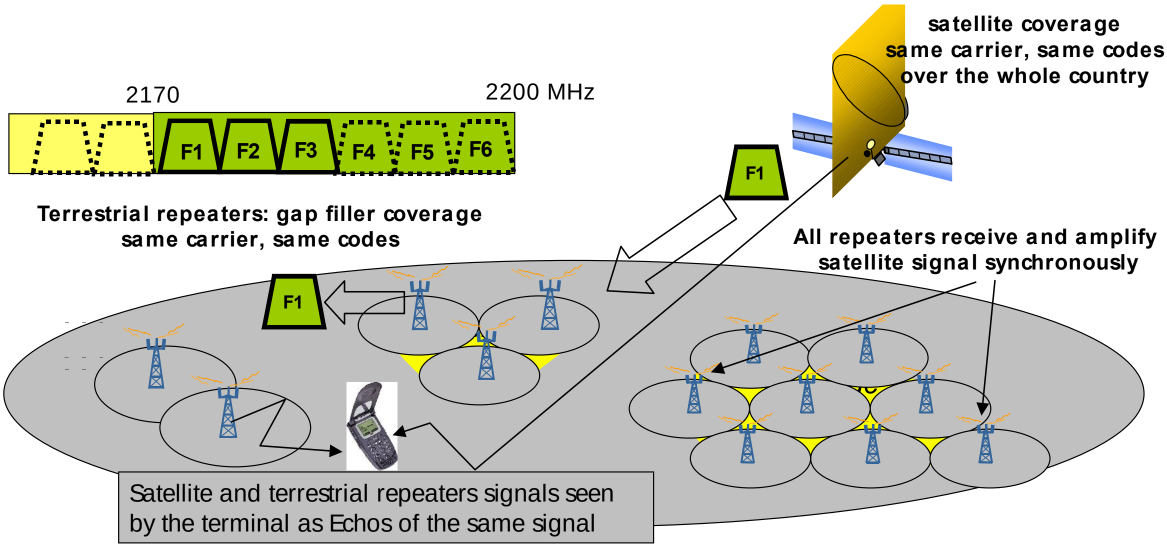


Figure 11: Single Frequency Network

7 ORGANIC/LOGICAL ARCHITECTURE

7.1 Presentation of the organic architecture

This architecture is composed of organs and logical interfaces that have been mainly formed by existing design requirements since the SDMB system shall be seen as a complement to an existing 3GPP mobile terrestrial system. The Figure 12: Organic Architecture presents all the components of the SDMB organic architecture and gives also the cardinality relation existing between two sub-systems For example, a satellite may be linked from 0 to n IMRs and an IMR is linked to one satellite.

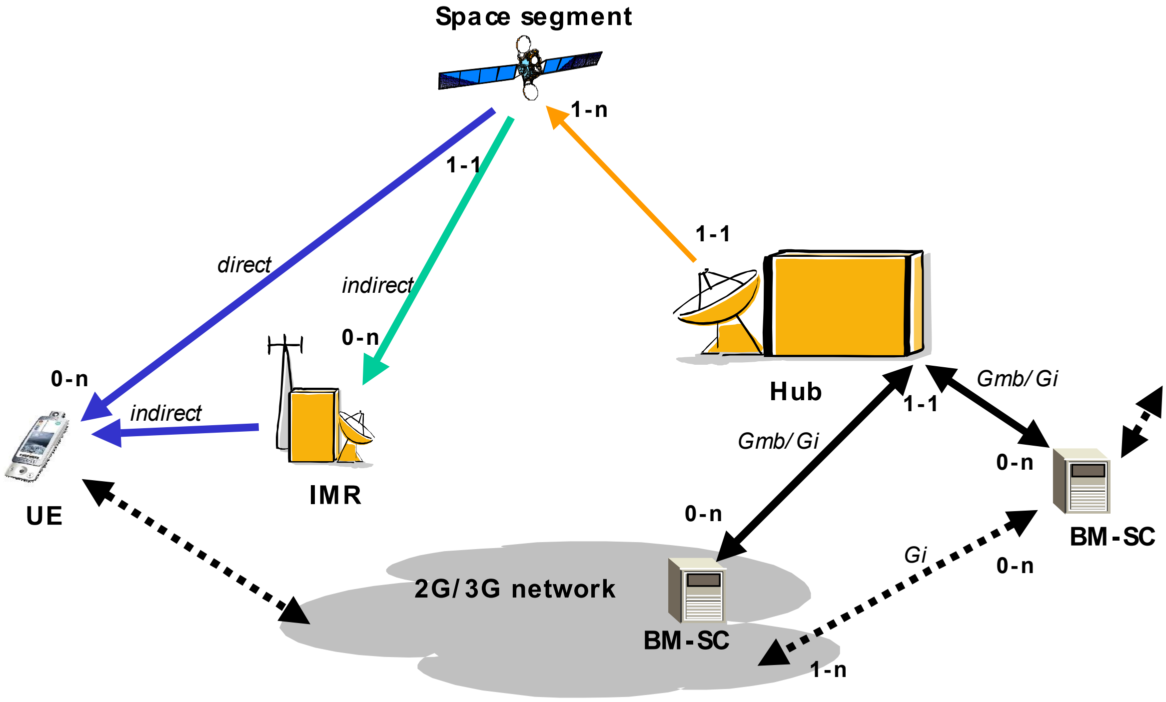


Figure 12: Organic Architecture

The following table lists the organs and logical interfaces at the sub-system level and identifies the document specifying it:

Characteristics of the organ or the logical I/F				Complementary information
Id	**Type**	**Reference**	**Title of the document**	
UE	**Organ**	**D6-3**	**UE SDMB specification**	
Space segment	**Organ**	**D6-9**	**Space segment specification**	
Hub	**Organ**	**D6-5**	**SDMB hub specification**	
IMR	**Organ**	**D6-4**	**IMR specification**	
BM-SC	**Organ**	**D6-6**	**Service Centre specification**	
Air interface	**Logical interface**	**D3-1, D2-1**	**SDMB Access layer definition**	
Hub-BMSC interface	**Logical interface**	**D4-3**	**Network functions and interface requirements for interworking of satellite gateway**	
O&M interface	**Logical interface**	**-**	**-**	**Not applicable in the MAESTRO context**

7.2 System Actors

7.2.1 Satellite operations team

These actors are in charge to configure and supervise all the equipment related to the space segment.

7.2.2 MNO operations team

These actors are in charge to configure and supervise all the equipment related to the terrestrial repeaters.

If the MNO has deployed its own broadcast infrastructure, they are also responsible to manage an BM-SC platform.

7.2.3 MNO terminal team

These actors are in charge of the relation with the terminal manufacturers and the sales of the terminal to the end user. They are managing the provisioning (configuration, SW download) of the terminal.

7.2.4 MNO Customer team

7.3 System scenarios

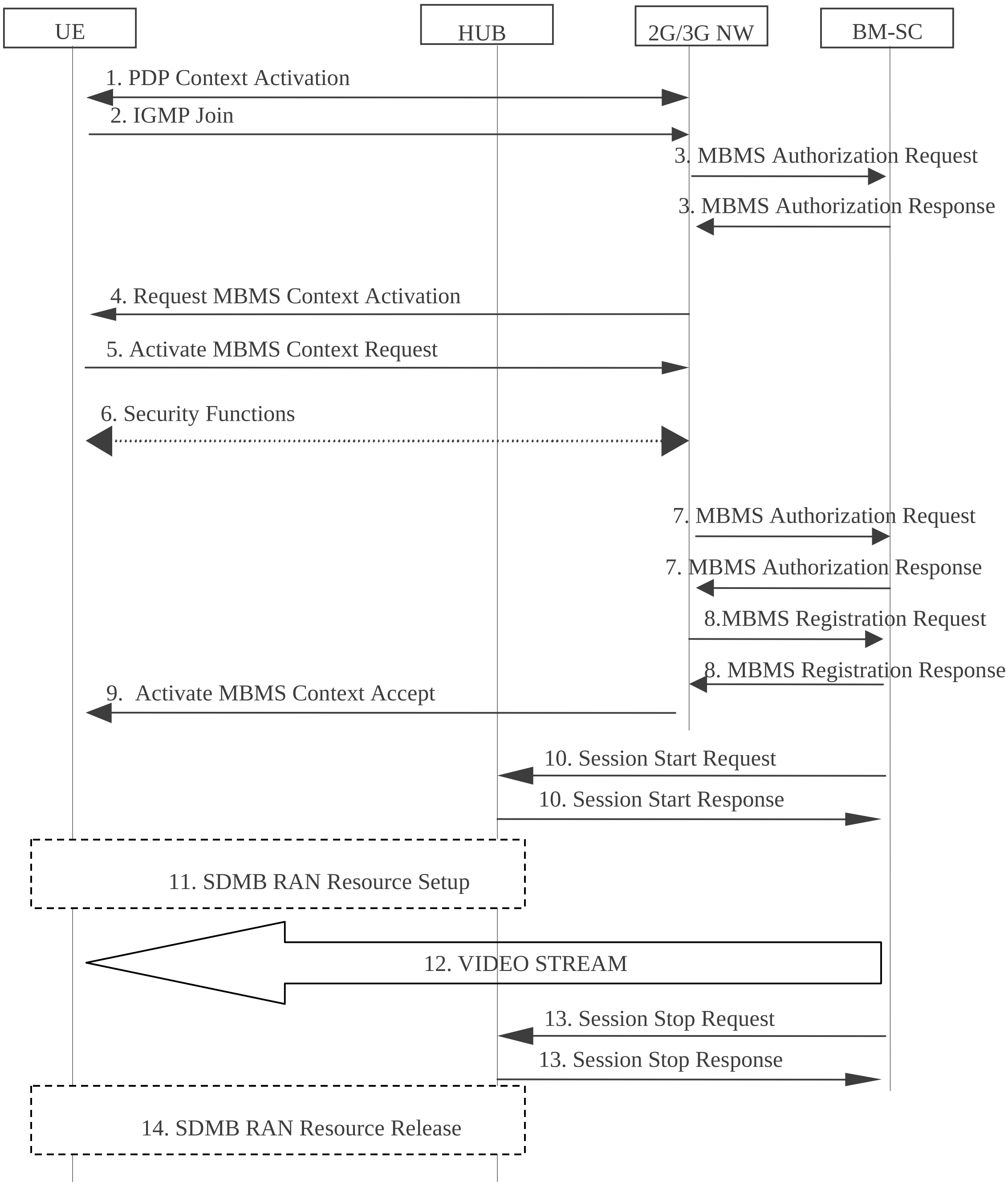
7.3.1 Nominal mode

The following scenarios will be detailed:

- Subscribe to an SDMB multimedia service
- Stream a video service to an SDMB terminal
- Download an audio file in a SDMB terminal
- Broadcast an emergency notification to idle and active SDMB terminals
- Incoming communications during SDMB reception
- Play an audio file partially received via SDMB requesting to retrieve data via unicast connection
- Roaming user

7.3.1.1 Nominal scenario "Stream a video file to an SDMB terminal"

- Preliminary conditions: The mobile network supports MBMS features therefore the multicast service may be triggered via MBMS standard procedures towards the terrestrial mobile network. The SDMB system is then used to broadcast the user data, i.e. the video stream.
- Based on 3GPP TS 23.246.
- There is no correlation between the service activation by the handset and the video session triggered by the BM-SC.



1- The UE activates a default, typically best-effort PDP context if not already established. This can be a PDP context used for basic IP services like WAP or Internet access

2- The UE sends an IGMP (IPv4) or MLD (IPv6) Join message over the default PDP context to signal its interest in receiving a particular multicast MBMS bearer service identified by an IP multicast address.

3- The 2G/3G network sends an MBMS Authorization Request seeking authorization for the activating UE to receive data. The authorization decision is provided in the MBMS Authorization Response together with the APN to be used for creation of the MBMS UE context. If the MBMS Authorization Response indicates that the UE is not authorized to receive the MBMS data the process terminates with no additional message exchange.

4- The 2G/3G network sends a Request MBMS Context Activation (IP multicast address, APN, Linked NSAPI) to the UE to request it to activate an MBMS context. Linked NSAPI allows the UE to associate the MBMS Context with the PDP context over which it sent the IGMP/MLD Join message in step 2.

5- The UE creates an MBMS UE context and sends an Activate MBMS Context Request (IP multicast address, APN, MBMS bearer capabilities) to the 2G/3G network. The IP multicast address identifies the MBMS multicast service, which the UE wants to join/activate. The MBMS bearer capabilities indicate the maximum QoS the UE can handle.

6- Security Functions may be performed, e.g. to authenticate the UE.

7- The 2G/3G Network sends an MBMS Authorization Request seeking authorization for the activating UE. The authorization decision is provided in the MBMS Authorization Response.

8- As the 2G/3G network does not have the MBMS Bearer Context information for this MBMS bearer service, it sends a MBMS Registration Request to the BM-SC. This MBMS bearer service being defined over SDMB, the BM-SC will indicate it in the MBMS Registration Response. If no TMGI has been allocated for this MBMS bearer service, the BM-SC will allocate a new TMGI. This TMGI will be passed to 2G/3G network via the MBMS Registration Response message and further to UE via Activate MBMS Context Accept message. The BM-SC responds with a MBMS Registration Response containing the MBMS Bearer Context information for this MBMS bearer service.

9- The 2G/3G network sends an Activate MBMS Context Accept (MBMS bearer capabilities indicating SDMB) to the UE. The MBMS bearer capabilities indicate the maximum QoS that is used by this MBMS bearer service and the UE may take it into account when further MBMS bearer services are activated.

10- The Session start

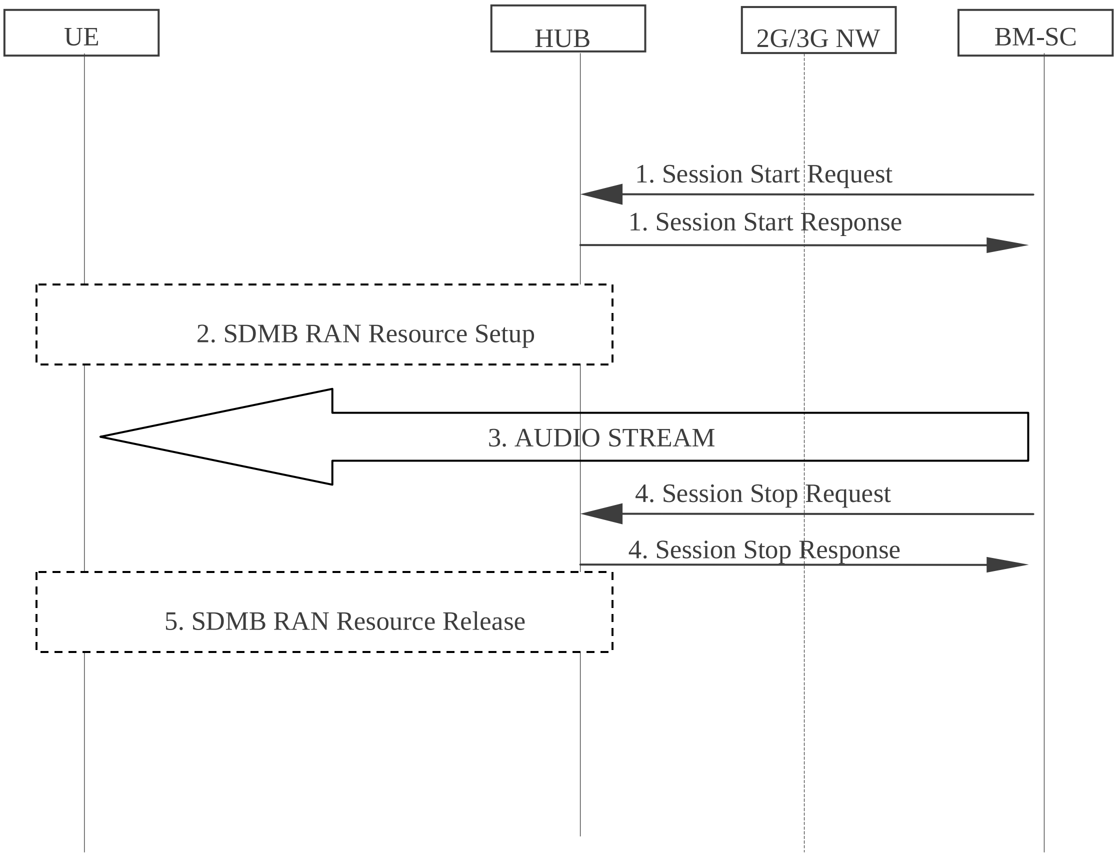
11- SDMB RAN –

12- file is transferred.

13- Session stop

14- SDMB RAN

7.3.1.2 Nominal scenario “ Download an audio file in a SDMB terminal ”/ MBMS Session Procedure



1- The BM-SC initiates the MBMS Session Start procedure when it is ready to send data. This is a request to activate all necessary bearer resources in the network for the transfer of MBMS data and to notify interested UEs of the imminent start of the transmission.

2- The SDMB RAN shall established the resource for the new broadcast session.

3- Audio files transfer

4- The BM-SC initiates the MBMS session stop procedure.

5- The resource may be released by the SDMB RAN

7.3.2 Degraded modes

7.3.2.1 Degraded scenario 'Reject a file broadcast request due to unknown source'

7.3.2.2 Degraded scenario 'Reject a file broadcast request due to resource congestion'

7.3.2.3 Degraded scenario 'Terminal not able to use SDMB data after change of cipher key'

7.4 User Equipment

The User Equipment receives, stores and plays the multimedia files broadcast by the SDMB system. It is a 3GPP compliant dual mode GSM/UMTS terminal.

7.4.1 Configuration

Two types of terminal's architecture could be foreseen considering different user requirements:

Type I. SDMB enabled handset terminal: multi-mode 2G/3G handset with local storage memory and application execution platform (like Java J2ME). The handset is "SDMB enabled" with frequency agility extension of the RF part to the IMT2000 satellite component frequency band. The hand-set is able to perform parallel idle mode, i.e. maintaining either GSM activity or UMTS activity during SDMB reception. The SDMB application software (application and transport layers) could either be native or be downloaded for running above the execution platform. In this category, two subtypes may be defined: a basic and an enhanced. The basic type 1 do not have a dedicated receiver for SDMB and is then required to switch from UMTS terrestrial to SDMB satellite reception. The enhanced type 1 has a dedicated reception chain for SDMB purpose and is then able to receive SDMB data flow without any interruption. **The basic type 1 is considered as the MAESTRO baseline.**

Type II. SDMB nomadic terminal: A device dedicated to the SDMB signal reception and cache management functionality interconnected to an external 2G/3G handset terminal via a short range wireless or wire-line interface. This kind of terminal may be designed for installation in vehicle or for user having a mobile of previous generation.

7.4.2 Functional architecture

The functional architecture of the SDMB user equipment is shown in the Figure 13: UE functional architecture.

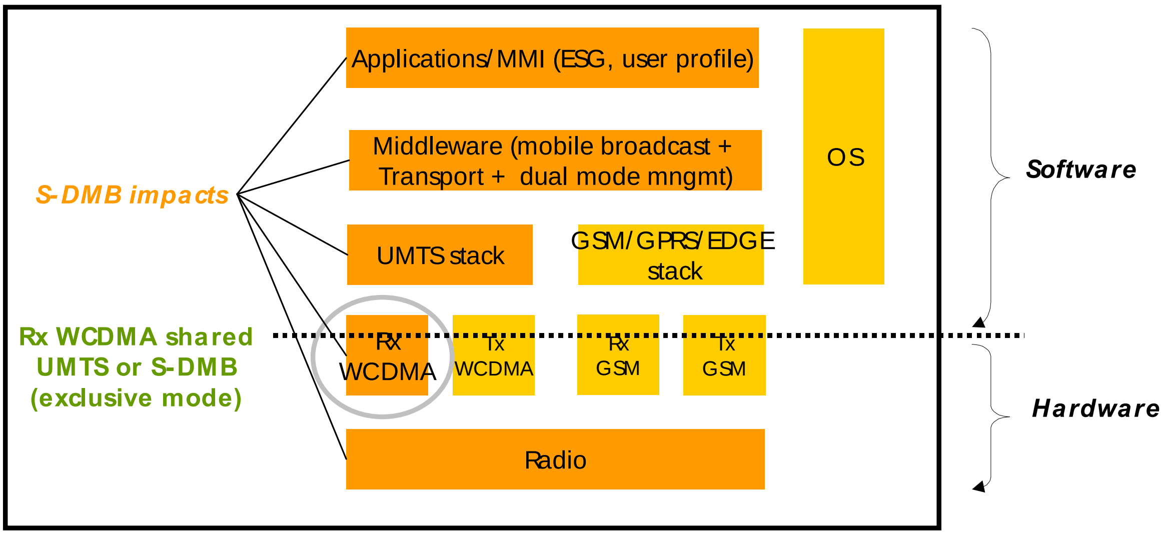


Figure 13: UE functional architecture

Basically, the UE consists in:

- Radio module enabling the reception of SDMB/T-UMTS/GPRS carriers with frequency agility extension of the RF part to the IMT2000 satellite component frequency band. It includes for the reception chain the RF front-end including antenna subsystem, input filter, LNA, diplexer, … and the reverse subsystem for transmission chain (PA, …).
- Protocol stacks handling all processing associated to one or several air interfaces (GPRS, T-UMTS). It consists of a single chip with embedded DSP, µP and specific hardware functions. Some limited applications may also be executed in this chip. It includes IF and baseband (Rake) subsystems and protocol processing.
- Middleware including all the enabling functions provided to the rich applications offered by high end 3G terminal
- Man-Machine Interface (MMI) and applications.
- Operating System including external connectivity (such as USB, Bluetooth, IrDa, external antenna connector, Multimedia Card, SD card) allowing to plug-in additional devices. Power supply module similar to terrestrial cellular handset's one. Special care shall be made to enable power saving functions when receiving SDMB signal. It may include audio.video (e.g. MP3/MP4) decoding/encoding, Speech recognition.
- SIM module relying on a standard USIM module with specific software applications.

7.4.3 Antenna subsystem

For handheld terminal, the existing 2G/3G antenna subsystem should be reused.

Normally, this antenna subsystem is designed in order to support vertical and horizontal polarisation or using system with ± 45° slanted (cross) polarisation.

On the other hand, SDMB signal coming from satellite will use circular polarisation and consequently 3 dB additional loss (at least) can be expected for the reception of the SDMB satellite signal. This additional loss is not required for SDMB signal reception through SDMB terrestrial repeaters.

In baseline, the average antenna gain is - 3 dB plus loss due to polarisation mismatch (for satellite signal) and potential body losses.

For vehicular terminal, dedicated antenna subsystem will be used and it could consist in using two separate antenna units (one for satellite reception and one for terrestrial reception) each using the suitable polarisation type. Therefore, there is no extra loss due to polarisation mismatching.

7.4.4 Input filter

Extension to S-UMTS core bandwidth is required in order to support SDMB system.

7.4.5 LNA

Main issues for this component concern the extension to IMT2000 MSS core bandwidth and its ability to support the SDMB signal dynamic range coming from satellite and terrestrial repeaters.

Basically, LNA designed for T-UMTS shall support a dynamic range of around 80 dB.

Such dynamic range requires automatic gain control (AGC) to avoid overloading of the ADC. AGC loop adjustment is based on the received signal power, which can be measured from both wideband and de-spread narrow-band signals.

7.4.6 Diplexer

A diplexer is required when using a multi-mode antenna to separate the different frequency bands (i.e. GPRS/UMTS/DMB/…) (frequency diplexer). Therefore, the main issue for this component concerns the extension to S-UMTS core bandwidth.

It has also to cope in the transmit direction with the high transmit power and provide in the receive direction a very high isolation such as the transmitter does not interfere the low-power signal. The size of the diplexer will be dictated by the loss required and the selectivity (number of resonators). A large number of resonators will increase the loss but improve the selectivity. As a rough assessment, the loss of a diplexer and associated components will be around 1.5 - 2 dB on both transmit and receive paths.

These 4 elements will impact the receiver noise figure applicable to the SDMB system and therefore the G/T performance of the terminal.

7.4.7 Baseband subsystem (Rake receiver)

The key success of the SDMB concept is based on efficient synergy with the T-UMTS system to provide a cheap product and in particular with the baseband processing (i.e. demodulation/decoding, …) which should be the same.

In particular, T-UMTS system based on 3GPP UTRA W-CDMA FDD air interface will include in the baseband processing a Rake receiver to take benefit from multi-path components and to provide additional performance improvement in the multi-path dominated urban environment.

In this respect, the same approach will be re-used for the SDMB system where the receiver can still take advantage of the time discrimination capability provided by CDMA waveform to perform power combining of the most powerful instantaneous rays (i.e. Rake receiver) providing diversity reception from the satellite to terrestrial repeater network.

The Rake receiver consists of a certain number of independent W-CDMA parallel branches controlled by a central processing unit. Baseband channel estimation provides the possibility of independently selecting, acquiring, tracking and de-modulating the various multipath components characterised by different group de-lays and coherently combining them prior of baseband decoding.

The key issue for the Rake receiver deals with its ability to support delay spread figures in the context of the SDMB system knowing that these figures will depends on:

- the environment (urban, rural, …)
- the terrestrial repeater configuration (processing time and transmitted power), its coverage and the network density.

Indeed, for the terrestrial repeater network transmitted power and coverage are normally closely linked but can be un-correlated for high throughput figures (i.e. typically for 1 Mb/s) where coverage is limited by interference and not by transmit-ted power.

7.4.8 Protocol stack

The protocol stack is MBMS (3GPP R6) compliant and includes the complement as described in D3.1.

7.5 Intermediate Module Repeater (IMR)

The IMR is the component which receives signal from the space segment and re-amplifies it for UE reception.

- .

In a general manner, SDMB terrestrial repeaters are required in order to cope with deep indoor penetration where SDMB satellite cannot provide the radio link availability and in order to support throughput increase. Basically, terrestrial repeaters will be installed on urban/suburban areas and should be as much as possible co-located with T-UMTS node B.

3 main scenarios can be envisaged for the SDMB terrestrial repeater segment:

- Frequency conversion repeater (baseline),
- On-channel repeater (option),
- Node B-based repeater (alternative).

7.5.1 Common requirements

Some requirements specified in 3GPP document [1] are applicable to all repeater solutions and among them:

- Spectrum emission mask,
- Adjacent Channel Leakage power Ratio (ACLR)
- > 45 dB for 5 MHz offset
- > 50 dB for 10 MHz offset,
- Error Vector Magnitude (EVM) < 17.5 %,
- Peak code domain error < -33 dB,
- Spurious Emissions.

7.5.2 Frequency conversion repeater

The frequency conversion repeater (see Figure 14: Frequency conversion repeater) receives the SDMB signal from the SDMB satellite in HDFSS frequency bands, amplifies and retransmits in S-UMTS core bandwidth.

It implements frequency conversion from HDFSS to S-UMTS core bands.

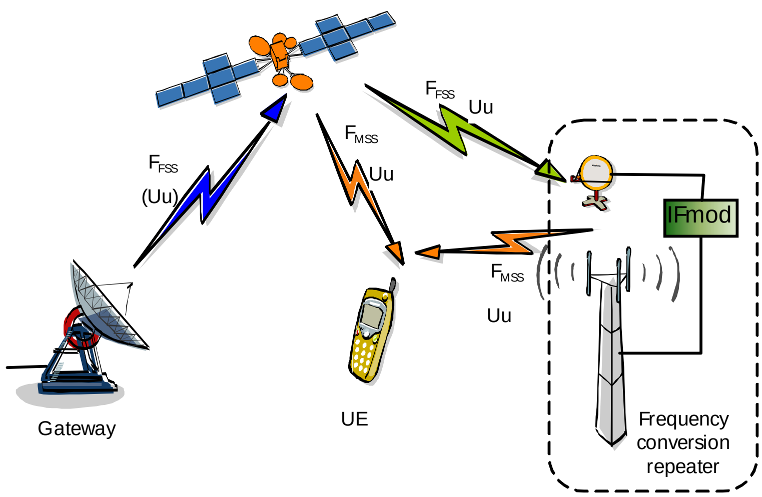


Figure 14: Frequency conversion repeater

It consists in:

- Rx front end including flat panel or reflector antenna sub-system in HDFSS bands,
- Amplification chain including a frequency conversion module,
- Tx front end including omni or sectored antenna,
- O&M module and a wireline/less modem for site supervision and equipment monitoring.

[LINK BUDGET TO BE INSERTED]

- Output power (@ the PA output) and Tx antenna gain

Based on preliminary results derived from SDMB planning tool, it is assumed that the total Tx power delivered by the repeater is 30 to 35dBm.

Tx antenna gain is 15 dB (sectored antenna).

The repeater should be able to support 1 FDM with several channelisation codes in the direct downlink bandwidth.

7.5.3 On-channel repeater

The on-channel repeater receives the SDMB carriers from the SDMB satellite in S-UMTS core bandwidth, amplifies them and retransmit them on the same frequency slot(s), as depicted in Figure 15: On channel repeater.

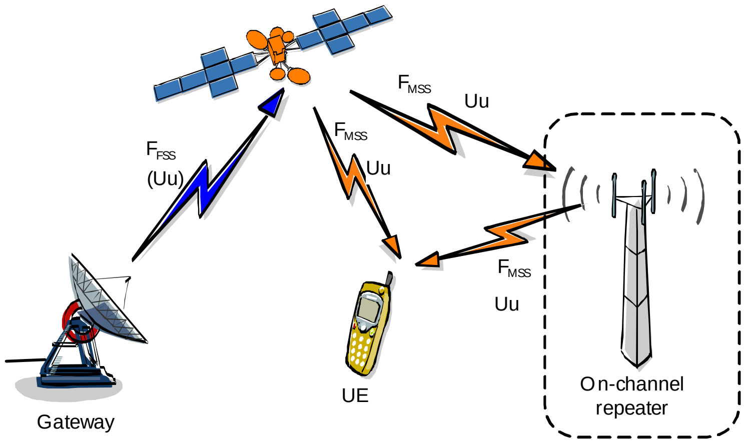


Figure 15: On channel repeater

It consists in:

- Rx front end including flat panel or reflector antenna sub-system,
- Amplification chain with echo cancellation mechanism,
- Tx front end including omni or sectored antenna,
- O&M module and a wireline/less modem for site supervision and equipment monitoring.

[LINK BUDGET TO BE INSERTED]

- Output power (@ the PA output) and Tx antenna gain

Based on preliminary results derived from SDMB planning tool, it was assumed that the total Tx power delivered by the repeater is 30 dBm.

Tx antenna gain is 15 dB (sectored antenna).

The repeater should be able to support 1 FDM with several channelisation codes in the direct downlink bandwidth. Due to required isolation between Rx and Tx antenna, this solution targets limited coverage like in-building, tunnel, underground, …

7.5.4 Node B-based repeater

This scenario is based on the reuse of a 3GPP standardised Node B as depicted in Figure 16: Node B-based repeater.

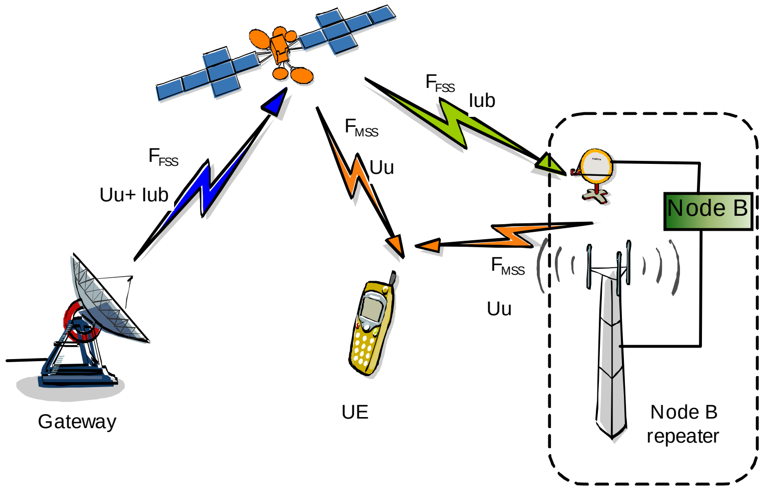


Figure 16: Node B-based repeater

This concept deals with interfacing Node B and RNC via satellite, i.e. some of the Iub interface features are implemented over a satellite radio link.

Attention must be paid on the fact that the link between satellite and terrestrial repeater is unidirectional, which means adaptation to Iub protocols must be implemented (Iub standard defines bi-directional protocols) through PIM (Protocol Interface Module). This may cause problems for Node B operational management.

The Node B in the satellite gateway addresses signal processing of the satellite cell, while the Node B of the terrestrial repeater addresses signal processing of the terrestrial repeater cell.

Co-ordination of satellite spot and terrestrial repeater cells is done at the Iub level, i.e. in terms of 3GPP air interface protocols at the MAC to physical layer interface level.

It consists in:

- HTI Rx (Hub To IMR Receiver) module receiving SDMB carriers transmitted by the IMR Tx module in the hub. This module includes:
    - Rx front end including flat panel or reflector antenna sub-system in HDFSS bands
    - Demodulation/decoding of the SDMB carriers for the provision of a base-band signal
    - Interconnection to the “enabled S-DMB” Node B modem via an interface supporting the 3GPP standardised Iub protocol.
    - A GNSS receiver providing time and frequency reference to the HTI Rx module.

- A SDMB-enabled modem delivering the W-CDMA carriers. It is interconnected with the RNC via an equipment called Base Common Functions (BCF) that support the 3GPP standardised Iub protocol and a proprietary O&M protocol. This O&M protocol is used to configure the Node B modem and monitor its operation.
- A RF Tx section (Rx section for W-CDMA modem dedicated to T-UMTS network) enabling the amplification of the SDMB carriers and the up-conversion to the MSS bands dedicated to SDMB.
- A coupling section enabling the combination of both SDMB and T-UMTS carriers in case of Tx antenna sharing. This coupling section is not required if dedicated SDMB sectored antennas are used.

Common Tx/Rx sectored antennas (Rx only for T-UMTS) supporting the extension to the MSS bands dedicated to the SDMB system or dedicated Tx sectored/omni antennas.

- Output power (@ the PA output) and Tx antenna gain

Based on preliminary results derived from SDMB planning tool, it was assumed that the total Tx power delivered by the repeater is 43 dBm.

Tx antenna gain is 15 dB (sectored antenna).

7.6 Hub

The hub is the Radio Access Network component which collects data from the BM-SCs, generates the W-CDMA waveform and broadcasts thanks to the space segment and the terrestrial repeater network.

The hub includes 3G radio access network equipment and 3G core network functions. It takes as input the incoming media services from the BM-SC.

Further mapped on the Iub interface, this information stream is fed to a Node B modem to build the SDMB W-CDMA downlink carrier which is modulated with a specific Radio frequency sub-system onto Fixed Satellite System frequency band 5 MHz carrier for direct satellite path (i.e. satellite to UE).

In parallel, for the indirect path (i.e. satellite to terrestrial repeater) there are several possibilities depending on the terrestrial repeater architecture.

For on-channel repeater, there is no need to add a specific upstream from the hub. This means that the upstream used for the direct path will be also used to feed on-channel repeater.

For conversion frequency repeater, two options could be envisaged. The first one is the same as on-channel repeater and the other one would lead to duplicate the upstream used for the direct path onto another FSS band carrier to feed terrestrial repeaters.

For node B-based repeater, the Iub information stream will be modulated (not in W-CDMA but DVB-S for instance) onto another FSS band carrier.

The baseline for the hub design is to implement signal duplication on-ground and not on-board, i.e. both direct and indirect signals are generated by the hub. This allows to feed the frequency conversion IMR using the indirect path.

7.6.1 Number of Hub

The SDMB system could be designed to allow up to several hubs to share the system capacity.

Two baselines could be considered in a first approach depending on the number of satellites and the operator requirements (i.e. hub sharing between operators).

Baseline 1 assumes that a single centralised hub will be required for a satellite providing a European coverage.

Baseline 2 assumes that if several satellites are required (i.e. one satellite provides 2 spot beams) then the number of hub is equal to the number of beams.

These are the two extreme baseline configurations.

7.6.2 Architecture description

The high-level functional hub architecture is depicted in Figure 17: Hub architecture.

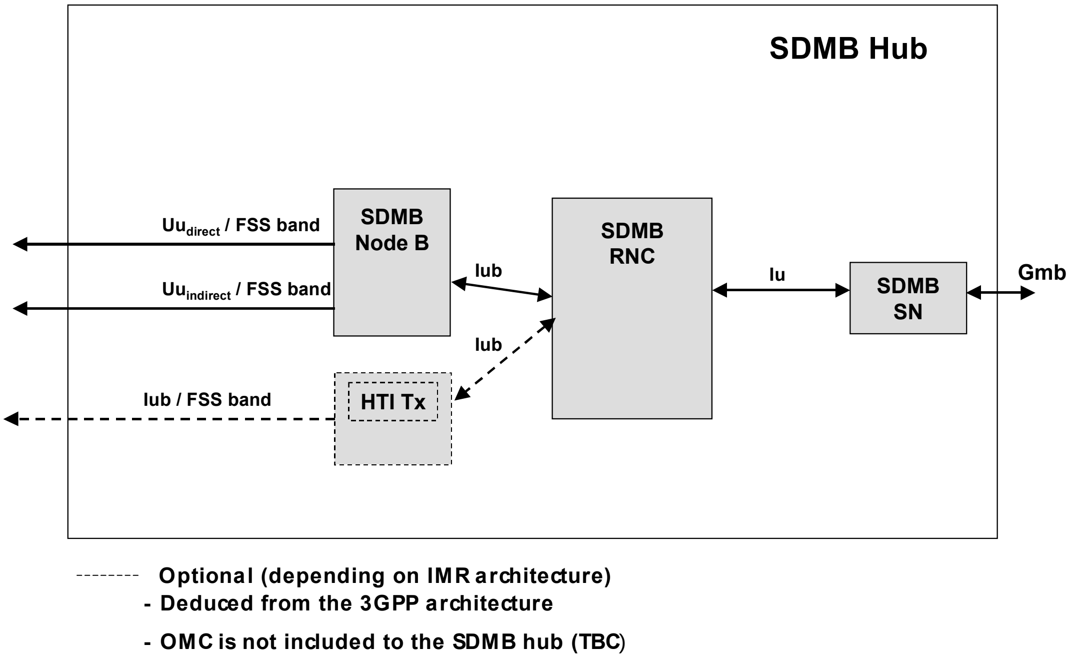


Figure 17: Hub architecture

1) <u>On-channel repeater/frequency conversion repeater</u>

The architecture of the SDMB hub is derived from UMTS radio access network (RNC + Node B) and a core network.

The hub includes (see Figure 17: Hub architecture):

- A SDMB service node (SN) to interface with the BM-SC,
- A 3GPP standardised RNC,
- One or several 3GPP Standardised UTRA FDD Node B,
- a RF front end including antenna subsystem.

The SDMB Service Node interconnects the BM-SC to a standard RNC.

The RNC controls several Node Bs each in charge of generating several W-CDMA carriers (for both the direct and indirect links) that are transmitted to the satellite.

The RF front end (including antenna subsystem) amplifies the W-CDMA carriers and up-converts them in FSS bands to feed SDMB satellite.

2) <u>Node B-based repeater</u>

The architecture of the SDMB hub is derived from UMTS radio access network (RNC + Node B) and a core network.

The hub includes (see Figure 17: Hub architecture):

- A SDMB service node to interface with the BM-SC,
- A 3GPP standardised RNC,
- One or several 3GPP Standardised UTRA FDD Node B,
- Several IMR transmitter or HTI Tx
- a RF front end including antenna subsystem.
- one GNSS receiver.

The basic modules remains the same compared to previous architecture.

In addition, the RNC also controls the HTI Tx through the Iub interface.

The HTI Tx converts the bi-directional 3GPP standardised Iub interface into a uni-directional interface. This indoor HTI Tx unit includes a DVB-S modem (for instance) providing signals to the outdoor unit (RF front-end) in IF band.

The RF front end (including antenna subsystem) amplifies both the W-CDMA and DVB-S carriers and up-converts them in FSS bands to feed SDMB satellite.

A GNSS receiver (TBC) is used to achieve synchronisation between the Hub and terrestrial repeaters. It provides a clock reference to the SDMB RNC and to the SDMB Node B.

7.7 Broadcast Multicast Service Centre (BM-SC)

The BM-SC is a functional entity that will provide a range of functions related to the provision of the SDMB service. For example, the BM-SC will control user access to services, authorise and initiate bearer services within the SDMB system, and schedule and deliver transmissions over the SDMB system. TS 23.246 defines the functional requirements for the BM-SC.

Depending on the state of the underlying 2G and 3G mobile networks, i.e. being MBMS enabled or not, several deployment scenarios are envisaged:

- Mobile Network is MBMS enabled, i.e. a BM-SC exists in the MNO domain (see architecture A in Figure 18: Models of architecture)
- Mobile Network is non-MBMS enabled, i.e. no BM-SC exists in the MNO domain (see architecture B in Figure 18: Models of architecture)
- Mobile Network is MBMS enabled and a dedicated BM-SC is deployed for SDMB (see architecture C in Figure 18: Models of architecture)

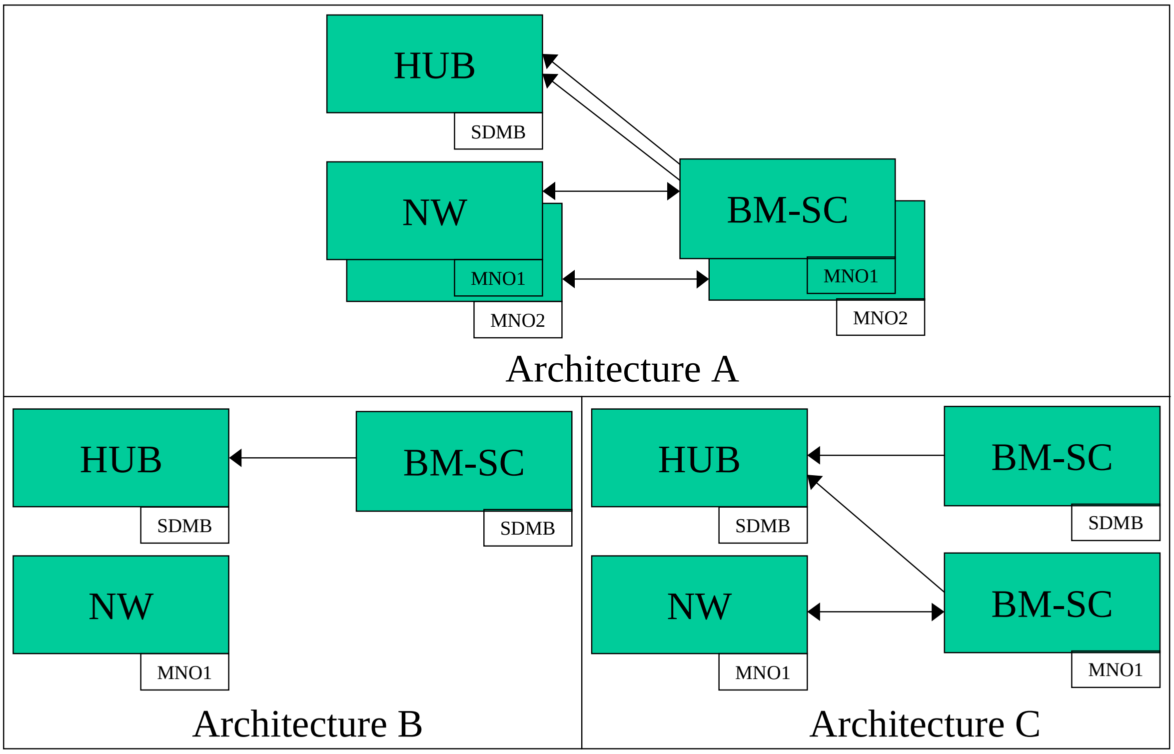


Figure 18: Models of architecture

7.8 Space segment

7.8.1 Functional description

The Space segment may be based on several SDMB satellites.

The SDMB satellite is based on high power transparent GEO satellite with large deployable reflectors to accommodate with the 3GPP standardised handsets G/T performances.

It should be able to provide European coverage through several spot beams; each of nation-wide size. This European coverage could be provided through one to several beams depending on satellite sizing to cope with direct indoor penetration needs.

For the direct downlink (satellite to UE), the satellite down-converts the W-CDMA carriers in FSS bands coming from the hub, amplifies them and retransmit each carrier in the corresponding spot beam in MSS bands.

For the indirect downlink (satellite to frequency conversion or node B-based re-peater), the satellite down-converts the W-CDMA or DVB-S carriers in FSS bands coming from the hub, amplifies them and retransmit each carrier in the corre-sponding spot/global beam in MSS bands or HDFSS bands.

7.8.2 Number of satellites

The coverage area can be provided in baseline by one or several SDMB satel-lite(s) depending on satellite sizing to cope with direct indoor penetration needs.

The number of satellite(s) will be in the range from 1 to 3 to provide the European coverage.

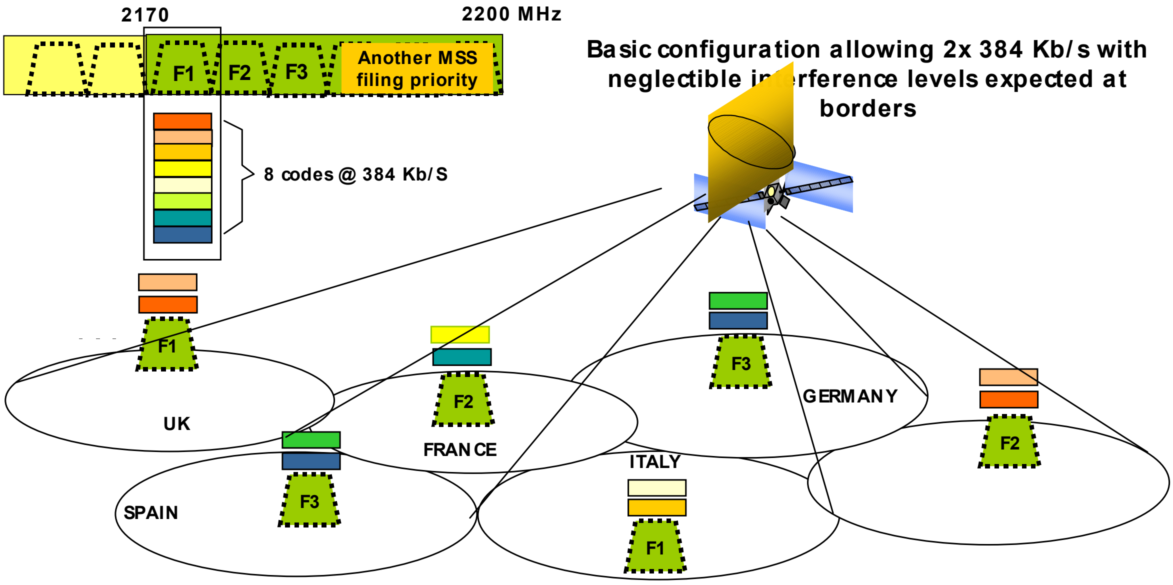


Figure 19: Frequency planning for a pan-european deployment

7.8.3 Orbital slot location

Six orbital slots location have been identified as potential candidate for the SDMB system (15°W, 1°W, 6°E, 10°E, 27.5°E, 32.5°E).

Considering a feeder link in C-band or in Ka-band, the most favourable orbital slots are 15°W, 10°E and 32.5°E. Three filings have been registered at ITU level for this orbital slots location.

Arbitrary, 10°E has been chosen as the preliminary figure for the SDMB satellite.

7.8.4 Service and spot area

The term “Service area” refers to the area where the SDMB services are available. Basically it is defined taking into account a set of satellite spots through one or several satellites providing the European coverage.

The term “Spot area” refers to the area where the SDMB broadcast channel and services are identical. Basically it is defined taking into account one satellite spot providing a linguistic or nation wide coverage. There is not necessarily a service continuity between two spot areas. It is assumed that the same data is broadcast in a spot area and all the contents are different when the user moves from a spot area to another one.

7.8.5 Service area

- <u>Feeder uplink</u>

The feeder uplink coverage shall roughly represents a typical global European coverage as depicted in Figure 20: Typical feeder uplink coverage.

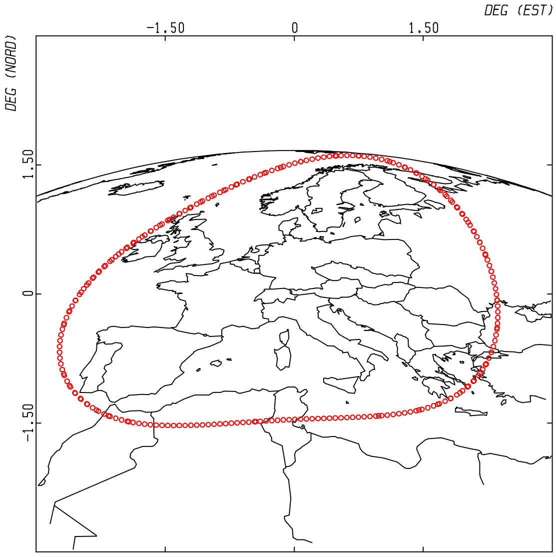


Figure 20: Typical feeder uplink coverage

- Service downlink

The SDMB service downlink coverage shall be an area from 10°W to 30°E longitude and 35°N to 65°N latitude as depicted in Figure 21: Typical S-band service downlink coverage.

Figure 21: Typical S-band service downlink coverage

7.8.6 Spot area

- Feeder uplink

Concerning the feeder uplink, the service and coverage areas refers in a first approach to the same area.

- Service downlink

On the service downlink, the number of spot areas for a given SDMB satellite is currently quite open in a possible wide range. It will depend firstly on the throughput to provide and secondly on the power sharing between satellite segment and terrestrial repeater segment in order to address indoor penetration; knowing also that the satellite segment is power limited (i.e. platform constraints) and repeater segment is interference limited if high throughput is required.

The basic granularity is defined by the spot area and represents a linguistic or nation-wide wide area (e.g. France, Spain, Germany, UK, Italy).

Depending on the above mentioned trade-off to carry out, the number spot areas per satellite should be in the range from 2 to 7.

7.8.7 EIRP level and antenna C/I

Depending on selected on-board configuration the range of EIRP per spot beam should be in the range from 60 to 72 dBW.

The antenna C/I depends on selected frequency reuse scheme, on-board antenna design, power allocated among beams and HPA section design.

As a preliminary figure, an average antenna C/I of 12 dB can be considered.

7.9 Assembly, Integration Verification and Validation (AIVV)

For Further Study.

7.10 Operations

For Further Study.

8 PHYSICAL ARCHITECTURE

For Further Study.

9 DEPLOYED ARCHITECTURE

NOT APPLICABLE at this step of development

10 IMPACT ON EXTERNAL SYSTEMS

10.1 Radio

The power levels received on ground from the satellite are well below the T-UMTS standard power levels.

For Further study following results from WP10/RAN4 studies

10.2 Network

For Further Study

APPENDIX A – FREQUENCY RANGE/PLAN

1/ Feeder uplink

From a regulatory point of view, frequency allocations for feeder links are part of the Fixed Satellite Service (FSS). “Conventional” unplanned FSS allocations in C, Ku or Ka band have been considered.

Over Europe (part of ITU Region 1), the corresponding frequency allocations synthesised in Table 2 are as follows :

	C band	Ku band	Ka band
Uplink	5.850/6.725 GHz 7.025 – 7.075 GHz	13.75/14.5 GHz	27.5/30 GHz

Table 1 : Candidate frequency bands for feeder uplink

The choice of best candidate feeder link frequency slot allocation mainly depends on the amount of spectrum required, number of SDMB Hub and orbital position of the SDMB satellite to derive the coordination process with existing systems.

Taking into account the current SDMB system architecture, coordination process with adjacent satellite networks appears feasible in C, Ku or Ka-bands but the chances of success of the coordination process are therefore quite high, especially in C and Ka bands, which are today less used than Ku-band over Europe.

As a current baseline, the Ka-band has been selected in the range from 27.5 – 30 GHz.

The detailed frequency plan depends on several issues that are still open in the current SDMB architecture definition.

Among them:

- Number of hub,
- Number of spot beam,
- Terrestrial repeater architecture.

As a rule of thumb, it could be considered the following.

- Feeder uplink for direct link (satellite to UE)

The 3GPP UTRA W-CDMA FDD air interface requires 4.68 MHz/FDM taking into account a roll-off of 0.22. In baseline, the channel spacing between FDM shall be 5 MHz.

The number of frequency slots (for uplink) is equal to the number of satellite beams if no polarisation reuse is considered.

In case of polarisation reuse the number of frequency slot is half of the number of beams.

- Feeder uplink for indirect link (satellite to repeater)

1) For on-channel repeater, no additional frequency slots are required.

2) Frequency conversion repeater

The indirect service downlink (from satellite to repeaters) should take place in HDFSS band in which it is not mandatory to implement a frequency reuse scheme due to lot of bandwidth available.

Two possibilities can then be envisaged for the feeder uplink dedicated to the indirect link:

1- On-board duplication and therefore, no additional bandwidth is required on the feeder uplink.

2- On-ground signal duplication and the number of additional 5 MHz frequency slots is equal to the number of spot beams on direct service downlink (without considering polarisation reuse).

3) Node B-based (See section 7.4.3.2.2)

The frequency slot size depends on the air interface used. For DVB-S, assuming a roll-off of 0,35, the required bandwidth is 1,35*Rs where Rs is the symbol rate ranging from 2 Ms/s to 45 Ms/s.

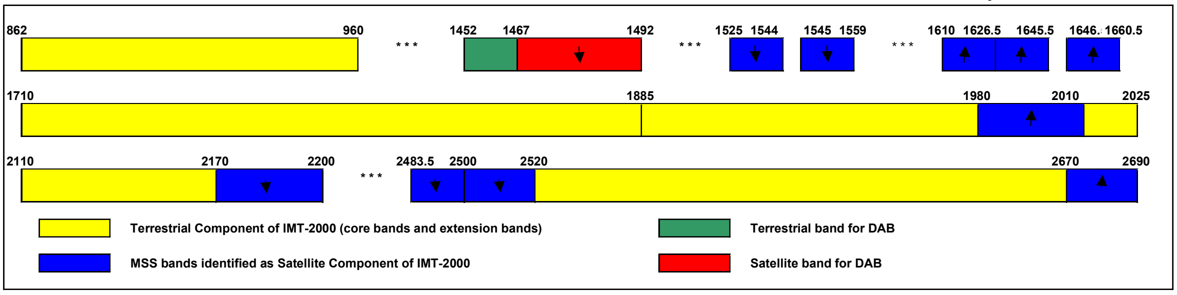
The frequency slot will depend therefore on the considered throughput and the modulation/coding scheme used.

Whatever the retained solution, the polarisation to use is linear (either vertical or horizontal).

2/ Service downlink

- <u>Direct service downlink and indirect service downlink for on-channel repeaters</u>

SDMB intends to use MSS bands. Specifically, two frequency bands could be under consideration for that system : the 2170-2200 MHz MSS band (space-to-Earth) part of the so called IMT2000 core band which is already targeted by other MSS systems (e.g. ICO) possibly significantly reducing the available spectrum for a new system, and the 2500 – 2520 MHz MSS band (space to earth), part of the so-called IMT 2000 extension bands, as depicted in



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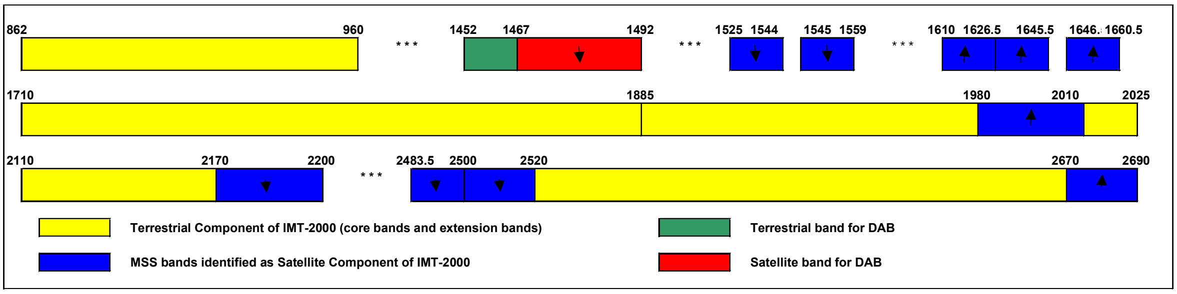

Figure 22: Candidate service link bandwidth

Over Europe and for long term perspective, the IMT 2000 extension bands have been finally granted to terrestrial systems and cannot therefore be reasonably considered for the SDMB system.

The 2170-2200 MHz band has the immediate advantage of enabling broadcast/multicast transmission in a frequency band adjacent to the core frequency bands of 3G networks in Europe, thus ensuring limited impacts, if any, on antenna and Radio Frequency stage of UMTS user terminals.

This frequency band is therefore best suited for the SDMB system.

Among these 30 MHz available, 15 MHz have been already pre-empted by ICO but are currently unused by ICO for service delivery and therefore the SDMB system could currently only rely on the 15 MHz adjacent to T-UMTS core bandwidth.

Taking into account these considerations and the fact that ICO could loose these bandwidths in the long term if unused but possibly other MSS projects could be interested by these bandwidths, the selected frequency bandwidth for the first generation of SDMB system is 2170 – 2200 MHz.

Considering the frequency plan and due to limited bandwidth allocated in the service downlink a frequency reuse scheme should be implemented to cope with possible required number of spot beams to cover Europe.

Basically, it could be assumed that 15 MHz among 30 MHz is available for the SDMB system. Preferably this 15 MHz should be adjacent to T-UMTS core bands to better cope with the frequency agility required for the 3GPP SDMB-enabled terminal.

Therefore, in a first step, 3 frequency slots of 5 MHz (i.e. 3 FDM) in the range from 2170 – 2185 MHz should be taken into account for the SDMB system.

The polarisation to use is circular (LHCP or RHCP).

- Indirect service downlink (if frequency conversion repeater/node B based repeater are required)

Currently, two main frequency ranges in Ka-band could be currently considered to feed terrestrial repeater segment :

- 17.3 – 17.7 GHz
- 19.7 – 20.2 GHz

Due to potentially large number of receiving terrestrial repeaters and the fact that their deployment has not to be constrained by coordination considerations with terrestrial services, an allocation to “high density” FSS (HDFSS) has to be preferably selected and is the current baseline for the SDMB system.

The band 17.3/17.7 GHz has been allocated to HDFSS in ITU Region 1 at WRC-2003. The harmonisation of the band for HDFSS use in Europe remains to be done.

The selected bandwidth for the indirect downlink is 19.7 – 20.2 GHz.

Since this frequency band is not currently overloaded, it is not mandatory to use a frequency reuse scheme in a first step.

For frequency conversion repeater type, the number of 5 MHz frequency slots will be equal to the number of S-band band spot beams assuming a single FDM per beam.

For node B based repeater type, the frequency slot size depends on the air interface used. For DVB-S, assuming a roll-off of 0,35, the required bandwidth is 1,35*Rs where Rs is the symbol rate ranging from 2 Ms/s to 45 Ms/s.

The frequency slot will depend therefore on the considered throughput and the modulation/coding scheme used.

The number of frequency slots will be also equal to the number of S-band spot beams.

Concerning polarisation, most of Rx antenna product available in this frequency band are designed for linear polarisation. Therefore, linear (V or H) should be used for this indirect downlink.

APPENDIX B – SYSTEM PARAMETERS

	System level		Baseline System Parameters Definition	
System Parameters	**SDMB PhaseA**	**MAESTRO**	**SDMB Phase A**	**MAESTRO**
SAT				
Number of satellite	X	X	From 1 to 3	Subset of SDMB Phase A
Number of spot / satellite	X	X	From 2 to 7	Subset of SDMB Phase A
Uplink spot frequency and polarisation	X	X	Ka-Band : 27.5 - 30 GHz with linear polarisation	
Number of FDM carrier / spot for feeder uplink	X	X	-	For HUB-UE : 1 if no polar reuse or 2 if polar reuse For HUB-IMR : - on-channel : idem - freq conv : idem with on-board freq duplication and 5 MHz / spot if on-ground freq duplication - Node B based : depends on air interface
Downlink spot frequency and polarisation	X	X	S-band : 2170 - 2185 MHz with circular polarisation, Ka-Band : 19.7 - 20.2 GHz with linear polarisation	
Number of FDM carrier / spot for feeder downlink	X	X	For HUB-UE or HUB-IMR : the number of FDM is equal to the number of spot : 1, 2 and 3 carriers among the 3 frequency slots available in 15 MHz are proposed(4.68 Mhz of useful bandwidth with 5 MHz spacing)	For HUB-UE or HUB-IMR : the number of FDM is equal to the number of spot : Subset of SDMB Phase A
HUB				
Number of HUB	X	X	One global	One global or one per spot
Number of HUB / spot	X	X		
IMR				
Number of IMR	-	X	Defined by prop channel model	no IMR or several IMR per spot (6 max for hexago-

Number of IMR / spot		X		

(1) "subset of" refers to the fact that the SDMB phase 1 ESA study will conduct SDMB trade-offs leading to a limited choice in the MAESTRO study.

	System study level		Baseline System Architecture Definition	
System Architecture	**SDMB Phase A**	**MAESTRO**	**SDMB Phase A**	**MAESTRO**
SAT				
HPA payload structure	X	X	mono-carrier, multi-carrier or MPA architecture	
HPA payload type	X	X	TWTA, LTWTA or SSPA	
Payload architecture	X	X (enhanced model)	One S-Band transponder	One S-Band transponder and one Ka-Band transponder
HUB				
Type of HUB	X	X (enhanced model)	W-CDMA UTRA FDD	W-CDMA UTRA FDD and DVB-S type for IMR feeder link
Physical channel mapping	X	X (enhanced model)	S-CCPCH, P-CCPCH, CPICH + P-SCH and S-SCH as interference	S-CCPCH, P-CCPCH, CPICH, P-SCH, S-SCH with PICH
IMR				
Type of IMR	-	X	Defined through the propagation channel modelisation via the SDMB Radio planning tool	"on channel", "frequency conversion" or "Node B based" implementation
Type of IMR / spot		X		same IMR for all spot, same IMR per spot only or different IMR in one spot
Type of IMR feeder link		X		W-CDMA UTRA FDD in MSS Band or DVB-S in FSS Band
UE				
Type of UE	-	X	-	Handset