IST Integrated Project No 507023 – MAESTRO

D6-2.2b

System Design Definition File (for R2)

Contractual Date of Delivery to the CEC:	**31/12/2004**
Actual Date of Delivery to the CEC:	**21/12/2004**
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Workpackage:	**WP06**
Est. person months:	**4 p.m.**
Security:	**Pub.**
Nature:	**R**
Version:	**3.0**
Total number of pages:	**49**

Abstract:

The D06-2-2b document describes the test bed as foreseen within MAESTRO release 2 scope. It aims at highlighting all of the SDMB functions supported in release 2 and at proposing a validation strategy composed of two test beds, namely laboratory test bed and field test bed. This document serves as a reference to all specification and design documents describing each component of the test bed (delivered within the scope of Work Package 6 or 7).

Keyword list: MAESTRO test bed R2 design

EXECUTIVE SUMMARY

This document contains D06-2-2b 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.

This is the second document of task 2 in Work Package 6 – "Architecture". The WP 6 aims at:

- Identifying the technical requirements of the SDMB system.
- Defining the SDMB system architecture that inter-works with the 3GPP architecture and meets all system requirements.
- Defining the functions and interfaces of all SDMB sub-systems namely User Equipment (UE), Intermediate Module Repeater (IMR), space segment, Hub and services centre.
- 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 D06-2-2b document describes the test bed as foreseen within MAESTRO release 2 scope. It aims at highlighting all of the SDMB functions supported in release 2 and at proposing a validation strategy composed of two test beds, namely laboratory test bed and field test bed. This document serves as a reference to all specification and design documents describing each component of the test bed (delivered within the scope of Work Package 6 or 7).

As the MAESTRO release 2 test bed is an extension of the MAESTTRO release 1 test bed, this document often refers to D6-2-1b (description of release 1 test bed) instead of recalling all the R1 features.

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

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DOCUMENT HISTORY

Vers.	Issue Date	Content and changes
1.0	19 Jul. 04	Table of content
2.0	23 Jul. 04	Initial draft
2.1	30 Sept 04	• Emphasise differences between R1 and R2 test beds • Add an overview description of the 2G functions. • Complete the network layer functions chapter. • Add a description of how the network layer functions are implemented in the BM-SC. • Introduce the two possible architectures of the UE • List the functions supported by the RNC
2.2	15 Oct 04	Update the document with respect to information exchange during the TB R2 meeting on October 11th
2.3	19-Nov-2004	LogicaCMG contribution incorporated Link budget added Various updates
2.4	16 Dec 04	Updated according to MSPS, Ercom and LogicaCMG comments
3.0	21 Dec 04	Updated according to SPH comments and minor corrections for delivery

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 Background

1.2 Fields of application

This document is meant to be used by the teams in charge of specifying, designing, developing, integrating verifying and validating the release 2 MAESTRO test bed.

1.3 Document structure

The document is composed of the following sections:

- General presentation. This section describes the concept of the SDMB system.
- Functional architecture. This section aims at identifying which functions of the commercial SDMB system will be supported and tested within the release 2 scope.
- Organic architecture. This section introduces both the laboratory and the field test beds; it provides a high-level description of each organ and interface of the test beds and identifies specific scenarios to be tested in release 2.

1.4 Document status

Draft

2 TERMS, DEFINITIONS, ABBREVIATED TERMS AND SYMBOLS

2.1 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.

2.2 Abbreviations

Version 1.5

2G	Second Generation (Mobile communication system)
3G	Third Generation (Mobile communication system)
3GPP	3rd Generation Partnership Project
A-CIT	Alcatel CIT, France (MAESTRO Partner)
AAC+	Improved 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

3 GENERAL PRESENTATION

The Satellite Digital Multimedia Broadcasting (SDMB) system intends to implement a multicast layer over uni-cast terrestrial 3G UMTS mobile networks. As shown on Figure 1, the system concept is based on a combined satellite and terrestrial repeaters architecture for delivery of interactive broadcasting/multicasting digital multimedia services to mobile end-users. The system will aim to permit indoor penetration by means of dedicated large power GEO satellites providing several beams over Europe.

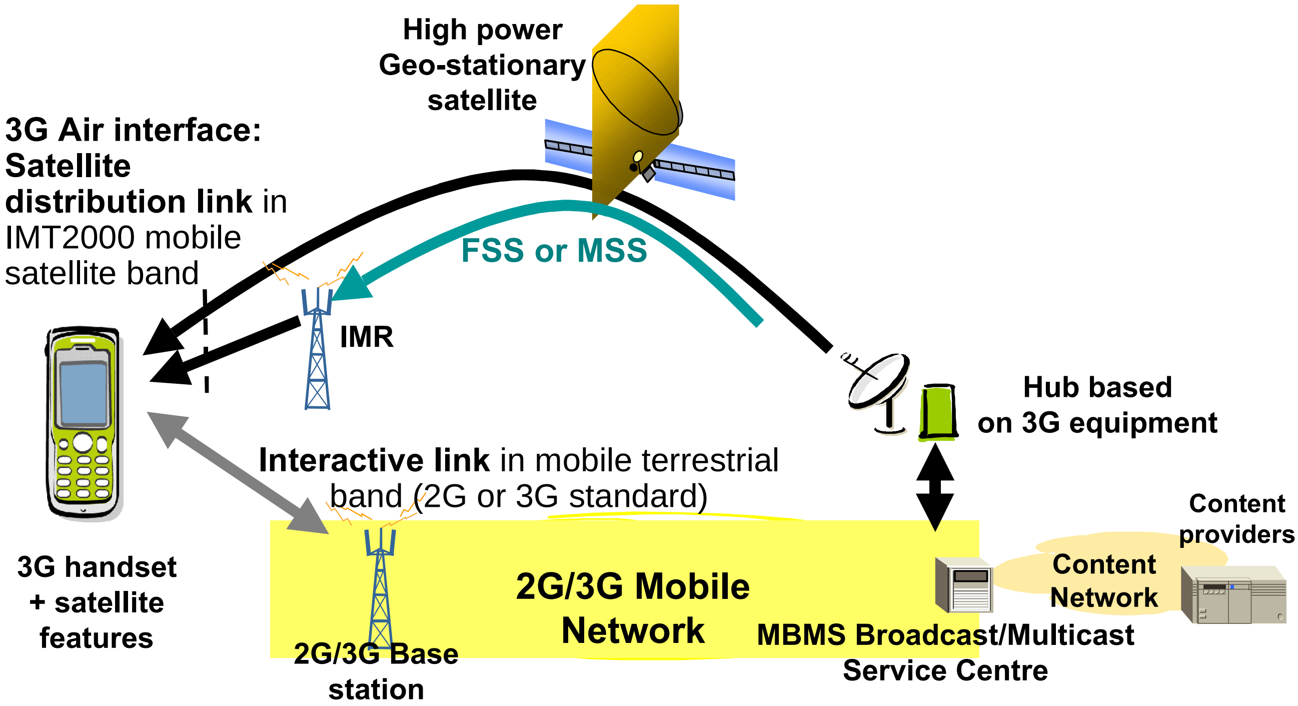


Figure 1 – SDMB system architecture

MAESTRO aims at specifying and validating the most critical services, features, and functions of satellite system architecture, 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.

In the scope of release 2, the MAESTRO study includes setting up both a laboratory and a field test bed representative of the SDMB system. The release 2 test beds will be built on the release 1 ones. The mains upgrades will consist in integrating both the BM-SC and a 2G terrestrial network to the existing platforms. In R2, application, transport and network layer features (in addition to the lower layer features already illustrated in R1) & dual mode operation in the handset will be tested and validated.

The goal of the laboratory test bed is to provide a platform to consolidate simulation results (WP02) and WP05 studies. Therefore, one of the key features of that platform is to allow reproducibility.

As in MoDiS, the goal of the field test bed is to demonstrate the feasibility of the SDMB system but using a terminal built on a commercial UE which features a higher integration level and a complete UMTS/GPRS protocol stack.

4 FUNCTIONAL ARCHITECTURE

The following figure presents the basic functional architecture of a SDMB system and highlights the functions that will be tested within the scope of MAESTRO release 2.

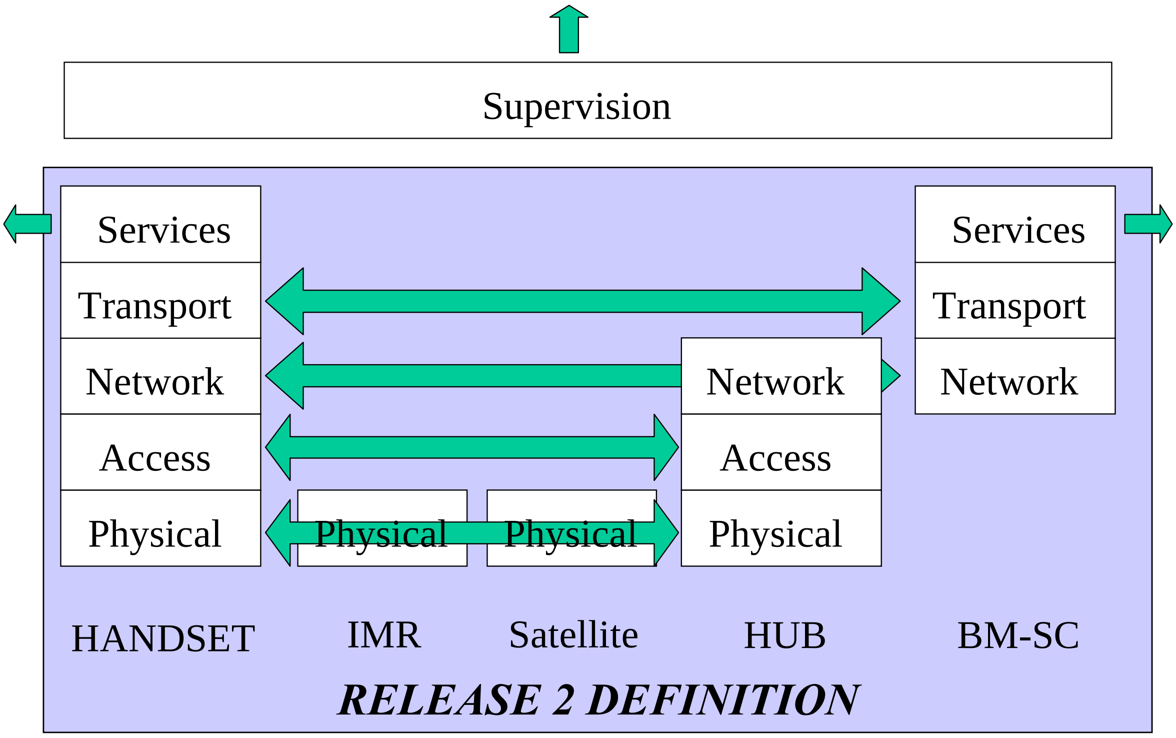


Figure 2 – Release 2 test bed objective

4.1 Radio interface

The release 2 test bed shall support two types of radio interfaces to connect to both the SDMB and the GPRS network.

4.1.1 SDMB radio interface

The SDMB radio interface is derived from the UMTS radio interface.

Physical channels used in release 2 are similar to the ones used in release 1.

Transport channels used in release 2 are similar to the ones used in release 1.

DTCH (Dedicated Traffic Channel) will be used as in release 1.

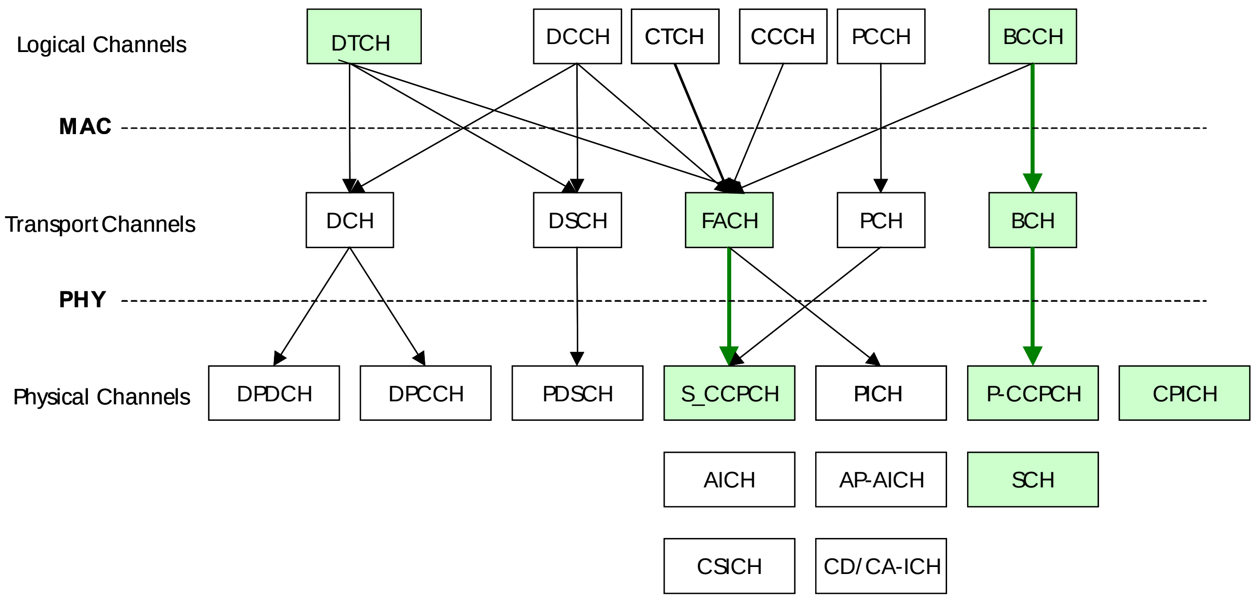


Figure 3 – Release 2 MAESTRO channel correspondence

Refer to D6-2-1b for more details.

4.1.2 GPRS radio interface

As shown on Figure 4, the GPRS radio interface uses a combination of FDMA and TDMA for multiple access. Each of the 200 kHz frequency channels carries eight TDMA channels themselves divided into eight time slots. The eight time slots in these TDMA channels form a TDMA frame. Each time slot of the TDMA frame lasts for a duration of 156.25 bit times and, if used, contains a data burst. The time slot lasts 15/26 ms = 576.9 µs; so a frame takes 4.615 ms. The recurrence of one particular time slot defines a physical channel.

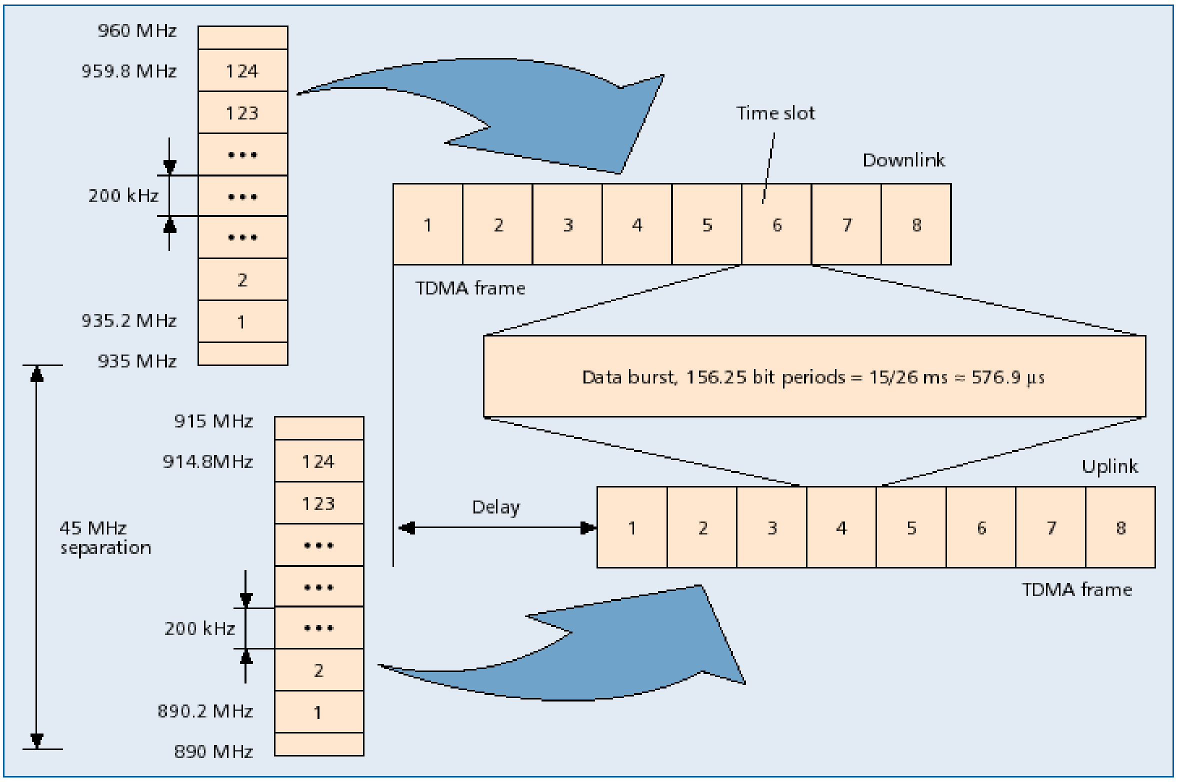


Figure 4 – GPRS radio interface

For more details, refer to GSM 03.64, GPRS, Overall description of the GPRS radio interface, Stage 2.

4.2 Physical layer function

Release 2 test bed shall implement the appropriate features so as to be able to demonstrate dual mode SDMB/GPRS operations. Overall, the GPRS operations while in SDMB reception shall consist in monitoring the serving cell, adjacent cell & the paging indications

4.2.1 SDMB physical layer function

The SDMB physical layer processing is identical to the one of release 1 test bed. Refer to D6-2-1b for more details. Overall, data are received with downlink only on a FACH channel.

4.2.2 GPRS physical layer function

The GPRS physical layer processing includes the following steps:

- Parity bits attachment
- Channel Coding
- Interleaving
- Encryption
- Modulation (GMSK)
- Transmission

For more details, refer to GSM 03.64, GPRS, Overall description of the GPRS radio interface, Stage 2.

4.3 Access layer function

On top of release 1 features (Refer to D6-2-1b for more details), release 2 access layer shall implement the appropriate features so as to be able to demonstrate dual mode SDMB/GPRS operation i.e. idle mode functions in GPRS (Refer to D6-3-2 for more details).

4.4 Network layer function

In the scope of release 2 test bed, it is proposed to address the following network layer functions:

- User authentication
- User authorisation
- Ciphering and deciphering (i.e. encryption and decryption)
- QoS Control
- Addressing Scheme

As the test bed will not make use of external Content Providers (the test bed will make use of local content servers), authentication and authorisation of Content Providers is not considered to be within the scope of the release 2 test bed. In addition, billing functions (either for the user or the Content Provider) will not be implemented at this stage.

The following sections define what functionality will be supported by the test bed under each of the categories listed above. How this functionality will be realised by the organs of the test bed is discussed in detail in section5.1.3.

4.4.1 User authentication

Authentication will be performed at two levels in the system:

1. During attachment to the GPRS network to set up the unicast PDP context between the handset/TE and the test-bed servers. This will use standard GSM Authentication and Key Agreement (AKA) mechanisms either with the SIM in the handset, or SIM-enabled GPRS card for insertion into the TE (e.g. PCMCIA card in laptop).
2. During SDMB ‘session join’, i.e. a user requesting access to one or more SDMB services. While work ongoing in the TSG SA3 WG on MBMS security is currently focussing on bootstrapping this session-level authentication onto the AKA mechanism, this will not be possible for the R2 test bed and an alternative mechanism will be used instead. This will authenticate the user based on a PKI certificate stored on the TE device, with the session-level join negotiated through signalling exchanges between the TE and BMSC.

Details of how this functionality will be implemented are provided in section 5.1.3.

4.4.2 User authorisation

Authorisation is the process of checking that a user actually has permission to access the particular network service that they are requesting. Typically these permissions are stored in a database that defines in detail the individual services that the user is allowed to access.

To demonstrate user authorisation, the release 2 test bed will provide the following functionality:

- A database (in the BM-SC) into which the following information can be provisioned as a minimum:
    - Details of the services that are to be supported by the test bed
    - Details of all of the users of the test bed including their access privileges to the services.
- A mechanism for the user to request access to one or more of the services;

- A mechanism for the BM-SC to verify that the user has the necessary privileges to be able to receive the service;
- A mechanism to communicate the authorisation decision back to the user.

Details of how these mechanisms will be provided are described in section 5.1.3.

4.4.3 Ciphering/Deciphering

Ciphering (or encryption) provides the means to secure and control user access to the SDMB application content and ensure the confidentiality of information exchange on communications networks. Through the use of ciphering, only registered subscribers are able to receive the content, thereby enabling the value chain from content source to user to be tightly controlled.

In the SDMB context, an important aspect will be that the ciphering mechanism employed is capable of securing transmissions to large groups of users rather than to individual users. In addition, it will also be important that the ciphering mechanism employed minimises the management overheads on the network to ensure that precious bandwidth is not wasted and the benefits of broadcast undermined.

It is proposed that the release 2 test bed will support ciphering between the BM-SC and the TE using an IP-based encryption method. The key management protocol employed within the test bed will be able to support groups of users in an efficient manner that will minimise management overheads on the network. Details of how these mechanisms will be provided are described in section 5.1.3.

4.4.4 QoS Control

There is one aspect to QoS control within the test bed:

- The establishment of broadcast bearers, whether in the propagation channel emulator in the laboratory test bed or the transmission equivalent in the field test bed, will be controlled using the signalling control plane interface between the BM-SC and the Hub (i.e. the Gmb* interface). This interface will include specifying the QoS parameters that must be provided by the radio bearer.

Details of how these mechanisms will be supported in the R2 test bed will be provided in section 5.1.3.

4.4.5 Addressing Scheme

The addressing scheme to be adopted for the laboratory test bed is completely under the control of the MAESTRO project. The TE (laptop) will support 2 network interfaces:

1. One interface will provide connectivity to the SDMB enabled MT that is supporting reception of SDMB broadcast transmissions.
2. The other interface will provide a LAN connection to simulate the presence of a GPRS connection providing direct connectivity to the BM-SC.

Both of these interfaces can be allocated static IP addresses in order to meet the requirements of the TB R2.

The addressing scheme to be adopted for the field test bed is dependent on the overall physical architecture to be adopted, in particular the means for integrating the test bed architecture with the MNO network for supporting the back channel. In this system, the TE will be connected to 2 MTs, one providing SDMB reception (as for the lab test bed) and the other providing GPRS connectivity to the BM-SC. The IP address for the SDMB interface can be allocated in the same manner as for the lab test bed. The IP address for the GPRS is likely to be allocated (either dynamically or statically) from the MNO number space (TBC following outcome of discussions with BYTL).

As the SDMB enabled MT is able to forward IP packets transparently (i.e. without them passing up the IP stack in the MT) it will be possible to use an IP multicast addressing scheme for the delivery of IP data across the system.

4.5 Transport layer function

In the scope of release 2 test bed, the transport layer will implement the following functions:

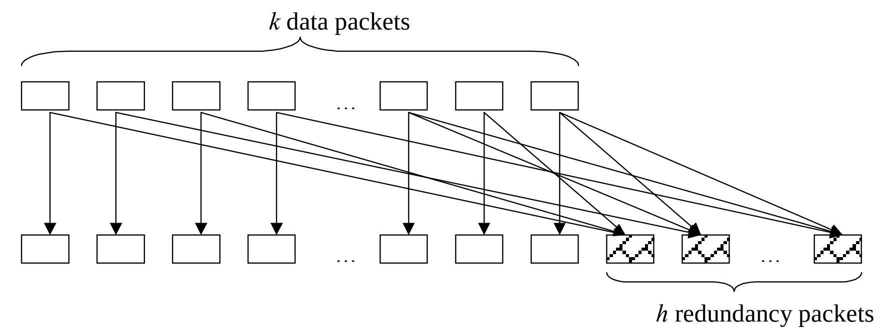
- FEC
- Interleaving
- Carousel
- Selective retransmission

4.5.1 Packet level Forward Error Correction

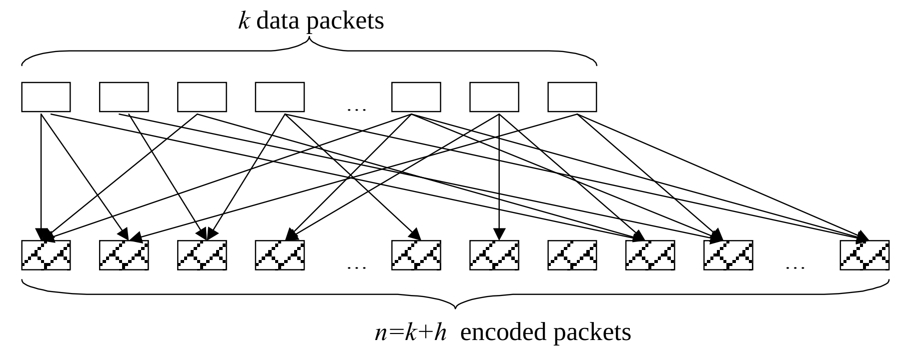
Packet level FEC differs from the bit level FEC in a sense that it deals with straight packet losses instead of unpredictable bit values.

The principle of the packet level FEC consists in transmitting K input packets complemented by H redundancy packets. The total number of broadcast packets is N. If at least $K \cdot (1 + r_0)$ packets out of N are received successfully, then all the K input packets can be retrieved. If fewer than $K \cdot (1 + r_0)$ packets are received successfully, we cannot gain advantage from the redundancy but we can at least retrieve a fraction of the initial K packets which made their way to the receiver. The parameter r_0 stands for the code reception overhead. In the ideal case, r_0=0.

As depicted on Figure 5, the packet level FEC can use a systematic or a non systematic algorithms.



a) systematic encoder



b) non-systematic encoder

Figure 5 – Packet level FEC encoding operation

The packet level FEC codes falls into the following categories: block, convolutional, low-density parity check, Turbo, and rate less codes.

Refer to D5-2 for more details.

4.5.2 Interleaving

Interleaving is another technique to increase the code correction capability. It is mostly efficient to struggle with burst errors. Burst errors may be the result of drop-tail buffer management schemes at the intermediate routes on the data flow path or sustained link outage intervals in case of wireless links.

The rationale behind interleaving is to spread data packets from one sequence over several sequences in order to randomise errors and increase the correcting capability of codes that can cope with random errors. An interleaver reorders data before transmission and a de-interleaver restores the order before decoding.

There are two classes of interleavers: block and convolutional.Refer to D5-2 for more details.

4.5.3 Carousel

A carousel is a multiple-pass transmission. Receivers are not expected to generate traffic but are expected to receive only traffic (passive receivers). In such situations, the receivers complement the missing blocks after each transmission. There is then a growing number of file completion after each transmission. The convergence is not expected to reach 100% completion.

Refer to D5-2 for more details.

4.5.4 Selective retransmission

By definition the carousel is a non selective retransmission mechanism in a sense that the full content is retransmitted to the terminals. Such a mechanism is less efficient than a selective retransmission mechanism where the server will select specific blocks to retransmit depending on terminals feedback. Retransmission can be server-solicited or server-unsolicited. It can use either the satellite segment or the terrestrial network depending on the amount of terminals requesting the same content.

In the scope of MAESTRO release 2, we want to be able to test both terrestrial and satellite retransmissions. Now, considering the number of terminals used in the test bed, a mechanism must be implemented to force satellite retransmission. We propose to support at least the following scenarios:

- Satellite selective retransmission solicited by the server at the end of the carousel
- Terrestrial selective retransmission upon end-user request.

Refer to D5-2 for more details.

4.6 Services function

Hot download, Cold download, streaming.

Nice to have : peer-to-peer.

5 ORGANIC (OR LOGICAL) ARCHITECTURE

In the scope of release 2, MAESTRO study includes setting up two platforms representative of a SDMB system. One of these platforms will be dedicated to laboratory trials while the other one will be used for field trials.

5.1 Laboratory test bed

The goal of the laboratory test bed is to provide a platform to consolidate simulation results. Therefore, one of the key features of the platform is to allow reproducibility.

5.1.1 Laboratory test bed description

The laboratory platform differs from the real SDMB system described on Figure 1 in the following:

- The satellite is replaced by the SIMSTAR emulator, which features satellite and terrestrial multi-path channels. Each channel can emulate up to 6 uncorrelated multi-path. The SIMSTAR emulator operating in the IF domain, frequency conversion modules are required at each end of the emulator.
- The Hub functions are fulfilled by a Node B and a RNC simulator featuring broadcast support and adapted to the MAESTRO application.
- The MAESTRO terminal is composed of a modified 3GPP mobile terminal connected to a PC. The mobile implements physical and access layers functionality while the PC implements network, transport and application functions.
- The service centre functions are simplified and adapted to the MAESTRO application.
- There is no external content provider. Only local streaming and download servers will be used.
- The test bed does not involve any terrestrial network operator. The SDMB mobile terminal (MT) is directly connected to a GPRS emulator to test its dual mode operation and the terminal equipment (TE) which is essentially a laptop is directly connected to the service centre to emulate the interactive GPRS link.
- On top of that, there is neither MBMS, nor billing implemented, and only a few (maximum three) UE will be used at a time.

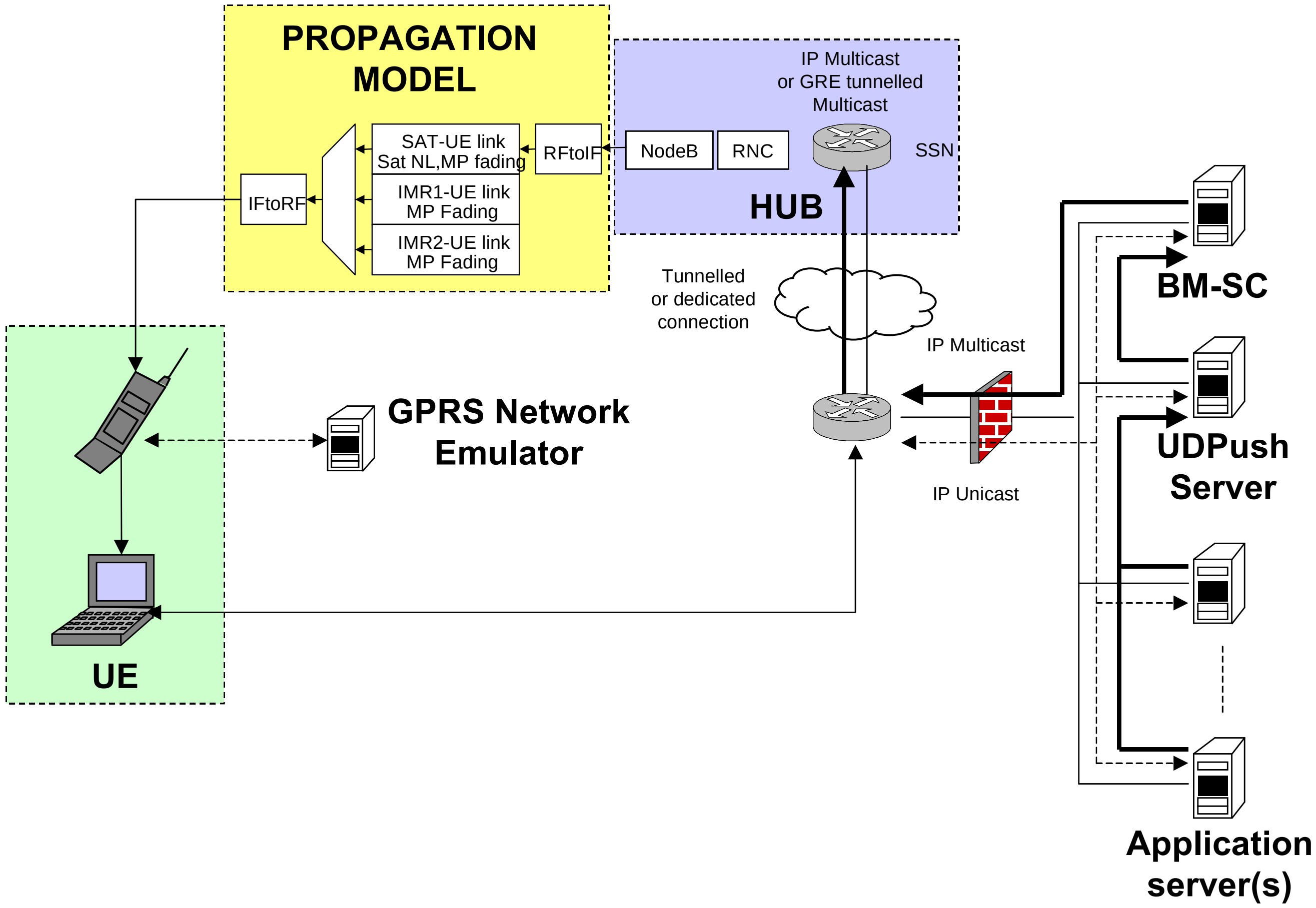


Figure 6 – Laboratory test bed architecture

5.1.2 Laboratory test bed organs and interfaces

The following table lists the organs and logical interfaces at sub-system level and identifies where it is specified.

Characteristics of the organ or the logical I/F				Complementary information
Id	**Type**	**Ref**	**Title of the document**	
Application server	**Organ**	**D6-2-2b** **D6-6-2**	**MAESTRO release 2 test bed design document** **Service centre specification document**	
BM-SC	**Organ**	**D4-4** **D7-4**	**Network layer Specification** **BM-SC design document**	
UDPush server	**Organ**	**D5-1** **D5-2**	**Reliable transport requirements** **Reliable transport design document**	
Hub	**Organ**	**D6-5** **D7-3**	**SDMB Hub Specification** **SDMB Hub design document**	
SIMSTAR	**Organ**	**D7-6**	**Propagation channel emulator design document**	
UE	**Organ**	**D6-3** **D7-2**	**UE SDMB specification** **SDMB UE design document**	
Terrestrial network emulator	**Organ**			**Off the shelf component**
Central controller	**Organ**	**TN7**	**Technical note to be written in the scope of WP7 activities**	
UE interfaces	**Interface**	**D6-3** **D7-2**	**UE SDMB specification** **SDMB UE design document**	
SIMSTAR input interface	**Interface**	**D7-6**	**Propagation channel design document**	
BM-SC interfaces	**Interface**	**D4-4** **D7-4**	**Network layer Specification** **BM-SC design document**	

Table 1 – Laboratory test bed organs and interfaces summary

5.1.3 Description of the organs and the logical interfaces

5.1.3.1 Application servers

In order to provide multicast streaming services of audio/video content, the TB R2 shall include a Server running VideoLAN. This Server provides full management of streaming services 'off-the-shelf' and can be used with a minimal level of user configuration. Full details of the capabilities provided by VideoLAN can be found at:

http://www.videolan.org/streaming

5.1.3.2 BM-SC

The BM-SC shall support all of the network layer functionality described in chapter 4.4. An overview of how this functionality will be provided is summarised below.

- User authentication

  The test bed BM-SC will support the necessary functionality to implement a dedicated PKI infrastructure for the test bed system. This will include the capability to generate certificates and public keys and store these securely on the TE and on the BM-SC itself. This will ensure that all management exchanges between each TE and the BM-SC will be mutually authenticated.

- User authorisation

  The test bed BM-SC will provide a service management facility to allow the provisioning of service and user details onto the system. It will be possible to define the services which are to be transmitted across the test-bed network, and the access rights of each user within the test bed to access these services.

- Ciphering / Deciphering

  The test bed BM-SC will provide a facility which handles the generation and distribution of ciphering keys to authorised users within the test bed so that they are able to decrypt one or more of the services to be demonstrated and access the content. A highly efficient key management mechanism will also be provided that will to help ensure that security management overheads are kept to a minimum. The above mechanisms will be based on two emerging standards being developed within the Internet community to manage subscriber access and distribution of keys. These are the Group Secure Association Key Management Protocol (GSAKMP) and Logical Key Hierarchy (LKH).

- QoS Control

  The test-bed BM-SC will support the Gmb* interfaces with the Hub (see section 5.1.3.11.1). The Gmb* interface will allow the BM-SC to specify the QoS parameters that must be supported by the radio bearer.

A more detailed description of the above functionality will be provided in the BM-SC Specification Document for R2 (D6-6.2).

5.1.3.3 UDPush server

See D6-6-2.

5.1.3.4 Hub

In details of what is shown on Figure 6, the Hub is composed of two entities, namely the Node B and the RNC simulator. The SSN (SDMB support node) is a function embedded into the RNC simulator. It provides the Iu interface to the RNC and the Gmb* and Gi* interfaces towards the BM-SC.

The Node B implements functions related to the physical layer while the RNC simulator is actually dedicated to the access layer.

5.1.3.4.1 Node B features

An off-the-shelf Alcatel Node B component is used.

The Node B is only responsible of the physical layer of the UTRAN interface except for the management of the BCCH where it acts also as an RRC entity.

- UTRA-FDD up-link [1920-1980] (unused), down-link [2110, 2170],
- No transmit diversity,

- Support of the following common down-link physical channels: one primary SCH, one secondary SCH, one primary CPICH, one PICH, one P-CCPCH and up to three S-CCPCH up to 384 kbps with or without use of TFCI ,
- Synchronisation to an external clock reference extracted from the Iub interface transmission link clock or to a GPS clock,
- Iub layer 3 = FP and NBAP,
- Iub layer 2 = ATM AAL2/AAL5,
- Periodic broadcast of BCCH System Information Blocks,
- Inclusion of the System Frame Number (SFN) in the BCH,
- LMT features: all the O&M is performed via the LMT (Configuration/Transmit power tuning/Node B set-up/ supervision).

5.1.3.4.2 RNC simulator features

The RNC main functions are to set-up a cell, to set-up the common transport channels, to broadcast the system information and to transmit SDMB Data to the NodeB. The RNC is implemented by ERCOM and includes a set of UMTS protocol layers.

To serve the purpose of the MAESTRO test bed, the following functions must be implemented in the RNC simulator:

- UDP encoding-decoding (Release 1 feature)
- UDP checksum (Release 1 feature)
- SIB menus integration (Release 1 feature)
- SIB values adjustment (Release 1 feature)
- MAC logical channels (Release 1 feature)
- Multiple S-CCPCH generation (Release 1 feature)
- PDCP header compression (Release 1 feature)
- Data file handling improvement (Release 1 feature)
- SIB update without a reset (Release 1 feature)
- Use of DTCH
- SDMB Support Node function
  - Iu interface towards the RNC
  - Gmb* and Gi* interfaces towards the service centre
- RNC graphical interface improvement

For more details, refer to D7-3 – “Hub design document” deliverable.

5.1.3.4.3 Node B / RNC simulator interface

The RNC – Node B interface is a 3GPP-compliant Iub interface, with an STM1/E1 device converting the optical STM1 of the RNC Simulator to/from the electrical E1 of the Node B.

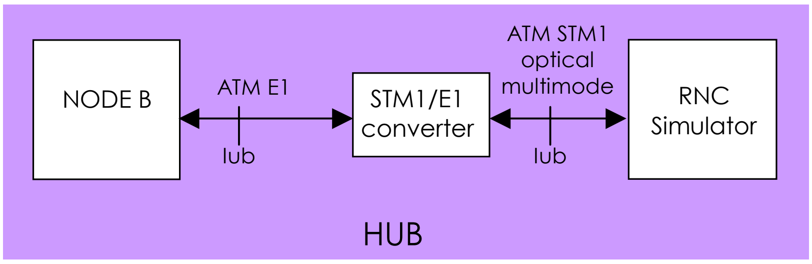


Figure 7 – NodeB / RNC simulator interface

5.1.3.5 Propagation model (SIMSTAR)

The propagation channel emulator SIMSTAR-1/MS is developed by ASCOM. It models mobile satellite channel with its characteristic effects and impairments due to transmission and propagation conditions such as path delay, Doppler, multi-path fading, shadowing and receiver internal and external thermal noise in a realistic manner.

All functions involved in the generation of the impairment previously mentioned are fully implemented in the digital domain, thus guaranteeing high accuracy and reproducibility.

It has been decided that multi-path fading will be developed first in order to guarantee evaluation of the rake performances in all relevant propagation conditions. Realistic satellite mobility will be implemented in release 1; on the other end, realistic terrestrial mobility implementation may be considered as an option. Indeed, its development is highly dependent on AWE co-operation to provide stored channel files with a channel delay profile (including rough Rice factor) of about every 5 m on a trajectory through a city and with the required post processing to reduce the number of paths to match SIMSTAR capability. SIMSTAR would then use these external files to produce the slow and very slow fading on each paths while the fast fading is generated internally with a power according to the mean power and Rice factor given in these files.

The SIMSTAR-1/MS is based on a modular concept. Basic modules are:

- Channel modules,
- DSP board and,
- Host PC.

The channel cards can emulate either forward link (FL) or return link (RL). In its full extension, the SIMSTAR-1/MS includes a total of six channel cards thus allowing emulating a maximum of three bi-directional satellite channels (Three FL channels and three RL channels). In the scope of MAESTRO, only the three FL cards will be used to respectively emulate satellite to UE, satellite to IMR and IMR to UE interfaces.

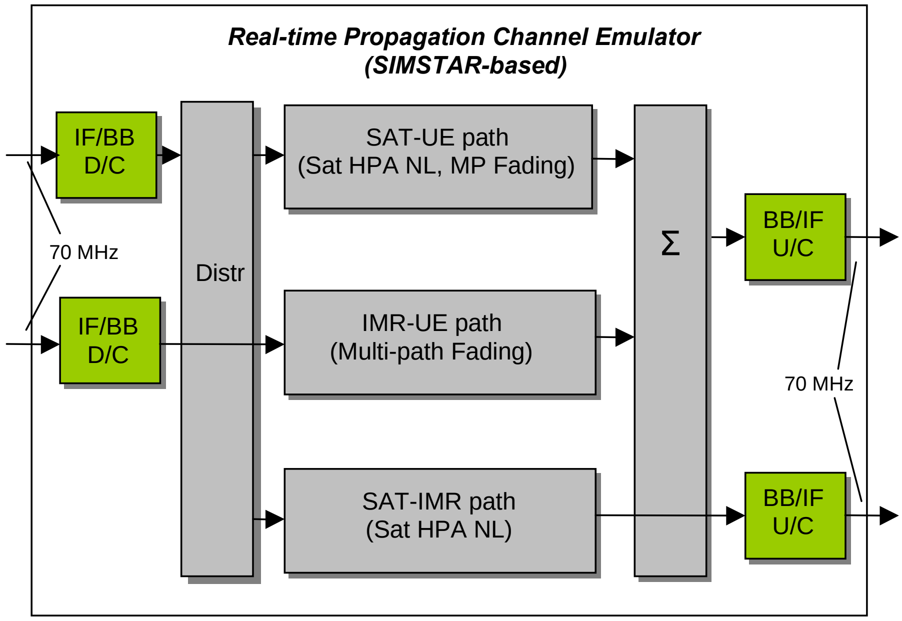


Figure 8 – SIMSTAR-1/MS block diagram

The channel modules perform all high speed digital processing required for functions directly involved in the signal path. They also perform analogue to digital and digital to analogue conversion. Parameters process generation (e.g. parameter interpolation, fading, shadowing) is performed by on the DSP board, which provides sufficient real time computing to supply parameters for up to 6 channel modules. The control interface is implemented on a standard host PC.

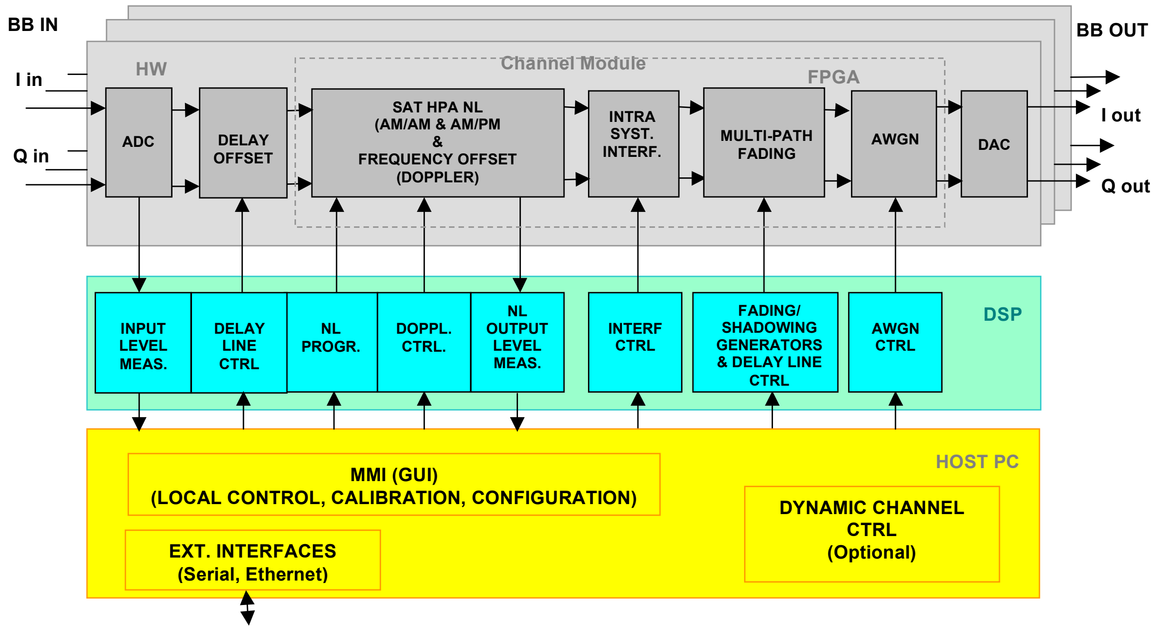


Figure 9 – SIMSTAR-1/MS functional architecture[1]

For more details, refer to document [RD8]: "Propagation Channel Emulator Design Document".

[1] SAT : Satellite, HPA : High Power Amplifier, NL : Non Linearity, MP : Multipath, BB/IF U/C : frequency converter

5.1.3.6 UE

The MAESTRO release 2 UE is built on a 3G commercial MSPS handset. It will support the following features:

- SDMB data reception (Release 1 feature)
- SDMB/GPRS dual mode support
- GPRS interactive link
- Extended rake receiver functions
- Network layer functions
- Transport layer functions
- Application layer functions
- Monitoring tools (Release 1 feature)

Considering that the interactive link does not involve any GPRS terrestrial network, the architecture of the UE for the laboratory test bed is a bit simpler than the one of the field test bed.

As for release 1, the UE is composed of two entities, namely a mobile terminal (MT) and a terminal equipment (TE). The MT is based out of a 3GPP compliant mobile terminal which has been modified so as to be able to receive SDMB broadcast data while processing basic signaling on the GPRS network. The MT hosts physical and access layers functionality of the UE, it also handles PDCP and SM. The TE is a laptop. It hosts network, transport and application layers functionality of the UE. The laptop receives the SDMB data from the mobile terminal to which it connects using a uni-lateral modem like interface. The laptop is also directly connected to the service centre so that security exchanges between the BM-SC and the UE (ciphering keys, authentication procedures…) can occur and so that selective retransmission can be implemented.

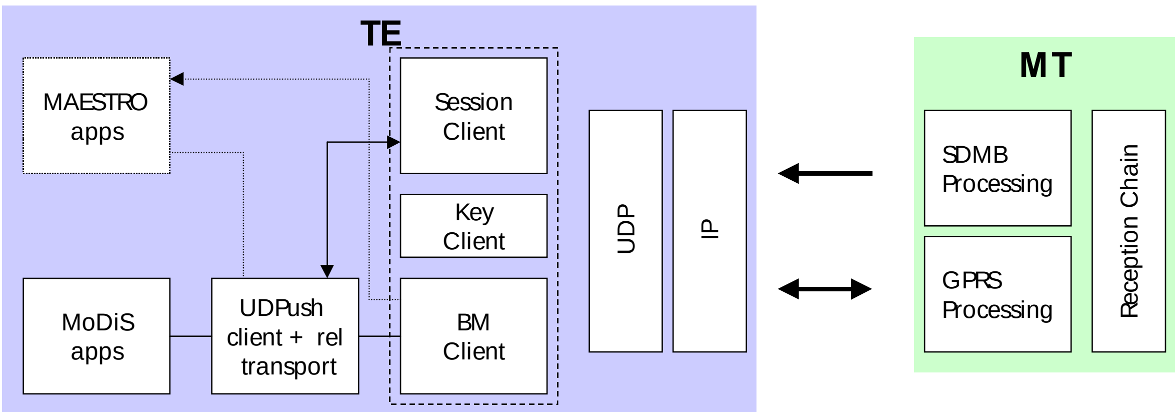


Figure 10 – UE architecture for the laboratory test bed

For more details, refer to D6-3-2 – “”UE SDMB specification document” and D7-2 – “UE high level design document”.

5.1.3.7 Terrestrial network

One of the goal of MAESTRO release 2 test bed is to prove the feasibility of the dual mode operation of the UE, which should allow SDMB content reception in parallel of basic signalling from GPRS/UMTS network processing.

However, no real terrestrial network will be used for the laboratory test bed. Instead the mobile terminal will be connected to a simple GPRS emulator. As a result, the laboratory test bed will allow to evaluate the performances of the reliable transport for different DRX periods and to eventually measure the impact of a relocation on those performances.

On an other hand, the interactive link between the UE and the service centre will not involve any terrestrial network but will be a direct link.

5.1.3.8 Central controller

All test bed equipment will be connected to a central controller PC through a LAN segment. That PC will also be connected to the internet via an ADSL connection so that any MAESTRO partner can remotely either check or set the configuration of any given equipment. A security protocol still remains to be defined in order to ensure that only one MAESTRO partner can launch a test at a time while multiple MAESTRO partners could access the test bed to provide debug support.

The RNC will be remotely controlled by the central PC via ssh with a command line interface.

Both the TE and the SIMSTAR will be remotely controlled by the central PC via VNC. VNC is a free software, thus it does not require any licenses to run. A VNC server is required to be installed on every PC whose screen we want to view remotely with a VNC client. As a result, a VNC server shall be installed on both the TE and the SIMSTAR while a VNC client shall be installed on the central PC. Given that we want to be able to access the central controller PC from the internet, a VNC server shall also be installed on the central controller PC.

Connections between the BM-SC and the central controller as well as connection between the UDPush and the central controller still remains to be studied.

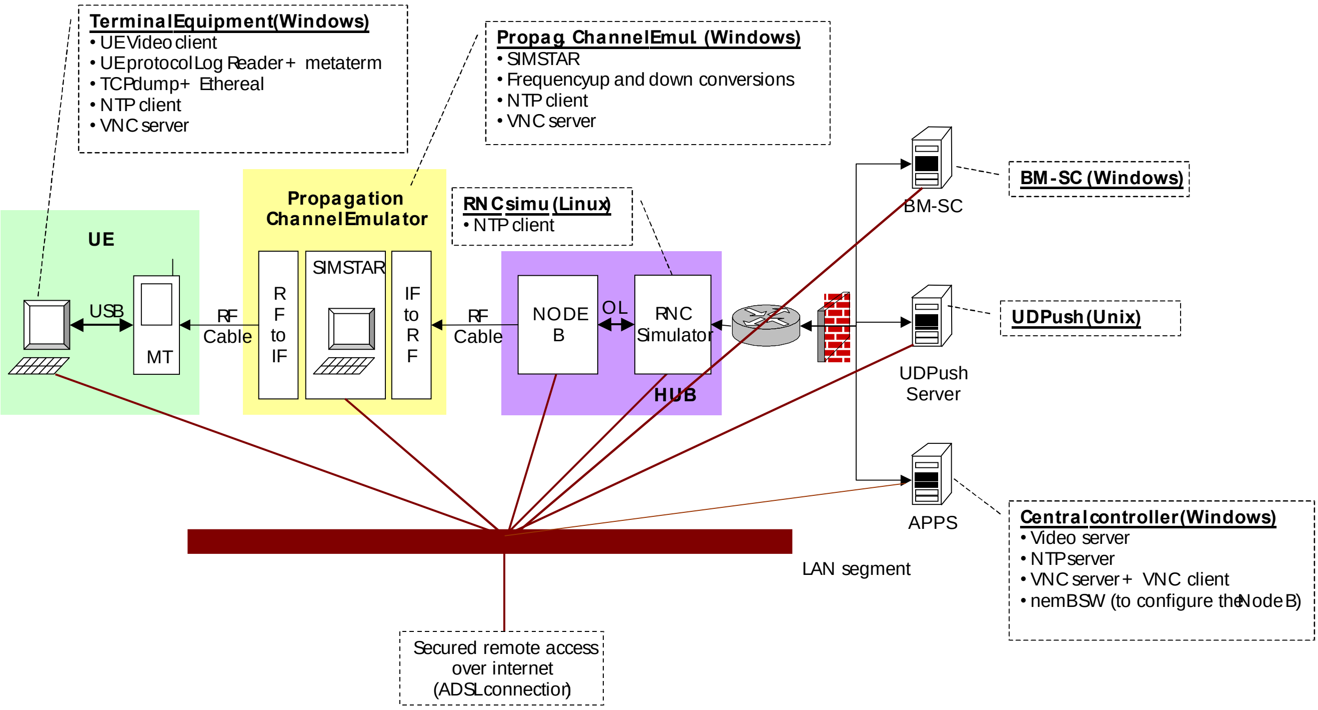


Figure 11 – Lab test central controller

The way the test bed will be controlled is still under investigation. The former figure shows the current status of the investigation. Updates and details on how the central PC will operate will be provided in a WP7 technical note & dumped into D8-1 in the end.

5.1.3.9 UE interfaces

The UE should be able to interface with both the SDMB system and the terrestrial GPRS network. The SDMB uses a 3GPP standardised UTRA FDD W-CDMA carrier while the GPRS networks uses a TDMA waveform.

5.1.3.10 SIMSTAR interfaces

Identical to release 1. Refer to D6-2-1b for more details.

5.1.3.11 BM-SC interfaces

The BM-SC should be able to interface with :

- the SDMB Hub,
- the UE (TE part)
- the Push server
- the streaming server.

5.1.3.11.1 Hub interface

The interface between the Hub and the BM-SC will support the Gmb* and Gi* interfaces specified bellow.

Gmb* Interface

The Gmb* interface provides the signalling plane interface to control establishment of broadcast bearers over the TB R2 system (whether in the propagation channel emulator in the laboratory test bed or the transmission equivalent in the field test bed). This includes the means to specify bearer-level QoS requirements.

The following procedures are used to control establishment of MBMS bearer contexts within the Hub:

- **Session Start** – i.e. a request to activate the necessary resources in the network for the transfer of IP multi-cast traffic and to notify UEs of imminent start of the transmission.

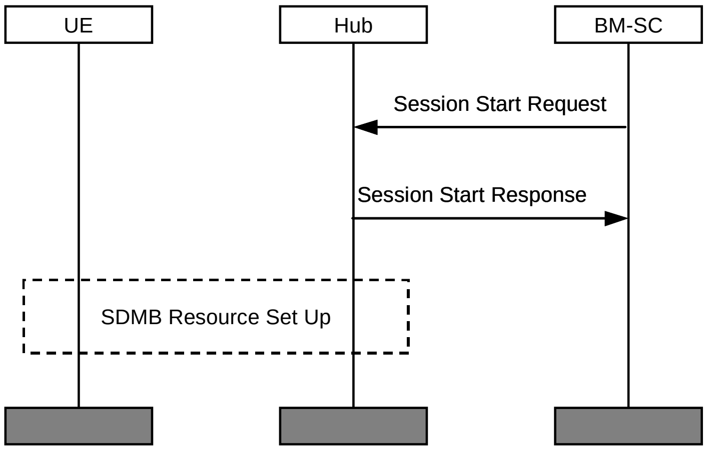


Figure 12 – Session start procedure

It is assumed that the Hub is not required to Register with the BM-SC prior to Session Start (i.e. the BM-SC is statically configured to always initiate sessions with the Hub if subscribers have requested to receive the service).

At Session Start the BM-SC needs to define the characteristics of the bearer context to be set up. These will include for example:

- Bearer identifier (e.g. TMGI as defined by 3GPP)
- IP multicast address
- Quality of Service parameters

- **Session Stop** – i.e. a request to release resources where there is no more IP multicast traffic expected for a sufficiently long period (or at end of service) to justify a release of user plane resources in the network.

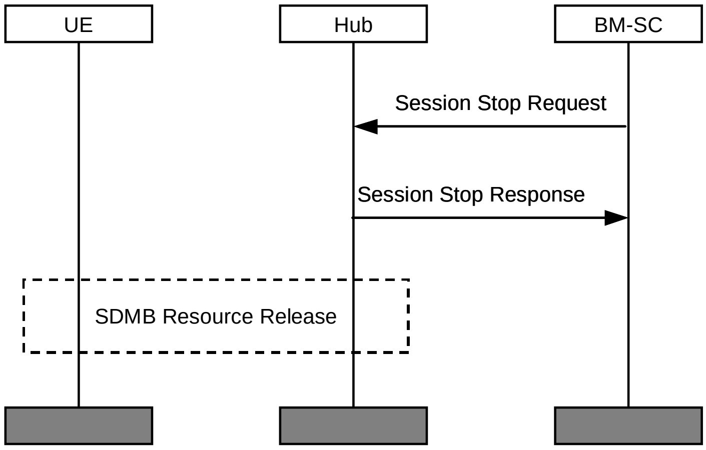


Figure 13 – Session stop procedure

Similarly It is assumed that the Hub is not required to De-Register with the BM-SC.

3GPP are currently proposing to use the IETF standard RADIUS protocol (RFC 3588). For the TB R2 it is proposed that a light-weight implementation of this protocol is used that implements sufficient functionality to meet the requirements of the test bed.

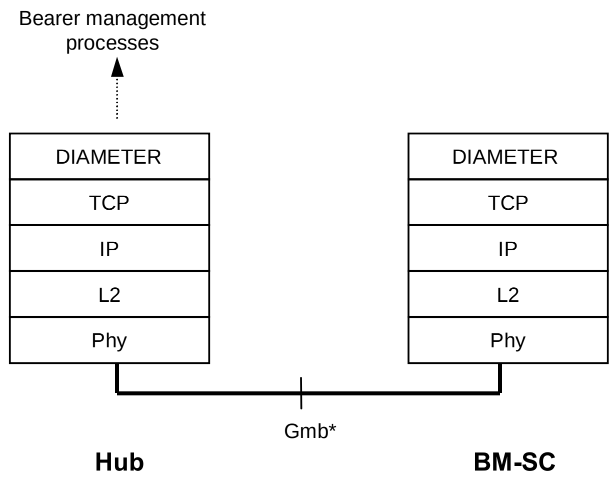


Figure 14– Gmb* bearer control signalling plane

Gi* Interface

The Gi* (user plane) interface is required to carry IP multicast traffic from the BM-SC to the Hub for transmission over the SDMB system.

In the TB R2, the following types of traffic may be transmitted over the Gi* user plane:

- **SDMB Services**: Data associated with each SDMB service (i.e. from the application servers) is delivered over the Gi interface with a unique IP multicast address.
- **SDMB Signalling**: some higher-layer signalling between the BM-SC and UE will also be supported over the Gi* user plane for transmission over the satellite including:
    - *Service Announcements*: To transmit the CDD data supplied by the UDPush server to inform the user about forthcoming services.

- *Service Rekeying*: To distribute updated traffic ciphering keys (multiplexed onto the same IP multicast stream carrying the SDMB service).

Once a SDMB bearer session is established for a particular multicast service, traffic can be injected into the Hub.

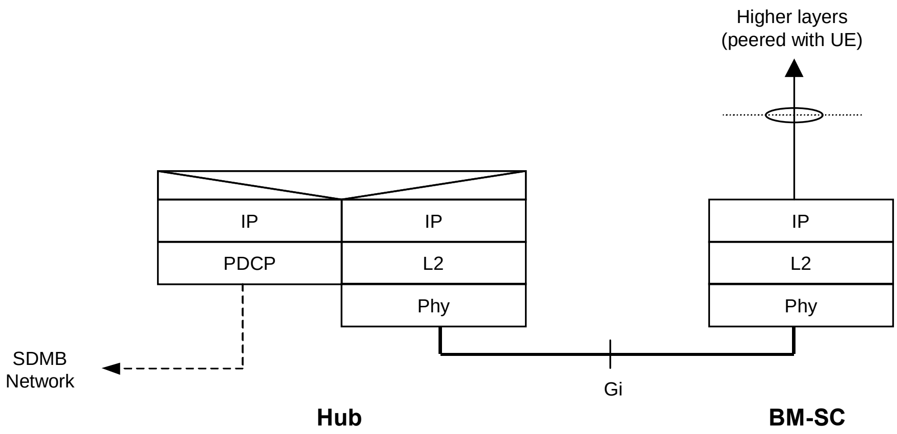


Figure 15 – Gi* User Plane

As a dedicated local connection will be used for the Test Bed, it is assumed that there is no requirement to support QoS control on the Gi* interface.

As the BM-SC and the RNC will be co-located in the laboratory test bed, it has been decided to use a dedicated local connection (Ethernet LAN) to connect them together. Both the Gmb* and Gi* interfaces will be supported over this Ethernet connection.

5.1.3.11.2 UE interface

The laptop of the UE will be connected to the BM-SC using a dedicated local connection of Ethernet LAN type.

5.1.3.11.3 UDPush interface

The interface between the UDPush Server and the BM-SC is required to transport CDD data that describe the SDMB services to be supported over the Test Bed. An XML based format will be used to transport the CDD data between the UDPush Server and the BM-SC.

5.1.3.11.4 Streaming server interface

The interface between the streaming server and the BM-SC will be a dedicated local area network (Ethernet LAN) connection.

5.1.4 Laboratory test bed scenarios

5.1.4.1 Streaming

The next two figures describe the streaming scenario respectively from the client side and the server side. This representation has been chosen in order to highlight the asynchronisme between the UE and the SDMB server.

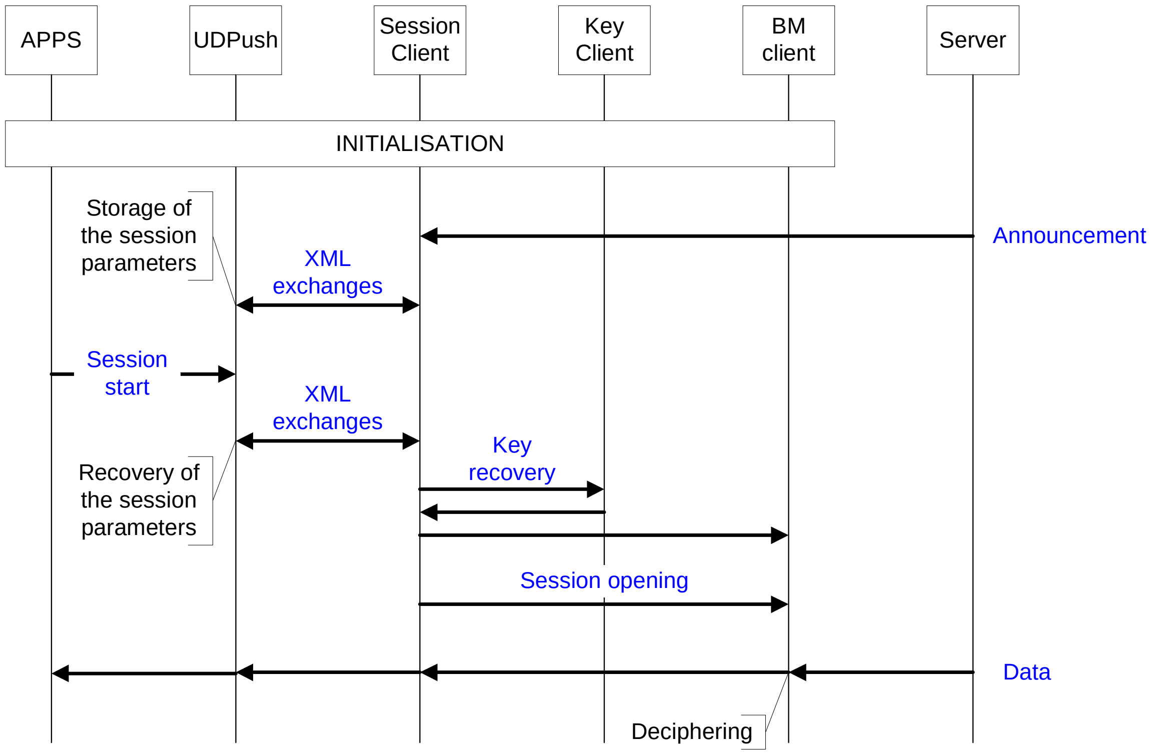


Figure 16 – Streaming scenario from the user perspective

Once the UE is attached to the SDMB network, it listens to incoming announcement messages sent by the server. Those are received by the session client which forwards the session parameters to the UDPush for them to be stored. When the end user request to stream data belonging to the "registered" session, the UDPush pass the session parameters back to the session client to request reception. The session client recover the decryption key and pass it to the BM client which is then able to receive and decipher the streamed content. Data are decoded by the UDPush and displayed on the terminal.

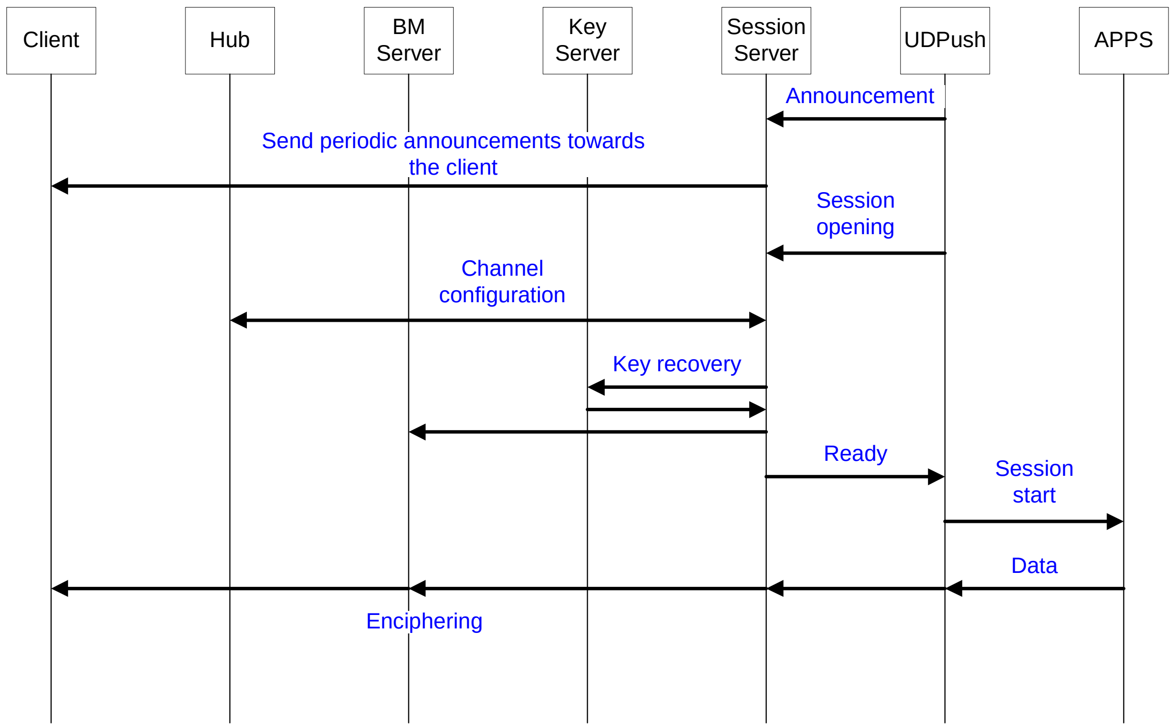


Figure 17 – Streaming scenario from the server perspective

1. The UDPush prepares the announcement information and exchanges it with the session server.
2. The session server translates the announcement information and transmits periodically the resulting packet on the "announcement channel" to the air interface.
3. The UDPush requests a session to the session server to be open.
4. The session server requests keys (for the new session) to the key server.
5. The key server provide the keys to the session server
6. The session server transfers enciphering information to the BM server.
7. The session server acknowledges the UDPush with the session opening.
8. The UDPush notifies the application that the system is now ready to broadcast data.
9. Data are transferred from the application to the UDPush where the are encoded; then they are forwarded to the BM server for encryption; finally the BM server transmit them to the client through the air interface

5.1.4.2 Hot download

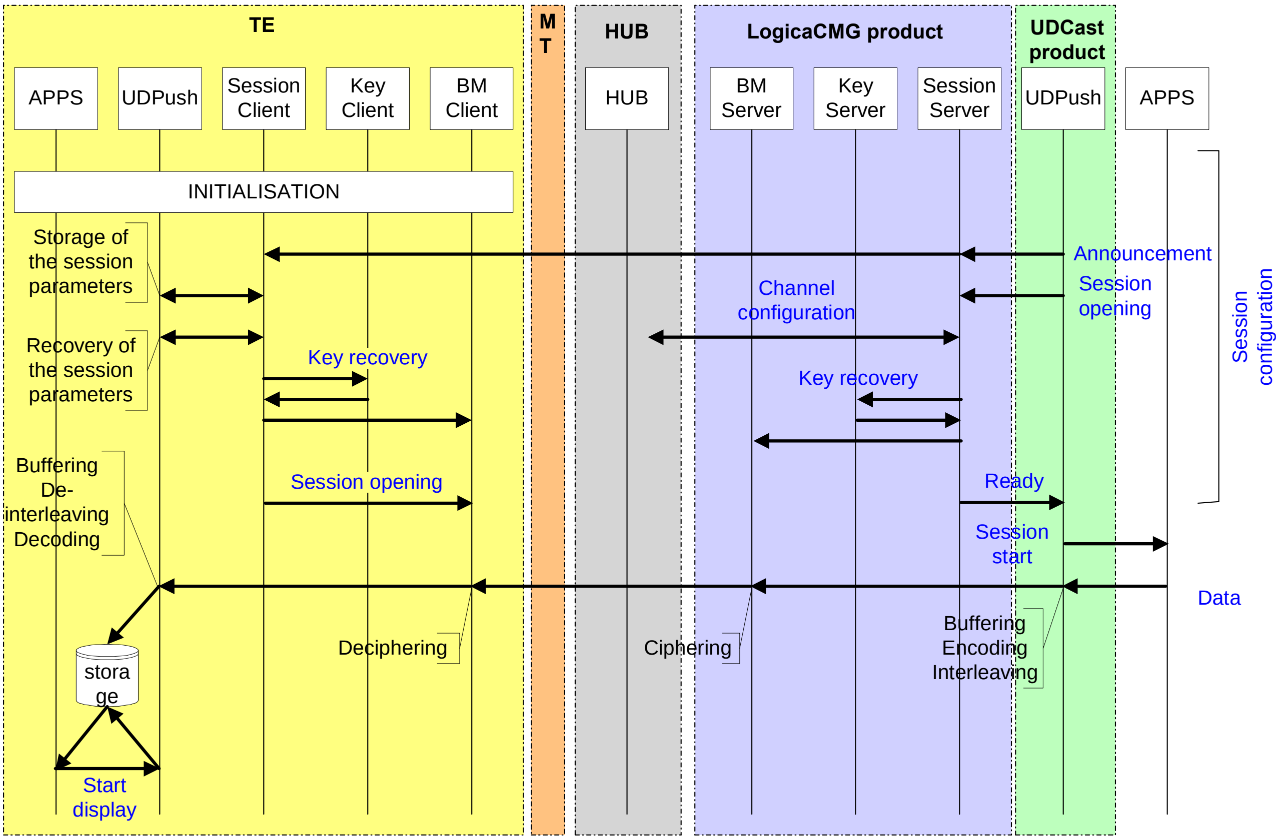


Figure 18 – Hot download scenario

1. The UDPush prepares the announcement information and exchanges it with the session server. The session server translates the announcement information and transmits periodically the resulting packet on the "announcement channel" to the air interface.
2. The SDMB modem already listening to that channel forwards data to session client. The session client exchanges data with the UDPush client. The UDPush server requests session opening to the session server.

3. The UDPush client requests session reception from the session client. The Session server configures the air interface (traffic channel).
4. The session client requests session keys for the advertised session and then configures the BM client with the decryption keys . The key server provides keys to the session server which configures the BM server encryption with the keys.
5. The Session server informs the UDPush server that everything is ready. The session client requests the SDMB modem to listen to the traffic channel.
6. The UDPush receives the "ready" message and "starts" the application.
7. Data are sent from the application server to the UDPush where they are buffered, encoded and interleaved prior to being sent to the BM server for encryption. The BM server ciphers the received data and broadcast them on the air interface. The BM client receives and deciphers the broadcast data and pass them on to the UDPush where they are buffered, de-interleaved and decoded. Finally data are stored locally on the terminal.
8. When the end user request the data to the UDPush, data are extracted from the local memory and displayed to the user.

5.1.4.3 Cold download (server-solicited retransmission)

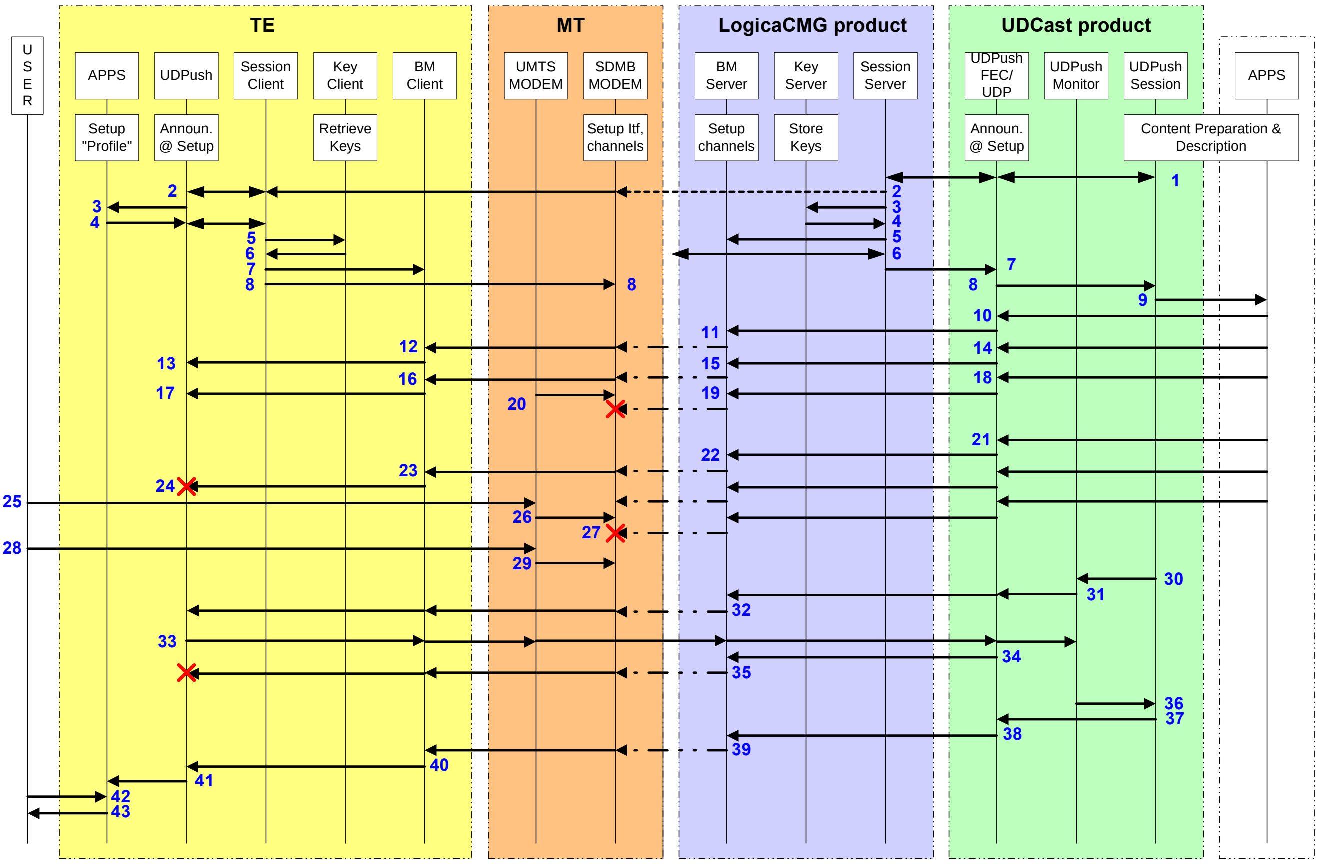


Figure 19 – Cold download scenario

1. The UDPush prepares the announcement information and exchanges it with the session server.
2. The session server translates the announcement information and transmits the resulting packet on the "announcement channel" to the air interface. The SDMB modem already listening to that channel forwards data to session client. The session client exchanges data with the UDPush.
3. The UDPush provides session information to the "profiling application". The session server requests keys (for the new session) to the key server.

4. The "profiling application" considers the advertised session as "relevant". It requests reception to the UD-Push. The UDPush requests session reception from the session client. The key server provides keys to the session server.
5. The session client requests session keys for the advertised session. The session server configures the BM server encryption with the keys.
6. The key client provides keys to the session client. The Session server configures the air interface (traffic channel).
7. The session client configures the BM client with the decryption keys. The Session server informs the UD-Push that everything is ready.
8. The session client requests the SDMB modem to listen to the traffic channel. The UDPush receives the "ready" message.
9. The UDPush "starts" the application.
10. Beginning of the 1st Carrousel : data are transmitted by application layer to the UDPush for encoding.
11. Encrypting of data at the BM server
12. .Decrypting of data at the BM client.
13. Data are decoded at the UDPush before being stored locally at the User terminal
14. Same as 10
15. Same as 11
16. Same as 12
17. Same as 13
18. Same as 10
19. Same as 15
20. The UMTS pre-empts the communication chain to serve DRA purposes, thus resulting in loss of SDMB packet. It is to be noted that this kind of losses will typically be handled by the UDPush FEC but this time we assumes it is not.
21. Beginning of the second carousel. Same as 10.
22. Same as 11
23. Same as 12
24. Data are decoded at the UDPush before being discarded because it has already been received in the first carousel.
25. The end user request to make a phone call.
26. Thus, the GPRS pre-empts the communication chain.
27. As a result, SDMB packets are lost again.
28. The end user terminates the phone call.
29. The GPRS reverts to IDLE mode and the SDMB reception can resume.
30. The UDPush session has finished its carousels. It requests monitoring (example is for active NACK mode).
31. The UDPush Monitor generates "challenge message" to request terminals to provide missing block information.
32. Message arrives at the UDPush client. It schedules a timer.
33. Timer elapsed : the UDPush client transmits NACK information using GPRS channel.
34. NACK information is automatically retransmitted on the satellite interface (to avoid feedback flooding).

35. The NACK received by the UDPush is trashed since it has already replied. For the sake of demonstration, we would need TWO UT.
36. Timer elapsed at UDPush monitor. It provides aggregated NACK information to the UDPush session server.
37. The UDpush session server prepares and transmits the missing blocks on the traffic channel. (we assume there are many receivers having requested the same content, else transmission is on the terrestrial GPRS path). Data are:
38. Encoded at the UDPush FEC
39. Encrypted by the BM server.
40. Decrypted by the BM client.
41. Decoded by the UDPush and stored locally. Now the terminal has achieved complete reception, so the retrieved file is transmitted to the application.
42. End user safely requests the contents. Since it is correctly stored, it begins to play the file instantaneously.

5.1.5 Laboratory trials

The goal of the laboratory test bed is to provide a platform to consolidate simulation results (WP02) and WP05 studies. Therefore, one of the key features of that platform is to allow reproducibility.

In that respect, the R2 adds on one hand the reliable transport to R1. The performance of the system will then be evaluated under the presence of a reliable transport layer, including FEC/interleaving, carrouseling and retransmission.

On the other hand, the R2 adds also network and security features that will be tested as well in laboratory.

5.2 Field test bed

The goal of the field test bed is to demonstrate the feasibility of the SDMB system using a terminal built on a commercial UE.

5.2.1 Field test bed description

The field platform differs from the real SDMB system described on Figure 1 in the following:

- The satellite and the transmission part of the Hub have been replaced by an equivalent transmitter located on a high altitude place, set in such a way that the received radio level at the terminal is about equivalent to what would be received from a satellite. For the trial, transmission will be performed in the terrestrial IMT2000 frequency band. Compared to the laboratory test bed, the propagation channel emulator has been completely removed from the picture, thus constituting the main difference between the two platforms. However, it may be interesting to evaluate the impact of including the SIMSTAR in the field test bed in order to measure satellite impairment degradations.
- The Hub is composed of a Node B and a RNC simulator featuring broadcast support and adapted to the MAESTRO application.
- The hub feeds the terrestrial repeaters directly. A maximum of 2 on-channel repeaters will be used in the MAESTRO field test bed.
- The MAESTRO terminal is composed of a modified 3GPP mobile terminal connected to a PC. The mobile implements physical and access layers functionality while the PC implements network, transport and application functions.

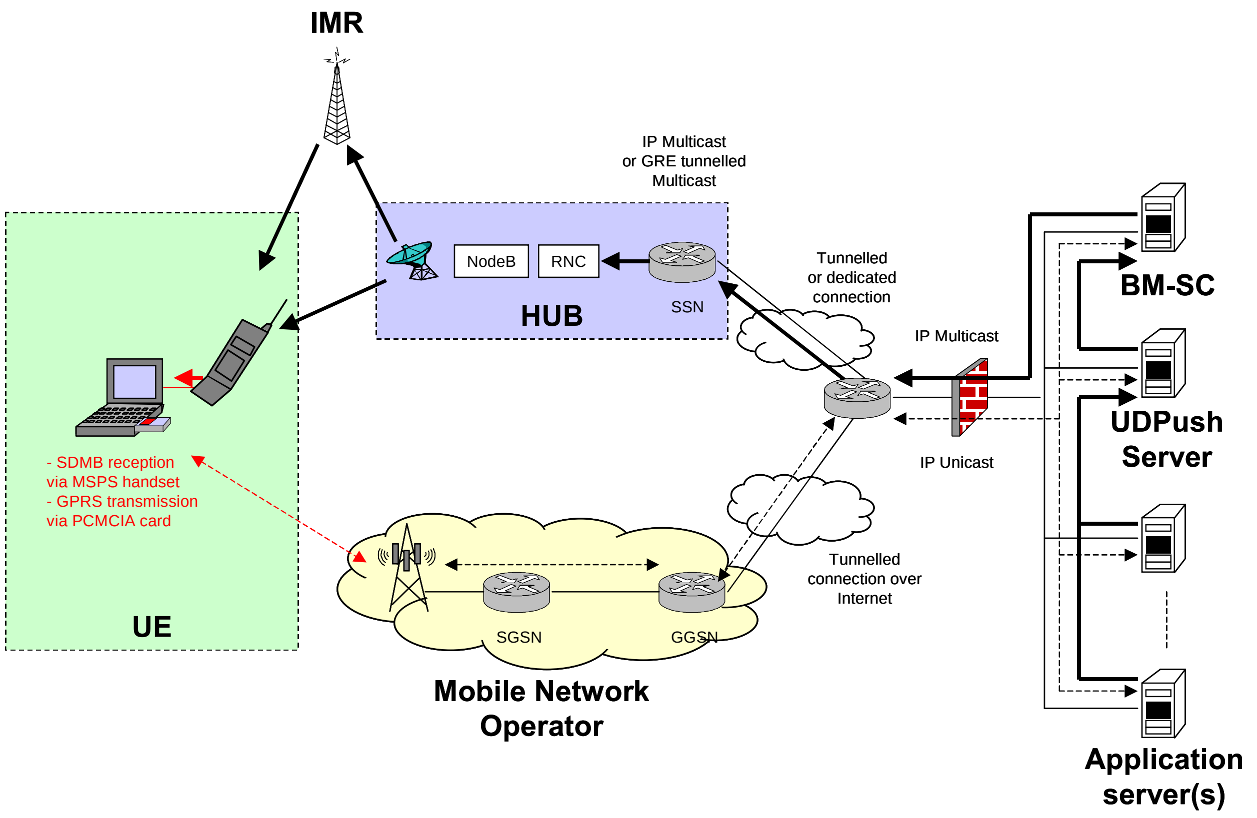


Figure 20 – Field test bed architecture

As depicted on

Figure 20, the Node B feeds an helix antenna which broadcasts the Node B output towards both the UE and the IMR. The IMR is essentially an amplifier. It is connected to a directional antenna oriented towards the UE. The link between the antenna and the UE is called the direct path while the link between the IMR and the UE is called the terrestrial path. One of the goal of the platform is to check recombination of signals issued on both direct and terrestrial paths at the UE.

5.2.2 Field test bed organs and interfaces

The following table lists the organs and logical interfaces at sub-system level and identifies where it is specified.

Characteristics of the organ or the logical I/F				Complementary information
Id	**Type**	**Ref**	**Title of the document**	
Application server	**Organ**	**D6-2-2b** **D6-6-2**	**MAESTRO release 2 test bed design document** **Service centre specification document**	
BM-SC	**Organ**	**D4-4** **D7-4**	**Network layer Specification** **BM-SC design document**	
UDPush server	**Organ**	**D5-1** **D5-2**	**Reliable transport requirements** **Reliable transport design document**	
Terrestrial repeater	**Organ**	**D6-2-2b**	**MAESTRO release 2 test bed design document**	**Included in this document**
Hub	**Organ**	**D6-5** **D7-3**	**SDMB Hub Specification** **SDMB Hub design document**	
UE	**Organ**	**D6-3** **D7-2**	**UE SDMB specification** **SDMB UE design document**	
Drive Test tool	**Organ**	**D7-12**	**Test facilities specification and design document**	
Central controller	**Organ**	**TN7**	**Technical note to be written in the scope of WP7 activities**	
Terrestrial network	**Organ**	**D6-2-2b**	**MAESTRO release 2 test bed design document**	**Included in that document**
UE interfaces	**Interface**	**D6-3** **D7-2**	**UE SDMB specification** **SDMB UE design document**	
BM-SC interfaces	**Interface**	**D4-4** **D7-4**	**Network layer Specification** **BM-SC design document**	

Table 2 – Field test bed organs and interfaces summary

5.2.3 Description of the organs and the logical interfaces

5.2.3.1 Application server

Identical to the release 2 laboratory test bed. Refer to chapter 5.1.3.1.

5.2.3.2 BM-SC

Identical to the release 2 laboratory test bed. Refer to chapter 5.1.3.2.

5.2.3.3 UDPush server

Identical to the release 2 laboratory test bed. Refer to chapter 5.1.3.3.

5.2.3.4 Hub

Identical to the release 2 laboratory test bed. Refer to chapter 5.1.3.4.

5.2.3.5 Space segment

For the MAESTRO test bed , the space segment is only emulated by an antenna directly connected to the Hub. A helix antenna of 5 to 7 dB gain (maximum input power: 150 W) will be used to achieve circular polarisation.

The characteristics of the helix antenna are:

- Size : 15cm (high) x 30cm (long)
- Horizontal beamwidth : ~100°
- Gain : 5dBi

This is identical to what was implemented in release 1.

5.2.3.6 Terrestrial repeaters

In the course of the MAESTRO project, several IMR implementations are to be studied (see D6-4). However the MAESTRO test bed will only consider a transparent on-channel repeater.

An off-the-shelf Andrew Node M product will be used. Its characteristics are:

- Downlink frequency : 2110- 2170 MHz
- Maximum downlink output power : 43 dBm at 1 carrier / 38 dBm at 3 carriers
- Minimum downlink input power at full output power : -60 dBm per 1 carrier / -65 dBm per 3 carriers
- Maximum input power without damage : +10 dBm
- Minimum antenna isolation for maximum gain : 83 dB
- Delays : < 8 μs
- Gain adjustment range : 53 to 103 dB. The Node M can be configured to operate either at fixed output power or at fixed gain.
- Return loss : 15 dB typical
- Adjacent channel leakage : -45 dBc (first adjacent channel), -50 dBc (second adjacent channel)
- Out of band rejection : -70 dB in 200 kHz

5.2.3.7 UE

The MAESTRO release 2 UE is built on a 3G commercial MSPS handset. It will support the following features:

- SDMB data reception (Release 1 feature)
- SDMB/GPRS dual mode support
- GPRS interactive link
- Extended rake receiver functions
- Network layer functions
- Transport layer functions
- Application layer functions
- Monitoring tools (Release 1 feature)

The UE is composed of three entities, namely a SDMB mobile terminal, a GPRS mobile terminal and a terminal equipment. As for the previous architecture, the SDMB MT is based out of a 3GPP compliant mobile terminal which has been modified so as to be able to receive SDMB broadcast data while processing basic signaling on the GPRS network. The GPRS MT is a commercial GRPS mobile phone; it is used to implement the point to point connection between the UE and the service centre. The TE is a laptop. It connects to both the SDMB and the GPRS MT using modem like interfaces. The link between the TE and the SDMB MT is uni-directional, while the one between the TE and the GPRS MT is bi-directional. A GRPS manager software is used to control data transfer between the two MT.

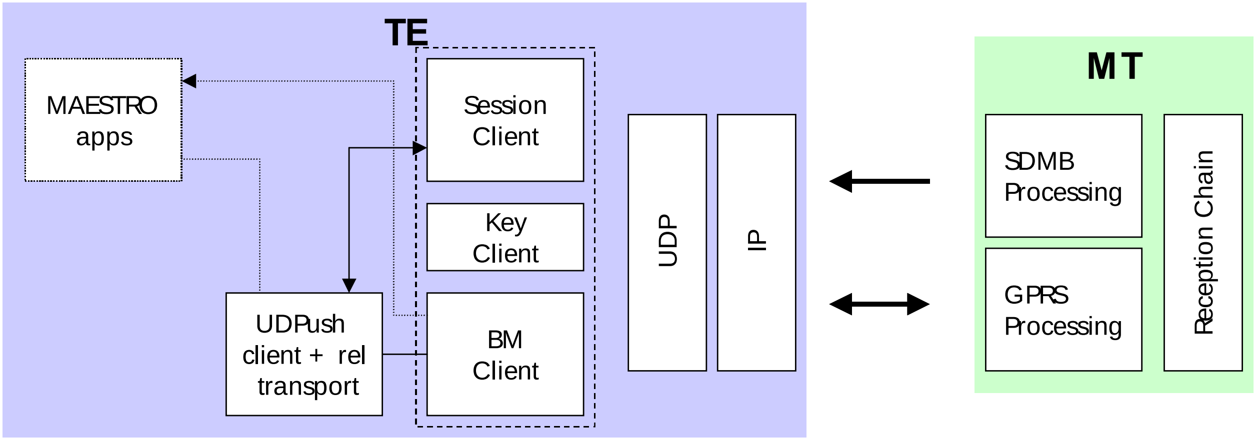


Figure 21 – UE architecture Option B

For more details, refer to D6-3-2 – “”UE SDMB specification document” and D7-2 – “UE high level design document”.

5.2.3.8 Drive test tool

The test bed integration will be eased due to the fact that we plan on using a drive test tool developed by Agilent.

There are three types of measurements that can be performed with the drive test tool:

- RF coverage: RF power estimation is based on AGC measurement.
- Inner-modem BER: BER is a measure of data integrity, expressed as the ratio of received bits that are in error, relative to the amount of bits received. It is often expressed as a negative power of ten. The inner-modem BER measurement is based on pilot data bits demodulated in the chip rate processing part (=inner-modem) of the data path. Offline recalculation is needed to translate between pilot data BER and user data BER at different data rates.
- RAKE internal status: For the 8 RAKE fingers, the following information will be measured and logged: finger position (taps), finger energy (dB) and finger status (searching, recombining, refining or idle).

For more details, refer to D7-12.1.

5.2.3.9 Terrestrial network

The field test bed will interact with an existing UMTS network operated by Bouygues Telecom. This latter will be used to test that the terminal can receive SDMB content while performing basic signalling processing on the UMTS network.

5.2.3.10 Central controller

As for the lab test bed, a central PC will be used to control the test bed. Details on how the central PC will operate will be provided in a WP7 technical note.

5.2.3.11 UE interfaces

Identical to the release 2 laboratory test bed. Refer to chapter 5.1.3.8.

5.2.3.12 Terrestrial repeater interface

The Hub – IMR interface uses a 3GPP standardised UTRA FDD W-CDMA carrier.

The on-channel repeater is actually connected to an antenna which is directly fed by the Hub emulator.

Initially this receiver antenna were foreseen to be a parabolic antenna. However, the minimum size of a parabolic antenna is about 4 times the wavelength, i.e. 60 cm at 2GHz. Alternative solutions are still being investigated:

- Horn antenna:
  - Dimensions (HxWxD) : 25x35x25 cm
  - Gain: about 12 to 13 dB in S-band
  - Linear polarisation (thus a 3dB loss must be considered when doing the link budget because the satellite emulator will operate with circular polarisation).

- Patch antenna:
  - Dimensions (HxWxD): 25x25x10 cm
  - Gain: 14dB
  - Beamwidth: 40°
  - Circular polarisation

- Panel antenna based on a commercial equipment
  - To be further studied

5.2.3.13 BM-SC interfaces

5.2.3.13.1 BM-SC / Hub interface

The logical interfaces (i.e. Gmb* and Gi*) supported over this interface are the same as in the laboratory test bed.

The physical interface between the BM-SC and the Hub remains to be finalised for the field test bed. Even though the RNC simulator and the BM-SC will most probably be remote, we still would like to use a dedicated local connection between the two (using BYTL network infrastructure). If this turn out not to be possible, then a tunnelled connection over the Internet could be used although this will impact on the QoS that can be provided over the BM-SC - Hub interface (i.e. no guaranteed QoS is possible). An alternative would be to use a leased line between the two - this would remove the QoS issue but obviously has a cost implication.

5.2.3.13.2 BM-SC / UE interface

On the opposite of what was done for the laboratory test bed, the BM-SC connects to the UE via the terrestrial 2G network.

One option could be to use a direct transparent access via the Internet with routing across the Internet to the 'MAESTRO' domain. This option was proposed because it seems to be the simplest to implement since it doesn't require any specific security mechanisms between GGSN and the MAESTRO domain. The UE would simply request service to a pre-defined Access Point Name (APN) which would select the correct GGSN to be used.

The IP address of the UE may be allocated statically or dynamically, dictated by operator policy. For connection across the Internet, the IP address would need to be allocated in the MNO address space. This will either be a public or private address (private address would be NAT translated at the GGSN). Note that NAT (and firewall) behaviour at the GGSN needs to be considered to ensure that all our traffic is routed correctly.

An agreement is still to be found with BYTL to finalise the details of the interface.

5.2.3.13.3 Other BM-SC interfaces

The other interfaces of the BM-SC (UDPush and streaming server) are identical to the ones of the laboratory test bed. Refer to the appropriate section for more details.

5.2.4 Field test bed scenarios

Identical to the laboratory test bed scenarios. Refer to section 5.1.4.

5.2.5 Field trials

The field test bed aims at providing a platform to demonstrate the feasibility of the SDMB system.

The trials objectives are to assess the overall quality of the SDMB reception on the handset terminal and the drive test tool for both indoor and outdoor environments.

In that respect, the R2 adds mainly the reliable transport to R1. The performance of the system will then be evaluated under the presence of a reliable transport layer, including FEC/interleaving, carrouseling and re-transmission.

6 DOCUMENTARY REFERENCE SYSTEM

6.1 Applicable documents

#	Reference	Title
[AD1]	MAESTRO Annex 1	Description of Work
[AD2]	D6-1.2b	SDMB system technical requirements (for test-bed R2)
[AD3]	D6-2.1b	MAESTRO Release 1 test bed design document

Table 3 – Application document table

6.2 Applicable norms and standards

#	Reference	Title
[AN1]	TS 25.	All 3GPP specifications serie TS25

Table 4 – Applicable norms

6.3 Reference documents

#	Reference	Title
[RD1]	D2-1.2	SDMB Physical Layer Specifications (Release 2)
[RD2]	D3-1.2	SDMB Access Layer Definition (Release 2)
[RD3]	D6-3.2	UE SDMB specification document (Release 2)
[RD4]	D6-5.2	SDMB HUB specification document (Release 2)
[RD5]	D7-1.2	Release 2 test bed integration plan
[RD6]	D7-2.2	UE high level design document (Release 2)
[RD7]	D7-3.2	Hub design document (Release 2)
[RD8]	D7-6.2	Propagation channel emulator design document
[RD9]	D7-12.2	Test facilities specifications and design document
[RD10]	D7-13.2	Release 2 test facilities integration report
[RD11]	D7-14.2	Release 2 test bed integration report
[RD12]	D4-4	Network layer requirements and specifications for the test bed.
[RD13]	D7-4	BM-SC design document
[RD14]	D5-1	Reliable transport technical requirements document
[RD15]	D5-2	Reliable transport design document
[RD16]	D6-6-2	Service centre specifications document

Table 5 – Reference documents table

APPENDIX A - LINK BUDGET

Lab test bed

The figure below show how all the test bed equipment will be connected together.

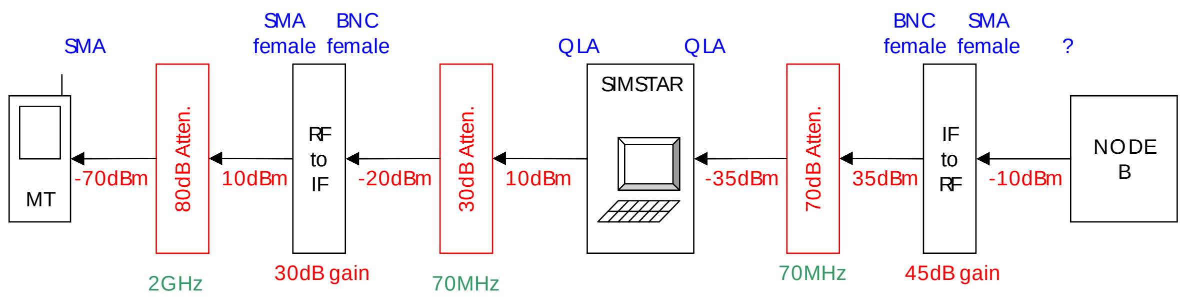


Figure 22 – Gain level study of the lab test bed

Field test bed

The table below aims at providing indications as per how the link budget will be computed for the field test bed.

		Unit	Description
Hub	Node B output power	dBm	The output power of the Node B is set by the test bed user. Its level will be defined in accordance with BYTL so as to insure good SDMB performances without perturbing any 2G and/or 3G networks. It is believed that the power at the output of the Node B shall not exceed 30 dBm
	Cable loss	dB	Lc
	Helix antenna gain	dB	5
IMR1	Distance between the satellite emulator and the IMR1	km	D
	Receiver antenna gain	dB	G_A
	Repeater gain	dB	G As for the level at the output of the Node B, the repeater gain will be set in accordance with BYTL so as to insure good SDMB performances without perturbing any terrestrial networks.
	Propagation losses	dB	LOSS=100+20log(D)
	Expected Rx power level	dBm	$P_{RX}=P_{NODE\ B} - Lc + 5 - LOSS + G_A$
	Expected TX power level	dBm	$P_{TX}=P_{RX}+G$ It is believed that the power at the output of the repeater shall not exceed 30 dBm

	Measured Rx power level	dBm	The measured RX power level shall be comparable to the expected level.
	Measured TX power level	dBm	The measured TX power level shall be comparable to the expected level.
IMR2	Distance between the satellite emulator and the IMR2	km	D
	Receiver antenna gain	dB	G_A
	Repeater gain	dB	G. As for the level at the output of the Node B, the repeater gain will be set in accordance with BYTL so as to insure good SDMB performances without perturbing any terrestrial networks.
	Propagation losses	dB	LOSS=100+20log(D)
	Expected Rx power level	dBm	$P_{RX}=P_{NODE\ B} - Lc + 5 - LOSS + G_A$
	Expected TX power level	dBm	$P_{TX}=P_{RX} + G$ It is believed that the power at the output of the repeater shall not exceed 30 dBm.
	Measured Rx power level	dBm	The measured RX power level shall be comparable to the expected level.
	Measured TX power level	dBm	The measured TX power level shall be comparable to the expected level.

Table 6 – Budget link for the field test bed

APPENDIX B - FIELD TEST BED INSTALLATION

The field test bed will be located in the south-west of Paris, France. The field trials will be conducted in close co-operation with Bouygues Telecom, who will also provide the necessary temporary UMTS frequency.

The test bed requires the use of three sites, one for the satellite emulator and two for the on-channel repeaters. The sites must be chosen to comply with the following requirements:

- The satellite emulator must be placed high enough to ensure an elevation angle of at least 8° everywhere in the coverage area of the test bed. The elevation angle is referred to as β in Figure 23.
- The repeaters must be between 1 and 4 km away from the satellite emulator.
- The angle between the repeaters and the satellite emulator (referred to as α in Figure 23) shall be in the range of 30° to 90°. This is because the helix antenna used to model the satellite emulator has an horizontal beamwidth of about 100°.

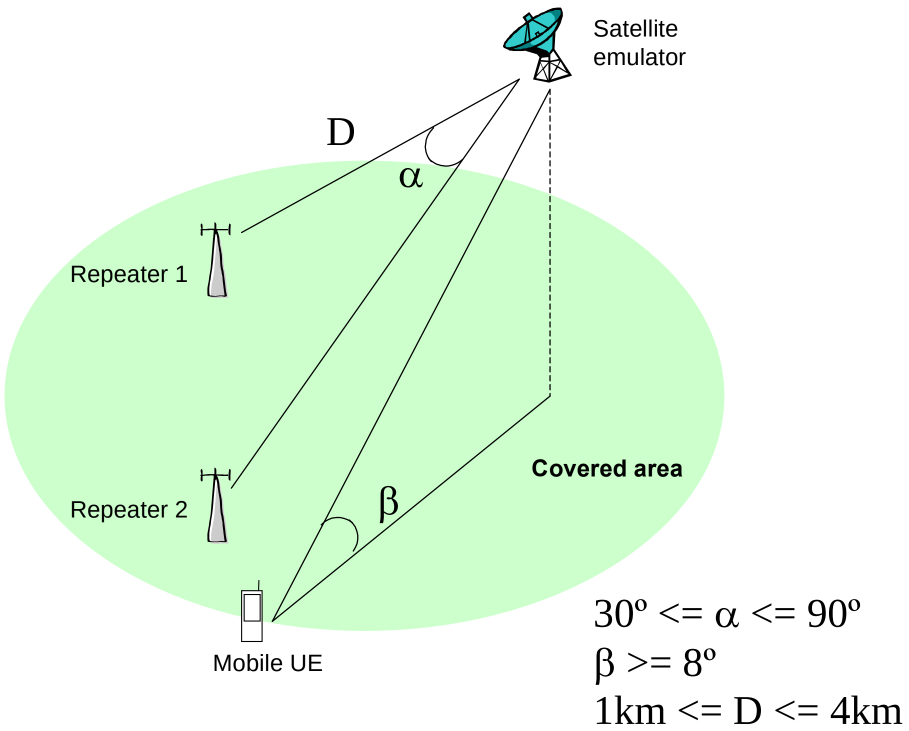


Figure 23 – Configuration of the field trial site