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MOBISERVE

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1 INTEGRATION & SERVICE PROTOTYPING

1.1 Prototyping Overview

1.1.1 Goal

The goal of this prototyping activity is to provide a complete DVB-H Rich Media service system, for demonstrations before the end of 2006, by integrating all available technologies and equipments from all contributing partners. This DVB-H prototype is used to demonstrate what DVB-H is capable of, to the Chinese market who is now influenced rather by competing technologies, and who is developing a domestic Mobile TV standard at the same time.

Since all contribution is from currently available technologies and equipments, it is well understood that these contribution are ready or running at the contributing partners. The spirit of T5.1 integration is to put different inputs from different partners together and to make them work with each other. No development work is engaged. These inputs include equipments, software and audiovisual/data contents.

1.1.2 Targeted Demonstration and Contribution

This section describes the targeted demonstration from the service point of view, as well as the expected contribution from partners.

The services to be demonstrated are sports oriented TV contents presented in the form of Rich Media, with ESG for service navigation. Signal is transmitted through both DVB-H and WIFI.

- Sports Oriented Content (CITVC)

Sports oriented service is a significant topic through MobiServe project, strengthened by the 2008 Olympic trial, the project final achievement. As a result, sports is emphasized from the very beginning, since the first demo at the end of 2006.

CITVC has provided to the first demo several TV programs, including popular sports (swimming, badminton, etc.) and entertainment, with each program varying from 15 min to 40 min. The programs are simulated as TV channels during demonstration.

THC takes the responsibility to transcode the original content to desired H.264 format.

FTB media streaming server is used to stream these content for demonstration.

– Rich Media service – STZ

STZ provides Rich Media solution to provide user interface and content presentation for integration and demonstration. This Rich Media solution is linked with ESG data.

– Electronic Service Guide – THC

THC provides their SmartVision Mobility system to produce ESG data and service to the demonstration.

A local static ESG approach is chosen for this prototyping. ESG data is edited using SmartVision Mobility system and pre-downloaded to demonstration terminals, which will rely on local ESG information for user service navigation.

- Signal Transmission and Reception – FTB, NXP, THC

Services are transmitted through both DVB-H network and WIFI network. Services on these two networks can be synchronized or customized/different.

FTB provides the complete DVB-H transmission system, from IP encapsulation until signal transmission.

NXP is in changed for DVB-H reception module. This module can be used directly with PDA through SDIO interface.

THC provides WIFI terminal with service interpretation and presentation.

The prototyping system contains 7 functional subsystems. Table 1 gives the list of all subsystems and their correspondent contributor(s).

Table 1 Subsystems and Contributors

Subsystem	**Contributor(s)**
Audiovisual source	CITVC, FTB, THC
SmartVision ESG	THC
Rich Media service platform	STZ
DVB-H transport subsystem	FTB
WIFI platform	FTB, THC
DVB-H terminal	FTB, NXP, STZ, THC
WIFI terminal	THC

1.1.3 Service Prototyping System Architecture

This section describes the entire prototyping system architecture from a logical point of view.

The prototyping system architecture is centered around the DVB-H transport subsystem. Together with DVB-H transmission is the WIFI network that can transport differentiated content to WIFI (local) terminals. Main services of the prototyping – audiovisual contents come from A/V sources subsystem and go into DVB-H or WIFI network according to the nature of the content and service needs, so that DVB-H and WIFI terminals can have different services in addition to common contents available on both networks.

The ESG subsystem provides static service guide information to all terminals. The rich media subsystem, with information from the ESG subsystem, sends rich media data to transport networks together with audiovisual contents to enhance user experience.

Figure 1 is the integration architecture which illustrates all 7 subsystems and their interfaces.

Following sections give in more details description of each subsystem.

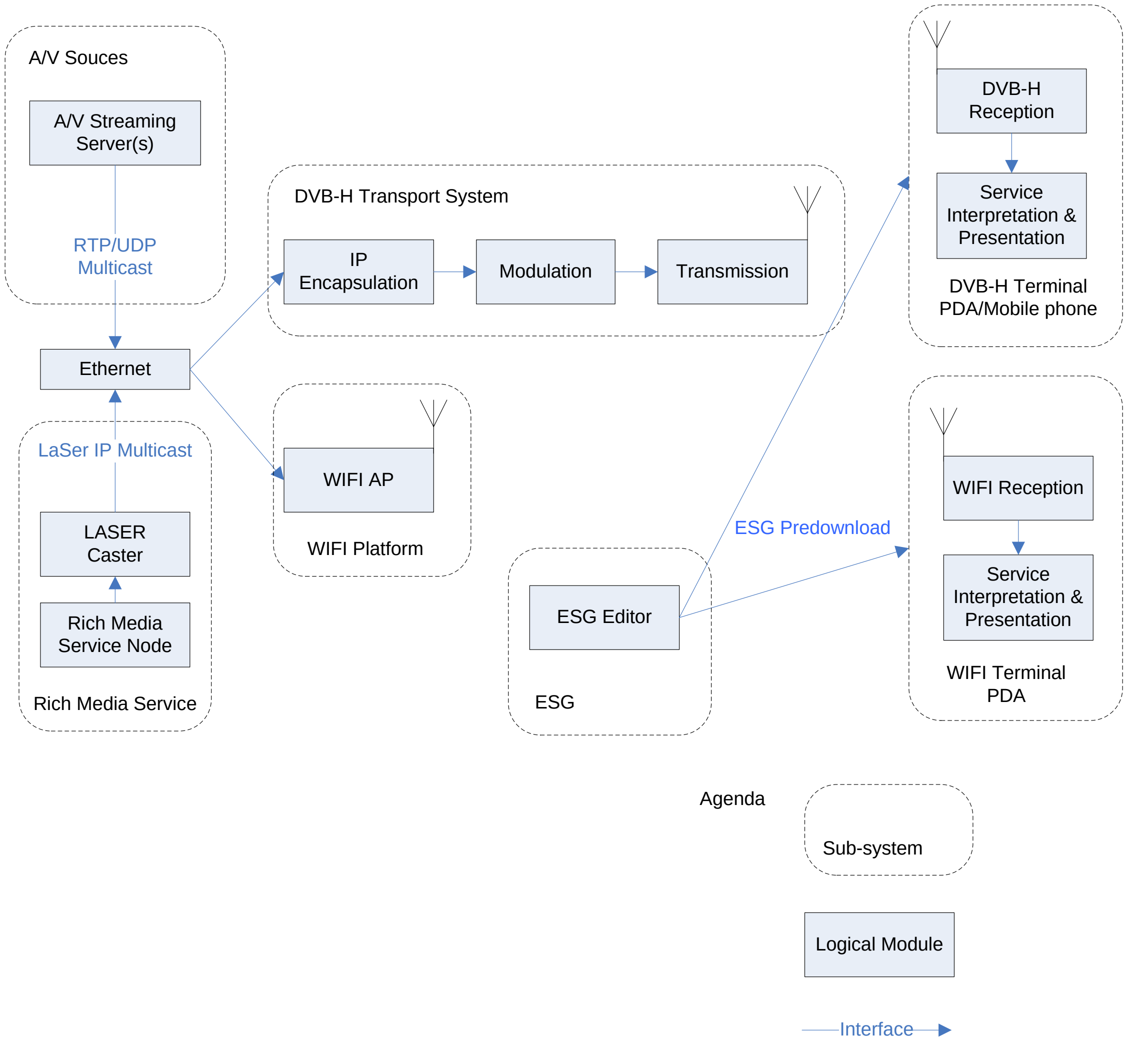

Figure 1 Integration Architecture

1.2 DVB-H Platform with ESG

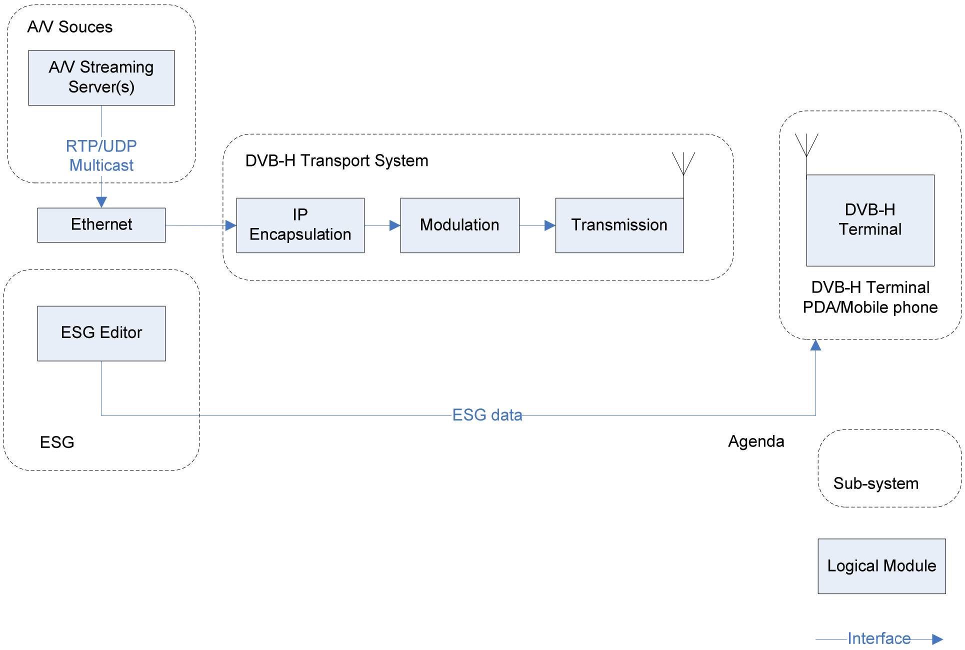

Figure 2 DVB-H Platform with ESG

This section describes the basic DVB-H TV service and the underlying system that it relies on. The basic service addressed here contains TV programs and ESG.

TV programs stored locally in the A/V Sources subsystem are streamed into the DVB-H transport subsystem to be channel coded, modulated and transmitted as DVB-H air signals. They are then received by DVB-H terminal and displayer to the user.

The DVB-H transport subsystem is in charge of the content transmission. It is composed of

- IP encapsulator. It receives IP flow and encapsulates IP packets into Mpeg2 TS.
- Modulator. It realizes the DVB-H modulation.
- Transmitter. It sends the modulated DVB-H signal to the air.

Detailed parameters can be found in 1.2.2.

A local static ESG approach is chosen for this prototyping. ESG data is generated in the ESG subsystem and pre-loaded into the terminal.

1.2.1 A/V Sources

The Audiovisual Sources Subsystem is based on a streaming server that streams out local A/V contents via RTP/UDP multicast to feed the DVB-H Transport Subsystem.

Local contents in this subsystem are TV programs provided by CITVC. 6 different programs are available all commended in Chinese: badminton match, Chinese basketball match, swimming match, F1, NBA match and entertainment. The length of each program varies from 15 min to 40 min.

The table below shows the encoding parameters of these contents.

Table 2 Content Encoding Parameters

Video codec	H.264
Video bit rate	150 kbps (vbr)
Video frame rate	12.5 fps
Audio codec	AAC
Audio bit rate	64 kbps

The local contents are streamed in circle to simulate 6 TV channels.

1.2.2 DVB-H Transport System

A classical DVB-H system is used for content transmission.

The input of this subsystem is an Ethernet interface. IPE (IP Encapsulator) receives TV channels transmitted in RTP flows, treat the IP packets and multiplexes all input channels by encapsulating them into TS (Transport Stream).

IPE realizes the functionalities of Time-Slicing and MPE-FEC. Table 3 gives the IPE configuration parameters.

Table 3 IPE configuration

Total Bit rate	11 Mbps
Time slicing period	1000 ms
FEC rows	512
FEC ratio	7/8

TS is then channel coded, modulated and sent to air. Table 4 shows the parameters of modulation and transmission.

Table 4 Modulation Transmission Parameters

Frequency	794 MHz
Bandwidth	8 MHz
Constellation	16QAM
FFT mode	8K
Guard interval	1/4
Inner code rate	3/4

1.2.3 ESG System

The ESG subsystem is based on Thomson SmartVision Mobility system.

ESG information available in this prototyping includes channel logo & name, with one day’s program list for each channel. ESG data also contains SDP files for each flow (channel).

ESG data is edited within this subsystem and loaded into DVB-H terminal by updating its database and data files.

1.2.4 DVB-H terminal

Terminal used to demonstrate basic DVB-H service with ESG is PDA with DVB-H receiver. It is also equipped with ESG interpreter and A/V player.

The terminal is explained in detail in the section 1.6.

1.3 WiFi System associated with DVB-H Platform

The WiFi system is illustrated as Figure 3. As associated with DVB-H platform, both WiFi and DVB-H share the same A/V sources and ESG data.

On one hand, video and data packets (rich media and ESG packets) are streamed out from their respective sources and in turn transmitted as WiFi signal into the air via the WiFi AP. On the other hand, the QoS server, including a FEC encoder and a QoS controller, generates and adaptively sends out the FEC redundant packets into the WiFi system. All packets, including video, data packets and FEC redundant packets, finally get to the WiFi terminals through the WiFi receiver. The QoS client module residing on the terminal thereafter plays the role to perform packet error correction based on the received video, data and redundant packets and then render the packets to application for further presenting and displaying.

It should be noted that in the current prototype system, QoS server and client part are still under developing and have not been integrated into the system. Therefore, the video and ESG can be displayed on the WiFi terminal but the quality cannot be guaranteed so far.

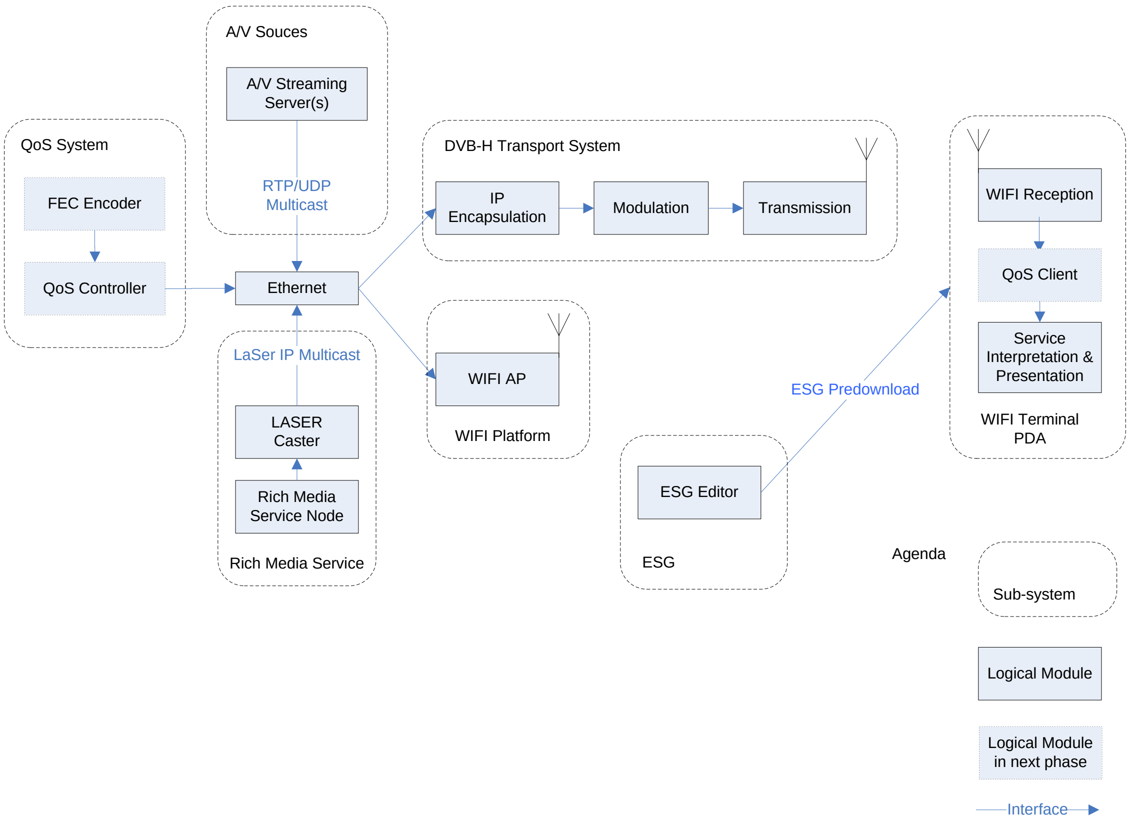

Figure 3 WiFi system associated with DVB-H platform

1.3.1 A/V source and ESG system

In the WiFi system, A/V contents may come from two sources. One is sharing with DVB-H and the other may be location dependent contents (or WiFi specific contents). The ESG subsystem can use the same platform as DVB-H does, see section 1.2.3. The ESG information is edited within this subsystem and loaded into WiFi terminal by updating its database and data files.

1.3.2 WiFi access point

Current WiFi system may use any off-the-shelf access point (AP) which is required to support IEEE 802.11b standard.

1.3.3 WiFi terminal

Terminal used to demonstrate basic WiFi service with ESG is PDA with WiFi receiver. The WiFi receiver supports IEEE 802.11b standard. The terminal is also equipped with ESG interpreter and A/V player.

Most of the functionalities and components, except the QoS client module and WiFi receiver, of the terminal are the same as DVB-H part which will be explained in more detail in the section 1.6.

1.3.4 QoS server and client

QoS server and QoS client are the counter-part that work together in order to perform packet error correction and help improving the video quality on the WiFi terminals.

The QoS server includes a FEC encoder and a QoS controller. The FEC encoder is responsible for on-line overhearing the video packets from the network and generating the corresponding FEC redundant packets. The generated FEC redundant packets are then fed to the QoS controller. The QoS controller is responsible for determining how many FEC redundant packets, based on the feedback information from the WiFi system, should be sent out to the WiFi system so as to offer video QoS for terminals while keep utilizing the wireless channel efficiently.

A QoS client module residing on the WiFi terminal is responsible for receiving the FEC redundant packets and sending feedback to the QoS server. The QoS client module is also in charge of the packet error correction with the received video and FEC redundant packets. All the correctly received and recovered video packets are then delivered (by the QoS client) to the application for further presenting and displaying.

Noted that the QoS server and client are still under developing now and will be integrated into the entire system in the future.

1.4 DVB-H Field Network

The DVB-H field network is built separately during the prototyping activities and is prepared for the next step integration.

Beijing mobile TV network, which adopts single frequency network structure, provides mobile TV service for users in Beijing district. Now the signal covers about 4800 square kilometers，which center is Beijing city.

The head end system of Beijing mobile TV network adopts the mixed multiplex construction (Fig.4), which can transmits DVB-T and DVB-H transport stream, so the users of mobile handsets and passengers in buses, taxis or subways can enjoy the mobile TV service

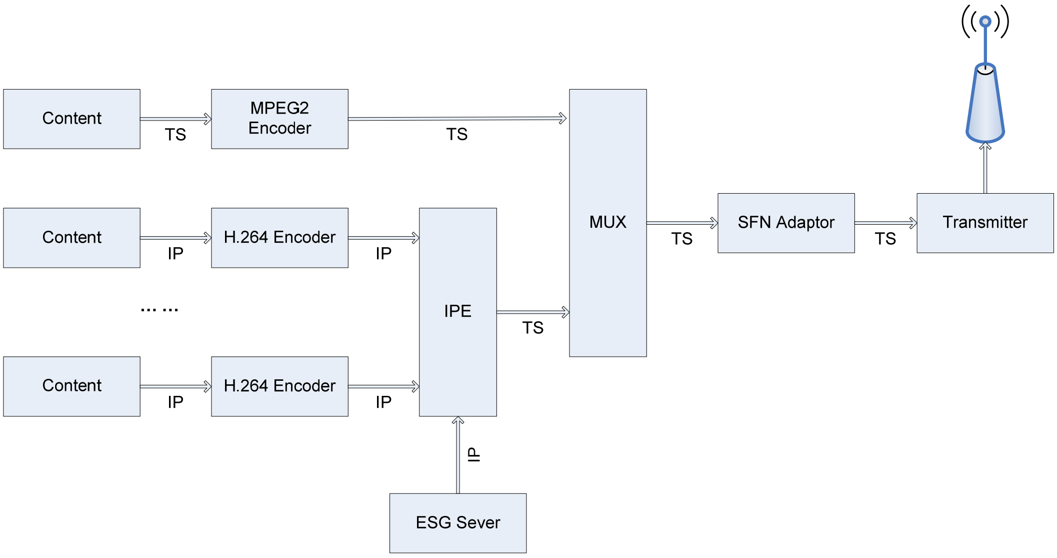

Figure 4 Beijing Mobile TV System Overview

The parameters of this network are as follows: 16QAM, 2/3FEC, 2K mode, 1/4 GI. Now this network is composed of four transmitters and five gap fillers. The powers of transmitters are in the range of 1 kilowatt. to 1.7 kilowatt. The powers of gap fillers are in the range of 2 watt. to 10 watt. The whole network is shown in Fig.5.

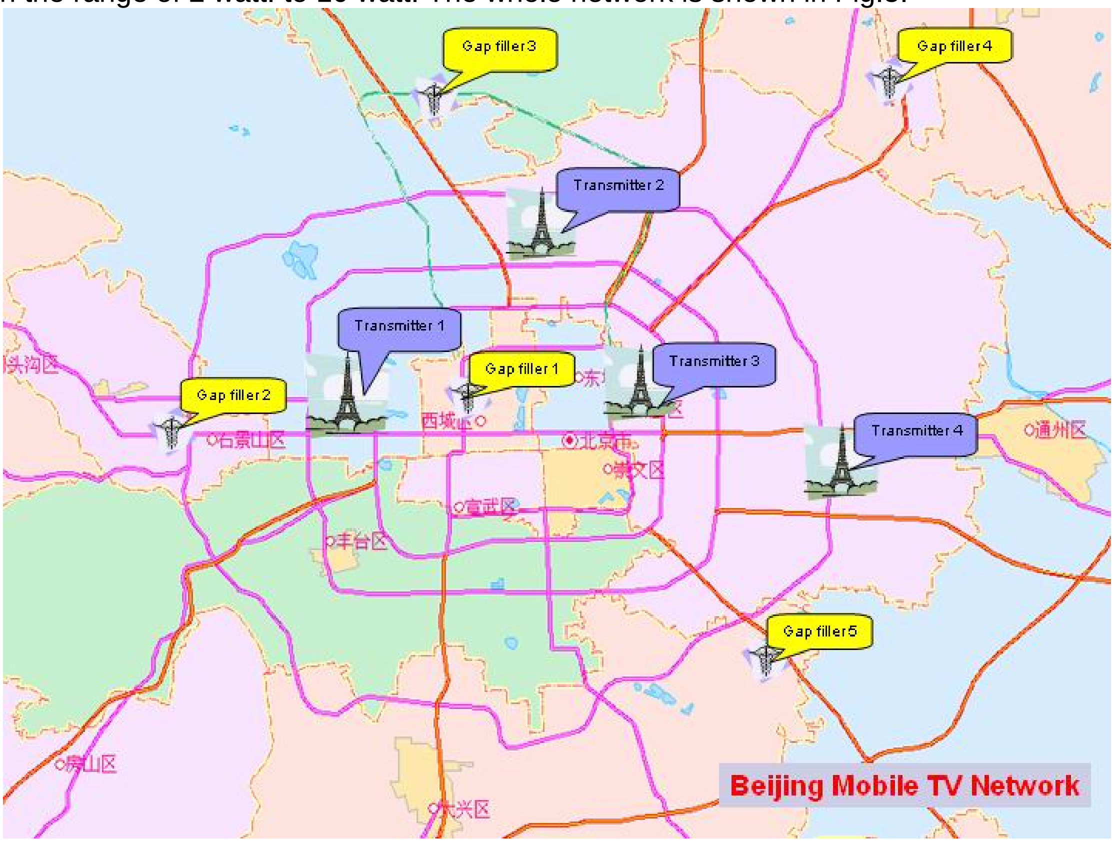

Figure 5 Beijing Mobile TV Network

According to the result of tests, the signal is acceptable in about 95% of this area, which covers five zones of Beijing city. In these areas, the equivalent receiver input voltages are more than 26dbuv, and the C/N ratios are more than 10dB.

Because of hard work in network planning, the signals are very good in some hot areas of the city, For example，in the CBD area (Fig.6),the equivalent receiver input voltages are in the range of 45dbuv-58dbuv, and the C/N ratios are in the range of 12-20dB.

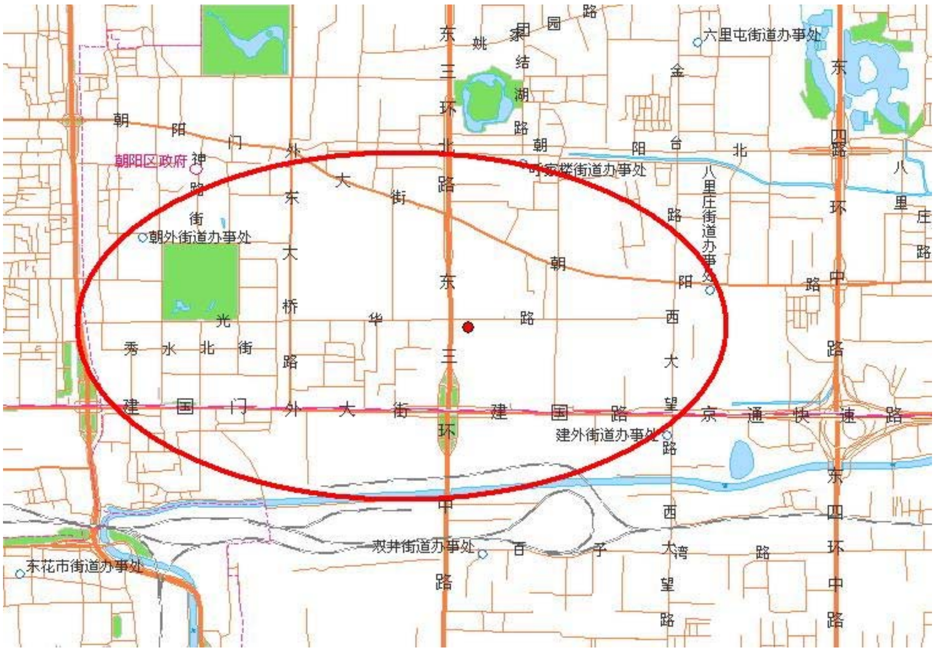

Figure 6 the Coverage of CBD in Beijing

As the development of network planning and coverage, more and more users can enjoy the mobile TV service.

1.5 Rich Media Prototype

Streamezzo is proposing a contribution to the short term demo in the integration of Rich Media in the demo. It is, in the first prototyping activities, a stand alone demo system from the physical point of view.

The architecture of DVB-H broad cast to mobile is well known and the figure below highlight the necessary evolution for injection of Rich media uses cases such as alerts, additional information, quiz, votes and access to VOD portals.

Particular attention is given to the Rich Media modules:

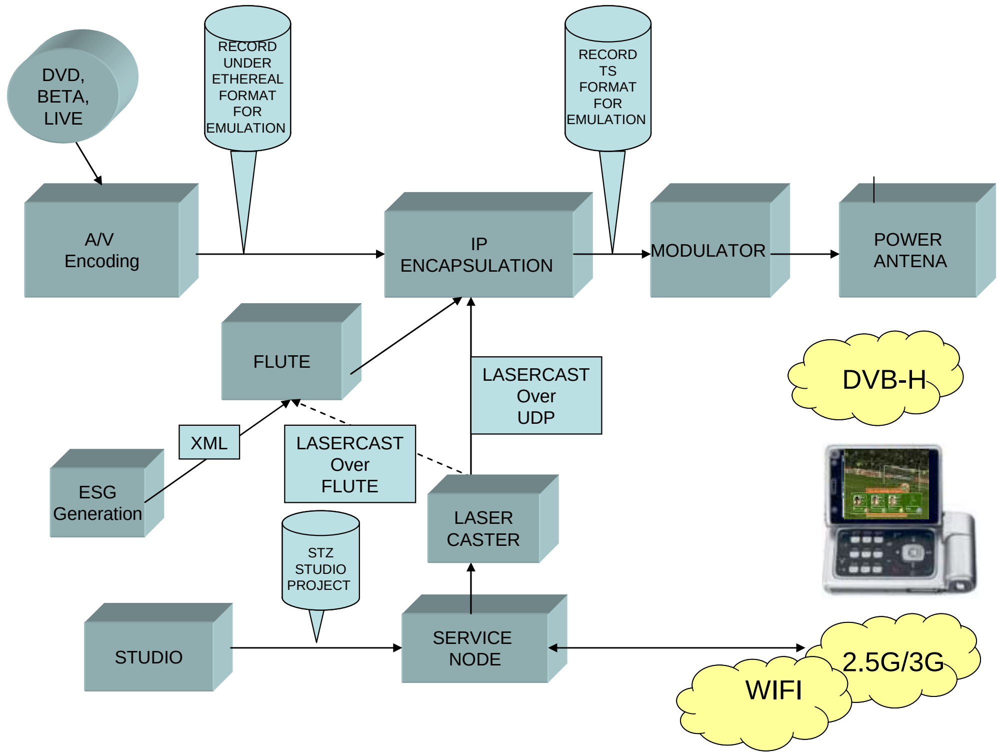

Figure 7 Rich Media Demonstration Architecture

Studio for the authoring of rich media elements , taking into account graphics “assets” such as images, text and animation and generating the rich media scenario according to the storyboard. Service Node is central and will manages streaming of Rich media elements according to inputs received from the terminal connected with 2;5G 3G or WIFI bidirectional network . Service Node is also injecting Richmedia elements inside the broadcast stream by the means of the Laser caster that interfaces with IP Encapsulator. Synchronisation can be obtained up to the second. Rich media is injected directly over UDP into the IPE or through the FLUTE. Terminal application will present Rich Media elements coming from Broadcast stream Connected feed. This application is also able to present ESG elements if present in a standard format inside the stream.

Special attention is also given to some useful intermediate formats that can be used to store contents in order to implement incremental strategies of integration and avoid immobilizing an expensive end to end chain when doing partial tests.

First intermediate format is the storing of ethereal content obtain from Encoder and accepted by IP Encapsulator, this allows to replay video independently from some time expensive configurations.

Other intermediate format is obtained in output of the IP encapsulation, by storing the Transport stream with or without Rich media elements. This format is taken for the prototyping activities and is very useful for the test of terminals as well as for independent demos performed with “head end” simulator as described below:

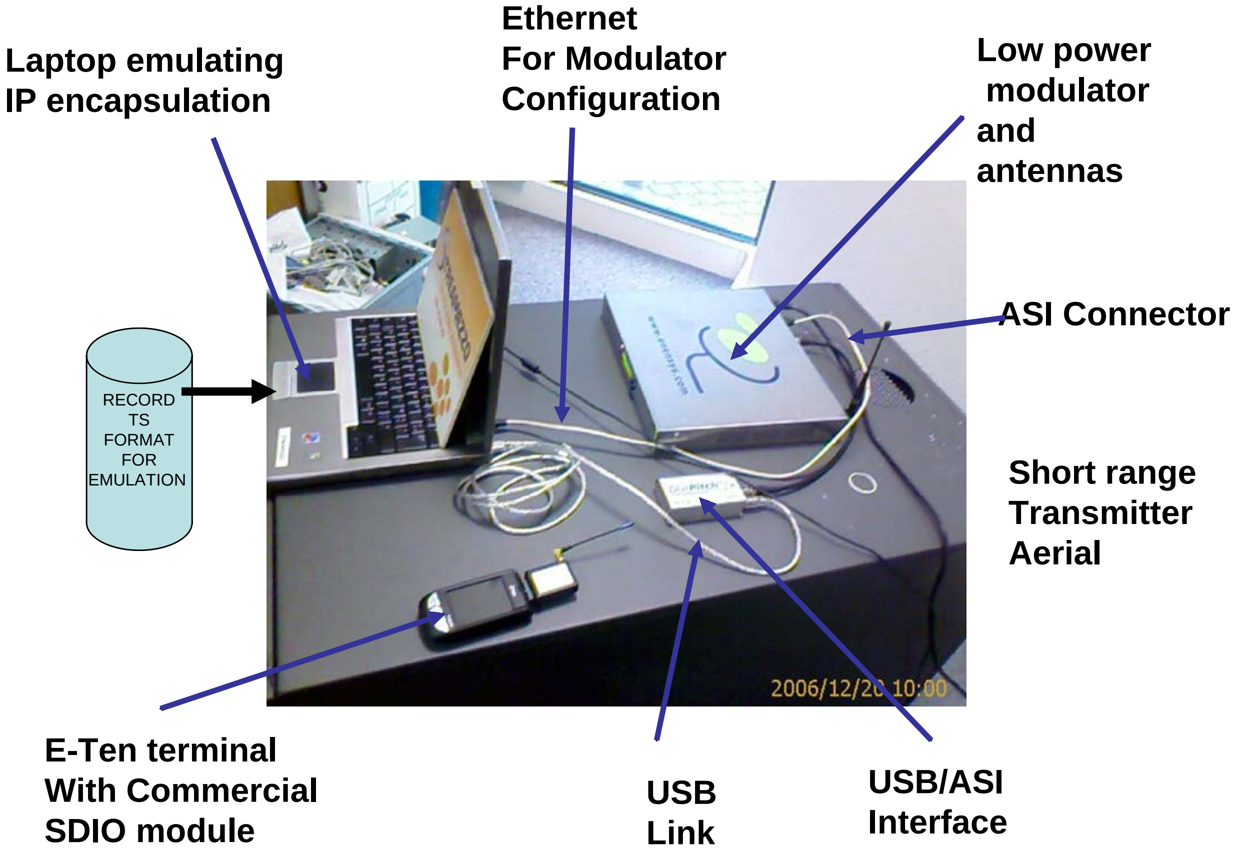

Figure 8 Rich Media Demo System

1.6 Terminal Prototype

Two terminal prototypes are proposed by this prototyping activity: DVB-H phone and PDA based prototype.

1.6.1 DVB-H Phone

1.6.1.1 General Introduction

The DVB-H terminal prototype is the NxPP provided by NXP. The appearance of the terminal is shown in Figure 9.

- 2.9” QVGA display with Touch Screen
- USB OTG interface
- MiniSD Card slot
- Stereo Headset with MIC input
- 4 directional buttons with Select key
- Docking connector (Charging + USB)

Figure 9 Appearance of the NxPP

The NxPP can provide the following functions for users.
Multimedia:

- Decode and display video formats H.264
- Playback MP3 audio
- Display pictures
- Store video clips on SD or MMC Flash memory card
- Provide a graphical user interface to users, to access the functions

DVB-H:

- Receive and display DVB-H transmissions carrying data compressed using the H.264 format
- Select different DVB-H channels

GSM/GPRS:

- Enter the PIN code for the SIM
- Register to a GSM network

- Accept and participate in an incoming GSM call
- Initiate an outgoing call

WLAN:

- Connect to a WLAN network
- Perform a voice over IP (VoIP) call via WLAN
- Download pictures and video clips from a server via WLAN

1.6.1.2 Hardware Specifications

The above functions of the NxPP are supported by a Multimedia Application Engine (AE) called PNX4008, and three sub systems which are controlled by the AE. Refer to Figure 10,

- DVB-H hardware sub-system. It is controlled by the AE. The control functions include carrier frequency and transport stream selection. The DVB-H HW subsystem performs TS de-multiplexing, MPE decoding and FEC processing. Data from the DVB-H HW subsystem, which is a stream of IP packets, is transferred to the AE.
- Cellular sub-system contains a GSM/GPRS module supporting normal phone functions
- Connectivity sub-system includes a wireless LAN module

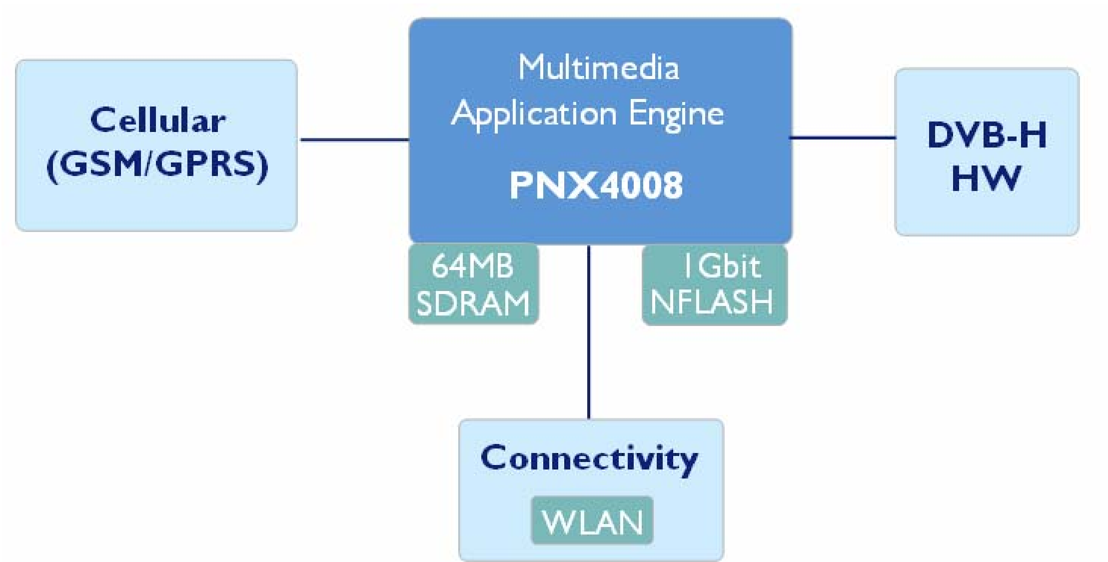

Figure 10 Block diagram of the hardware system of the NxPP

The PNX4008 AE is based on an ARM9 RISC processor, which is accelerated by dedicated video and audio engines. It delivers optimum performance with very low power consumption. Refer to Figure 11, the CPU subsystem combines a 208-MHz ARM926-EJ processor with dedicated 32k instruction and 32k data caches. The video engine provides high-performance support for still and video images. It includes an encode acceleration JPEG decoder, an MPEG-4/H.263 video encoder/decoder, and a graphics accelerator. The audio engine combines a fully dedicated audio DSP with integrated stereo DACs and ADCs to provide sound capabilities. The audio DSP can operate independently from the ARM CPU and can reference embedded RAM memories for full audio flexibility.

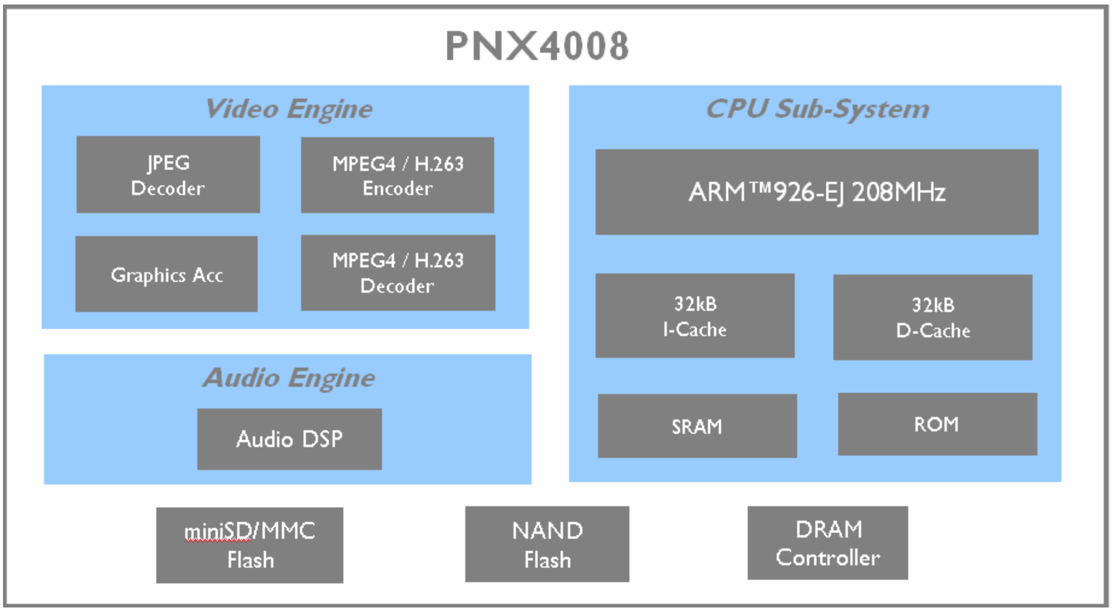

Figure 11 PNX4008 Application Engine

1.6.1.3 Software Sub-system

To support TV-on-mobile applications, a software sub-system is developed for the NxPP. Refer to Figure 12, an embedded Linux is running on the ARM CPU of the PNX4008 application engine. A Driver Resource Abstraction Layer (DRAL) running on top of the embedded Linux acts as a unified interface between the DVB-H hardware sub-system of the NxPP and the DVB-H middleware, which is also called CBMS IPDC stack. The RTP video player get input as RTP packages with H264 video as the payload from the DRAL, unpack the RTP packages in the RFC3984 compliant way, decode the H264 video and show it in the Graphics User Interface (GUI).

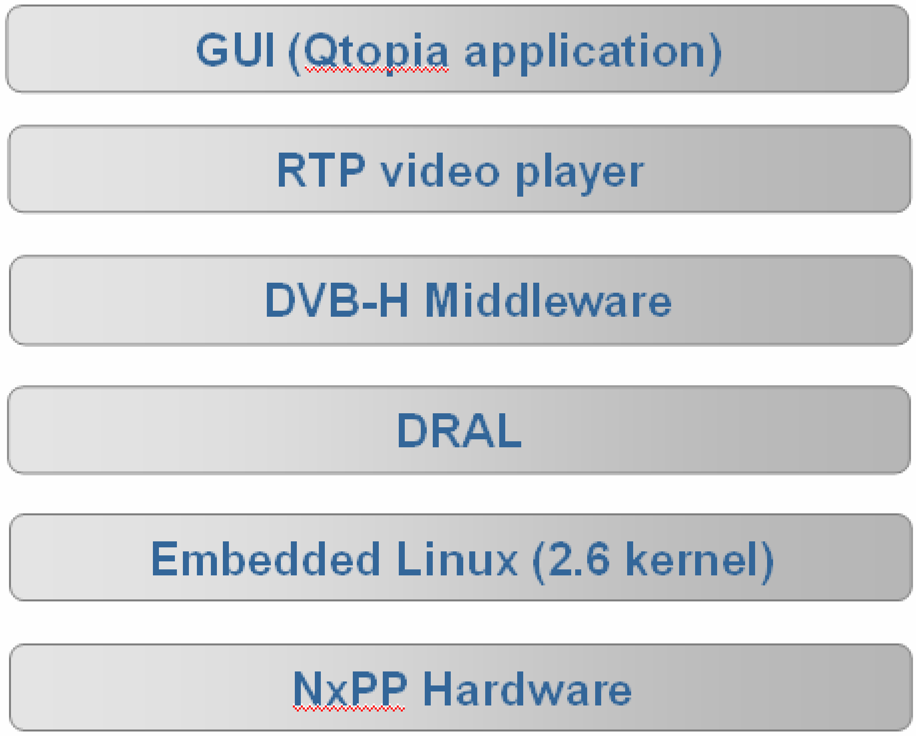

Figure 12 software sub-system supporting TV-on-mobile applications

DRAL

The DRAL is responsible for handling the IP and section data flow from the DVB-H HW module and for maintaining the resources used by the DVB-H middleware. The resources are section and IP filters and the contexts on which they run. For example, the DVB-H middleware uses the specified DRAL API to control the tuner, the demodulator and the demux during a service scan to get appropriate information about the available services and/or networks.

The DRAL ensures a smooth data flow between the middleware and the DVB-H HW module.

DVB-H middleware

The DVB-H middleware used in the software sub-system is the onHandTV™ middleware provided by Silicon & Software Systems Ltd. (S3), which is the world leading provider of Mobile DTV handheld solutions. The onHandTV™ is a fully DVB-H/CBMS compliant software stack. It is architected to deliver the same core TV features such as ESG and Interactivity across multiple networks using preconfigured Operator Adaptation Packages (OAPs). For further information please visit www.s3group.com.

1.6.1.4 Limitations

Regarding DVB-H related TV-on-mobile applications, the NxPP currently has some limitations:

- Since the video engine of the PNX4008 only supports H.263 hardware decoding, the RTP video player can only partially use it for the H264 decoding. Therefore, the NxPP can’t support H264 QVGA.
- The audio engine of the PNX4008 is not dedicate for AAC, so the NxPP currently can’t support AAC audio decoding if it is decoding H264 video in the mean time.

These limitations will possibly be solved with the future terminal prototypes.

1.6.2 PDA based prototype

The PDA based terminal prototype is composed of 3 parts: terminal device, RF reception, and ESG interpreter / AV player.

1.6.2.1 Terminal device

The terminal prototype uses 2 PDA models: HP iPAQ and Dell x51v. These 2 models of PDA support both WiFi connection and SDIO interface, which is used for DVB-H reception card.

1.6.2.2 RF reception

In this prototyping, both DVB-H and WiFi are included.

- WiFi reception
  WiFi connection is provided by the embedded WiFi reception module in the 2 chosen PDA.

- DVB-H reception
  Receivers in SDIO form provided by NXP and DiBcom are used for PDA terminals.

1.6.2.3 ESG interpreter / AV player

Tow suits of ESG interpreter / AV player are available to illustrate different services.

- Thomson solution

The Thomson experimental solution combines EyePhone, the ESG interpreter, and Thomson Player, the AV player to provide terminal side user interface.

EyePhone reads the pre-downloaded ESG data stored locally and provide interfaces for user to choose channels and to view program list (EPG). Figure 13 illustrates EyePhone interfaces.

Figure 13 EyePhone Interface

Despite of the local ESG approach chosen in this prototyping, EyePhone is also capable to handle on-air broadcasted ESG data.

– Streamezzo rich media engine

The Streamezzo rich media engine is a terminal side UI software. It interprets rich media data and provides rich media interface to the user. It has its own A/V player.

2 EXISTING TECHNOLOGIES

After a long period of detailed preparation, the DVB-H standard, including IP DataCast, has reached a practical level, leading to the commercial launch in Italy July 2006. Meanwhile DVB-H centered media technology set is evolving fast, including audio/video encoding technology, media streaming technology, data streaming technology, broadcast/mobile network convergence technology, rich media technology and so on; providing services from simple TV program to including more novel user experience features, by absorbing various technologies.

At the meanwhile, DVB-H is not the only technology to provide high quality and convergent TV service to mobile. Other broadcast- or mobile network- based technologies bring a strong competition to the maturating mobile TV market.

This chapter will both present DVB-H centered technologies, which will support the succedent research and development work inside the project MobiServe; and summarize DVB-H competing technologies.

Work Task 5.1, issuing this report D5.1, is aiming at preparing and making DVB-H service demonstrations very quickly, with off-the-shelf technologies and solutions. This chapter will illustrate these technologies behind T5.1 prototypes, and introduce main competing technologies to DVB-H.

2.1 DVB-H Overview

DVB-H is developed on the foundation of DVB-T technology, which has been proved practical and robust. By adding new technologies and features, DVB-H inherits DVB-T advantages and realizes new services in a mobile condition for hand-held devices.

2.1.1 Motivation to develop TV on Mobile technology

TV service on mobile is an inevitable demand by the market.

On one hand, the need to access from handset to audiovisual/data services as entertainment, news, other public information and so on, is more and more demanded by the market.

On the other hand, mobile phone has evolved from a voice communication tool to a media entertainment tool. During this evolvement, TV is the last media and the biggest one missing from mobile, in terms of a general service.

Under this consideration, the approach of building a handset targeted TV technology based on a mature broadcast technology (DVB-T) becomes demanding and necessary.

2.1.2 DVB-T Summary

With its conception in 1993, the DVB-T standard has been developed since more than 10 years and has been running around the world. Up to nowadays, it has become the world’s most successful DTT (Digital Terrestrial TV) standard. Based on COFDM and QPSK, 16QAM and 64QAM modulation, DVB-T is also the most sophisticated and flexible DTT system available today.

DVB-T is now providing on-air services in 29 countries, with adoption and pre-launch in more areas.

Mobility is an important feature of DVB-T. It is proved to be practical to provide service not only to home/fixed reception, but also in conditions of car- and bus- based reception. It supports a terminal movement up to more than 200km/h.

2.1.3 DVB-H is DVB-T to Handset, and More

The need of the market of TV services on mobile and the success of DVB-T lead to the birth of DVB-H.

Despite of the wide usage of DVB-T, especially under mobile conditions (bus, car…), there are several limits that prevent if from providing services to mobile/handset terminals.

- Terminal energy consumption aspect is a major concern for battery powered mobile/handset, knowing that DVB-T targets to unlimited power supported terminals (fixed, car based…).
- DVB-T supports a good terminal mobility, while it has other limitations combined to this feature (SFN cell size limited). In order to make high mobility more practical for mobile/handset environment, a better trade off is needed
- Mobile/handset terminals work under more complex air channel conditions, including indoor/outdoor reception, multi path reception in city, etc. DVB-T needs to be enhanced to adapt to these situations.

Following sections will deal in more detail with these improvements of DVB-T to serve mobile/handset receivers.

While TV on mobile services ask for more than just DVB-T signal to mobile/handset. As a personal media center, a mobile phone, or another kind of handset terminal, must provide more abundant services than traditional TV to differentiate from the latter one and to attract users. These services can be interactivity, different audiovisual content, community, etc.

DVB-H is to achieve all the goals described above.

2.1.4 Terminal Energy Saving and Smooth Handover – Time Slicing

One import work for DVB-T is to reduce terminal power consumption. Now the consumption of a DVB-T receiver (tuner + demodulator) has been reduced to about 500mW. Never the less, a power consumption of the mobile/handset DVB receiver should be under 100mW, both to control heat dissipation in a miniaturized environment, and to maintain a reasonable usage time with current battery capacity constraint.

In the framework of DVB-T system, one channel can be used to transport a data bit rate of about 10Mbps. This is far beyond the data consumption ability for any mobile-like device with a small display. A mechanism to make best use of this bandwidth for the most of services and to reduce power consumption could solve this problem.

Time-slicing is the answer.

In a simple DVB-H transport channel with out time slicing, several services are multiplexed to share the total bandwidth, as illustrated by figure 14. When a receiver listens to one service, it must receive the whole bandwidth continuously and then pick out the useful data related to the service.

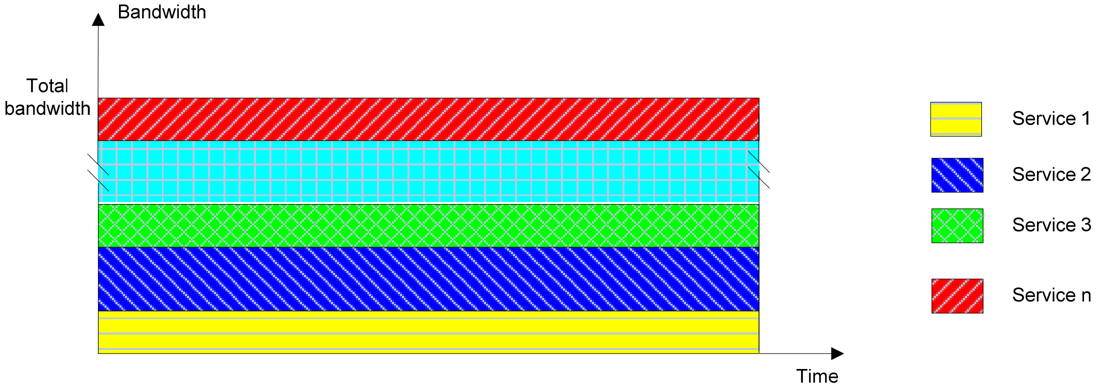

Figure 14 DVB-H services without time-slicing

In Figure 15 time-slicing is introduced. Instead of receiving the total bandwidth continuously, the receiver is only turned on during the burst of the service being listened. For the other time of the period, the tuner is off to reduce power consumption.

As each burst occupies normally less than 10% of the period, the power consumption reduction can theoretically reach 90%.

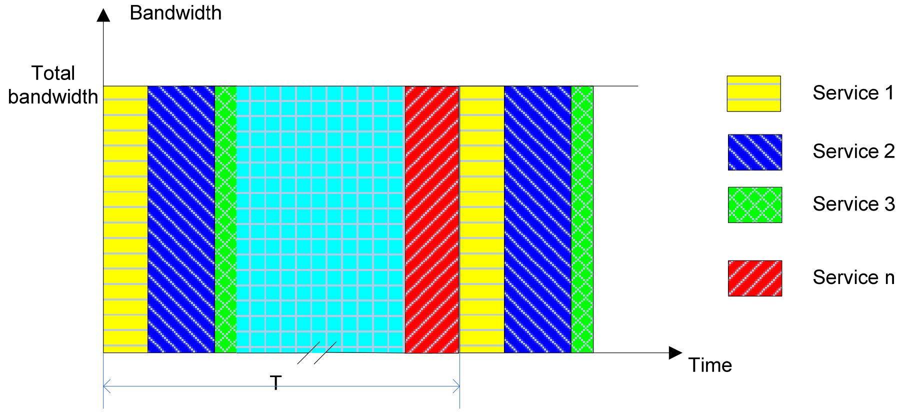

Figure 15 DVB-H services with time-slicing

Another benefit of time-slicing is the best support for hand over in MFN architecture. Without time-slicing, two antennas must be used in case of cell handover, one antenna to receive the signal from the current cell and another one to search for neighbor cell(s).

With time-slicing, even in case of handover, only one antenna is necessary. It receives service signal during the burst for this service; and lists to neighbor cell(s) during the off-time of that burst for handover purpose.

2.1.5 Mobility & Cell Size – 4k mode

In a traditional DVB-T system, two FFT size options are available: 8K mode and 2K mode, with the number of active carriers in one OFDM frame equaling respectively to 6817 and 1705. The choice of FFT size affects two aspects: terminal mobility performance and SFN network cell size.

The 2K transmission mode is known to provide significantly better mobile reception performance than the 8K mode, due to the larger inter-carrier spacing it implements. However, the duration of the 2K mode OFDM symbols and consequently, the associated guard intervals durations are very short. This makes the 2K mode only suitable for small size SFNs, making difficult for network designers to build spectrally efficient networks. [1]

Therefore 8K mode is chosen in most of the cases.

When it comes to mobile TV services, the terminal's mobility is of a great importance. According to its potable characteristic, a mobile TV terminal can be used under different situation, from a still position to a fast movement, in a car, or even in a train with a very high speed (300km/h in the case of TGV in France). Based on this consideration, the 2K mode is appropriate.

In order to have a better trade off between the SFN size and the terminal mobility, a third mode – 4K mode is defined for DVB-H. It improves considerably the terminal mobility comparing to 8K mode while guaranteeing a reasonable SFN cell size.

2.1.6 Robustness over the Mobile Channel – in-depth interleaving & FEC

Mobile TV terminal receives signal under a complex air channel condition. In order to improve receiving robustness, additional mechanisms are introduces to DVB-H system on different levels.

On the physical level, in-depth interleaving is introduced for 2K and 4K mode. It decouples the choice of the inner interleaver from the transmission mode used. This flexibility allows a 2K or 4K signal to take benefit of the memory of the 8K symbol interleaver to effectively quadruple (for 2K) or double (for 4K) the symbol interleaver depth to improve reception in fading channels. This provides also an extra level of protection against short noise impulses caused by, e.g. ignition interference and interference from various electrical appliances.

DVB-H uses MPE (Multi-Protocol Encapsulation) to encapsulate IP packets into TS stream. On the MPE level is associated FEC (Forward Error Correction), to improve C/N and Doppler performance in mobile channels and to improve the tolerance to impulse interference. [2]

2.1.7 Variety of Service – IP based system

As mentioned in the previous section, DVB-H has MPE mechanism to encapsulate IP packets into DVB TS stream. This is a significant additional feature of DVB-H comparing to DVB-T which uses TS stream to transport directly audiovisual and data content.

In an era of "IPlization", where all major telecos are migrating their service to full-IP network, introducing IMS (IP Multimedia Subsystem), etc., an IP based multimedia system is of great advantage in terms of service flexibility, compatibility and convergence, comparing to traditional digital TV systems.

The next session will discuss in more details about this IP based mechanism

2.2 DVB-IPDC Overview

IPDC (IP DataCast) is an end-to-end broadcast system for delivery of any types of digital content and services using IP-based mechanisms optimized for devices with limitations on computational resources and battery. An inherent part of the IPDC system is that it comprises of a unidirectional DVB broadcast path that may be combined with a bi-directional mobile/cellular interactivity path. IPDC is thus a platform that can be used for enabling the convergence of services from broadcast/media and telecommunications domains (e.g., mobile / cellular). [4]

IPDC is constructed on the base of DVB-H network and deals with key issues in digital content transmission and service, including service discovery, service navigation, content transmission protocols, service protection and so on.

Figure 16 illustrates the architecture of IPDC system. [3]

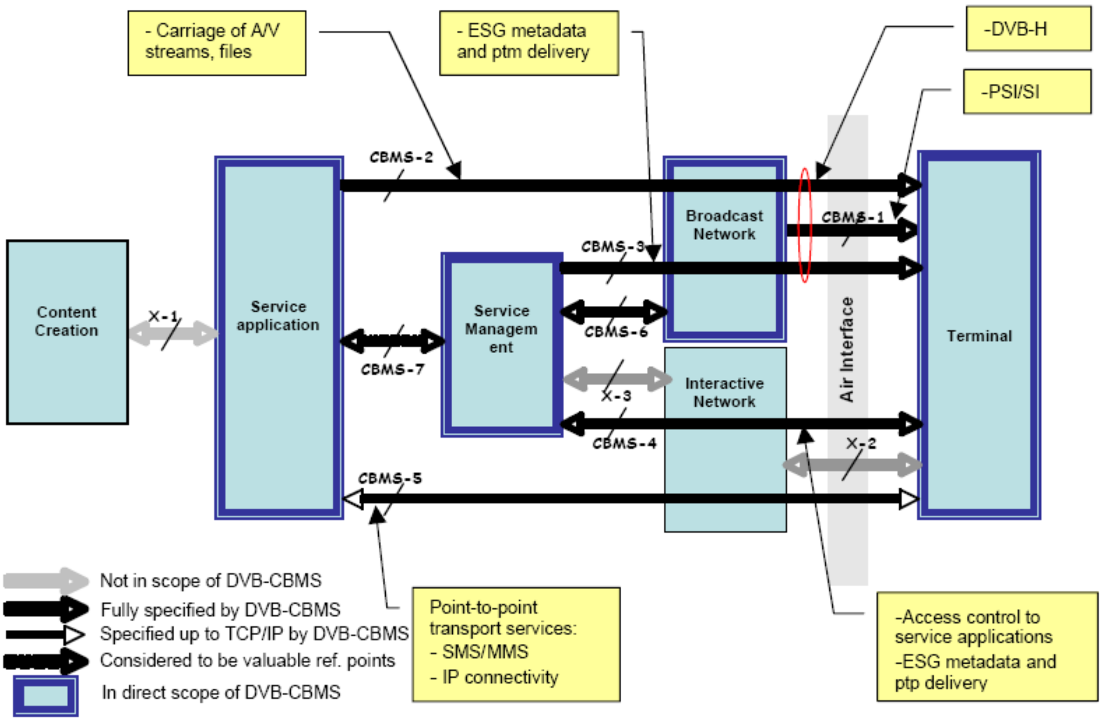

Figure 16 IPDC Architecture

The IPDC standardization work is in phase 1, having the following specification documents, some of which have be accepted as ETSI standards:

- PSI/SI (ETSI TS 102 470 v1.1.1)
- Set of Specifications for Phase 1 (A096)
- Use Cases and Services (ETSI TR 102 473 v1.1.1)
- Architecture (ETSI TR 102 469 v1.1.1)

- Electronic Service Guide (ESG) (ETSI TS 102 471 v1.1.1)
- Service Purchase and Protection (SPP) (A100)
- Content Delivery Protocols (CDP) (ETSI TS 102 472 v1.1.1)

Figure 17 illustrates the protocol stack of IPDC, including both broadcasting network and interactive network. [3]

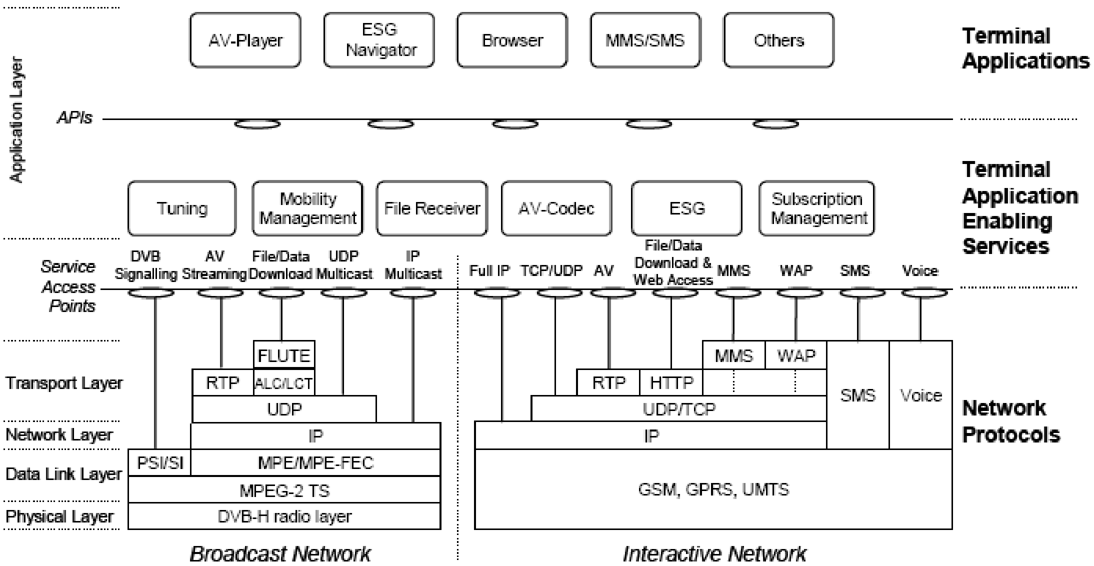

Figure 17 IPDC Protocol Stack

2.3 Rich Media Technology

2.3.1 A Vision on Rich Media Services

A Rich Media service is a dynamic, interactive collection of multimedia data such as audio, video, graphics and text. It ranges from a movie enriched with vector graphics overlays and interactivity (possibly enhanced with closed captions), to complex multi-step services with fluid interaction and different media types at each step.

The demand for such Rich Media service is increasing at a high pace, spurred by the development of the next generation mobile infrastructure and the generalization of TV content to new environments.

Despite long lasting deployments and significant investments that have been made by the various actors of their respective industries, mobile and more generally embedded interactive services (e.g. mobile internet, interactive mobile TV) have failed to reach the masses.

There are certainly a number of reasons for this failure, some of them being conjectural (e.g. economical) or structural (e.g. lack of compelling business models). Still, from a pure user experience point of view, the technologies in place also suffer from major drawbacks:

- XHTML-like approaches (e.g. WAP, I-Mode, XHTML …), although successful on the Internet, have shown their limits to provide a simple, efficient and deterministic user experience on non-PC heterogeneous devices.

- The transposition of PC technologies to constrained devices and networks without the requested adaptation to take into account the characteristics of these environments (e.g. network latency, bandwidth, devices capabilities, screen sizes …) lead to very low browsing capacity and poorly usable services.

- In addition, the current technical approaches did not integrate from their original design the integration of audio and video media. Although they then attempted to integrate multimedia when it was recognized as a key driver of growth of services, only poor results have been achieved so far.

Even though technology is definitely not a sufficient condition of economical success, we think it is a pre-condition to the pervasive development of Rich Media services on non-PC devices:

- Using Rich Media services on embedded devices is more challenging than on a PC
  where various interfaces are available and homogeneously implemented (e.g. mouse, keyboard, …), and for which ergonomic concepts have been tested and validated for years. On the move, in situation where it is not always easy to interact, where time is limited, users expect to be one click away from the information they need.

- End-users have been accustomed to quality interfaces on the Web. To be successful on the embedded domain, service interfaces need to leverage the "on-line experience".

- Finally, since these services are expected to generate revenues, the users also expect a decent level of quality, efficiency and readability as a pre-condition to pay.

2.3.2 State of the Art

Several technologies are competing to achieve the vision described in the previous section, among which Flash is the first to analyze.

Indeed, Flash is very successful on the PC. It is the current de-facto standard for distributing Rich Media content on the Internet but suffers from serious drawbacks to address efficiently other industries requirements:

- Flash is not an open standard. This is a critical issue to get massive industry support, especially on mobiles. Content creators, services operators and device manufacturers would be tied to Macromedia for the creation, distribution and playback of Rich Media content. Knowing that once deployed, a media infrastructure is hard to make evolve, the trend is to avoid proprietary solutions and promote open standards.

- Flash is a technology designed for the PC. As such, it is not suitable for the mobile environment as demonstrated by the current development of the mobile version of Flash, called Flash Lite. To match the double constraint of being compatible with its existing PC format and to fit constrained devices requirements, Macromedia had to compromise a lot on technology. The first version of Flash Lite is a downgraded version of what is available on PC. In addition, the problem of having a single vendor and a proprietary format remains.

Following this analysis, an important requirement for a Rich Media solution for mobiles is to be open and allow easy conversion from the many existing types of Flash and other proprietary content into this new standard.

Two standardization groups have tried to specify standards which would satisfy this requirement: MPEG and W3C.

MPEG-4 BIFS is the first attempt of MPEG in the field of composition coding. It features innovative tools that allow the creation of multimedia content mixing 2D and 3D graphics, introduces the notion of incremental updates of the scene, enabling streaming of long running scenes, and insures a tight synchronization between the different audiovisual elements of the scene.

We attempted at profiling MPEG-4 BIFS to create a small enough subset to be used on mobile phones, to no avail. The inherent content and binary encoding structure makes it inappropriate for the mobile. Instead of compromising on the technology performances, MPEG reached the conclusion that an optimum between feature richness/compression efficiency and device constraints needed to be found and decided to create a new standard for Rich Media for constrained devices.

As an alternative to the Flash proprietary solution, the W3C also made attempts to define languages for creating Rich Media content. The SMIL and SVG standards are among these languages. Both of them are getting traction in the mobile industry, where SMIL and SVG mobile profiles have been adopted by the 3GPP and OMA consortia.

However, both are XML languages, relying on the HTML model for content consumption: download-and-play, or progressive download and rendering. However, the streaming of SMIL or SVG content is not specified, making these models inappropriate for fast, dynamic and interactive and interoperable content. A strong requirement for the new standard for Rich Media content for mobiles is to leverage the adoption of SVG by providing means to extend its consumption scenarios to streaming and broadcast.

Creating Rich Media content services for the mobile is not only about composition coding. An important aspect in the success of a mobile service is the reactivity and fluidity of the user experience. Such characteristic is achieved through efficient delivery mechanisms. However, efficiency is difficult to achieve when distributing Rich Media content made of individual audio, video, and image content. Separate delivery of all these media streams to a mobile incurs a high latency unless an efficient aggregation mechanism is used: high-latency networks attach a specific penalty to multi-media content when consumed in download-and-play mode, because the waiting time of the content is the sum of the waiting time of each media requested separately. Instead, getting all streams in one single package would reduce waiting time to one single request delay.

The requirements for such aggregation mechanisms are simplicity of implementation and efficiency.

A natural candidate for this task is the ISO Base Media File Format because it is very popular and already adopted by the mobile industry. However, this file format was designed for storage of large amount of media data, easy editing or streaming operations. It is not efficient for the storage of small amounts of timed media data. A simple to implement yet efficient aggregation format for mobile is needed to complement the ISO Base File Format.

2.3.3 Key Features that Make a Difference with LASeR based solutions.

The LASeR standard has been designed to satisfy the end-users expectation listed above. Four key features can be highlighted that makes a real difference with existing technology:

1. Graphic Animations, Audio, Video and Text are packaged and streamed altogether.
Contrary to existing technologies on mobile that are mostly aggregation of various components, not necessarily well integrated together (e.g. XHTML + SMIL + SVG + CSS + Ecmascript + …), LASeR grounds its design from what made the success of Macromedia Flash on the Web: a single, well defined and deterministic component that integrates all the media. This integration ensures both the richness and quality of the end user experience.

2. Full screen and interactivity with all streams.
With the use of vector graphic technology, content can easily be made to fit the screen size. This feature enables to provide an optimal content display although the screen resolution is highly varying. In addition, virtually all pixels can be used as elements of the user interface. This allows the design of rich and user-friendly interfaces, similar to what people used to have when interacting with their devices.

3. Real-time content delivery.
LASeR has been designed for an efficient delivery over constrained networks. More specifically, Rich Media LASeR content can be delivered into packaged pieces, allowing display as soon one piece is received (as opposed to a download an play mechanism). This concept of “streaming”, already into place for audio and video data, has been generalized to scene description and Rich Media. As such, services can be designed such has there is always some information of interest on the screen.

4. Low bandwidth.
Last but not least, LASeR has been designed to deliver Rich Media Service starting from 10 Kb/s. The key technology used here is vector graphics compression and dynamic updates of the scene. This feature enable to drastically limit the waiting time of the end users as opposed to a standard Web-like approach where the complete page is re-sent even though only small changes had been made. Needed for low bitrate networks such as GPRS, this functionality is also useful on higher bit rate network where Rich Media services can be sent at low rate, therefore preserving bandwidth to improve audio and video quality.

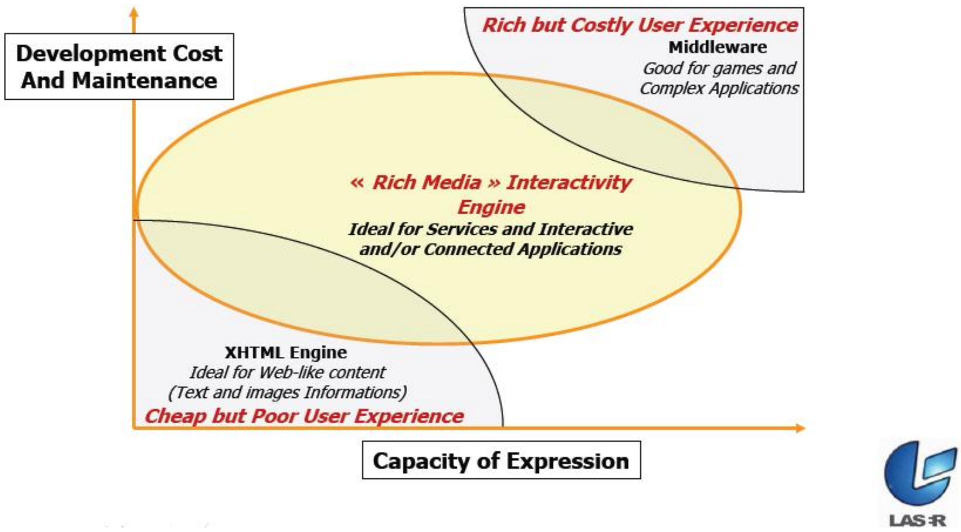

Figure 18 Cost vs. Expression Capacity

2.4 DVB-H Competing Technologies

In the fast developing market of Mobile TV, DVB-H faces several competing technologies and standards. This section will give brief introductions of main standards and their characteristics.

2.4.1 DAB based technologies (T-DMB, S-DMB)

DAB (Digital Audio Broadcast), with the core technology also called Eureka 147, is of the original intention to digitalize radio broadcast to provide distortion-free and CD quality audio service, and to increase station numbers. Its typical spectrum is allocated in Band III and L-Band. DAB applies OFDM and DQPSK modulation technologies to avoid fading and inter-symbol interference in transmission.

DAB is now used in countries of UK, Denmark, Norway and Switzerland.

While DAB is capable not only to carry audio, but also various content like picture, data and even video. Some other technologies are developed based on DAB to realize these applications.

DMB, Digital Multimedia Broadcast, is one such technology. It is based on the DAB transmission system. It uses BSAC or HE-AAC V2 audio coding for audio services, Advanced Video Coding for video services and BIFS for interactive data related services.

Figure 16 shows that DMB services (video/audio & data) are added to Eureka-147 DAB Multiplex using DAB Stream Mode. As it keeps DAB system architecture unchanged, DMB terminal is technically compatible with DAB system.

DMB is the first commercially launched broadcast Mobile TV service, with two modes available in South Korea and in Japan T-DMB and S-DMB. T-DMB is a terrestrial DMB broadcast in Band III while S-DMB combines satellite and terrestrial gap-filler broadcast both in S-Band.

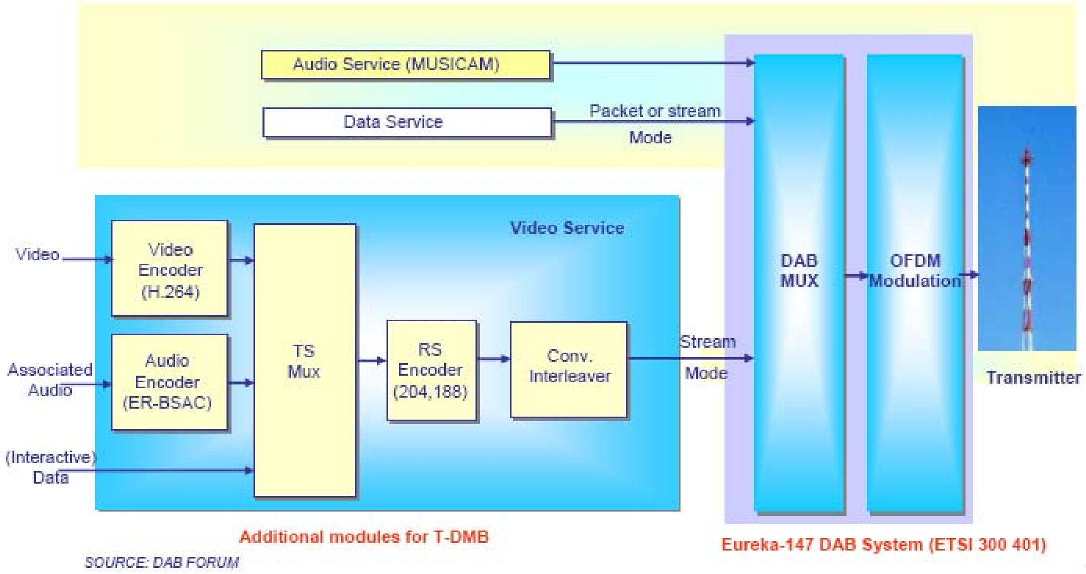

Figure 19 DMB System

2.4.2 MediaFlo

MediaFlo is Qualcomm's proprietary technology to provide audiovisual service through "Forward link only" network. Figure 20 illustrates MediaFlo distribution network combined with return channel.

MediaFlo is designed for national wide coverage with convenient local content support. It uses OFDM modulation technology and is supports SFN transmission network.

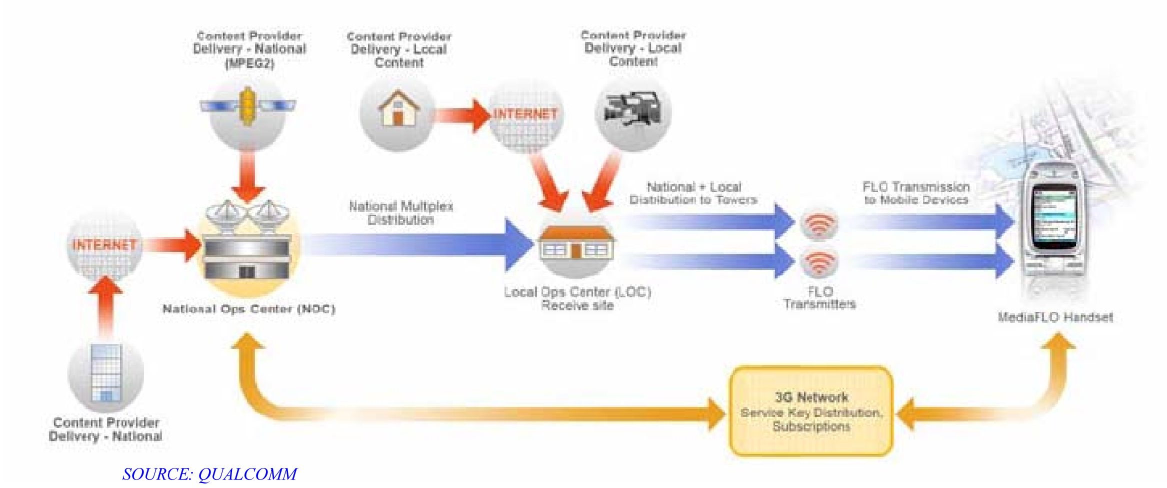

Figure 20 MediaFlo Architecture

2.4.3 CMMB/STiMi

CMMB defines a Mobile Multimedia Broadcasting system provides TV programs, information services and other services to small terminals with a screen size under 7 inches, as mobile phone, PDA, MP3/MP4, digital camera and laptop, through satellite and terrestrial broadcasting. It is announced as China's recommended standard for the Mobile TV industry.

CMMB is a standard system covering service source formats, transmission, extended services, terminal, and operation aspect. The transmission is satellite wide coverage with terrestrial gap fillers, and is specified by STiMi.

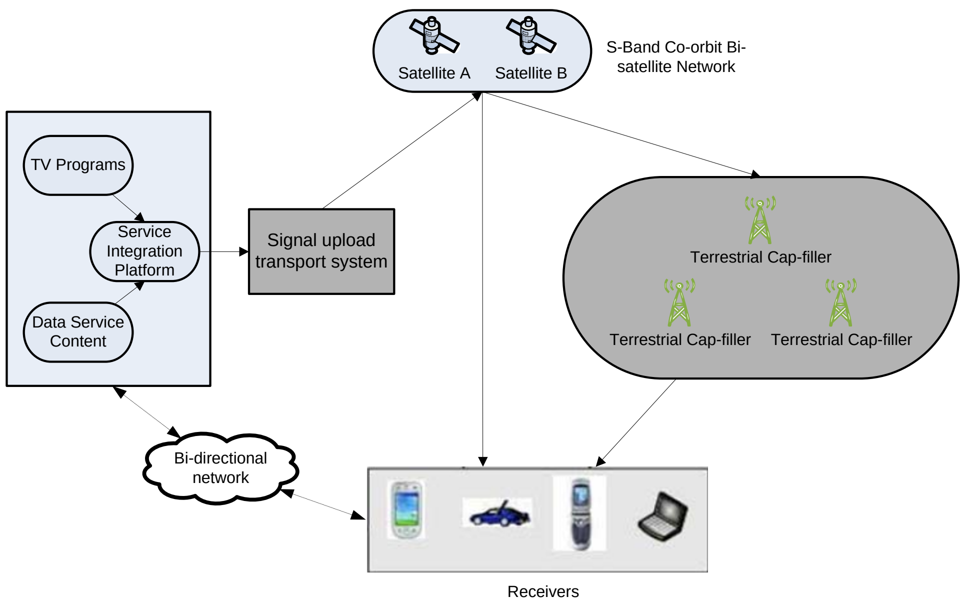

Figure 21 CMMB Architecture

CMMB will comprise all the aspects of digital TV broadcasting. Its core part, channel transmission is based on STiMi, the Chinese standard for digital broadcasting via satellite and terrestrial relays. It was announced to contain no foreign license.

Figure 21 illustrates the brief CMMB architecture.

CMMB is defined to occupy a bandwidth of 25GHz in S-Band from 2635GHz to 2660GHz. This bandwidth is further divided into 3 sub-bands of 8GHz in order to reduce the bandwidth received by the terminal at each time given. Figure 22 illustrates this spectrum division.

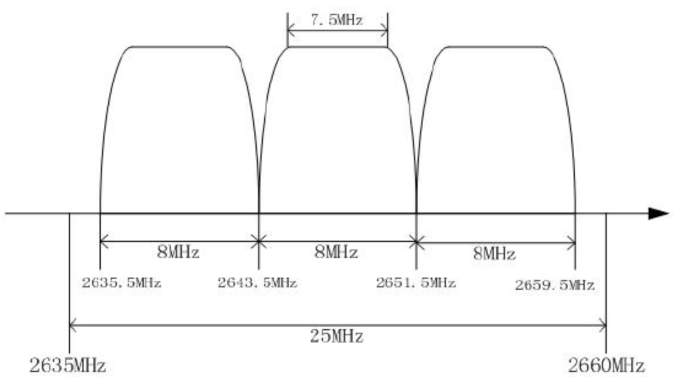

Figure 22 CMMB Spectrum Division

2.4.4 Conclusion

As mobile TV is believed to be a huge emerging market, many standards are proposed and more or less available on the market. Besides the technologies introduced above, major standards include:

- DAB-IP, DAB extension supporting IP transmission;
- DVB-SH, DVB extension for handset using satellite transmission;
- ISDB-T, the Japanese digital broadcast standard;
- 3GPP MBMS, a multimedia broadcast/multicast standard based on 3G/B3G network;
- TDtv, a time-division system using idle unpaired 3G spectrum, also based on MBMS; etc.

Comparing to the standards described in this section, DVB-H shows its own advantages in the Mobile TV industry.

- Power efficiency. Thanks to the time-slicing mechanism, DVB-H reduces the reception power consumption by the order of 10^{-1}.
- Service variety. Supporting IP, and with the newly developed DVB-IPDC standard, DVB-H is capable to deliver more various services, than just audio and video content.
- Technology maturity. Developed from DVB-T, a world wide adopted technology, DVB-H has a mature technology base and a huge potential market.

3 REFERENCES

[1] ETSI, "Digital Video Broadcasting (DVB);DVB-H Implementation Guidelines", ETSI TR 102 377, 2005

[2] ETSI, "Digital Video Broadcasting (DVB); Transmission System for Handheld Terminals (DVB-H)", ETSI EN 302 304, 2004

[3] ETSI, "IP Datacast over DVB-H: Architecture", ETSI TR 102 469, 2006