Requirements and technical specifications of the chosen development platform and DVB-H front-end

Nikolai Daskalov ■ Atanas Boev

MOBILE3DTV

MOBILE3DTV project has received funding from the European Community's ICT programme in the context of the Seventh Framework Programme (FP7/2007-2011) under grant agreement n° 216503. This document reflects only the authors' views and the Community or other project partners are not liable for any use that may be made of the information contained therein.

MOBILE3DTV

MOBILE3DTV

Project No. 216503

Requirements and technical specifications of the chosen development platform and DVB-H front-end

Nikolai Daskalov, Atanas Boev

Abstract: This report describes the requirements and technical specifications for selected silicon solution sub-platforms for video encoding/decoding, DVB-H front-end and auto-stereoscopic LCD. The selection process includes the definition of specific requirements, shortlisting the available solutions and final selection of the best fit. The specifications of the selected platforms are delivered and checked against the requirements.

Keywords: OMAP, DVB-H, auto-stereoscopic LCD

Executive Summary

Well defined requirements for the development platform are crucial for the project success. Often, the requirements to be met are contradictory and selection of the final design is not obvious.

In this report, the requirements for video encoding decoding platform to be used for the design of the terminal devices in later project phases are defined. The technical specifications of the platform selected are disclosed and analysis about how they match the already defined requirements is executed to prove the selection.

Furthermore, a DVB-H front-end solution to be embedded in the terminal device is selected. The selected platform technical specifications are disclosed and analysis how they match the already defined requirements is executed as well.

The report addresses also the selection process of an auto-stereoscopic LCD to equip the terminal device with. While the requirements have been carefully defined, the selection process has not been completed at the time the report is prepared.

The report concludes with summarizing the further steps in bringing-up the selected sub-platforms.

Table of Contents

1. Development platform requirements

A number of objectives were targeted when the development platform for decoding and display of stereoscopic content was selected. Below is the list of the major ones:

- To be accepted by Tier 1 mobile phone vendors.
- To provide a means for connecting stereoscopic LCD and DVB-H receiver.
- To provide enough processing power to decode simultaneously at least two H.264 BP simulcast coded streams (QWVGA@25fps) or H.264 BP multi-view coded stream (two views) plus up-sampling in vertical direction by factor of two
- To provide means to implement custom type H.264 decoder as a base of multi-view or view+depth type of stereo video encoder
- To provide enough processing power to execute DVB-H stack, GUI and decoding.
- To provide means for dual camera simultaneous connection.
- To be capable to run HLOS (Linux, Symbian or WinMo).
- To have good means for debugging applications.
- To have EVM capable to connect DVB-H receiver and stereoscopic LCD.

2. Development platform specifications

The development platform selected was OMAP 3430 manufactured by Texas Instruments. General information about this platform can be found at TI webpage (http://focus.ti.com/pdfs/wtbu/ti_omap3family.pdf).

Features:

- New OMAP™ 3 architecture combines mobile entertainment with high performance productivity applications

- Industry's first processor with advanced Superscalar ARM® Cortex™-A8 RISC core enabling 3x gain in performance
- Industry's first processor designed in 65-nm CMOS process technology adds processing performance - 500MHz clock speed
- IVA™ 2+ (Image Video Audio) accelerator enables multi-standard (MPEG4, WMV9, RealVideo, H263, H264) encode/decode at D1 (720x480 pixels) 30 fps
- Integrated image signal processor (ISP) for faster, higher-quality image capture and lower system cost
- Flexible system support
- Composite and S-video TV output
- XGA (1024x768 pixels), 16M-color (24-bit definition) display support
- Flatlink™ 3G-compliant serial display and parallel display support
- High Speed USB2.0 On-The-Go support
- Seamless connectivity to Hard Disk Drive (HDD) devices for mass storage
- Leverages SmartReflex™ technologies for advanced power reduction
- M-shield™ mobile security enhanced with ARM TrustZone™ support
- Software-compatible with OMAP™ 2 processors
- HLOS (Linux, Symbian, WinMo) support for customizable interface

We would like to emphasize features especially appropriate for the MOBILE3DTV project goals. Demanding applications such as stereo-video decoding and playing can be parallelized employing different cores (ARM, IVA and ISP) with sufficient speed provided by the high clock rate. XGA display support allows for choosing high-resolution LCD. Power reduction technologies enable the implementation of power-demanding applications such as rendering stereo-video with increased backlight. Various interfaces allow for easy embedding extra modules, e.g. the DVB-H front-end. The support of high-level operating systems is also a key

factor for rapid application development. The system architecture of OMAP 3430 is given in Figure 1 and all features of the OMAP 34xx family are listed in Table 1 (Figure and technical data provided bit TI).

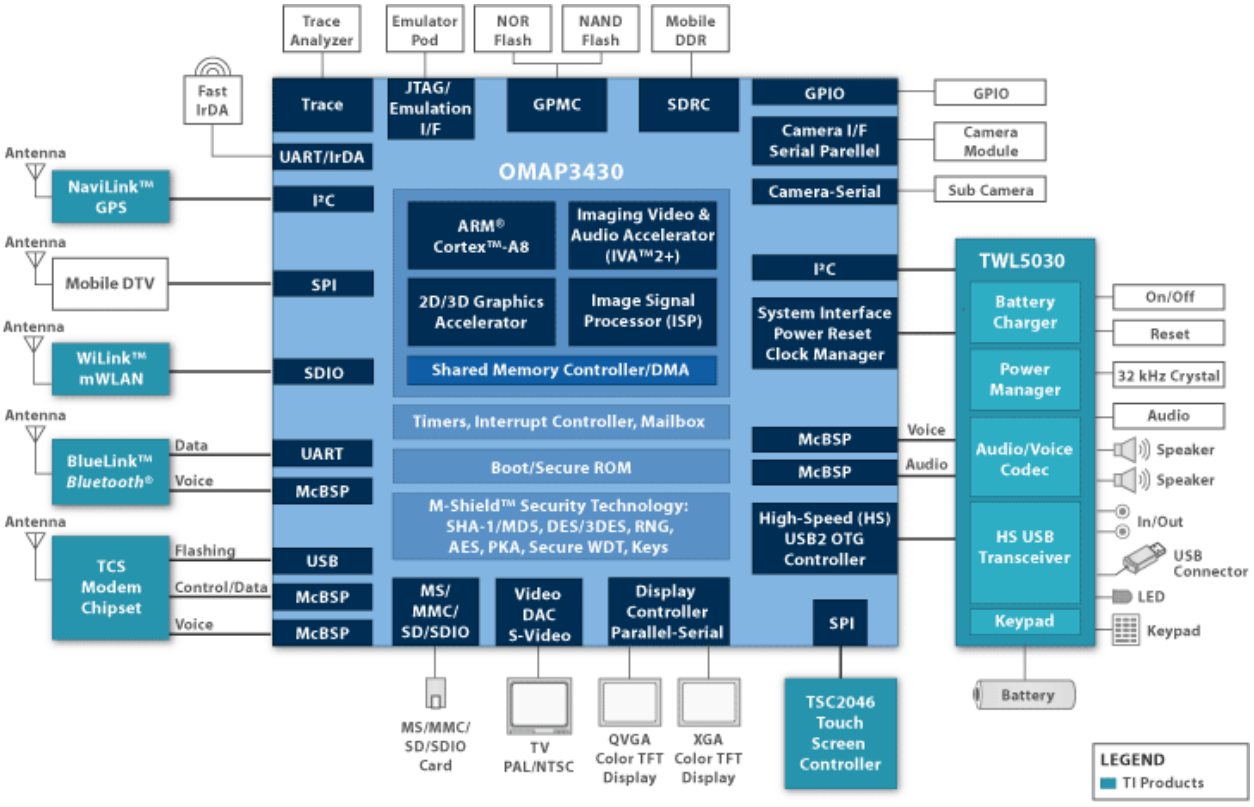

Figure 1. Development platform system diagram

Table 1: OMAP3 family technical data

Function	Block	OMAP3430	OMAP3420	OMAP3410
Application Platform	ARM	Cortex A8 w/Neon 500MHz (1.2V) 600MHz (1.35V)	Cortex A8 w/Neon 332MHz (1.2V) 600MHz (1.35V)	Cortex A8 w/Neon 266MHz (1.2V) 320MHz (1.35V)
	L1 Data/Instruction Cache	16KB/16KB	16KB/16KB	16KB/16KB
	L2 Data/Instruction Cache	256 KB	128KB	64KB
	DSP Megacell	IVA2.2 TMS320DMC64+ DSP core 360MHz (1.2V)	IVA2.1 TMS320DMC64+ DSP core 360MHz (1.2V)	IVA2.1 TMS320DMC64+ DSP core 266MHz (1.2V)
	L1 Data Cache/RAM	32 KB/48KB	32 KB/48KB	32 KB/48KB
	L1 Instruction Cache	32 KB	32 KB	32 KB
	L2 Data/Instruction Cache	64 KB	64 KB	64 KB
	Shared L2 RAM (for IVA2.2 HWA)	32KB	NO	NO
	L3 Interconnect	Dolphin - Asynchronous	Dolphin - Asynchronous	Dolphin - Asynchronous
	L4 Interconnect	One s3220_bpm	One s3220_bpm	One s3220_bpm
	Boot Mechanism	ROM-code (GP/HS)	ROM-code (GP/HS)	ROM-code (GP/HS)
	Process	65 nm (C021.M)	65 nm (C021.M)	65 nm (C021.M)
	Power Management Companion IC	Triton2	Triton2	Triton2
	AVS (Automatic Voltage Scaling)	YES	YES	YES
Multimedia	HW 3D Graphic Coprocessor	SGX530 OpenGL ES2.0 (110MHz)	SGX530 OpenGL ES2.0 (55MHz)	NO
	HW Audio and Video Coprocessor	IVA2.2	IVA2.1	IVA2.1
	HW Accelerators (for IVA2)	iME, iLF, iVLCD, Sequencer	NO	NO
	TV-Out	YES - Composite + TV Amps + TV Detect + S-Video	YES - Composite + TV Amps + TV Detect + S-Video	YES (Optional)
Memory	On-chip memory	96KB ROM 64KB SRAM	96KB ROM 64KB SRAM	96KB ROM 64KB SRAM

Serial Communication interfaces	McBSP	**YES (5)**	**YES (5)**	**YES (5)**
	McSPI	**YES (4)**	**YES (4)**	**YES (4)**
	MSI2C	**YES (3) HS**	**YES (3) HS**	**YES (3) HS**
	MIPI-HSI (SSI)	**YES (2)**	**YES (2)**	**YES (2)**
	UART_IRDA_CIR	**UART Only (2)**	**UART Only (2)**	**UART Only (2)**
	UART_IRDA_CIR (TV remote)-3	**UART3/IRDA (SIR/MIR/FIR)**	**UART3/IRDA (SIR/MIR/FIR)**	**UART3/IRDA (SIR/MIR/FIR)**
	USB 1.1 Host / Client	**YES Host/Client -FS (3 ports)**	**YES Host/Client -FS (3 ports)**	**YES Host/Client -FS (3 ports)**
	USB 2.0 Host / Client	**YES Host/Client -FS/HS (3 ports)**	**YES Host/Client -FS/HS (3 ports)**	**YES Host/Client -FS/HS (3 ports)**
	USB 1.1 OTG	**YES-FS (1 port)**	**YES-FS (1 port)**	**YES-FS (1 port)**
	USB 2.0 OTG	**YES - (1)HS (1 port each) interface to transceiver is ULPI12**	**YES - (1)FS & (1)HS (1port each) interface to transceiver is ULPI12**	**YES - (1)FS & (1)HS (1port each) interface to transceiver is ULPI12**
	HDQ - 1WIRE	**YES**	**YES**	**YES**
Removable Media interfaces	Memory Stick Pro	**YES**	**YES**	**YES**
	uSIM	**YES**	**YES**	**YES**
	MMC_SDIO-1	**Std HS MMC - intgr TCVR 8 bit; 1.8V & 3.0V**	**Std HS MMC - intgr TCVR 8 bit; 1.8V & 3.0V**	**Std HS MMC - intgr TCVR 8 bit; 1.8V & 3.0V**
	MMC_SDIO-2	**Std HS MMC 8 bit 1.8V; 4bit 3.0V (Ext TCVR)**	**Std HS MMC 8 bit 1.8V; 4bit 3.0V (Ext TCVR)**	**Std HS MMC 8 bit 1.8V; 4bit 3.0V (Ext TCVR)**
	MMC_SDIO-3	**8bit; 1.8V**	**8bit; 1.8V**	**8bit; 1.8V**
	Integrated MMC transceiver	**YES**	**YES**	**YES**
External Memory Interfaces	DRAM interface	**165MHz - 16bit/32bit**	**165MHz - 16bit/32bit**	**165MHz - 16bit/32bit**
	Flash Interface	**100MHz - 8bit/16bit**	**100MHz - 8bit/16bit**	**100MHz - 8bit/16bit**
	NAND Flash Controller (NFC)	**YES**	**YES**	**YES**
GPIO / Timers	GPIO	**YES (6)**	**YES (6)**	**YES (6)**
	32KHz sync timer	**YES**	**YES**	**YES**
	GPTIMER	**YES (12)**	**YES (12)**	**YES (12)**
	WDTIMER1	**YES (3)**	**YES (3)**	**YES (3)**
Debug	Emulation - CSTI	**YES**	**YES**	**YES**
	JTAG	**YES**	**YES**	**YES**
	ETM (9/11)	**YES**	**YES**	**YES**
	TI-XTI	**4-bit/DDR**	**4-bit/DDR**	**4-bit/DDR**
	Command Write Trace	**YES**	**YES**	**YES**
Other	MAILBOX	**Mailbox to IVA2.2**	**Mailbox to IVA2.2**	**Mailbox to IVA2.2**
Package	POP - Package Stacking	**12x12 - 0.4pitch**	**12x12 - 0.4pitch**	**12x12 - 0.4pitch**

Camera and Display Interfaces				
	Image Pipeline	YES (Optional)	YES (Optional)	YES (Optional)
	Parallel Camera Interface	YES-10bit	YES-10bit	YES-10bit
	Serial Camera Interface (CSI)	CSI1/CCP2 + CSI2	CSI1/CCP2 + CSI2	CSI1/CCP2 + CSI2
	Camera Resolution/Format	12Mpix	5Mpix	3Mpix
	Camera Sensor Type	CMOS/CCD	CMOS/CCD	CMOS/CCD
	Camera color space (HW/SW)	YES	YES	YES
	Parallel LCD Interface (parallel/RFBI)	Parallel + RFBI	Parallel + RFBI	Parallel + RFBI
	Serial LCD Interface (HSSDIF)	CMADS2000, Flatlink™ 3G, MIPI DSI (1.6Gbps, 2 DL)	CMADS2000, Flatlink™ 3G, MIPI DSI (1.6Gbps, 2 DL)	CMADS2000, Flatlink™ 3G, MIPI DSI (1.6Gbps, 2 DL)
	Max Resolution	XGA	VGA	VGA
	Pipeline	GUI, Video 1, Video 2	GUI, Video 1, Video 2	GUI, Video 1, Video 2
	Downsampling	/4 in each direction	/4 in each direction	/4 in each direction
	Alpha Blending	Yes	Yes	Yes
	Color LCD Controller, Color Depth	Color & monochrome; 24bit	Color & monochrome; 24bit	Color & monochrome; 24bit
	Parallel LCD Interface (parallel/RFBI)	RFBI	RFBI	RFBI
	Serial LCD Interface (HSSDIF)	DSI	DSI	DSI
	Resolution	QVGA	QVGA	QVGA
Security	AES	YES	YES	YES
	DES3DES	YES	YES	YES
	Magic Gates (Ms_PRO)	YES	YES	YES
	PKA	YES - Fast PKA	YES - Fast PKA	YES - Fast PKA
	RNG	YES	YES	YES
	Secure ROM/RAM	112KB/64KB	112KB/64KB	112KB/64KB
	SHA1MD5	YES	YES	YES
	Firewall	SMX Firewall	SMX Firewall	SMX Firewall
	TrustZone	YES	YES	YES

3. Stereoscopic LCD requirements

- Size – Preferably around 4”. Typically, a mobile device has 2.6” to 3” display size. The limiting factor here is a 3D artifact called “frame violation”. “Frame violation” occurs when an object which should appear as if floating in front of the screen is partially occluded by the frame display. To overcome this problem, content providers avoid having 3D objects near the screen borders. As a consequence, the absolute size of an auto-stereoscopic display cannot be too small. A good compromise between size and portability can be achieved by displays of sizes of 3.2 to 4’’. An example is the 4.1” display of Nokia N800/810.

- Resolution – the resolution of each view is a fraction of the fully-addressable resolution of the display. Typical QVGA display with two views would have resolution of 160xRGBX240 for each view. When the views have low resolution, the coarser step between two disparity values limits the apparent levels of depth of the screen, and could cause the so called “cardboard effect”. “Cardboard effect” is when a solid 3D object appears as being made of a number of separate, parallel layers. An acceptable resolution is 800x480 at 225dpi.

- Aspect ratio – should be landscape, 16x9 seems more modern for TV applications, but 4x3 is also acceptable.

- Number of views – more views will result in smaller resolution per view. As we target a portable device with a single observer, two views should be enough. Furthermore, choosing two views gives freedom to experiment with side-by-side or source-plus-depth video, without format conversion on the device.

- Sub-pixel orientation – When the display is in portrait mode, the sub-pixels should appear as vertical stripes, otherwise the resolution in both directions would differ too much. If the display is sold as a completed auto-stereoscopic 3D display, this is already taken into consideration.

- Screen brightness – The brightness of a stereoscopic display is very important factor. Auto-stereoscopic displays suffer from so called “accommodation-convergence rivalry”, which appears when the apparent and the focal depth of an object are different. Brighter

display causes the pupil to contract, which expands the focal depth of the eye. The brighter the display is, the better.

- Crosstalk – this is a parameter which measures how much of the image intended for one eye is seen in the other eye. The smaller the crosstalk, the better. For 2-view auto-stereoscopic displays a good value is < 5-7%.

- Observation angle of a view – the observation zones of the views in an auto-stereoscopic display are placed like a fan in front of it. When the eye of the observer moves from left to right in front of the screen, it sees alternatively left and right views. If every view spawns across a small observation angle, the user should position himself on a very precise position to see a proper 3D image – in other words, the “sweet spot” is too small. A good auto-stereoscopic display has wider observation zone of each view (e.g. >15-20 degrees) which gives the user freedom some freedom of position while still yielding good stereoscopic image.

- Type of optical element – there are two major types of auto-stereoscopic LCD displays – using lenticular sheet, and using parallax barrier. Usually, the ones using lenticular sheet allow more light to pass through, and have higher brightness. The displays using parallax barrier are easier to produce and are more widespread. Also, the gaps between the pixel elements in each view are more visible when using parallax barrier. However, when the pixels density is high, displays using parallax barrier also produce stereoscopic images with sufficient quality.

- Power – it should be a low power display with LED type backlit.

- Interface – parallel, PanelLink or similar serial interface.

4. Stereoscopic LCD specifications

No suitable displays have been identified so far.

5. DVB-H platform requirements

Several objectives were targeted when the DVB-H Front-End for receiving of stereoscopic content was selected. Below is the list of the major ones:

- To be accepted by Tier 1 mobile phone vendors.
- To have low power consumption
- To have form factor, small enough to fit in mobile device
- To provide development kit for rapid system integration
- To provide good support in development process
- To provide software API for HLOS (Linux, Symbian or WinMo)
- To provide hardware interface, good for easy system integration

6. DVB-H Front-End features

We selected DIB9080H module from DiBcom because it fit very well to our requirements.

- DiBcom is a company that specializes in developing and marketing highly integrated, low power system-on-chips for use in consumer products such as TV in automobiles, TV on laptop, PC and Portable Multimedia Player (PMP), mobile devices (mobile phone, PDA), and portable TV decoders (Set Top Boxes, Integrated LCD TV). DiBcom has shipped over 10 Million Mobile TV Components to customers such as Nokia, LG, Samsung, ASUS, Garmin, JVC and others.
- DIB9080H is a module, specially designed for a mobile device, complying with the existing DVB-H standards. Typical power consumption of the DVB-H front-end is 50mW for 500Kbits/s.
- DIB9080H has small form factor perfectly suited for devices like mobile phones. Its size is about 35x15x2 mm.
- DIB9080H comes as development kit including DVB-H front-end, SDK, antenna and sample applications. The block-diagram of the front-end is given in Figure 2.

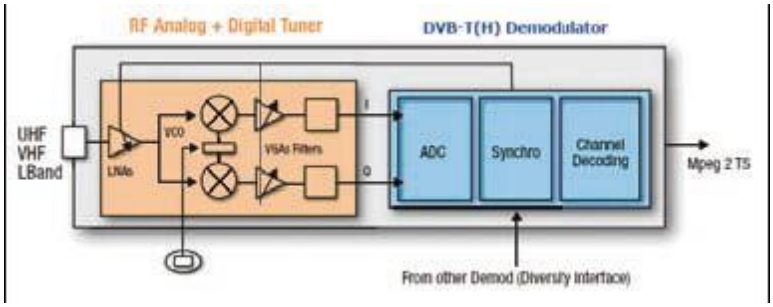

Figure 2: Block diagram of DIB9080H (provided by Dibcom)

- DIBcom dedicated resources to support us during this project
- The development kit offers libraries for Linux and Windows operating systems. SDK block diagram is shown in Figure 3.

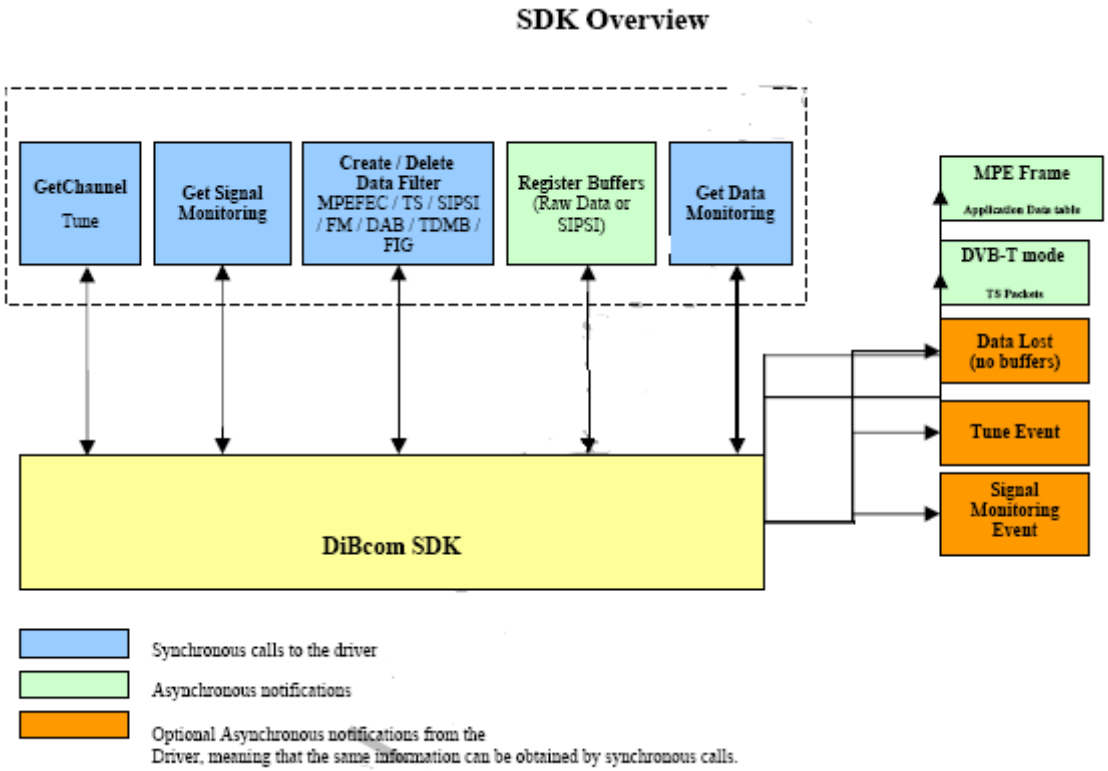

Figure 3: SDK for DIB9080H (provided by Dibcom)

DVB-H front-end interfaces via SDIO interface, which is directly supported by the OMAP platform, chosen for the project.

7. Results

The choice has been made for development platform. The silicon vendor Texas Instruments (TI) was contacted and support confirmed. TI provided one EVM of OMAP 3430 and MMS team started studying the platform in terms of hardware and software capabilities and application possibilities. Today the team is in position to develop drivers, plug-ins, and to embed additional modules.

Many efforts were spent on finding suitable 3D optics for enabling auto-stereoscopic LCD. While the technology seemed matured, it is in very early prototyping stage and there are no “off-the-shelf” products. Even though, some of the leading companies in the field, which were contacted, declared that very soon they will have their products on the market. Solutions with different level on maturity are being considered. The main issue is to precisely meet the formulated requirements. Having a spectacular auto-stereoscopic display is of crucial importance for accepting the whole mobile 3DTV technology.

DVB-H kit (receiver, adapter board and reference SW) was received from Dibcom and support secured. Bring-up on PC is ongoing.

DecTek modulator obtained for creating the DVB-H transmission environment (DVB-H test channel). A test-bed, based on the DecTec transmitter and Dibcom DVB-H receiver, and for transmitting and receiving MPEG2 transport streams has been set up. Three identical test-bed channels (at MMS, TTY and METU sites) are being set up.

8. Short-term plans

MMS team will continue the work on developing the project applications on the selected platform. A stereo-video player application to be used for subjective testing is under development. Work started with TI for getting the knowledge of the DSP used in the platform for

content decoding. A source code is being studied in order to be able to modify it for the goals of the project.

Work is continuing to find LCD vendor. Getting marketing samples (MS) from a leading vendor has been negotiated. Contacts with other vendors have been maintained as well. While looking for display solution, the development of the player and decoder continues targeting simultaneous plays of the two-channel decoded video.

Test DVB-H receiver and stack in PC environment and port it for selected platform. Test DVB-H transmissions using the test-bed at MMS and synchronize with the streaming applications being studied at other partners' sites.

Mobile 3DTV Content Delivery Optimization over DVB-H System

MOBILE3DTV

MOBILE3DTV - Mobile 3DTV Content Delivery Optimization over DVB-H System - is a three-year project which started in January 2008. The project is partly funded by the European Union 7th RTD Framework Programme in the context of the Information & Communication Technology (ICT) Cooperation Theme.

The main objective of MOBILE3DTV is to demonstrate the viability of the new technology of mobile 3DTV. The project develops a technology demonstration system for the creation and coding of 3D video content, its delivery over DVB-H and display on a mobile device, equipped with an auto-stereoscopic display.

The MOBILE3DTV consortium is formed by three universities, a public research institute and two SMEs from Finland, Germany, Turkey, and Bulgaria. Partners span diverse yet complementary expertise in the areas of 3D content creation and coding, error resilient transmission, user studies, visual quality enhancement and project management.

For further information about the project, please visit **www.mobile3dtv.eu**.

Tuotekehitys Oy Tamlink
Project coordinator
FINLAND

Tampereen Teknillinen Yliopisto
Visual quality enhancement,
Scientific coordinator
FINLAND

Fraunhofer Gesellschaft zur Förderung der angewandten Forschung e.V
Stereo video content creation and coding
GERMANY

Technische Universität Ilmenau
Design and execution of subjective tests
GERMANY

Middle East Technical University
Error resilient transmission
TURKEY

MM Solutions Ltd.
Design of prototype terminal device
BULGARIA

MOBILE3DTV project has received funding from the European Community's ICT programme in the context of the Seventh Framework Programme (FP7/2007-2011) under grant agreement n° 216503. This document reflects only the authors' views and the Community or other project partners are not liable for any use that may be made of the information contained therein.