Broadcast Mobile TV

MDA – Singapore Market

January 4th, 2008

CONTENTS

GLOSSARY

3GPP	3rd Generation Partnership Project
A/V	Audio and Visual
AMR-WB	Adaptive Multirate - Wideband
AVC	Advanced Video Coding
BIFS	Binary Format for Scenes
BMCO	Broadcast Mobile Convergence
BTS	Base Station
C/N	Carrier to Noise
CA	Conditional Access
CDMA	Code Division Multiple Access
COFDM	Coded Orthogonal Frequency Division Multiplexing
CTA	Clear to Air
DAB	Digital Audio Broadcast
DRM	Digital Rights Management
DVB-H	Digital Video Broadcast - Handheld
DVB-SH	Digital Video Broadcast – Satellite Handheld
ESG	Electronic Service Guide
ETSI	European Telecommunications Standards Institute
FEC	Forward Error Correction
FFT	Fast Fourier Transform
FLO	Forward Link Only
FPS	Frames per second
FTA	Free to Air
HE-AAC	High Efficiency – Advanced Audio Coding
IEEE	Institute of Electrical & Electronic Engineers
IMT	International Mobile Telecommunications
IP	Internet Protocol
IPDC	Internet Protocol Data Casting
ITU-R	International Telecommunications Union - Radio
MBMS	Multimedia Broadcast Multicast Service
MFN	Multiple Frequency Network
MPE	Multi Protocol Encapsulation
MPEG	Moving Pictures Expert Group
NOC	Network Operation Centre
OMA	Open Mobile Alliance
OSF	Open Security Framework
QAM	Quadrature Amplitude Modulation

QCIF	Quarter Common Intermediate Format (176x144 pixels)
QoS	Quality of Service
QPSK	Quadrature Phase Shift Key
QVGA	Quarter Video Graphics Array (320x240 pixels)
RS	Reed Solomon
SFN	Single Frequency Network
SMS	Short Message Service
SPP	Service Purchase and Protection
TDM	Time Division Multiplexing
T-DMB	Terrestrial Digital Multimedia Broadcast
TIA	Telecommunication Industry Association
UHF	Ultra High Frequency
VHF	Very High Frequency

1 Introduction

The scope of the document is to assess the main available standards for Mobile TV.

Based on studies and fair comparisons, Alcatel-Lucent will recommend a standard that would be the best suitable for Mobile TV Broadcast in Singapore.

Network based mobile TV solutions like Unicast and MBMS are not considered here. The document will focus specifically on broadcast mobile TV. In addition, satellite broadcast Mobile TV is also beyond the scope of this document.

Excluding the pure satellite systems and network-based component of Mobile TV, Alcatel-Lucent is proposing to study:

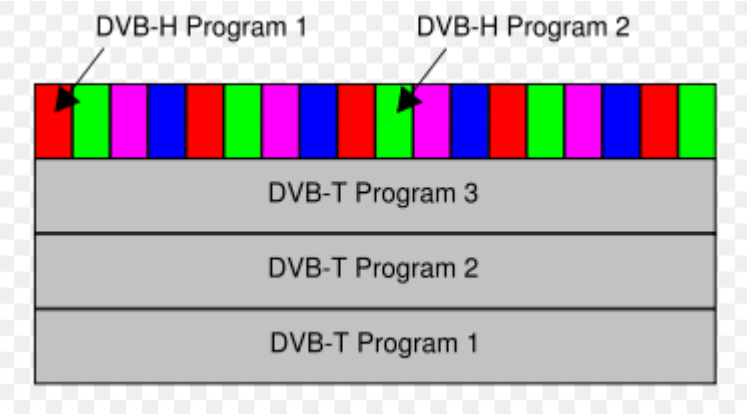
1. Digital Video Broadcast for Handheld (DVB-H) and the evolution to the DVB-SH standard
2. Terrestrial Digital Multimedia Broadcast (T-DMB)
3. Forward Link Only (MediaFLO)

2 Relevant Broadcast Mobile TV Standards

2.1 Digital Video Broadcast – Handheld (DVB-H) and Evolution to DVB-SH

DVB-H is based on the digital terrestrial broadcast standard DVB-T. DVB-T is successfully deployed in many places worldwide and mainly throughout Europe. Changes to the DVB-T standard were made, among other features, to incorporate power saving features and improve mobility.

As the DVB-H is a further development of DVB-T and uses the same radio system, they can co-exist in a network even sharing a multiplex. All services are defined individually so that it is possible to multiplex not only video and audio, but radio-only signals thus enabling also digital mobile radio reception.

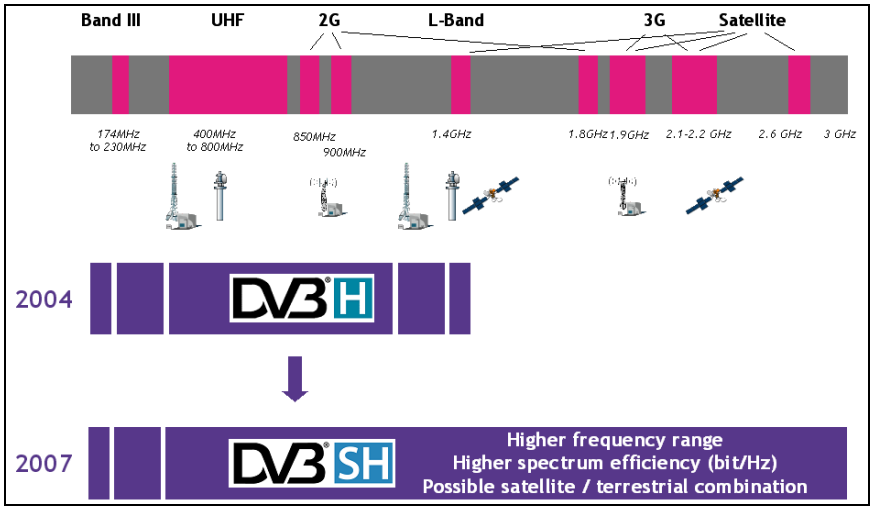


DVB-H framestructure

is being deployed in nearly 50 pilots and commercial deployments across the globe. Several of those have lead to commercial launches – Albania, Finland, India, Italy and Vietnam. Several other countries are in a process of launching services commercially either during 2H 2007 or 1H 2008, e.g. Germany, Spain, Malaysia, Netherlands, Austria, Czech Republic, Sweden, Indonesia, Philippines and Sri Lanka to name a few. All elements of DVB-H are standardized by ETSI and all documents are freely available.

The status of public trials and deployments is freely available and maintained by the DVB project organization [http://www.dvb-h.org/services.htm].

is defined as a system that is able to deliver IP based media content and data to handheld terminals via satellite or terrestrial transmission. The DVB-SH system has been designed for frequencies below 3 GHz, typically the UHF, L band and S band. It complements the existing DVB-H physical layer standard and like its sister specification (DVB-H) uses the DVB IP Datacast (IPDC) set for content delivery, electronic service guide and service purchase and protection standards.



DVB-SH includes features such as turbo coding for forward error correction and a highly flexible interleaver in an advanced system designed to cope with the hybrid satellite/terrestrial network topology. Satellite transmission (if any) ensures wide area coverage, with a terrestrial component assuring coverage where the satellite signal cannot be received (or where there is simply no satellite available), as may be the case in built-up areas (indoor coverage). DVB-SH in fact specifies two operational modes. SH-A specifies the use of COFDM on both satellite (if any) and terrestrial links with the possibility of running both links in SFN mode. SH-B uses a Time Division Multiplexing (TDM) on satellite (if any) with COFDM on the terrestrial link. The DVB Steering Board approved the DVB-SH specification on February 14th 2007.

The DVB-SH terrestrial transmission only is to be assessed in this document.

DVB-SH is been also deployed in nearly 10 pilots and trial deployments across the globe in Italy, Spain, France, Finland, Portugal and USA.

2.2 Media Forward Link Only (MediaFLO)

is designed specifically for mobile applications and for wireless multimedia services. It was designed for the efficient distribution of multimedia content to multiple users.

The technical characteristics of the Forward Link Only physical layer are described in the context of the identified requirements. The result is a new mobile broadcast technology, known as Forward Link Only technology.

Standardizing of the Forward Link Only technology has been achieved by the Telecommunications Industry Association (TIA) as Standard TIA-1099 and is further coordinated through the FLO Forum, www.floforum.org.

Media FLO trials have been performed in the following locations:

1. Taiwan – China Network Systems and Taiwan TV
2. Hong Kong – PCCW
3. UK – BSkyB – two trials

Commercial deployment with MediaFLO USA with carrier partners Verizon is already launched and AT&T is expected to launch its Mobile TV service in Q1, 2008.

Two joint ventures in Japan with KDDI and Softbank Mobile are in progress. MediaFLO services will be launched once spectrum is made available.

2.3 Terrestrial - Digital Multimedia Broadcast (T-DMB)

With radio being consumed in a very similar way to mobile TV, the DAB community soon realized that the addition of a mobile TV layer to the DAB standard was an important step forward and a way of delivering radio and mobile TV in a cost effective manner. Since DAB has a flexible transport and is targeted at fixed/portable/mobile devices it was a simple step to add video services to the standard. These video services are generically called Digital Multimedia Broadcasting (DMB), which received ETSI standardization in July 2005.

DMB allows video services at a range of video bit rates and frame rates using H.264 video coding along with a tool box of audio codecs to be added to the DAB base standard. DMB also upgrades the data services of DAB by adding new data services such as MPEG-4 BIFS, traffic and travel information, middleware, conditional access and voice applications.

Since DMB is based on the DAB standard the two can share the same network. This makes DMB a very cost effective solution for many countries who want both digital radio and mobile TV. Since most of Europe already has existing DAB infrastructures, DMB is proving to be a very attractive solution for many European broadcasters who are keen to take part in the mobile TV business.

The launch of the world's first Mobile TV services took place in Korea in December 2005 using DMB technology. Within 1 year, the DMB receives sold reach to 2.5 million. Currently there are more than 150 kinds of DMB receivers are available in the market, ranging from USB, mobile phone to in car and personal multimedia player receivers. With the involvement of Chinese receiver manufactures and IC design house the price of the DMB receivers continues to decline.

The World DMB Forum is responsible for promoting and coordinating DAB/DMB systems based on the Eureka 147 standard. (www.worlddab.org)

3 Technical Requirements of a Mobile TV System

The list below highlights some of the technical requirements that the Mobile TV should conceptually have. This list was compiled mainly from the end user and network infrastructure reference point that is highly relevant to the Singaporean environment.

Note: this list does not include terminals and devices, techno-economic business plan studies nor take content packaging and aggregating into view.

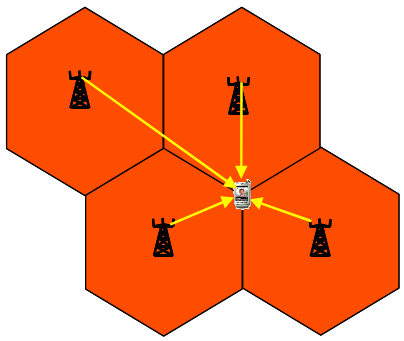
The list below shows some of the more important features that the Mobile TV system should have.

3.1 Radio Bearer and Frequency Bands

The system should use frequency bands from the sub 1 GHz region as this promotes greater propagation reach and minimizes the number of transmitting stations.

To efficiently use the channel bandwidth, the Mobile TV system must support 8 MHz bandwidth in the UHF band (Band IV & V). For Band III, the bandwidth requirement is 7 MHz or in multiples of 1.75 MHz. The bandwidths specified here are based on current Singaporean spectrum allocations for analog TV broadcast.

Mobile TV Systems must support both Single Frequency Networks (SFN) and Multiple Frequency Networks (MFN). This is to ensure that scarce spectrum is efficiently used.



SFN

Mobile TV systems must support mobility of at least 110 km/h. This is to cater for in car usage in urban areas and also highways.

The practical upper frequency limit for broadcast Mobile TV is 742MHz. Any channels between 470-742 MHz can be used. Higher frequencies in the broadcast band would not be usable due to the interoperability requirements with cellular systems in 800/900 MHz band. At this time, studies are being conducted to ascertain the interference protection ratios required. There is an existing work item within ITU-R to address this issue.

ITU-R Agenda Item 1.17
"to consider the results of sharing studies between the mobile service and other services in the band 790-862 MHz in Regions 1 and 3, in accordance with Resolution COM4/13, to ensure the adequate protection of services to within this frequency band is allocated, and take regulatory actions as appropriate."

3.2 Channel Switching Time

The system should be capable of fast channel switching time and be capable of supporting a minimal set of ESG (electronic service guide). The channel switching time should be less than 5 sec when switching between channels.

Both these features are aimed at providing the end user with good mobile TV watching experience.

3.3 Device Battery Lifetime

The technology should be capable of implementing battery saving measures so that the Mobile TV devices/receivers reduce the amount of power consumption and hence extend the battery lifespan.

The system should be capable of supporting long continuous viewing time. From a full battery charge, it is expected that a continuous viewing time of at least 3 hours is expected.

This is also aimed at providing a good end user experience.

3.4 Encoding Format and Error Correction

The system should be capable of providing high quality audio and video stream via advanced digital encoding formats. In addition, the radio interface physical layer should include forward error correction mechanisms to increase robustness of the radio channel especially during mobility.

A flexible time interleaving should also be implemented in order to avoid service disruption due to mobility (in-car, etc…).

Because handheld devices have small antennas that require reception from many different locations they require a robust transmission system with solid error protection. To better match the handheld environment, the technology shall offer

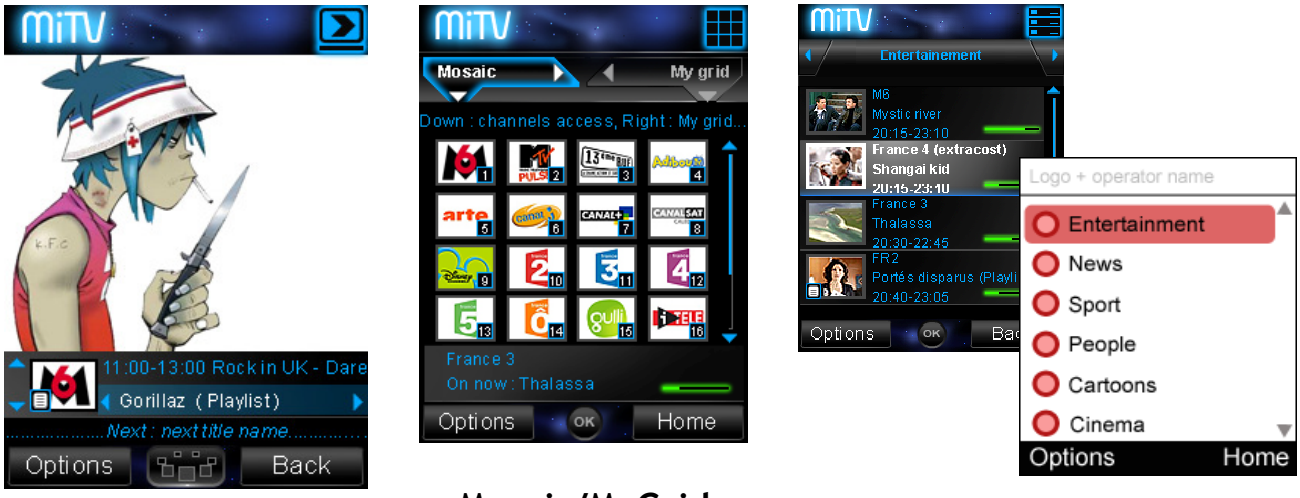
improved transmission robustness through the use of an additional level of forward error correction (FEC) at the some layer of protocol(s) for an improvement in C/N-performance and Doppler performance in mobile channels, also improving tolerance to impulse interference. The use of FEC is highly recommended due to benefits of usage.

3.5 Interactive Return Channel

The system should provide a return channel for interactive services. The return channel should utilize the packet data cellular channel of any suitable wireless system.

Besides supporting interactive services, this return path has many other advantages including service authentication, user identification, billing and charging and roaming.

- Interactivity shall use existing cellular (3G) networks, Wi-Fi network or any suitable wireless technology for interactivity.



Mosaic/MyGrid

Alcatel-Lucent Mobile TV Broadcast client

3.6 Content Protection

Service protection and content protection are two of the fundamental roles for security systems in the context of mobile TV. The terms service protection and content protection are often used interchangeably although they do have specific areas of applicability.
Service protection refers to controlling consumer access to content on a service provider's network. It's a subscription management role that grants access to a service, for example access to a defined set of audiovisual multimedia data for a specified length of time. Service protection protects the pipe and prevents theft of service. It does not define what happens to content once delivered to the client. Content protection deals with post-delivery usage rights which specify how content can be used according to permissions and constraints. It has the purpose of securing the individual pieces at the content level. Note that content delivered via free-to-air does not use any kind of content protection.

The requirements for a mobile TV Service Purchase and Protection (SPP) system would be:

• Open Standard Security System

A standard that is fully specified and leaves no room for variations gives a solid base for interoperable products. Service systems and terminals will interoperate without a compromise in system performance.

An Open Standard would therefore enable all manufacturers to produce products compatible with the standard as soon as there is business potential.

• Support of Horizontal markets

A horizontal market is a must for all new systems. Horizontal markets catalyst fast growth for new services as well as bring costs down rapidly for system components. The systems shall be standardized completely. They shall not contain any proprietary elements thus making independent, interoperable implementations possible. They should have a Trust Model that is provided by an external organization thus freeing the system users from single vendor lock in.

• Interoperability between terminals and networks

The success and future-proofness of any system requires that there are several equipment vendors present with products. And those products need to be interoperable to complete a success story. The systems shall be designed for interoperability. All elements of the specification shall be available and public information. There shall be several system providers for the technology, both for head ends as well as for terminals.

• Roaming of terminals and services

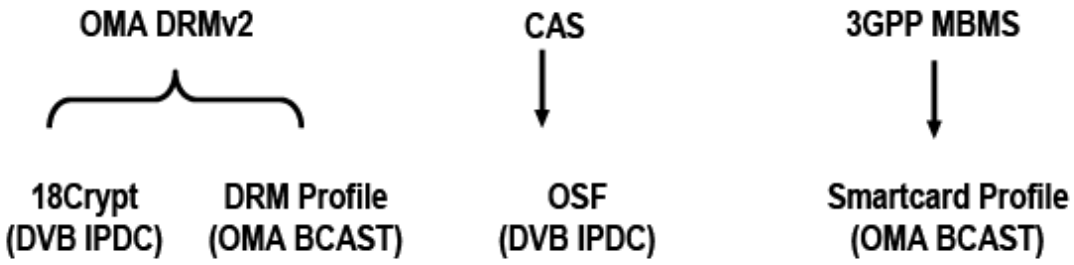
Any user of a mobile device is used to having access to different services – also while not in their home network area. Providing services to visiting customers is potentially a big business. This is true as long as terminals and services can roam and are not locked to a proprietary system. The standardized systems shall base their roaming on several technical measures:

- All terminals follow the one and same standard,
- All Broadcast systems follow the same standard
- Roaming is a key element of the specification. It has been designed to follow the roaming mechanisms currently used for mobile voice and data services.

• Need to enable versatile usage models:

- A/V, File-casting

The need for data-casting, not only TV services have been known from day one of Mobile broadcasting. There is a growing user demand for additional services, music, ring tones, SW applications etc. Any system that will be used for Service Protection must provide a mechanism to protect those services. It shall be used for all IP based content and it provides a secure bit pipe for transmitted content. In case an additional Digital Rights Management system is used, it shall not limit the choice of the system.



BCAST-Broadcast

CAS= Conditional Access System

IPDC= IP Data Casting

MBMS=Multimedia Broadcast / Multicast Service

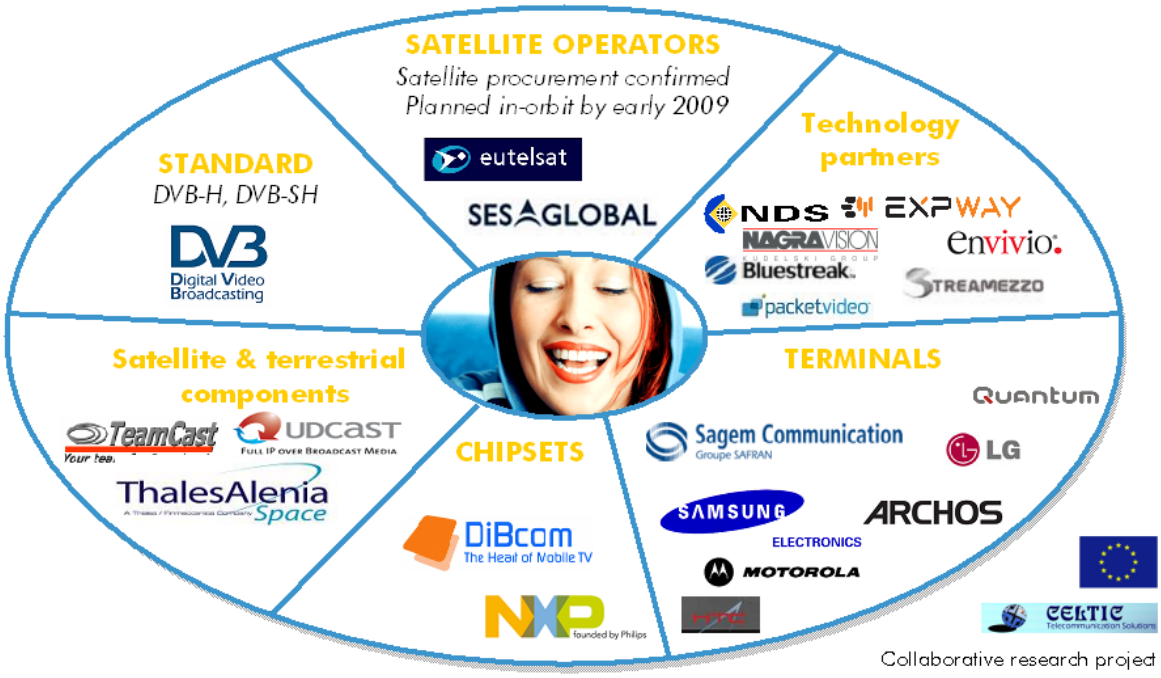
Technologies for Content and Service Protection

3.7 Thriving Ecosystem

The Mobile TV system should be part of a healthy and thriving eco-system. This has many advantages that can lead to:

- Devices mass produced available low cost
- Wide variety of device form factors
- Fast fixes of system bugs
- Economies of scale

The standard/technology shall allow for separate development of the handsets and head end security solution. The security solution shall be standardized and technically works across any head-end implementation that follows the standard. This means that end user equipment is portable amongst service providers who have chosen the same standard/technology, without changes to the handset.



DVB-SH ecosystem

4 Technical Analysis

Several technical studies of Mobile TV technologies exist. For example, the BMCO forum has done system neutral comparisons between several mobile TV technologies (Mobile Broadcast Bearer Technologies – A Comparison, January 2007 and Mobile Broadcast Technologies – Link Budgets, January 2007). These public documents compare various Mobile TV systems in similar conditions. These reports can be found on BMCO forum's website under the Studies and White Papers section [http://www.bmcoforum.org/index.php?id=53].

4.1 Radio Bearer and Frequency Bands

Parameter	DVB-H	DAB/T-DMB		FLO	DVB-SH (DVB-H evolution)
		Band III	L-Band		
Frequency range	VHF:174-230 MHz UHF: 470-862 MHz L-Band	174-240 MHz	1452-1492 MHz	VHF:174-230 MHz UHF: 470-862 MHz L-Band	Up to 3Ghz inclusive of VHF, UHF, L band and S band
Bandwidth	5,6,7,8, MHz	1.712 MHz		5,6,7,8 MHz	1.7,5,6,7,8, MHz
Spectral Efficiency (bits/s/Hz)	0.46 QPSK ½ MPE/FEC ¾ 1.86 64QAM 2/3 MPE/FEC 3/4	0.396 DQPSK1/4 1.221 DQPSK 4/5		0.47-1.8 (No RS code) 0.35-1.40 RS(16,12) outer code	0.49 in QPSK 1/3 TC 0.99 in 16QAM 1/3 TC Up to 2.15 in 16QAM 2/3
Modulation Type	COFDM	COFDM		COFDM	COFDM
Constellation	QPSK, 16QAM, 64QAM	DQPSK		QPSK, 16QAM	QPSK, 16QAM
Code rate	½..7/8	¼..4/5		Turbo code 1/3, ½, 2/3	Turbo code 1/5, 2/9, 1/4, 2/7, 1/3, 2/5, 1/2, 2/3
Guard interval	¼.1/8, 1/16, 1/32	1/4		1/8	¼.1/8, 1/16, 1/32
Guard interval time	224 µs to 7 µs	246 µs (Transmission Mode I)	62 µs (TM II) or 123 µs (TM IV)	69.2 µs to 92.2 µs	224 µs to 7 µs
FFT size	2k, 4k, 8k	256,512,1k,2k		4k	1k, 2k, 4k, 8k
Time interleaving	Yes with MPE-FEC	Yes (over 16 data burst = 384 ms)		Over 4 burst, 750 ms	Yes (up to 10s,

					typically 200 ms)
Hierarchical Modulation	Yes	Not necessary		Yes	Yes
Theoretical net data rates	Up to 27.7 Mbps	Up to 1.8 Mbps		Up to 14.9 Mbps	Up to 17.2 Mbps (8 MHz channel)
Practical net data rates	Up to 15 Mbps	Up to 1.4 Mbps		Up to 14.9 Mbps	Up to 17.2 Mbps (8 MHz channel)
Mobility	Using QPSK ½ 2k > 1,185 km/h 4k > 592 km/h 8k > 296 km/h	> 300 km/h DQPSK ½. Guard interval 256 us	Not stated	Using QPSK ½ Up to 500km/h	In UHF, up to 1000 km/h (2k mode/8 MHz channel) In S-band, up to 160 km/h (2k mode/5 MHz channel)
SFN cell size	Typ 60-100 km in 8k mode	70km (Band III)	37km (L-Band)	Not stated	In UHF, 67 km (8k mode/8 MHz channel) In S-band, 27 km (2k mode/5 MHz channel)

Table showing relevant bearer layer technical parameters for the 3 Mobile TV technologies (source: ITU-R, BMCO technical report and Alcatel-Lucent)

All 3 technologies meet the requirements of

- Frequency bands in the specified bands and supported bandwidth
- Single frequency network mode is supported
- Even in 8k mode, the mobility criterion is satisfied at legal Singaporean highway speeds.

Practical Considerations

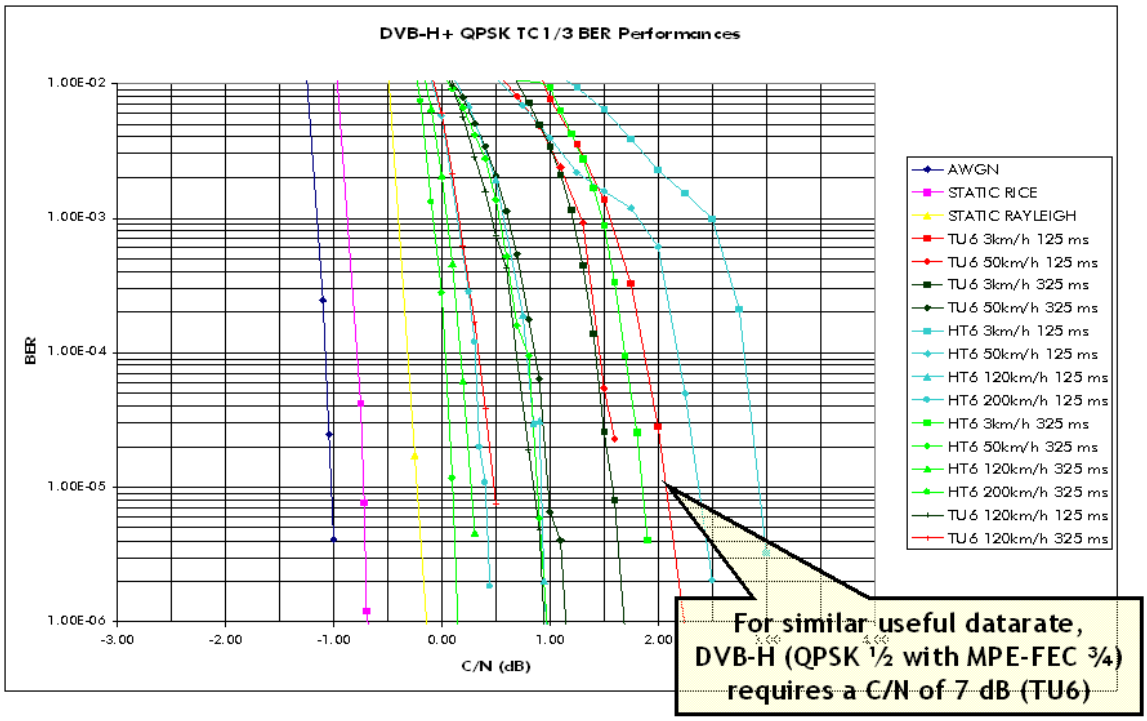
As the mobility criterion is satisfied, it is therefore recommended that the largest FFT size be used. This is ensures the flexibility of radio planning the cell sites due to ability to support large cell sizes.

While some standards promote high modulation scheme such as 64QAM and high spectral efficiencies and high throughputs, it is expected that to provide robust, low BER transmissions and extended coverage, it may be necessary to use a lower modulation scheme like QPSK. This has practical implications:

- Good in-building penetration

- Improved usability for in-car usage
- Minimize the number of transmission stations

All 3 standards meet the above technical requirements.



DVB-SH radio improvements towards DVB-H

4.2 Channel Switching Time and Device Battery Lifetime

Parameter	DVB-H/DVB-SH	T-DMB	MediaFLO
Channel switching time	From practical experiences 2-5 sec	384 ms (same ensemble) ~600ms (different ensemble)	Average 1.5sec
Device battery lifetime	Dependent on device	Dependent on device	4 hrs continuous
Supporting ESG	YES	YES	YES
Time slicing technology	Time slicing period > 100 msec to 40 sec.	At symbol rate 1	Super-frame per second
Low power consumption for handheld receivers	Time slicing (~90% power saving compared to continuous reception in the DVB-H receiver part) The viewing time is not limited by the DVB-H receiver but by the video/audio decoders, displays and speakers	Low power consumption feature of DAB is applied Optimized narrow bandwidth allows low system clock frequency and simple FFT calculation. Supports sub-channel decoding for selected service	Supports selective access to desired content (partial signal demodulation) which is achieved in both time and frequency domains Data is transmitted (synchronously) from the transmitter station to the handset every second. Each transmission has therefore 1 second duration and includes the information required by the receiver to demodulate only that portion of the data (service) that the user is interested in

Table showing relevant power saving techniques and channel switching times for the 3 Mobile TV technologies (source: ITU-R and BMCO technical report)

All 3 technologies do employ time slicing features and therefore power saving initiatives. Total continuous viewing times are generally device dependent.

Channel switching times are different for the 3 technologies ranging from < 1 sec for T-DMB to average 1.5 sec for MediaFLO and between 2 sec and 5 sec for DVB-H/DVB-SH.

4.3 Encoding Format and Error Correction

Parameter	DVB-H/DVB-SH	T-DMB	MediaFLO
Video Format	H.264/AVC	H.264	Enhanced H.264
Picture size	Max 400x224	Max QVGA (320x240)	QQVGA, QVGA, CIF, QCIF (176x144)
Frame rate	Max 30 fps	Up to 30 fps	Up to 30 fps
Video bit rate	Max 768 kbps	Max 1 Mbps Typ 256-544 kbps	Max 1 Mbps
Audio format	HE-AAC v2 mandatory AMR-WB+ optional	MPEG4 ER-BSAC HE-AAC for Europe	HE-AAC
Max audio rate	192 kbps for stereo	20-192 kbps	12 kbps and higher

Table showing relevant video and audio formats & parameters supported by the 3 Mobile TV technologies (source: ITU-R and BMCO technical report)

The 3 technologies supports very similar video/audio formats, video/audio bit rates, picture sizes and frame rates. Hence, it is expected that in good radio conditions, the audio and video quality between the 3 technologies should be similar.

4.4 Interactive Return Channel

Parameter	DVB-H/DVB-SH	T-DMB	MediaFLO
Provision of interactivity	Supports local and remote interactive applications using IMT-2000 and/or digital cellular networks or other IP connections Electronic service guide provides the basic access information to enable interactive services	Supports hypertext linkage using mobile telecommunication network and Internet MPEG-4 BIFS provides frame-synchronized overlay of animated text and graphics objects upon natural scenes	Interactivity content and applications use: –References to interactive services available on the devices or remotely located –Return channel using IMT-2000 networks, and/or other IP connections
Interoperability with mobile telecommunication networks	Same IP-based solutions, optimized for handheld device reception, used to enable delivery of services over both broadcast and mobile cellular networks (3GPP) Maximum harmonization with e.g. A/V codecs, payload formats, content delivery protocols	Support for traditional and mobile telecommunication network and Internet, e.g. IMT-2000 networks, IEEE 802.1x, etc.	Support for traditional voice and data services over mobile telecommunication networks such as IMT-2000 systems Platforms harmonization enabled via IP

Table describing interactivity and interoperability support for the 3 Mobile TV technologies (source: ITU-R and BMCO technical report)

From the studies conducted, the 3 technologies claim to support interactivity and interoperability with wireless mobile systems in particular GSM/UMTS.

However note at the time of writing, the team has not witnessed any live or trial mobile TV systems and related terminals that support the above claims. This item is recommended for future study.

4.5 Billing Subsystems and Service Authentication

Parameter	DVB-H(SH)/IPDC	OMA BCAST	T-DMB	MediaFLO
Service protection	2 profiles: OSF and 18Crypt	2 profiles: OMA DRM with extensions and Smartcard profile	CA system supporting AES128 scrambling.	FLO Forum Open CA
Content protection	TBC	2 profiles: OMA DRM with extensions and Smartcard profile	TBC	FLO Forum Open CA

Table describing service and content protection support for the 3 Mobile TV technologies (source: ITU-R and BMCO technical report)

All 3 technologies support their own form of service protection via proprietary conditional access (CA) systems. At this time of writing, CA is the being used exclusively in all Mobile TV deployments.

OMA BCAST is developing service and content protection standards based on DRM and Smartcard profiling. This standard is required to support service portability and roaming capabilities.

4.6 Roaming and Service Portability

In order to support roaming and service portability, it is imperative for the handheld terminals to conform to set standards. The terminals have to be flexible in supporting the various frequency and bandwidth requirements in the visiting network.

Technically, once technical issues on compatibility are solved, at least the accessing of clear-to-air content in the visiting network can be done.

In the future, it is expected that mobile TV consumers will expect to access local clear-to-air content in the visiting network.

5 Recommendations

Based on the above study, Alcatel-Lucent would recommend DVB-H/DVB-SH in Singapore that not only provides the best radio performances but also the most complete ecosystem in compliance with the Singaporean handset market, DVB-SH being the natural evolution of DVB-H in 2008.

6 Evolution from DVB-H to DVB-SH

DVB-SH was originally designed to accommodate satellite receiving handheld terminals. The standards are based on DVB-H building blocks as much as possible to avoid duplication. In order to provide exceptional user experience, the standards incorporate technology advances to increase robustness of the air interface mainly through use of turbo codes, advanced interleaving and antenna diversity techniques.

Originally, the SH standard was slated to be used in the S-band (2170-2200 MHz). However once this standard was formalized, it was clear that this standard could be extended for use in the UHF bands as there was substantial improvements to coverage.

Chipsets for the DVB-SH are being developed now and is expected to be available in 2008. Initial specifications show that the chipsets supports both UHF and S-Band and is compatible with DVB-H.

Key Improvements

The DVB-SH incorporates a number of changes compared to DVB-H.

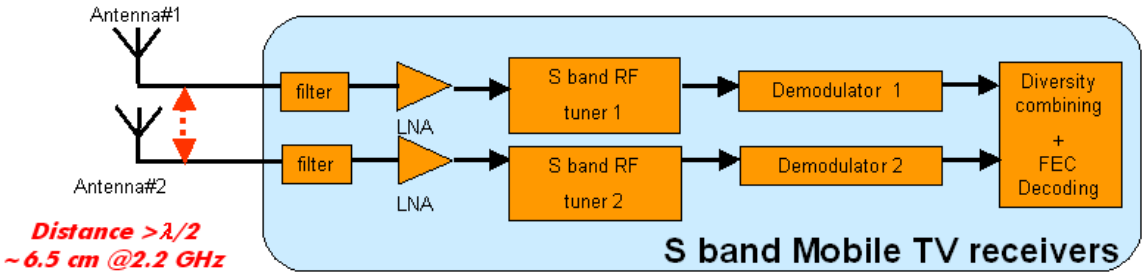
- More ratios on coding rates are available

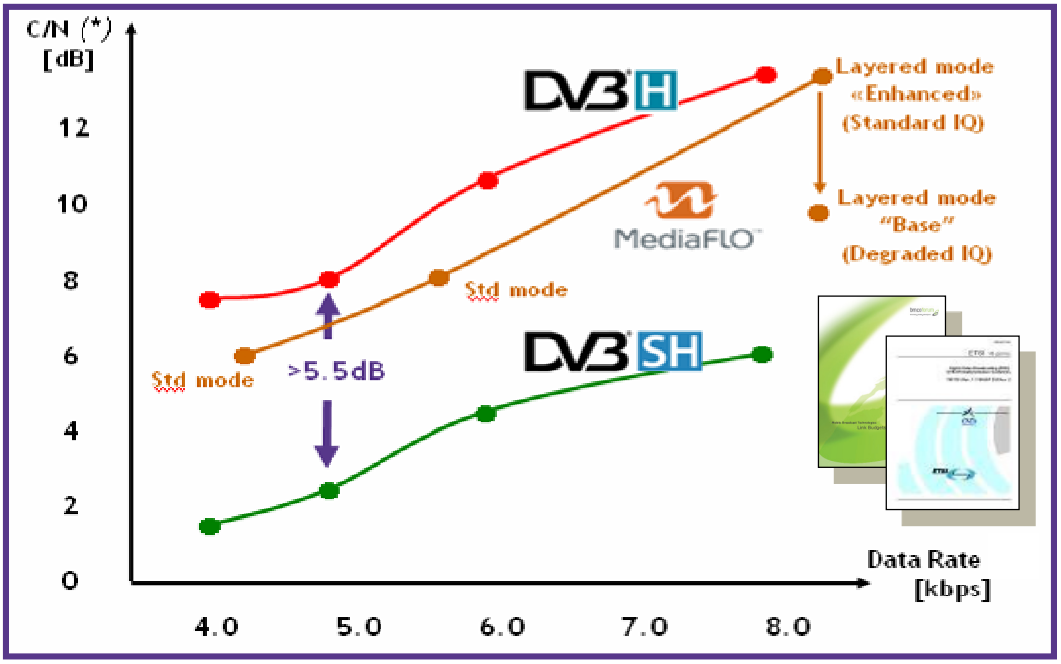
Modulation	Code Rate	Required C/N (*)	Data Rate (**)
QPSK	1/5	1.5 dB	1.481 Mbps
QPSK	1/4	2.8 dB	1.865 Mbps
QPSK	1/3	4.5 dB	2.469 Mbps
QPSK	1/2	7.5 dB	3.703 Mbps

Modulation	Code Rate	Required C/N (*)	Data Rate (**)
16QAM	1/5	6.0 dB	2.963 Mbps
16QAM	1/4	7.4 dB	3.703 Mbps
16QAM	1/3	9.5 dB	4.937 Mbps
16QAM	1/2	13.0 dB	7.406 Mbps

(*) TU6 @ 3 km/h including implementation loss (worst case) *(**) In a 5 MHz channel with GI=1/8*

- The omission of the 64QAM modulation scheme
- The inclusion of support for 1.7 MHz bandwidth and 1k FFT
- FEC using Turbo coding
- Improved time interleaving
- Support for antenna diversity in terminals





(*) TU6 propagation models at 300 Hz with a time interleaving of ***200 ms for DVB-SH*** *(IG values) - BMCO values for DVB-H/SH and MediaFlo*

Source: BMCO technical report

The results from BMCO forum shows the improvement of at least 5.5 dB on signal requirements between DVB-H and DVB-SH. The improvements to signal requirements translates to better in-building penetration, better in-car coverage and extension of outdoor coverage.

What does it mean?

either → For same CAPEX, **>2 times more data-rate** (more channels / video quality)

or → For the same number of channels / video quality, **<1/2 CAPEX**