Mobile Television Services Implementation Stategies and Roadmap

- Project on Development of a Roadmap for Mobile Television Broadcasting Deployment and Regulation in Thailand

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Mobile Television Services:

Implementation Strategies and Roadmap

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This report has been prepared by International Telecommunication Union (ITU) experts Peter Walop and Sharad Sadhu. This work was carried out in the framework of the Voluntary Contribution Agreement between ITU and the National Broadcasting and Telecommunications Commission of Thailand (NBTC). This report covers the results of an implementation study, carried out in the period September 2015 to July 2016.

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Content

Introduction

By virtue of Section 27 and Section 49 of the Act on Organization to Assign Radio Frequency and to Regulate the Broadcasting and Telecommunications Services B.E. 2553 (2010), the NBTC has formulated the Broadcasting Master Plan for the period 2012 – 2016 (BMP).

In the BMP the NBTC has formulated its general mission and objectives, as well as specific strategies for digital terrestrial television broadcasting (DTTB) and digital sound broadcasting (DSB). Mobile television services, based on a digital terrestrial broadcasting (either audio or video) network, are considered to be a subset of DTTB or DSB services and are referred to as MTV services (by the ITU). The BMP does not explicitly mention MTV services. However, from the wording of the BMP it may be concluded that MTV services were not intended to be included.

But as MTV services are (continuously) discussed and also presented to the NBTC by (foreign) industry parties as useful services for the Thai people, the NBTC has to define its policy and objectives around a possible introduction of these services in Thailand.

The ITU and NBTC agreed a project document (as an Annex to the Voluntary Contribution Agreement) specifying the project scope, objectives and expected results and a provisional timeline for carrying out a feasibility study, as well as defining a strategy for a possible introduction of MTV services.

Feasibility Study

In May 2015 the ITU finalised the feasible study. The results of this study are included in ITU report "Mobile Television Services: Feasibility Study for Thailand", dated May 2015. The report's key recommendation to the NBTC was to proceed carefully, what is to say:

1. Not to carve out any specific spectrum in the UHF Band for MTV services;
2. A relative small carve out may be considered, depending on the final requirements for local Digital Sound Broadcasting (DSB) services;
3. In-band reservations in both the UHF and VHF may be considered (i.e. respectively DVB-T Lite and T-DMB) as a way of enhancing the business case of respectively DTTB and DSB.

The above listed options are represented in Table 1 below. Given the adopted transmission standards for Digital Terrestrial Television Broadcasting (DTTB) and Digital Sound Broadcasting (DSB) in Thailand, Table 1 also includes the feasible transmission standard per option.

TABLE 1: OPTIONS FOR SPECTRUM MANAGEMENT AND SYSTEM COMBINATIONS

	Spectrum carve-out		In-band reservation	
UHF Band IV/V	~~NO~~	~~-~~	**YES**	①DVB-T2-L only
VHF Band III	**YES** small	③ISDB-T_{mm}	**YES**	②T-DMB only
		④DVB-T2-L		

It is noted that Table 1 only includes options where a broadcast network (i.e. a network based on a broadcast transmission standard and operating on broadcasting allocated spectrum) is used to deliver the mobile television services. Apart from deploying mobile television services with the aid of broadcast networks, mobile television services can also be deployed on the sole basis of mobile networks (like 3G and 4 G networks). Especially with the introduction of LTE and LTE-eMBMS such a mobile television service deployment is technically possible (with some limitations).

In the Feasibility report also the option of using the current DTTB network (DVB-T2) for use case 4 (in-car reception) and use cases 5 and 7 (laptop and tablet) was recommended to consider first, before launching any MTV services (e.g. on the basis of DVB-T2 Lite)[1]. For the delivery of television services at laptops and tablets it was recommended to apply Physical Layer Pipes (PLPs) to increase the robustness of the signal and consequently increase the needed indoor coverage.

Finally, the Feasibility report indicated that future traffic off-loading from mobile platforms (i.e. LTE) to MTV systems may be needed in the case mass-audience viewing of live mobile television services would become a reality. Hence a MTV option should be kept open and the uptake of live mobile television services and its characteristics (spikey or constant demand) should be monitored[2].

Implementation strategies, RIA and Roadmap

Following presentations of the feasibility study results to the NBTC and an ITU/NBTC jointly organized international seminar on Mobile Television Services in August, it was concluded that the in-band reservations were deemed most feasible. This **implementation strategy** report covers how the NBTC could go forward with presenting and implementing the four MTV options as included in Table 1.

Under the assumption that one or more of the presented options would be selected and implemented, the report will address what implementation aspects should be addressed by the NBTC. These implementation aspects include spectrum management, technical and operational (which includes the sharing of existing broadcasting infrastructure[3]), business and regulatory aspects.

Also a **regulatory impact assessment** (RIA) was carried out, assessing the impact on industry and consumers, if MTV services would be launched on the Thai market. On the basis of the insights of the feasibility study and implementation aspects, a high-level **Roadmap** has been drafted for the introduction of mobile video services (including MTV services).

For addressing the above listed implementation aspects, the ITU has relied on previous MTV implementation experiences abroad. Also an international benchmark study was carried out, focussing on the applied regulatory framework and measures.

Report structure

This report is structured as follows:

[1] See section 3.3 in ITU report “Mobile Television Services: Feasibility Study for Thailand”, dated May 2015.

[2] See chapter 5 in ITU report “Mobile Television Services: Feasibility Study for Thailand”, dated May 2015.

[3] It is noted that sharing of existing broadcasting infrastructure is also addressed ITU report “Mobile Television Services: Feasibility Study for Thailand”, dated May 2015, see sections 2.1.3, 3.1.1, 3.2.1 and 3.4.2.

1. Spectrum management aspect;
2. Technical and operational aspects;
3. Business and regulatory aspects;
4. Regulatory impact assessment;
5. Conclusions, recommendations and roadmap;

Annex A: Global overview of MTV operations and regulations;
Annex B: MTV case studies.

1. Spectrum management aspects

In this Chapter the key spectrum management aspects are addressed for the MTV implementation options as identified in Table 1. The introduction of MTV services requires that spectrum will have to be made available for these services. How much spectrum is needed depends on three key parameters or service requirements:

1. The number of live TV services;
2. The picture quality of each service;
3. The coverage area and reception conditions.

It is noted that the reception conditions are determined by the use case as described in the Feasibility study[4]. In this Section we only address use case number 7, reception at smartphones which is the most demanding reception condition.

Following the above, this Chapter is structured as follows:

1. Number of live TV services;
2. Picture quality of each service;
3. Coverage area and reception conditions;
4. Evaluation overview.

1.1 Number of live TV services

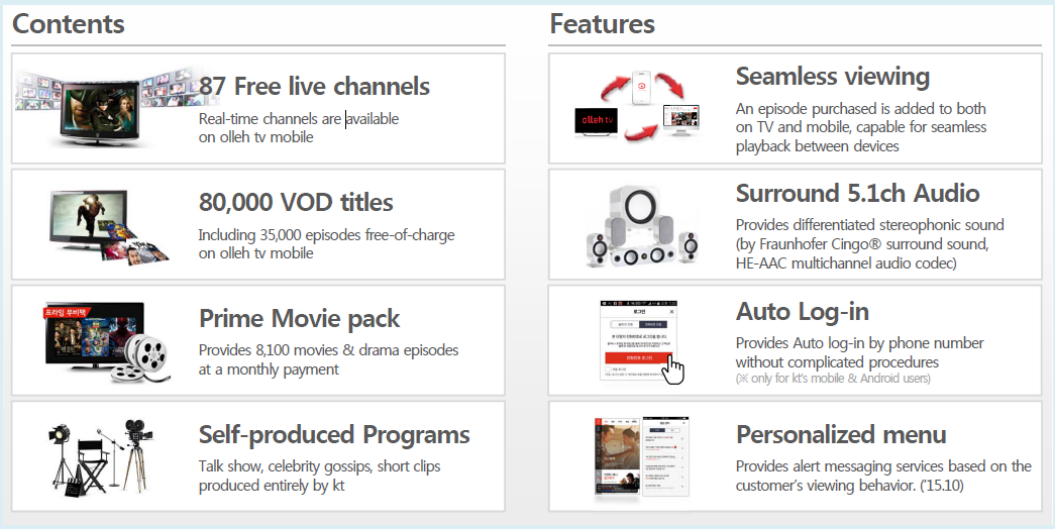
The number of MTV services is driven by the number of TV services that would be required from a competitive or marketing point of view. MTV-based services would have to compete with a LTE-eMBMS-based service. If both technologies would be combined to complement each other, i.e. LTE-eMBMS for small urban areas and MTV for larger urban and rural areas, the MTV service capacity should match the number of TV services on the LTE platform.

Considering this competitive view, a target number of MTV services could be provided by the commercial mobile TV offering in South Korea[5]. In this country, KT is offering a service package containing 80+ live TV services and over 80,000 VOD titles on the basis of LTE-eMBMS for smartphone distribution[6]. An overview of this 'Olleh Mobile TV' package is shown in Figure 1.

[4] See ITU report "Mobile Television Services: Feasibility Study for Thailand", dated May 2015, p11-12 and p59.

[5] This country is selected as it is the first country to launch LTE-eMBMS on a commercial basis (not trials), to have a nationwide LTE coverage, to have the highest 4G smartphone penetration in the world, and also to have a competing MTV service commercially on air. For more details on these offers see also ITU report "Mobile Television Services: Feasibility Study for Thailand", dated May 2015, pp38-63.

[6] Distribution to other devices, like tablets and PC's, other wireless technologies are used like WiMax (i.e. IEEE 802.16e also called Wibro in South Korea) and WiFi.



Source: KT, 2015

FIGURE 1: OVERVIEW OF OLLEH MOBILE TV SERVICE PACKAGE

It could be envisioned that this number of mobile TV services is gradually build-up over time. An introduction offering could start at a lower number of services. This introduction offering should however consider the TV situation at home. As can be observed from Figure 1 a mobile TV service comprises converged service delivery whereby seamless viewing between the TV set at home (IPTV based) and the mobile device is possible. Hence the number of required services is correlated with number of TV services at the average TVHH. In Thailand this would entail approximately 40-50 services[7].

1.2 Picture quality of each service

For assessing the required picture quality we can also learn from user experiences in South Korea. In South Korea Smart T-DMB, a MTV-based service, is operational. This service offers a picture ratio or resolution of 640 x 480. Not to be confused with the traditional or initial T-DMB service which has a picture ratio of 320 x 420. In the same market Olleh Mobile TV (as mentioned in Section 1.1) offers in their mobile package HD services with a picture resolution from 1280 x 720 to 1920 x 1080.

Customer surveys have demonstrated that the Olleh Mobile TV picture quality is perceived superior to that of Smart T-DMB. With the current generation of smartphones, equipped with HD resolution screens, the difference in picture quality can be easily perceived. Consequently, for a future MTV service the minimum picture ratio is at least 1280 x 720.

[7] This number is based on the number of available TV service slots on the DTTB platform; i.e. 48. On the satellite platform over 200+ services are available. However the viewing-per-service figure has an extreme long-tail character. At the end of the tail the viewing figures are very low and hence should not be considered. See NBTC report, "Implementing Digital Terrestrial Television in Thailand", dated August 2014, figure 7, p13.

The required bit rate for delivering a MTV service with a given picture resolution is dependent on the applied encoding technology. Currently the H.264 encoding standard is commonly applied. However, increasingly the more efficient H.265 is applied, especially for streaming and IP based service delivery[8]. Hence for determining the required bit rate for a future MTV-based service, only the H.265 encoding standard is considered.

Table 2 shows an indication of the required bit rates for the various picture ratios, H.265 encoded and delivered at relative small smartphone screens (i.e. not large television screens at home). It should be noted that the required bit rate is subjective and guided by perceived picture quality. Also technically the encoding efficiency and hence the bitrate is dependent on the type of content ('talking heads' or 'football'), colour definition, statistical multiplexing and framerate.

TABLE 2: TYPICAL BITRATES FOR H.265 ENCODING AND DELIVERY AT MOBILE DEVICES[9]

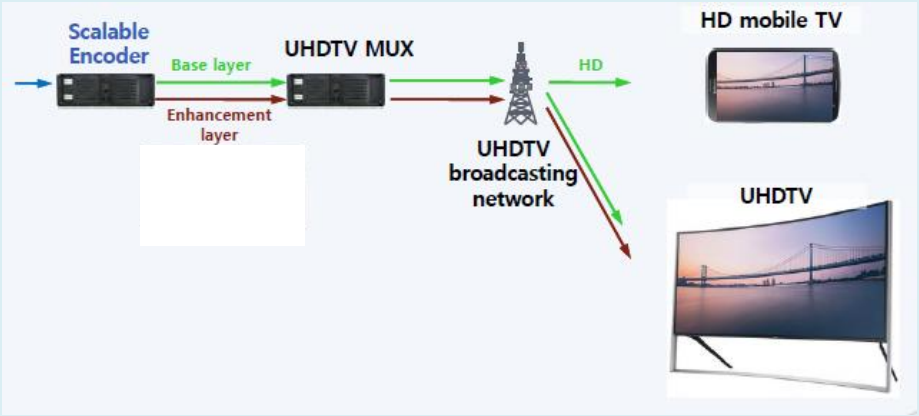
Picture Ratio	Typical Bitrate (Kbit/s)
640 x 480	250
960 x 540	600
1280 x 720	700
1920 x 1080	1000

From Table 2 it can be observed that a MTV service would typically require 700 to 1000 Kbit/s for having a good enough perceived picture quality.

A future proof MTV service, as part of a converged service delivery, should cater for the delivery of UHDTV services. In Figure 2 shows this concept of converged service delivery of UHDTV services on mobile devices and television sets at home.

[8] Is should be noted that the H.265 standard has been successfully tested for the transmission standards DVB-T2 and ATSC3.0 (i.e. ATSC3.0 proposal) for terrestrial distribution. However H.265-based receivers are not commercially available yet.

[9] Source: KBS, presentation at the ITU/NBTC organized seminar on MTV services called "Smart DMB based on Hybrid DMB", dated 8 August 2015.



Source: KBS, 2015

FIGURE 2: CONVERGED UHDTV SERVICE DELIVERY

Figure 2 also shows that with layered encoding a smaller bitrate can be offered to mobile devices, as the screen size is smaller. For at home delivery of UHDTV services the base layer encoded stream can be enhanced with extra bits for higher picture quality. To date no UHDTV services are commercially delivered to mobile devices. Hence no typical bitrates are known. In this light it should be noted that KT delivers already UHDTV services at Koreans homes in their IPTV package. Also Netflix delivers UHDTV services to homes in the United States[10]. With the convergence of services a future proof MTV service should be able to follow these developments, not only in terms of picture quality but also in terms of seamless viewing between platforms[11].

1.3 Coverage area and reception conditions

Table 1 shows two in-band options, on respectively DVB-T2 Lite in UHF Band and T-DMB in the VHF Band. Also a small spectrum carve-out in the VHF Band was considered feasible, either applying ISDB-T_{mm} or DVB-T2 Lite.

First the coverage requirements for the two in-band options will be analysed. Followed by the two VHF option.

1.3.1 Option 1 (In-band UHF/DVB-T2L)

As concluded in the Feasibility Study for smartphone reception (use case 7), DVB-T2 Lite is required because of the lower costs (as the chipset is cheaper due to reduced number of system parameters)

[10] These services are delivered over the free internet (i.e. Over-The-Top) and Netflix states that 15 Mbit/s is required, being twice the average bandwidth available to US broadband households, and hence uptake is still relatively slow. Also it can be claimed that 15 Mbit/s is not enough to really provide a UHDTV/4K service. 40 Mbit/s is more an acceptable rate for true UHDTV/4K.

[11] A mediation platform as described in ITU report "Mobile Television services: Feasibility study for Thailand", dated May 2015, p18, will be required and complex.

and longer battery life (due to time slicing). It was also demonstrated that with the applied DVB-T2 system variant in Thailand (64 QAM, code rate 3/5, Pilot Pattern 2, Guard interval 226 µs), the coverage shows gaps in the centre of Bangkok for portable indoor (PI) reception[12]. As mobile reception with smartphones is more demanding, these coverage gaps will be larger if not a more robust signal is used (i.e. DVB-T2 Lite).

It is however unlikely that with the application of a PLP/DVB-T2 Lite these gaps can be closed. For good dense urban coverage more sites, preferably operated in SFN, should be applied[13]. For the DTTB services 171 sites were planned with the application of over 50 SFNs. Also when improving the PI coverage by adding more sites (up to 182 sites), the planning work showed that these additional sites can be configured in SFN[14]. Hence it assumed here that additional sites, required to improve the coverage for mobile reception, can be configured in SFN.

Detailed frequency planning work is required to determine how many sites can be configured in SFN and what the resulting mobile coverage will be like. If the resulting coverage is not sufficient, additional sites will be have to be configured in MFN and this will require additional spectrum beyond the current 30 channels of 8 MHz wide[15]. However, the in-band option is limited to the spectrum assigned to the DTTB services.

Consequently, it can be concluded that the spectrum requirement is that no extra frequency can be assigned and that detailed planning work has to show what mobile coverage can be offered. The resulting mobile coverage (in percentages or number of HH) can however be assessed to be between the PI and Fixed (FX) reception as planned for the DTTB services. A summary of these PI and FX coverage results are represented in the respectively Table 3 and Table 4 below[16].

TABLE 3: DTTB PI COVERAGE RESULTS FOR 171 AND 182 SITES

Multiplex	Operator	Household coverage by the 171 sites from DTTB Plan 3.2, needed to reach the FX coverage target	Household coverage by 182 sites (including the 11 sites to reach the PI coverage target in major municipalities)
1	NBT	43.3%	44.8%
2	Army TV-1	42.5%	44.0%
3	MCOT	42.4%	43.8%
4	TPBS	41.9%	43.4%
5	Army TV-2	43.2%	44.6%
6	Community TV	44.4%	45.7%

[12] See Figure 28, p58 of ITU report Mobile Television services: Feasibility study for Thailand", dated May 2015.

[13] See ITU Guidelines on the Transition from Analogue to Digital Broadcasting, dated January 2014, p202-209.

[14] See ITU report "DTTB Plan 3.3 in Thailand, after analogue TV switch-off and during transition", dated August 2015.

[15] See Figure 52, p94 of ITU report Mobile Television services: Feasibility study for Thailand", dated May 2015.

[16] See footnote 14.

It should be noted that results as presented in Table 3 are for the situation after analogue switch-off (ASO) of the ATV services in the UHF Band (i.e. Scenario C).

TABLE 4: DTTB FX COVERAGE RESULTS FOR 171 AND 182 SITES

Multiplex	Operator	Household coverage by the 171 sites from DTTB Plan 3.2, needed to reach the FX coverage target	Household coverage by 182 sites (including the 11 sites to reach the PI coverage target in major municipalities)
1	NBT	95.0%	95.0%
2	Army TV-1	95.0%	95.0%
3	MCOT	95.0%	95.0%
4	TPBS	95.0%	95.0%
5	Army TV-2	95.1%	95.2%
6	Community TV	95.4%	95.5%

It should be noted that results as presented in Table 4 are for the situation after analogue switch-off (ASO) of the ATV services in the UHF Band (i.e. Scenario C).

Under the here described in-band implementation option, the DVB-T2 Lite services are carried in a PLP. A single PLP can have a maximum capacity of 4 Mbit/s[17]. The DTTB services operate on a system variant which has an effective bit rate capacity of 22 Mbit/s. This effective bit rate allows for the following DTTB service configurations, as prescribed by the NBTC and included in Table 5.

TABLE 5: DTTB SERVICE CONFIGURATION OPTIONS PER MULTIPLEX

	Option 1	Option 2	Option 3	Option 4
Number of HD services	0	1	2	3
Number of SD services	12	9	6	3

The number of services as included in Table 5 are based on H.264 encoding. For a future MTV implementation, we may assume that the encoding efficiency of H.264 will improve. From past experience a 20-25% efficiency gain can be expected[18]. This would imply that the same number of services with the same picture quality can be broadcasted in 20-25% less bit rate capacity, being 4.4 - 5.5 Mbit/s. Consequently, one PLP could be facilitated in each multiplex. Having 5 national multiplexes deployed, would result in 5 PLPs in total. Application of the H.265 encoding standard on

[17] See Table 2 of ITU report "Mobile Television Services: Feasibility study for Thailand", dated May 2015, p23.

[18] Not considering improvements in statistical multiplexing, which could be further improved if the four multiplex operators would agree to apply statistical multiplexing across all multiplexes (which is currently not the case).

the DTTB services is excluded here as a feasible option. Because this would require the replacement of the installed base of H.264 DTTB receivers.

Depending on the allocated bitrate per service (see Table 2, please note that it assumed that the DVB-T2 Lite services will be H.265 encoded) the number of MTV services can range between 4 and 16 services per PLP of 4 Mbit/s.

A business case analysis is required to assess whether a viable business can be deployed on the resulting mobile coverage and number of services. Under the assumption that the NBTC would allow for this in-band MTV option, this would be then a matter for the (current) DTTB license holders to assess.

1.3.2 Option 2 (In-band VHF/T-DMB)

For Digital Sound Broadcasting (DSB) in the VHF Band III frequency planning work has been carried out by a third party. Applying the DAB+ transmission standard the PI coverage was assessed for the Trial, nationwide and local network deployments[19]. However these planning results have been reviewed by ITU and different results have been presented to the NBTC for the Trial phase[20]. The review of the national planning showed that a near nationwide PI coverage of 95% can been reached by utilizing the DTTB network topology plus an additional 29 sites (hence a total of 171 + 29 = 200 sites)[21].

Furthermore, the results showed that after ASO of the ATV services in the VHF Band III:

1. Large SFNs can be applied for the national services and one (or two) DAB block is needed per layer;
2. Across the 39 local areas MFNs have to be applied for the local services and that 6 (to 7) different DAB blocks are needed per layer.

Depending on the required number of national and local DSB multiplexes, the required spectrum for DSB can be determined. Table 6 shows an overview of the number of DAB blocks for the various scenarios.

TABLE 6: NUMBER OF DAB BLOCKS NEEDED FOR DSB

Scenario	Number of National multiplexes	Number of Local multiplexes	Total number of DAB blocks needed	Total spectrum needed (in MHz)
1	2	0	2	3.50
2	2	1	8	14.00
3	2	2	14	24.50

[19] See respectively LS report "Practical Principles and Technical Standards for DAB+ Trial" and "Practical Principles and Technical Standards for DAB+ National and Local", both dated May 2015.

[20] See ITU report "Results of the verification of the T-DAB plan in the Trial phase", dated November 2015.

[21] See ITU report "Results of the verification of the T-DAB plan for the final phase, dated December 2015.

Scenario	Number of National multiplexes	Number of Local multiplexes	Total number of DAB blocks needed	Total spectrum needed (in MHz)
4	3	3	21	36.75
5	4	4	28	49.00

Like with DVB-T2 Lite it is expected that more sites will be needed as compared to the number of sites needed for DAB+ PI reception. In comparison with the DVB-T2 system, the DAB+ system allows for the application of large(r) SFNs[22]. Hence for the T-DMB service carried in the DAB+ multiplex the network topology can be densified (i.e. adding more sites for the mobile reception conditions) more easily.

The concept of creating a T-DMB PLP in a DAB+ multiplex is not present. Hence the T-DMB signal will be sitting in the same multiplex next to base DSB services (and will have the same signal robustness). The effective bit rate capacity of a DAB+ multiplex is 1.152 Mbit/s. Depending on the allocated bitrate per service (see Table 2, please note that it assumed that the T-DMB services will be H.265 encoded) and assuming that a maximum of 25% of the available capacity (i.e. 288 Kbit/s) can be allocated to MTV services[23], would result in having only one 250 Kbit/s (picture ratio of 640 x 480) MTV service per DAB+ multiplex.

Again, detailed frequency planning work is required to determine how many sites can be configured in SFN and what the resulting T-DMB mobile coverage will be like. If the resulting coverage is not sufficient, additional sites will have to be configured in MFN. This would require more blocks as included in Table 6. But also the T-DMB in-band option is limited to the spectrum assigned to the DSB services.

A business case analysis is required to assess whether a viable business can be deployed on in-band option whereby the resulting mobile coverage is below the DAB+ PI coverage and one MTV service per multiplex can be broadcasted. Under the assumption that the NBTC would allow for this in-band MTV option, this would be then a matter for the (current) DTTB license holders to assess.

1.3.3 Option 3 and 4 (Carve-out VHF/ISDB-T_{mm} or DVB-T2L)

A spectrum carve-out for MTV services is a result from a decision on the number of multiplexes for respectively national and local DSB services. The less DSB multiplexes are required the more spectrum is available for MTV services. In the DAB+ frequency planning work the available spectrum in the VHF Band III was limited from ATV channel 5 to 11 (i.e. from 174 to 223 MHz) as an unknown

[22] See footnote 21.

[23] The Service license terms and conditions would have to allow for this. A higher percentage, nearing 100%, would effectively result in a spectrum carve out for T-DMB, i.e. a separated multiplex for T-DMB. This option was not included in the Feasibility study as more efficient technologies are available to operate in the VHF Band, see p25.

military aeronautical communication system is in use in channel 12, which is deemed not to be compatible with DAB[24].

Taking the required spectrum for the various DSB scenarios from Table 6 and mapping these requirements on the available spectrum (= 223-174 = 49 MHz) will result in the remaining spectrum for a MTV spectrum carve-out. Table 7 shows the remaining spectrum under the 5 scenarios as included in Table 6.

TABLE 7: REMAINING SPECTRUM FOR MTV SPECTRUM CARVE-OUT

Scenario	Number of National multiplexes	Number of Local multiplexes	Total spectrum needed (in MHz)	Remaining spectrum for MTV (in MHZ)
1	2	0	3.50	45.50
2	2	1	14.00	35.00
3	2	2	24.50	24.50
4	3	3	36.75	12.25
5	4	4	49.00	0

ISDB-T_{mm} system features

A near nationwide MTV network on the basis of ISDB-T_{mm} is implemented by service provider NOTTV in Japan. This network is implemented in the VHF Band ranging from 207.5 to 222 MHz (i.e. 14.5 MHz which equals 33 segments of the ISDB-T system)[25]. Although the NOTTV transmitters have a capacity of 33 segments not all segments are used, as illustrated in Figure 3.

Source: NOTTV

FIGURE 3: UTILIZATION OF THE 33 SEGMENT ISDB-T_{MM} SYSTEM IN JAPAN

NOTTV launched its MTV services with 13 segments on which it broadcasts four live television services. In April 2015 six new life television services were added, using the green slots as depicted in

[24] It should be observed that currently channel 12 is used across the country for ATV services.

[25] This is the so-called V-High band. See also ITU report "Mobile Television Services: Feasibility Study for Thailand", dated May 2015, pp46-48.

Figure 3. It should be noted that in this bandwidth also HD VOD services and other data is file- or data-casted to the cash memory of the ISDB-T_{mm} enabled handsets.

As indicated in the Feasibility study, in an ISDB-T_{mm} multiplex operating in a 6 MHz-wide channel the effective bit rate is 8.1 Mbit/s[26]. In a future MTV launch the more efficient encoding technology (H.265) would be used and the utilization of the effective bit rate will be different from NOTTV as their system is implemented on the basis of H.264 encoding. Also the picture ratio of the NOTTV live television services is 720x480 (VGA+), perhaps not enough for future launches.

Combining Table 7 (i.e. the remaining spectrum) and Figure 3 provides an indication of what kind of ISDB-T_{mm} network deployment can be fitted into the available spectrum in Thailand. For example, a 33-segment implementation like in Japan (i.e. 14.5 MHz), would require that the number of local DAB+ layers are limited to two in Thailand (see Table 7, scenarios 1 to 3).

It is important to realize that the ISDB-T_{mm} allows for aggregating segments into a single bandwidth system. Any combination of 1, 3 and 13 segments can be aggregated. The 33-segment implementation is actually 2 times 13 and 7 times 1 segment. This aggregation of segments provides many options for fitting in the ISDB-T_{mm} system in the available spectrum and deploying the network.

DVB-T2 Lite system features

To date, for DVB-T2 Lite no commercial implementations are operational. More specifically, no (near) nationwide implementation, nor in-band or as a standalone system. Hence a practical check on the required spectrum is absent. However, in the Feasibility study it was demonstrated that a DVB-T2 Lite system can operate, as a standalone system, in various bandwidths[27]. These bandwidths range from 1.7 to 10 MHz, similar to the ISDB-T_{mm} system.

Comparing these system bandwidths with Table 7 (i.e. the remaining spectrum) it shows that many possibilities exist for deploying a DVB-T2 Lite system in the VHF Band III. For example, scenario 4 in Table 7 (i.e. 3 national and 3 local multiplexes) would leave 12.25 MHz available for DVB-T2 Lite. In this available spectrum a DVB-T2 network could then be deployed by applying either a system bandwidth of 6 or 10 MHz.

It is important to note that the choice of the system bandwidth (for both ISDB-T_{mm} and DVB-T2) has two main implementation consequences:

1. The lower the system bandwidth the more frequencies are available for deploying a (near) nationwide network. For example, applying a DVB-T2 Lite system bandwidth of 10 MHz in 12.25 MHz would require the application of a single very large SFN across Thailand (as in any area only one frequency will be available). Applying the 6 MHz bandwidth variant would provide 2 frequencies in any area, and hence the deployment of MFNs would be possible;
2. The lower the system bandwidth the more transmitters per site would be required for the same number of services (above the maximum capacity of a single DVB-T2 Lite multiplex). For example a DVB-T2 Lite multiplexer of 6 MHz wide can carry up to 21 services, whereby

[26] See Table 2 of ITU report "Mobile Television Services: Feasibility Study for Thailand", dated May 2015, p23.

[27] See footnote 26.

each service is transported in 384 Kbit/s[28]. Having a service requirement of let us say 40 services would result in having two multiplexers and hence two transmitters at each site, where as in the 10-MHz variant such a service offering would fit in one multiplexer and hence one transmitter per site.

As with the two in-band options, detailed frequency planning work will have to show what is possible in the available spectrum for either an ISDB-T_{mm} or DVB-T2 Lite implementation. On the basis of this insight (i.e. the net available capacity and coverage will be known) the business case has to be assessed for financial feasibility.

Number of layers and services

On the basis of a theoretical examination additional insight can be provided on what would be possible for an ISDB-T_{mm} and DVB-T2 Lite deployment. The DVB-T2 frequency planning for Thailand showed that 30 channels were needed for deploying 6 multiplexes nationwide. Hence 5 frequencies were on average needed for a single nationwide network or layer. Also recent studies in the EBU[29] concluded that by applying large SFNs with the DVB-T2 standard the number of channels could be reduced to four to five per national coverage taking into account that interference from one country into another should be avoided. Hence assuming that the ISDB-T_{mm} and DVB-T2 Lite systems can be planned in a similar way[30] four to five frequencies would be needed to have a near nationwide coverage.

Table 8 shows how many nationwide layers (i.e. 90 to 95% of population) are possible given the number of frequencies needed for nationwide coverage and the available spectrum as given in Table 7. It also provides how many services (with a picture ratio of 960 x 540 and requiring 600 Kbit/s, see Table 2) can be facilitated in each nationwide layer for either DVB-T2 Lite or ISDB-T_{mm}.

TABLE 8: NUMBER OF MTV LAYERS AND SERVICES FOR DIFFERENT SPECTRUM RESERVATIONS

Scenario	# DSB National MUX	# DSB Local MUX	MTV (in MHZ)	# MTV layers (4 frequencies of 6 MHz = 24 MHz)	# MTV layers (5 frequencies of 6 MHz = 30 MHz)	# MTV services (4 frequencies of 6 MHz = 24 MHz)	# MTV services (5 frequencies of 6 MHz = 30 MHz)
1	2	0	45.50	1	1	25/14	25/14
2	2	1	35.00	1	1	25/14	25/14
3	2	2	24.50	1	0	25/14	0
4	3	3	12.25	0	0	0	0
5	4	4	0	0	0	0	0

[28] See footnote 26.

[29] See EBU Technical Report 029 DVB-T2 Single Frequency Networks and spectrum Efficiency, dated October 2014.

[30] As both are OFDM systems and have similar modulation schemes and guard intervals, see Table 2 of ITU report "Mobile Television Services: Feasibility Study for Thailand", dated May 2015, p23.

Having a lower bit rate per service could provide more services per layer. However, the competitive edge of an MTV system should be better coverage and picture quality against lower costs, as compared to LTE- eMBMS.

1.4 Evaluation overview

Table 9 provides an overview of the results of the analysis in Sections 1.1 to 1.3.

TABLE 9: OVERVIEW OF MTV IMPLEMENTATION OPTIONS

MTV implementation option	Coverage	Condition	Picture ratio	Bitrate per service (H.265) in Kbit/s	# of MTV services/ layer	# of MTV services in available spectrum
1. In-Band UHF DVB-T2 Lite	Limited to DTTB coverage, between 40 – 95%	Not more than 1 PLP per MUX	640 x 480	250	16	5 x 16 = 80
			960 x 540	600	6	5 x 6 = 30
			1280 x 720	700	5	5 x 5 = 25
			1920 x 1080	1000	4	5 x 4 = 20
2. In-Band VHF T-DMB	Limited to DSB coverage, below 95%	Not more than 25% of National DAB MUX capacity	640 x 480	250	1	(1-4) x 1 = 1-4
			960 x 540	600	-	-
			1280 x 720	700	-	-
			1920 x 1080	1000	-	-
3. Carve-out VHF DVB-T2 Lite	Near nationwide coverage (90% - 95%)	No more than 2 National + 2 Local DAB layers	640 x 480	250	60	60
			960 x 540	600	25	25
			1280 x 720	700	21	21
			1920 x 1080	1000	15	15
4. Carve-out VHF ISDB-T_{mm}	Near nationwide coverage (90% - 95%)	No more than 2 National + 2 Local DAB layers	640 x 480	250	32	32
			960 x 540	600	14	14
			1280 x 720	700	12	12
			1920 x 1080	1000	8	8

From Table 9 the following can be concluded:

1. MTV implementation option 1 (In-Band UHF DVB-T2L) provides a good enough number of MTV services of acceptable picture quality, considering the competitive technology landscape. An initial launch could provide in the range of 20 to 25 live MTV services. For a longer term development of a converged service offering (whereby seamless viewing is possible between the at-home and mobile TV services) additional spectrum would be needed;

2. MTV implementation option 2 (In-Band VHF T-DMB) provides too few services with a too low picture quality, considering the competitive technology landscape. This option will no longer be considered as practically viable for Thailand and excluded from further analysis;
3. MTV implementation options 3 and 4 (Carve-out VHF ISDB-T_{mm} or DVB-T2L) provide a good enough number of MTV services of acceptable picture quality. Not considering current hand-set availability, the DVB-T2 Lite option provides more services and would be a better option from a technology point of view. The spectrum carve-out for both options is however determined by the DSB service and coverage requirements, not being larger than 2 national and 2 local layers;
4. Options 1, 3 and 4 require that MTV capacity is aggregated across several layers or multiplexes. Without this aggregation the service bouquet will be too small (like option 2). Hence an industry wide coordination and introduction is needed. This aspect will require attention when issuing MTV licenses (see Section 3.2).

2. Technical and operational aspects

As discussed in Chapter 1, considering the results on the spectrum management aspects of the four considered implementation options, one options is excluded in the further analysis: option 2 (In-Band VHF III/T-DMB). The remaining three options are depicted in Table 10.

TABLE 10: THREE REMAINING OPTIONS

	Spectrum carve-out		In-band reservation	
UHF Band IV/V	~~NO~~	~~-~~	**YES**	①DVB-T2-L only
VHF Band III	**YES** small	③ISDB-T_{mm} ④DVB-T2-L	~~YES~~	~~②T-DMB only~~

In this Chapter the following technical and operational aspects of the remaining options will be addressed:

1. Network deployment and infrastructure sharing;
2. Platform and service synchronisation;
3. Handset availability and pricing.

2.1 Network deployment and infrastructure sharing

The ideal network topology for MTV broadcasting networks is different from the network topology employed for DTTB broadcasting networks. The MTV broadcasting networks are based on distributed transmitters and distribution of transmitting power over the coverage zone. These are also characterised by a large number of SFN transmitters and gap fillers.

The basic idea behind this distributed network infrastructure is to provide a high level signal at the street level, indoors, in public areas such as shopping malls, buses, trains, cars and subways. The reception environment for MTV services is very demanding (more demanding than mobile communication, because of the heavy payload of MTV services), and a lot of precise planning is required to setup a network. These networks are, in principle, similar to the cellular networks for mobile communication (i.e. Low Power Low Tower – LPLT). One of the distinguishing features between the two is that MTV networks have to offer a much heavier payload (in terms of content bit rate capacity) as against much lower payload (speech or data) in mobile networks.

While it would be ideal to have a new network infrastructure for MTV, it is also possible to modify the classical DTTB networks to meet some of the important requirements of MTV. Several technical measures need to be taken to modify the DTTB networks for MTV (i.e. from the network site more transmitter have to be added, see Section 1.3.1). Also combining an MTV infrastructure with a mobile infrastructure (i.e. LTE) is possible.

As indicated in the Introduction, It is noted that this report only addresses options where a broadcast network (i.e. a network based on a broadcast transmission standard and operating on broadcasting allocated spectrum) is used to deliver the mobile television services. Apart from deploying mobile

television services with the aid of broadcast networks, mobile television services can also be deployed on the sole basis of mobile networks (like 3G and 4 G networks). Especially with the introduction of LTE and LTE-eMBMS such a mobile television service deployment is technically possible (with some limitations).

Hence for the deployment of a MTV network the following options may be considered:

1. Sharing broadcast network infrastructure;
2. New MTV network infrastructure;
3. Tower overlay concept (a form of combining broadcast and LTE networks);
4. Backhaul concept (a form of combining broadcast and LTE networks).

In Sections 2.1.1 to 2.1.4 the above listed network deployment options are described and evaluated. In Section 2.1.5 a summary of this evaluation is provided.

2.1.1 Sharing broadcast network infrastructure

The essence of sharing broadcast infrastructure is that the operator make use of high powers and high towers (HPHT), in combination with (a large) number of smaller additional sites.

In principle a MTV network can be shared with any broadcast infrastructure, however in varying degrees (and dependent on the technical capacity of the intended infrastructure element):

1. For option 1 (In-Band UHF/DVB-T2L): multiplexer, distribution network, transmitter, tower and antenna system;
2. For option 3 (Carve-out VHF/ISDB-T_{mm}): tower and antenna system;
3. For option 4 (Carve-out VHF/DVB-T2L): tower and antenna system.

Option 1 (In-band UHF/DVB-T2L)

The basic reception norm for indoor coverage for DTTB services (see the coverage % in Table 3) certainly helps putting out MTV services on the same infrastructure. A first assessment could be that around 50% of the constraints of the mobile reception would be overcome by indoor coverage. In ideal circumstances, this would make sure that the MTV broadcasts are actually received indoors.

However, the reception of signals at street level (and in moving vehicles) needs more signal level, its availability in the geographical and temporal domains. The blockage introduced by buildings and other infrastructure in cities is a major factor that reduces signals on the street level. Man-made electrical noise also drastically reduces the signal to noise ratio for the MTV signals. Densely populated cities and urban canyons also produce additional constraints in providing an adequate signal level for mobile reception in the mobile environment.

The mobile receiver devices are very different than indoor reception antennas. The mobile devices do not have the advantage of having a sizeable antenna and the antenna gain is negligible or even negative. Mobile devices are also not held in one position and the position keeps on changing. This produces additional difficulties in providing a high-level signal for MTV.

Consequently although multiplexer, distribution network, transmitter, tower and antenna systems of the DTTB can be shared (as it is in-Band MTV delivery and part of the DVB-T2 standard[31]), a number of additional sites will have to be deployed. The latter is dependent on the MTV coverage target. However, contemporary MTV services will have to be offered as part of a converged service offering[32] (delivered on smartphones) and hence the coverage target is at least equal to the mobile coverage (and the coverage target of 3G services in Thailand is set at 95% pop).

These additional MTV sites can be shared with any broadcast site, not necessarily a DTTB site. However, all useable UHF ATV towers are already utilized for the DTTB service. Hence in practice these additional MTV sites will be non-DTTB sites and only the tower facility could be shared. For sharing towers not only free space and the effective antenna height, which can be lower as an MTV network is in principle LPLT architecture, should be considered. Also the wind load capacity of the tower should be considered (which is often the limiting factor).

Option 3 and 4 (Carve-out VHF/ISDB-T_{mm} or DVB-T2L)

In options 3 and 4 the MTV multiplex is a stand-alone system and cannot share the multiplexer, distribution network and transmitter. When deploying these options only towers and possibly existing VHF antenna can be shared. As an ATV ASO[33] will take place in the VHF Band III, it is unlikely that MTV services can share ATV VHF Band III antennas, because of their age and their technical specification. After ATV ASO this Band is allocated to DSB. For DSB (and more particularly DAB+) new antenna systems are recommended and the ITU recommended network architecture includes new antenna systems[34].

Hence any VHF antenna sharing will be dependent on the availability of DAB antenna systems (i.e. the DAB deployment schedule) and the specifications of the DAB antenna systems[35]. The latter is mostly a matter of the maximum permissible powers on the system (which in turn is driven by the number of transmitters/multiplexes per system).

Again, for tower sharing not only free space and the effective antenna height should be considered but also the wind load capacity of the tower.

For options 3 and 4 the total number of MTV sites will be in principle be equal to option 1 (depending on the MTV coverage target). However, as the multiplexer, distribution network and transmitter cannot be shared, the MTV network operator has more degrees of freedom when selecting suitable sites.

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[31] DVB-T2 Lite is defined as a specific profile for mobile reception conditions in the DVB-T2 standard (version 1.3.1 and up).

[32] See also Section 0.

[33] The last ATV transmitters to be switched-off are those of service providers Channel 3 and 7, as they hold concessions rights (from MCOT and Army) lasting un till 2020 and 2023 respectively. However it is expected that ATV ASO will take place in 2020.

[34] See report “DAB+ System Architecture Design for Thailand”, update February 2015.

[35] The antenna system specifications are included in the report as mentioned under footnote 34.

2.1.2 New MTV network infrastructure

The essence of a new MTV network infrastructure is that the network is designed without considering the reuse of existing broadcast infrastructure. As argued before such a network would ideally be a LPLT infrastructure.

Option 1 (In-Band UHF/DVB-T2L)

This in-band option makes use of existing DTTB/DVB-T2 infrastructure and hence this option is not applicable here.

Option 3 and 4 (Carve-out VHF/ISDB-T_{mm} or DVB-T2L)

Since the ideal network structure for MTV is similar to that of the cellular mobile networks, it is feasible to co-locate the MTV transmitter facilities with those of the cellular mobile phone networks. If this is done, there is some reduction in the costs involved for setting up the MTV networks. It is noted however that in contemporary mobile networks a majority of sites consist of 'rooftop' sites (and not dedicated towers) and hence costs efficiency gains are limited. For these type of sites new rental contracts have to be agreed with landlords. Housing, security and power facilities may be shared. Since the power requirement for the MTV transmitters is on the lower side, the infrastructure required (including land area) is relatively smaller in size and in capacity.

There are not any significant deployments of MTV networks currently available which could be cited as examples of cellular or LPLT networks. Technically there is ample scope for MTV networks to be designed and deployed together with the mobile phone infrastructure. However, the real issue is that setting up of new networking and transmission infrastructure for MTV involves significant costs, much more than that involved in using, for example, the existing DTTB infrastructure.

But more importantly with the emergence of LTE eMBMS, mobile operators have another technical alternative. LTE eMBMS can be deployed as a system enhancement of LTE-A[36]. LTE eMBMS network cells can be switched in broadcast mode and can provide (temporarily) broadcast services (similar to MTV). In other words, MTV services deployed on the basis of an LPLT architecture is unlikely to occur.

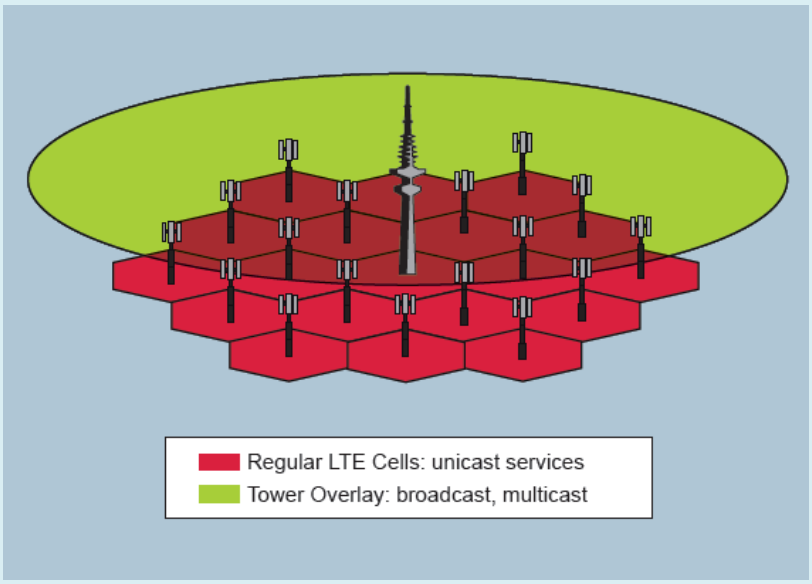
2.1.3 Tower overlay concept

The essence of the tower overlay concept is combining a DVB-T2 broadcast technology with a mobile (LTE) infrastructure[37]. In this concept the HPHT broadcasting architecture is used to provide wide area broadcasting coverage and as consequence the mobile network is relieved from carry broadcasting traffic (and hence not having to switch from unicast to broadcast mode). This has the advantage of mobile operators not having to 'sacrifice' their unicast capacity for broadcast services.

This combined system is called the 'tower overlay' and is depicted in Figure 4.

[36] See ITU report as mentioned in footnote 4, section 2.2.3 and 2.2.4.

[37] Which is different from deploying mobile television services on the sole basis of a mobile network, in particular on a LTE or LTE-eMBMS network.



Source: Gatesair, TDF, Technische Universitat Braunschweig

FIGURE 4: THE TOWER OVERLAY CONCEPT

The applicability of this tower overlay concept varies for the three remaining options (see Table 10).

Option 1 (In-Band UHF/DVB-T2)[38]

As explained in the MTV Feasibility report the DVB-T2 system makes use of Future Extension Frames (FEF). In these frames any data can be carried. Hence these FEFs can be used to carry the data stream of the broadcast services in an LTE (eMBMS) network. The video or broadcast services are delivered over a typical DVB-T2 network with HPHT network layout. At the receiving end the services are received by devices which are LTE-A+ enabled and logged into the cellular network of a mobile network operator, who is addressing all signalling and service management.

The advantage is that several network operators can share this DVB-T2 FEFs for delivering broadcast service without loading their LTE networks with broadcast traffic. Consequently, they will not have to switch from unicast to broadcast mode. In addition, LTE handset can be used and there is no need for MTV enabled handsets.

This tower overlay concept has been demonstrated to work in field tests. However, some practical implementation aspects will have to be considered:

1. As argued in Sections 2.1.1 and 2.1.2, for dense urban areas the number of DVB-T2 broadcast sites will have to be increased;

[38] Please note that the MTV option as mentioned in Table 1 and Table 10 is adjusted as DVB-T2 is used and not DVB-T2L.

2. The mobile terminal needs to be LTE-A+ terminal, the plus sign indicating that it deviates from a 'standard' LTE-A handset. The difference likely to be software and RF based (i.e. the handset will need the RF part of the DVB-T2 receiver). Manufacturers should be willing to produce these LTE-A+ handsets and up to date no such handsets are produced commercially and at a large scale;
3. For the concept to work in the most efficient way mobile operators should agree to share the FEF data capacity of the DVB-T2 network. Hence all mobile operators will deliver the same set of broadcast services. Hence there is no differentiator between the mobile network operators in terms of delivering broadcast services. Here again the added value of these broadcast services for a mobile operator needs to be addressed as to determine if this is a likely hurdle for sharing FEF capacity. A relatively low value for broadcast services (as compared to unicast traffic), as argued before, may point in the direction of a likelihood of mobile operators willing to share;
4. Although the signalling and service management is all provided for in the LTE network, a mediation platform will be needed to make the mobile and broadcast network work together in synchronising their services (see Section 0).

Option 3 and 4 (Carve-out VHF/ISDB-T_{mm} or DVB-T2L)

Option 3 is based on ISDB-T_{mm} which doesn't have FEF and hence this tower overlay concept is not applicable.

Option 4 entails a standalone system of DVB-T2L and the whole multiplex capacity is used for delivering MTV services (see also Section 1.3.3) and hence the tower overlay concept is not applicable.

2.1.4 Backhaul concept

The backhaul concept is also a concept which combines a broadcasting and LTE network[39]. The essence of the backhaul concept is that the broadcast network is used for (a) delivering broadcast services at rooftop or indoor antennas (i.e. the regular DTTB services) and (b) supplying LTE eMBMS enabled network cells with a service feed (i.e. backhauling). This concept is illustrated in Figure 5.

[39] See footnote 37.

Source: Fraunhofer IIS

FIGURE 5: BACKHAUL CONCEPT

The applicability of this backhaul concept varies for the three remaining options (see Table 10).

Option 1 (In-band UHF/DVB-T2)[40]

The DVB-T2 network can supply the LTE eMBMS network cells in two ways:

1. By means of the regular DTTB signal (i.e. with the system parameters for rooftop or indoor coverage), or;
2. By means of creating a PLP with a more robust signal.

The advantage of the latter way is that the backhaul signal will carry further, which may be relevant if the coverage of the LTE network is larger and/or does not match the coverage areas of the DVB-T2 network. The disadvantage is that television services may be carried twice; in the regular multiplex capacity (i.e. the base service) and in the PLP. Also the capacity per PLP is limited to 4 Mbit/s[41].

The advantage of this backhaul concept is the same as that of the tower overlay concept; the service feed can be used between the different mobile service providers. But also here the argument applies that broadcast service differentiation between the mobile service providers is not possible.

In contrast with the tower overlay concept, the backhaul concept does not need MTV enabled handsets or a mediation platform. Also it is unlikely that the number of DTTB sites has to be increased as the reception of the service feed at the eMBMS site is generally outdoors and located at an elevated point, with a large antenna (with a gain).

It should be noted that the role of the DTTB network operator under this scenario is limited to signal or service feed provider and has no direct business relationship with providing MTV services. In this role its competitiveness is determined by the cost effectiveness of delivering the service feed. In other words, the revenues are determined whether there are alternative ways for the LTE provider

[40] See footnote 38.

[41] See footnote 17

to get these service feeds delivered at the eMBMS network cells. Hence a marginal business at best for the DTTB network operator. In the backhaul concept the mobile operator has to switch its eMBMS network cells to broadcast mode, in contrast with the tower overlay concept (where this is not necessary as the broadcast services are delivered by the DVB-T2 network).

Option 3 and 4 (Carve-out VHF/ISDB-T_{mm} or DVB-T2L)

Option 3 is meant as a standalone system for delivering MTV services. The ISDB-T_{mm} broadcast signal may be used as a service feed for eMBMS too. However, this seems an unlikely scenario as it will entail supplying a direct competitor.

Option 4 is also meant as standalone system. The DVB-T2L broadcast signal may be used as a service feed for eMBMS too. But again, this seems an unlikely scenario as it will entail supplying a competitor.

2.1.5 Evaluation overview

Table 11 provides an overview of the advantages and disadvantages of the presented network deployment options as included in Sections 2.1.1 to 2.1.4.

TABLE 11: OVERVIEW OF NETWORK DEPLOYMENT OPTIONS

		Sharing broadcast infrastructure	New MTV infrastructure	Tower overlay concept	Backhaul concept
Applies to	Option 1 (In-band UHF/DVB-T2L)	√	NA	√ (but T2)	√ (but T2)
	Option 3 (Carve-out VHF/ISDB-T)	√	√	NA	NA
	Option 4 (Carve-out VHF/DVB-T2L)	√	√	NA	NA
Advantages		Cost advantages as compared to cellular networks (due to HPHT), most for option 1	Network topology designed for mobile (LPLT)	Cost advantages as compared to cellular networks (due to HPHT)	Cost advantage for content distribution (only)
				(Tailored) LTE-A+ handsets	LTE-A handsets
		Joined MTV service provider role[42]	Joined MTV service provider role	No need to switch to broadcast mode in LTE network	
Disadvantages				Content carrier	Content carrier

[42] This is a joined role as contemporary MTV services are offered in combination with other telecommunication services (in a converged manner). Hence the broadcast network operator needs another partner provider. See also Section 3.1.1.

	Sharing broadcast infrastructure	New MTV infrastructure	Tower overlay concept	Backhaul concept
			or supplier role	or supplier role
	MTV handsets needed	MTV handsets needed		
	Maybe suboptimal design due to HPHT (additional sites needed)	Many sites due to LPLT. LPLT is (too) close to cellular network (no cost advantage)	Maybe suboptimal design due to HPHT (additional sites needed)	
	Mediation platform needed	Mediation platform needed		Need to switch to broadcast mode in LTE network

As can be observed from Table 11, new MTV infrastructure would take away the key advantage of deploying MTV services on the basis of broadcasting infrastructure and hence only the network sharing option is assumed in the further analysis.

2.2 Platform and service synchronisation

Contemporary mobile video and television services are delivered to smart devices and smartphones. Service convergence between all these devices is the current standard. A good example is the Olleh service packages as illustrate in Figure 1. Seamless viewing between the TV set at home (IPTV based) and the mobile device is possible. Also VOD services can be ordered from the mobile device with a wide range of options to 'dice and slice' content libraries. Also the customer can order its content in many paying schemes and options (such as pay-per-view and multi-play discounts). This in sharp contrast with the early MTV launches between 2000 and 2005. In other words a standalone MTV service delivery (for example MTV just as a FTA TV delivery) is not realistic any longer.

With this convergence between devices and services the system architecture of the operating and back office support systems (OSS/BSS) becomes far more complex. The following interrelated functional areas should be dynamically managed[43]:

1. Content management system: streamlines editorial and technical workflows with a metadata hub that efficiently organizes and manages video libraries;
2. Billing engine: based on collected video/service consumption and applying dynamic billing rules, invoices the user;
3. Video content and commerce engine: enables a large set of business models to be designed and run, driving monetization and content merchandising;

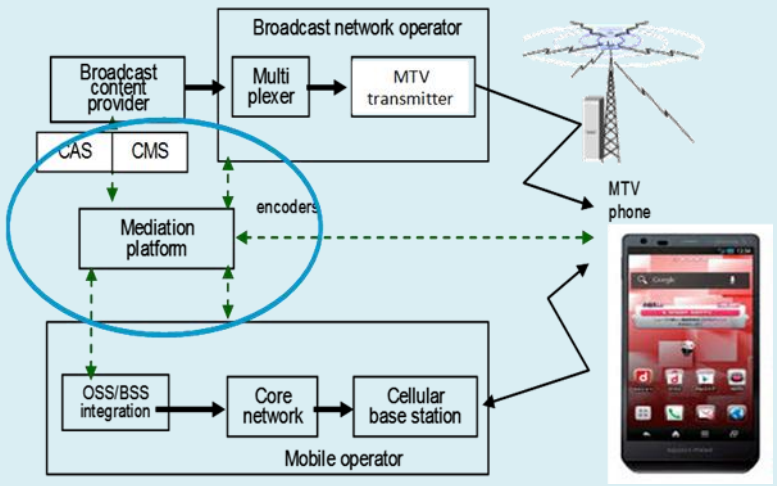
[43] Source: Accenture's Video Solutions suite.

4. Digital advertising module: provides a range of digital interactive formats and sales packages that are deliverable to a wide range of devices, and can target specific customer profiles, devices and locations;
5. Analytics engine: based on a big data layer, increases understanding of viewer behaviour and drives a personalized video experience for maximizing user engagement;
6. Video CRM and self-care solution: provides customer management and service assurance, and includes a set of features for back office operators;
7. Video marketing and campaign management: leverages advertising and analytics to help turn video into a revenue source.

As discussed in the Feasibility study, these OSS/BSS processes should be managed between the broadcasting and telecommunication networks. This will require a mediation platform (see also Table 11)[44]. This mediation platform is not necessary for a mobile TV implementation on the basis of LTE-eMBMS. The LTE-eMBMS solution provides the basic components for this process synchronisation.

2.2.1 MTV mediation platform

As described in the Feasibility study the mediation platform is a tailor-made software platform that sits in between the telecommunications and broadcasting networks. This is illustrated in Figure 6.



Source: ITU

FIGURE 6: MEDIATION PLATFORM FOR MTV AND MOBILE NETWORK INTEGRATION

During the period of the early MTV implementation (2000-2005) most implementations were standalone implementations, either by:

[44] See page 17 and 18 of the Feasibility Study.

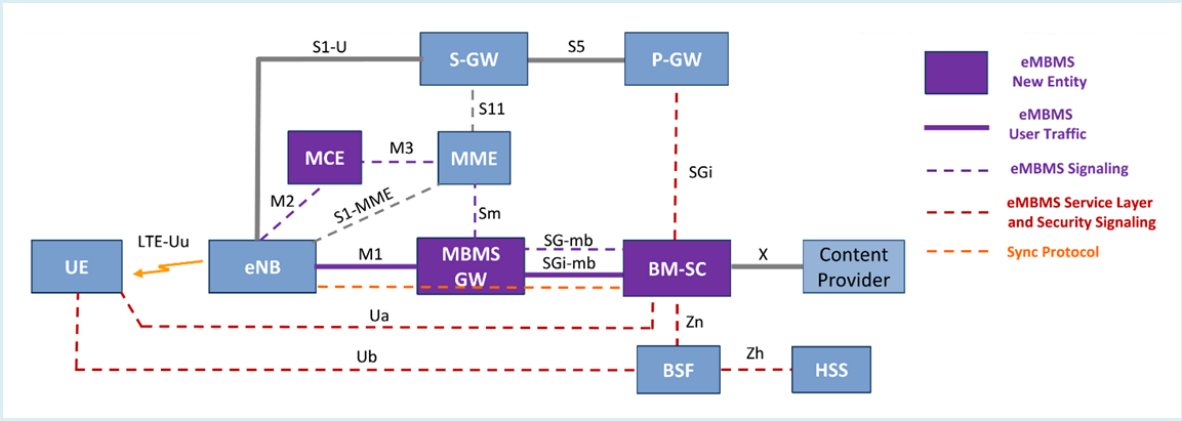
1. A single television package on top of a mobile telephony package. This package was basically switched on or off (by the CAS/CMS) and the interface with the OSS/BSS of the mobile operator was simple, or;
2. A FTA offering like T-DMB in South Korea[45].

One of the rare implementations that the OSS/BSS of the mobile operator was integrated with the (DVB-H) broadcasting system, was in Italy for 3i (at that time). The mediation platform made it possible for the mobile operator (3i) to charge different VOD and live TV service packages through their OSS/BSS. However, this mobile pay-tv implementation was discontinued.

The only advanced implementation of a mediation platform to date, is the one in Japan: NOTTV. Hence the experience of implementing such solutions is rare (and consequently expensive).

2.2.2 LTE eMBMS service synchronisation

As described in the Feasibility study the eMBMS system leverages the investments in a LTE's radio access network. It sits on top of LTE's radio access network and can be considered as an extension of LTE's core network. Figure 7 shows in some detail how the eMBMS system components can be integrated in an existing LTE ecosystem.



Source: Qualcomm

FIGURE 7: INTEGRATION OF EMBMS SYSTEM COMPONENTS

The functionality of each of the eMBMS system components (in Figure 7) can be briefly listed as follows:

[45] The same also applies for the current Smart T-DMB. As indicated in the Feasibility study although Smart DMB services utilize both networks, the operational and business processes (for delivering and billing the interactive services) are not integrated. See the Feasibility study page 42-44.

1. MCE (Multi-call/multicast Coordination Entity): This is a logical entity – this does not preclude the possibility that it may be part of another network element. It includes the following functionality:
    a. Admission control and allocation of the radio resources for all eNBs in the MBSFN area for multi-cell MBMS transmissions;
    b. Controlling suspension/resumption of MBMS session within MBSFN area;
2. MBMS GW (MBMS Gateway): This is also a logical entity and has the following functionality:
    a. Sending/broadcasting of MBMS packets to each eNB transmitting the service;
    b. Uses IP multicast as the means of forwarding MBMS user data to the eNB;
    c. Performs MBMS Session Control Signalling (session start/update/stop) towards the E-UTRAN via MME;
3. BM-SC (Broadcast/Multicast Service Centre): This centre has the following main functions:
    a. Authentication, authorization content provider;
    b. Charging and the overall configuration of the data flow through the core network.

For the above listed functionality, it can be concluded that BM-SC (in combination with MCE and MBMS GW) provides functionality that is normally found in the CAS and Subscriber Management System (SMS) of a pay-tv operator/broadcaster.

For a mobile service provider integrating this functionality into the existing OSS/BSS processes and systems, tailor-made system integration should take place. The amount of system integration work is difficult to assess as this is dependent on the incumbent OSS/BBS systems, the service requirements (e.g. seamless integration with an IPTV offering) and the deployment schedule of these services.

The number of LTE deployments is large and still growing (422 deployments by July 2015 and estimated to total to 460 by End 2015)[46]. More importantly the number of eMBMS deployment is expected to grow (beyond the current commercial deployment of KT in South Korea), as indicated in Table 12.

TABLE 12: GLOBAL EMBMS DEPLOYMENTS AND TRIALS[47]

Country	Network/Service provider	Status
Australia	Telstra	Deploying
China	China Mobile	Trialled
China	China Telecom	Large scale user trial
France	Orange	Trialled
France	TDF	Trialling
Germany	Vodafone	Trialled

[46] Source: Windsor Place Consulting: "Introduction to LTE eMBMS: Evolution and Applications", as presented on 8 August 2015 at the NBTC/ITU Regional Seminar on "Delivery Technologies and Business Models for Mobile Television and Multimedia Services" in Bangkok.

[47] Source: see footnote 46

Country	Network/Service provider	Status
Germany	IRT	Trialling
India	RJIL	Trialled
Italy	RAI	Trialling
Italy	TIM	Trialling
Netherlands	KPN	Trialled
Philippines	Globe	Deploying
Philippines	Smart	Trialled
Poland	Polkomtel Plus	Trialled
Portugal	Meo	Trialling
Singapore	SingTel	Trialling
South Korea	KT	Commercial
UAE	Etisalat	Trialling
UK	EE & BBC	Trialling
UK	Three UK	Trialling
USA	AT&T	Deploying
USA	Verizon Wireless	Deploying

With this expected number of eMBMS deployments it likely that the system integration effort will be less in the near future because standard software suites will become available. Also experiences can be shared across the world (as all service providers work with the same standardized eMBMS system[48]), leading to a higher quality of converged service delivery.

2.2.3 Evaluation overview

Table 13 provides an overview of the advantages and disadvantages of the presented platform and service synchronization options as included in Sections 2.2.1 and 2.2.2.

TABLE 13: OVERVIEW OF PLATFORM AND SERVICE SYNCHRONISATION

	Option 1 (In-band UHF/DVB-T2L)	Option 3 (Carve-out VHF/ISDB-Tmm)	Option 4 (Carve-out VHF/DVB-T2L)	eMBMS (includes Tower overlay & Backhaul)
Attribute	Mediation platform	Mediation platform	Mediation platform	eMBMS suite
Advantages		has a current OSS/BSS integration		Has a commercial implementation

[48] eMBMS is standardized in 3GPP R9, see Feasibility report page 32 and also table 3.

	Option 1 (In-band UHF/DVB-T2L)	Option 3 (Carve-out VHF/ISDB-Tmm)	Option 4 (Carve-out VHF/DVB-T2L)	eMBMS (includes Tower overlay & Backhaul)
		(NOTTV)		(KT)
				Standardized system
				Future implementations in the pipeline
Disadvantages	No current OSS/BSS system integrations		No current OSS/BSS system integrations	

It should be noted that the eMBMS option, as included in Table 13, includes the network deployment options 'Tower overlay' and 'Backhaul' concept (which are variants of option 1, see also Table 11). Combining a Tower overlay concept with eMBMS may require some extra system integration effort for service synchronisation as the broadcast stream is carried in the FEFs (received at the handset) and not delivered through LTE's core network. The same applies when eMBMS is combined with the Backhaul concept as the broadcast stream is delivered at the eNB (i.e. the base transceiver station) and not through the core network.

2.3 Handset availability and pricing

As discussed in the Feasibility report, handset availability and pricing are paramount for a successful implementation of any mobile TV service.

As indicated in Section 1.2, a contemporary implementation of MTV or mobile video services should cater for HD services. For this purpose, MTV handsets should be able to process H.265 encoded signals. Modern smartphones (equipped with the Qualcomm snapdragon 800 chipset or higher) already include the H.265 decoder and can process the video stream[49].

In the following Sections the handset availability and pricing are evaluated for the following options:

1. Option 1 (In-band UHF/DVB-T2L);
2. Option 3 (Carve-out VHF/ISDB-Tmm);
3. Option 4 (Carve-out VHF/DVB-T2L);
4. eMBMS/Tower overlay concept (a variant of option 1);
5. eMBMS/Backhaul concept (a variant of option 1).

This Section is concluded with a summary of the evaluation for handset availability and pricing.

[49] For example the following Samsung models; Galaxy Note 3 uses snapdragon 800 and Galaxy Note 4 uses snapdragon 805. Please note that the Galaxy Note 3 is equipped with Samsung's Exynos chipset in Thailand. This chipset does not support LTE-A.

2.3.1 Option 1 (In-band UHF/DVB-T2L)

As indicated in the Feasibility report, to date no commercial MTV services on the basis of DVB-T2L are offered. Recently chip-sets for DVB-T Lite have been developed and it is reported that a few manufacturers (Sony and Broadcom) are offering DVB-T2L chip-sets.

As this chip-set has low power consumption and allows very robust reception with a capacity of up to 4 Mbit/s, it is also proposed as a future transmission standard for digital radio. This possibility of offering radio service over DVB-T Lite was also tested in field trials in the years 2011/12 (in Denmark). No commercial launch followed.

It should be noted that if a future commercial launch of radio services would be on the basis of DVB-T2L, this would take place in the VHF Band (as the UHF band is not available for radio broadcasting in most countries). For keeping the costs of these radio receivers low, it may well be that these DVB-T2L receivers (i.e. chipsets) are not suitable for the UHF Band.

Consequently, mass produced DVB-T2 Lite receivers for either MTV or radio services are not available to date.

2.3.2 Option 3 (Carve-out VHF/ISDB-Tmm)

Smartphones and tablets equipped with an ISDB-T_{mm} receiver are commercially available in Japan. Japan is the only market that has ISDB-T_{mm} services commercially in operations. Hence the market for ISDB-T_{mm} receivers is led by developments in Japan. After television ASO in Japan, the whole V-High (VHF) band became available for MTV services.

Since the NOTTV service launch in April 2012, over 1.7m people subscribed to the service. The latest subscriber data available is of December 2014. As a minimum one can assume that this number of 1.7m is equal to the cumulative sales of ISDB-T_{mm} receivers.

It should be realised that these ISDB-T_{mm} enabled models come together with subscribing to the service. This is different from the T-DMB market in Korea where the MTV services are all free (i.e. FTA).

In total over 70 ISDB-Tmm enabled models are available on the website of NOTTV. Most of them are also LTE enabled. It should be noted that these devices are only available in Japan (through DoCoMo's web shop) and that on 27th of November DoCoMo announced that it will terminate the NOTTV service by 30th of June 2016[50]. Hence it is very likely that the number of available ISDB-Tmm enabled handsets will not grow any longer and eventually will seized to be commercially available.

Table 15 provides and overview of the ISDB-T_{mm} equipped and NOTTV software prepared devices (in total 72 models).

[50] See NTT DOCOMO press release of 27 November 2015 "Termination of NOTTV Multimedia Broadcast Services". In this press release the following is stated on the reason for termination of the service; "With the number of NOTTV subscriptions falling short of plan due to the increased popularity of video distribution services for smartphones over the internet and the like in the recent years, we concluded that it was difficult to continue the business and decided on its termination.". The full text of this press release is included in Annex C.

TABLE 14: ISDB-T_{MM} EQUIPPED AND NOTTV PREPARED DEVICES[51]

Number of models	Device type	Brands
61	Smartphones	Sony, Sharp, Fujitsu, Samsung, Panasonic, NEC, Huawei, LG
9	Tablets	Sharp, Panasonic, Sony, NEC,
2	STBs	No information

Table 15 shows 8 different brands of which 5 are Japanese and consortium partners of NOTTV/MMBI. The Apple iPhone and tablets are missing in Table 15. Apple iPhone sales are approximately half of the Japanese smartphone market. Especially the launch of the iPhone 5 (2012) and iPhone 5C/S (Sept 2013) impacted NOTTV sales (see also Figure 22 in the Feasibility report).

Under various subscription plans NOTTV enabled handsets can be acquired against large discounts (up to 100%). However, ISDB-T_{mm} enabled sets can also be purchase without subscribing to the NOTTV services. NOTTV also offers FTA services and buying an ISDB-T_{mm} enabled set will suffice for receiving these services. All NOTTV enabled sets are purchased in the web shop of DoCoMo. NOTTV handset prices, without a subscription plan, range from USD 180 to USD 800+ (for a Samsung Galaxy S5).

2.3.3 Option 4 (Carve-out VHF/DVB-T2L)

Please refer to Section 2.3.1. However, this option is a MTV implementation in the VHF Band and this option may benefit better from a possible DVB-T2L launch for radio services (likely to be in the VHF Band).

2.3.4 eMBMS/Tower overlay concept

In a tower overlay concept the mobile terminal needs to be a LTE-A+ terminal[52], the plus sign indicating that it deviates from a 'standard' LTE-A handset. The difference likely to be software and RF based differences. Although the differences will be small as compared to having an integrated MTV/LTE handset, manufacturers should be willing to produce these LTE-A + handsets. To date it is unknown whether manufacturers are planning to produce these handsets for the mass market.

2.3.5 eMBMS/Backhaul concept

In the backhaul concept the broadcast services are delivered at the eMBMS base transceiver station (eNB). Consequently, the standardized air interface exists between the base station and LTE handset. The handset requirements are therefore no different from a mobile TV implementation on the basis of eMBMS alone (like Olleh TV).

[51] Source: NOTTV/DoCoMo, as of December 2015.

[52] See Feasibility report page 63.

From the network side eMBMS is deployed on LTE-A. From the handset side eMBMS requires a chipset which supports processing the eMBMS broadcast signals. Qualcomm is the largest chipset manufacturer and the majority of smartphones are equipped with their chipsets. The Snapdragon 800 series (i.e. 800, 801, 805, 808 and 810) supports eMBMS. The Snapdragon 801, 805, 808 and 810 also support H.265.

Table 15 provides and overview of the Snapdragon equipped devices (in total 77 models) which are globally available.

TABLE 15: SNAPDRAGON EQUIPPED DEVICES[53]

Chipset	Number of models	Device types	Brands
800	32	Smartphones, Tablets, Cameras, Audio systems, STBs	Samsung, Sony, Amazon Kindle, Nexus, LG, Nokia, Asus, ZTE, HP
801	23	Smartphones, Tablets	ZTE, OnePlus, OPPO, HTC, Samsung, Vertu, Sony, LG
805	8	Smart glasses, STBs, Tablets, Smartphones	ODG, Razer Forge, Motorola, Nexus/Google, Amazon Fire, Samsung
806	6	Smartphones	Blackberry, Microsoft, LG, Nexus, Moto X
810	8	Tablets, Smartphones	Motorola, Microsoft, Nexus, OnePlus, ZTE, HTC, Sony, LG

Table 15 shows 20 different brands and again the Apple iPhone and tablets are missing. The global market share of iPhones/iOS is approximately 14%[54]. The iPhones which support LTE-A and H.265 are the iPhone 6, 6 Plus, 6S and 6S plus (which house the A8/9 chipset), launched respectively September 2014 and 2015. The iPhone 6 and 6 Plus comprise approximately 40% of all iPhones sales today[55]. However the iPhone 6 has not be used in eMBMS trials or commercial operations yet (see Table 12).

Like with the ISDB-T_{mm}/NOTTV enabled devices (see Section 2.3.2), a software download is necessary to have a LTE-A enabled handset processing an eMBMS broadcast signal. For example, at the launch of KT's eMBMS service (2014) users were required to download a software upgrade on their

[53] Source: Qualcomm.

[54] Source: IDC, August 2015.

[55] Source: Localytics, September 2015.

Samsung Galaxy Note 3 (uses Snapdragon 800 – which doesn't support H.265). Currently the range of models is much wider (see Table 15).

Smartphones (and other devices) housing either the Snapdragon 800 series or the A8/9 chipsets are the high-end smartphones because they come together with a HD screen (and hence with H.265 encoding). The price range of these LTE handsets is similar to the price range as mentioned for the NOTTV handsets. They range also between USD 200 to USD 800+. However, the number of models is wider and this number is expected to grow as the Snapdragon 800 and A8/9 (and its successors) will be incorporated as a standard in all new models. This is driven by the fact that all LTE networks evolve into LTE-A networks (i.e. the latest releases R10/R11 from 3GPP, the standardization body for LTE).

2.3.6 Evaluation overview

Table 16 provides an overview of the handset availability and pricing as included in Sections 2.3.1 to 2.3.5.

TABLE 16: OVERVIEW OF HANDSET AVAILABILITY AND PRICING

	Option 1 (In-band UHF/DVB-T2L)	Option 3 (Carve-out VHF/ISDB-Tmm)	Option 4 (Carve-out VHF/DVB-T2L)	eMBMS/Tower overlay concept	eMBMS/Backhaul concept
Attribute	MTV enabled handset	MTV enabled handset	MTV enabled handset	LTE-A+ (and proprietary software) handset	LTE-A (and eMBMS software) handset
Advantages		Handsets were commercially available			Handsets commercially available
			May benefit from digital radio launch in VHF band		Standard LTE-A handset
				Long term availability dependent on global LTE evolution	Long term availability dependent on global LTE evolution
Disadvantages	No commercial product available		No commercial product available	No commercial product available	
	Requires MTV designed and produced		Requires MTV designed and produced	Requires LTE A+ designed and produced handsets	

	Option 1 (In-band UHF/DVB-T2L)	Option 3 (Carve-out VHF/ISDB-Tmm)	Option 4 (Carve-out VHF/DVB-T2L)	eMBMS/Tower overlay concept	eMBMS/Backhaul concept
	handsets		handsets		
		Long term availability unlikely as NOTTV will be terminated		Proprietary software required	

3. Business and regulatory aspects

In this Chapter applicable business models for the various options are addressed and evaluated. Also the regulatory consequences of applying different business models are analysed in this Chapter. The Chapter is concluded with an overview of this evaluation. Consequently, this Chapter is structured as follows:

1. Business models;
2. Regulatory consequences;
3. Evaluation overview.

3.1 Business models

As discussed in Section 1.2, contemporary mobile video and television services are delivered to smart devices and smartphones. Service convergence between all these devices is the current standard. A standalone MTV service delivery (as was the case for the early MTV launches in 2000-2005) is not realistic any longer, it has to be integrated with other telecommunication services. These other services are mostly paid and combined in multi-service packages. Figure 8 provides an example of KT in South Korea.

Source: KT, 2015

FIGURE 8: MULTI-SERVICE PACKAGE AND PRICING PLANS

As can be observed from Figure 8, free live TV services are offered as part of a subscription package. This is a similar offering as NOTTV in Japan. NOTTV also provides some free live TV services next to paid services, like for music down loading or premium TV content. They phrase their service package as a “freemium” package. As remarked in Section 2.3.2, please note that NOTTV services will be

terminated due to popularity of distributing video services for smartphones over the Internet (including fixed and mobile – hence including LTE) in recent years[56].

Consequently, offering MTV services on a FTA-only basis are unlikely to be competitive nowadays. This conclusion seems to be confirmed by what was observed during the country visit of KBS/T-DMB[57]. In the T-DMB business model (i.e. the FTA model) advertising income is the main source of income. Although no hard evidence could be collected on the profitability of the MTV services, it is generally argued that the model is loss making as no new advertising revenues can be found. As the additional costs to the broadcasters are minimal, the service is continued. Hence this FTA business model is no longer considered in this report.

3.1.1 Options 1, 3 and 4

In the options 1 (In-band UHF/DVB-T2L), 3 (Carve-out VHF/ISDB-Tmm) and 4 (Carve-out VHF/DVB-T2L) the broadcast network operator has the role of a joined MTV service provider (see also Table 11). When MTV services are delivered at smartphones the mobile service provider is in the lead, as this party owns the customer relationship for supplying the phone and an associated data package.

With reference to the ITU Guidelines[58], the corresponding business model (mobile service provider led model) is depicted in Figure 9.

[56] See footnote 50.

[57] See Feasibility Study, page 42.

[58] See ITU Guidelines on the Transition from Analogue to Digital Broadcasting, 2014 edition, see section 3.4.2.

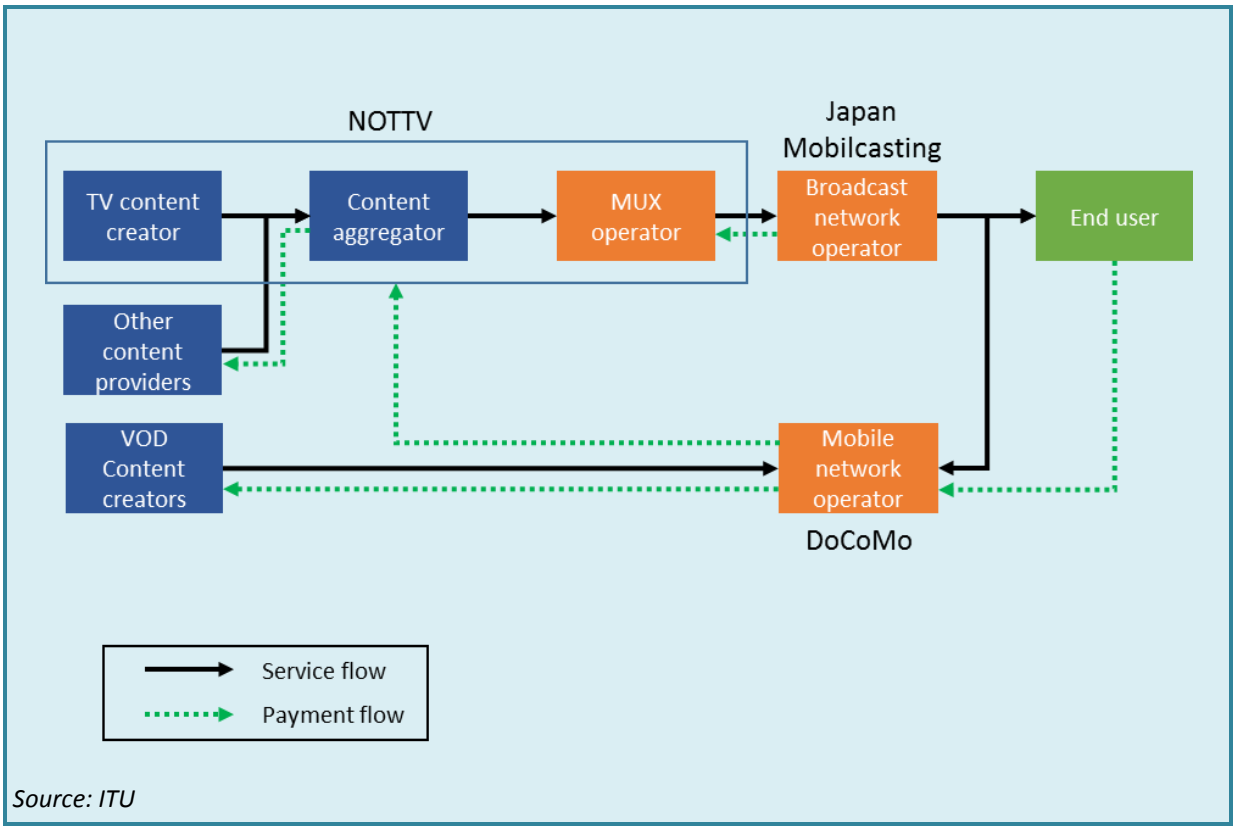


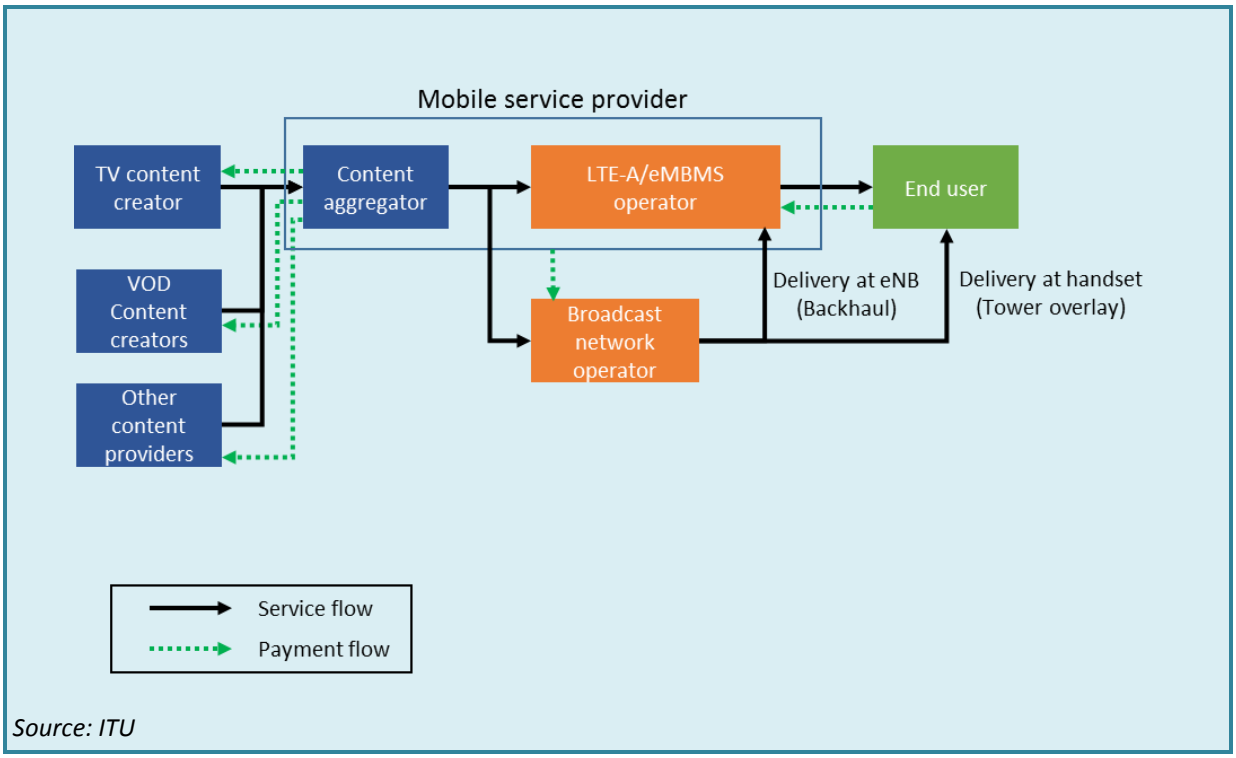
FIGURE 9: MOBILE SERVICE PROVIDER LED BUSINESS MODEL

In Figure 9 the NOTTV actors are depicted in the business model (corresponding with option 3). NOTTV has the role of content creator as it makes its own TV programming (it has studios). NOTTV aggregates its own content and that of third party content providers into several broadcast streams (content aggregation). It also manages the multiplex capacity, allocating capacity to broadcasting and datacasting services. Japan Mobilecasting (a 100% subsidiary of MMBI) is the MTV broadcast network operator. DoCoMo manages the client relationship also for the NOTTV branded services. DoCoMo offers the web shop for acquiring the NOTTV enabled handsets and service packages. Subsequently it bills the NOTTV services through the mobile phone bill.

For the other two options 1 and 4 (Carve-out VHF/ISDB-Tmm and DVB-T2L) a similar business model can be anticipated: a consortium of parties (across the business model or value chain) have to work together in delivering these converged MTV services.

3.1.2 eMBMS/Tower overlay & Backhaul concept

In these two options (Tower overlay and Backhaul concept, variants of option 1), the broadcast network operator has the content carrier role (or supplier role). All service delivery and client management tasks are carried out by the eMBMS service provider (i.e. the mobile service provider). The associated business model is depicted in Figure 10 (including both Tower overlay and Backhaul concept).



Source: ITU

FIGURE 10: MOBILE SERVICE PROVIDER CONTROLLED BUSINESS MODEL

Figure 10 is different from Figure 9 in the sense that NOTTV is in charge of some content aggregation (not for VOD content) and that the TV services are branded and offered as NOTTV to the end-user (who pays for them). In Figure 10 both are absent.

3.2 Regulatory consequences

The discussed business models, as included in Figure 10 and Figure 9, do have different regulatory consequences for the NBTC to consider. It is assumed here that any future MTV licensing will take place under the current regulatory framework, which is briefly summarized below.

The regular licensing framework for broadcast services and distribution is based on the Broadcast Business Act (2008) and the Act on Organization to Assign Radio Frequency and to Regulate the Broadcasting and Telecommunications Services (2010). The licensing framework is depicted in Figure 11.

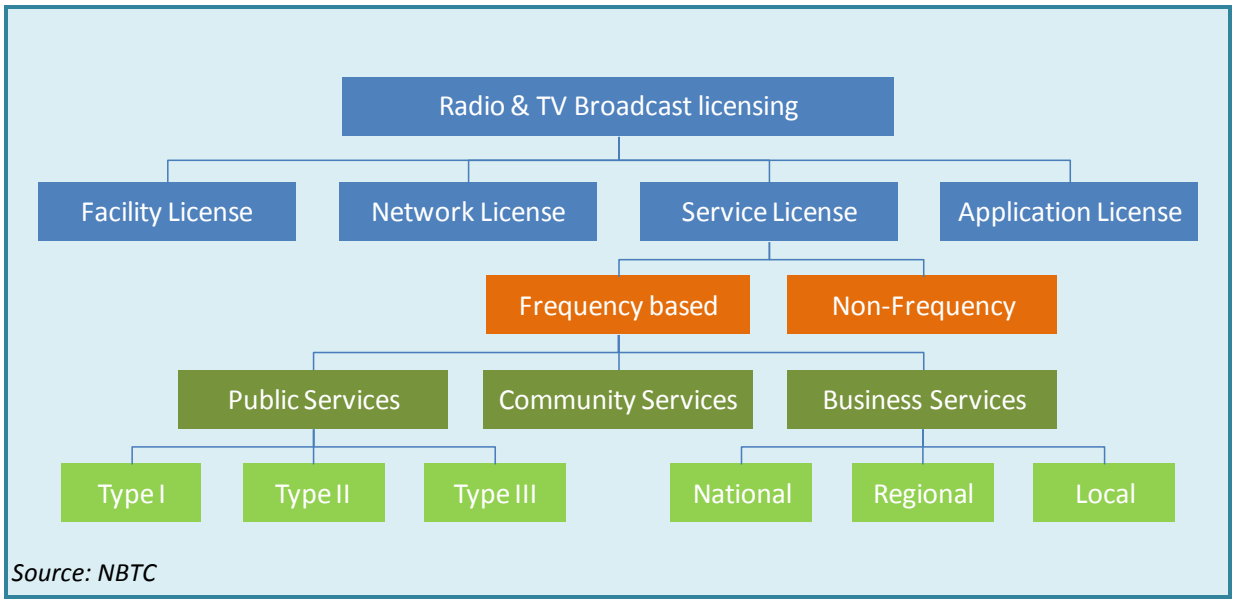


FIGURE 11: LICENSING FRAMEWORK FOR BROADCASTING

In the following three Sections the regulatory consequences of the two different business models are addressed for the following options:

1. Option 1 (In-band UHF/DVB-T2L);
2. Option 3 and 4 (Carve-out VHF/ISDB-Tmm and DVB-T2L);
3. eMBMS/Tower overlay & Backhaul concept (variants of option 1).

3.2.1 Options 1 (In-band UHF/DVB-T2L)

Under this option no spectrum rights have to be assigned as these rights have already been assigned for the DTTB services. Following the diagram in Figure 11 no new "Frequency based" Service licenses are needed if no new content (i.e. other than broadcasted on the DTTB platform) is broadcasted. Reversely, if new content would be offered under this option a "Non-Frequency based" Service license would have needed to be assigned.

It is important to note that in the Thai market incumbent TV services (i.e. services already available on the DTTB platform) are also delivered by Over-The-Top (OTT) Service Providers (SPs) and the current 3G SPs. It should be checked if for both SP types "Non-Frequency based" service licenses have been assigned and if so, what the license terms and conditions say[59]. As the delivery method is irrelevant for the end-consumer (whether it is OTT or MTV delivered) and the SPs operate in the same relevant market, the Regulator should ensure that SPs compete at a level-playing-field. In other words, the OTT and MTV SP have the same regulatory costs and degrees of operational freedom. From a legal perspective this may constitute a complex matter.

[59] For the 3G delivered TV services the spectrum rights have been already been assigned to the SP in the 3G spectrum auction as the SP and Network Operator (NO) are the same entity. For the OTT delivered TV services the SP does not operate a telecommunications network and hence no spectrum rights need to be assigned to this OTT SP.

In particular, the following requirements should be checked for ensuring a level-playing-field:

1. Free-To-Air (FTA) requirements: under a FTA requirement services can only be delivered on the basis of FTA. This would exclude pay-based services which are deemed to be an important success factor (see Section 3.1.1)[60];
2. 'Must provide' regulations: for example, for the DTTB SPs it was required that they offer their services for distribution on the satellite platform too;
3. 'Must carry' regulations; for example, a minimum set of services (often PSB) have to be offered or carried.

As indicated in Section 1.4, option 1 (In-band UHF/DVB-T2L) and also options 3 and 4 require that MTV capacity is aggregated across several layers or multiplexes. Without this aggregation the service bouquet will be too small. Hence DTTB SPs will need to collaborate if they would like to provide a competitive proposition. For this purpose, a joint venture company (JVC) is likely to be needed. The Regulator may wish to stipulate the establishment of such a MTV JVC, before assigning "Non-Frequency based" Service licenses, because of:

1. Avoiding non-effective competition between MTV SPs as they will have to compete against LTE and OTT delivered mobile TV services;
2. Ensuring spectrum efficiency as MTV service delivery will require the creation of a PLP and in turn this will require a rearrangement of the DTTB services across the multiplexes;
3. Ensuring operational efficiency as MTV service delivery will require:
    a. Design, sourcing and deployment of additional network equipment;
    b. Sourcing of MTV enabled handsets (which will require large scale ordering).

As discussed in Section 1.3.1, this option is limited to the frequencies as assigned for the DTTB services. It was also assumed that any additional MTV sites can be planned in a SFN (with other DTTB stations). Although no new frequencies are assigned under this option, the Regulator should approve these additional MTV stations in the same way as it currently does for the DTTB stations. Before a MTV station is taken into operations, a (updated) frequency plan should show:

1. The protection of the existing DTTB services (i.e. no unacceptable additional interference);
2. The protection of any ATV services (if still in operations);
3. The compliancy with any coordination agreement (currently only the Malaysian agreement).

In addition, the NBTC should verify if the base DTTB services are well protected in terms of maintaining the agreed DTTB service levels. The picture quality of the existing DTTB services should not deteriorate as multiplex capacity is shared between the DTTB and MTV services. Also the coverage requirements should be checked because a less robust mode could be applied for freeing up multiplex capacity for the MTV services.

[60] See also Annex B: MTV case studies.

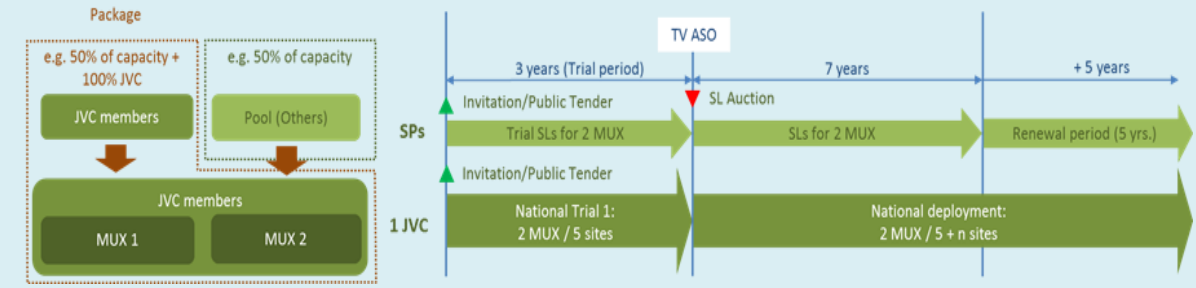
3.2.2 Option 3 and 4 (Carve-out VHF/ISDB-Tmm and DVB-T2L)

Under these options spectrum rights need to be assigned. As discussed in Sections 1.3.2 and 1.3.3, the number of VHF frequencies available for MTV services is dependent on the DSB requirements. It was assumed that these DSB requirements would be limited to no more than 2 National and 2 Local layers. Any requirements beyond this DSB limit would result in a too small MTV service package.

Following the diagram in Figure 11, "Frequency based" Service licenses need to be assigned under this option. Again, the Service license terms and conditions should be checked for ensuring a level-playing-field, in particular with an eye on OTT delivered mobile services in the market.

Also as indicated in Section 1.4, these options require that MTV capacity is aggregated across several layers or multiplexes. For this purpose, a joint venture company (JVC) is likely to be needed. The DSB Service licenses still need to be assigned at the moment of writing this report. Hence it is recommended to include the possibility of offering MTV services in the proposed licensing framework and procedure for the DSB services. For the DSB licensing it was also recommended that spectrum and content rights are assigned to a JVC, starting with a Trial period which is followed by a regular licensing period.

The essence of the recommended DSB deployment strategy and policy is reflected in Figure 12[61].



Source: ITU

FIGURE 12: ESSENCE OF THE RECOMMENDED DAB DEPLOYMENT STRATEGY AND POLICY

It is important to note that the following was recommended for the DSB services in relationship to other data services (i.e. non-PAD):

1. Limit the possibilities to broadcast data only in the following manner;
2. Data can only be broadcasted if an audio service is broadcasted too, and;
3. The allocated capacity for these data services should not exceed 25% of the allocated capacity to the service provider;
4. A EWS responsibility could be exempted from this data limit.

[61] For more details, please refer to ITU report "Deployment Strategies for Digital Radio Services in Thailand", dated June 2016.

A MTV service can be classified as other data (i.e. non PAD). As indicated for the DSB licensing the 25% can be changed, depending on market requirements (i.e. MTV market demand).

3.2.3 eMBMS/Tower overlay & Backhaul concept

For these two options (i.e. two variants of option 1 - In-band UHF/DVB-T2) the DTTB network is used as a technical platform for delivering data to another SP of telecommunications services (i.e. the content carrier or supplier role, see Table 11). Following the diagram in Figure 11, nor a "Frequency based" or "Non-Frequency based" Service license is needed under this option.

However, a Facility licenses may be needed as the DTTB platform can be considered as a technical facility provided to a SP. However this SP is not a broadcaster as meant under the licensing framework as depicted in Figure 11. The principle of assigning a Facility license under the Thai legislation is to ensure the long term availability and appropriate technical delivery of these facilities. It should therefore be checked if this principle also applies for the delivery of services in the telecommunications domain.

Depending on the market demand for either Tower overlay or Backhaul carrier services, a JVC may be needed. It should be noted that this need is different from what was described previously in Section 2.3.1. For example, the LTE SP can decide to split its TV services into (a) the most popular TV services and (b) niche or tailored TV services. The most popular services can then be carried over the DTTB network and the other TV services remain to be delivered over the LTE network. Consequently, the need for DTTB capacity is dependent on this split of content by the LTE SP. It is likely that the DTTB capacity need is less (as compared with options 3 and 4) and aggregation is limited to for example two PLPs.

As discussed in Section 1.3.1, these variants of option 1 are limited to the frequencies as assigned for the DTTB services. It was assumed that any additional MTV sites can be planned in a SFN (with other DTTB stations). Although no new frequencies are assigned under these variants, the Regulator should approve these additional MTV stations in the same way as it currently does for the DTTB stations.

Again, as indicated in Section 3.2.1, the NBTC should verify if the base DTTB services are well protected in terms of maintaining the agreed DTTB service levels.

3.3 Evaluation overview

Table 17 provides an overview of the business and regulatory aspects as included in Sections 3.1 and 3.2.

TABLE 17: OVERVIEW OF BUSINESS AND REGULATORY ASPECTS

	Option 1 (In-band UHF/DVB-T2L)	Option 3 (Carve-out VHF/ISDB-Tmm)	Option 4 (Carve-out VHF/DVB-T2L)	eMBMS/Tower overlay concept	eMBMS/Backhaul concept
Attribute	No new spectrum and converged SP role	New spectrum and converged SP role	New spectrum and converged SP role	No new spectrum and supplier role	No new spectrum and supplier role

	Option 1 (In-band UHF/DVB-T2L)	Option 3 (Carve-out VHF/ISDB-Tmm)	Option 4 (Carve-out VHF/DVB-T2L)	eMBMS/Tower overlay concept	eMBMS/Backhaul concept
Advantages		Can be included in single assignment procedure (for DSB)	Can be included in single assignment procedure (for DSB)	JVC only needed for aggregating DTTB capacity (dependent on LTE SP demand)	JVC only needed for aggregating DTTB capacity (dependent on LTE SP demand)
	No spectrum assignment (i.e. auction)			No spectrum assignment (i.e. auction)	No spectrum assignment (i.e. auction)
Disadvantages	JVC needed for spanning the whole value chain + aggregating DTTB capacity	JVC needed for spanning the whole value chain + aggregating DTTB capacity	JVC needed for spanning the whole value chain + aggregating DTTB capacity		
	Level-playing-field to be checked	Level-playing-field to be checked	Level-playing-field to be checked	Facility licensing to be checked	Facility licensing to be checked
		Dependent on DSB requirements	Dependent on DSB requirements		

4. Regulatory impact assessment

This Chapter examines the impact of the alternative implementation options as identified in the Chapters 1 to 3 for consideration by NBTC. The study on the potential impact of the identified implementation options covers:

1. Social impact;
2. Economic impact;
3. Industry impact (comprising mobile and broadcasting industries);
4. Consumer impact.

First these four impact areas will be addressed for MTV services common to all implementation options. For any identified adverse or negative impact area mitigation measures are proposed (when possible). This generic assessment is followed by an impact assessment for the individual implementation options, respectively:

1. Option 1 (In-band UHF/DVB-T2L);
2. Option 3 and 4 (Carve-out VHF/ISDB-Tmm and DVB-T2L);
3. Tower overlay and Backhaul concept (variants of option 1).

This chapter is concluded with an overview of the regulatory impact.

4.1 Impact by MTV services common to all options

The Section addresses the social, economic, industry and consumer impact by MTV services common to all implementation options.

4.1.1 Social impact

MTV services offer an entirely different viewing and listening experience. The environment in which MTV services are consumed is very different from that of linear and Internet TV. The important aspect of being able to consume MTV services on the move, either in a portable environment or in the vehicular environment, in a converged manner is quite innovative.

Most importantly, experience has shown that while a sizeable proportion of the MTV audience belongs to the younger generation, other segments of the population are also keen to consume MTV services on the go.

These factors create a unique impact on the society. For one, the viewing habits of a large proportion of the society undergo a dramatic change. The consumption of the broadcasting services, particularly video and TV services, witnesses a significant change.

The consumption is no longer confined to the indoors (or offices and similar areas) but is extended to outdoors, while walking on the street, while shopping, while riding a car, in metro trains and in subways. All these possibilities add a new dimension to media consumption.

In addition, the media consumption seamlessly transitions from indoors to outdoors without any break. It is also possible for the audiences to catch up their favourite program after a time lapse (see also Figure 1).

It may also be noted that the advertisements on MTV services tend to be very personal in their message. This will have an impact on the society as the advertisements would appear to be more directed to each individual than to a group of people as in the case of linear and stationary TV.

In conclusion, the impact on the society would be substantial and positive. Significantly, the young population in Thailand will particularly benefit by an introduction of MTV services. Given the rapid uptake of smartphones in Thailand, the MTV services would certainly provide an attractive media consumption alternative to them.

It is expected that a positive impact will be established on the social structures and societal processes in Thailand due to the introduction of MTV services. MTV will bring in personal aspects of media consumption, providing services on-the-go and focusing on some of the demographic sections of the society.

4.1.2 Economic impact

Implementation of the MTV broadcasting network and the offering of MTV services in Thailand will have a significant impact on the industrial economy of this country. This impact will be based on meeting the requirements of MTV projects, consumer purchases and software (MTV content) development. In addition, the deployment project will generate a number of job opportunities in the country.

Countrywide networks for MTV broadcasting need infrastructure and equipment facilities. This equipment can either be imported or produced in Thailand. Together with the cost of the equipment, its installation and commissioning will generate a good amount of positive impact in the Thai industry.

Setting up of new MTV broadcasting stations and MTV content facilities is another factor that will add to the economy of the country, setup modern facilities and provide employment to a diverse cross-section of professionals, from the TV and radio artistes to professional managers and technicians. The task of content creation and content repurposing for mobile TV to cater to a large number of MTV services itself is large and will provide a positive impact to the broadcasting industry in Thailand and to its economy.

Is expected that the most significant impact will be on the mobile device manufacturing industry which will be called upon to manufacture and supply a large number of such devices into the market. With consumers already having such mobile devices and/or purchasing new ones with better facilities, this industry will be provided with growth opportunities and will add value to the economy of the country.

In addition to this, the whole process will create a large number of jobs for professionals and semi-professional personnel, further adding to the positive impact on the economy of this country.

What is imperative in this case is that MTV should be able to provide better quality mobile multimedia content services and many new types of value-added services which are useful to the citizens and to the people in the countryside. In particular, MTV services should cater to the needs of the young population in Thailand who will particularly benefit by the introduction of MTV. It is this segment of the society that will create a positive impact on the economy.

4.1.3 Industry impact

The impact of a MTV introduction on the other sectors of the multimedia industry may be significant. If MTV services were positioned as a direct competitor to already existing mobile video services (delivered over 3G/4G), MTV services may have a reversed impact on mobile operators. On the current DTTB service providers a MTV introduction may have a negative impact as MTV broadcasting may open up additional capacity for new service providers to enter the Thai TV market.

Impact on mobile broadband services

An implementation of MTV broadcasting services is expected to have only a significant adverse impact on mobile operators if these MTV services are launched as a direct competitor to already present mobile video services in the mobile market (delivered over 3G/4G). As described in the MTV Feasibility report mobile video services (including live TV services) are already present in the Thai market[62].

Whether MTV services are introduced as a direct competing offer to 3G/4G delivered mobile video services, is dependent on what business model would be adopted for these MTV services and whether mobile operators are part of the MTV business model:

1. **FTA and broadcaster led model**: In this model the main source of income is advertising income. In South Korea the T-DMB services are provided on the basis of this FTA model[63]. A FTA business model for MTV services is basically no different from the FTA model as applied for DTTB services. In the T-DMB based MTV market in South Korea, the MTV services are offered FTA to the end-users. The MTV broadcasters own the (MTV) content and also directly operate their own shared MTV network. They directly distribute audio, video, and data (TPEG, EPG, News, Weather, etc.) to the MTV viewers through their shared MTV network. Importantly the MTV broadcasters are existing broadcasters that re-transmit their content and newly produced content in prime time over their shared MTV network;
2. **Pay and mobile operator led model**: In this model the main source of income is subscription fees. These subscription fees are part of an integrated offering from a mobile operator. In Japan NOTTV (part of DoCoMo) was offering MTV services on the basis of a such a pay model[64]. In South Korea KT is also offering its Olleh TV Mobile services on the basis of a pay model, although delivered over LTE eMBMS[65]. In both examples the mobile operator is in the lead as this operator owns the customer relationship and bills its customers. Also the mobile operator is responsible for the service offering and sources the mobile video and TV content. TV broadcasters are suppliers to the mobile operator in this model.

As argued in Section 3.1, contemporary mobile video and TV services are delivered to smart devices and service convergence is considered to be a critical requirement. A standalone MTV service

[62] See section 1.2 of ITU report "Mobile Television Services: Feasibility study for Thailand", dated May 2015.

[63] See section 3.2.3 of ITU report "Mobile Television Services: Feasibility study for Thailand", dated May 2015.

[64] See Section 3.1.1.

[65] See Section 3.1.

delivery is not realistic any longer, it has to be integrated with other telecommunication services. These other services are mostly paid, combined in multi-service packages and are mobile operator led. Consequently, offering MTV services on a FTA-only basis is unlikely to be competitive nowadays.

Under pay and mobile operator led models, mobile TV services are not competing with existing 3G/4G based mobile services, as the mobile operator is part of the business model and has adopted the introduction of MTV services as an enhancement of the existing business. This enhancement of the existing business could be traffic off-loading (from LTE to MTV) or a cheaper distribution of broadcasting services.

It is noted that the in this report described option 1 variants – Tower overlay and Backhaul concept – do not constitute the introduction of competing MTV services as the DTTB network is only used to deliver the broadcasting data (either at the handset or base station) as part of LTE-eMBMS delivered services. LTE e-MBMS services are per definition mobile operator led as they are based on a LTE deployment of which the spectrum is held by mobile operators.

As said, offering FTA based MTV services (like T-DMB in South Korea) is not considered competitive any longer and hence it is unlikely that FTA MTV services would be launched. A pay and mobile operator led model is assessed to be more likely, if a MTV based service would be launched. Under the scenario of having a mobile operator led model for MTV services, the impact would be positive.

However, such a positive impact would only apply for all mobile operators in the market, if all these operators would have access to the MTV platform. In other words, a market with MTV services (and mobile operator led) should be tested for the following, whether:

1. MTV services are offered on the basis of *exclusivity*. That is to say, MTV services are exclusively offered to one or more mobile operators and other remaining operators cannot acquire access, *and*;
2. MTV services have a *unique competitive edge*, possibly constituting an Essential Facility. In other words, the excluded mobile operators cannot acquire an economic viable alternative for offering mobile TV services, which are deemed to be necessary for remaining competitive in the market.

Both tests should result in a confirmation, before a Regulator may wish to interfere as the introduction of MTV services would under such a scenario lead to unfair competition due to a disturbance of the level-playing-field. However, this is currently assessed as highly unlikely as:

1. Any provider of MTV services[66] will have a commercial interest in offering the MTV services to all mobile operators as the same (aggregated) infrastructure can be sold to an infinitive number of mobile operators without an increase in delivery costs;
2. LTE eMBMS based services offer the same functionality, if not better. Also LTE delivered mobile TV services have the critical advantage of having the availability of universal standard handsets. In addition, LTE eMBMS based deployments are expected to be more numerous

[66] Please note that the offering of MTV services will require DTTB network operators and service providers to aggregate capacity across the different multiplexes as to offer a competitive number of MTV services with good enough picture quality. See Sections 1.4 and 3.2.2.

(as compared to MTV based deployments[67]) and the number of subscribers to LTE mobile services are expected to be very high. Consequently, LTE eMBMS based mobile TV services can be offered at a (more) competitive cost level.

The only remaining future scenario to be considered would be the scenario that MTV is needed for traffic off-loading. Under this scenario LTE capacity is needed for both Unicast and Broadcast traffic and the network capacity is insufficient to fulfil demand and the country runs out of Mobile spectrum. This future scenario is currently assessed to be many years ahead of us. However, if such a situation would arise in the future, the MTV provider has a commercial incentive to offer its services to all interested mobile operators.

Impact on FTA linear television and radio services

Successful implementation of MTV services may result either in a positive or adverse impact on the existing TV (DTTB) and radio broadcasting services (AM/FM and DAB), depending on the whether new service providers would enter the market:

1. MTV broadcasting provides seamless continuation of services while the consumers travel from indoors to outdoors and also into vehicles[68]. This may prove to be a very attractive facility provided by the MTV broadcasting services. In this respect, the MTV broadcasting services could have a significant positive impact on the viewership of linear TV broadcasting services (i.e. the current DTTB services). However, it is important to note that this positive impact assumes that no new TV service providers/broadcasters enter the market;
2. In contrast to the above assumption, if the launch of MTV services would entail market entry for new TV service providers/broadcasters, market competition would further increase and could have a negative impact on the current DTTB service providers. In the light that these current DTTB service providers are already struggling to acquire or maintain market share, a further enlargement of the number of TV service providers may result a market shake-out (in which companies go into insolvency or pull-out from the TV market);
3. The argument for the impact of MTV broadcasting on radio services is somewhat different. Radio services are inherently consumed on portable (and mobile) radio receivers, including on mobile phones, for both AM/FM and DAB. However, as MTV broadcasting offers a package of services including video, radio and data services, this attracts audiences more than the radio-only services provided by radio broadcasting[69]. As such, there would be a significant impact on the consumption of radio broadcasting services due to the introduction of MTV broadcasting;
4. Generally, the competition between broadcasting services is predicated on the quality of content delivered. If the quality of content delivered by MTV broadcasting is attractive and tailor-made for the specific audiences addressed by the services, there would be a definite

[67] See Section 2.2.2.

[68] Like KT offers with Olleh TV Mobile, see Section 3.1.

[69] See for example "TV Thailand" offers already linear TV and radio services in a single mobile application (on the basis of 3 and 4G networks). It should be noted that the traffic volumes are still relatively low and hence this application can work using unicasting rather than broadcasting.

adverse impact on other broadcasting services. This negative impact would only occur if MTV services were not part of a converged services offered and would be provided by new market entrants;

5. With the introduction of MTV services by broadcasters offering already DTTB services, would result in these broadcasters to reconsider their program content and service offering. The incumbent DTTB broadcasters would have to make new investments in program production and channel management to meet the MTV requirements. This would mean additional expenditure for such broadcasters and at the same time MTV may not directly add to their revenues. However, DTTB broadcasters entering the MTV service market will only do so after having assessed the long-term profitability of their intended MTV investments;
6. Although deemed to be unlikely, a future introduction of FTA based MTV broadcasts could have a direct impact on the advertisement revenue available in the broadcasting sector. A portion of the advertisement revenue could get diverted to the MTV broadcasting services. In particular, those advertisements addressing individuals and high brand advertisements could migrate to MTV services. As a result of this, the DTTB broadcasters will stand to lose a part of the current revenue. However, this negative impact would only be true if the MTV broadcasters are new market entrants. Under the scenario that the DTTB and MTV broadcaster is the same entity, the introduction of MTV services only constitutes a shift of revenue income between service offerings, of which shift the broadcaster has direct control over.

Mitigation measures for mobile operators and broadcasters

It is assessed that if any MTV based service will be launched in the future, it is most likely to be pay and mobile operator led. Hence only a positive impact on mobile operators is expected as they see an opportunity to enhance their business. It is also very likely that MTV services will be made available to all interested mobile operators and that economic viable and competitive alternatives will be available in the market (LTE based alternatives). Consequently, no mitigation measures are necessary under such future scenario.

In the case of a future need for traffic off-loading (from mobile to MTV networks), the Regulator may be required to stipulate ‘must provide’ rules for the MTV service provider, in order to guarantee access for mobile operators to off-loading capacity. These ‘must provide’ rules will also constitute the obligation of the MTV provider to offer a Reference Offer (which has to be approved by the Regulator) for MTV distribution services and fees. Also in the case of a mobile led MTV introduction and the involved mobile operator (likely to be part of a consortium) is not offering equal access to MTV capacity to any other interested market party, the Regulator can mitigate this unwanted situation by stipulating a ‘must provide’ rule in combination with an obligation to provide a Reference Offer.

The introduction of MTV based services could only have a negative impact on the current DTTB service providers, if such a future MTV introduction would entail new market entrants. If the Regulator assesses more competition for DTTB service providers to be undesirable, it can mitigate by offering MTV licenses or authorizations only to the current DTTB services providers. For the in-band option (see Sections 3.2.1) this is virtually automatically the case as MTV capacity has to come out of the capacity of the base services (i.e. DTTB).

For the possible negative impact on radio services, the Regulator could take some general mitigation measures to assist radio broadcasters. Among these measures would be tax relief measures for a specified period of time. In addition, relief could be given on the costs that are related to issuing of radio licenses and other permits.

4.1.4 Consumer impact

The most significant impact in the whole broadcasting industry would be on the subscribers / consumers. The consumer would be impacted in various ways with the introduction of MTV services. This is examined in the following:

1. The mobile experience provided by the MTV services will catalyse the interest of consumers/ potential subscribers to subscribe to the MTV services;
2. Consuming MTV services inculcates an entirely different lifestyle and consumer behaviour. This is going to impact the day-to-day working routines and consumption patterns of the subscribers across all age groups in the society;
3. MTV broadcasting will initiate a new interest in purchase of appropriate mobile devices and the potential subscribers will use this opportunity to upgrade their mobile phones. This will have a positive impact on the mobile device market;
4. As the mobile device is mostly a personal device, specific and new types of advertising messages would have to be generated to address the mobile audience. These advertisements and other messages are bound to have a significant impact on the mind-set and all the lives of the subscribers of MTV broadcast services;
5. As noted above, MTV broadcasting services will provide a large number of value-added services to the consumers, in addition to video and radio services. These services include lifestyle services, city information, traffic information, weather, financial markets and other similar data based information. All these together will help enrich the lives of the subscribers of MTV broadcasting services. It is expected that this will have a very profound and positive impact on the subscribers.

On the whole, it is expected that impact on consumers would be very positive once the MTV broadcast services are available, suitable receiving devices have been purchased and migration to MTV services is in place.

Impact on consumers in rural areas

In the rural areas, the uptake of MTV broadcasting services is expected to be slower than that in the major cities. Several factors are contributing to this, including that the MTV broadcasts arrives later in the rural areas and income levels are lower (and hence less purchasing power for MTV receiving devices). While MTV broadcasts would provide a good quality service, the value-added services only attract more audiences if these services are based on local needs. However, that means these services would need to be produced locally and that would need significant additional investment and operational expenditure.

Mitigating measures for consumers

In order to encourage consumers in general to consume MTV broadcasting services, it would be necessary to provide incentives to them for subscribing to such services. These incentives are not

necessarily monitory in nature. These incentives could include better programming and content delivered by MTV broadcasters, more relevant value-added services which are of current interest to the subscribers, good-quality signal reception in all the coverage areas and creating an overall positive feel-good environment for consuming mobile TV services on the go. Sufficient incentives may also be earmarked for covering low-density suburban areas and rural areas with MTV services, where applicable.

4.2 Specific impact of Option 1 (In-band UHF/DVB-T2L)

The option-specific impact is addressed in this Section, including:

1. Spectrum and multiplex capacity;
2. Infrastructure;
3. Consumers.

4.2.1 Spectrum and multiplex capacity

As explained in Section 1.3.1, not more than 1 PLP per multiplex is available for MTV services. The reason for this limitation was the following. For a future MTV implementation, it was assumed that the DTTB applied encoding efficiency (H.264) will improve. From past experience a 20-25% efficiency gain can be expected. This would imply that the same number of DTTB services with the same picture quality can be broadcasted in 20-25% less bit rate capacity, being 4.4 -5.5 Mbit/s. Consequently, one PLP for MTV services could be facilitated in each multiplex. Without this encoding efficiency gain (or without any unused capacity) the MTV services would directly compete with DTTB services for multiplex capacity.

In conclusion one can say, the impact on the identified / allocated frequency spectrum for DTTB would be adverse as the MTV services would actually compete for the available multiplex capacity. This may give rise to more constraints as both DTTB and MTV providers seek additional spectrum or multiplex capacity for developing the service further.

4.2.2 Infrastructure

In addition to using the multiplex capacity already available (which includes the transmitting equipment) no significant amount of new infrastructure is to be setup for transmitting facilities such as land, antenna mast, transmitting building and other utilities. However, incremental infrastructure may be required for transmission of MTV services, which would need incremental investments as well.

In addition, the expenditure on the already existing DTTB content delivery network (which feeds the transmitters stations) would also be minimal. The expenditure on engineering staff employed for transmission activities would also be only incremental.

As such, the impact on DTTB infrastructure for transmission of MTV services would only be marginal and the expenditure would only be incremental. This aspect can be taken as a positive factor in implementation of this strategy. In addition, the time required to make the necessary changes to the existing transmitting infrastructure would be marginal. This is second positive factor in implementation of this strategy

However, given the requirements of signal availability for MTV services at street level, in shopping centres, in moving vehicles and in subways, a number of gap fillers and signal boosters would be required to be setup. All of these small transmitters would also require transmitting antennas and other facilities. This additional infrastructure would also have CAPEX and OPEX implications.

Understandably, the most important infrastructure facility required for MTV services would be the content creation / production and play out facility to be setup by each of the MTV SPs. This would involve a substantial amount of CAPEX and setup time. However, such a facility would be required in in options 3 and 4 too. As such, the impact of this part of infrastructure built up is not unique to option 1. However, the two variants of option 1 (Tower overlay and backhaul concept) do not require such content investments (as they are the responsibility of the LTE SP).

In conclusion, the impact on setting up of new transmission and distribution infrastructure is minimal, both in terms of capital expenditure and time required. However, a significant amount of CAPEX and time would be required to setup the content production and play out facility for MTV services.

4.2.3 Consumers

There are two main issues addressed in this Section:

1. Coverage limitations;
2. Service bouquet limitations.

Coverage limitations

As explained in Section 1.3.1, using the existing DTTB infrastructure may limit the possibilities of providing a good enough signal for the MTT reception conditions. Providing gap fillers and signal boosters will help to overcome this limitation. As option 1 is an in-band option the number of additional gap fillers is limited by the possibility of planning those addition sites in SFN.

Therefore, if this implementation option is followed, there would be worries about signal availability for MTV broadcast reception in all the areas of the coverage zone. This would certainly have a relatively adverse impact on the consumers, particularly in those areas where the signal availability is less than adequate.

Service bouquet limitations

The second issue pertains to the number of MTV services that can be offered at the time of introduction of MTV's broadcasting and at a later stage when the expansion of MTV broadcasting takes place.

Due to the inherent restrictions in the availability of multiplex payload capacity (available bit-rate) due to the shared use of the DTTB infrastructure, there would be definitive restrictions on the number of MTV services that can be provided at the time of introduction. Having a restriction of one PLP per multiplex, the number of possible MTV services are included in Table 9. It is important to note that the number of MTV services as included in Table 9 are only applicable if the PLP capacity is aggregated across the available DTTB multiplexes.

In the situation that demand for MTV services is higher than the numbers as include in Table 9 (i.e. a combination of the required number of services and the picture quality of each service), option 1 may impact the sentiment of the consumers (like with T-DMB in South Korea, see also Section 1.2). If the number of MTV services offered at the time of introduction is not large enough to attract attention and maintain subscriptions of the subscribers, the whole MTV operation will receive a setback.

Secondly, if the MTV services are not expanded quickly in response to the market demands, the churn of the subscribers to other multimedia delivery services cannot be halted.

In conclusion, the limited capacity available in the currently operated DTTB multiplexes may have an adverse impact on the introduction and on the uptake of MTV broadcasting services.

4.3 Specific impact of option 3 and 4 (Carve-out VHF/ISDB-Tmm and DVB-T2L)

The option-specific impact is addressed in this Section, including:

1. Spectrum and multiplex capacity;
2. Infrastructure;
3. Consumers.

4.3.1 Spectrum and multiplex capacity

Use of a part of VHF Band III for the MTV broadcasting would imply having adequate frequency spectrum multiplex capacity for the proposed MTV services. Such an arrangement would mean that an optimum number of MTV broadcasting services can be introduced at the initial stage and frequency spectrum capacity for expansion of the services at a later stage would still be available.

As explained in Section 1.3.3, a spectrum carve-out for MTV services is a result from a decision on the number of multiplexes for respectively national and local DSB services. The less DSB multiplexes are required the more spectrum is available for MTV services. If no more than 2 National and 2 Local DAB layers are required, a number of MTV services are possible as indicated in Table 9. It is important to note that the number of MTV services as included in Table 9 are only applicable if the capacity is aggregated across the available DAB multiplexes.

In conclusion one can say, the impact on the identified/allocated frequency spectrum for DSB would be adverse as the MTV services would actually compete for the available spectrum/multiplex capacity. This may give rise to more constraints as both DTTB and MTV providers seek additional spectrum or multiplex capacity for developing the service further.

4.3.2 Infrastructure

Since there is no current available infrastructure for DSB (and MTV) broadcasting in the VHF Band III in Thailand, the issue of any eminent impact on existing infrastructure does not arise.

However, this frequency band is being used for VHF TV broadcasting all over Thailand. As per the current plans, all the TV broadcasting services in this band will migrate to the UHF band. This will leave a considerable amount of VHF Band III transmission infrastructure in place in Thailand without

any use. It may be a good idea to study whether a part of this infrastructure or most of it can be deployed for DSB and MTV broadcasting services in this band[70].

If the study comes to the conclusion that this infrastructure can be used for MTV broadcasting, with or without any substantive changes, this will have a positive impact on the need for new infrastructure for MTV broadcasting in this band. In addition, this will also have a positive impact on the time period required for putting up a workable infrastructure for MTV services in this band.

This will also positively impact the costs involved in setting up a transmission infrastructure for MTV services in Thailand. It is estimated that if the VHF transmission infrastructure is made use of, the infrastructure costs will be substantially reduced. This is again a positive impact.

However, given the requirements of signal availability for MTV services at street level, in shopping centres, in moving vehicles and in subways, a number of gap fillers and signal boosters would be required to be setup also the coverage areas. All of these small transmitters would also require transmitting antennas and other facilities. This entire infrastructure would also have CAPEX and OPEX implications.

Again, the most important infrastructure facility required for MTV services would be the content creation/production and play out facility to be setup by each of the MTV SPs. This would involve a substantial amount of CAPEX and setup time. However, such a facility would be required in option 1 too. As such, the impact of this part of infrastructure built up is not unique to options 3 and 4. However the two variants of option 1 (Tower overlay and backhaul concept) do not require such content investments (as those investments are the responsibility of the LTE SP, see also Figure 10).

4.3.3 Consumers

There are two main issues addressed in this Section:

1. Coverage limitations;
2. Service bouquet limitations.

Coverage limitations

A new transmission infrastructure / independent transmission infrastructure for MTV services would be able to provide a wider coverage for MTT services (see Table 9, up to 90/95%). It would be relatively easier (as compared to option 1) to provide strong signal coverage in densely populated urban areas, at the street level and in vehicles.

Therefore, if this implementation option is followed, there would be more possibilities of signal availability for MTV broadcast reception in all the areas of the coverage zone. This would certainly have a positive impact on the consumers.

[70] It is noted that this study has been carried out by the NBTC in preparing the DAB frequency plans. See footnote 19.

Service bouquet limitations

The second issue pertains to the number of MTV services that can be offered at the time of introduction of MTV's broadcasting and at a later stage when the expansion of MTV broadcasting takes place.

As a new /independent transmission network will be used for MTV broadcasting, the availability adequate multiplex payload capacity can be better assured (as compared to option 1). However as said before the available VHF spectrum for MTV services is dependent on the DSB requirements. As Table 9 showed, if the DSB requirements are limited to 2 National and 2 Local layers, a number of MTV services can be offered (depending on the required picture quality).

In the situation that demand of MTV service is higher than the numbers as include in Table 9, options 3 and 4 may impact the sentiment of the consumers. If the number of MTV services offered at the time of introduction is not large enough to attract attention and maintain subscriptions of the subscribers, the whole MTV operation will receive a setback.

Secondly, if the MTV services are not expanded quickly in response to the market demands, the churn of the subscribers to other multimedia delivery services cannot be halted.

In conclusion, MTV capacity limited by DSB requirements may have an adverse impact on the introduction and on the uptake of MTV broadcasting services.

4.4 Specific impact of option 1 variants (Tower overlay and Backhaul)

Under the two variants of option 1, the DVB-T2 infrastructure is used to deliver the broadcast services either at the LTE-A+ enabled handsets (Tower overlay) or at the eNB (i.e. the LTE eMBMS enabled base transceiver/station). Under both variants the broadcast network operator acts as a supplier for the LTE SP.

The option-specific impact is addressed in this Section, including:

1. Spectrum and multiplex capacity;
2. Infrastructure;
3. Consumers.

4.4.1 Spectrum and multiplex capacity

The impact is the same as described in Section 4.2.1. Please refer to this Section.

4.4.2 Infrastructure

The impact is the same as described in Section 4.2.2, i.e. the impact on setting up of new transmission and distribution infrastructure is minimal, both in terms of capital expenditure and time required. However, under these two variants no CAPEX and time would be required to setup the content production and play out facility for MTV services. Those investments are the responsibility of the LTE SP, see also Figure 10.

4.4.3 Consumers

There are three main issues addressed in this Section:

1. Coverage limitations;
2. Service bouquet limitations;
3. Handset availability

Coverage limitations

As explained in Section 1.3.1, using the existing DTTB infrastructure may limit the possibilities of providing a good enough signal for the MTT reception conditions. Providing gap fillers and signal boosters will help to overcome this limitation, as long as it is possible to plan those additional sites in SFN. This coverage limitation applies for the Tower overlay variant as the signal is delivered at the handset/smartphone (and hence the same challenging reception conditions).

However, for the Backhaul variant the number of additional sites is expected to be much lower as compared with the Tower overlay variant. This is because the DVB-T2 PLP is delivered at the LTE transceiver station, which is normally an elevated site having an effective antenna height between 15 to 60 meters (see also Figure 5). In addition, the receiving antenna has a positive antenna gain. Hence the possibilities of providing a wide coverage area with the same number of frequencies is larger.

Therefore, if this implementation variant of the Backhaul is followed, there would be less worries about signal availability for MTV broadcast reception in all the areas of the coverage zone. This would certainly have a positive impact on the consumers, particularly in those areas where the signal availability is less than adequate.

Service bouquet limitations

The impact is the same as described in Section 4.2.3 under Service bouquet limitations. Please refer to this part of the Section.

Handset availability

As described in Section 2.3.4 and 2.3.5, the two option 1 variants are based on respectively the use of LTE-A+ (Tower overlay) and standard LTE-A handsets (Backhaul). Especially under the latter variant it is expected that the number of commercially available handsets will be large, considering the global deployment of LTE networks.

In conclusion, the wide availability of standardised handsets will have a positive impact on consumer uptake of the MTV services and will also provide consumer choice when selecting an appropriate handset, as well as lower handset prices.

4.5 Regulatory impact overview

Table 18 provides an overview of the regulatory impact which is common to all implementation options, as well as of the option-specific impact.

TABLE 18: OVERVIEW OF REGULATORY IMPACT

	Impact area	Option 1 (In-band UHF/DVB-T2L)	Option 3 (Carve-out VHF/ISDB-Tmm)	Option 4 (Carve-out VHF/DVB-T2L)	eMBMS/ Tower overlay concept	eMBMS/ Backhaul concept

	Impact area	Option 1 (In-band UHF/DVB-T2L)	Option 3 (Carve-out VHF/ISDB-Tmm)	Option 4 (Carve-out VHF/DVB-T2L)	eMBMS/ Tower overlay concept	eMBMS/ Backhaul concept
Common impact	Social	**Positive**: new multimedia experience is offered				
	Economic	**Positive**: opportunities for the mobile device manufacturing industry				
	Industry	**Positive**: MTV is complementary to LTE				
		Negative: MTV may impact radio broadcasting revenues				
		Negative: MTV may impact DTTB revenues, only when new market entrants				
	Consumer	**Positive**: new multimedia experience, matching contemporary life styles				
Option-specific impact	Spectrum/MUX capacity	**Negative**: DTTB and MTV compete for same capacity	**Negative**: DSB and MTV compete for same spectrum	**Negative**: DSB and MTV compete for same spectrum	**Negative**: DTTB and MTV compete for same capacity	**Negative**: DTTB and MTV compete for same capacity
	Infrastructure	**Negative**: content CAPEX	**Negative**: content and site CAPEX	**Negative**: content and site CAPEX	**Positive:** no content CAPEX	**Positive:** no content CAPEX
			Positive: reuse of VHF sites	**Positive:** reuse of VHF sites		
	Coverage limitations	**Negative**: coverage limited by SFN	**Positive**: more options for providing coverage	**Positive**: more options for providing coverage	**Negative**: coverage limited by SFN	**Positive**: better coverage due to eNB delivery
	Service bouquet limitations	**Negative**: DTTB may limit bouquet	**Negative**: DSB may limit bouquet	**Negative**: DTTB may limit bouquet	**Negative**: DTTB may limit bouquet	**Negative**: DTTB may limit bouquet
	Handset availability	**Negative**: No availability (yet)	**Negative**: Limited availability	**Negative**: No availability (yet)	**Positive:** Wide availability and lower prices	**Positive:** Wide availability and lower prices

5. Conclusions, recommendations and roadmap

This Chapter includes the key conclusions as addressed in the evaluation of the various implementation aspects (covered in Chapters 1 to 4) and will provide recommendations for the NBTC to consider. This Chapter is concluded with a high-level roadmap for mobile video services (including MTV services).

5.1 Conclusions

The four proposed implementation options, as indicated in the Feasibility study, were evaluated for the number and quality of services they would provide. It was concluded that option 2 (In-Band VHF/T-DMB) does not provide enough capacity and hence was excluded from further analysis. Table 19 provides an overview of the results (see also Sections 1.1 to 1.3 and Table 9).

TABLE 19: OVERVIEW OF MTV IMPLEMENTATION OPTIONS

MTV implementation option	Coverage	Condition	Picture ratio	Bitrate per service (H.265) in Kbit/s	# of MTV services/ layer	# of MTV services in available spectrum
1. In-Band UHF DVB-T2 Lite	Limited to DTTB coverage, between 40 – 95%	Not more than 1 PLP per MUX	640 x 480	250	16	5 x 16 = 80
			960 x 540	600	6	5 x 6 = 30
			1280 x 720	700	5	5 x 5 = 25
			1920 x 1080	1000	4	5 x 4 = 20
~~**2. In-Band VHF T-DMB**~~	~~Limited to DSB coverage, below 95%~~	~~Not more than 25% of National DAB MUX capacity~~	640 x 480	250	1	(1-4) x 1 = 1-4
			960 x 540	600	-	-
			1280 x 720	700	-	-
			1920 x 1080	1000	-	-
3. Carve-out VHF DVB-T2 Lite	Near nationwide coverage (90% - 95%)	No more than 2 National + 2 Local DAB layers	640 x 480	250	60	60
			960 x 540	600	25	25
			1280 x 720	700	21	21
			1920 x 1080	1000	15	15
4. Carve-out VHF ISDB-T_{mm}	Near nationwide coverage (90% - 95%)	No more than 2 National + 2 Local DAB layers	640 x 480	250	32	32
			960 x 540	600	14	14
			1280 x 720	700	12	12
			1920 x 1080	1000	8	8

Subsequently, the presented MTV implementation options were evaluated for the various network deployment options: sharing broadcast infrastructure and new MTV infrastructure. In addition, two additional network deployment options were identified which combine LTE and broadcasting

infrastructure: The Tower overlay and Backhaul concept. Table 20 provides an overview of the advantages and disadvantages of the presented network deployment options (see also Sections 2.1.1 to 2.1.4 and Table 11).

TABLE 20: OVERVIEW OF NETWORK DEPLOYMENT OPTIONS

		Sharing broadcast infrastructure	New MTV infrastructure	Tower overlay concept	Backhaul concept
Applies to	Option 1 (In-band UHF/DVB-T2L)	√	NA	√ (but T2)	√ (but T2)
	Option 3 (Carve-out VHF/ISDB-Tmm)	√	√	NA	NA
	Option 4 (Carve-out VHF/DVB-T2L)	√	√	NA	NA
Advantages		Cost advantages as compared to cellular networks (due to HPHT), most for option 1	Network topology designed for mobile (LPLT)	Cost advantages as compared to cellular networks (due to HPHT)	Cost advantage for content distribution (only)
				(Tailored) LTE-A+ handsets	LTE-A handsets
		Joined MTV service provider role[71]	Joined MTV service provider role		
Disadvantages				Content carrier or supplier role	Content carrier or supplier role
		MTV handsets needed	MTV handsets needed		
		Maybe suboptimal design due to HPHT (additional sites needed)	Many sites due to LPLT. LPLT is (too) close to cellular network (no	Maybe suboptimal design due to HPHT (additional sites	

[71] This is a joined role as contemporary MTV services are offered in combination with other telecommunication services (in a converged manner). Hence the broadcast network operator needs another partner provider. See also Section 3.1.1.

	Sharing broadcast infrastructure	New MTV infrastructure	Tower overlay concept	Backhaul concept
		cost advantage)	needed)	
	Mediation platform needed	Mediation platform needed		

As the Tower overlay and the Backhaul concept were only applicable to option 1 (In-band UHF/DVB-T2), they were considered as two variants of option 1, noting that the broadcasting network is DVB-T2 and not DVB-T2L. Also it was concluded that new MTV infrastructure would take away the key advantage of deploying MTV services on the basis of broadcasting infrastructure. Hence only the network sharing option was assumed in the further analysis.

When implementing contemporary MTV services, platform and service synchronisation is needed (i.e. a mediation platform). For the LTE based options the development of such a mediation platform is not necessary. Table 21 provides an overview of the advantages and disadvantages of the presented platform and service synchronization options (see also Sections 2.2.1 and 2.2.2 and Table 13).

TABLE 21: OVERVIEW OF PLATFORM AND SERVICE SYNCHRONISATION

	Option 1 (In-band UHF/DVB-T2L)	Option 3 (Carve-out VHF/ISDB-Tmm)	Option 4 (Carve-out VHF/DVB-T2L)	eMBMS (includes Tower overlay & Backhaul)
Attribute	Mediation platform	Mediation platform	Mediation platform	eMBMS suite
Advantages		has a current OSS/BSS integration (NOTTV)		Has a commercial implementation (KT)
				Standardized system
				Future implementations in the pipeline
Disadvantages	No current OSS/BSS system integrations		No current OSS/BSS system integrations	

As concluded in the Feasibility study, handset availability and pricing are critical in the successful delivery of MTV or mobile TV services. Table 22 provides an overview of the handset availability and pricing (see also Sections 2.3.1 to 2.3.5 and Table 16).

TABLE 22: OVERVIEW OF HANDSET AVAILABILITY AND PRICING

	Option 1 (In-band UHF/DVB-T2L)	Option 3 (Carve-out VHF/ISDB-Tmm)	Option 4 (Carve-out VHF/DVB-T2L)	eMBMS/Tower overlay concept	eMBMS/Backhaul concept
Attribute	MTV enabled handset	MTV enabled handset	MTV enabled handset	LTE-A (and proprietary software) handset	LTE-A (and eMBMS software) handset
Advantages		Handsets were commercially available			Handsets commercially available
			May benefit from digital radio launch in VHF band	Standard LTE-A handset	Standard LTE-A handset

The various options were also evaluated for what business model would be most applicable and what the regulatory consequences would arise when deciding on such a business model. Table 23 provides an overview of the business and regulatory aspects (see also Sections 3.1 and 3.2 and Table 17).

TABLE 23: OVERVIEW OF BUSINESS AND REGULATORY ASPECTS

	Option 1 (In-band UHF/DVB-T2L)	Option 3 (Carve-out VHF/ISDB-Tmm)	Option 4 (Carve-out VHF/DVB-T2L)	eMBMS/Tower overlay concept	eMBMS/Backhaul concept
Attribute	No new spectrum and converged SP role	New spectrum and converged SP	New spectrum and converged SP	No new spectrum and supplier role	No new spectrum and supplier role
Advantages		Can be included in single assignment procedure (for DSB)	Can be included in single assignment procedure (for DSB)	JVC only needed for aggregating DTTB capacity (dependent on LTE SP demand)	JVC only needed for aggregating DTTB capacity (dependent on LTE SP demand)
	No spectrum assignment (i.e. auction)			No spectrum assignment (i.e. auction)	No spectrum assignment (i.e. auction)
Disadvantages	JVC needed for spanning the whole value chain + aggregating DTTB capacity	JVC needed for spanning the whole value chain + aggregating DTTB capacity	JVC needed for spanning the whole value chain + aggregating DTTB capacity		

	Option 1 (In-band UHF/DVB-T2L)	Option 3 (Carve-out VHF/ISDB-Tmm)	Option 4 (Carve-out VHF/DVB-T2L)	eMBMS/Tower overlay concept	eMBMS/Backhaul concept
	Level-playing-field and DTTB service levels to be checked	Level-playing-field to be checked	Level-playing-field to be checked	Facility licensing to and DTTB service levels be checked	Facility licensing and DTTB service levels to be checked
		Dependent on DSB requirements	Dependent on DSB requirements		

Finally, the regulatory impact of an MTV service introduction was evaluated, both for the impact common to all implementation options and option-specific impact. Table 24 provides an overview.

TABLE 24: OVERVIEW OF REGULATORY IMPACT

	Impact area	Option 1 (In-band UHF/DVB-T2L)	Option 3 (Carve-out VHF/ISDB-Tmm)	Option 4 (Carve-out VHF/DVB-T2L)	eMBMS/ Tower overlay concept	eMBMS/ Backhaul concept
Common impact	Social	**Positive**: new multimedia experience is offered				
	Economic	**Positive**: opportunities for the mobile device manufacturing industry				
	Industry	**Positive**: MTV is complementary to LTE				
		Negative: MTV may impact radio broadcasting revenues				
		Negative: MTV may impact DTTB revenues, only when new market entrants				
	Consumer	**Positive**: new multimedia experience, matching contemporary life styles				
Option-specific impact	Spectrum/MUX capacity	**Negative**: DTTB and MTV compete for same capacity	**Negative**: DSB and MTV compete for same spectrum	**Negative**: DSB and MTV compete for same spectrum	**Negative**: DTTB and MTV compete for same capacity	**Negative**: DTTB and MTV compete for same capacity
	Infrastructure	**Negative**: content CAPEX	**Negative**: content and site CAPEX	**Negative**: content and site CAPEX	**Positive:** no content CAPEX	**Positive:** no content CAPEX
			Positive: reuse of VHF sites	**Positive:** reuse of VHF sites		
	Coverage limitations	**Negative**: coverage limited by	**Positive**: more options for	**Positive**: more options for providing	**Negative**: coverage limited by SFN	**Positive**: better coverage

	Impact area	Option 1 (In-band UHF/DVB-T2L)	Option 3 (Carve-out VHF/ISDB-Tmm)	Option 4 (Carve-out VHF/DVB-T2L)	eMBMS/ Tower overlay concept	eMBMS/ Backhaul concept
		SFN	providing coverage	coverage		due to eNB delivery
	Service bouquet limitations	**Negative**: DTTB may limit bouquet	**Negative**: DSB may limit bouquet	**Negative**: DTTB may limit bouquet	**Negative**: DTTB may limit bouquet	**Negative**: DTTB may limit bouquet
	Handset availability	**Negative**: No availability (yet)	**Negative**: Limited availability	**Negative**: No availability (yet)	**Positive:** Wide availability and lower prices	**Positive:** Wide availability and lower prices

5.2 Recommendations

Table 25 provides the overall evaluation results on the basis of the conclusions as included in Table 20 to Table 24.

TABLE 25: OVERALL EVALUATION RESULTS

	Option 1 (In-band UHF/DVB-T2L)	Option 3 (Carve-out VHF/ISDB-Tmm)	Option 4 (Carve-out VHF/DVB-T2L)	eMBMS/ Tower overlay	eMBMS/ Backhaul
Key advantages	Network costs lower	Network costs lower (only if broadcast infra is used)		Network costs lower	
	Re-use of broadcasting infrastructure			Standardized eMBMS suite	
				LTE-A+ handset	Standard LTE-A handset and readily available
					better coverage due to eNB delivery
	No auction needed	VHF spectrum still to be assigned		No auction needed	
				JVC only needed for MUX aggregation	
Key dis-advantages	Tailored mediation platform				
	MTV handset needed, not available		MTV handset needed, not available		
	Wide scope JVC needed				

	Option 1 (In-band UHF/DVB-T2L)	Option 3 (Carve-out VHF/ISDB-Tmm)	Option 4 (Carve-out VHF/DVB-T2L)	eMBMS/ Tower overlay	eMBMS/ Backhaul
				No content CAPEX	

On the basis of overall evaluation (as included in Table 25) and the recommendations of the Feasibility study, the following is recommended in this report:

1. While it is technically viable for a MTV service to be deployed in Thailand, it is currently doubtful that the conditions necessary for a successful commercialisation of such a service exist. Given current patterns of demand for converged video content, smartphone penetration, and impending technological developments (LTE), it is unlikely that a business case for deploying and operating a broadcasting based MTV service could successfully be made out in the short term (2-4 years);
2. However, if in the short term market interest would arise, the options where the basis is LTE-eMBMS (i.e. the Tower Overlay and Backhaul variants), are assessed to be more likely than the broadcasting based services. Both these eMBMS options are in-band options and the current DTTB service providers could organize themselves in a JVC (when capacity demand exceeds a single PLP) to provide for these variants;
3. NBTC is recommended to allow current DTTB service providers to pursue this opportunity if LTE service providers would be interested in collaborating with the broadcasting industry. As indicated this would likely require the issuing of a Facility license and also level-playing-field and DTTB service level aspects should be checked;
4. Having said this, option 1 (In-Band UHF/DVB-T2L) is not excluded, if there were to be demonstrated market interest. However, business viability should be tested and only when interest is expressed by all necessary parties in the value chain, such an option could be considered for licensing. In other words, a JVC (with all necessary parties) should demonstrate the viable business case. Also level-playing-field and DTTB service level aspects should be checked;
5. For options 3 and 4 (Carve-out VHF/ISDB-T_{mm} and DVB-T2L), the NBTC is recommended not to license these options before the DSB requirements have been agreed (and published). In the case that these DSB requirements have been agreed and spectrum capacity remains in the VHF band, the NBTC may consider reserving capacity and license market parties. However, like for option 1, the business case viability and the establishment of a JVC should be tested, before issuing licenses;
6. Within the short term, if market interest is tested to be present, the NBTC is recommended to actively pursue the option for current DTTB service providers to test PLPs. With the introduction of PLPs other use cases (i.e. laptop and tablet reception) can be tested. After positive test results and a decision to commercially launch, other additional revenue streams can be generated. In the situation of having idle DTTB capacity these PLP tests are especially recommended as the creation of PLPs will not necessarily lead to sacrificing the service levels of the current DTTB services;
7. In addition, for the short term, the NBTC is recommended to monitor the following market developments (as future service introductions for both LTE and MTV are not excluded):

a. Availability and sales of DVB-T2 enabled devices (as increasing availability and sales would further support the option of generating additional revenues streams on the basis of the current DTTB networks in combination with PLPs);
b. Uptake of 3G/4G based VOD and live TV services in Thailand, but also abroad (especially in South Korea);
c. 3G/4G network congestions levels and available mobile spectrum left for increasing capacity in Thailand;
d. Number of deployments of LTE eMBMS networks around the world, and the type and number of services introduced on these networks;

8. Finally, if in the future a MTV service introduction is prepared for licensing, the NBTC is recommended to carefully reconsider the indicated impact of the RIA at that time. If any impact is deemed to be undesirable, the NBTC can resort to the various mitigation actions as indicated in the RIA.

5.3 Roadmap and Checklist for mobile video services

Following the Recommendations (in Section 5.2), this Section outlines an NBTC initiated Roadmap for the short term. This is a Roadmap to be actively pursued by the NBTC.

A MTV introduction was assessed to be unlikely but at the same time, if market interest would be expressed, options 1, 3, 4 and the LTE eMBMS options were not excluded from being licensed. Hence this section also includes a checklist of what the NBTC should check, in the event that serious market interest was to be expressed for launching mobile television services on a commercial basis.

5.3.1 Short term Roadmap

For the short term (2-4 years) the NBTC was recommended to allow current DTTB service providers to test PLPs and to monitor market developments in the areas of VOD, live mobile TV services, LTE-eMBMS network deployments, as well as the sales of DVB-T2 enabled smart/handheld receivers (see Recommendations 6 and 7).

As indicated in Sections 1.4 and 3.2.2, the offering of PLP based services will require DTTB network operators and service providers to aggregate capacity across the different multiplexes as to offer a competitive number of mobile television services with good enough picture quality. A form of industry collaboration is therefore needed, if the market would like to pursue this opportunity. This industry collaboration is needed for preparing and carrying out the Trial, as well as for the commercial operations of PLPs (if decided to bring these mobile television services to market).

If the NBTC would decide to pursue this possibility of having PLPs for mobile television services, the following key activities and decisions are to be carried out:

1. Industry stakeholders (i.e. DTTB Service Licensees, Network Operators and equipment suppliers[72]) are invited to send a letter to the NBTC expressing their interest (or not) in

[72] Is noted that DVB-T2 enabled mobile phones and tablets, as well as dongles for mobile devices (not to be confused with DVB-T2 Lite enabled handsets), are available globally and also in Thailand. Thailand has a local producer of these devices, called SAMART.

exploring ways for introducing PLPs, to start with a Trial. In the present situation this Trial could take place in idle multiplex capacity[73];

2. If market interest is present, NBTC drafts the key terms and conditions under which it wishes to see this PLP Trial to be carried out, including:
    a. Objectives of the Trial; which could include:
        i. To the test different PLP parameters as to arrive to the best balance between additional indoor coverage and number/picture quality of mobile television services, as well as the impact on the reception and picture quality of the Base services (i.e. DTTB services). The latter objective is to test for the situation that all multiplexes would be fully loaded with Base services and PLPs can only be introduced by either reducing picture quality and/or applying improved encoding;
        ii. To survey and analyse consumer interest and behaviour of receiving these mobile television services;
        iii. Consumer support which may include the purchase and introduction of a number of DVB-T2 enabled tablets and smartphones;
    b. Minimum number of services, involved multiplexes and coverage areas;
    c. Type of services (new services or existing DTTB services);
    d. Infrastructure contributions to the Trial, including[74]:
        i. Program feeds, as DTTB Service Licensees have to agree that their existing or newly created content can be used for the Trial;
        ii. Encoding and multiplexing, as the PLPs are created in the multiplex centre[75];
3. Industry stakeholders establish a representative body and formulate their Trial plan, including:
    a. Trial participants, their roles and how the Trial is managed between the participants;
    b. Service terms and conditions, i.e. what and how many services can be contributed by the DTTB Service Licensees;
    c. Infrastructure contributions and the cooperation between the DTTB Network Operators;
    d. Set-up and Trial methodology, including technical tests, consumer surveys and support;
    e. Trial work planning;

[73] Currently capacity is idle in the following multiplexes: Thai PBS, MCOT and PRD. The two multiplexes operated by RTA have no capacity left. However, it is recommended to invite RTA for the Trial, as commercial operations should be open to all parties interested.

[74] It assumed that the Trial is carried out on the basis of the currently deployed DTTB infrastructure and no new infrastructure investments are necessary. PLPs are created in the multiplex center and once carried in the transport stream, the further distribution to the transmitter sites and the actual broadcasting is no different, in terms of needed equipment, from carrying only the Base services.

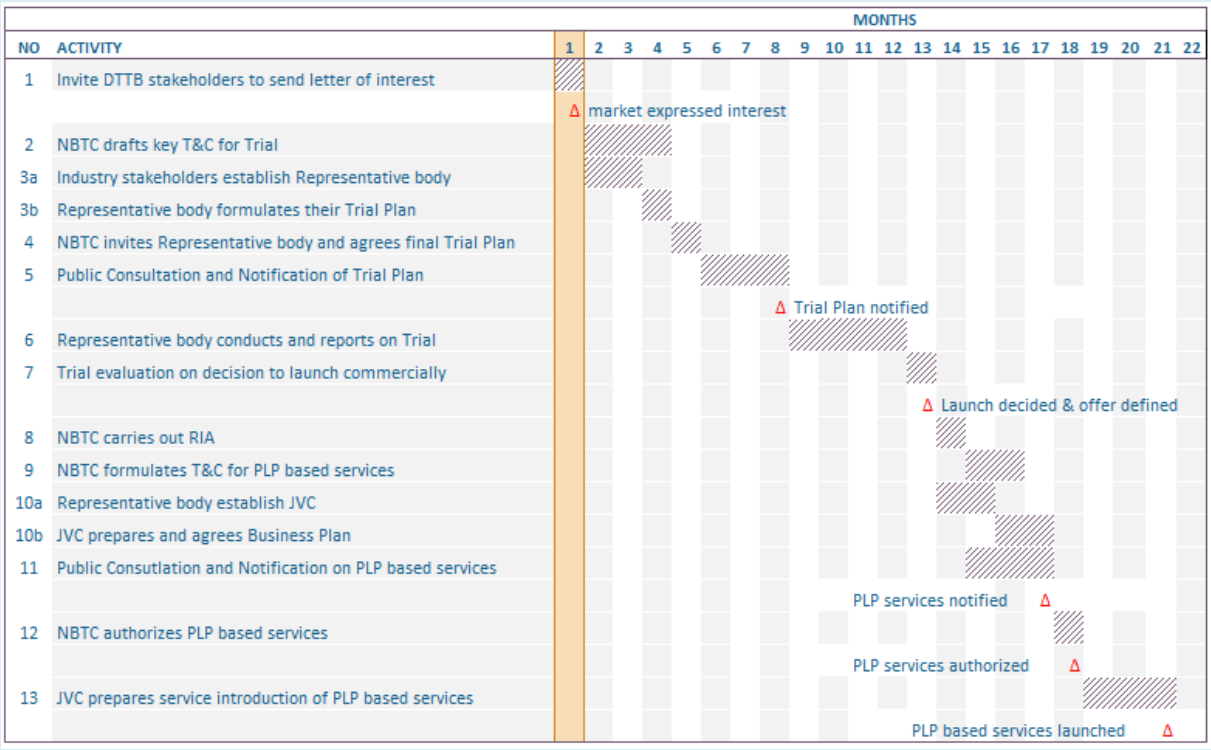
[75] The situation of having four different multiplex centers (located at different locations) may constitute an extra challenge for offering an aggregated service offering across these multiplexes. Hence this is also a technical aspect to be considered during the Trial.

   f. Financial plan which includes the participants financial and contributions in-kind, as well as any necessary support from the NBTC;
   g. Reporting of Trial results to the NBTC and sharing of information to the public;
   h. Outline of terms and conditions under which a commercial launch could be organized, if the test results would result in a decision to commercially launch PLP bases services;
4. NBTC invites the representative body to agree a final Trial plan;
5. Public Consultation and Notification of Trial Plan by the NBTC. This Notification would also have to outline what can happen after the Trial, including a decision to commercially launch PLP based services;
6. Representative body conducts and reports on the Trial;
7. Representative body evaluates the Trial results and decides on whether to launch commercially. A decision to commercially launch is accompanied with a description of the intended PLP based services (including aspects such as service definition, commercial proposition, market access for other parties and access fees to be paid);
8. If decided to commercially launch PLP based services, the NBTC carries out a RIA of licensing these PLP based services. This RIA includes and considers:
   a. RIA aspects as described in this report (see Chapter 4);
   b. Trial results (especially the impact on the Base services);
   c. At that time, the status of licensing of DTTB Service Licenses and future expected developments in this area (i.e. the loading of multiplexes and idle capacity);
   d. The uptake of DTTB services and the financial position of the DTTB Service and Network Licensees;
9. Based on the RIA, the NBTC will formulate the terms and conditions under which it would like to license the PLP based services. This may include:
   a. Industry collaboration, i.e. the DTTB parties should establish a Joint Venture Company (JCV or similar body) as the ensure service aggregation between multiplexes;
   b. Market access conditions for market parties to offer PLP bases services, which may include 'must provide' rules and a Reference Offer (see Section 4.1.3);
   c. Conditions for balancing Base services and PLP based services, including the minimum number of services and their services levels for each service category;
   d. Technical terms and conditions, including any changes to the Base services[76];
10. If decided to commercially launch PLP based services and parallel to work of the NBTC, the representative body for the Trial should establish a Joint Venture Company (JVC or similar body) as to commercially operate the PLP based services. This JVC should prepare a common and shared business plan, detailing how they technically and commercially implement the PLP based services, as well as how cost and revenues are going to be shared. This common business plan also forms the basis for providing counter proposals and feedback on the intended NBTC licensing of PLP based services;

[76] Currently the NBTC has published Technical Standards for DTTB, including common system parameters and four multiplex loading scenarios. These Technical Standards need to be changed to allow for PLPs.

11. Public consultation and Notification on the intended licensing of PLP based services (and impact/changes to the Base DTTB services);
12. Authorization of PLP based services by NBTC[77];
13. Preparation and launch of PLP based services by JVC.

Figure 13 shows an estimate timeline of the above listed activities and decisions (i.e. the short term Roadmap). Figure 13 does not include the recommended monitoring of the market as described under Recommendation 7, as this is not a specific activity but a continuous task to be carried-out.



Source: ITU

FIGURE 13: SHORT TERM ROADMAP

5.3.2 Checklist

The NBTC was recommended not to actively pursue an introduction of MTV or LTE based mobile television services. However, in the event that market parties would show serious interest in launching these services, the NBTC should check the business proposition and regulatory impact of a

[77] It is assumed that no auction or public tender is necessary as the PLP based services are authorized to be operated by existing DTTB licensees only (as this will help improving their DTTB business case).

possible licensing of the proposed services. The following possible mobile television options were identified (see also Table 25)[78]:

1. Option 1: In-band UHF/DVB-T2L;
2. Option 3: In-band VHF/T-DMB;
3. Option 4: Carve-out VHF/DVB-T2L);
4. LTE based Option (variant of Option 1): In-Band UHF/DVB-T2 (Tower overlay);
5. LTE based Option (variant of Option 1): In-Band UHF/DVB-T2 (Backhaul concept).

After having established what option is in essence proposed by market parties, the NBTC should carry out a number of checks as proposed in this report. Table 26 shows an overview of the checks to be carried out by the NBTC. Reference to the relevant Sections are included in Table 26. The order in which the checks are listed are not necessarily the order in which the NBTC should carry out these checks. Also the checks as listed in Table 26 are not presented to be comprehensive and future proof. They are drafted on the basis of the topics covered in this report and for the current insights.

TABLE 26: CHECKLIST

	Option 1 (In-band UHF/DVB-T2L)	Option 3 (Carve-out VHF/ISDB-Tmm)	Option 4 (Carve-out VHF/DVB-T2L)	eMBMS/Tower overlay concept	eMBMS/Backhaul concept
Key Regulatory attributes	*No new spectrum to be assigned and protection of Base services*	*New spectrum to be assigned and protecting DSB services*		*No new spectrum to be assigned and DTTB network operator in supplier role*	
Check 1	New content or existing content? (see Section 3.2.1)	If JVC for DSB offers MTV services, check for new content (see 3.2.2)		Facility license as defined under Broadcasting Act needed? (see Section 3.2.3)	
Check 2	Level playing field is maintained? (see Section 3.2.1)	Level playing field is maintained? (see Section 3.2.1 and 3.2.2)		Level-playing field is primarily arranged by the number and Terms & Conditions of 3G/4G licenses assigned	
Check 3	JVC spans whole MTV value chain, including business viability and enough capacity aggregation? (see Section 3.2.1)	JVC spans whole MTV value chain, including business viability and enough capacity aggregation? (see Section 3.2.1 and 3.2.2)		JVC spans whole MTV value chain, including enough capacity aggregation? (see Section 3.2.1 and 3.2.3). Note: business viability is already tested in the 3G/4G auction.	
Check 4	Base DTTB frequency plan	If JVC for DSB services offers also MTV services, check the		Base DTTB frequency plan compatibility is assured? (see Section 3.2.1 and 3.2.3)	

[78] It is noted that in the future other options may arise, especially considering the rapid technological advancements in encoding and transmission standards.

	Option 1 (In-band UHF/DVB-T2L)	Option 3 (Carve-out VHF/ISDB-Tmm)	Option 4 (Carve-out VHF/DVB-T2L)	eMBMS/Tower overlay concept	eMBMS/Backhaul concept
	compatibility is assured? (see Section 3.2.1 and 4.2.1)	datacasting limit (see Section 3.2.2)			
Check 5	Base DTTB service levels are assured? (see Section 3.2.1 and 4.2.1)	DSB service levels are assured? (see Section 3.2.2 and 4.3.1)		Base DTTB service levels are assured? (see Section 3.2.1, 3.2.3 and 4.4.1)	
Check 6	Can all interested parties have MTV access or is it based on exclusivity? (see Section 4.1.3)			Access is primarily arranged by the number and Terms & Conditions of 3G/4G licenses assigned	
Check 7	Are economic viable/competitive alternatives available in the market? (see Section 4.1.3)			Alternatives are primarily arrange by the number and type of 3G/4G licenses	
Check 8	Is MTV needed for traffic offloading and have all interested parties access (see Section 4.1.3)			Traffic offloading is offered in these options	
Check 9	Are there coverage and service bouquet limitations for certain consumer groups? (see Section 4.2.3)	Are there coverage and service bouquet limitation for certain consumer groups? (see Section 4.3.3)		Are there coverage and service bouquet limitation for certain consumer groups? (see Section 4.4.3)	

Glossary of Abbreviations

AAC	Advanced Audio Coding
ASO	Analogue Switch-Off
AT-DMB	Advanced Terrestrial – Digital Multimedia Broadcasting
BMP	Broadcasting Master Plan (of NBTC)
BSS	Back office Support Systems
CAS	Conditional Access System
CMS	Customer Management System
DAB	Digital Audio Broadcasting
DRM	Digital Rights Management
DSB	Digital Sound Broadcasting
DTTB	Digital Terrestrial Television Broadcasting
DVB-T2	Digital Video Broadcasting – Terrestrial 2nd generation
EBU	European Broadcasting Union
EBU	European Broadcasting Union
eMBMS	evolved Multimedia Broadcast/Multicast Service
eNB	Evolved Node B
EWS	Emergency Warning System
FTA	Free To Air
HPHT	High Power High Tower
IMT	International Mobile Telecommunications
IP	Internet Protocols
ISDB-T	Integrated Services Digital Broadcasting – Terrestrial
ISDB-Tmm	Integrated Services Digital Broadcasting – Terrestrial Multimedia
ITU	International Telecommunication Union
JVC	Joint Venture Company
LPLT	Low Power Low Tower
LTE	Long Term Evolution
LTE-A	LTE-Advanced
MFN	Multi Frequency Network
MPEG	Moving Picture Experts Group
MTV	Mobile Television (based on a digital broadcasting network)
MUX	Multiplex
NTFA	National Table of Frequency Allocations
OB	Outside Broadcasting
OFDM	Orthogonal Frequency-Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access
OSS	Operating Support Systems

OTT	Over The Top
PAD	Program Associated Data
PAPR	Peak-to-Average Power Ratio
PLP	Physical Layer Pipe
QAM	Quadrature Amplitude Modulation
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
SFN	Single Frequency Network
SMS	Subscriber Management System
SNR	Signal to Noise Ratio
T-DMB	Terrestrial – Digital Multimedia Broadcasting
TPEG	Transport Protocol Experts Group (i.e. for traffic information)
UE	User Equipment
UHDTV	Ultra-High Definition Television
UHF	Ultra-High Frequency
UMTS	Universal Mobile Telecommunications System
VHF	Very High Frequency
WLAN	Wireless Local Area Network

Annex A: Worldwide overview of MTV operations and regulations

This Annex deals with the regulatory policies in respect of MTV operated in place in a handful of countries where such mobile TV services are operating or had been mooted.

Operation of MTV services: History and development

Ever since MTV broadcasting was developed (2004), the proliferation of MTV services has not been very wide. Only a handful of countries have actually operated MTV services for public consumption. However, there have been many pilot trials in most parts of the world making use of several systems including T-DMB, DVB-H, AT-DMB, MediaFlo and DVB-T2 Lite. Out of all these systems, a sizeable number of presently operating MTV services makes use of the T-DMB platform.

The other two systems, DVB-H and MediaFlo, have not made much of an impact on the MTV broadcasting environment. While the DVB-H technology was well in advance of its time, the services did not sustain themselves. This was largely because of the market forces rather than due to technology. Many experts are of the view that, given the proper regulatory incentives, DVB-H mobile TV services could have attracted large number of subscribers and could have developed into a sustainable delivery platform.

Similarly, although MediaFlo mobile TV services operated in some countries for a few years, this could not be sustained. Again, the technology was not at fault but the market was not ready for such new services. Again, a benign regulatory regime could have played a supporting role to make this MTV service sustainable.

The current DVB-based MTV system standard, DVB-T2 Lite, is also based on a sound technology and advanced features. Many trials based on this MTV system standard have been carried out, mostly in countries in Europe. There are no reports of any significant service operations using DVB-T2 Lite system. It is known that many operators are intending to enter into the MTV market using the system, again mostly in European countries. MTV services based on the system have the advantage of using, at least initially, the DVB-T2 infrastructure with a separate PLP providing the MTV features. It can be said that in that respect, DVB-T2 Lite services have an initial introductory advantage.

Introduction of MTV services in countries across the globe has been by fits and starts, unlike the introduction of digital TV in those countries. There are many reasons for this, the most significant among them being the regulatory regime. MTV was an entirely new concept when it was introduced in 2004. It was a revolutionary service on an entirely new platform, the mobile platform. The requisites and regulatory requirements for this service were very different from the other services such as digital TV and digital radio. The audience segment, at which MTV services were directed, was also at different cross-section of the society, those on the move. The display system required for MTV services was also revolutionary, in the sense are totally opposed of the home TV large display system.

As a result of these unprecedented facets of mobile TV, introduction and sustenance of MTV services required a new regulatory approach, something which had no precedents and no history. In particular, the MTV industry required incentives, support and other regulatory assistance in respect of implementation of the network, support on the consumer device and support for content creation. This was, indeed, imperative if this new type of service had to sustain itself.

In perspective, it can be said that in many countries the regulatory regime did not come up to the expectations as far as MTV services are concerned. As a result, MTV services in most countries petered out after these were introduced or were not taken up at all due to the regulatory indifference cited above. In particular, MTV services had to compete with the Mobile communication services as far as the subscriber time- consumption was concerned.

In this Annex, attempt has been made to trace the history of development of MTV services in the Asia-Pacific region and in some other countries where such services were taken up over the last 10 years. In addition, some important features of the regulatory regimes put into place for MTV services (or sometimes in common with other broadcasting services) have been cited.

This Annex provides the essential elements of regulations and policy decisions of several countries as applicable directly to MTV services or as a part of the regulatory regime governing broadcasting services in general.

MTV services operating on T-DMB platform

So far, the countries that have adopted the T-DMB standard are Korea in 2007, Norway in 2008, Cambodia in 2009, and Mongolia in 2013. Vietnam and Laos are also considering commercialization of the service.

In addition, T-DMB services were also operated in some cities in China several years ago. There are reports of such services being operated in Ghana, South Africa and a couple of other countries.

Korea Republic

As the first country to commercially launch mobile TV, South Korea is the most successful DMB market in the world. More than 62 million DMB enabled devices have been sold, of which the most popular are mobile phones. This number is expected to rise even more with an increase in coverage; services already cover over 80% of the country. Hundreds of DMB devices are available in this market and usage of mobile TV increases year on year. Interactive services are also growing in popularity adding value to broadcasting services.

Korea's latest innovation is an interactive mobile TV service, or Smart DMB, launched in May 2011 with six terrestrial-DMB operators (T-DMB). With Smart DMB, mobile TV viewers are able to search the internet, receive EPG information updates, and even enjoy 'TV Screen Capture and Share Service' through SNS while watching television. Moreover, hybrid DMB was launched in Aug 2013 for the high quality video service.

Korea's DMB broadcasts currently covers 80% of the country (almost all residential areas) with all commercial and national broadcasting stations and their associated multi-channels. Coverage is currently at 90% of the population. Planning is based on achieving robust indoor and outdoor coverage using VHF Band III spectrum.

There are three regular national multiplexes on air. There are six major broadcasters providing a variety of services to the South Korean market including mobile TV services. TPEG (traffic info) services are available giving the consumer traffic and travel information. There are 19 video services, two audio services and six data services on air.

Features of service on air

For DMB application for smart phones, Smart DMB Lite application was released in May 2011. Consumers have downloaded and used the application (including EPG, BBS service). Smart DMB pro (including VOD, SNS service) was released in January 2013, which is the improved version of Smart DMB Lite.

A nationwide TPEG service was started by four broadcasters in July 2007. The cumulative sales of the GPS navigator to date are about 10 million and 80% of those devices feature TPEG.

TABLE 1: DMB PROGRAMMES ON AIR (2014)

	Simulcast on AM / FM	Exclusive on digital	Total of services
DAB programs	2	0	2
DMB programs	15	4	19
Data services	0	6	6

Coverage, services and Receivers

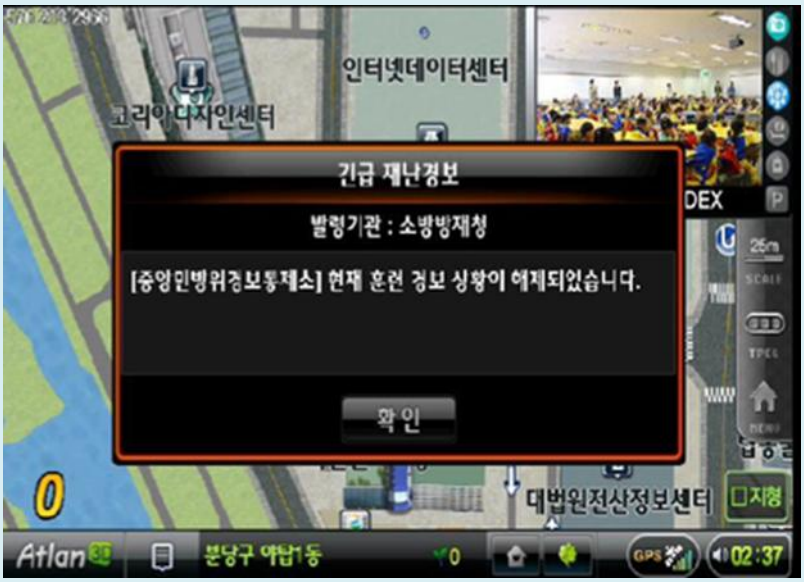
There are a large number of retailers in Korea selling DMB devices, and there are over 100 different models by over 30 different manufacturers on the market (2014). The most popular are DMB mobile phones and GPS devices. Many mobile phones include DMB, and especially smart phones support Smart DMB applications including interactivity via internet, EPG and BBS service.

TABLE 2: T-DMB COVERAGE AND RECEIVERS (2015)

Item	Figures
Population coverage	90%
Services	19 DMB, 6 Data
Receiver sales (cumulative)	62 million devices
Penetration by population	50%

Emergency Warning Services function of T-DMB

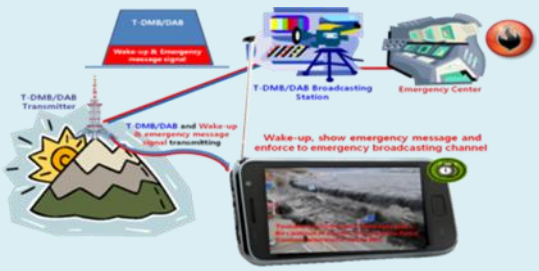
The Korean government provides Emergency Warning Services via the T-DMB network. Some Navigation systems with T-DMB function can show emergency warning messages when people are watching or receiving TPEG service. Now major broadcasters KBS, MBC, SBS and YTN transmit emergency warning signals in FIDC channel.



Source: KBS

FIGURE 1: EXAMPLE OF EMERGENCY WARNING SERVICE IN T-DMB

ETRI is under development of an emergency wake-up alter technology for T-DMB/DAB. As emergency situations occur, the T-DMB/DAB transmitters or repeaters transmit a wake-up signal and emergency warning messages using the T-DMB/DAB signal. A T-DMB/DAB receiver 'wakes-up', shows the emergency warning messages and finally tunes to the emergency broadcasting channel.



Source: KBS

FIGURE 2: CONFIGURATION OF EMERGENCY WAKE-UP ALERT TECHNOLOGY FOR T-DM

National Regulator: Ministry of Communication Committee (KCC)

The Ministry of Communication Committee (KCC) governs broadcasting. The KCC is responsible for the development of broadcasting technology, spectrum management, and the licensing of stations.

The KCC is also responsible for regulation of content and advertising, as well as authorising and recommending licences.

Only one licence is awarded to the multiplex operator, who can then either provide their own programs or can lease capacity to other program providers.

The government has divided the country into six regional broadcasting areas and 13 new nationwide broadcast licences have been granted for DMB services.

Mongolia

Launch of T-DMB service (2014)

December 2013 saw the launch of a new mobile digital media broadcasting service in the Mongolian capital of Ulaanbaatar.

Based on the Korean-developed T-DMB standard, the Mongolian service was to begin with an initial four free channels. It was to add five more channels in early 2014 before transitioning to subscription-based service.

The Korean Ministry of Science, ICT and Future Planning (MSIP) has been providing the broadcast equipment and consultation required to launch the service. Mongolian T-DMB service provider UBDMB, and UNITEL, Mongolia's second largest mobile telecommunications company, took part in a pilot service. A pilot T-DMB ensemble was on-air in Ulan Bator.

In 2009 UBDMB LLC established to develop a T-DMB paid service in Mongolia. UBDMB was awarded a license to broadcast in the 182-190 MHz frequency and also is the sole T-DMB operator. UBDMB worked with the Korean Radio Promotion Association (RAPA) to bring a T-DMB system to Mongolia. UBDMB has managed to install T-DMB equipment and systems. Initially, the Mongolian people were able to watch DMB TV on their devices for free. In November 2014, the T-DMB services became paid-for only services.

To boost T-DMB service in Mongolia, low priced hand set with high demand are necessary. The operators have tied up with MBC-Korea for content because of high popularity of Korean drama and programs, expecting that this content will help boost T-DMB in Mongolia.

MTV in Cambodia

In Cambodia four MTV networks using the T-DMB standard have already been planned and a licence for T-DMB operation in TV channel 10 (VHF Band III) has been granted to the Cambodia public service broadcaster, TV Cambodia (TVK), as multiplex and network operator.

The Cambodia television market is characterized by a great number of national TV services and a wide choice of TV platforms (analogue and digital terrestrial, analogue and digital cable, Internet Protocol Television (IPTV) and satellite TV). Thirteen analogue TV services provided by 11 broadcasters can or will be soon received in Phnom Penh and a lower number in other parts of the country. In addition, a package of 60 digital terrestrial TV services provided by cable operator Phnom Penh Cable Television (PPCTV) is offered in Phnom Penh.

With regard to the digital television systems, two DTTB standards are permitted by the government, DVB-T and the Chinese system standard DTMB. It is up to the broadcaster to select one of the two.

Cambodia on August 2010 chose T-DMB as the national standard for terrestrial digital broadcasting. T-DMB test transmissions took place in Phnom Penh some time ago. TVK is ran a trial service. Operational T-DMB services were expected soon.

In Cambodia, four MTV networks using the T-DMB standard have been planned and a licence for T-DMB operation in frequency block 10A, 10B, 10C and 10D has been granted to TVK as multiplex and network operator. MTV introduction has been planned in a phased approach, as under:

TABLE 3: MTV INTRODUCTION TIME-LINES IN CAMBODIA

Year	Channels	Cities
2011	10A, 10B, 10C	Phnom Penh
2012	10A, 10B, 10C	Battambang, Siem Riep
2013	10A, 10B, 10C	Kampong Cham, Sihanouk Ville
2014	10 D	Phnom Penh, Battambang, Siem Riep, Kampong Cham, Sihanouk Ville
2015	10A, 10B, 10C, 10D	Other regions

In the longer term, there may be requests for more T-DMB services or from other operators. For that purpose, it may be necessary to be set aside one or more channels in Band III. These channels will be available after analogue switch-off.

A new telecommunication law was in preparation. The establishment of a regulatory body, the Telecommunications Regulator Cambodia (TRC) is foreseen.

MTV in Ghana (2015)

In 2008 FonTV, Africa's first mobile phone enabled television content service, was launched via DMB. The network is operated by Black Star TV in collaboration with OneTouch and VDL. This launch followed on from a successful trial that ran in Accra during 2007.

FonTV is a subscription based service costing around 2 Euros a month. Black Star TV currently operates three mobile TV services, including the BBC World News and ultimately hopes to provide up to six TV channels and four digital radio services. While coverage is currently limited to the areas around Accra and another city, the operator has plans to roll out FonTV across the country. It is not clear if these services are still on air.

Economic Impact (2007)

The mobility and interactivity of this technology is poised to positively compliment business growth in Ghana. Companies operating in Ghana will be able to use the platform to build and expand their commercial activities; television adverts can now reach its intended audience anytime of the day

offering marketing executives lucrative advertising slots other than the key slots of breakfast, lunch and evening-news schedules.

To give further insight to the commercial possibilities that T-DMB offers, radio stations for example will be able to simulcast their programmes, allowing users to both hear and see the stations' Disc Jockey hosting the programme. Traffic and Travel Information – allowing users to receive real-time traffic information on their mobile phones is expected to represent a lucrative revenue source for businesses that offer the service through T-DBM.

A direct impact to the Ghanaian economy will be in the form of the construction of an assembly plant in the country. The operator has negotiated with the Korean Manufacturers to establish the assembly plant in the country which will create jobs and add export revenue to the economy.

T-DMB is a service provided via broadcasting networks, and as such is unaffected by network bottlenecks, enabling the delivery of large-volume multimedia content to a virtually unlimited number of users without loss of quality. When fully rolled-out, consumers in Ghana will be able to view a rich content of programs whilst on the move and benefit from a vast choice of digital-quality multiple channels.

T-DMB also allows CD-quality sound. The mobility of this technology is unprecedented and enables users to watch TV while on the move by resolving the spatial limitations of existing broadcast services.

To ensure its success the operator has designed a rich programme content that will truly bring the best of African Movies, Hollywood and Nollywood Blockbusters, International News (BBC, CNN, DW-TV), community programmes, political debates, music videos to satiate the demand from Ghana's MTV generation, ground-breaking documentaries, sports, educational programmes, science and technology channels, local and international radio broadcasts and internet content - all within the palm of the people.

Receiver device cost considerations

T-DMB phone sets cost from GHC 200.00 upwards. As with all mobile devices, price variations vis-à-vis enhanced features will pertain. Those who own the latest models of mobile phones will however be able to purchase USB dongles which when plugged into their phone handset, digital camera or laptop will serve as receivers for mobile television broadcast signals. These USB terminals will retail from GHC 100.00, still significantly less than the price of most mobile phones being sold in Ghana.

Social benefits

The launching of mobile TV service in Ghana is expected to positively impact the society in many diverse ways. Firstly, its relative affordability makes T-DMB an ideal solution to the widening digital divide, whether between generations or income groups, extending the benefits of the information technology to all segments of society.

Distance learning becomes more practical as even the remote parts of the country will receive the service.

The Broadcast Website Service, a feature of T-DMB, will bring the internet café to the office, home, and taxi station or wherever the viewer is. When the mobile phone receiver is connected to a projector, whole classrooms and community audiences can view and listen to television content, be

it religious programmes, political debates, edutainment programmes etc. The implementation of T-Commerce, T-Government and T-learning are all achievable with mobile TV.

Another key benefit of T-DMB is its ability to support the functions of NADMO (National Disaster Management Organization). This is because T-DMB can be received and watched anywhere anytime and can be provided on channels for free public purposes, making it a suitable medium for disaster warning (floods, fire, hurricanes and earthquake) broadcasting. According to the severity, warning messages can be simply displayed on the terminal screen, or a loud alarm given alerting users in time for them to better cope with the situation in an informed manner.

South Africa (2015)

The Joint SADIBA/NAB Digital Radio DAB+ Trial Working Group's trial ran for a year up to March 2015. MobileTV PTY performed technical tests of DMB (Digital Multimedia Broadcasting) and DAB+ for two years until July 2013 and planned to expand trials in the Free State and the Western Cape in South Africa.

MobileTV PTY trial ran two TV channels and one radio station on a test license. If a license is granted they would then cover 15-20 million of the 45 million people in South Africa and expand coverage in parallel to sales of devices and uptake of services.

The company has teamed up with SABC, the public service broadcaster in South Africa. It was also considering use of mobile TV technology for educational purposes reaching rural schools and colleges in a cost effective manner.

If a commercial license by the government, the company will, within the first year, cover up to 50% of the population of South Africa. The aim is to increase this to 80 - 90% within 2 to 3 years. Their plan is to broadcast 6 to 10 mobile TV channels and two radio stations. Additional services that combine broadcasting and the Internet on the same device will be an essential part of the business model. Such services include traffic information, gambling, integration with social media and touch-screen shopping.

MTV Services in Vietnam (2013)

VTV has been broadcasting T-DMB services on air in Ho Chi Minh City since December 2010 with three transmitters covering the city area. T-DMB Total Solution has been developed by ETRI to provide a T-DMB pay service and includes CAS (Conditional Access System), MOS (Monitoring Operating System), CMS (Customer Management System), and BS (Billing System). VTV planned to launch a T-DMB commercial service in Hanoi in 2012. VTV was granted a 15-year digital broadcasting license in 2011 to provide T-DMB services, in Vietnam.

VTV Broadcom, a subsidiary of State-run Viet Nam Television (VTV), has applied for a new national license to carry out T-DMB services nationwide after a two-year trial run in Ha Noi and Ho Chi Minh City.

The services aim to cover 10 cities in Vietnam in the next two years. VTV Broadcom was to invest an initial VND50 billion (US $2 .4 million) providing a DMB service, also called mobi TV in Vietnam, in Ha Noi and Ho Chi Minh City. It was expected to make a profit from the service within two years.

VTV have partnered with a radio station with a target focus of young audiences, to provide digital radio content through T-DMB networks. They also planned to launch self-branded mobile phone receivers at a retail price of approximately $100 per unit.

VTV also plans to apply for a Telecom operator license in the near future in order to converge digital broadcasting and telecom services in Vietnam to provide more diverse services including data and traffic services.

Hong Kong MTV service in UHF Band (2015)

HKTV needs a separate domestic TV program license to offer commercial mobile TV Change to launch over-the-top (OTT) video services. Such a service is distributed via special set-top boxes, online and on mobile platforms. A part of the China Mobile Multimedia Broadcasting China Industry Standard (CMMB) has the capability in supporting portable and mobile digital TV services in Hong Kong.

In Oct 2014 Hong Kong Television Network (HKTV) launched mobile TV service "UTV" Cross-network which integrates cellular, internet and broadcasting companies to supply content, regardless of the user's mobile provider.

Users can watch programs through Android smartphones, iPhone, tablets, computer and TV boxes. Trends in Hong Kong show steady growth of Smartphone penetration rate, and steady growth of watching video and TV programs

Accessible to all Hong Kong cellular users regardless of their mobile network provider Owners of portable media players using CMMB software can also access the TV service Hong Kong's telecoms regulator OFCA allocated the 678MHz–686MHz band for licensed broadcast mobile TV.

MTV in China

China's State Administration of Archiving, Radio, Film, and Television (SAARFT) tested DMB services from 2007 onwards. Beijing Jolon, GTM in Guangzhou and other broadcasters provided DMB services during the Olympic Games in 2008. DAB is now on air in three cities (Beijing and Hong Kong in Band III and Shanghai in L-Band).

Some of them provide several DMB services among audio services. Beijing Jolon, the biggest local broadcaster in Beijing, has launched 'Push Radio' based on DAB in 2010 in Beijing. Beijing Jolon broadcasts 30 hours or 25 program channels every day through Push Radio. 16 Audio programs are broadcast 15 times per day and downloaded onto receivers. Value added services such as news, data and slideshow have been provided through Push Radio services.

In 2008 Beijing had 20 digital radio services, 4 video services, 2 data services operated by the commercial broadcaster Beijing Jolon on Band III.

In Dalian, the Dalian Tiantu Cable Television Network received a licence for digital radio and mobile TV via DAB/DMB with plans to launch 4 radio services and 1 video service

MTV services operating on ISDB-T platform

ISDB-Tmm in Japan[79]

ISDB-Tmm (Terrestrial mobile multi-media) uses a suitable number of segments of the ISDB-T multiplex with video coding MPEG-4 AVC/H.264. With multiple channels, ISDB-Tmm serve dedicating content such as sport, movie, music channel and other with CD quality sound. This service uses the VHF Band III, 207.5–222 MHz which was available after the switchover to digital television in 2011.

Japanese Ministry issued a licence to Multimedia Broadcasting, Inc in 2010 for use of ISDB-Tmm method for multi-media mobile broadcasting.

The ISDB-Tmm broadcasting service by mmbi started the new broadcasting station NOTTV in October 2011. It started services with a monthly subscription fee of 420 yen for areas in south Kanto Plain, Aichi, Osaka, Kyoto and some other prefectures from April 2012. BY end on 2012, around 75% of households were covered and around 90% by end of 2014. More than 125 stations or repeaters will be installed in 2016 to cover all cities nationwide.

General policies for broadcasting services (2015)

The current size of the broadcasting market in Japan is roughly four trillion yen, and has seen a diversification of media in terms of satellite and cable broadcasts, as well as the proliferation of numerous channels. As such, broadcasting has come to play an indispensable role in Japanese industry and the people's daily lives. The MIC has handled this expansion and development of broadcasting services from the administrative side by means of setting in place legislation and instituting budgetary measures.

As of the end of March 2012, television broadcasting had completely switched to digital, and progress has been made with enhancing the functionality of broadcasting services, such as images with high-definition image quality and the realization of data broadcasting. What is more, multimedia broadcasting for mobile devices that use the frequencies that were opened up following the end of terrestrial analogue television broadcasting were initiated in April 2012. Through this an environment has been set in place where viewers can view television programs and other content with high-definition image quality even when they are away from home.

It is under this sort of environment that the MIC is partnering with broadcasters, telecommunications carriers, and home electronics manufacturers to promote initiatives like international standardization and demonstration trials related to further enhancing the functionality of these broadcasting services. In this, they aim to achieve "ultra-high-definition" (4K / 8K), which would make it possible to view images that have even higher resolution and image quality than those of current high-definition images, as well as "smart TV," which would interlink communications and broadcasting services to display additional information on the screen or transmit information related to the broadcast programs according to the user's preferences.

Moreover, Japan's broadcast content is ranked second in the world behind that of the United States in terms of its market scale and is highly appraised in other countries overseas, though the ratio

[79] Please refer to footnote 50 as the service will be terminated in June 2016.

exported overseas is low. The MIC is partnering with broadcasters, rights holders, and others to advance support when it comes to financial and institutional aspects for the overseas expansion of quality broadcast content, in the aim of creating a platform for expanding the scale at which Japanese products and services are deployed overseas.

The MIC is also promoting initiatives conducive to strengthening broadcast networks, such as extending radio services to areas where such services have been unavailable, and disaster protection measures for broadcasting facilities, so as to be able to properly provide the public with disaster information and the like via broadcasts in the future, with this focused primarily around radio, which has been recognized as being particularly useful during earthquakes.

In addition, in January 2014 it launched the Investigative Commission for Subtitles in the Age of Smart TV, which is moving forward with examinations of policies geared towards offering subtitles in multiple languages via smart TV and disseminating subtitled commercials.

Broadcast Laws

In 1950, the Three Radio Laws, which included the Broadcast Law, were established. These made Nippon Hoso Kyokai (NHK) into a special corporation, and established the Radio Regulatory Commission. The Broadcast Law also clarified the legal basis for commercial broadcasters which began service in 1951.

The Broadcast Law embodies three basic principles: assurance of the maximum availability of broadcasting, assurance of freedom of expression through broadcasting, and assurance of the broadcaster's commitment to a healthy democracy. The law regulated broadcasters so that they would promote the public welfare and strive for the sound development of broadcasting.

The Radio Regulatory Commission was abolished when the first TV license was issued.

Broadcasting services operating on DVB-T2 Lite platform

Denmark (2012)

A DVB-T2 Lite trial was launched in 2012 by Open Channel in Copenhagen. The trial, which could run for up to three years, uses UHF channel 39 in Copenhagen, and claims coverage of more than 700,000 households.

In contrast to the BBC R&D trial, the Copenhagen trial consists entirely of T2-Lite TV and radio channels carried on up to 16 Physical Layer Pipes (PLPs). As their name suggests, each of these can be regarded as a separate data-pipe with its own bit-rate and robustness characteristics.

Configured in this manner, a T2-Lite multiplex can match the data-rate offered by a DVB-T, yet still offer good mobile reception.

The difference between the T2-base multiplex data-rate (40.2 Mbit/s in the UK) and that of a T2-Lite mux (20-25 Mbit/s) is explained by the fact that the PLPs within it are configured to be much more robust for mobile reception purposes, so run at lower bit-rates (the DVB-T2 spec sets a maximum of 4MBit/s for PLPs when T2-Lite is used).

It also means that these can easily be captured by fixed aerials, too. The same channel offer is receivable on either living-room displays fed from a fixed rooftop antenna or handheld devices

equipped with a T2-Lite tuner. These channels will, of course, not be HD quality, but that has to be set against the fact that no separate (expensive) mobile TV network needs to be constructed.

The reception of mobile television is taking advantage of an extraordinary boom thanks to the new generation of electronic receiver devices (the popular tablets and smartphones). One of the main goals of the trials being carried out was to demonstrate the suitability of the DVB-T2 Lite Profile for mobile services.

MTV in other countries

Some T-DMB trials were on-going or planned in other countries:

1. In Norway T-DMB services were available in 2009. MiniTV DMB service launched by the Corporation was backed by the three largest broadcasters in Norway: the public broadcaster NRK, TV2 and MTG Group. The live channels could be viewed in and around Greater Oslo.
2. Germany's Mobiles Fernsehen Deutschland (MFD) launched the commercial T-DMB service "Watcha" in 2006, in time for the World Cup 2006. It was stopped in 2008 as MFD is then favoured the DVB-H standard.

Annex B: MTV case studies

This Annex is intended to provide case studies on the various regulatory provisions that have been adopted by various countries in respect of MTV services, their introduction and their development.

The essential elements of regulations and policy decisions of several countries are offered here, as applicable directly to MTV services, or as a part of the regulatory regime governing the broadcasting services in general.

Some specific regulatory provisions have also been examined by researchers, as appropriate, to illustrate the efficacy (or otherwise) of some of these regulations. A gist of the analysis has been offered here for information.

Case Study 1: Korea Communications Commission

The Korea Communications Commission (KCC) is an independent administrative commission under the Presidential Office, established in 2008 pursuant to the Act for the Establishment and Operation of the Korea Communications Commission.

KCC operates to actively meet the ongoing trend of convergence between broadcasting and telecommunications which is triggered by the advancement of digital technology, and to provide citizens with advantageous results of the convergence of broadcasting and telecommunications as shown below.

KCC's strategic purposes are:

1. To enhance user protection and public interest in the area of broadcasting and telecommunications;
2. To develop brand-new services and various contents;
3. To activate wired/wireless network resources, and;
4. To secure an environment for fair play and competition, and so forth.

KCC carries out the following assignments:

1. To facilitate the convergence of broadcasting and telecommunications, thus enhancing the efficiency of policy implementation;
2. To ensure professionalism and accountability of both broadcasting and telecommunications, thus meeting the quickly changing environment; and
3. To consolidate the policy-making and regulatory functions, thus promoting the advancement of both broadcasting and telecommunications.

KCC's Functions

Under the KCC Act, KCC should take efforts to:

1. Establish the policy to converge broadcasting and telecommunications;
2. Develop and activate such convergence services and technologies;
3. Formulate policy on broadcast frequencies and resources;

4. Promote the competition in the broadcasting and telecommunications markets;
5. Enhance broadcasting and telecommunications networks;
6. Prevent adverse effect of broadcasting and telecommunications;
7. Establish and enforce user protection policy, and;
8. Investigate unfair activities of, and mediate disputes among, broadcasting and telecommunications businesses, and so on.

Some KCC Policies: Promotion Convergence Industry

Authorization of Cross-Ownership of Diverse Media

In order to enable the media industry to lead the national economy and contribute to a market environment reformation such as the integration of different media, the Korea Communications Commission is scheduled to improve regulations on cross-ownership of media and also increase such cross-ownership. Authorization of cross-ownership of media is to be executed through processes including the collection of specialist advice and public opinions

Reduced Restrictions on Broadcasting Business Ownership

The Korea Communications Commission is planning to reduce restrictions on ownership for the advancement of the broadcasting industry. It is in the process of reducing restrictions on ownership of satellite broadcasting by large enterprises (currently 49%) and foreign funds shareholding (currently 33%) for improved balance in regulations on different media as well as revitalization of investments. Moreover, shareholding for daily newspapers and new broadcasting (currently 33%) are also planned to be improved for cable SO and satellite broadcasting.

On the other hand, to improve the business conditions of DMB business, which are experiencing accumulating deficits, restrictions on individual shareholding (currently 30%) and large enterprise shareholding (currently prohibited) are also being reduced for non-ground-wave DMB services.

Introduction of New Business

In addition, new comprehensive PP is planned be introduced in order to satisfy audiences' diverse desires for media and re-energize the broadcast content market. This will take place at the same time as the revision of the broadcasting laws.

Vitality in the Content Business

Broadcasting and communications content constitutes a high-value-added industry which has great a ripple effect. The international content market is estimated to grow at a rate of 13.4% per year.

In order to consolidate the competitive power of broadcasting and communications content, efforts are carried out to determine if the fees for the content provided by program providers are appropriate, and actions will be taken to allow content production companies to get the rate they deserve through the consolidation of copyright protection for outside production companies.

Foundation for Production and Distribution of Broadcasting Content

Production cost support will be increased for various program providers and small- and medium-sized content producers, and a one-stop cluster where the production, processing, and distribution of the content of small- and medium-sized businesses can be supported is being formed.

In addition, an online content market to enable easy trading of content for support to small- and medium-sized businesses with weak content distribution networks will be established, and a mid- to long-term distribution of human resources in the field of content is planned.

Case Study 2: Digital Multimedia Broadcasting in South Korea

This section discusses the validity and impact of regulatory policies in rapidly changing media industries, with the case of satellite and terrestrial digital multimedia broadcasting (DMB) in South Korea. In spite of their innovativeness, it is difficult to state that both DMB services have been successful in the market as had been expected, especially facing the explosion of smart-phones which enable the reception of various audio and video services. Many argue that one of the main reasons for such weak performance of DMB services is the inconsistency of regulatory policies. In the Korean DMB case, satellite DMB and terrestrial DMB have been regulated under different conditions in terms of content and coverage, as well as cost systems in spite of their functional similarity. Such asymmetric regulation has proven to be ineffective in this case and, thus ultimately, has resulted in the instability or failure for both services.

Digital Multimedia Broadcasting (DMB) emerged as a promising example of convergence technology between broadcasting and telecommunication in South Korea. The industry and the consumers had anticipated DMB to become an innovative convergence service and technology even before its introduction to the market. However, after 8 years (till 2013) of operation, both satellite DMB (S-DMB) and terrestrial DMB (T-DMB) have suffered from serious setbacks in terms of financial outcomes as well as providing competitive content.

S-DMB, a joint service of SK Telecom with Japan's MBCo,2 launched its satellite in 2004, and started its multi-channel pay broadcasting in May 2005 as the world's first S-DMB service. Despite its diverse content, S-DMB provider TU Media failed in maintaining the original subscription business model and was merged with one of the subsidiaries of the main investor, SK Telecom in 2010 in order to substitute the losses. Ultimately, SK officially terminated its service in August 2012 with a huge financial loss, which marked the largest failure in the shortest time throughout the South Korean communication history.

T-DMB, the competitor, launched its service in December 2005 starting in Seoul. T-DMB took a favourable position with free services available via most mobile phones, though it was difficult to assess the actual viewing rate of the services. However, it could not find a profit-making business model except advertising, resulting in weak financial outcomes. In addition, T-DMB was not successful in developing and providing its own competitive content other than the retransmission of incumbent terrestrial broadcasting channels, KBS, MBC and SBS.

Numerous factors affected such setbacks of the DMB industry. Obviously, the most significant factor is the explosive diffusion of smart-phones which enable television viewing through their applications. However, researchers and service providers have criticized the inconsistent DMB policies which hampered the expansion of market and the development of competitive content for the DMB industry before the entrance of smart-phones in South Korea.

South Korean S-DMB and T-DMB related policies were established and executed through the former Korean Broadcasting Commission (KBC) and the former Ministry of Information and Communication (MIC), eventually combined into the Korea Communication Commission (KCC). Although these

institutions recognized the importance of DMB in providing subscribers with mobility in broadcasting, they did not hold enough discussion and preparation in the policy-making process. Consequently, DMB services were launched without clear positioning as a new entrant of the market as well as the appropriate conditions for competition with each other.

The argument is that DMB could have gained a better position before facing the competition against smart-phones, had the appropriate regulatory policies been applied.

Asymmetric regulation over emerging media

When a new technology and service is introduced to the market, especially a convergence medium between broadcasting and telecommunication, various regulatory policies are implemented in order to secure fair competition and to promote consumer welfare. However, the difficulties of defining market boundaries and assessing dominant power over a specific industry often raise the question of feasibility or relevance of such policies.

Asymmetric regulation mainly focuses on intense regulations for firms of advantageous positions, such as market-dominant or incumbent service providers. Asymmetric price regulation promotes the entrance of competing firms and that Asia's dramatic mobile development and sustainable competition in the market are largely the results of asymmetric regulation. However, there are also assertions that the counter effects of strong regulatory policies including asymmetric regulation might bring the inefficiency distorting competition conditions of the market.

The asymmetric regulation applied on S-DMB and T-DMB usually utilized different levels of regulatory policies for the dominant and the following service providers in order to promote competition in the market and to protect consumers. As for DMB in South Korea, competition between and among S-DMB, launched by the leading mobile communication service provider SK Telecom, and T-DMB, led by major incumbent terrestrial broadcasters, has constantly raised the issue of unfair competition.

During the process of digitalization of the incumbent terrestrial broadcasting, T-DMB was introduced in order to solve the problem of mobile reception of HD system which had been selected for Korea's digital terrestrial television standard. For T-DMB which launched its service in December 2005, KBC added three new DMB-only service providers in addition to three incumbent terrestrial broadcasters with a goal of not only retransmitting terrestrial broadcasting through T-DMB but also establishing it as a new mobile broadcasting medium for consumers.

The subscribers to S-DMB, TU, reached over 2 million and sales surpassed 110 billion won in revenue by the end of 2009 but started to slow down and ultimately decreased radically until the service was terminated in August 2012.

T-DMB is provided through approximately 35 million reception devices (in use), mainly mobile phones (by end 2011), but advertising revenue has continued to remain weak, resulting in continuous annual losses. T-DMB service providers have experienced their difficulties in generating advertising revenue in spite of the fast.

Basic principle of regulatory policies on DMB

Since DMB is classified either as terrestrial or satellite broadcasting, the regulatory policies which have been applied to the incumbent terrestrial and satellite broadcasters have also been applied to these new services, respectively.

For example, in terms of ownership, T-DMB is prohibited from receiving foreign investment as is the incumbent terrestrial broadcasting, and the investment of major national conglomerates are limited up to 10%, although the licensed DMB-only service providers have relatively weak financial positions. In other words, T-DMB is considered as a terrestrial broadcasting which is a universal service focusing on public interest, using public resources, and emphasizing its social influence.

On the other hand, the ownership regulation on the S-DMB industry follows those of pay services with less strict rules (49%) on the national conglomerates and foreign investment. S-DMB follows the regulatory principle of incumbent satellite broadcasting which is a multichannel pay service and aims to make profit.

Thus, the basic foundation of the asymmetric regulation and policy decisions mainly come from the two services' fundamental differences in their conceived identity; S-DMB is considered essentially as a commercial service of a convergence technology between broadcasting and communication, and the regulatory policies are applied accordingly, while T-DMB, competing against it, is regarded a public service as an extension of public terrestrial broadcasting which require higher level of regulation on their business models and content.

DMB policy decisions and execution

Cost and profit model

Upon launching, TU charged 20,000 won for service initiation and 11,000 for monthly subscription, and adopted individual usage-based rate system which is normally applied in telecommunication market.

On the other hand, T-DMB was defined as a free service without subscription fee, whether terrestrial-affiliated or DMB-only, and the cost for program production and distribution as well as the establishment of transmission network for transportation system has been covered solely by advertising revenue. This is an application of free terrestrial broadcasting model based on advertising, unlike S-DMB's telecommunication model.

It became clear that such definitions of service and revenue models required a significant revision. Although S-DMB arrived at the market first and had the advantage of being multichannel, its subscription and initiation fee served as a limitation in competing against free T-DMB. The number of S-DMB subscribers became stagnant and even decreased after T-DMB expanded its service coverage to nationwide in 2007, but increased back again after they changed their rate system virtually free in 2008.

With its limitation of smaller screen and mobile-watching environment, pay service proved to have a difficult stand in competing against free service, unlike the rivalry between incumbent free terrestrial and pay cable or satellite service in the broadcasting market.

Meanwhile, T-DMB service providers experienced difficulty in maintaining free service due to lower advertising revenue and larger infrastructure investment than expected. The dependency of T-DMB solely on the limited advertising market in which the competition was ever increasing has been a major setback for the service providers. Especially, DMB-only service providers continuously requested for other revenue sources including initiation fee or subscription fee, but the current KCC have opposed changes in its regulatory principle of T-DMB as a free universal service for everyone.

Thus, for both S-DMB and T-DMB, the difficulties in establishing appropriate revenue models have been a major issue in improving their weak performances. Yet, it will be difficult to argue that the regulatory policies have helped increase the competitiveness of DMB services from the perspective of profit making business models.

Content policy

The regulatory policy on content can have a huge impact on the market competition, and has been an important variable in Korean DMB competition. The core issues of DMB content are the right to retransmit the incumbent terrestrial broadcasting services and the institutional support for developing new content for DMB services.

TU, until the termination of its service, provided 22 video channels, 20 audio channels, plus one adult channel, but could not find the core content which appeals to the disappearing subscribers. On the other hand, T-DMB service providers consist of three terrestrial-affiliated broadcasters, mainly retransmitting existing terrestrial content, and three DMB-only service providers with original content and programs from other pay broadcasters.

The first issue on DMB content was the retransmission of incumbent terrestrial broadcasting (KBS, MBC, and SBS); while S-DMB was prohibited from retransmitting incumbent terrestrial broadcasting at the launching, T-DMB has been retransmitting all of them. The difference was mainly due to the early decision of SK Telecom to request for the exemption of delivering Must Carry channels including KBS1 and EBS. However, during the following discussion of launching free T-DMB business, the former KBC decided not to allow TU's retransmission of any terrestrial broadcasting temporarily.

After T-DMB was introduced six months later, KBC decided that TU and the incumbent terrestrial broadcasters solve the retransmission issue with individual contracts, but it was obvious that the incumbent terrestrial broadcasters, already retransmitting their channels through T-DMB service, would not be active in the negotiation with TU. TU was successful in signing retransmission contract with only one of three channels, MBC, in spite of its willingness to pay significant amount of retransmission fee.

Another content issue was the lack of ability to develop DMB-exclusive content. While terrestrial-affiliated DMB broadcasters retransmit their channels with no additional cost, DMB-only channels must find and produce new content appropriate for DMB technology. However, it is difficult for them to invest in such content development since they have been accumulating wide losses annually. As a result, T-DMB also demonstrated a limitation in creating new and competitive content strategies for new services other than the retransmission of already proven content, including sports and reruns of drama series from the terrestrial and cable broadcasting stations.

In addition, T-DMB channels started to lease their time blocks to cable channels to substitute for the lack of content and to find revenue sources, but such strategy did not contribute much to solving T-DMB's content problem.

In summary, the regulatory policy on the content of S-DMB and T-DMB has proven the ineffectiveness and inefficiency of asymmetric regulation.

Coverage area and localism policy

Localism has been one of the most important yet difficult public goals in South Korean broadcasting industry. Localism can either be understood as geographical/administrative or social/cultural concept. In both dimensions, DMB policy has provided a very significant case to consider.

From a geographical/administrative perspective of localism, S-DMB and T-DMB were fundamentally different due to their technological basis; S-DMB, covering the entire nation with one satellite, provided nationally simultaneous content with identical quality broadcasting, although it required high-cost gap fillers. On the other hand, T-DMB had to establish a network for local reception which took more than a year to build and still has a problem of unequal reception quality in some regions. The network-building cost has been a considerable burden for T-DMB service providers.

S-DMB had a limited channel capacity to retransmit all regional terrestrial broadcasting signals, which made it impossible to realize the regulatory principle of localism. On the other hand, T-DMB has made it clear that localism was one of its major goals from the beginning and a total of 13 service providers, including six metropolitan and seven non-metropolitan providers, have participated in its nation-wide distribution. However, instead of dividing the nation into small sized local markets, it is decided to establish middle-range regional markets to balance the economies of scale and the regulatory goal of localism. Still, such policy decisions have neither provided the financial stability for the providers nor satisfied the localism demand of the viewers.

In summary, the regulatory decisions concerning localism issues also have undermined the expansion of market and financial outcome of the DMB industry.

Impact of regulatory policies on DMB industry

Adoption and usage patterns of DMB service

One of the ways to assess the successful entrance of a new medium in the market is its adoption and expansion rates among users. The number of subscribers for S-DMB and the number of T-DMB equipped devices as well as the results of audience survey can provide such information.

On the other hand, for advertising-based T-DMB, the indicators of adoption and usage include the number of reception devices, including mobile phones and vehicle reception devices, as well as the actual viewing rate. It is difficult to distinguish the availability and actual viewing for free T-DMB, but the number of mobile phones available for T-DMB service has increased at a very fast rate. Currently (2012), T-DMB is available via more than 40 million mobile phones in use. The actual viewing rate for T-DMB has been reported since 2008, and the survey results have shown that the average DMB viewing rate was 1.17% (highest reaching 3.59%) in 2008, but unfortunately dropped to 0.6% in 2011. The most watched programs have been sports events such as the Summer and Winter Olympic Games, as well as national soccer and baseball league games.

Financial achievement

For T-DMB, advertising revenue increased from 1.7 billion won in 2006 to 12.4 billion won in 2009. However, service providers are not making the most out of the advantages of T-DMB that enables focused viewing and personalized marketing. In addition, the revenue gap between terrestrial-affiliated and DMB-only service providers is in fact increasing, giving DMB-only providers a dark prospect. As of 2011, DMB-only service providers each have accumulated losses of up to 30 billion won. Without a new business revenue model, it will be hard for T-DMB to maintain its business in the face of continued recession, low evaluation of its advertising effect, and competition against smart-phone applications for video distribution.

TABLE 4: REVENUE OF DMB-ONLY SERVICE PROVIDERS (IN 100 MILLION WON)

Service	Item	2006	2007	2008	2009	2010	2011	Total
Korea DMB	Revenue	3	23	43	33	55	65	243
	Profit	-57	-65	-45	-41	-18	-5	-231
YTN DMB	Revenue	8	25	52	51	72	90	298
	Profit	-75	-65	-51	-51	-38	-7	-287
U1 Media	Revenue	12	47	75	47	50	55	286
	Profit	-87	-59	-37	-43	-25	-11	-262

In conclusion, S-DMB and T-DMB have not been successful in generating profit for the past years. Although a huge initial investment for starting business could have affected the situation, the fundamental problem was that the profit generating models for S-DMB and T-DMB as new media have been neither effective nor pertinent.

Conclusion

DMB has received much attention since its 2005 introduction as a new medium representing a convergence technology and service between broadcasting and telecommunication. S-DMB, the world's first broadcasting service with DMB-exclusive satellite, and T-DMB, ancillary service to incumbent terrestrial broadcasting for its HD conversion, were highly promoted by the South Korean industry and government. However, seven years after the introduction of the DMB business, current status and future prospect of DMB seem unpromising.

For one, the availability of audio and video channels through smart-phone applications for more than 31 million smart-phone users (60 % of total mobile-phone as of September 2012) appears as the strong and imminent threat to DMB at this point. During the past seven years, the DMB industry has lost its opportunity to stabilize business, to increase the number of subscribers, and to develop competitive content for the broadcasting market.

Diverse political, social, and economic variables could have affected this result. However, most of all, inconsistent asymmetric regulatory policies are pointed out to have had a significant influence. The basic assumption of such regulatory policies was the principle that S-DMB was considered as a telecommunication service and T-DMB a terrestrial broadcasting. Thus, policy decisions on ownership, content, and the realization of localism were made accordingly. Nevertheless, such asymmetric regulatory policies have undermined the successful entrance of DMB into the market in several ways; for example, ownership regulation has worsened the weakness of T-DMB-only service providers.

In terms of content regulation, strict regulatory policies prohibiting retransmission of incumbent terrestrial broadcasting weakened the business value of S-DMB service provider, which were already lacking the content know-how and competitiveness. In addition, the policy goal of localism has made it difficult for S-DMB, technically impossible for local service, to negotiate retransmission with terrestrial broadcasters, and for T-DMB to satisfy the balance between localism and economies of scale.

The case of South Korean DMB demonstrates the importance of policy decisions regarding the introduction of new technology and service. Successful introduction and expansion of a new technology and service basically requires adequate policy support. The case of South Korean DMB also leads to reconsider the conditions for fair competition in the emerging convergence media industry. A number of different levels of asymmetric regulatory policies have been applied to the DMB competition structure, since S-DMB was provided by a dominant telecommunication firm and T-DMB was led by dominant terrestrial broadcasters. However, inconsistent and inadequate regulations imposed upon them undermined the DMB industry as a whole.

Based on this analysis of the DMB industry in South Korea, it should be emphasized that the application of regulatory policies involving the formation of competitive relationship among new media technologies and services be carefully examined in the future.

Case Study 3: MTV Regulations in Hong Kong

Regulatory Issues of Broadcast-type Mobile Television Service (“Mobile TV Service”) Approach Separate regulations for TV content and broadcasting network infrastructure Broadcasting Ordinance (BO) Governs content regulations of TV broadcasting services in Hong Kong Telecommunications Ordinance (TO) Covers the establishment, maintenance and operation of telecommunications networks in Hong Kong Include infrastructure for conveyance of TV broadcasting services Focus on Broadcasting Ordinance (BO).

Licensing and Regulatory Requirements under the Broadcasting Ordinance (BO)

If a person provides free/pay television programme service which is intended or available for reception by an audience of more than 5,000 specified premises (any domestic premises, or hotel

room, in Hong Kong), the person must take steps to obtain a domestic free television programme service ("FTV") licence or domestic pay television programme service ("PTV") licence If a person is unable to ensure that his/her television service is not available for reception by an audience of more than 5,000 specified premises, the person must take steps to obtain a FTV/PTV licence under the BO.

Framework of development of broadcast type mobile TV (A): Spectrum Availability One frequency multiplex of 8MHz in UHF Band.

Framework of development of broadcast type mobile TV (B) Spectrum Allocation Transmission capacity: 75%; provide mobile TV services 25%; other services (e.g. datacasting) Mandatory % of transmission capacity for mobile TV: Should be review by OFTA within five years by successful bidder.

Framework of development of broadcast type mobile TV (C) Spectrum Assignment auction with a pre-qualification process Included utilization fee Bidder should propose obligation (e.g. development plan).

Framework of development of broadcast type mobile TV (D) Licensing Arrangements Operator is required to obtain a unified carrier licence. If rented out, the other TV service, provider is required to obtain - services-based operator licence - other permitted telecommunications services to the public.

Framework of development of broadcast type mobile TV (D) Licensing Arrangements Content (for 'local broadcast-type' or 'streaming-type') is regulated by general laws: Self–regulation

Framework of development of broadcast type mobile TV (E) Access to Hilltop Broadcasting Sites Share existing hilltop broadcasting site facilities. If mutual agreement cannot be reached TA could intervene and adjudicate.

Framework of development of broadcast type mobile TV (F) Geographical Coverage able to set up transmitting stations; provide coverage for 50% of the population within 18 months. NOT necessary to cover in tunnels (e.g. mass transit railway); negotiable.

Framework of development of broadcast type mobile TV (G) Technical Standards a market-led technology-neutral approach by leaving the market to select.

It may be added that DTMB HKTV's proposal to use DTMB for HKTV's mobile television service was rejected by the Communications Authority due to laws that govern traditional and new media by different standards: Characteristics Bandwidth - Channel bandwidth can be modulated into 1.5MHz Bit-rate from 4.813 Mbit/s to 32.486 Mbit/s Signal frequency in the 470-806 MHz band.

Case Study 4: Broadcasting Regulation in Japan

Regulatory Policies at a glance

TABLE 5: REGULATORY POLICIES AT A GLANCE

Area	Regulations
Media Regulatory Authority	Ministry of Internal Affairs and Communications
Foreign investment controls or restrictions	Restricted to 20% voting rights in "Core Broadcasters" (see Section 1 below).
	No restrictions for "General Broadcasters" and non-broadcast media

Area	Regulations	
Cross-media ownership controls or restrictions to protect competition in the local media sector	Media owners are only permitted to control one broadcasting station. However, there are no restrictions on companies owning shares across various different media platforms.	
Forms of media that may be supplied without a government licence	Online content, newspapers, other print publications, mobile content	
Forms of media that may only be supplied under a government licence	License or registration is required for all television media and radio broadcasters	
Primary legislation	Broadcast Law	Nippon Hoso Kyokai and private (commercial) broadcasters, broadcasting via a telecommunications service (including IPTV), and cable TV
	Radio Law	Radio and private television broadcasting and licensing
	The Act on Development of an Environment that Providers Safe and Secure Internet Use for Young People	Online content
	Penal Code	Defamation
	Unfair Competition Prevention Act	Competition/injury to business reputation/misleading advertising
	Civil Code 1896	Defamation
	Copyright Law	Copyright

Basic Principles of the Broadcast Law and Programming Regulations

The Broadcast Law defines the purpose of broadcasting as to satisfy "public welfare" (public interest) and to promote sound development of broadcasting, for both NHK and private broadcasters.

The law defines the following three as the basic principles for realizing this purpose (programming standards):

1. To secure the maximum availability and benefits of broadcasting to the people (universality);
2. To assure the freedom of expression through broadcasting by guaranteeing impartiality; integrity in broadcasting and its autonomy (contribution to freedom of expression through independence and autonomy);
3. To make broadcasting contribute to the development of a healthy democracy by clarifying the responsibility of those persons engaged in broadcasting (responsibility toward the democratic society).

Furthermore, it stipulates that "broadcast programs shall never be interfered with or regulated by any person, except in the case where it is done through invested powers provided by law."

In domestic program broadcasting, the basic principles are that broadcasting:

1. Shall not disturb public security and good morals and manners;
2. Shall be politically impartial (impartiality);
3. Shall broadcast news without distorting facts (report of facts);
4. As regards controversial issues, shall clarify the point of issue from as many angles as possible (multilateral investigation);
5. Shall, in compiling the broadcast programs for television broadcasting, maintain harmony among the broadcast programs, except those provided in accordance with a special business project, by providing a general cultural or educational program, as well as news and entertainment programs vi) when a broadcaster conducts domestic broadcasting, it shall, in the event of a disaster caused by storm, heavy rain, flood, earthquake, large-scale fire or other causes that have occurred or danger of a disaster is foreseen to occur, conduct broadcasting which helps to prevent occurrence of disaster or to reduce damages caused thereby.

Particularly for NHK, the law requires, in addition to the aforementioned standards, the organization "shall exert all possible efforts to satisfy the wishes of the people as well as to contribute to the elevation of the level of civilization by broadcasting or by entrusting for broadcasting abundant broadcast programs," "shall keep local programs in addition to national programs" and "shall strive to be conductive to the upbringing and popularization of a new civilization as well as to the preservation of past excellent civilization of our country" as "exemptions regarding broadcast programming."

Looking at the aforementioned principles from the perspective of society and the receiving side of broadcasting, broadcasting by both NHK and private broadcasters is expected to be independent of the government, any political party or specific business enterprises, to be received anywhere within the service territory, to present facts and evidences in news and other programs, to reflect a variety of opinions, not to be partial to certain genres in programming (terrestrial broadcasting only in case of private broadcasters) and serve as means to obtain information on natural disasters.

For NHK, it is obliged further to offer a wide range of programs, pursue programming quality standards and to fulfil a cultural role.

The policy underlying broadcasting is that both NHK and private broadcasters are expected to fulfil these functions actively in order to enable the TV/radio audiences to gain information on society and made their own decisions and to exercise freedom of expression and, as a result, contribute to healthy development of democratic society and to advancement in culture and quality of life.

Since programming standards are related to freedom of expression, they have been interpreted commonly as ethical standards and indicators that broadcasters must comply with and do not have legal binding force, including cancellation of wireless transmission licence.

Action on Legislation to Replace the Broadcasting Law (2011)

The government conducted a review into a system adapted to the integration and ordination of telecommunications and broadcasting and was planning to submit a bill on this issue in the Diet. The

objective was to consolidate the vertically structured broadcasting and telecommunications laws separated by broadcasting, cable TV, telecommunications and media, including the Broadcasting Law, into nine categories, into an "information and communication law" for regulatory organisation extending across the board into these areas, including content and transmission infrastructure, and based on the policy of "technology neutrality" regardless of media used.

in past deliberations, broadcasting that had been conventionally classified under the names of "media service" is being studied into the form of preservation, maintenance and development of program-related regulatory scheme for both public and private broadcasting sectors, including guarantee of freedom of speech and program standards that are the objectives of the Broadcast Law, and also into what position NHK's operations will be defined amid coordination and consolidation of broadcasting and telecommunications.

Local Media Regulation: What licences are required?

Free-to-air TV

The Broadcast Law governs Japan's national broadcaster, the Nippon Hoso Kyokai (NHK) and private (commercial) broadcasters.

NHK is a special, quasi-governmental corporation. NHK is legally independent from the government and is funded chiefly by mandatory consumer fees.

The private (commercial) entities which are involved in broadcasting of Free-to-air TV classified into the following categories:

1. Broadcasters who conduct broadcasting by establishing and using broadcasting facilities;
2. Radio station providers who are not broadcasters under the Broadcast Law and broadcast programs based on an entrustment by broadcasters who fall within category (c) below, by establishing and using the broadcasting facilities, and;
3. Broadcasters who entrust broadcasting of programs to others (who fall within category (b) above).

The broadcasters are further classified into "Core Broadcasters" or "General Broadcasters". All of Free-to-air TV in Japan are classified into "Core Broadcasters".

In order to conduct a service of the kind defined in (a) or (b) above (whether wireless and/or terrestrial broadcasting) a television station licence under the Radio Law must be obtained from the Ministry of Internal Affairs and Communications (MIC). In order to become a private broadcaster of the kind defined in (c) above, the private broadcaster must obtain an approval under the Broadcast Law from MIC. Private broadcasters must have their licences and approvals reviewed by MIC every three years.

Subscription TV

Under the Broadcast Law, subscription television service providers are classified as "General Broadcasters". In order to provide cable television services in Japan, either (a) a registration with MIC or (b) a notification to MIC is required.

Online content service, Mobile content service

No licences are required in Japan.

Obligations/conditions placed on licensees

Free-to-air TV

The Broadcast Law requires all broadcasters (both NHK and private commercial broadcasters) to ensure that domestic programs:

1. Do not disturb public security;
2. Are not contrary to good morals and manners;
3. Are politically impartial;
4. Broadcast news without distorting facts; and
5. Put forwards all perspectives on controversial issues.

The Broadcast Law also requires broadcasting to include cultural, educational, news and entertainment content.

The implementation and interpretation of these broad principles is assisted by the use of content guidelines set out in a largely self-regulated code of practice. Each television channel is obliged to set up a program review board to ensure compliance with the code.

Other key content related obligations include the following:

1. The Broadcast Law provides that when a Core Broadcaster conducts domestic broadcasting, it must conduct broadcasting which helps to prevent or reduce the damage caused by any natural disasters;
2. When compiling broadcast programming for domestic broadcast, all broadcasters must offer as many broadcasting programs as possible that provide voices and other sounds to explain transient images of fixed or moving objects for blind persons, and providing characters or patterns to explain voices and other sounds for deaf persons;
3. The Broadcast Law requires all private broadcasters (i.e. broadcasters other than NHK or the Open University of Japan) to take measures to enable the audience to clearly identify paid advertisements;
4. The Broadcast Law provides that where a private Core Broadcaster conducts the broadcasting of educational programs intended for schools, the broadcast programs must not include advertisements deemed to be obstructive to school education;
5. In addition to the Broadcast Law, the National Association of Commercial Broadcasters Broadcasting Standards (Broadcasting Standards) serves as guidelines for all broadcasters. Note that the Broadcasting Standards do not have the effect of law and failure to follow the Broadcasting Standards does not result in legal penalties for broadcasters.

Cable TV and Subscription TV

Under the Broadcast Law, cable TV, subscription TV, IPTV, radio and satellite and digital terrestrial services are under the same obligations regarding content and conditions as free-to-air private broadcasters.

Mobile content service

Whilst licences are not required for mobile content services, service providers should note that the Act on Development of an Environment that Provides Safe and Secure Internet Use for Young People provides that where persons under the age of 18 enter into a contract for a mobile internet service or a mobile phone or other like device, the mobile internet service provider must provide its services on the condition that the young person use a service to filter online content considered harmful to young people. The exception to the rule is where the legal guardian of the young person requests the non-use of the service to filter content.

Foreign ownership and investment restrictions

Under the Ordinance of the MIC pursuant to the Broadcast Law, in principle, media owners are permitted to control only one broadcasting station.

"Control" is defined differently depending on the type of broadcast service being operated so that:

1. A person will control a terrestrial Core Broadcaster if they possess more than 10% of voting rights;
2. A person will control a terrestrial Core Broadcaster that does not have an overlapping broadcast service area (i.e. no other broadcasting services are provided in the same area) if they possess 20% or more of voting rights, and;
3. A person will control a satellite Core Broadcaster if they possess 33.33333% or more of voting rights.

However, there are no laws in Japan restricting companies from owning shares across various media platforms. For instance, many newspaper owners also have a majority shareholding in an affiliated television network.

Restrictions on foreign ownership

Under the Broadcast Law, foreign investors are permitted to acquire 20% of all voting rights in Core Broadcasters, including satellite Core Broadcasters.

Foreign individuals and companies may still invest in the above companies beyond the maximum levels detailed above. However, they will not be able to be registered as shareholders and will therefore not be afforded the usual rights given to shareholders in Japan (e.g. voting rights, dividend rights, etc.).

In contrast, General Broadcasters are not subject to such restrictions.

The regulations relating to broadcasting are technical and fluctuate more than other regulations, and as such need to be closely considered prior to any substantial acquisition in such entities.

Regulatory Bodies for broadcasting

As an arm of MIC, Japan's Information and Communications Bureau (Broadcasting Bureau) is responsible for planning and implementing broadcasting policy, and for licensing and supervising broadcasting stations. The Broadcasting Bureau's responsibility extends over all broadcasting (radio, free-to-air and cable television, and satellite broadcasting).

Content Regulation - Copyright

The law protecting copyrights is the Copyright Law, as amended. Because Japan is a civil law country, no common law copyright action exists. The administrative body charged with enforcing the Copyright Law is the Agency for Cultural Affairs of the Ministry of Education, Culture, Sports, Science and Technology.

There is no requirement to register the ownership of a copyright under the Copyright Law. However, the Copyright Law permits the registration of a true name, the registration of the date of the first publication or first disclosure and the registration of assignment or establishment of a pledge with the Agency for Cultural Affairs. While insufficient to confer ownership upon the person filing for registration alone, the registration creates a presumption that the person who has registered his/her true name is the author of the work that is the subject of such registration, and that the date recorded is that of the first publication, broadcast, recitation or performance. Registration is also necessary to perfect a pledge or assignment against third parties.

The Copyright Law contains a number of exemptions to acts or otherwise that constitute an infringement. It is important to refer to this "Limitations on Copyrights" portion of the Copyright Law when considering using any works of authorship or utilizing copyrights, since such provisions, including those listed above, contain many detailed exceptions.

Restricted product advertising

The Broadcast Law requires private broadcasters clearly identify paid advertisements.

Where a private Core Broadcaster broadcasts educational programs intended for schools, under the Broadcast Law the broadcast programs must not include advertisements deemed to be obstructive to school education.

The Broadcast Law also prohibits a private broadcaster from entering into contractual arrangements pursuant to which a single sponsor supplies programs exclusively.

In addition to the Broadcast Law, the National Association of Commercial Broadcasters Broadcasting Standards (Broadcasting Standards) serves as guidelines for all broadcasters. The Broadcasting Standards do not have the effect of law and failure to follow the Broadcasting Standards does not result in legal penalties for broadcasters.

Promoting enhanced functionality for broadcasting services (2015)

The current size of the broadcasting market in Japan is roughly four trillion yen, and has seen a diversification of media in terms of satellite and cable broadcasts, as well as the proliferation of numerous channels. As such, broadcasting has come to play an indispensable role in Japanese industry and the people's daily lives. The MIC has handled this expansion and development of

broadcasting services from the administrative side by means of setting in place legislation and instituting budgetary measures.

As of the end of March 2012, television broadcasting had completely switched to digital, and progress has been made with enhancing the functionality of broadcasting services, such as images with high-definition image quality and the realization of data broadcasting. What is more, multimedia broadcasting for mobile devices that use the frequencies that were opened up following the end of terrestrial analogue television broadcasting were initiated in April 2012. Through this an environment has been set in place where viewers can view television programs and other content with high-definition image quality even when they are away from home.

It is under this sort of environment that the MIC is partnering with broadcasters, telecommunications carriers, and home electronics manufacturers to promote initiatives like international standardization and demonstration trials related to further enhancing the functionality of these broadcasting services. In this, they aim to achieve "ultra-high-definition" (4K / 8K), which would make it possible to view images that have even higher resolution and image quality than those of current high-definition images, as well as "smart TV," which would interlink communications and broadcasting services to display additional information on the screen or transmit information related to the broadcast programs according to the user's preferences.

Moreover, Japan's broadcast content is ranked second in the world behind that of the United States in terms of its market scale and is highly appraised in other countries overseas, though the ratio exported overseas is low. The MIC is partnering with broadcasters, rights holders, and others to advance support when it comes to financial and institutional aspects for the overseas expansion of quality broadcast content, in the aim of creating a platform for expanding the scale at which Japanese products and services are deployed overseas.

The MIC is also promoting initiatives conducive to strengthening broadcast networks, such as extending radio services to areas where such services have been unavailable, and disaster protection measures for broadcasting facilities, so as to be able to properly provide the public with disaster information and the like via broadcasts in the future, with this focused primarily around radio, which has been recognized as being particularly useful during earthquakes.

In addition, in January 2014 it launched the Investigative Commission for Subtitles in the Age of Smart TV, which is moving forward with examinations of policies geared towards offering subtitles in multiple languages via smart TV and disseminating subtitled commercials.

Annex C: Press release DoCoMo on NOTTV termination

NTT DOCOMO, INC.
President and CEO: Kaoru Kato
Tokyo Stock Exchange: 9437
New York Stock Exchange: DCM
November 27, 2015

Termination of "NOTTV" Multimedia Broadcasting Service

NTT DOCOMO, INC. (hereinafter, "DOCOMO") announced today that the "NOTTV" multimedia broadcasting services for smartphones operated by its subsidiary, mmbi, Inc. (hereinafter "mmbi",) will be discontinued effective June 30, 2016.

mmbi started "NOTTV"—the first-of-its-kind broadcasting service in Japan tailored for smartphones, to allow users to enjoy variety of video content services anytime, anywhere via smartphones or tablet devices, and DOCOMO had accepted subscription applications at docomo Shops and other points of sale from April 2012.

However, with the number of "NOTTV" subscriptions falling short of plan due to the increased popularity of video distribution services for smartphones over the internet and the like in the recent years, we concluded that it was difficult to continue the business and decided on its termination.

Following this announcement, we will stop accepting new applications for "NOTTV" service.

For existing "NOTTV" service users, DOCOMO is preparing various programs that will allow them to use DOCOMO services, such as "dTV," with certain privileges. Further details of the programs will be announced separately on DOCOMO's web site at a later date.

For further information, please contact:
Investor Relations Department
Tel: +81-3-5156-1111

About NTT DOCOMO
NTT DOCOMO provides innovative, convenient and secure mobile services that enable smarter living for each customer. The company serves over 67 million mobile customers in Japan via advanced wireless networks, including a nationwide LTE network and one of the world's most progressive LTE-Advanced networks. DOCOMO is a leading developer of a 5G network that it plans to deploy by 2020, as well as network function virtualization (NFV), NFC infrastructure and services, emerging IoT solutions, and more. Outside Japan, the company is providing technical and operational expertise to seven mobile operators and other partner companies, and is contributing to the global standardization of all-new mobile technologies. DOCOMO is listed on stock exchanges in Tokyo (9437) and New York (DCM). Please visit www.nttdocomo.co.jp/english.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