Deployment Strategies for Digital Radio Services in Thailand

NBTC/ITU Project on Roadmap Development for Digital Terrestrial Radio Roll-out in Thailand

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This report has been prepared by International Telecommunication Union (ITU) experts Les Sabel and Peter Walop. 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 the development of a deployment strategy for digital radio services in Thailand, carried out in the period July 2015 till June 2016.

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Content

Introduction

In this Introduction the Thai digital radio broadcasting objectives, the non-existence of a 'Digital Dividend' and the other ITU digital radio deliverables are addressed. Also the report purpose and structure are outlined in this Introduction.

Digital radio broadcasting in Thailand

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). It provides clear objectives for the introduction of DSB in Thailand, including:

1. Provide a DR transition plan (i.e. DR Roadmap) within two years (by April 2014);
2. Have DR licensing procedures within three years (April 2015);
3. Have broadcasters start DR services within four years (April 2016) and have them cover at least 80% of the number of households in main cities within five years (April 2017);
4. Have (DR) Facilities and Network licensing procedures within two years. Network and Facility database to be ready within two years for facilitate infrastructure sharing (Apr 2014).

Also in Thailand's Digital Economy Plan (2016-2018), the introduction of digital radio broadcasting is included. Strategy no. 1 in this Plan says that infrastructure for digital radio broadcasting services should be introduced within three years.

No Digital Dividend

From a global perspective, the introduction of digital broadcasting technologies is also promoted, most notably by the ITU. Digital television and radio broadcasting technologies are more spectrum efficient. More services can be delivered in the same amount of spectrum or spectrum can be freed-up for other applications and technologies. The latter was a prominent driver of the introduction of digital terrestrial television broadcasting (DTTB) across the world. As this introduction would allow for the introduction of International Mobile Telecommunications (IMT)[1] in the freed-up spectrum in the UHF Band. This freed-up spectrum was commonly referred to as the 'Digital Dividend'.

However, it is important to note that such a Digital Dividend is not present when addressing the introduction of digital radio in the VHF Band and ultimately the discontinuation of analogue radio services in the FM Band. To date there are no alternative allocations for the freed-up spectrum when analogue television broadcasts will be discontinued in the VHF spectrum, other than digital television and radio broadcasting services. Moreover, if analogue radio services in the FM band will be discontinued, because they are replaced by digital broadcasting, there are to date no alternative allocations for this freed-up spectrum in the FM band either.

[1] More commonly referred to as LTE (Long-Term Evolution) or 4G mobile communications.

Earlier deliverables

The ITU and NBTC agreed in their Voluntary Contribution Agreement the project scope, objectives and expected results for helping the NBTC in pursuing their strategic objectives for DSB. Prior to the development of the deployment strategies the ITU delivered the following reports:

1. Considerations on Available DAB+ Capacity in Thailand, dated 22 November 2013;
2. DAB+ Services & Planning Requirements, dated 21 February 2014;
3. Roadmap for the Introduction of Digital Terrestrial Radio Services in Thailand: Plan A and B, dated 28 February 2014;
4. Local and Regional Areas for Digital Radio, dated 25 April 2014;
5. DAB+ System Architecture Design for Thailand, dated February 2015;
6. DAB+ Cost Assessment: CAPEX cost model, dated February 2015.

Additional deliverables

Further support was provided to the NBTC by a third party frequency planning company to plan the required DAB+ networks. This planning work provided insights into (a) the network topology and site characteristics for providing network coverage in 5 municipality cities (i.e. the Trial plan) and (b) a network topology for the National services and (c) a frequency arrangement for National and Local services in 39 defined local areas.

An ITU review of the third party's planning work was carried out in the period August to December 2015. This **frequency planning review** led to changes to the Trial and National frequency plans. These changes have been incorporated in this report.

In the period September to November 2015, an extensive **benchmark study** was carried out by the ITU, covering an in-depth analysis of the deployment strategies used around the globe and more specifically in four leading countries (i.e. Australia, Norway, Switzerland and the UK). It covers both industry measures and cooperation as well as applied licensing frameworks and measures taken by the regulator/Government to support the development of digital radio market. The benchmark study results were presented to the NBTC in November 2015.

In addition to the work Chulalongkorn University carried on the valuation of digital radio services in Thailand, a more **detail valuation model** was developed for DAB+ services in Thailand. This model incorporates the DAB+ system Architecture Design and the CAPEX model as mentioned above. The revenue (and OPEX) side was modelled on the basis of the above benchmark results. The model calculates the Net Present Value of projected cash flows for different deployment scenarios. This NPV model was presented to the NBTC in November 2015.

For developing the proposed deployment strategies radio broadcasters, equipment suppliers and car manufacturers were interviewed. These **industry interviews** were carried out in the periods 18 – 22nd of January and 9 – 26th of May 2016. On the 27th of May 2016 a **public consultation** meeting (focus group meeting) was organised by the ONBTC and ITU to collect additional feedback from the industry. The lists of the visited companies and public consultation participants are included in Annex A, as well as the main observations from the company visits.

The proposed deployment strategies included in this report build mainly on the results from these abovementioned additional deliverables.

Report purpose and structure

The purpose of this report is to provide deployment strategy options, for the NBTC to consider when formulating its licensing regime. The strategy covers the short (i.e. the Trial) and long term (i.e. the National and Local services). It is assumed that the NBTC has the intention to launch DAB before the end of their current term (i.e. September 2017). Formulating such a comprehensive strategy will provide clarity for industry parties wishing to invest in the radio market in Thailand.

This report is structured as follows:

1. Strategy inputs;
2. Trial service deployment and licensing;
3. National and Local service deployment and licensing;
4. Regulatory impact assessment;
5. Conclusions and recommendations;

Glossary of Abbreviations;
Annex A: List of visited companies and key observations;
Annex B: Outputs of valuation scenarios;
Annex C: Summary of FM congestion analysis;
Annex D: Radio market structure and revenues;
Annex E: LRIC model;
Annex F: Key advantages of DAB+ for Thailand.

Note

In this report the term "T-DAB" is used to refer in general to Digital Terrestrial Audio Broadcasting with the T-DAB system referred to as "System A" in ITU-R[2]. The term "DAB+" is used when the T-DAB system is meant that uses AAC audio compression and Equal Error Protection (EEP).

[2] See Recommendation ITU-R BS.1114 "Systems for terrestrial digital sound broadcasting to vehicular, portable and fixed receivers in the frequency range 30-3 000 MHz".

1. Strategy inputs

This Chapter describes which inputs and principles were considered when formulating the deployment strategies. As stated in the Introduction the following specific and additional activities and deliverables were produced to facilitate the development of the strategies:

1. DAB frequency planning review;
2. International benchmark study;
3. Detailed valuation model.

In the following sections a concise overview of the above listed inputs is provided. For more detailed information, please refer to the relevant documents. References to these documents can be found in the subsequent sections.

1.1 DAB frequency planning review

As said in the Introduction a third party planned the required DAB+ networks. This planning work provided insights into (a) the network topology and site characteristics for providing network coverage in 5 municipality cities (i.e. the Trial plan) and (b) a network topology for the National services and (c) a frequency arrangement for National and Local services in 39 defined local areas[3].

An ITU review of the third party's planning work was carried out in the period August to December 2015. For the Trial frequency plan an alternative frequency plan was developed. For the National and Local services, the verification process showed that the presented frequency plan was not optimal.

1.1.1. Trial frequency planning review

NBTC defined the following principles for the verification of the T-DAB plan in the trial phase[4]:

1. T-DAB, using the DAB+ system variant;
2. Portable indoor reception;
3. Eight T-DAB transmission sites with three multiplexes (covering 11 cities);
4. Protection of analogue TV (system B/PAL with a single sound carrier) by T-DAB;
5. For information also without protection of analogue TV;
6. Application of internationally accepted planning parameters and best practises.

Potentially the T-DAB frequency blocks in channels 5, 7, 9 and 11 are available in areas where analogue TV channel group V2 (channels 6, 8, 10, 12) is used. In the same way, potentially T-DAB frequency blocks in channels 6, 8, 10 and 12 are available in areas where analogue TV channel group V1 (channels 5, 7, 9, 11) is used. According to these principles the analogue TV and T-DAB channel arrangement is illustrated in Figure 1.

[3] See reports "Practical Principle and Technical Standards for DAB+ Trial Planning", dated 11 May 2015 and "Practical Principle and Technical Standards for DAB+ National and Local Planning", dated 11 May 2015.

[4] For the full report please refer to ITU report "Results of the verification of the T-DAB plan in the trial phase", dated 28 October 2015.

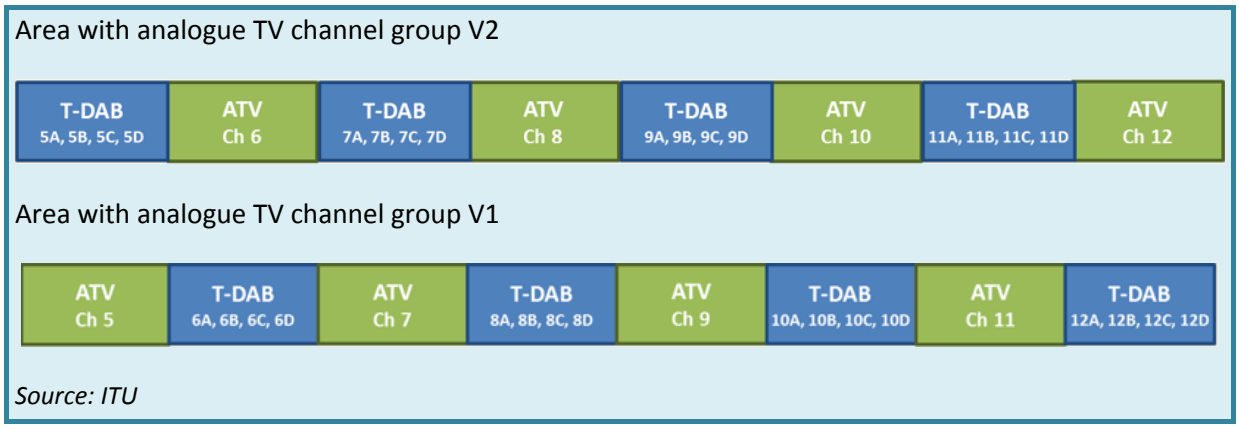


FIGURE 1: ANALOGUE TV AND DAB CHANNEL CONFIGURATION

Because of this alternating ATV channel arrangement in the VHF Band III, as illustrated in Figure 1, a national DAB deployment in a Single Frequency Network (SFN) is not possible before an ASO in this band. Currently all incumbent ATV broadcasters, except TPBS, (i.e. Channel 3, 5, 7, 9 and 11), use VHF spectrum. The complete ASO in this band is expected to be in 2020. By this time only Channel 7 has still a running concession contract (which lasts till 2023). It is however unlikely that by 2020 Channel 7 would still continue to operate their VHF sites as the only broadcaster. It is noted that with a partial ASO before 2020, it may be possible to commence a national deployment of a limited number of multiplexes (one or two) in those areas where VHF sites have been switched-off.

In addition to the above channel arrangement, the available spectrum for DAB services is restricted in two other ways in Thailand:

1. VHF, Band III, channels 5 to 11 (i.e. channel 12 is not available for DAB services);
2. In coordination zone with Malaysia only channels 6, 7, 9 and 12 are available in accordance with the coordination agreement.

At the time that the T-DAB plan for the trial phase was prepared by the third party, it was expected that the final phase with a national T-DAB coverage would follow soon. It was therefore required that the T-DAB transmitters in the trial phase continue to operate in the final phase (i.e. when the National and Local services will be introduced) without frequency changes. Currently it is unclear when the final phase will start. The requirement to operate the same frequency in the trial phase and in the final phase was therefore withdrawn by NBTC.

Cancelling the requirement for frequency continuity has a number of advantages in the trial phase such as:

1. Using T-DAB station Nakhon Ratchasima, with potentially odd numbered-DAB channels in the trial phase and channel 8 planned in the national network in the final phase;
2. Assigning different channels to the T-DAB stations where channels in the current plan gives adjacent channel interference to analogue TV;
3. Assigning frequency block C in three different channels to obtain equal coverage per multiplex, because the ERP on blocks A, B and D is much more restricted.

Cancelling the frequency continuity requirement and applying a different set of planning parameters and methodology, resulted in alternative frequency plans for the Trial phase. In Table 1, an overview is provided of the main characteristics of the two alternative ITU plans (respectively for protecting and not protecting ATV coverage) and the third party frequency plan for the Trial phase. The last column is added to compare the alternative frequency plans on the basis of each having five sites.

Item	Third Party	ITU		
ATV channels	7, 8	5-11	5-11	5-11
# Sites	5	8[1]	8	5
MUX	1-3	1-3[2]	1-3	1-3
SFN	SFN identified[3]	SFN applied[4]	SFN applied	NA
ATV protection	?	√	X	√
ATV coverage provided	X	√	√	√
Pop coverage (3 MUX)	5,736,251[5] (9%)	9,123,000[6] (14%)	17,422,000[7] (27%)	8,431,000[8] (13%)
Pop coverage (2 MUX)	-	10,712,000 (16%)	17,965,000 (28%)	9,873,000 (15%)
Pop coverage (1 MUX)	-	11,894,000 (18%)	18,560,000 (29%)	10,624,000 (16%)
Total ERP / #TX (3 MUX)	255 kW / 15	88 kW / 23	240 kW / 24	61 kW / 15
Range ERP	0.5 - 50 kW*	0.1 - 10 kW	10 kW	0.1 - 10 kW

(1) = Chonburi, Hua Hin, Nakhon R are the 3 additional sites as compared to third party plan
(2) = with the exception that Song Khla DAB station has only 2 ATV compatible MUX available.
(3) = Option identified between BKK and Hua Hin, Chonburi (if implemented)
(4) = Applied between BKK and Chonburi
(5) = Hybrid (20 dB+ in BKK, rest 10-20 dB) – see Table 7 in third party report
(6) = Table 14 in ITU report. HH size = 65m pop/22 HH ~ 2.9 (9,123,000 = 3,145,863*2.9)
(7) = Table 16 in ITU report. (17,422,000 = 6,007,587*2.9)
(8) = Table 14 in ITU report. Chonburi, Hua Hin and Nakhon R removed = 2,907,269 HH = 8,431,000 pop

(*) = ERP is maxed at 50 kW, 3 Transmitters have permissible powers > 50 kW

TABLE 1: ALTERNATIVE FREQUENCY PLANS FOR TRIAL PHASE[5]

In this report the deployment strategy for the Trail is based on the ITU frequency plans as included Table 1 and described in detail in ITU report on the verification of the T-DAB plan in the Trial phase[6].

[5] Data derived from to ITU report "Results of the verification of the T-DAB plan in the trial phase", dated 28 October 2015.

More specifically the site characteristics of the ITU Trial frequency plans are used to model the CAPEX in the DAB valuation model (see Section 1.3).

1.1.2. National and Local frequency planning review

The ITU verification process showed that the T-DAB Plan for National and Local services (developed by the third party) was not optimal because of[7]:

1. The relative low household coverage compared to alternative network topologies with the same number of sites;
2. Serious self-interference in the coverage of the national and regional SFNs;
3. Serious co-channel interference between regional SFNs;
4. A procedure for adding stations to increase coverage (the so-called "Channel Allotment Plan") that does not ensure compatibility with the entries in T-DAB Plan and between the added stations.

It was therefore recommended to develop a revised plan, taking into account the planning parameters included in the report. Also such a plan revision should take into account the guidelines and recommendations provided in the report. In the development of the T-DAB Plan for National and Local services careful attention should be given on the one hand to resolve self-interference and co-channel interference and on the other hand to achieve the required coverage target.

As stated above, the ITU provided alternative network topologies for reaching the 95% population or household coverage target. Table 2 provides an overview of the different network topologies. The table also includes the third party's proposed topology. However, the associated household coverage was calculated by the ITU team with a different set of planning parameters and methodology[8].

#	Number of sites	Example network topology	ERP	Mean ERP per site	Household coverage	Remaining HH to reach 95%	Household coverage %
1	200	T-DAB Plan third party	1 kW to 50 kW	13.3 kW	20,598,811	1,096,167	90.2%
2	171[9]	DTTB topology	All sites 10 kW, except Bangkok 20 kW	10.1 kW	21,291,221	403,757	93.2%
3	200	DTTB topology plus 29 additional non-	All sites 10 kW, except Bangkok 20 kW	10.1 kW	21,863,987	-169,009	95.7%

[6] See footnote 4.

[7] For the full report please refer to ITU report "Results of the verification of the T-DAB plan in the final phase", dated 18 January 2016.

[8] It is noted that the third party calculated the household or population coverage on this topology to be between 51.85 and 54.00%, see table 4 in report "Practical Principle and Technical Standards for DAB+ National and Local Planning", dated 11 May 2015.

[9] It is noted that this number is the number of planned sites at time of the DTTB frequency planning work (2015). The number of DTTB sites may change during the actually deployment (as some sites cannot be implemented or the population changes).

#	Number of sites	Example network topology	ERP	Mean ERP per site	Household coverage	Remaining HH to reach 95%	Household coverage %
		existing sites					
4	200	70% of the DTTB sites and 31% of additional sites replaced by DAB, FM, ATV or telecom sites	All sites 10 kW, except Bangkok 20 kW	10.1 kW	21,824,153	-208,843	95.6%
5	225	DTTB topology plus 54 additional non-existing sites	All sites 10 kW, except Bangkok 20 kW	10.0 kW	21,978,392	-283,414	96.2%

TABLE 2: ALTERNATIVE NETWORK TOPOLOGIES FOR THE NATIONAL SERVICES

Table 2 shows that the household target of 95% can be reached with 200 sites[10]. Only network topologies number 3 and 4 (blue shaded rows) are considered in this report and more specifically for the assessing the CAPEX for National and Local network deployments (see Section 1.3.3). Network topology number 3 includes 29 non-existing sites (and hence these towers have to be build) and topology 4 is based on existing towers only.

The required number of sites for coverage targets below 95% was also further investigated on the basis of the DTTB topology. In order to give an impression of the portable indoor coverage as a function of the numbers of sites, Table 3 shows the noise limited coverage with portable indoor reception for different number and type of sites out of the DTTB network topology (see network topology 3 in Table 2).

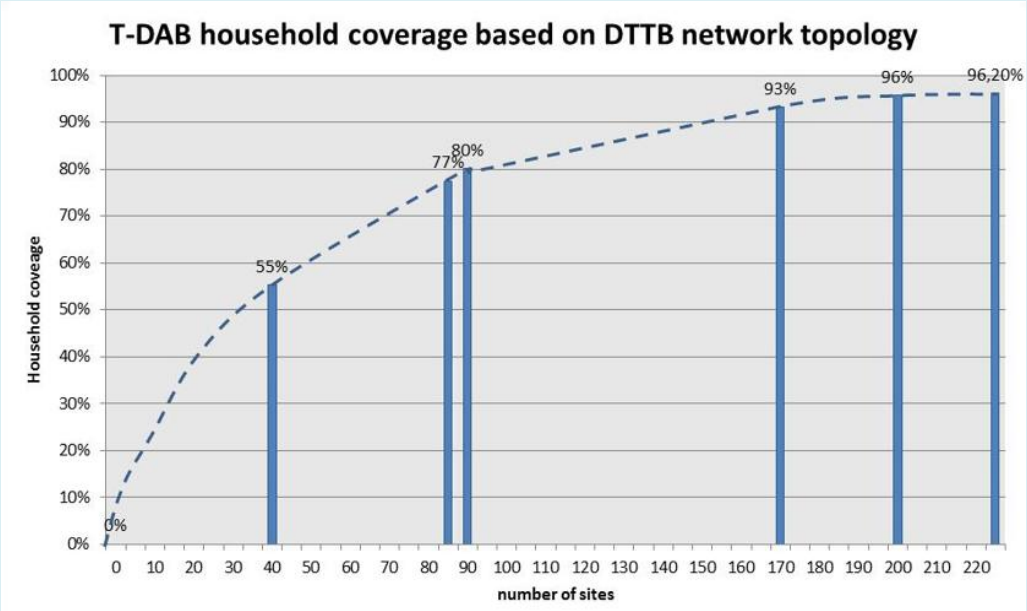
Number of type of DTTB sites	Total number of sites	Household coverage	Difference per step
39 M	39	55.2%	55.2%
39 M+ 45 A1	84	77.4%	22.2%
39 M+ 45 A1 + 6 A2	90	80.1%	2.7%
39 M+ 45 A1 + 38 A2 + 49 A3	171	93.2%	13.1%
39 M+ 45 A1 + 38 A2 + 49 A3 + 29 additional sites	200	95.7%	2.5%
39 M+ 45 A1 + 38 A2 + 49 A3 + 54 additional sites	225	96.2%	0.5%
Notes: M = Main site A1 = Additional site, existing broadcasting tower			

[10] It is noted that the included coverage percentages as included in Table 2 are noise limited. However, it assumed that in the detailed planning work, interference can be resolved to a large extend. Please refer to the full report (as referred to in footnote 7) for details on how different types of interference can be resolved

Number of type of DTTB sites	Total number of sites	Household coverage	Difference per step
A2 = Additional site, existing telecom tower A3 = Additional sites, no tower (new location)			

TABLE 3: T-DAB COVERAGE AS FUNCTION OF THE NUMBER OF SITES

T-DAB household coverage as function of the number of sites, based on Table 3, is illustrated in Figure 2.



Source: ITU

FIGURE 2: T-DAB COVERAGE (NOISE LIMITED) AS FUNCTION OF THE NUMBER OF SITES

In this report an alternative scenario is considered on the basis of 90 sites providing approximately 80% household coverage (see Section 1.3.3).

1.2 International benchmark study

The international benchmark study covered four leading DAB countries; Australia, Norway, Switzerland and the United Kingdom (UK)[11]. In order to develop a deployment strategy for Thailand a comprehensive analysis of the key components of deploying digital radio services is required. The benchmark study covered those key components from both a general perspective to describe the various options available as well as overviews of how digital radio services were developed and deployed in the covered countries.

[11] For the full report please refer to ITU report "International Benchmarks for DAB+ Digital Radio Deployment", dated December 2015.

Amongst other areas, the key areas explored in the study included[12]:

1. Broadcaster landscapes;
2. Licensing frameworks;
3. Operating and funding models;
4. Business drives and incentives.

1.2.1 Broadcaster landscapes

A summary of each country's status (as of November 2015) on the development of digital radio services is provided in Table 4.

Aspect	UK	Norway	Switzerland	Australia
Population	64.1m	5.1m	8.1m	23.1m
Listening				
Public	53%	66%	66%	23%
Commercial	44%	31%	29%	75%
Community	3%	3%	5%	2%
DAB launch	1995	1995	1999	-
DAB+ launch	2015	2010	2008	2009
Services	415	108	129	189
Population covered	95%	99.5%	99%	63%
% DAB/DAB+ listening	26.4% All digital=50.9% of households	36% All digital=58% of households	45% of population	24.6% of population
Receivers sold (non-vehicle)	20.7m	1.4m	2.0m	1.9m
Vehicles with line fit DAB/DAB+	4.2m	600k	305k	277k
% new vehicles with DAB/DAB+	70%	65%	60%	22%

TABLE 4: SUMMARY TABLE OF TARGET COUNTRIES' PROGRESS

In this report the digital radio uptake figures are used to model the uptake in Thailand. More specifically the uptake of Australia is used as this is the most recent launch of the digital radio services.

[12] Two more areas were explored; Marketing and Support Organisations. For more information on these areas please refer to the full report (see footnote 11).

1.2.2 Licensing frameworks

A summary of the applied licensing frameworks for digital radio services across the four selected countries is provided in Table 5.

Aspect	UK	Norway	Australia	Switzerland
Regulator	Ofcom	NMA	ACMA	OFCOM
Spectrum license holders	Multiplex operator (e.g. Digital One), broadcasters and broadcaster consortiums	Multiplex and transmission provider (e.g. Norkring), broadcasters and broadcaster consortiums	Broadcasters through JVC Multiplex operators	OFCOM holds the spectrum license and issues Broadcast licenses to deliver content via multiplexes
License period (years)	12	NA	15	NA
License application process	Beauty contest	Applications for new multiplexes through the NMA	Regional licencing is under review	Applications for new multiplexes through the OFCOM
Access fees	Set by multiplex operator	Set by multiplex operator	Set by JVC under ACCC guidelines	Set by multiplex / transmission provider
ASO	Decision expected in 2016-17	Planned for 2017	No plans	Phased approach from 2020 to 2024

TABLE 5: LICENSE FRAMEWORK SUMMARY

The licensing frameworks as summarised in Table 5 are used in this report to develop a licensing framework for Thailand (see Section 2.4 and 2.5). The Australian model comes closest to the current licensing practice in Thailand. The Australian broadcasters or service providers jointly hold the spectrum rights. This is similar to the Thai situation where the Service license, which is assigned to the service provider (or broadcaster), includes the spectrum rights.

1.2.3 Operating and funding models

Table 6 shows an overview of the operating models as applied in the four benchmark countries.

Characteristic	Operating Model				
	1. Transmission provider (pure service provision)	**2. Mixed**	**3. Mixed 2**	**4. Mixed 3**	**5. Broadcaster**
Spectrum ownership / license	3rd Party – transmission provider	3rd party – multiplex provider	Broadcaster / JVC	Broadcaster / JVC	Broadcaster / JVC
Broadcaster license	Broadcaster / content provider	Broadcaster / content provider	Broadcaster / content provider	Broadcaster / content provider	Broadcaster / content provider

Characteristic	Operating Model				
Tower	3rd Party	3rd Party	3rd Party	3rd Party	Broadcaster / JVC
Antenna	3rd Party	3rd Party	3rd Party	3rd Party	Broadcaster / JVC
Transmitters	3rd Party	3rd Party	3rd Party	JVC	Broadcaster / JVC
Distribution NW	3rd Party	3rd Party	3rd Party	JVC	Broadcaster / JVC
Ensemble multiplexer	3rd Party	3rd Party	JVC	JVC	Broadcaster / JVC
Studio equipment and contribution NW	3rd Party	3rd Party/ Broadcaster	Broadcaster	Broadcaster	Broadcaster
Configuration Control	3rd Party	Broadcaster	Broadcaster	Broadcaster	Broadcaster

TABLE 6: APPLIED OPERATING MODELS

In this report the operating models as included in Table 6 are considered. More specifically when developing proposals for licensing procedures in Thailand (see Section 2.4.2). It should be noted that the operating model is closely related to the funding model applied. Hence a choice for an appropriate operating model cannot be considered in isolation from the funding model.

There are two main funding options, for the three different types of broadcasting services (Public, Commercial and Community), with some minor variations between countries:

1. Public funds;
2. Private funds, including private investments and advertising income.

Table 7 shows the funding of public radio services across the four benchmark countries.

Country	Organisation	Funding Source	Comments
UK	BBC	TV license fees Commercial licencing of content through BBC Worldwide	 Approx. 20% of total income
Norway	NRK	TV license fees	
Australia	ABC	General revenue	No separate TV license is charged
Australia	SBS	General revenue plus advertising	No separate TV license is charged
Switzerland	SSR SRG	TV license fee	

TABLE 7: FUNDING OPTIONS FOR PUBLIC RADIO SERVICES

Public radio services are either fully funded by public funds or have a mixed model including advertising income (see Australia). Commercial radio services are always solely funded by private

investments and advertising income. Community services are funded in different ways, including Government subsidies, advertising income and contributions.

The report considers these different ways of funding digital radio services (see Section 2.3.2).

1.2.4 Business drivers and incentives

In most countries with a mature DAB industry there have been a number of incentives and penalties built into the general regulating/licencing/operating framework to encourage the establishment and ongoing operation of digital radio. This is generally with a view to analogue radio switch off.

Example incentives include:

1. Free spectrum for initial services to build the platform, these licences may last until ASO;
2. License conditions on the extension of analogue licenses;
3. Moratoriums on new broadcasters i.e. Non-compete period;
4. The option to purchase additional capacity once the initial allocation is completed;
5. Full or part funding by Government, or a license fee rebate to fund the transition;
6. Digital Dividend through alternative uses for analogue licenses when they are released.

While it is essential to encourage the establishment of digital radio with incentives it is arguably more important to ensure that there is a positive business model for the broadcasters. That is a business model which will improve their business in one or more ways, for example:

1. Long term business viability;
2. Reduction in operations costs;
3. New features to add or retain listeners and enhance competitive edge relative to other technologies and mediums;
4. Added value to current and new content.

The above mentioned business drivers and incentives are considered in this report when developing options for Thailand. More specifically when developing licensing assignment procedures and license terms and conditions (see Section 2.4 and 2.5).

1.3 Detailed valuation model

A valuation model was developed on the basis of:

1. The network architecture design for the Trial and the final phase (National and Local services)[13];
2. The associated CAPEX model for the Trial and the final phase[14];
3. The reviewed frequency plans for the Trial and the final phase (see Section1.1);

[13] See report "DAB+ System Architecture Design for Thailand", dated February 2015.

[14] See ITU report "DAB+ Cost Assessment: CAPEX cost model, dated February 2015.

4. The benchmark study results (see Section 1.2).

1.3.1 Key assumptions

The valuation model is based on a 14 years (twice a 7-years license period) free cash flow (FCF) projection. In the FCF projection the following key assumptions are made:

1. The network architecture is deployed as described in the network design report which implies:
   a) All DAB services (National and Local) share the same antenna system and associated facilities (including towers, power supplies, housing, etc.);
   b) Local services are not deployed before National services;
   c) National services share a single multiplex centre;
   d) Each local area has a single multiplex centre;
   e) The distribution network (comprising satellite and microwave links) is shared between all services;
   f) The redundant equipment is deployed as described in the network design report and follows the included redundancy rules (e.g. a redundant transmitter is shared between all services);
2. The equipment is purchased against the benchmarked prices as included in the CAPEX model and subsequently depreciated (without remaining value) over commonly applied economic life spans;
3. The model assumes an existing analogue radio business and consequently the CAPEX and OPEX are the marginal costs for an existing player (e.g. existing FM/AM content costs are not included in the model). The same applies for the revenues. The model includes only the additional DAB revenues, generated by offering these digital radio services next to analogue radio services;
4. The costs for service and network provisioning are integrated in a single cash flow statement. Hence no profit margin is assumed in the transaction between the service provider (i.e. the radio broadcaster) and network operator. This profit margin is generally applied over the OPEX component. The model does apply a Weighted Average Cost of Capital (WACC) over the CAPEX component;
5. No subsidies or other public financial contributions are included in the model. Hence this model provides insight into the commercial viability of the DAB services and whether commercial investors would be interested in investing.

1.3.2 Dashboard

Figure 3 shows the dashboard of the valuation model and shows what key parameters can be changed to run the different network and service deployment scenarios[15]. Next to the parameters on

[15] For more details on the Network deployment (CAPEX) dashboard please refer to ITU report "DAB+ Cost Assessment: CAPEX cost model, dated February 2015.

the dashboard, more detailed parameters can be changed in the subsequent worksheet of the model (all marked in yellow).

Network deployment (CAPEX) Dashboard

		Pop coverage	
Frequency Plan	T2 National	80%	52,000,000
Total # sites	90	parameter should be "ITU Trial" when Trial	
Number of National MUX (layer)	2		
Number of Local MUX (layer)	1	parameter should be "0" when Trial	
Number of Local areas	39		
# audio services in national ensemble	18		
# audio services in local ensemble	18	parameter should be "0" when Trial	
% greenfield sites	0%	parameter should be "0" when Trial	
	National	**Local**	
Redundant encoder	no	no	
Redundant multiplexer	yes	yes	
Redundant distribution	no		
Redundant transmitter	no		

OPEX and Revenue Dashboard (NA for Trial)

	National	Local	
DAB only serivces (% of total number of services)	50%	50%	
NBTC licence fees (% of DAB revenues)	4%		
Radio ADEX growth rate (= forecasted GDP growth %)	2%		
DAB critical listening share (% of total market)	10%		
ASO for FM (Yes/No)	y		
FM ASO announcement year		2029	FM ASO year
DAB National/Local revenue split (% National)	85%	Allocate % to National!	
WACC	12%		

Source: ITU

FIGURE 3: VALUATION MODEL DASHBOARD

For the OPEX and Revenue Dashboard the following parameters can be entered[16]:

1. A percentage for the DAB-only services: a percentage of 50% implies that for each existing analogue service a DAB-only service is produced. This parameter will drive the DAB content production costs;
2. NBTC license fees: the commonly applied percentage is 2+2%. This can be changed to, for example, 0%. This parameter will drive the overall cost level;
3. A percentage of the Radio Advertising Expenditure (ADEX) forecasted growth rate over the total planning horizon (i.e. 14 years). The ADEX growth rate is assumed to be equal to the

[16] Please note that this part of the dashboard is not relevant for the Trial as the Trial only spans a limited period (much smaller than 14 years) and has a very limited network coverage. Consequently, the projected revenues and the calculated Net Present Value have no meaning.

GDP growth of Thailand. This parameter will drive the DAB revenues as the DAB revenues are a percentage of the total radio ADEX;

4. A percentage for the DAB critical listening share as percentage of the total market. A DAB listening share below this percentage will result in no DAB revenues in that particular year. This phenomenon is explained by advertisers only being interested in advertising on a new platform when that platform has exceeded a critical mass (i.e. the critical listening share). This parameter drives the DAB revenues;
5. Analogue Switch-Off for (a part of) the FM services. ASO cannot be modelled before the first 7 years of the planning horizon. The date of the ASO announcement and the actual ASO date can be modelled. The model assumes that between the ASO announcement and ASO date the FM market share is reduced to zero and that this market share loss is gained by the DAB platform. This model drives the revenues for DAB in the last 7 years of the planning horizon;
6. A percentage of the total DAB revenues to be allocated to National services. Consequently, this parameter will also determine the remaining DAB revenues for Local services. This parameter is meant to model the 'long tail' character of radio revenues[17]. An entered percentage of for example 85% results in 15% of DAB revenues being allocated to the Local services. These revenues are then equally shared between the number of Local service providers (as modelled under certain scenarios, see the number of local multiplexes, the number of services per multiplex and the number of services per service provider in the model). The same applies for the nationally allocated DAB revenues; they are equally shared between all National service providers in the model;
7. A percentage for the WACC. The WACC reflects the required compensation for private investors in the DAB services. The WACC drives the Net Present Value. The higher the WACC the lower the NPV for the same projected FCFs. For the DTTB services in Thailand the NBTC prescribed a WACC of 12% (for determining the DTTB transmission fees).

In Figure 4 the output windows of the value model are depicted (when entering the parameters as shown in Figure 3).

[17] See ITU report "Roadmap for the Introduction of Digital Terrestrial Radio Services in Thailand", dated 28 February 2014, Section 2.1.4.

CAPEX Output

SP	NATIONAL	LOCAL
CAPEX/SP	$24,600	$24,600
Total SP CAPEX	$442,800	$8,634,600
Total CAPEX all SPs	$9,077,400	

NO	NATIONAL	LOCAL
	per MUX	per MUX per LA
Head-end	$122,450	$159,050
Distribution	$2,806,800	$46,931
Transmission	$17,106,973	$438,640
Total	**$20,036,223**	**$644,621**
	all national MUXs	All local MUXs
Total NO CAPEX	$40,072,447	$25,140,223
Total CAPEX all MUX	$65,212,670	
	check = ok	

NPV Output (NA for Trial)

NPV Total market	-$297,557,588
NPV per National SP	$11,411,848
NPV per Local SP	-$1,000,720

Source: ITU

FIGURE 4: OUTPUT WINDOWS OF THE VALUATION MODEL

In the Net Present Value (NPV) Output window the following can be read[18]:

1. The NPV for the total market: this value reflects the value of all DAB services in the market. Revenues are not split between National and Local services and all CAPEX and OPEX are aggregated. A positive NPV would theoretically imply that a private investor would invest (as a NPV of nil results in the investor getting its required compensation, namely equal to the entered WACC %);
2. The NPV per National SP: this value reflects the value of the Service license held by a single National Service Provider. This Service license may include more than one service (for example one existing analogue and one DAB-only service). As said, the nationally allocated revenues are equally split between all National SPs in the model. CAPEX is either directly allocated to each National SP or shared on the basis of the technical capacity claim. The CAPEX for Studios and Head-ends is directly allocated. For Distribution and Transmission, the CAPEX is allocated on the basis of the technical capacity claim of each National SP. The

[18] For more details on the CAPEX output window, please refer to the report as mentioned in footnote 14.

annual OPEX is a percentage of the CAPEX allocated to each SP. A positive NPV reflects a positive business case worthwhile investing in;

3. The NPV per Local SP: this value reflects the value of the Service license held by a single Local Service Provider. This Service license may include more than one service. As said, the locally allocated revenues are equally split between all Local SPs in the model. CAPEX is either directly allocated to each Local SP or shared on the basis of the technical capacity claim. The annual OPEX is a percentage of the CAPEX allocated to each SP. A positive NPV reflects a positive business case worthwhile investing in.

1.3.3 Base scenarios

In the valuation model a series of scenarios was modelled as to determine (a) what CAPEX is needed for the Trial and (b) what DAB deployment scenarios are financially viable (i.e. NPV positive). The following scenarios are included in this Section:

1. Trial services, carried over 2 multiplexes, on the basis of 5 and 8 sites (see also Section 1.1.1);
2. Only National services deployed, carried over respectively 2 and 3 multiplexes, on the basis of 200 sites and 90 sites (see also Section 1.1.2);
3. National and Local services, 2 National and 1 Local multiplex, on the basis of 200 sites and 90 sites.

Annex B: Outputs of valuation scenarios includes the following:

1. The Dashboard (as described in Section 1.3.2) for each scenario, showing the key parameters entered in the model and the resulting CAPEX and NPV[19];
2. The associated graphs for each calculated National and Local scenario, including:
    a. Listening shares over time;
    b. Cumulative FCF over time.

Trial scenarios

Table 8 shows the CAPEX results of the two Trial Scenarios. NO and SP stands for respectively Network Operations and Service Provisioning in Table 8.

Ref.	# sites	% greenfield sites	Pop %	# MUX	# SPs	CAPEX SP	CAPEX NO	Total CAPEX
T1	5	0%	15%	2	18	$442,800	$2,396,900	$2,839,700
T2	8	0%	16%	2	18	$442,800	$3,638,900	$4,081,700

TABLE 8: CAPEX RESULTS OF TRIAL SCENARIOS

National and Local scenarios

Table 9 shows the NPV results of the various National and Local service deployments.

[19] See footnote 16.

Ref.	# sites	Pop %	# MUX	# SPs	Total CAPEX	NPV total market	NPV / Nat. SP	NPV / Local SP
N1	200	95%	2+0	18+0	$84,702,880	$190,502,461	$10,583,470	NA
N2	90	80%	2+0	18+0	$37,973,880	$266,538,766	$14,807,709	NA
N3	200	95%	3+0	27+0	$131,831,770	$67,201,171	$2,488,932	NA
N4	90	80%	3+0	27+0	$59,252,770	$204,157,121	$7,561,375	NA
NL1	200	95%	2+1	18+351	$146,869,070	-$434,513,538	$6,710,995	-$1,149,838
NL2	90	80%	2+1	18+351	$74,290,070	-$297,557,588	$11,411,848	-$1,000,720

TABLE 9: NPV RESULTS OF NATIONAL AND LOCAL SCENARIOS

1.3.4 Key observations

When modelling different DAB deployment scenarios (e.g. different number of DAB only services, number of national and local multiplexes, population coverage, etc.) and calculating the Net Present Value a series of observations can be made:

1. The business case is very challenging and the NPV only shows positive values when the number of multiplexes does not exceed three National multiplexes, in combination with a population coverage target of 95% (200 sites) or 80% (90 sites). The model shows that the Thai radio ADEX market doesn't offer enough room for more DAB investments. In other words, any requirement to have more DAB multiplexes, in combination with a high population coverage target, will require strong financial support from Government;
2. Any addition of Local services will result in a negative NPV for the Local service providers. Consequently, local DAB services cannot be expected to be financed by the market at the start of the DAB deployment. Either Government financially supports an early deployment of local DAB services or waits till a critical mass of DAB listeners has been reached. But even in the latter case it seems doubtful whether a positive business case can be reached due to the 'long tail' character of the (radio) ADEX market; local/small stations collect very small proportions of the total radio ADEX market. It is noted that the remarks on the NPV of a Local layers applies to a full deployment in all 39 Local areas. A positive NPV may be possible if only in the most promising Local areas a network is deployed;
3. Initial DAB service licenses should be issued to incumbent radio market leaders only, as they will have the means to finance the DAB introduction out of their FM/AM profit margins in the years that the DAB services will not generate any ADEX (as DAB services have to first surpass the critical mass of listeners);
4. The requirement to produce and broadcast DAB only services should be (initially) set low and gradually migrate to "1-to-1". The latter meaning that for one simulcast service one DAB-only service should be offered. In this context it should be realised that the added value of DAB for Thailand is also to provide more nationwide services. Popular Bangkok radio services broadcasted on DAB will constitute a new radio service for a relative large proportion of the people;

5. The DAB Trial should be used to start building up critical mass of DAB listeners, as DAB ADEX cannot be expected to commence before this critical mass of listeners is reached. Building up critical mass will be challenging as the DAB Trial network comprises only 5 to 8 sites and was assessed to cover 15-16% of the total Thai population;
6. Trial listening data should be periodically and accurately collected. This data should be used to update and reassess the business case and NPV model, as well as finalizing the Service and Network license terms and conditions;
7. If the maximum number of multiplexes is limited to 2 for national deployment, the number of multiplexes in the Trial phase should be reconsidered, as the number of multiplexes for the Trial was initially set at three[20];
8. Waiving the NBTC license fees for the first 5 to 7 years can help launching commercial DAB services;
9. A license duration of 7 years is too short to make the cumulative cash flow positive, in any realistic scenario. Hence any DAB Service and Network license should be provided at least for a license period of 10 years or more. This could be facilitated by offering an initial Service license period of 7 years with an option to extent for another period of 7 years (unless the licensee is mal performing its duties). For the Network license a period of 10 to 15 years matches the average economic life of the DAB network better;
10. The NPV is critically dependent on radio ADEX growth. Growth percentage below 2% result in negative NPV values. Hence growth in DAB ADEX or alternative revenues should be encouraged by the regulator by:
    a. Allowing more (as compared to FM/AM) advertising opportunities on DAB, for example by allowing hybrid DAB whereby DAB content has IP interactivity for generating advertising or other income;
    b. Measuring periodically and accurately digital listening figures, and;
    c. Allowing DAB value added services to be explored (e.g. allowing flexible multiplex loading – e.g. for 'pop-up' services).

[20] See ITU report "DAB+ Services & Planning Requirements", dated 21 February 2014.

2. Trial service deployment and licensing

This Chapter provides a comprehensive overview of the decisions to be made on the different aspects of the digital radio deployment strategy for the Trial phase and what licensing framework accompanies such decisions.

The Trial service deployment includes the deployment of the DAB network, the digital radio services to be carried in the DAB multiplexes, as well as the supporting measures. For the licensing framework the assignment procedures and the digital radio specific license terms and conditions will be addressed. It should be noted that the assignment procedures not only include the assignment instrument but also the applied or envisioned operating model (between the different actors in the digital radio value chain).

When developing a Trial strategy, the phase after the Trial should be considered as a migration to full National and Local services. The decisions on the Trial have an impact on the operations and licensing of the National and Local services. Hence in this Chapter, where appropriate, the National and Local deployment strategies will also be addressed.

This Chapter is structured accordingly:

1. Network deployment;
2. Service deployment;
3. Supporting measures;
4. Assignment procedures;
5. License terms and conditions.

2.1 Network deployment

In this Section the following aspects of the DAB Trial network deployment are addressed:

1. Start of the Trial;
2. End of the Trial;
3. Number of sites;
4. Deployment speed.

2.1.1 Start of the Trial

Figure 5 shows an overview of the options and considerations. The option in red is the recommended option.

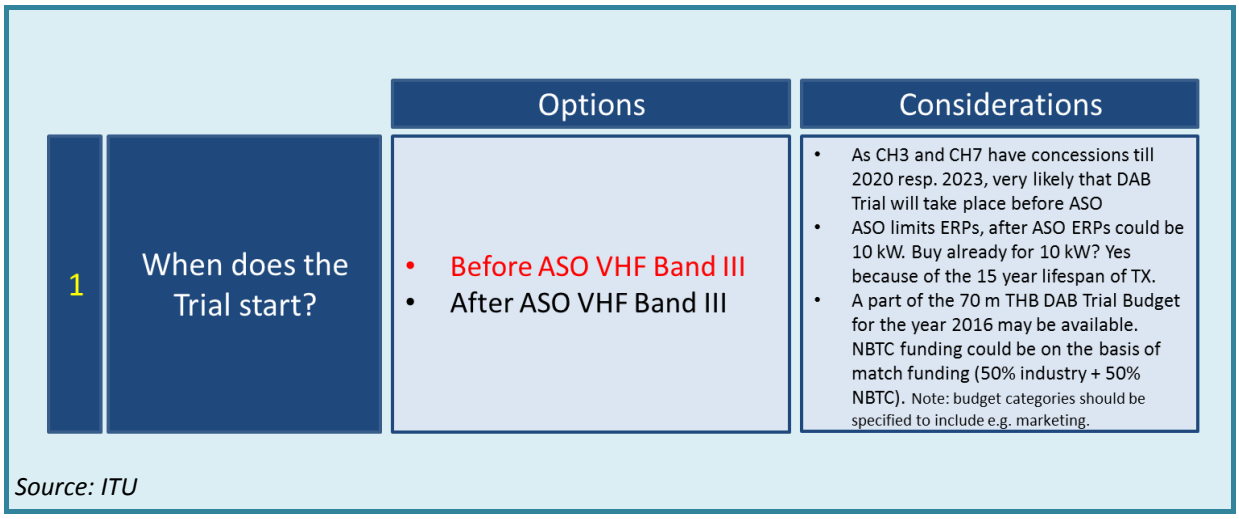


FIGURE 5: OPTIONS AND CONSIDERATIONS ON START OF THE TRIAL

Options

A frequency planning requirement is that DAB services will have to be introduced in the VHF Band III[21]. In this part of the spectrum ATV services are currently in use. Hence two options arise whether the Trial would start before or after ASO of these ATV services.

Considerations

ATV services Channel 3 and Channel 7 hold concession rights till respectively 2020 and 2023. As the NBTC has expressed the ambition to start the Trial before the current term of the NBTC (i.e. September 2017), the Trial is very likely to start before ASO. This has the following consequences:

1. The ITU frequency plan, protecting ATV services, should be applied (see Section 1.1.1);
2. ATV services have to be protected and hence the ERPs of the Trial sites are limited as compared to after ASO[22];
3. After ASO the ERPs can be increased to 10 kW (which is assumed to be a practical limit).

Recommendations

The following is recommended on the start of the Trial:

1. Plan and start the Trial on the basis of the ITU frequency plan, protecting analogue TV services;
2. Purchase transmitter and antenna systems on the basis of 10 kW ERP as the economic life span of these systems are in the range of 15 years or more. Also the difference in annual depreciation costs is limited[23]:

[21] See ITU report "Roadmap for the Introduction of Digital Terrestrial Radio Services in Thailand: Plan A and B, dated 28 February 2014 and ITU report "Results of the verification of the T-DAB plan in the trial phase", dated 28 October 2015.

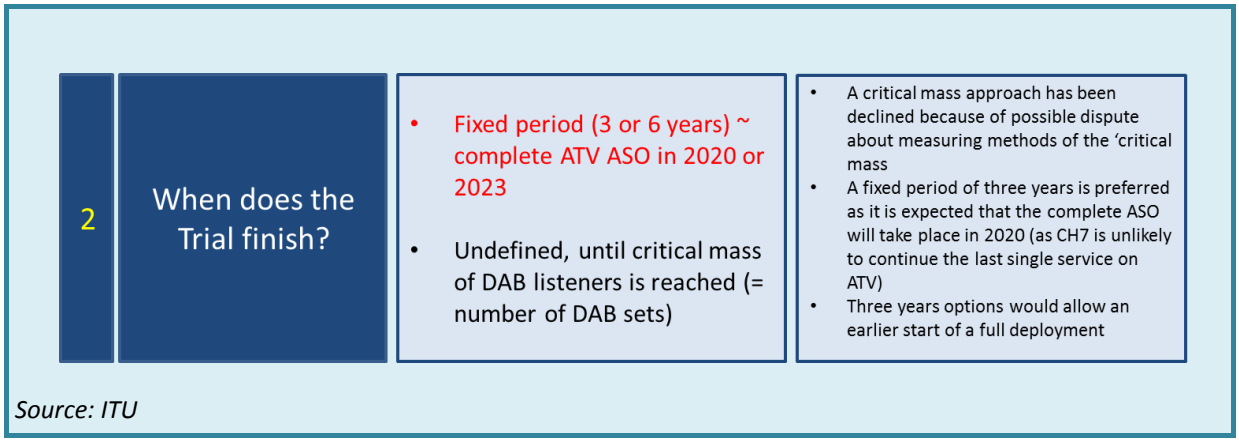
[22] They range between 0.1 and 10 kW, for more details see ITU report "Results of the verification of the T-DAB plan in the trial phase", dated 28 October 2015.

a. A site of 10 kW ERP will require a transmitter in the range of 2.0 to 2.6 kW with a current estimated cost of $80,000 and an annual depreciation of $5,335[24];
b. A site of for example 1 kW ERP will require a transmitter in the range of 0.5 to 0.7 kW with a current estimated cost of $35,000 and an annual depreciation of $2,335;

3. Any NBTC funding should be based on matched funding: i.e. any NBTC amount should be matched by industry for the same amount. This will ensure commitment of 'DAB-serious' industry parties.

2.1.2 End of the Trial

Figure 6 shows an overview of the options and considerations. The option in red is the recommended option.



Source: ITU

FIGURE 6: OPTIONS AND CONSIDERATIONS ON END OF THE TRIAL

Options

Two basic options exist when deciding the end of the Trial; (a) fixed period or (b) an undefined, qualified time (i.e. when qualifiers have been met and more specifically when a critical number of DAB listeners has been reached).

Considerations

The ASO of the ATV services in the VHF Band III should be considered as a full deployment is only possible when ATV services are switched-off[25]. The valuation model shows, under certain scenarios, that a positive business case can be achieved when National networks are deployed. In other words, only after ASO, full Service and Network licenses can be assigned.

Although Channel 7 holds spectrum rights until 2023, it is unlikely that they will continue broadcasting the last remaining ATV service, whilst all other ATV broadcasts have stopped in 2020. Under the unlikely scenario that Channel 7 would continue after 2020, it is implicitly expecting that

[23] See valuation spreadsheet model, worksheet "CAPEX transmission".

[24] Straight line deprecation over 15-year life span and no remaining value.

[25] See ITU report "Considerations on Available DAB+ Capacity in Thailand, dated 22 November 2013.

the remaining ATV viewers will continue using their Band III antenna for only one ATV service (whilst all other TV services are received with a UHF DTTB antenna and/or satellite dish).

Hence the ATV ASO is currently assumed to take place at the start of 2020. With an assumed Trial start late 2016 or at the beginning of 2017, this would result in a 3-year Trial duration.

Recommendations

The following is recommended on the end of the Trial:

1. Set a fixed period for the Trial as:
    a. A critical mass approach would result in long disputes about the right measuring method and results;
    b. A fixed period provides clarity about the future of DAB and this clarity is need for investors in the Trial;
2. Set or arrange for a fixed period of at least three years as:
    a. A fixed period of three years would coincide with a (promoted) ASO in the VHF Band, providing some extra incentive for ASO in the VHF Band III;
    b. A shorter fixed period does not allow for nationwide deployment at the time of the Trial license expiration (and hence no market interest).

2.1.3 Number of sites

Figure 7 shows an overview of the options and considerations. The option in red is the recommended option.

FIGURE 7: OPTIONS AND CONSIDERATIONS ON NUMBER OF SITES

Options

Theoretically the number of sites in the Trial can range from one to eight sites. However, as said before, it is important that a critical mass is reached as quickly as possible. Starting with the Trial. The bare minimum is therefore set to be five. Consequently, two basic options result; (a) eight sites or (b) five (i.e. the five best sites that cover most population).

Considerations

The number of sites in the Trial depends on the following factors:

1. The willingness to invest by the radio industry;
2. The availability of NBTC funds for the Trial, typically in the form of matched funding;
3. The offered incentives, licensing procedure and license terms and conditions.

For the latter factor, we refer to the subsequent Sections (see specifically Section 2.4 and 2.5). For measuring the willingness to invest, a licensing proposal on the basis of this report should be offered to leading radio broadcasters. For various Trial scenarios the CAPEX levels should be discussed. On the basis of the CAPEX model, as included in the valuation model, the following CAPEX levels can be identified for the various deployment scenarios:

1. The Trial on the basis of 5 or 8 sites, with 2 multiplexes, all sites purchased for 10 kW ERP, are respectively (see Table 8):
    a. 5 sites: $2,839,700 (= $442,800 for SP and $2,396,900 for NO);
    b. 8 sites: $4,081,700 (= $442,800 for SP and $3,638,900 for NO);
2. The Trial on the basis of 5 or 8 sites, with 1 multiplex, all sites purchased for 10 kW ERP, are respectively:
    a. 5 sites: $1,537,450 (=$221,400 for SP and $1,316,050 for NO);
    b. 8 sites: $2,182,450 (= $221,400 for SP and $1,961,050 for NO).

It should be noted that other costs such as OPEX, marketing and content costs should be considered as well.

The population coverage for the above Trial deployment scenarios can be observed from Table 1:

1. The Trial on the basis of 5 or 8 sites, with 2 multiplexes, with ERPs protecting ATV:
    a. 5 sites: 9,873,000 (15%);
    b. 8 sites: 10,712,000 (16%);
2. The Trial on the basis of 5 or 8 sites, with 1 multiplex, with ERPs protecting ATV:
    a. 5 sites: 10,624,000 (16%);
    b. 8 sites: 11,894,000 (18%).

Recommendations

The following is recommended on the number of sites in the Trial:

1. Considering the fact that the NBTC will not make any substantial funds available for the network deployment in the near future, it is recommended to negotiate for the 5 best sites with 2 multiplexes as this still covers a large proportion of the population (15%);
2. A lower number of multiplexes (i.e. one multiplex) or sites should be avoided as this will not provide enough content and generate a critical mass quickly. It will not justify the large effort needed for mobilizing the industry and setting up the Trial.

2.1.4 Deployment speed

Figure 8 shows an overview of the options and considerations. The option in red is the recommended option.

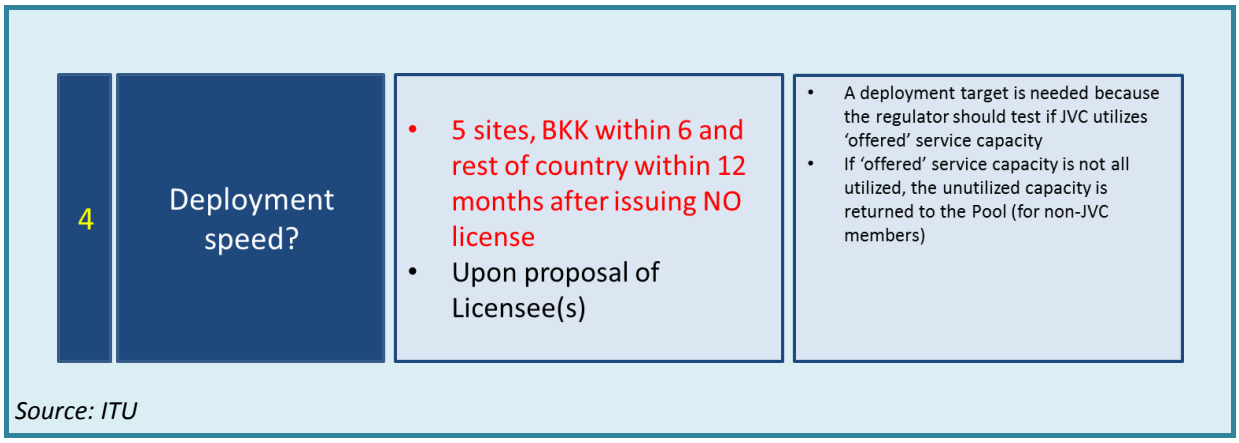


FIGURE 8: OPTIONS AND CONSIDERATIONS ON DEPLOYMENT SPEED

Options

After industry consultation the Regulator can prescribe a deployment speed of the Trial network. Or alternatively the Regulator asks the industry for their "best offer", for example in a public tender or by invitation.

Considerations

Under a licensing procedure whereby industry is invited to bid for the Trial license(s), it could be envisioned that a pre-defined multiplex capacity is reserved for the bidder (or bidding consortium) to broadcast its DAB services. A pre-defined remaining multiplex capacity could then be reserved for other broadcasters (or non-bidding industry parties). This remaining capacity can be labelled as the 'Pool'.

Under such a construction the NBTC should test whether reserved capacity is utilized. The Regulator should be aware of possible strategic hoarding of capacity or preventing third party broadcasters to enter the market. This test can only be carried out if the DAB network and services are fully deployed.

A set deployment schedule provides clarity for the market. The logistic chain for providing DAB receivers has to be organized and also the car manufacturers need to know as early as possible when and where DAB services will be available.

Recommendations

The following is recommended on the deployment speed of the Trial network:

1. After industry consultation, the NBTC should set a deployment schedule. On the basis of previous DAB network deployments elsewhere, the following deployment schedule is preliminary recommended:

a. The Bangkok site should be deployed within 6 months (after awarding the Trial license);
b. All other sites (4 or 7 sites) should be deployed within 12 months (after awarding the Trial license);

2. After the final site and its services have been deployed, the NBTC should check whether the bidder (or bidding consortium) has utilized its reserved capacity. Any underutilized capacity should (after a warning period) then be returned to the Pool. The extra capacity in the Pool can then be assigned to other service providers or broadcasters.

2.2 Services deployment

In this Section the following aspects of the DAB Trial service deployment are addressed:

1. Number of multiplexes;
2. Number of services per multiplex;
3. Number of services per service provider;
4. Simulcast requirement;
5. Type of audio and associated services;
6. Data and other advanced services.

2.2.1 Number of multiplexes

Figure 9 shows an overview of the options and considerations. The option in red is the recommended option.

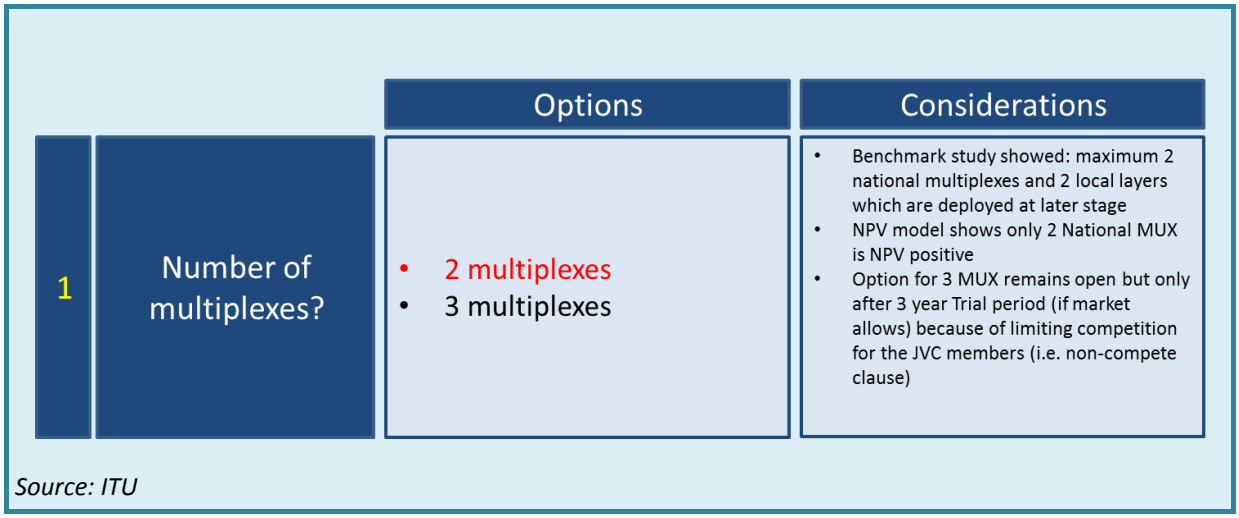


FIGURE 9: OPTIONS AND CONSIDERATIONS ON DEPLOYMENT SPEED

Options

The number of multiplexes offered in the Trial can range from 1 to 3 multiplexes[26]. However, the maximum number of 3 is derived from a spectrum management point of view. Other factors, such as economic viability, investment risk profile and practical implementation should be considered. Hence the two basic options are either 2 or 3 multiplexes.

Considerations

When deciding the number of multiplexes for the Trail, the Regulator should consider the deployment phase after the Trial. As the services in the Trial are national services, the National deployment should be considered.

The benchmark study showed that in the selected countries the maximum number of National multiplexes is generally limited to two (and also any additional Local multiplexes are often limited to two)[27]:

1. UK: National commercial multiplexes Digital One and Two (plus the BBC multiplex);
2. Norway: National multiplexes Norway 1 and 2;
3. Australia: In each of the metropolitan areas 1 or 2 multiplexes for local commercial services and 1 multiplex for national services;
4. Switzerland: one national layer for national Public Broadcasting Services (SRG SSR) and a second layer for commercial services, with language customisation and some programme variations between the 4 regions.

The valuation model showed that from an economic point of view the maximum number is limited to two multiplexes for the deployment of national services. A deployment of three multiplexes showed a lower NPV than for two multiplexes (see Table 9).

Recommendations

The following is recommended on the number of multiplexes for the Trial network:

1. Set a maximum of two multiplexes for the Trial with any increase in the successive National deployment being dependant on commercial demand. The international benchmark showed a typical implementation limit of two multiplexes. The valuation model showed a positive NPV with a maximum of three multiplexes. However, a careful approach is needed. The number of multiplexes can be increased at a later stage if market success has been proven;
2. A higher number of multiplexes is not excluded. However, any additional multiplexes to be assigned should consider the license terms and conditions awarded to the bidder (or bidding consortium) for the Trail license. These terms and conditions could include a non-competition clause (like the Australian Regulator did). Any additional multiplexes should then

[26] The maximum number is based on the defined frequency planning target as described in ITU report “DAB+ Services & Planning Requirements, dated 21 February 2014” and ITU report “report “Results of the verification of the T-DAB plan in the trial phase”, dated 28 October 2015.

[27] See footnote 11.

be awarded after the expiration of this non-competition clause, which is likely to last for the duration of the Trial phase.

2.2.2 Number of services per multiplex

Figure 10 shows an overview of the options and considerations. The option in red is the recommended option.

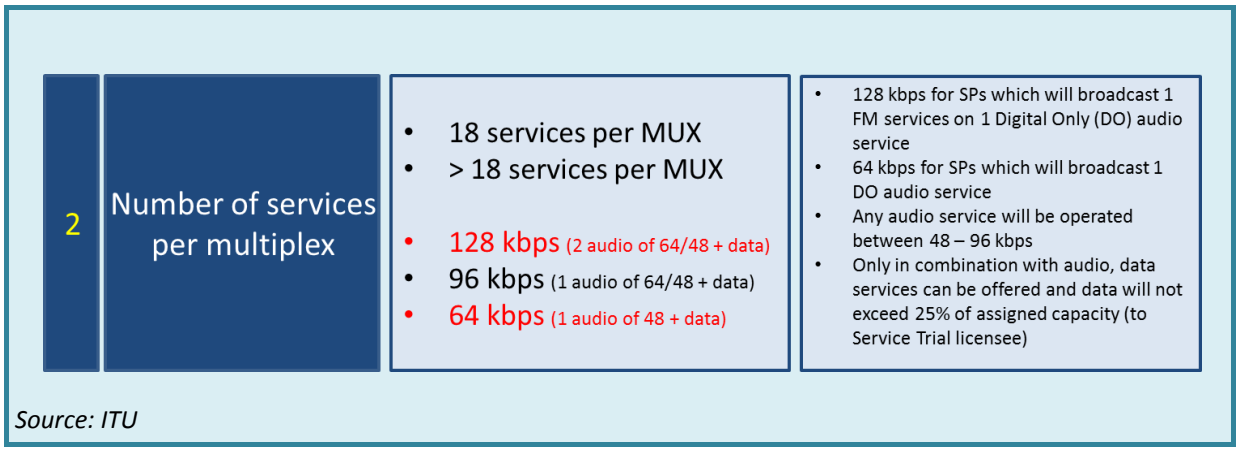


FIGURE 10: OPTIONS AND CONSIDERATIONS ON NUMBER OF SERVICES PER MULTIPLEX

Options

The options under consideration are (a) a fixed number of audio services in the multiplex or (b) a capacity slot per service provider, allowing a degree of freedom to determine the service configuration on this capacity slot.

Considerations

A DAB+ system applies the advanced audio encoding technology (AAC), with this encoding technology it is possible to provide good to excellent audio quality on the following bit rates[28]:

1. 48 - 56 kbps for most music types (including pop music, rock and jazz)[29];
2. 64 - 96 kbps for classical music.

An important objective of the Trial is for service providers to find out what the best service configuration is for their business and audiences. This would argue for a degree of freedom of determining the services on offer. Also a wide range of different services should be promoted. To some extent this would limit the allocated capacity per service provider. Hence a balance is needed when determining a defined capacity per service provider.

[28] See ITU report "DAB+ Services & Planning Requirements", dated 21 February 2014.

[29] Bit rates as low as 40kbps have been used with some success for Pop, even 32kbps; if mono is used for speech 32kbps can also be used.

A DAB network can be used to broadcast any data and can be operated in the sense of a “bit pipe”. Service providers using the DAB system only as a bit pipe could hamper the availability of terrestrial audio services, which is especially relevant if a (partial) ASO is considered of the analogue radio services.

Recommendations

The following is recommended on the number of (audio) services per multiplex:

1. Provide freedom to experiment with the type of services on offer and hence two different capacity slots can be picked:
    a. A slot of 128 kbps, allowing for:
        i. A minimum of two audio services;
        ii. For example, two audio services of 48 kbps and the remaining capacity for data/other services;
    b. A slot of 64 kbps, allowing for:
        i. A minimum of one audio service;
        ii. For example, one audio service of 48 kbps and the remaining capacity for data/other services;
2. Match these possible capacity slots with any simulcast requirement, if stipulated (see also Section 2.2.4), in the following manner:
    a. The 128 kbps slot is offered to service providers wishing to simulcast its existing analogue radio services together with a Digital Only (DO) service;
    b. The 64 kbps slot is offered to service providers wishing to broadcast only a DO service;
3. Limit the possibilities to broadcast data only in the following manner. Data can only be broadcasted if an audio service is broadcasted as well and the allocated capacity for these data services should not exceed 25% of the allocated capacity to the service provider.

2.2.3 Number of services per service provider

Figure 11 shows an overview of the options and considerations. The option in red is the recommended option.

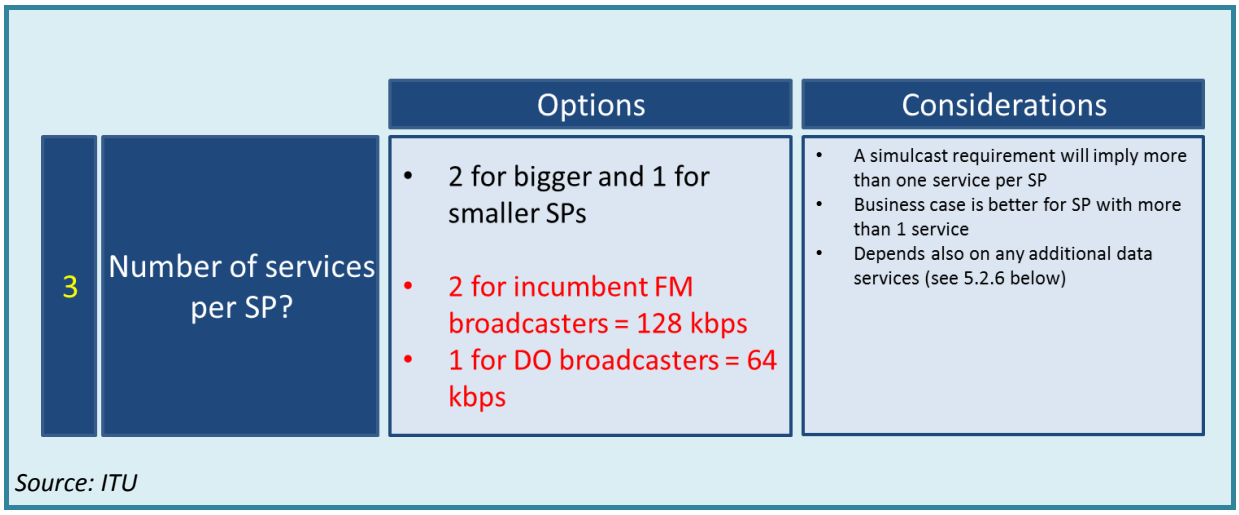


FIGURE 11: OPTIONS AND CONSIDERATIONS ON NUMBER OF SERVICES PER SERVICE PROVIDER

Options

The number of services per service provider is closely related to the number of services per multiplex (see Section 2.2.2). When opting for a capacity slot per service provider also the number of services per multiplex is regulated. The options at consideration here are (a) the number of DAB services per service provider is related to the number of current analogue services of a service provider or (b) the number of DAB services per service provider is related to the service provider's intention to simulcast existing analogue services and provide additional DO services.

Considerations

Any simulcast requirement for current analogue radio services will imply that on average more than one DAB service per service provider will have to be broadcast[30]. Hence regulating the number of services per service provider is related to a possible simulcast requirement (see also Section 2.2.4).

The CAPEX model as included in the valuation model (see Section 1.3) shows that the cost for service provisioning (SP) is lower per service provider when this provider offers two or more services. This is due to cost sharing between two or more services of the following equipment in the service provider's studio:

1. SP controller (although this functionality sits at the multiplexer);
2. PAD server;
3. IP Router/Switch;
4. Installation, commissioning and training (on all the above listed equipment).

When deciding the number of services per service provider (or the capacity slot per service provider), any requirements for data and other advanced services should be considered (see Section 2.2.6). For

[30] Under assumption that one service provider broadcasts one FM service, two DAB services will be broadcasted. A service provider broadcasting two (or more) FM services will result in four (or more) DAB services.

example, a requirement for the implementation of an Emergency Warning Service (EWS), should result in some capacity reservation levied on the service provider(s) having a EWS responsibility[31].

Recommendations

The following is recommended on the number of services per service provider:

1. As recommended in Section 2.2.2, assign the two possible capacity slots with any simulcast requirements (see also Section 2.2.4) in the following manner:
    a. The 128 kbps slot is offered to service providers wishing to simulcast their existing analogue radio services together with a Digital Only (DO) service;
    b. The 64 kbps slot is offered to service providers wishing to broadcast only a DO service;
2. Limit the possibilities to broadcast data only in the following manner. Data can only be broadcasted if an audio service is broadcasted as well and the allocated capacity for these data services should not exceed 25% of the allocated capacity to the service provider. A EWS responsibility could be exempted from this data limit.

2.2.4 Simulcast requirement

Figure 12 shows an overview of the options and considerations. The option in red is the recommended option.

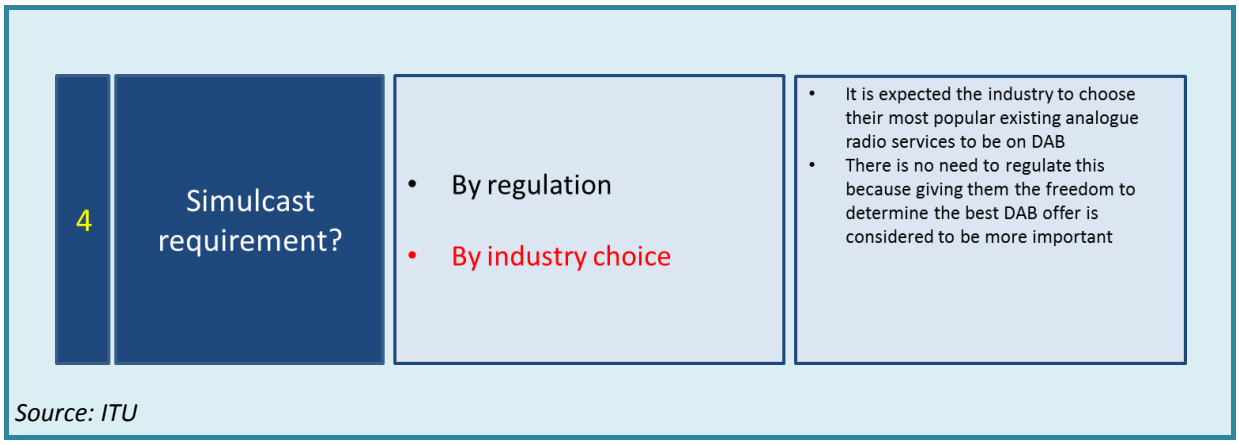


FIGURE 12: OPTIONS AND CONSIDERATIONS ON SIMULCAST REQUIREMENT

Options

The options under consideration here are (a) set a simulcast requirement for a defined set of existing analogue services or (b) any simulcasting of existing analogue services is by industry choice. This decision is closely related to a possible decision on setting a capacity slot per service provider (see Section 2.2.2 and 2.2.3).

[31] A capacity of approximately 16 kbps is recommended per EWS. This capacity is only needed at the time of the emergency. See ITU report as mentioned in footnote 28.

Considerations

In addition to the considerations provided in Section 2.2.2 and 2.2.3, it is expected that the radio industry itself will decide to broadcast their most popular services. Such an industry choice is likely to be driven by the fact that near nationwide broadcasts of (popular) analogue services are absent in Thailand. Under such conditions it is commercially interesting to extend the terrestrial coverage of for example popular services in the Bangkok area.

Recommendations

The following is recommended on the simulcast requirement:

1. As recommended in Section 2.2.2 and 2.2.3, assign the possible capacity slots in the following manner:
    a. The 128 kbps slot is offered to service providers wishing to simulcast its existing analogue radio services together with a Digital Only (DO) service;
    b. The 64 kbps slot is offered to service providers wishing to broadcast only a DO service.

2.2.5 Type of audio and associated services

Figure 13 shows an overview of the options and considerations. The option in red is the recommended option.

		Options	Considerations
5	Type of audio services and basic program associated data (PAD, DLS text, Slideshow)?	• By regulation • By industry choice	• Benchmark study shows: (a) no regulation of audio service or features + (b) features are regularly delivered • Guidelines for Audio quality, PAD & DLS • DO services have the same advertising rules as the analogue services – to keep a level-playing-field • CS can participate in the Pool and have to accept national broadcast + network rental fee to be paid (like others) • After ASO the local layer for CS will be available

Source: ITU

FIGURE 13: OPTIONS AND CONSIDERATIONS ON TYPE OF AUDIO AND ASSOCIATED SERVICES

Options

The following options are under consideration here:

1. Regulation of audio/program associated data (like PAD, DLS text and Slideshow);
2. Regulation on the advertising minutes (as part of the audio service) as compared to analogue radio services;
3. Regulation of type of audio services, meaning Public Broadcasting Services (PBS), Commercial and Community Services (CS). In this section we focus only on CS as these type of services

requires the implementation of local insertion (by having a local multiplex centre per local area) or in other words a Local network layer (requiring a Multi Frequency Network- MFN architecture between the local areas[32]).

Considerations

The international benchmark study showed that Regulators tend not to regulate the audio/program associated data in the sense of requiring the delivery of this data (in a prescribed format). The benchmark study showed that this associated data is delivered in the studied markets in a harmonized manner (between the service providers) without any strict regulation.

A commonly observed way of loosely regulating these services is to issue operational guidelines on the delivery of this associated data. These guidelines are formulated to ensure that the deployed DAB receivers will properly process and display the audio/program associated data. For the DTTB service in Thailand, the NBTC issued similar operation guidelines on the configuration of the DVB-T2 multiplexes and services[33].

For the analogue radio services, the number of advertising minutes per broadcasted audio hour is regulated by the NBTC. DAB DO services could have a higher number of maximum advertising minutes per broadcasted audio hour, as to promote the uptake of DAB services. For example, the NBTC regulated for the DTTB services a higher number of advertising minutes as compared to satellite services. However, when differentiating the advertising minutes one should consider a level playing field with the analogue radio services as these services are expected to run parallel with DAB for a long period. Also, simulcast services will have identical audio content to their analogue program source.

As the VHF Band III is currently in use by ATV, the available spectrum is limited. Only after ASO in this band enough spectrum is available for deploying a Local network layer at a nationwide basis. This spectrum limitation also applies for the deployment of a National network (see Section 1.1).

Technically the insertion of Local services during the Trial is possible however this will have the following consequences:

1. A local head-end has to be built at each Trial site broadcasting Local services, adding an additional CAPEX of at least $160k per head-end (depending on the number of local services), whilst the satellite distribution for the National services will remain in place;
2. A Local service will take the capacity of a National service and this may have a significant impact on the earning capacity of the DAB platform during the Trial (and at later stages);
3. A larger spectrum usage as SFNs cannot be applied between sites (i.e. for the Trial between Bangkok and Chonburi, see Section 1.1.1). This will be in particular the case when networks

[32] Please note that with a local area a Single Frequency Network (SFN) can/should be applied.

[33] See NBTC notification on “Technical standards and frequency plans for digital terrestrial television broadcasting”, several editions.

are deployed nationally, a Local layer will take between 6 and 7 frequencies. Whereas a National layer will take 1 to 2 frequencies[34];

4. A fragmented network planning and deployment which will hamper:
    a. Sharing of facilities and network equipment, resulting in much higher OPEX and CAPEX levels;
    b. Efficient spectrum use as final frequency planning requirements will be unclear as the demand for distribution capacity for Local services will varies across the country and be patchy (in the short term).

Recommendations

The following is recommended on the type of audio and associated services:

1. Provide only operational guidelines on audio/program associated data (like PAD, DLS text and Slideshow) as to ensure that the deployed DAB receivers will properly process and display the audio/program associated data;
2. Do not set different advertising regulations for DO services as to ensure a long term level-playing-field between the DO and analogue radios service;
3. Allow a CS onto the Trial network only on the following basis:
    a. The CS is broadcasted as a national service, meaning that all sites in the Trial broadcast the CS (hence avoiding the disadvantages as listed above);
    b. The CS service provider access the DAB network under the same conditions as any other service provider, including the payment of distribution fees;
    c. If the CS service provider is not participating in the bidding consortium, it will have to acquire access to DAB capacity in the Pool (in competition with other service providers if no capacity in the Pool is earmarked for CS).

2.2.6 Data and other advanced services

Figure 14 shows an overview of the options and considerations. The option in red is the recommended option.

[34] See footnote 7

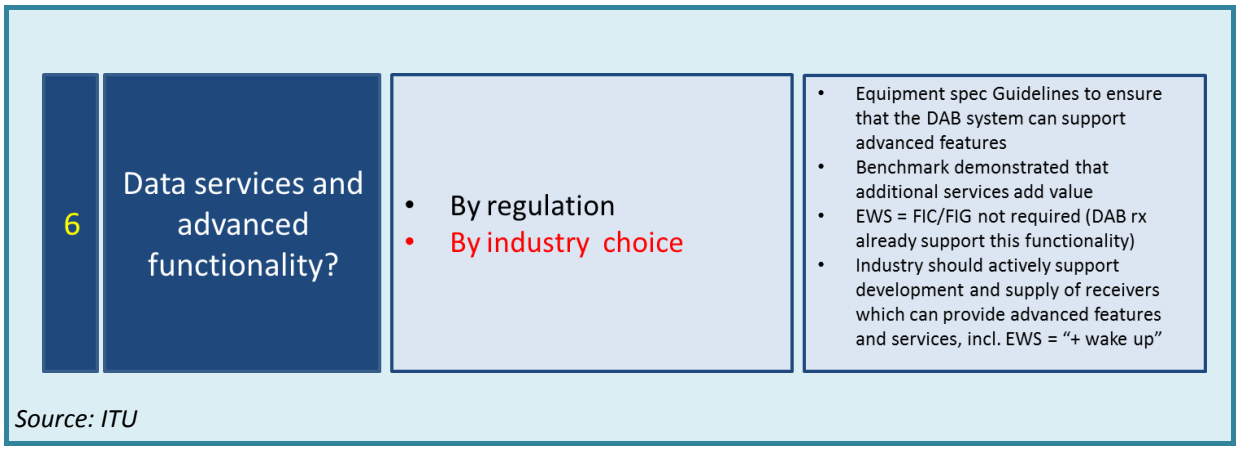


FIGURE 14: OPTIONS AND CONSIDERATIONS ON DATA AND OTHER ADVANCED SERVICES

Options

Similar to the options as discussed in Section 2.2.5, the options here are whether data services and other advanced services should be regulated or are left to the market to decide (by industry choice). As stated in Section 2.2.2, this topic is closely related to the number of services per multiplex.

Considerations

In addition to the considerations as discussed in Section 2.2.2 and 2.2.3, the following considerations can be listed:

1. Receiver specifications can ensure the proper processing of these data and other advanced services[35];
2. EWS as an advanced service can be implemented in two basic forms:
    a. EWS on the basis of the Fast Information Channel (FIC) and the Fast Information Group (FIG) through the use of Announcements. This form of EWS does not provide the functionality of receiver "wake up" from standby mode. This form of EWS is commonly supported by DAB receivers complying to the standard receiver specifications;
    b. EWS with the functionality of receiver "wake up". This form of EWS is not supported in any known DAB receiver and the requirement is not included in the WorldDAB DAB standard receiver specifications. As this type of receiver is currently not commercially available in the market, the development and wide introduction of such receivers will require an internationally coordinated effort. Additionally, the head-end functionality will need to be included in both existing and new DAB system deployments.

[35] The third party frequency planner has provided a comprehensive set of receiver specifications. See report "Radio Frequency Plan Project - Addendum 1 to Interim Milestone IB Report (DAB+ Receiver Technical Specifications)", dated May 2015.

Recommendations

The following is recommended on data and other advanced services:

1. Provide only DAB standard receiver specifications on data and other advanced services (in particular EWS on the basis of FIC/FIG delivered Announcements) as this ensures that the deployed DAB receivers will properly process and display the data;
2. Promote the industry development of data and other advanced services by allowing the service providers to allocate a part of their slot capacity for these services (see recommendations in Sections 2.2.2 and 2.2.3). EWS may be prescribed and assigned to one or more service providers.

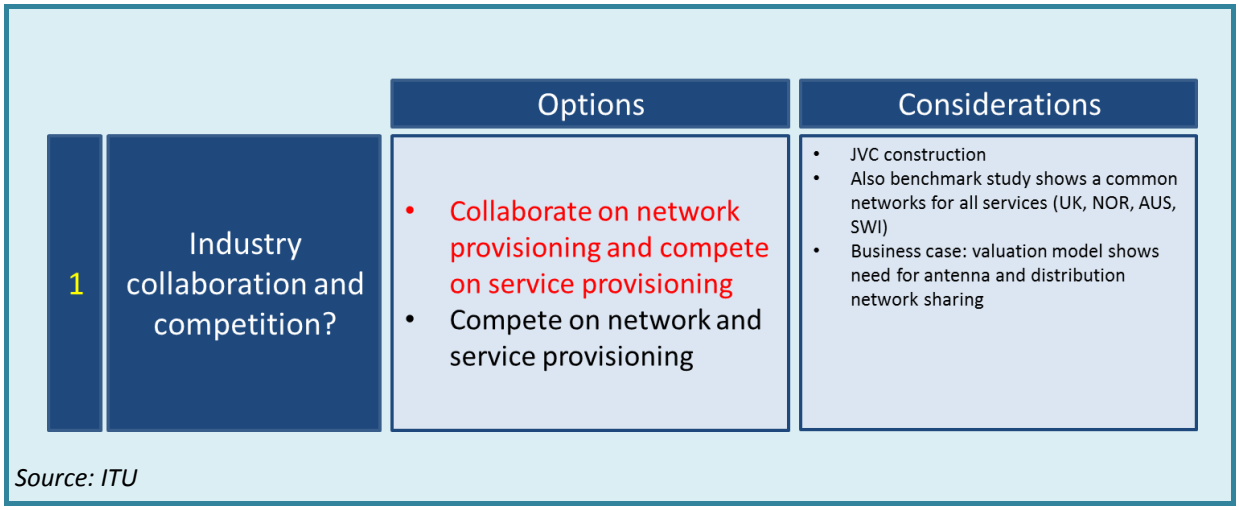
2.3 Supporting measures

In this Section the following aspects of the DAB Trial supporting measures are addressed:

1. Industry collaboration and competition;
2. Sources of funding;
3. Funding of cost elements;
4. Incentives;
5. Support organization.

2.3.1 Industry collaboration and competition

Figure 15 shows an overview of the options and considerations. The option in red is the recommended option.



Source: ITU

FIGURE 15: OPTIONS AND CONSIDERATIONS ON INDUSTRY COLLABORATION AND COMPETITION

Options

The options under considerations here are addressing the aspect of competition at what level; (a) at service and network provisioning or (b) mainly at service provisioning level (and maximum

collaboration on the network provisioning). Such a principle decision will help designing the license procedure and license terms and conditions.

Considerations

The international benchmark study has shown in the target countries (but also in other countries) that a common network has been deployed for all DAB services in the market:

1. UK: Digital One and Two deployed and operated by Arqiva (in collaboration with other industry parties);
2. Norway: Norway 1 and 2 deployed and operated by Norkring;
3. Australia: In each metropolitan area Digital Radio Broadcasting (for commercial broadcasters) and ABC/SBS (for Public Broadcasting Services);
4. Switzerland: SRG/SSR and SwissMediaCast AG for first and second layer.

In Australia and the UK, for respectively the commercial DAB services (Digital Radio Broadcasting) and Digital Two, an industry wide consortium or Joint Venture Company (JVC) has been established for the planning, deployment and operations of the DAB networks and services. The aim of such a JVC is to pull resources together and share network facilities and equipment. The underlying notion is that competition takes place at the level of service provisioning (essentially the content delivered) and not at network operations. Network provisioning is considered a commodity and listeners should be offered the same services and service quality at any location within the common coverage area.

The valuation model has demonstrated that the business case is very challenging and that only with antenna sharing (and hence sharing of all other site facilities and equipment) and distribution network sharing (between all services) a viable business case can be devised (see Section 1.3.3).

Recommendations

The following is recommended on industry collaboration and competition:

1. Let the industry collaborate on network operations and compete on service provisioning. This would allow for the industry to pull resources together and minimize DAB network costs;
2. Invite industry to establish a JVC for the common operation of the DAB networks and promote competition between DAB services by controlling the number of service slots available:
    a. For the JVC in the reserved capacity part of the DAB multiplexes, and;
    b. In the Pool.

2.3.2 Sources of funding

Figure 16 shows an overview of the options and considerations. The option in red is the recommended option.

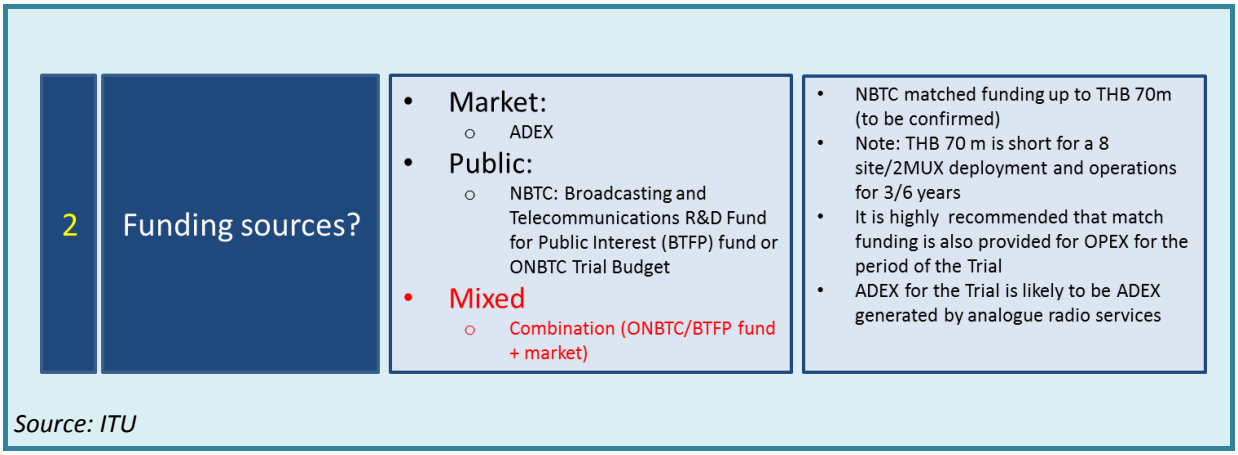


FIGURE 16: OPTIONS AND CONSIDERATIONS ON SOURCES OF FUNDING

Options

Basically three options are available for funding the Trial; (a) ADEX, (b) Public funds, which could include the Broadcasting and Telecommunications R&D fund for Public Interest (BTFP), and (c) a combination of ADEX and Public funding (i.e. a mixed model).

Considerations

In addition to the considerations as included in Section 2.1.3 (i.e. the number of sites in the Trial), the following considerations are listed here:

1. As argued in Section 2.1.1, any NBTC funding should be based on matched funding as this will ensure commitment of 'DAB-serious' industry parties;
2. The Trial costs are not limited to CAPEX only. For a successful Trial also the following costs have to be financed:
    a. Content creation, especially for the DO services;
    b. Marketing;
    c. OPEX.
3. DAB services do not generate any additional ADEX before the critical mass of listeners has been surpassed (in the base case scenarios in the valuation model set a 10% of all radio listening). This critical mass is unlikely to be surpassed during the Trial (as the Trial network coverage for two equal multiplexes is limited to 15 – 16 % of the total Thai population, see Section 1.1.1). Consequently, it has to be assumed that the ADEX made available for the Trial has to come out of the ADEX generated by analogue radio services. Funding from analogue radio revenues would require a continuation of these revenues over a longer period. Regulators in other countries have therefore offered extensions of the running of FM licenses as an incentive to invest in DAB[36].

[36] Please refer to ITU report "International Benchmarks for DAB+ Digital Radio Deployment", dated December 2015.

Recommendations

The following is recommended on sources of funding:

1. As recommended in Section 2.1.1, any NBTC funding should be based on matched funding;
2. As DAB services will initially not generate any additional ADEX, invite only financially strong incumbent radio broadcasters to bid for the Trial license(s);
3. In return of investing in DAB, offer an extension of the current FM licenses for broadcasters. In Section 3.3.4 more details are included on this incentive.

2.3.3 Funding of cost elements

Figure 17 shows an overview of the options and considerations. The option in red is the recommended option.

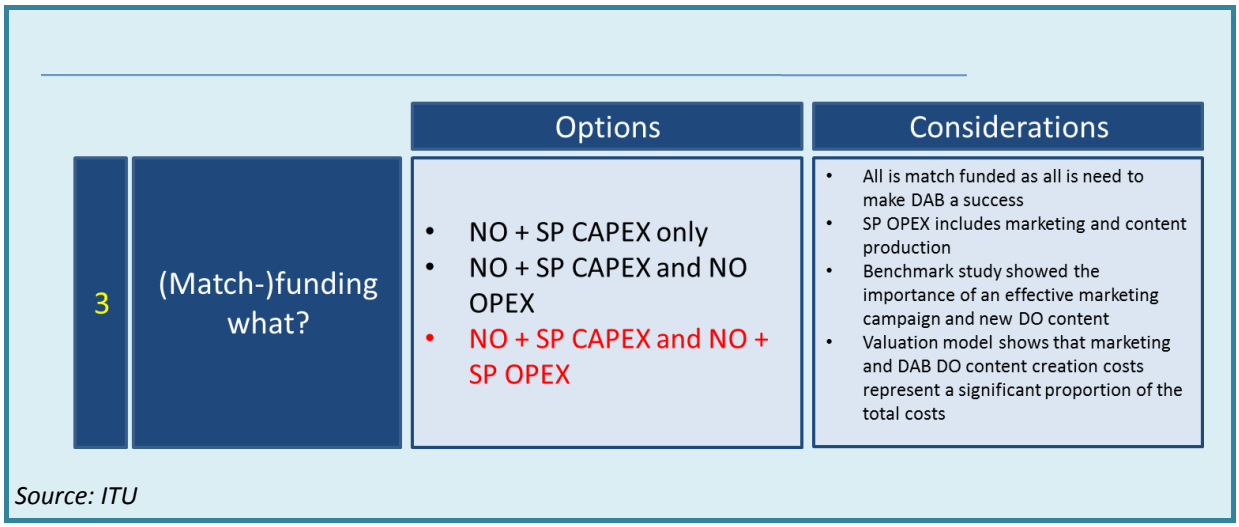


FIGURE 17: OPTIONS AND CONSIDERATIONS ON FUNDING OF COST ELEMENTS

Options

As addressed in the previous Section 2.3.2, the Trial costs comprise OPEX and CAPEX for both the network operations and service provisioning (NO and SP respectively). The three options presented here are; (a) CAPEX only for both NO and SP, (b) CAPEX for both NO and SP and OPEX for NO, and (c) CAPEX and OPEX for both NO and SP.

Considerations

In addition to the considerations as presented in Section 2.1.1 and 2.3.2, the following considerations are listed:

1. The principle of matched funding does not only apply to the funding of CAPEX but should also be considered for funding OPEX. Again, as this will create commitment on all aspects needed for a successful Trial;
2. The benchmark study showed the importance of an effective marketing campaign and the creation of DO content. Both comprise a significant cost of providing DAB services. Please refer to the valuation model. It is advised to consider a deployment scenario when the

multiplexes are fully deployed (nationwide) and not the Trial. A fully deployed scenario represents a good scenario for showing the proportion of the different cost elements. As content creation costs are fixed costs (irrespectively of the size of the network coverage), a Trial scenario would over-represent the content costs as compared to the total costs.

Recommendations

The following is recommended on funding of cost elements:

1. As recommended in Section 2.1.1 and 2.3.2, any NBTC funding should be based on industry matched funding;
2. Matched funding should be based on all cost elements for designing[37], deploying and operating the DAB networks and services.

2.3.4 Incentives

Figure 18 shows an overview of the options and considerations. The option in red is the recommended option.

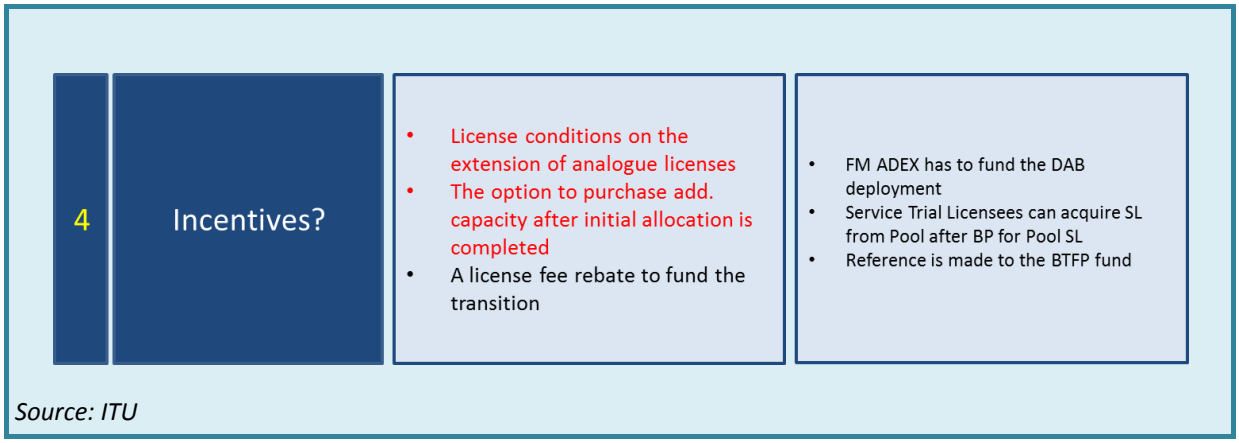


FIGURE 18: OPTIONS AND CONSIDERATIONS ON INCENTIVES

Options

In the international benchmark report a list of incentives or supporting measures is provided[38]:

1. Free spectrum for initial services to build the platform, these licences may last until FM ASO;
2. License conditions on the extension of analogue licenses;
3. Moratoriums on new broadcasters i.e. Non-compete period;
4. The option to purchase additional capacity once the initial allocation is completed;

[37] Strictly speaking, some design costs have already been incorporated by the NBTC by the work it carries out together with the ITU. However, a frequency plan as presented in Section 1.1.1 should still be translated into detailed site design (including the multiplex centre and studios sites) and sourcing of distribution services (like satellite and VPN services). The latter is typically the task of the network operator and service provider.

[38] See section "Business Drivers and Incentives" in the ITU report as mentioned in footnote 11.

5. Full or part funding by Government, or a license fee rebate to fund the transition;
6. Digital Dividend through alternative uses for analogue licenses when they are released.

In this Section the incentive options 2, 4 and 5 are considered. Incentive options 1 and 3 are addressed in Section 2.4. Incentive options 6 is not considered for financing the Trial because a possible ASO in the FM Band (and hence creating a digital dividend which can be auctioned off for alternative spectrum use) is projected to be too far from the introduction date of the Trial.

Considerations

As covered in the international benchmark study, some Regulators provided incentives for FM broadcasters to participate in DAB broadcasting by:

1. Offering a FM license extension (e.g. of seven additional years) if the FM broadcaster would also broadcast on the DAB platform, or alternatively;
2. An FM license could only be acquired if the broadcaster accepted also to broadcast on the DAB platform.

These linked license terms and conditions, made it possible for broadcasters to assess the value of a DAB license. For example, a FM license extension of seven years would incorporate seven years of additional FM ADEX (minus the costs for a combined FM and DAB network and service provisioning).

In Thailand the NBTC is in the process of refarming and relicensing the FM services. The FM band is heavily congested and radio broadcasters are suffering from significantly reduced network coverage areas, reception quality and audience reach. This poor network coverage does not contribute to the positive development of the radio market in Thailand in terms of services and revenues. The NBTC has therefore embarked on a program to improve FM coverage and as a first phase (Phase I) has carried out together with the ITU an extensive analysis on the congestion situation in Thailand[39].

On the basis of this analysis three frequency and implementation scenarios were developed for resolving congestion. In the month May of this year the NBTC has opted for Scenario 1. In the second phase of this program (Phase II) detailed FM frequency planning work will be carried out on the basis of the selected Scenario 1. This planning work will result in a new FM frequency plan, ensuring lower congestion levels and optimized coverage areas for FM radio services in Thailand.

The main FM stations currently operate on the basis of a temporary authorization to use the assigned spectrum (i.e. 313 spectrum assignments for the Main FM stations). Several Main FM stations (i.e. incumbent FM broadcasters) have awarded concessions to commercial broadcasters (3rd party broadcasters), allowing these commercial broadcasters to broadcast FM services on their frequencies[40]. Before these spectrum authorizations expire in July 2017:

[39] In Annex C a summary of the results of this congestions analysis is provided. For more details on the FM congestion analysis please refer to ITU report "Analysis of congestion in the FM band", dated 18 May 2016.

[40] For more information on the radio market structure, its market players and revenue streams please refer to Annex D.

1. The current spectrum holders (i.e. the incumbent FM broadcasters which are mainly public entities) will have to demonstrate that they will need the assigned spectrum for future use. If the spectrum is considered needed and upon approval by the NBTC, a Service license will then be assigned to the current spectrum holders. Such a situation would also enable the current spectrum holders to continue the concession contracts with their 3rd party broadcasters, if such a concession agreement would be in place;
2. In the event that spectrum has to be returned to the NBTC and these frequencies are in use by a 3rd party broadcaster, this commercial broadcaster will then have to acquire spectrum in an auction (under the current legislation) in order to continue its FM business.

It is expected that the DAB candidate service providers will be amongst the FM Main stations as these broadcasters have the financial means and resources (like content creation resources) to produce and broadcast value adding DAB services. However, the re-farming and re-licensing creates considerable uncertainty for 3rd party broadcasters whether they can continue their business after the re-licensing. Under such market conditions it will be difficult for these commercial FM broadcasters to invest in DAB as the FM ADEX will have to finance the first years of DAB operations.

Consequently, under the scenario that the DAB Trial would commence before the FM spectrum refarming and relicensing has been concluded, the NBTC should offer FM broadcasters willing to invest in the DAB Trial a form of guarantee to continue their FM business (as the revenues from this business has to finance the DAB investments). Such a guarantee should be warranted to 3rd party broadcasters for the situation that they could not continue their business under their current concession contract (as the spectrum of the incumbent broadcaster/'concession giver' would be revoked).

Alternatively, the Trial licenses are awarded after the refarming and relicensing of the FM Band. After refarming the congestion levels will be much lower and hence coverage areas will be much larger for the Main FM stations[41]. Having larger coverage areas will improve their FM revenues and hence there will be more room for investing in DAB.

Awarding DAB Trial licenses after the FM refarming and relicensing has been concluded, will still require offering 'DAB investors' a prolonged FM license duration. This would entail that in the case a FM auction would be organized for licensing 3rd party or commercial broadcasters, the FM license terms and conditions should stipulate that if the FM licensee is willing to invest in DAB the FM license duration would be extended for example with 7 years. In other words, the auction should have two different lots:

1. One lot with FM only and a limited FM license duration, and;
2. Another lot with FM and a DAB commitment, in combination with an extended FM license duration.

A DAB Trial licensee is exempt from paying the NBTC license fees. This should be considered as a minimal incentive as normal license fees would be based on the DAB revenues (and these are very limited in the initial years). However, at the same time a Trial licensee is neither allowed to have any

[41] See for example Figure 86 and Figure 87 in Annex C.

commercial income. This limitation should be waived for the limited DAB advertising revenues that are expected. It is essential that DAB service providers already start attracting advertisers, especially for the DO services.

Recommendations

The following is recommended on incentives:

1. Under the scenario that the DAB Trial would commence before the FM spectrum refarming and relicensing has been concluded, the NBTC should offer FM broadcasters willing to invest in the DAB Trial a form of guarantee to continue their FM business;
2. Alternatively, under the scenario that the Trial licenses are awarded after the refarming and an auction would be organized for 3rd party broadcasters for acquiring FM spectrum rights, the NBTC should offer two types of auction lots:
    a. One lot with FM only and a limited FM license duration, and;
    b. Another lot with FM and a DAB commitment, in combination with an extended FM license duration;
3. Provide the Trial licenses on the normal basis of waiving the license fees, but provide a possibility for the Trial licensees to start attracting advertisers as this will increase the earning capacity of the DAB services in the longer term;
4. As indicated in Section 2.3.2 and 2.3.3, providing a form of matched funding should be pursued by the NBTC;
5. Provide an additional incentive (not included in the six incentive options as listed above) by allowing the Trial bidder (or bidding consortium) to acquire additional capacity from the Pool, after the assignment procedure (likely to be a public tender) for the Pool capacity has been completed and remaining Pool capacity determined (see also Section 2.4).

2.3.5 Support organization

Figure 19 shows an overview of the options and considerations. The option in red is the recommended option.

		Options	Considerations
5	Support organizations?	• Industry body to coordinate marketing, technical and political activities on behalf of the broadcasters • Listener engagement measurement • Receiver and retailer support • Automotive support • Marketing support	• Yes, such body should be established. It includes JVC members, SLs, NBTC, RX manufacturers • Yes, NBTC should initiate this, periodically over longer plan horizon (in AUS 6 measurements/year) • Is a sub committee of the industry body • Is a sub committee of the industry body • SLs + industry body

Source: ITU

FIGURE 19: OPTIONS AND CONSIDERATIONS ON SUPPORT ORGANIZATION

Options

In the international benchmark report the following support organization functions are listed[42]:

1. Industry body to coordinate marketing, technical and political activities on behalf of the broadcasters;
2. Listener engagement measurement;
3. Receiver and retailer support;
4. Automotive support;
5. Marketing support.

Considerations

The industry body to support the DAB deployment and operations comprises DAB licensees (including a JVC as proposed in Section 2.3.1), NBTC, receiver and car manufacturers as well as retailers. In the benchmark study the importance of having such a supporting industry body was demonstrated (see for example Commercial Radio Australia -CRA).

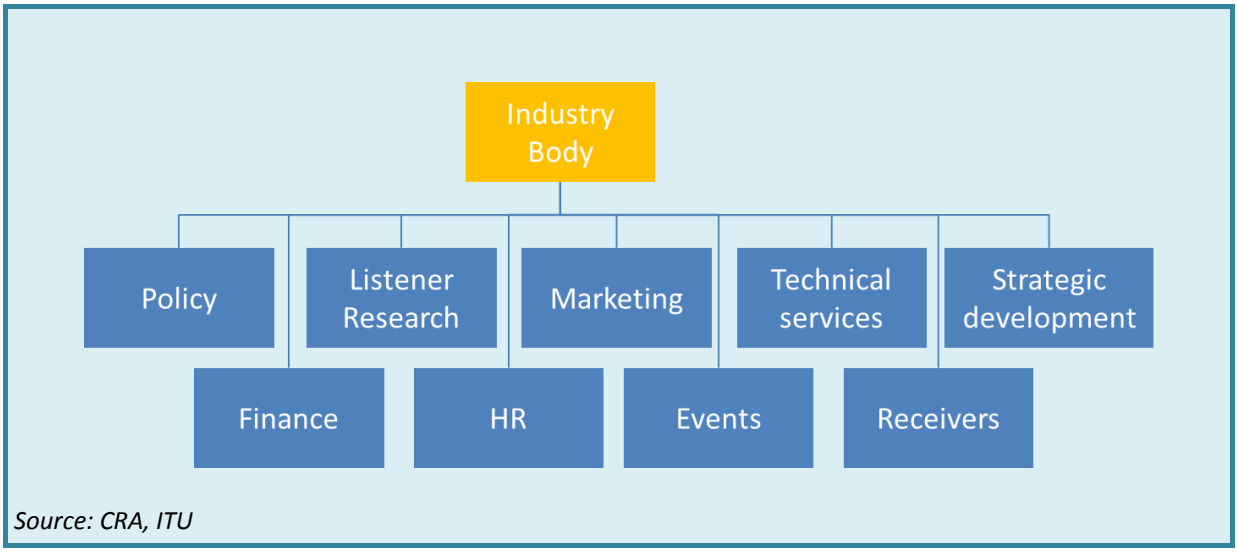
Setting up and running such an industry body will have to be financed ideally by industry and Government. The scope and depth of the activities of the intended industry body will depend on these available commercial and public funds.

While finance is needed to fund activities such as external (non- radio) advertising/marketing and receiver purchases a lot can be achieved through internal resources such as radio air-time for marketing and seconded staff time for cross industry discussions, e.g. broadcasters working with retailers on product launches and approaches.

Figure 20 shows an example organization chart for a digital radio industry body. This organization chart is based on CRA[43].

[42] See section "Support Organisations" in the ITU report as mentioned in footnote 11.

[43] For more details on the objectives and activities of CRA please consult their website on: www.commercialradio.com.au.



Source: CRA, ITU

FIGURE 20: EXAMPLE ORGANIZATION CHART FOR DIGITAL RADIO INDUSTRY BODY

It is noted that 'Receivers', as included in Figure 20, includes car receivers. Early involvement of the car manufacturers is paramount because car reception constitutes an important radio market. Early involvement is also critical because of the long lead times for having standard fit DAB radios. The Thai car manufacturers indicated that these lead times could be as long as 4 years for cars and up to 8 years for vans and lorries.

Figure 20 also illustrates that listener research is a key activity for an industry body. Listener measurements should be carried out at regular intervals (e.g. six times a year) to monitor the uptake of DAB receivers and listening behaviour. This should not only include the measurements of DAB but should also include all other platforms for radio listening; FM/AM, digital TV (DTTB) and Internet IP (fixed and mobile).

When consulting the various Thai broadcasters[44] it was evident that the available listening measurement data was confusing and often incomplete:

1. Main stream listening statistics (e.g. AC Nielsen) only cover Bangkok;
2. FM listening statistics are not trusted due to major month-on-month variations (probably because the sample sizes are too small)
3. IP statistics are unclear – multiple different interpretations possible, and;
4. Unclear how to correlate listening shares/behaviour between FM and IP.

An industry body could help organizing and establishing shared standards for listening measurements. Especially in the area of IP listening statistics shared and commonly accepted standards are missing. This situation will hamper selling advertising slots to advertisers as they will not understand either. But more importantly, without a profound insight in the actual listening shares between the various platform, investment decisions may be wrongly directed at for example only IP. As an example, the listening shares between the various platforms in respectively Norway

[44] See Annex A for list of the visited companies.

and the UK are included in Figure 48 and Figure 49 (in Section 4.1.1). What can be observed from these Figures is that IP listening stands at surprisingly low levels, respectively 17% and even below 10%.

Recommendations

The following is recommended on support organizations:

1. Establish an industry supporting body, including commercial and public entities, with the following activities (dependent on the available financial means):
    a. Industry body to coordinate marketing, technical and political activities on behalf of the broadcasters;
    b. Listener engagement measurement (see also Section 1.3.4);
    c. Receiver and retailer support;
    d. Automotive support;
    e. Marketing support.
2. Listener engagement measurements should be carried out regularly and over a long period (for example in Australia 8 measurements are carried out per year, and are expected to continue indefinitely);
3. Receiver, retailer and automotive support could be organized as sub-committees of the industry body;
4. A marketing effort should be provided by the Trial licensees (including the JVC and service providers from the Pool) and the industry body. These efforts can be split in the sense that (a) the industry body covers the general or market wide marketing (for example promoting the uptake of DAB receivers) and (b) the service licensees program for service specific marketing. In a similar way the NBTC and the DTTB service providers did when helping the uptake for DTTB receivers and services;
5. In the marketing effort the word 'Trial' should be avoided. Considering the Trial network population coverage between 15 – 16% the word 'Trial" may convey the wrong message (i.e. being a small network).

2.4 Licensing procedures

In this Section the following aspects of the DAB licensing procedures are addressed:

1. Assignment instruments;
2. Operating models.

2.4.1 Assignment instruments

Figure 21 shows an overview of the options and considerations. The option in red is the recommended option.

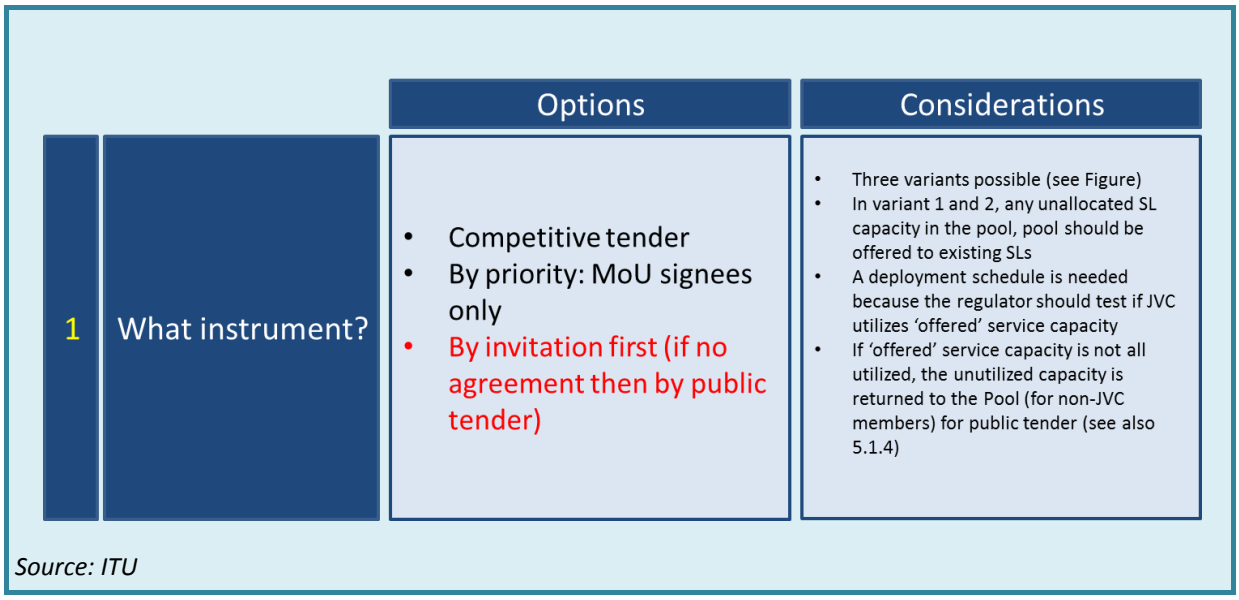


FIGURE 21: OPTIONS AND CONSIDERATIONS ON ASSIGNMENT INSTRUMENTS

Options

For deploying and operating the Trial, three basic rights have to be assigned[45]:

1. Spectrum right;
2. Content or broadcast right;
3. Operating right.

With a Trial License (as defined in the Broadcasting Act), it is possible to assign all these three basic rights together in a single license. However, it is also possible to split the rights over various Trial Licenses. A Trial license can be assigned by Public Tender, by Priority or Invitation. This Section addresses how these Trial licenses can be modelled and what assignment instrument can be applied.

Considerations

The international benchmark study and the valuation model showed the importance of industry collaboration on network operations and promoting competition on content and service creation (see Section 2.3.1).

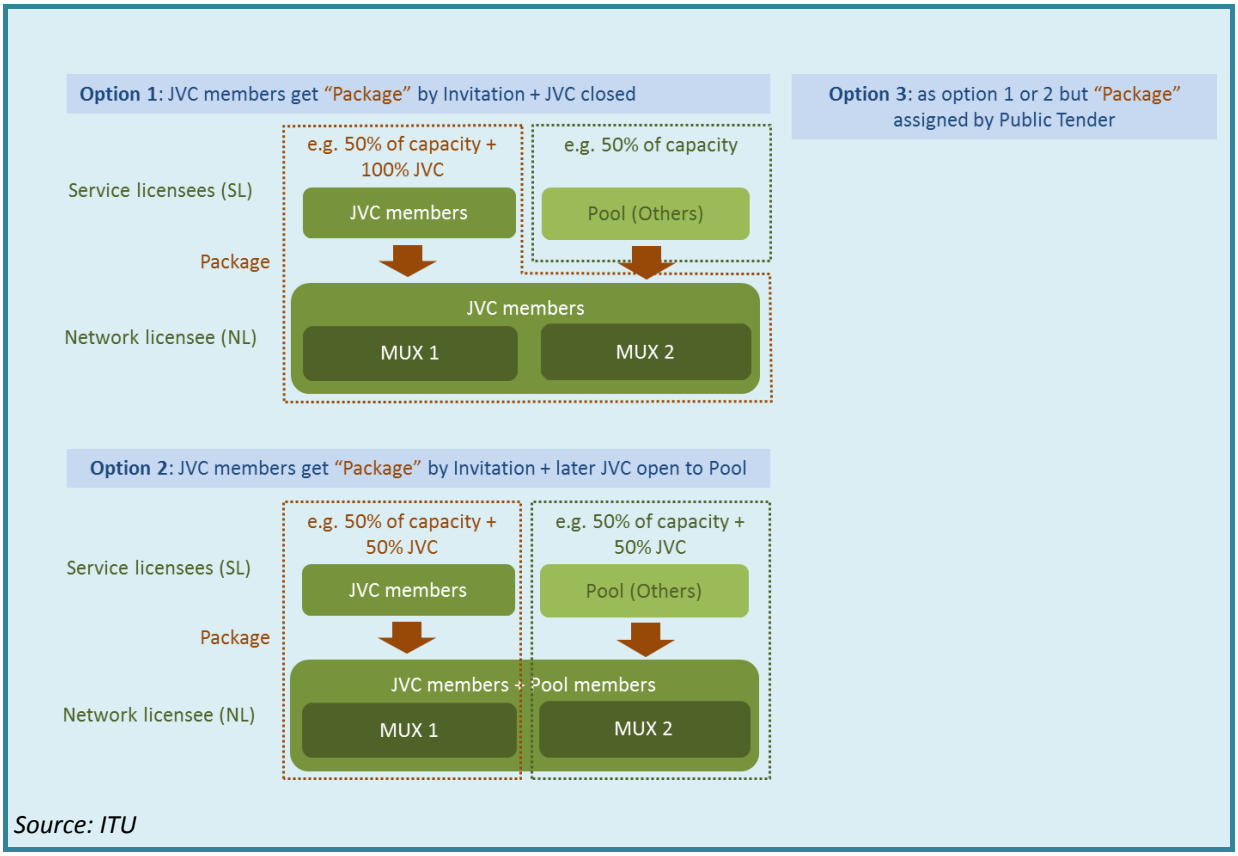
The investments in the DAB networks are relatively large and the economic life of the various network element long (>10 years). Also the valuation model showed that a license duration of seven years is too short to make the cumulative cash flow positive, in any realistic scenario. Hence any DAB Service and Network license should be provided at least for a license period of 10 years or more. This could be facilitated by offering an initial Service license period of 7 years with an option to extent for another period (of for example 5 to 7 years). For the Network license a period of 10 to 15 years better matches the average economic life of the DAB network (see Section 1.3.4).

[45] See the ITU Guidelines for "Transition from Analogue to Digital Broadcasting", dated January 2014, section 2.2.1.

Following the above competition principle and considering the business viability, the following assignment procedure options can be devised:

1. **Option 1**, which comprises the following:
    a. A Network license (including the operating right) 15 years, in combination with a Trial Service licence (including only the broadcast and spectrum right) for providing DAB services, is assigned to a JVC;
    b. By invitation first, and if no agreement can be accomplished between the NBTC and JVC, the Network license and Trial License will be offered in a public tender;
    c. The JVC holds 100% ownership of the network operations (NO) and 50% of reserved multiplex capacity for providing DAB services. The JVC has an obligation to offer the remaining multiplex capacity of 50% (i.e. the Pool capacity) to other non-JVC market parties. It is noted here that these percentages are items for negotiation between the market parties and NBTC;
    d. The Pool capacity is assigned by public tender (by the NBTC) and the DAB transmission fee to be paid is regulated (by the NBTC).
2. **Option 2**, which comprises the following:
    a. A Network license (including the operating right) 15 years, in combination with a Trial Service licence (including only the broadcast and spectrum right) for providing DAB services, is assigned to a JVC;
    b. By invitation first, and if no agreement can be accomplished between the NBTC and JVC, the Network license and Trial License will be offered in a public tender;
    c. The JVC holds only 50% ownership of the NO and 50% of reserved multiplex capacity for providing DAB services. The JVC has an obligation to offer the remaining multiplex capacity of 50% (i.e. the Pool capacity) to other non-JVC market parties. Again it is noted here that these percentages are items for negotiation between the market parties and NBTC;
    d. The Pool capacity, in combination with NO ownership, is assigned by public tender (by the NBTC) and the DAB transmission fee to be paid is regulated (by the NBTC).
3. **Option 3**, as Variant 1 with the exception that the assignment procedure 'by invitation' is skipped and the Network and Trial Service license is directly assigned by public tender.

The above described assignment variants are depicted in Figure 22.



Source: ITU

FIGURE 22: ASSIGNMENT VARIANTS

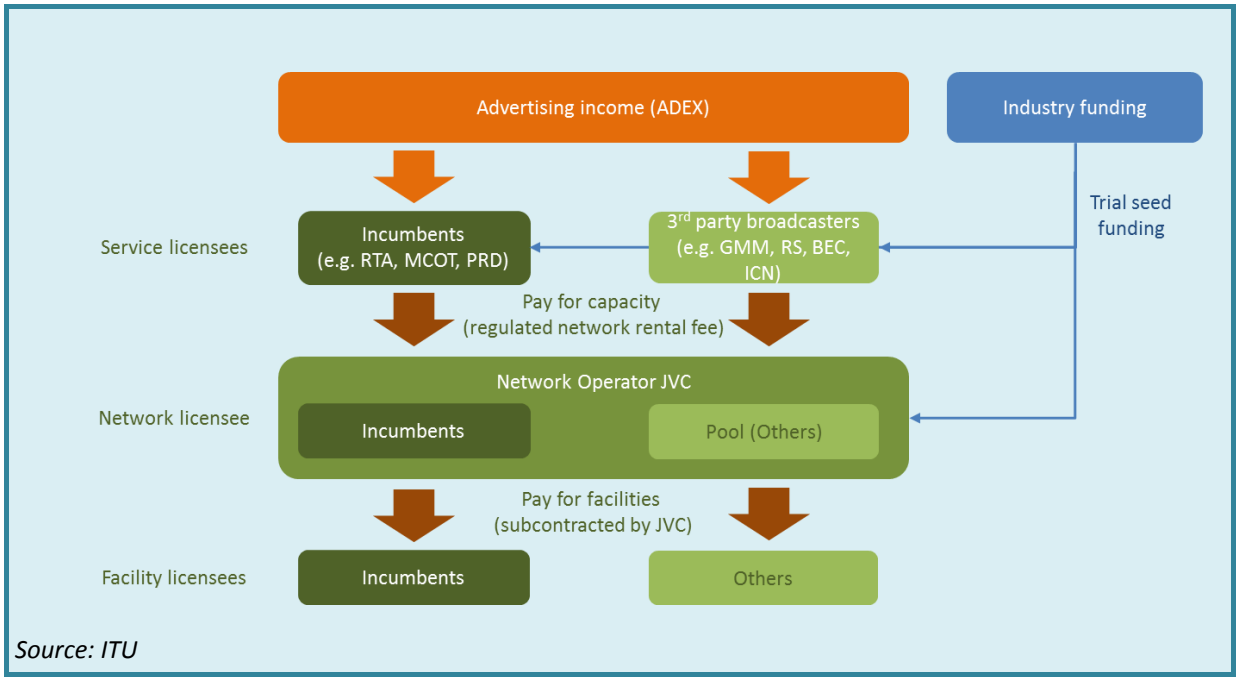
Table 10 shows for each variant as depicted in Figure 22, the assignment instrument and examples of possible market parties. The 'Big 3' refers to the market parties which control most assets in the radio market (i.e. Royal Thai Army – RTA, MCOT and PRD). 3rd party broadcasters refer to commercial broadcasters (e.g. GMM, RS, BEC-Tero, ICN, etc.) not holding any spectrum rights. These broadcasters rent capacity from incumbent broadcasters, who hold spectrum rights. Please note that SP stands for service provisioning and NO for network operations in Table 10.

Variant	SP/NO	By invitation - parties	By public tender - parties
1	SP	50% - Big 3 or (Big 3 + 3rd party broadcasters)	50% - Others
	NO	100% - Big 3 or (Big 3 + 3rd party broadcasters)	None
2	SP	50% - Big 3 or (Big 3 + 3rd party broadcasters)	50% - Others
	NO	50% - Big 3 or (Big 3 + 3rd party broadcasters)	50% - Others
3	SP	-	50% - Best Bidder(s) and 50% - Others
	NO	-	100% - Best Bidder(s)

TABLE 10: ASSIGNMENT INSTRUMENTS AND EXAMPLE BIDDERS

Considering the fragmentation of tower assets (and other facilities) in the Thai radio market, the JVC can be organized in such way that a balanced participation in the JVC can be arranged for. Figure 23 shows that the JVC can subcontract the installation and operations of network elements to its members. The subcontracting may also be split in two parts; the overall network deployment by a single third party (i.e. system implementation and integration) and the subsequent operations of the network elements by the various JVC members. It is important to note that for assuring an efficient (i.e. sharing of network facilities and equipment) and coordinated DAB deployment, it is essential that the JVC keeps in control of:

1. Network design (this may include any additional frequency planning work before and during the network deployment, possibly with assistance of the NBTC);
2. Network deployment planning;
3. Single sourcing of the DAB equipment (for all services).



Source: ITU

FIGURE 23: SUBCONTRACTING BY THE JVC

The above presented assignment variants offer the following advantages:

1. Efficient and coordinated deployment of DAB networks and services by assigning the Trail Service and Network license to a single coordinating entity: the JVC;
2. Pulling financial and other resources together and ensuring a balanced market participation by establishing a JVC which subcontracts activities to members;
3. Incentives for market parties to invest in DAB as exclusive access is offered to reserved multiplex capacity and a long running (15 years) operating right for the network operations;
4. Allowing other market parties (non-JVC members) to enter the market by offering a Pool.

Recommendations

The following is recommended on assignment instruments:

1. Assign the Trial Service and Network license in a single assignment procedure to a JVC, either in option 1 or 2. Option 1 and 2 offers the NBTC the possibility to negotiate details of the JVC and the license terms and conditions (see Section 2.5). Option 3 (directly a public tender) excludes this possibility. Moreover, option 1 and 2 can always resort to a public tender if the negotiations fail;
2. Discuss or negotiate with the market whether option 1 or 2 is preferred. Option 2 provides more possibilities for other market parties to enter the JVC at a later stage (after a successful negotiation) and this may reflect interests in the market better. This option however complicates matters of ownership in the JVC and entails a risk for the initial JVC member as it is unknown which members will participate after establishing the JVC.

2.4.2 Operating models

As described in the benchmark report various operating models are possible and implemented across the world[46]. This Section shows when selecting either variant 1, 2 or 3 as described in Section 2.4.1, which operating model would best match which such a variant.

Options

The benchmark report described the following operating models, as included in Table 11.

Characteristics	Operating model				
	Transmission provider	**Mixed 1 (UK, NOR)**	**Mixed 2 (half way)**	**Mixed 3 (AUS)**	**Broadcaster**
Spectrum ownership / licence	3rd Party – transmission provider	3rd party – multiplex provider	Broadcaster / JVC	Broadcaster / JVC	Broadcaster / JVC
Broadcaster licence	Broadcaster / content provider	Broadcaster / content provider	Broadcaster / content provider	Broadcaster / content provider	Broadcaster / content provider
Tower access	3rd Party	3rd Party	3rd Party	3rd Party	Broadcaster / JVC
Antenna system	3rd Party	3rd Party	3rd Party	3rd Party	Broadcaster / JVC
Transmitters	3rd Party	3rd Party	3rd Party	JVC	Broadcaster / JVC

[46] See section "Operating model" in ITU report as indicated in footnote 11.

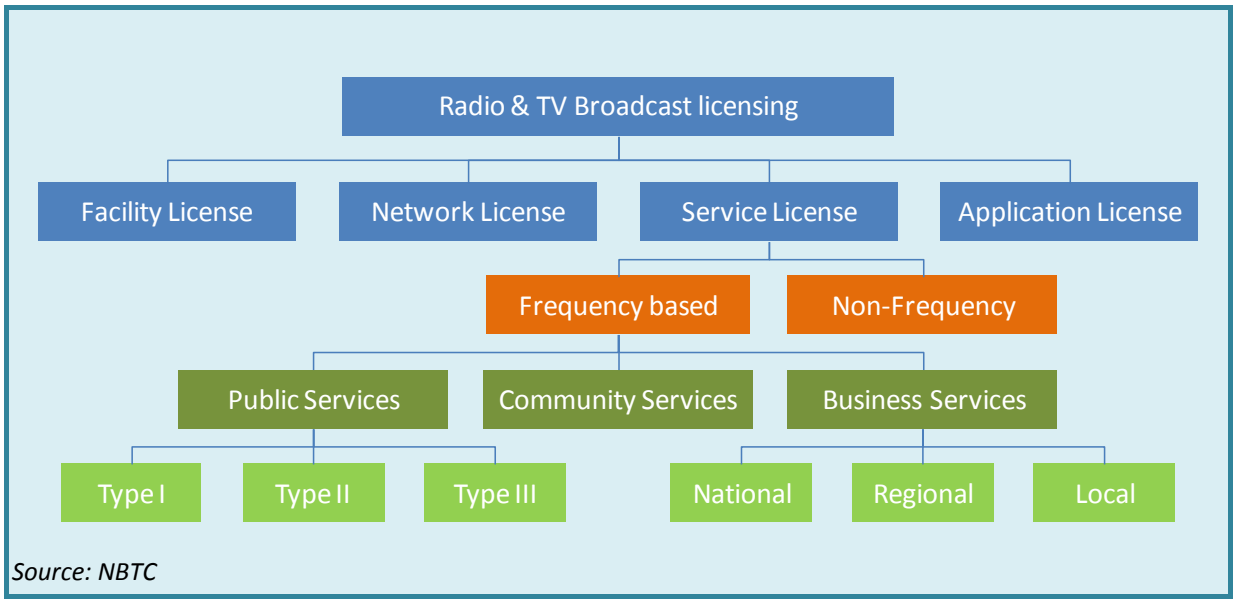
Characteristics	Operating model				
Distribution (Sat)	3rd Party	3rd Party	3rd Party/broadcaster	JVC	Broadcaster / JVC
Ensemble multiplexer	3rd Party	3rd Party	Broadcaster / JVC	JVC	Broadcaster / JVC
Studio equipment /contribution	3rd Party	Broadcaster	Broadcaster	Broadcaster	Broadcaster
Configuration Control of slot	3rd Party	Broadcaster	Broadcaster	Broadcaster	Broadcaster
Operations and maintenance DAB NO	3rd party	3rd party except for studio equipment	Controlled by JVC – can be broadcaster or 3rd party	Controlled by JVC – can be broadcaster or 3rd party	Controlled by JVC – can be broadcaster or 3rd party

TABLE 11: OPERATING MODELS FOR DAB

Considerations

Any selected operating model should consider the Thai licensing framework, which comprises next to the Trial license also the regular licenses. 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)[47]. The licensing framework is depicted in Figure 24.

[47] The Organization Act is currently in the process of being revised and a draft for the new Act is awaiting final approval. In this draft of the new Act, apart from the changes in the governance structure of the NBTC, auction is no longer the only instrument for assigning spectrum rights, also a public tender can be applied.



Source: NBTC

FIGURE 24: LICENSING FRAMEWORK FOR BROADCASTING

For the Trial the Regulator can make use of the Trial license. However, the Regulator should consider the transition from the Trial licensing to the regular licensing regime. This transition is specifically addressed in Section 2.5.1.

Operating model Mixed 3 (see Table 11) comes close to the assignment variants as described in Section 2.4.1.

Recommendations

The following is recommended on operating models:

1. Apply the operating model Mixed 3 as this model comes closest to the basic principles underpinning the recommended assignment variants as described in Section 2.4.1;
2. Adapt operating model Mixed 3 for the regulatory framework as applicable in Thailand.

Table 12 shows how the operating model Mixed 3 can be implemented in Thailand as to match the current regulatory framework. In Table 12, SL stands for Service Licensee and FL for Facility Licensee. The changes to Mixed 3 are indicated in Italic.

Characteristics	**Operating model**	
	Mixed 3 (AUS)	**Thailand proposal**
Spectrum ownership / licence	Broadcaster / JVC	Trial SLs
Broadcaster licence	Broadcaster / content provider	Trial SLs
Tower access	3rd Party	FLs have rental contract with JVC
Antenna system	3rd Party	*provided by JVC to Tower FLs*

Transmitters	JVC	provided by JVC to Tower FLs
Distribution (Sat)	JVC	JVC, sub-contracted to FLs/contractor
Ensemble multiplexer	JVC	provided by JVC to Site FLs
Studio equipment /contribution	Broadcaster	Trial SLs
Configuration Control of slot	Broadcaster	Trial SLs
Operations and maintenance DAB NO	Controlled by JVC – can be broadcaster or 3rd party	JVC, sub-contracted to FLs

TABLE 12: PROPOSED OPERATING MODEL FOR DAB

2.5 License terms and conditions

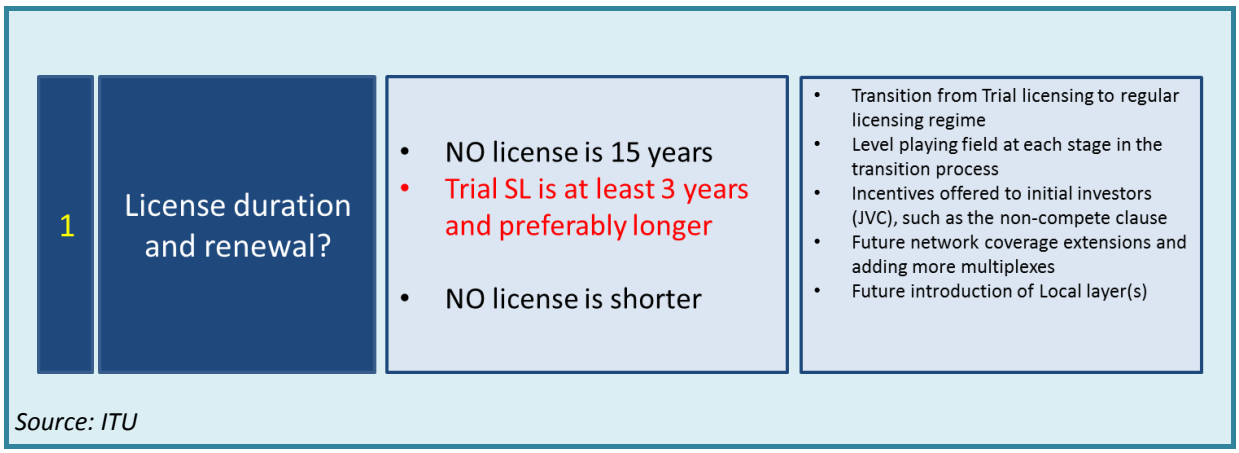
In this Section the following aspects of the DAB licensing terms and conditions are addressed:

1. License duration and renewal;
2. Service level requirements.

It is noted that a range of license terms and conditions have already been addressed in the previous sections. This section only addresses those license terms and conditions not specifically addressed yet.

2.5.1 License duration and renewal

Figure 25 shows an overview of the options and considerations. The option in red is the recommended option.



Source: ITU

FIGURE 25: OPTIONS AND CONSIDERATIONS ON LICENSE DURATION AND RENEWAL

Options

The duration of the Network license has already been addressed in Section 2.4.1. In this Section the duration and renewal of the Trial Service license is discussed. The options are:

1. 3 years, which is expected to correspond to the ATV ASO date in the VHF Band III (see Section 2.1.2). After this ASO date it is possible to deploy the Trial network further into the country (i.e. the National and Local network deployment). A later ASO date, let's say in the year 2021, would result in a duration of 4 years;
2. A longer period, which does not necessarily correspond to the ATV ASO data. This longer period would allow more time for market parties to operate DAB services under the Trial licensing regime.

In this Section also the assignment procedure after the Trial Service license is addressed.

Considerations

Alternative scenarios have to be drafted and evaluated when determining the license duration, renewal or re-assignment procedures. The following aspects should be evaluated:

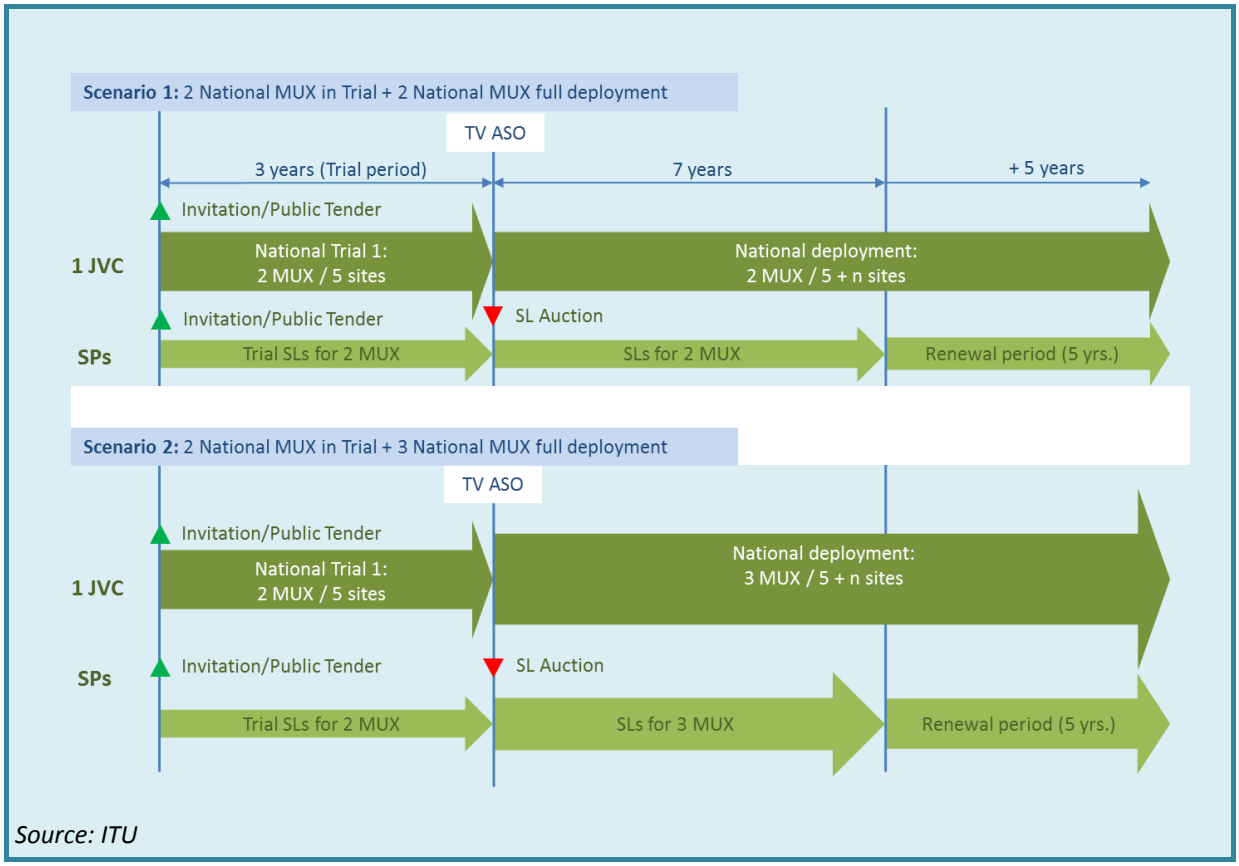
1. The transition from the Trial licensing to the regular licensing regime. This addresses the question "What is the best time for assigning the regular licenses?". As stated before, only after ATV ASO it is possible to deploy National and Local networks. With this comes the possibility to seriously increase the earning capacity of the DAB services (as a large network coverage is then possible). The Trial should at the same time provide enough time to build-up some critical mass and to find out what services work best;
2. A level playing field should be encouraged where possible. Creating a level playing field should be balanced against the investment risks the Regulator requests from market parties to take when investing in DAB (in particular in the case of matched funding). At the moment of extending or re-assigning licenses the Regulator should check if market parties can access the market for providing the same service under similar conditions and assignment mechanisms (i.e. public tender or auction);
3. Providing enough incentives for the market parties to enter the DAB market at the beginning of the process (i.e. the Trial licensing) and also in the following stages (i.e. the regular licensing).

The following three scenarios have been drafted to address the transition from Trial to Regular licenses:

1. **Scenario 1**: only the network coverage is extended in the next deployment stage. In this scenario the number of multiplexes (assumed to be two, as recommended in Section 2.2.1) is not increased and only the network coverage is extended to reach for example 80% or 95% of the population (see Section 1.1.2);
2. **Scenario 2**: both the network coverage and the number of multiplexes is increased. For example, the number of multiplexes can be increased to three. This scenario implies that more service providers can access the market;

3. **Scenario 3**: as scenario 1 plus a Local layer is introduced in the next deployment stage. This scenario implies that the Local network operators and service providers can enter the market.

Figure 26 shows the scenarios 1 and 2 as listed above.



Source: ITU

FIGURE 26: SCENARIOS 1 AND 2 FOR LICENSING EVALUATION

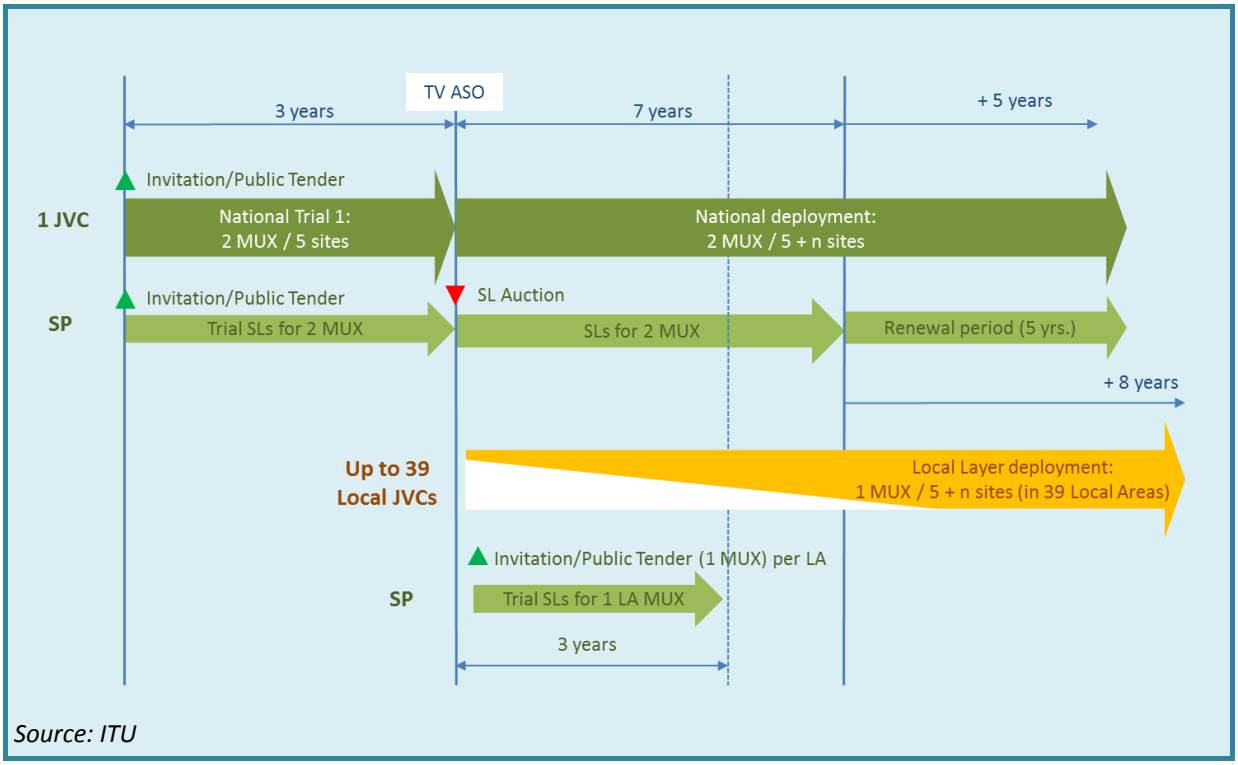
The following can be observed and concluded from Figure 26:

1. Under scenario 1 and 2, the JVC keeps operating all multiplexes and sites. For scenario 2 the introduction of a second network operator for operating the third multiplex was rejected because:
    a. The principle of operating a commonly designed, deployed and operated DAB platform would be jeopardized (see also Section 2.3.1);
    b. The incentive for the JVC to enter the market would be significantly reduced as it can expect Network competition as well as service competition;
2. Under scenario 1 and 2, when migrating from the Trial period to national deployment, all available capacity slots for service provisioning are assigned by auction (for commercial service providers). This implies that the (commercial) JVC members can only continue their business when they are successful in the auction. Considering that it is likely that no government funding will be available for the Trial, it is argued that this period should preferably be longer than 3 years. The Trial duration is a typical element for negotiations

between the market parties and the NBTC. It is noted that market parties having participated in the Trial will be in a better position in this auction than DAB new comers as they have gained a DAB market position and experience (over a period of 3 years or longer).

In addition, it should be considered to provide a further incentive to Trial Service licensees by reserving a defined amount of capacity for incumbents (i.e. the Trial licensees) in the Service license auction. This will provide the Trial Service licensees a clear path to the future where at least some of the services that they have developed during the trial period will continue and hence they will be able to maintain business momentum. Hence the reservation of some capacity, e.g. half of what they use in the Trial, is a reward for their risk taking and initial financial investment.

Figure 27 shows scenarios 3 as listed above. LA refers to Local Areas. A total of 39 LAs are assumed for the Local Layer.



Source: ITU

FIGURE 27: SCENARIOS 3 FOR LICENSING EVALUATION

Figure 27 the following can be observed and concluded:

1. Under scenario 3, the JVC keeps operating all National multiplexes and sites. As argued for scenario 1 and 2 the introduction of a second National network operator for operating the third multiplex was rejected as described above (this third National multiplex is not depicted in Figure 27);
2. As under scenario 1 and 2, under this scenario when migrating from the Trial period to national deployment, all available capacity slots for service provisioning are assigned by auction (for commercial service providers);
3. Under scenario 3 when introducing a Local layer (only possible after TV ASO), a Trial Service license in combination with Network license of 15 years, can be assigned to a Local JVC for

the distribution and provisioning of Local services[48]. This is the same assignment procedure as described in Section 2.4.1;

4. When deploying the Local layer, the following should be noted:
    a. The deployment of these Local networks should follow the deployment of the National networks. Hence the following two aspects are depicted in Figure 27:
        i. First the 5/8 Trial sites should be equipped with a Local transmitter sharing the already installed DAB antenna system for the National services;
        ii. The National network is introduced in a LA first and then the Local services (see the delayed start of the yellow arrow);
        iii. LA networks are deployed in stages and LA networks are first deployed in the most promising areas (for example the Bangkok and Chang Mai provinces);
    b. The National JVC is leading in the network design and should design the DAB system in such a way that the Local services can be inserted and transmitted. The network design as described in ITU report "DAB+ System Architecture Design for Thailand" allows for this;
    c. The Local JVC designs and deploys the Local network for a near total population coverage in the LA in a spectrum efficient manner. This means the application of a SFN in a LA. This explicitly excludes the possibility of just erecting a few single sites on the basis of a MFN. A MFN deployment in the LAs would result quickly in enormous spectrum shortages in the rest of the country.

Recommendations

The following is recommended on license duration and renewal:

1. Do not end the Trial licensing regime before the ATV ASO in VHF Band III takes place. This is currently assumed to take place at the start of 2020. With an assumed Trial start late 2016 or at the beginning of 2017, this would result in a 3-year Trial duration. A longer Trial duration is preferred as no Government funding will be likely available for the Trial. The Trial duration is a typical element for negotiations between the market parties and the NBTC;
2. Ensure that the National JVC keeps operating all National multiplexes and sites when migrating from the Trial to regular licensing regime;
3. Assign regular Service licenses either in an auction or public tender[49] (for commercial broadcasters) for all available National capacity slots (at the start of the regular licensing period). It should be considered to provide a further incentive to Trial Service licensees by reserving a defined amount of capacity for incumbents (i.e. the Trial licensees) in the Service license auction, this is a reward for their risk taking and initial financial investment;
4. When introducing a Local layer (dependent on demonstrated market demand accompanied with enough funding resources), assign a Trial Service license in combination with a Network

[48] The option of the National NO JVC also providing for Local services is not explicitly excluded.

[49] Assigning spectrum rights to commercial entities by public tender may become a possibility under the new Organization Act which is currently awaiting final approval. See also footnote 47.

license of 15 years, to a Local JVC for the distribution and provisioning of Local services in a single LA. This is the same assignment procedure as described in Section 2.4.1;

5. Ensure a spectrum efficient and coordinated network deployment between the National and Local JVCs, by having the National network deployment leading the Local deployment.
6. Do not allow the fragmented establishment of a few single sites (in MFN configuration) in LAs across the country.

2.5.2 Service level requirements

Figure 28 shows an overview of the options and considerations. The option in red is the recommended option.

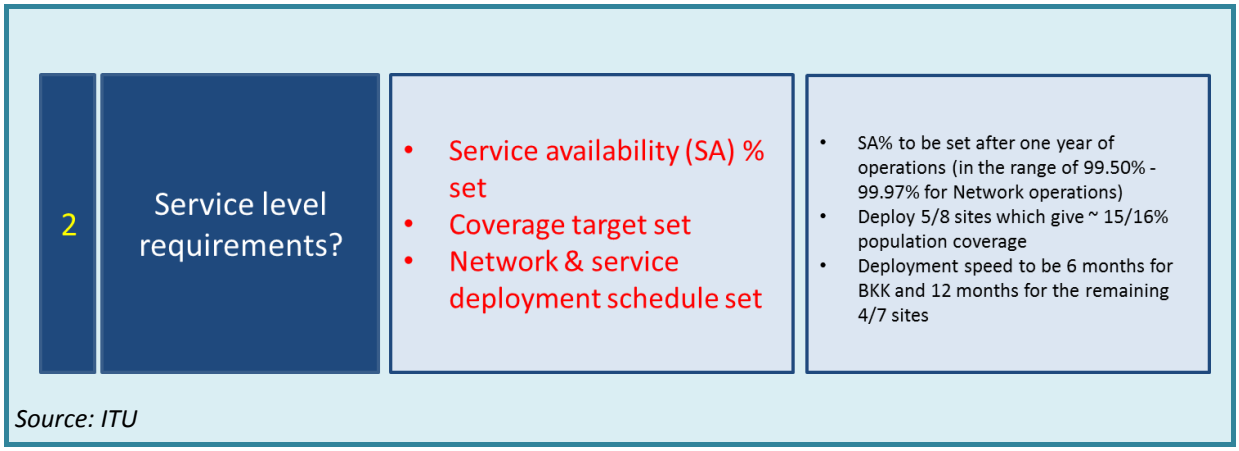


FIGURE 28: OPTIONS AND CONSIDERATIONS ON SERVICE LEVEL REQUIREMENTS

Options

The following service level requirements could be set by the Regulator:

1. Service Availability (SA);
2. Coverage target (in % of population or households);
3. Network and service deployment schedules.

This Section addresses the options of regulating or not regulating the above listed service level requirement. For the third service level requirement it was already recommended to set such a requirement (see Section 2.1.4).

Considerations

One of the objectives of the Trial is for the network and service providers to learn about the reliability and performance of the various network elements. Each DAB network deployment is different and it will be difficult to set a SA% and have the network and service providers comply with this norm. Alternatively, after one year of (Trial or commercial) operations and the Regulator having

monitored the actual SA% levels, the Regulator can set a SA% for both the network operations and the service provisioning (i.e. studio output)[50].

For setting a coverage target the number of sites, the ERPs per site and the number of multiplexes (with the same coverage) should be considered. As discussed in Section 1.1.1 and included in Table 1 various coverage percentages are possible. A summary of Table 1, including only the coverage percentages for the various network deployments, is provided in Table 13 below.

Item	ITU frequency plans		
# Sites	8	8	5
ATV protection	√	X	√
ATV coverage provided	√	√	√
Pop coverage (3 MUX)	9,123,000 (14%)	17,422,000 (27%)	8,431,000 (13%)
Pop coverage (2 MUX)	10,712,000 (16%)	17,965,000 (28%)	9,873,000 (15%)
Pop coverage (1 MUX)	11,894,000 (18%)	18,560,000 (29%)	10,624,000 (16%)

TABLE 13: POPULATION COVERAGE TARGETS FOR DIFFERENT NETWORK DEPLOYMENTS

Recommendations

The following is recommended on service level requirements:

1. Set a SA% requirement for studio output and network availability after one year of DAB operations. In this way the Regulator and the radio industry can learn from the Trial what feasible SA levels are;
2. Set a coverage target as included in Table 13. If 5 sites would be deployed and 2 equal multiplex coverages are required, this coverage target would be 15% of the total Thai population;
3. Prescribe a deployment schedule as follows (see also Section 2.1.4):
    a. The Bangkok site should be deployed within 6 months (after awarding the Trial license);
    b. All other sites (4 or 7 sites) should be deployed within 12 months (after awarding the Trial license).

[50] This SA% could be ramped up over a couple of years, e.g. year 1 = 99.00%, year 2 = 99.90% and year 3+ = 99.97%.

3. National and local service deployment and licensing

This Chapter provides a comprehensive overview of the decisions to be made on the different aspects of the digital radio deployment strategy for the National and Local services and what licensing framework accompanies such decisions.

The National and Local service deployment includes the deployment of the DAB network, the digital radio services to be carried in the DAB multiplexes, as well as the supporting measures. For the licensing framework the assignment procedures and the digital radio specific license terms and conditions will be addressed. It should be noted that the assignment procedures not only include the assignment instrument but also the applied or envisioned operating model (between the different actors in the digital radio value chain).

As said in Chapter 2, the National, Local and Trial deployment strategies are interrelated. Hence the options considered in this Chapter follow directly from the decisions made for the Trial deployment strategy.

This Chapter is structured as follows:

1. Network deployment;
2. Service deployment;
3. Supporting measures;
4. Licensing procedures;
5. License terms and conditions.

3.1 Network deployment

In this Section the following aspects of the DAB National and Local network deployment are addressed:

1. Start of National and Local licensing;
2. Duration of Network and Service licenses;
3. Network sharing requirements;
4. Number of sites;
5. Deployment speed.

3.1.1 Start of National and Local licensing

Figure 29 shows an overview of the options and considerations. The option in red is the recommended option.

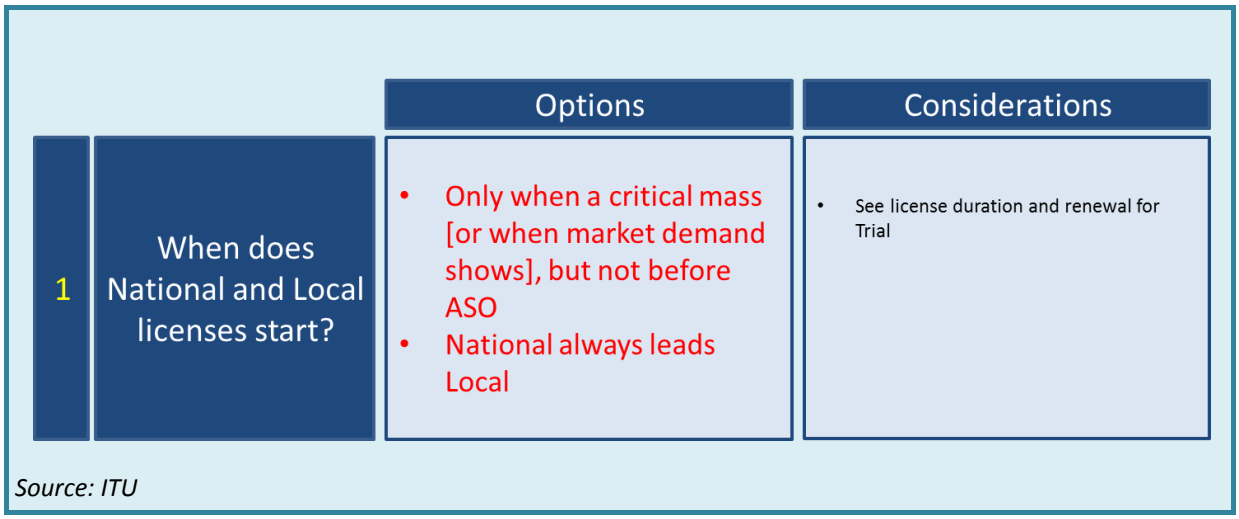


FIGURE 29: OPTIONS AND CONSIDERATIONS ON START OF NATIONAL AND LOCAL LICENSING

Options

The start of the regular licensing regime has already been addressed in Section 2.5.1.

Considerations

In addition to what has been considered in Section 2.5.1, here the additional possibility is suggested that if enough DAB listeners have been generated during the Trial, the regular licensing could start. However as said in Section 2.1.2, it is recommended to set a fixed period for the Trial as:

1. A critical mass approach would result in long disputes about the right measuring method and results;
2. A fixed period provides clarity about the future of DAB and this clarity is need for investors in the Trial.

Recommendations

The following is recommended on the start of National and Local licensing (please note that the recommendations are the same as suggested in Section 2.5.1):

1. Do not end the Trial licensing regime before the ATV ASO in VHF Band III takes place. This is currently assumed to take place at the start of 2020. With an assumed Trial start late 2016 or at the beginning of 2017, this would result in a 3-year Trial duration. A longer Trial duration is preferred as no Government funding will be likely available for the Trial. The Trial duration is a typical element for negotiations between the market parties and the NBTC;
2. Ensure that the National JVC keeps operating all National multiplexes and sites when migrating from the Trial to regular licensing regime;
3. Assign regular Service licenses either in an auction or public tender[51] (for commercial broadcasters) for all available National capacity slots (at the start of the regular licensing period). It could be considered to provide a further incentive to Trial Service licensees by

[51] See footnote 49.

reserving a defined amount of capacity for incumbents (i.e. the Trial licensees) in the Service license auction. This is a reward for their risk taking and initial financial investment;

4. When introducing a Local layer (dependent on demonstrated market demand accompanied with enough funding resources), assign a Trial Service license in combination with Network license of 15 years, to a Local JVC for the distribution and provisioning of Local services in a single LA. This is the same assignment procedure as described in Section 2.4.1;
5. Ensure a spectrum efficient and coordinated network deployment between the National and Local JVCs, by having the National network deployment leading the Local deployment.
6. Do not allow a fragmented establishment of a few single sites (in MFN configuration) in LAs across the country.

3.1.2 Duration of Network and Service licenses

Figure 30 shows an overview of the options and considerations. The option in red is the recommended option.

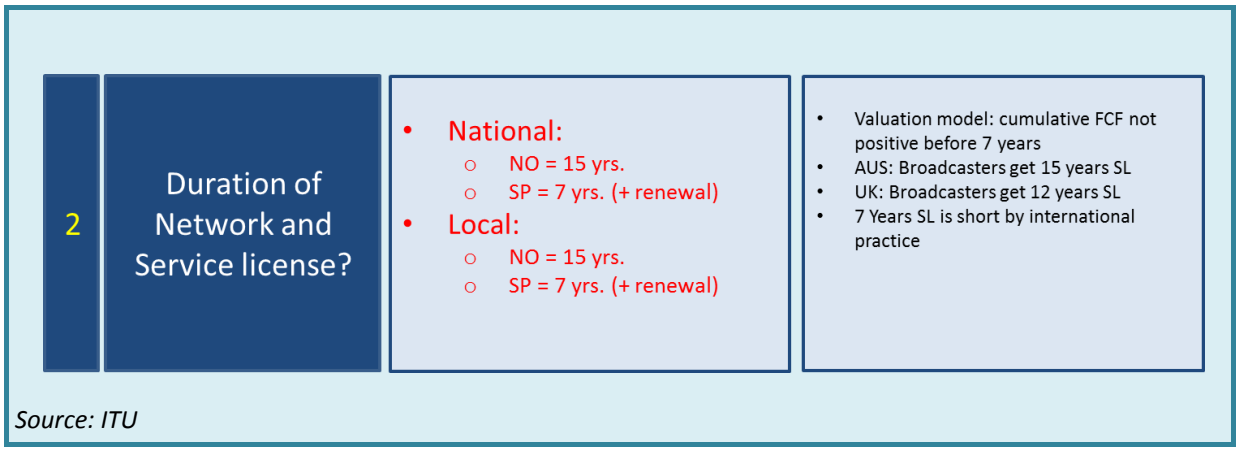


FIGURE 30: OPTIONS AND CONSIDERATIONS ON DURATION OF NETWORK AND SERVICE LICENSES

Options

The duration of the Network license has already been addressed in Section 2.4.1. In Section 2.5.1 (i.e. the Service license was assumed to be seven years (see Figure 26 and Figure 27). The duration of Service license is specifically addressed in this Section.

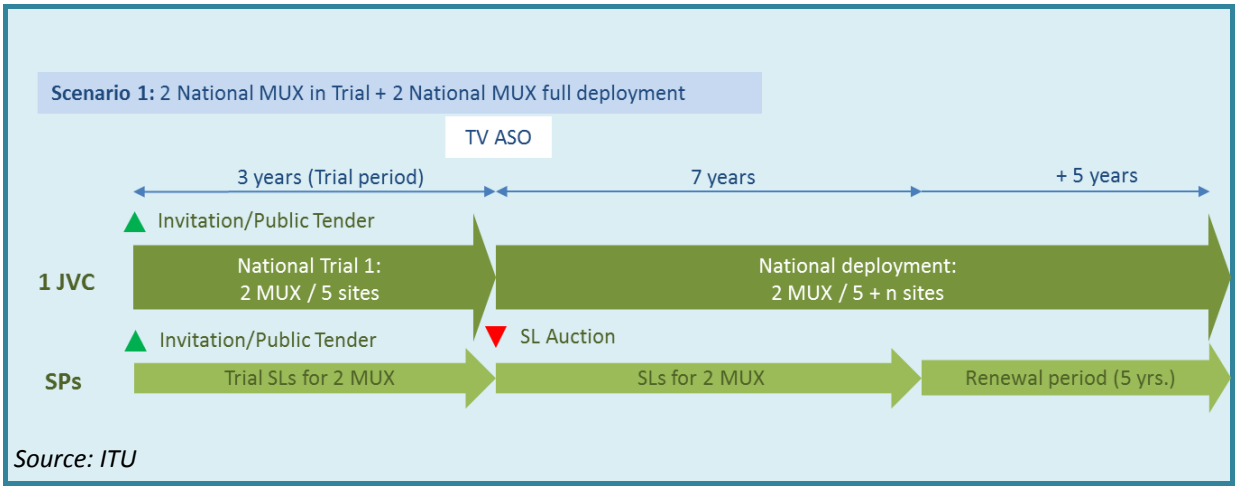
Considerations

As discussed in the Section 1.3.4, the valuation model showed that a license duration of 7 years is too short to make the cumulative cash flow positive, in any realistic scenario. Hence any DAB Service and Network license should be provided at least for a license period of 10 years or more. Without considering the duration of the Trial, this could be facilitated by offering an initial Service license period of 7 years with an option to extent for another period of 5 to 7 years (unless the licensee is mal performing its duties).

The international Benchmark study showed that comparable licenses (to the Service licenses in Thailand) are assigned with a longer duration than 7 years (see Table 5):

1. Australia: 15 years;
2. UK: 12 years.

When including a renewal option in the Service license the termination of the Network license should be considered. A Service license that would last longer than the license of the Network operator the Service licensee has a distribution agreement with, should be avoided. Under such a scenario the Service licensee would be faced with uncertainty about the continuity of the distribution services (and the terms and conditions under which a continuity would take place as a different Network operator may continue the DAB distribution service). Figure 31 shows a possible duration of the renewal period under the assumption of 3-years Trial period, ensuring the equal termination of the Service and Network license (see also Figure 26).



Source: ITU

FIGURE 31: RENEWAL PERIOD FOR SERVICE LICENSE

It should be noted that the renewal period of 5 years as depicted in Figure 31 is based on the following assumptions:

1. Trial Service License duration of 3 years;
2. Network license duration of 15 years and assigned at the same time of the Trial Service license;
3. Service License assigned directly following the termination of the Trail Service license.

Recommendations

The following is recommended on the duration of Network and Service licenses:

1. Assign the Service license for 7 years with an option for renewal. This renewal is awarded when the Service licensee is performing its duties in accordance with the stipulated license terms and conditions;
2. Organize an auction for the reassignment of the capacity used by those Service Licensees that are not performing their duties in accordance with the stipulated license terms and conditions. For those Service licenses in the auction it is recommended to assign them for a period with end date that is equal to the end date of Network license (on which the

associated services will be carried). As suggested in Figure 31 this would imply a Service license duration of 5 years.

3.1.3 Network sharing requirements

Figure 32 shows an overview of the options and considerations. The option in red is the recommended option.

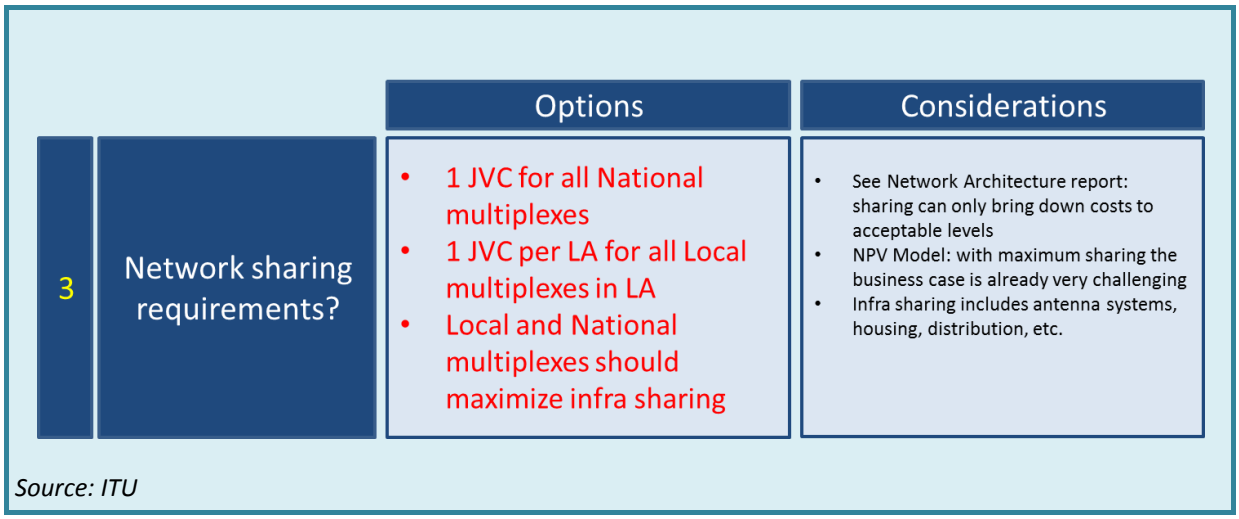


FIGURE 32: OPTIONS AND CONSIDERATIONS ON NETWORK SHARING REQUIREMENTS

Options

Network sharing requirements have been already addressed in Section 2.4.1 and 2.5.1.

Considerations

No additional considerations, as compared to those listed in Section 2.4.1 and 2.5.1.

Recommendations

The following is recommended on network sharing requirements (see also what was recommended in Section 2.4.1 and 2.5.1):

1. Assign the Network license in a single assignment procedure to a JVC;
2. Ensure that the National JVC keeps operating all National multiplexes and sites (when migrating from the Trial to regular licensing regime);
3. When introducing a Local layer, assign a Trial Service license in combination with Network license of 15 years, to a Local JVC for the distribution and provisioning of Local services in a single LA;
4. Ensure a spectrum efficient and coordinated network deployment between the National and Local JVCs, by having the National network deployment leading the Local deployment;
5. Do not allow a fragmented establishment of a few single sites (in MFN configuration) in LAs across the country.

3.1.4 Number of sites

Figure 33 shows an overview of the options and considerations. The option in red is the recommended option.

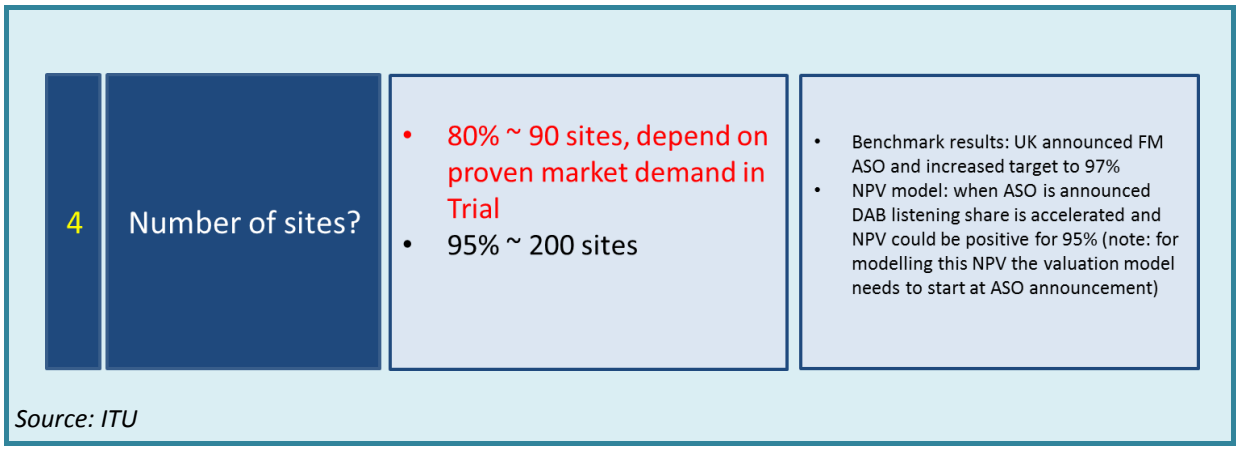


FIGURE 33: OPTIONS AND CONSIDERATIONS ON NUMBER OF SITES

Options

Theoretically the number of sites for a nationwide deployment can range from 5+ (i.e. the minimum number of sites in the Trial) to 200+ sites, depending on the coverage target. Here three options will be considered; (a) 90 sites providing approximately 80% pop coverage, (b) 200 sites providing approximately 95% pop coverage, and (c) no set target and consequently not included in the Network license terms and conditions, the target will depend on market demand.

Considerations

As concluded in Section 1.3.4, there is no realistic scenario possible under which the deployment of a Local layer would result in a positive NPV. Hence the deployment of a Local layer is dependent on financial support by Government. In other words, when considering the number of sites for a commercial based nationwide deployment, we are considering only the National layers.

In addition, as was argued in Section 2.5.1, the National layer has to be leading as to avoid spectrum inefficiencies and ensure maximum infrastructure sharing.

The valuation results for National (only) deployments are included in Table 14 (see also Table 9).

Ref.	# sites	% greenfield sites	Pop %	# MUX	# SPs	Total CAPEX	NPV total market	NPV / Nat. SP	NPV / Local SP
N1	200	15%	95%	2+0	18+0	$84,702,880	$190,502,461	$10,583,470	NA
N2	90	0%	80%	2+0	18+0	$37,973,880	$266,538,766	$14,807,709	NA
N3	200	15%	95%	3+0	27+0	$131,831,770	$67,201,171	$2,488,932	NA
N4	90	0%	80%	3+0	27+0	$59,252,770	$204,157,121	$7,561,375	NA
N5	200	15%	95%	4+0	36+0	$158,662,660	-$11,069,193	-$307,478	NA

TABLE 14: VALUATION RESULTS FOR NATIONAL DEPLOYMENTS

As Table 14 shows, setting a coverage target of 95% could be set as long as the number of multiplexes is below three (but three is not advised, see Section 2.2.1). It is noted that the coverage target for DAB is also correlated to the best national coverage in the FM market (which is set at 70% in the base case scenarios in the valuation model[52]). A DAB coverage target (e.g. 80%) exceeding the best national FM network coverage will clearly add value.

The benchmark study showed that in the target countries either a FM ASO date is set (Norway) or a conditional FM ASO date or plan is proposed (UK/Switzerland) or discussed (Australia). With a complete FM ASO (so not only parts of the FM band) the DAB platform should replace all FM listening. Under such conditions the coverage target requirement for the DAB platform may increase, as was the case in the UK (from 95% to 97%). The underpinning notion here is that terrestrial radio distribution (either analogue or digital) is considered a Universal Service. Hence it should be noted that only the BBC (i.e. for PSB) multiplex was increased and consequently financed with the aid of public means.

As demonstrated in the valuation model an ASO announcement in combination with a set FM ASO date will accelerate the uptake of DAB services (see for example Figure 63 and Figure 67). At the moment of announcing the FM ASO date the NPV may well go up significantly. A scenario modelled before the ASO announcement may prove that 3 multiplexes are not feasible. However a scenario modelled at the moment of the ASO announcement, may prove a 3 or 4-multiplex scenario to be positive[53].

Recommendations

The following is recommended on the number of sites:

1. Set a coverage target, as this will provide clarity for the receiver and car industry about the potential market size;

[52] From the FM congestion analysis as included in Annex C, 70% can be considered as theoretically the best possible coverage percentage as this would assume that all FM stations of a single spectrum holder (i.e. RTA) would all broadcast the same service and all interference would be eliminated.

[53] This will require the valuation model to start at the moment of the ASO announcement.

2. At the end of the Trial and after consulting the market at that time, do not set the maximum coverage target but a lower target. On the basis of the presented data in this report, it is recommended to set the coverage target initially at 80% (which is exceeding by far the best FM national network coverage);
3. At the time of a FM ASO announcement the network coverage target can be increased to 95%, dependent on:
    a. A FM ASO announcement;
    b. DAB market success, and;
    c. Public financial resources available at that time.

3.1.5 Deployment speed

Figure 34 shows an overview of the options and considerations. The option in red is the recommended option.

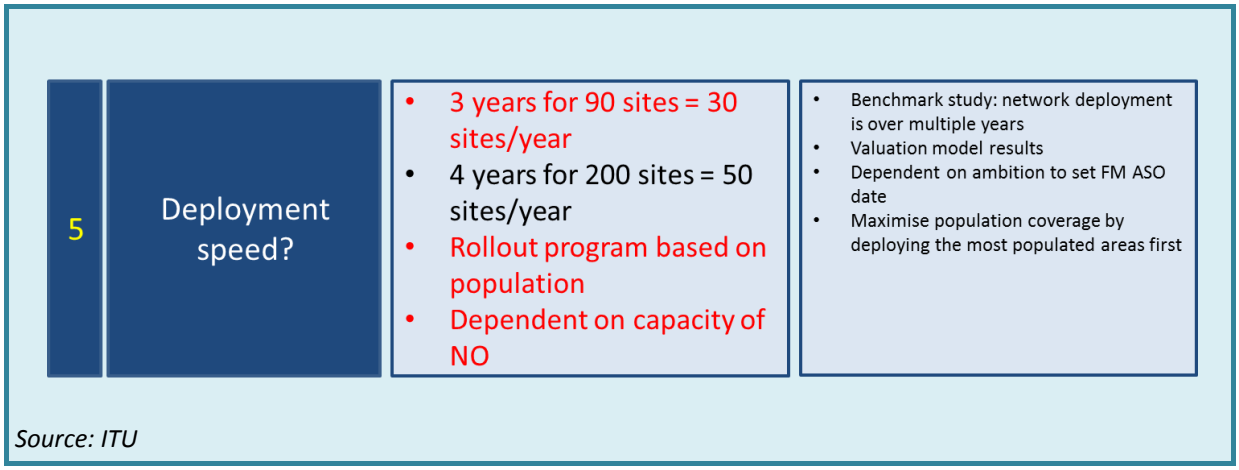


FIGURE 34: OPTIONS AND CONSIDERATIONS ON DEPLOYMENT SPEED

Options

In this Section, given the coverage target (as discussed in the previous Section 3.1.4), the deployment speed is addressed, i.e. how many sites in each year.

Considerations

The benchmark study showed network deployments over multiple years.

The valuation model showed that with a given number of sites, but a varying deployment speed the NPV is not impacted heavily. Table 15 shows the results of this analysis for the base case scenario N1 and N2, which includes respectively 200 and 90 sites (see also Table 9).

Ref.	# sites	% greenfield sites	Pop %	# MUX	# SPs	Deployment speed in # years	NPV total market
N1	200	15%	95%	2+0	18+0	3	$190,502,461
N1	200	15%	95%	2+0	18+0	4	$182,780,070

Ref.	# sites	% greenfield sites	Pop %	# MUX	# SPs	Deployment speed in # years	NPV total market
N2	90	0%	80%	2+0	18+0	3	$266,538,766
N2	90	0%	80%	2+0	18+0	4	$260,035,701

TABLE 15: NPV RESULTS FOR DIFFERENT DEPLOYMENT SPEEDS (N2 SCENARIO)

An ambition to set an FM ASO date may result in the requirement of a speedy deployment. However, when stipulating a deployment schedule requires the consideration of:

1. The financial viability. A speedy deployment requires that many deployment resources have to be made available in a shorter time, which is more expensive, and;
2. The operational capacity of the network operator (i.e. JVC).

The deployment schedule should not only consider the number of sites to be deployed per year but also in which areas they should be deployed. From a business perspective they should be deployed in the most populated areas first. This may conflict with demands for making radio Community Service available (in rural areas). Responding to such demands will depend on the financial contribution of those services.

Recommendations

The following is recommended on the deployment speed:

1. In line with the recommendations as listed in Section 3.1.4 and in consultation with the Network operator (JVC), the following deployment schedule is recommended; 80 sites in 3 years in the most populated areas;
2. Any requirement for the introduction of Local services in other then the most populated areas, should be accompanied with a sound business case (including revenues from Local commercial broadcasters and public funding for CS), showing enough funding in the long term.

3.2 Service deployment

In this Section the following aspects of the National and Local service deployment are addressed:

1. Number of multiplexes and services per multiplex;
2. Number of services per service provider;
3. Simulcast requirement;
4. Type of service providers;
5. Additional services.

3.2.1 Number of multiplexes and services per multiplex

Figure 35 shows an overview of the options and considerations. The option in red is the recommended option.

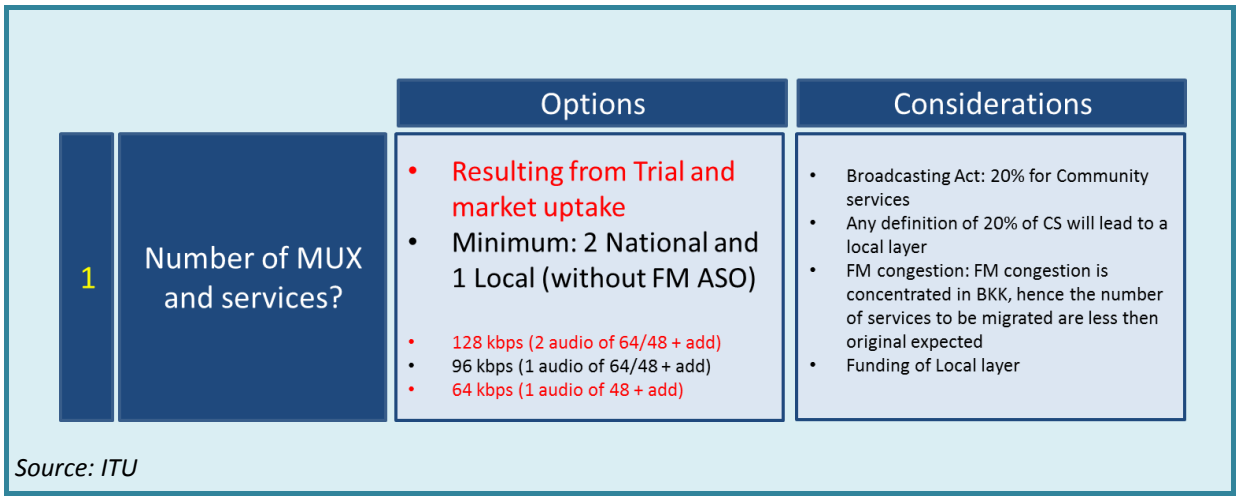


FIGURE 35: OPTIONS AND CONSIDERATIONS ON NUMBER OF MULTIPLEXES AND SERVICES PER MULTIPLEX

Options

The options for the number of multiplexes and the number of services per multiplex are correlated to these numbers during the Trial (see Section 2.2.1 and 2.2.2). The correlated options are:

1. Resulting from the Trial and market uptake, or;
2. A minimum requirement (for example 2 National + 1 Local multiplex), and;
3. The number of services per multiplex is dependent on market demand (by offering two type of slots that can be acquired), or;
4. A minimum number of (audio) services per multiplex.

Considerations

In addition to the considerations as listed in Section 2.2.1 and 2.2.2, the following aspects can be considered:

1. The number of multiplexes offered in the Trial should be considered. This number of multiplexes sets a precedence for the National and Local service deployment. For example, if 3 multiplexes were selected (not recommended though, see Section 2.2.1) for the Trial it is virtually impossible to reduce the number of multiplexes when deploying nationwide. A Higher number may be possible if the market uptake is proven to be successful during the Trial;
2. A similar argument applies for the choice between a market-driven number of services per multiplex or given number per multiplex. The Trial sets a precedence for the National and Local service deployment in terms of typical number of services per ensemble;
3. As indicated in Section 2.4.1 and 2.5.1, network sharing is necessary between all services, including between National and Local Services. Consequently, when 20% of spectrum has to be reserved for CS, the Local layer will have to share its sites and antennas with the National layer. It should be noted that the Broadcasting Act doesn't regulate when this Local layer should be introduced;

4. As argued before, first the (public) financing should be arranged for in combination of an evident sound business case (see Section 3.1.5). This business case includes any revenues from (smaller) Local commercial broadcasters;
5. The NBTC is considering to migrate Local commercial FM broadcasters to the DAB platform, as a measure to lift congestion in the FM Band. The number of FM broadcasters to migrate is however dependent on where congestion is experienced.

Recommendations

The following is recommended on the number of multiplexes and services per multiplex:

1. Determine the number of multiplexes for the National services on the basis of the results of the Trial. Avoid reducing the number of multiplexes when migrating from the Trial licensing to the regular licensing regime. Hence set the number of multiplexes for the Trial realistically and on the basis of a best assessment of the future business case for National services. Following the recommendations on the number of multiplexes for the Trial (see Section 2.2.1), this number would be two (and not three);
2. For the number of services per multiplex (for National and Local layer) continue with the system as proposed for the Trial. Provide freedom to the market and hence let service providers apply for two different capacity slots:
    a. A slot of 128 kbps, allowing for:
        i. Two audio services of 64 kbps, or;
        ii. Two audio services of 48 kbps and the remaining capacity for data/other services;
    b. A slot of 64 kbps, allowing for:
        i. One audio service of 64 kbps, or;
        ii. One audio service of 48 kbps and the remaining capacity for data/other services;
3. Similar to what was proposed for the Trial, match these possible capacity slots with any simulcast requirements in the following manner:
    a. The 128 kbps slot is offered to service providers wishing to simulcast its existing analogue radio services together with a Digital Only (DO) service;
    b. The 64 kbps slot is offered to service providers wishing to broadcast only a DO service;
4. Also limit the possibilities to broadcast data only in the following manner. Data can only be broadcasted if an audio services is broadcasted too and the allocated capacity for these data services should not exceed 25% of the allocated capacity to the service provider.

3.2.2 Number of services per service provider

Figure 36 shows an overview of the options and considerations. The option in red is the recommended option.

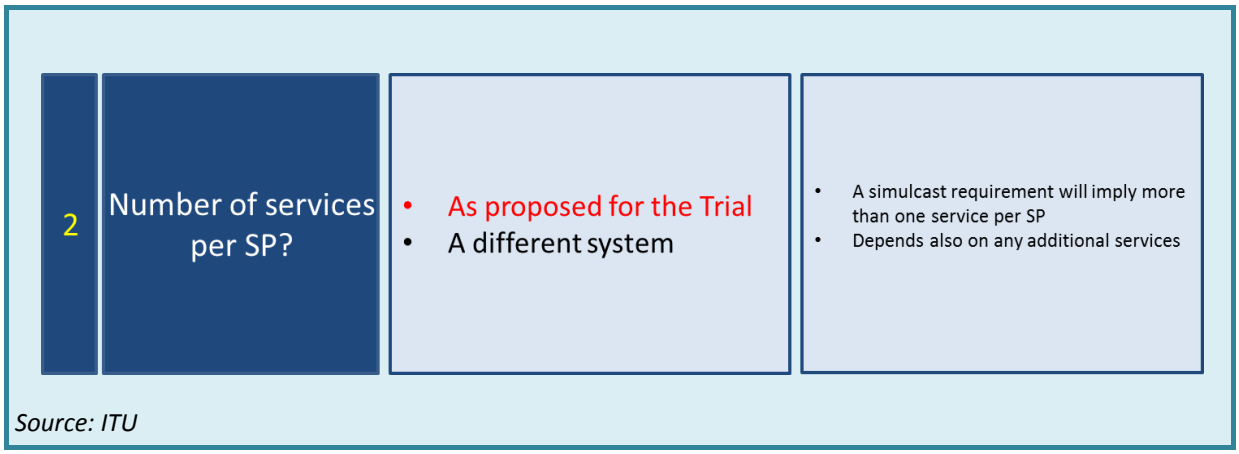


FIGURE 36: OPTIONS AND CONSIDERATIONS ON NUMBER OF SERVICES PER SERVICE PROVIDER

Options

The number of services per service provider is closely related to the number of services per multiplex (see Section 3.2.1). When opting for a capacity slot per service provider also the number of services per multiplex is regulated. The options at consideration here are (a) to continue with the system as proposed for the Trial (b) a different system.

Considerations

In addition to the considerations as discussed in Section 2.2.3 the Regulator should consider that the Trial regulations set a precedence for the regular licensing.

Recommendations

The following is recommended on number of services per service provider:

1. As recommended in Section 2.2.3, assign the two possible capacity slots with any simulcast requirements in the following manner:
    a. The 128 kbps slot is offered to service providers wishing to simulcast its existing analogue radio services together with a Digital Only (DO) service;
    b. The 64 kbps slot is offered to service providers wishing to broadcast only a DO service;
2. Limit the possibilities to broadcast data only in the following manner. Data can only be broadcasted if an audio services is broadcasted too and the allocated capacity for these data services should not exceed 25% of the allocated capacity to the service provider. A EWS responsibility could be exempted from this data limit.

3.2.3 Simulcast requirement

Figure 37 shows an overview of the options and considerations. The option in red is the recommended option.

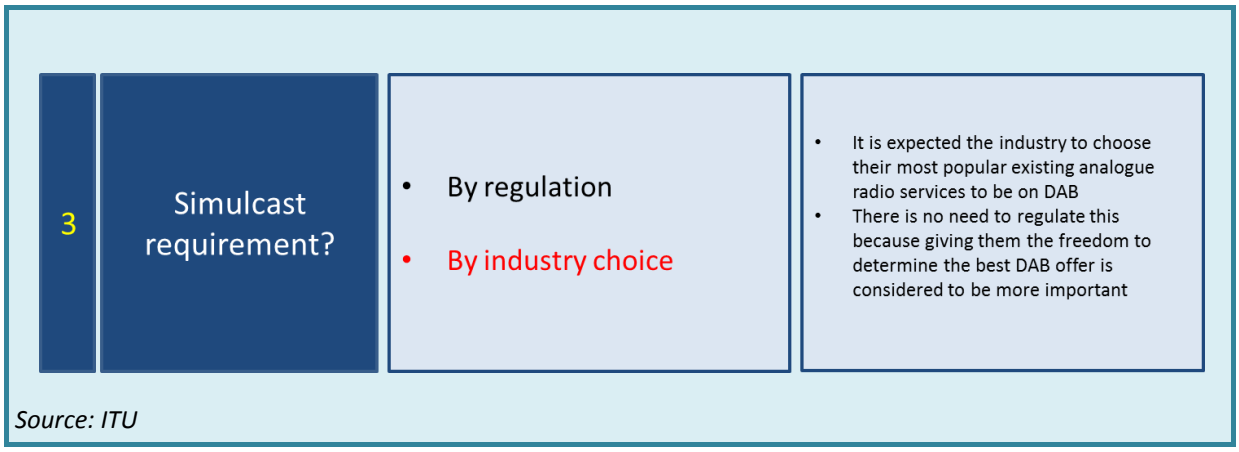


FIGURE 37: OPTIONS AND CONSIDERATIONS ON SIMULCAST REQUIREMENT

Options

The options under consideration here are (a) set a simulcast requirement for a defined set of existing analogue services or (b) any simulcasting of existing analogue services is by industry choice.

Considerations

No other considerations as provided in Section 2.2.4.

Recommendations

The following is recommended on the simulcast requirement (see also Section 2.2.4):

1. Assign the possible capacity slots in the following manner:
    a. The 128 kbps slot is offered to service providers wishing to simulcast its existing analogue radio services together with a Digital Only (DO) service;
    b. The 64 kbps slot is offered to service providers wishing to broadcast only a DO service.

3.2.4 Type of service providers

Figure 38 shows an overview of the options and considerations. The option in red is the recommended option.

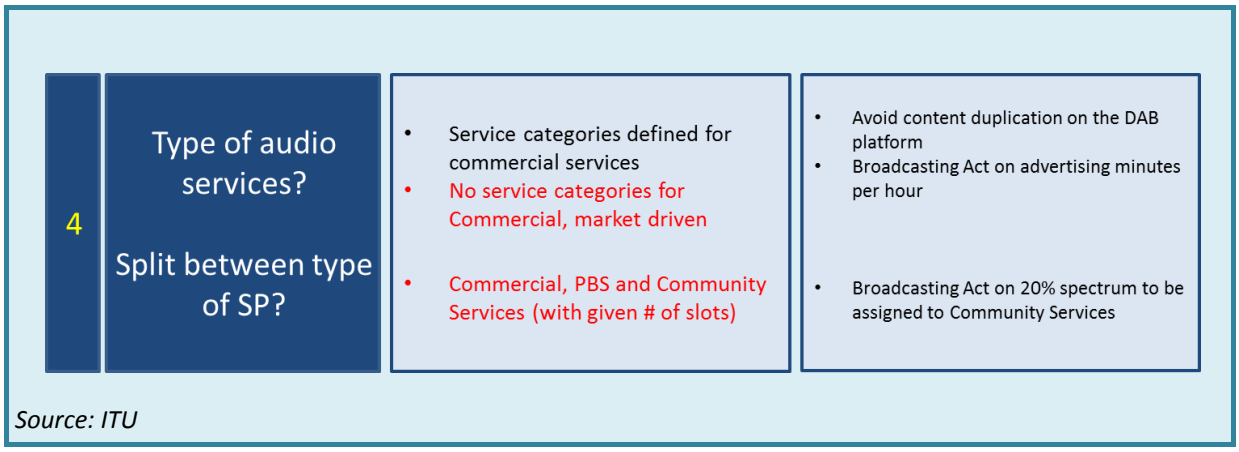


FIGURE 38: OPTIONS AND CONSIDERATIONS ON TYPE OF SERVICE PROVIDERS

Options

The options under consideration here are:

1. Service categories are defined for commercial services (e.g. News, Popular music, Thai music, etc.), or;
2. No further categorization of services, and;
3. What split between the different type of service providers (as defined by the Broadcasting Act, i.e. Commercial, PBS and CS).

Considerations

Content diversity may be limited when the commercial broadcasters are free to determine what works best for their business. There may be a tendency to go for popular music. On the other hand, it should be realized that Regulators can regulate content diversity and ensure certain desired radio content by assigning capacity to PBS and CS.

The Broadcasting Act requires a reservation of at least 20% of the available spectrum for radio and television Community services. '20% of spectrum' does not have meaning in real terms if not 'translated'.

If a similar definition would be applied as to what has be applied for CS on the DTTB platform, the CS requirement would be defined as 20% of the total number of available services in a Local Area (LA) should be allocated to CS. This definition, like for DTTB, reflects access to the market. What this definition would imply is demonstrated in Table 16 (the reference numbers correspond to the numbers as applied in Table 9, new reference numbers are added in this table):

Ref.	# MUX (N + L)	# service in each mux	Total capacity in each LA (# services)	20% for CS (# services)	Remaining capacity for other SPs in Local layer(s) (# services)
NL3	1+1	18	36	7	11
NL1/NL2	2+1	18	54	11	7

Ref.	# MUX (N + L)	# service in each mux	Total capacity in each LA (# services)	20% for CS (# services)	Remaining capacity for other SPs in Local layer(s) (# services)
NL4	3+1	18	72	14	4
NL5	4+1	18	90	18	0
NL6	2+2	18	72	14	22

TABLE 16: SCENARIOS COMPLIANT WITH CS REQUIREMENT

What Table 9 demonstrates is that a CS requirement in terms of services seriously limits the access for Local commercial broadcasters, of which Thailand has many (thousands). The CS claim on the market gets even more eminent when considering the actual spectrum claim of the Local layer as compared to a National layer (a factor 6):

1. A Local layer requires between 6 and 7 blocks (or frequencies)[54];
2. A National layer requires between 1 and 2 blocks (or frequencies).

Why this definition works for DTTB but not for DAB is explained by the following factors:

1. In the Television market there aren't thousands of smaller broadcasters willing to invest in television services for LAs and hence the limitation of getting access to the Local layers is less urgent;
2. The spectrum claim of the Local DTTB layer is about equal to National layer, as it is not possible to deploy a nationwide SFN (as is the case for DAB);
3. The number of available channels in the VHF Band III is smaller than the number in the UHF Band V/IV; respectively 7 x 4 = 28 blocks/channels in VHF and 35 TV channels in UHF.

It would be better to consider this large disproportional spectrum claim of the Local Layer when translating the 20% requirement for CS.

Recommendations

The following is recommended on type of service providers:

1. Do not apply a further service categorization of commercial radio services. Arrange for content diversity and ensure certain desired radio content by assigning capacity to PBS and CS;
2. Do not define the '20% CS requirement' as 20% of the total number of available services in a Local Area (LA). When 'translating' this requirement into a workable requirement, consider the large disproportional spectrum claim of the Local Layer.

[54] See ITU report "Considerations on Available DAB+ Capacity in Thailand", dated 22 November 2013 and ITU report "Results of the verification of the T-DAB plan in the final phase", dated 18 January 2016.

3.2.5 Additional services

Figure 39 shows an overview of the options and considerations. The option in red is the recommended option.

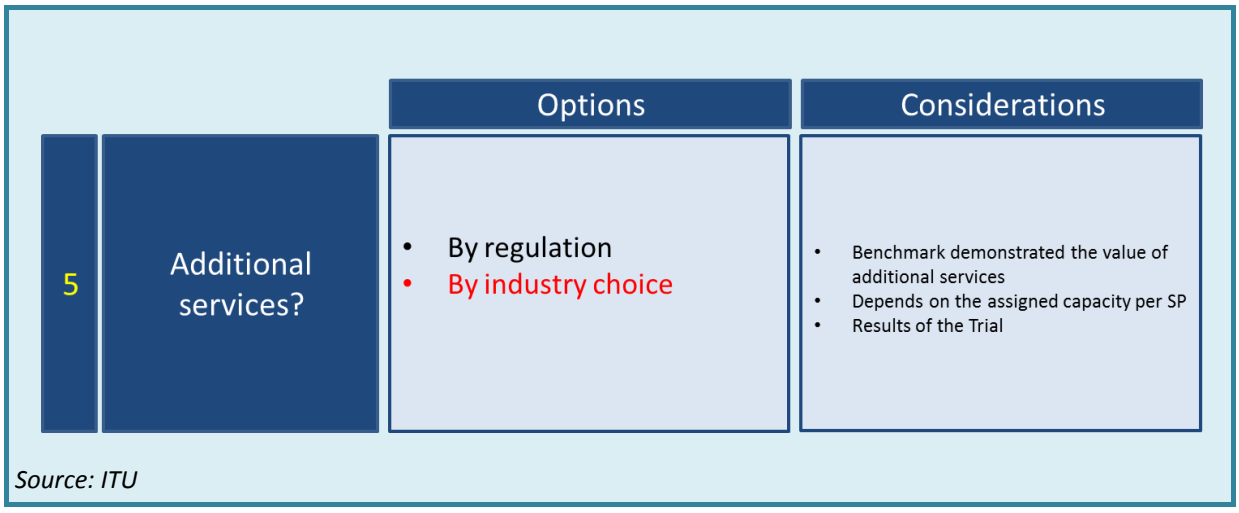


FIGURE 39: OPTIONS AND CONSIDERATIONS ON ADDITIONAL SERVICES

Options

The options under consideration here are (see also Sections 2.2.5, 2.2.6 and 3.2.2):

1. To regulate both program associated data and non-program associated data;
2. By industry choice, for both program associated data and non-program associated data the service provider decides (within the assigned capacity slot and the 25% data restriction, see Section 3.2.2).

Considerations

No other considerations as discussed in Sections 2.2.5, 2.2.6 and 3.2.2.

Recommendations

The following is recommended on additional services:

1. Provide only operational guidelines on audio/program associated data (like PAD, DLS text and Slideshow) as to ensure that the deployed DAB receivers will properly process and display the audio/program associated data;
2. Provide only DAB standard receiver specifications on data and other advanced services (in particular EWS on the basis of FIC/FIG) as the ensure that the deployed DAB receivers will properly process and display the data;
3. Promote the industry development of data and other advanced services by allowing the service providers to allocate a part of their slot capacity for these services. EWS may be prescribed and assigned to one or more service providers;
4. Limit the possibilities to broadcast data only in the following manner. Data can only be broadcasted if an audio service is broadcasted too and the allocated capacity for these data

services should not exceed 25% of the allocated capacity to the service provider. A EWS responsibility could be exempted from this data limit.

3.3 Supporting measures

In this Section the following aspects of the supporting measures for the DAB National and Local service deployment are addressed:

1. Industry collaboration and competition;
2. Sources of funding;
3. Funding of cost elements;
4. Incentives;
5. Support organization.

3.3.1 Industry collaboration and competition

Figure 40 shows an overview of the options and considerations. The option in red is the recommended option.

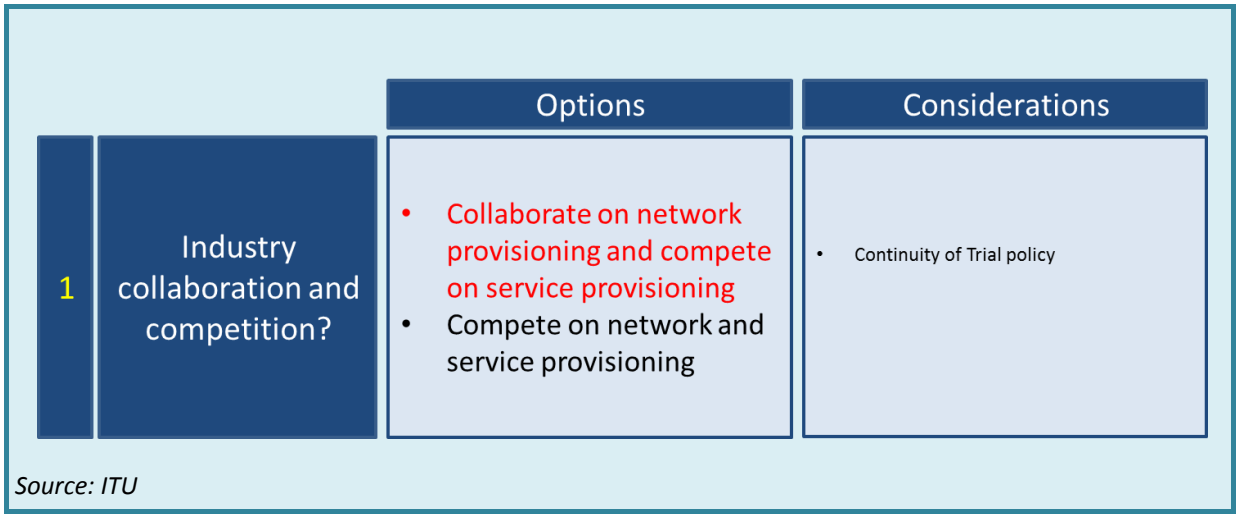


FIGURE 40: OPTIONS AND CONSIDERATIONS ON INDUSTRY COLLABORATION AND COMPETITION

Options

The options under considerations here are addressing the aspect of competition at what level; (a) at service and network provisioning or (b) mainly at service provisioning level (and maximum collaboration on the network provisioning).

Considerations

In Section 2.3.1 the following was recommended to let the industry collaborate on network operations and compete on service provisioning. This would allow for the industry to pull resources together and minimize DAB network costs.

This Trial policy should be continued for the regular licensing. The only difference is that after the regular licensing (see Figure 26) Service licenses have been reassigned (any may not all end-up with the members of the National JVC).

The same applies for the Local JVCs, let the industry collaborate on network operations and compete on service provisioning.

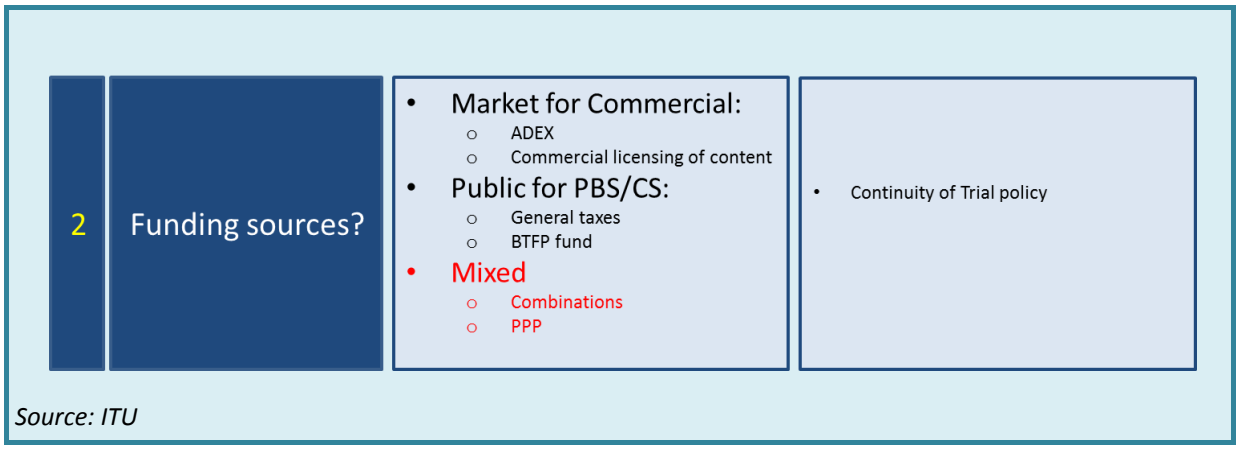
Recommendations

The following is recommended on industry collaboration and competition:

1. Continue the policy as defined in the Trial, meaning (see also Section 3.1.3):
    a. Assign the Network license in a single assignment procedure to a JVC
    b. Ensure that the National JVC keeps operating all National multiplexes and sites (when migrating from the Trial to regular licensing regime);
    c. When introducing a Local layer, assign a Trial Service license in combination with Network license of 15 years, to a Local JVC for the distribution and provisioning of Local services in a single LA;
    d. Ensure a spectrum efficient and coordinated network deployment between the National and Local JVCs, by having the National network deployment leading the Local deployment;
    e. Do not allow a fragmented establishment of a few single sites (in MFN configuration) in LAs across the country.

3.3.2 Sources of funding

Figure 41 shows an overview of the options and considerations. The option in red is the recommended option.



Source: ITU

FIGURE 41: OPTIONS AND CONSIDERATIONS ON SOURCES OF FUNDING

Options

Basically three options are available for funding the National and Local deployment; (a) ADEX and commercial licensing of content, (b) general taxes and public funds and (c) combinations and Public Private Partnerships (PPP).

Considerations

The establishment of JVC as proposed for the Trial (see Section 2.4), is a form of PPP as the JVC members could comprise public and commercial entities. In addition to the proposed JVC construction, the JVC members act as Service provider (SP) and pay a regulated distribution fee. There activities are financed as follows:

1. Commercial SPs financed by ADEX and other commercial revenues (like commercial licensing of DAB content or Traffic Information services);
2. PBS or CS SPs financed by general taxes, public funds or community member contributions.

This Trial policy should be continued for the regular licensing. The only difference is that after the regular licensing (see Figure 26) Service licenses have been reassigned (any may not all end-up with the members of the National JVC).

Recommendations

The following is recommended on sources of funding:

1. Continue the JVC construction and the associated funding principles. Keep in mind that DAB costs are not limited to CAPEX only. For a successful DAB deployment also the following costs have to be financed:
    a. Content creation, especially for the DO services;
    b. Marketing;
    c. OPEX.

3.3.3 Funding of cost elements

Figure 42 shows an overview of the options and considerations. The option in red is the recommended option.

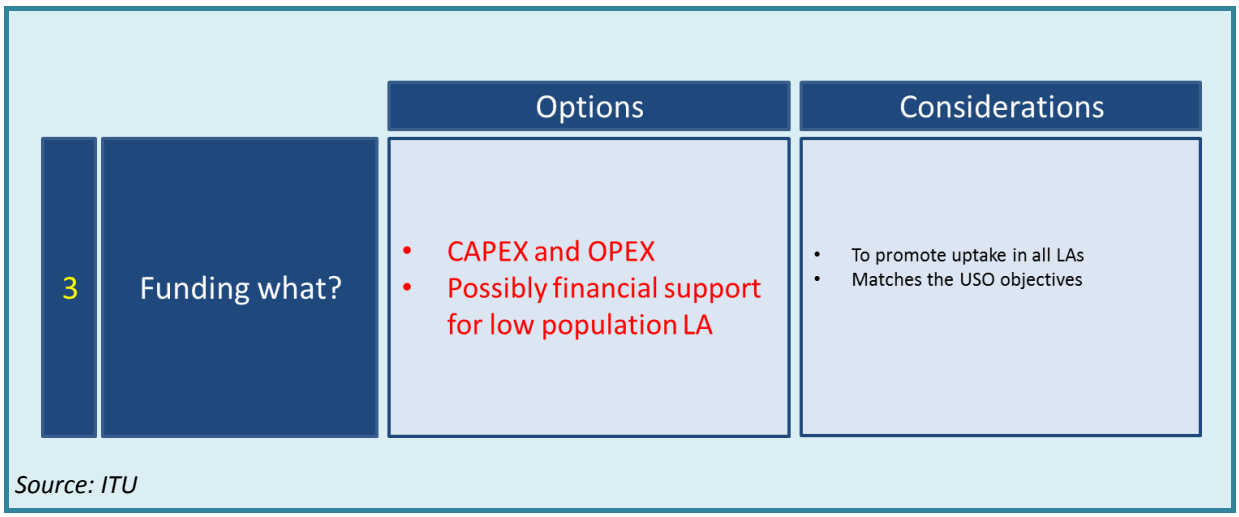


FIGURE 42: OPTIONS AND CONSIDERATIONS ON FUNDING OF COST ELEMENTS

Options

As addressed in the previous Section 3.3.2, the DAB costs comprise OPEX and ADEX for both the network operations and service provisioning (NO and SP respectively). Basically three options are possible; (a) CAPEX only for both NO and SP, (b) CAPEX for both NO and SP and OPEX for NO, and (c) CAPEX and OPEX for both NO and SP.

Considerations

In addition to the considerations as listed in Section 2.3.3 the following could be said. The CAPEX and OPEX levels for National and Local deployments are much higher than for the Trial. Table 17 provides a comparison for CAPEX (see also Table 8 and Table 9).

Ref.	# sites	% greenfield sites	Pop %	# MUX	# SPs	CAPEX SP	CAPEX NO	Total CAPEX
T1	5	0%	15%	2	18	$442,800	$2,396,900	$2,839,700
T2	8	0%	16%	2	18	$442,800	$3,638,900	$4,081,700
N1	90	0%	80%	2+0	18+0	$442,800	$37,531,080	$37,973,880
NL2	90	0%	80%	2+1	18+351	$9,077,400	$65,212,670	$74,290,070

TABLE 17: CAPEX COMPARISON

Table 18 provides a comparison for the annual OPEX (year 1).

Ref.	# sites	% greenfield sites	Pop %	# MUX	# SPs	OPEX SP	OPEX NO	Total OPEX
T1	5	0%	15%	2	18	NA[55]	NA	NA
T2	8	0%	16%	2	18	NA	NA	NA
N1	90	0%	80%	2+0	18+0	$4,194,700	$7,506,216	$11,700,916
NL2	90	0%	80%	2+1	18+351	$14,282,440	$13,042,534	$27,324,974

TABLE 18: ANNUAL OPEX (YEAR 1) COMPARISON

The financing of the Local CS and PBS in a Local Layer could be based on the argument that they are Universal Services and hence funding from a USO fund may be possible.

Recommendations

The following is recommended on funding of cost elements:

1. As recommended in Section 2.3.3, any NBTC funding for the National and Local deployments should be based on matched funding (the public funding may be from a USO fund);

[55] The valuation model is dimensioned for assessing costs over a longer planning horizon (14 years) and hence the OPEX will be over dimensioned for the Trial. But the OPEX will be roughly a factor 10 lower compared to the deployments N1 and NL2 (as this is the ratio between the number of sites in the Trial and the nationwide network, respectively 8 and 90 sites).

2. Match-funding should be based on all cost elements for designing, deploying and operating the DAB networks and services (i.e. OPEX and CAPEX of both SP and NO).

3.3.4 Incentives

Figure 43 shows an overview of the options and considerations. The option in red is the recommended option.

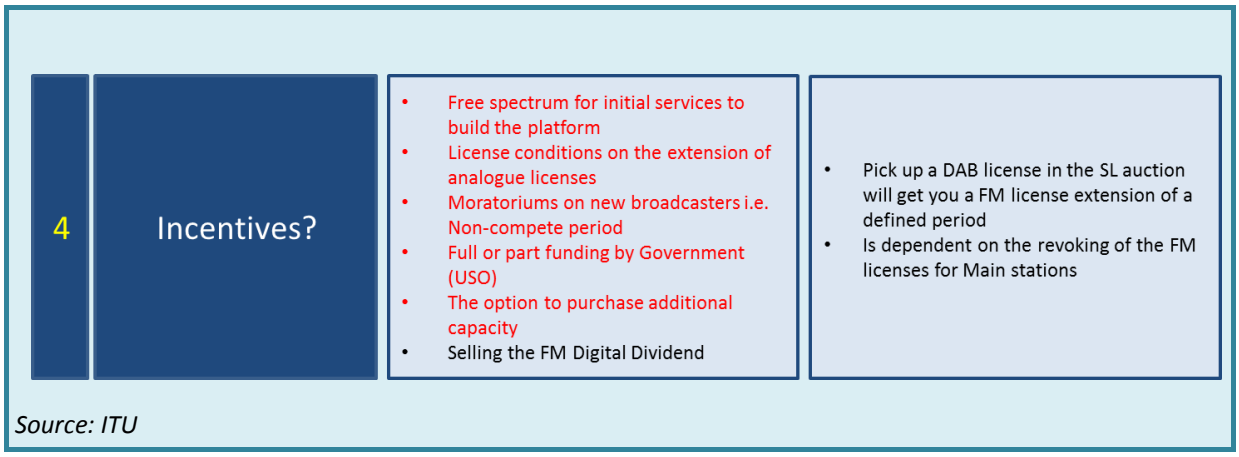


FIGURE 43: OPTIONS AND CONSIDERATIONS ON INCENTIVES

Options

In the international benchmark report, several incentives were listed:

1. Free spectrum for initial services to build the platform, these licences may last until FM ASO;
2. License conditions on the extension of analogue licenses;
3. Moratoriums on new broadcasters i.e. Non-compete period;
4. The option to purchase additional capacity once the initial allocation is completed;
5. Full or part funding by Government, or a license fee rebate to fund the transition;
6. Digital Dividend through alternative uses for analogue licenses when they are released.

These incentives have been evaluated for the Trial (see Section 2.3.4). One incentive was excluded as it is considered to be impossible/unrealistic, that being incentive (6). Incentive options (1), (2), (3) and (4) were recommended. Option (5) was recommended in the previous Section 3.3.3.

Hence no new options have to be considered in this Section.

Considerations

No other considerations as provided for the Trial (Section 2.3.4) and as discussed in Section 3.3.3.

Recommendations

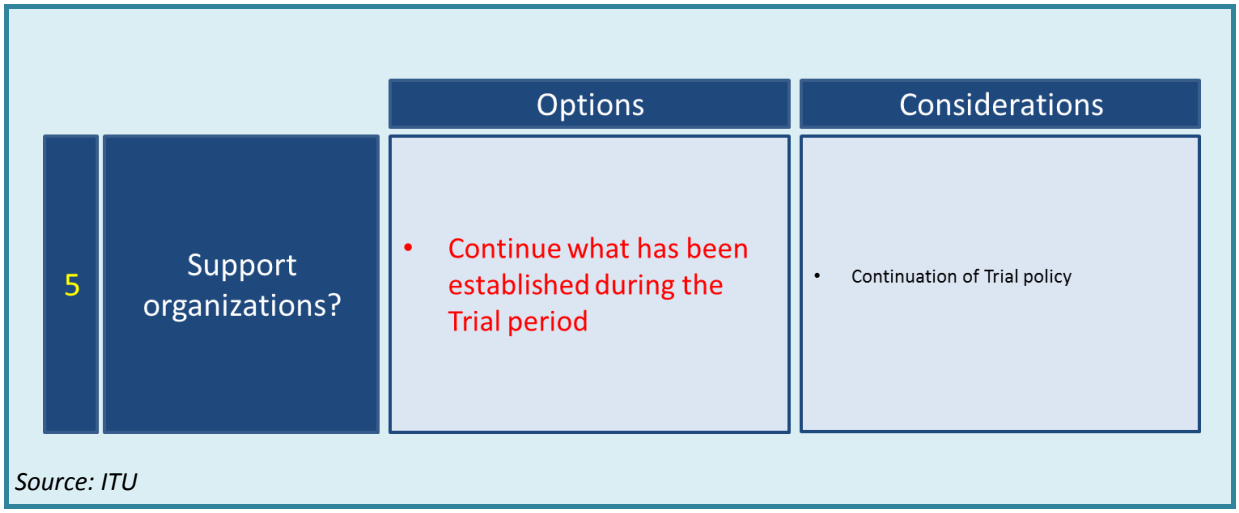
The following is recommended on incentives:

1. Provide no additional incentives to those as recommended for the Trial, including:
    a. Free spectrum for initial services to build the platform (by means of the JVC construction);

b. License conditions on the extension of analogue licenses (see Section 2.3.4);
c. Moratoriums on new broadcasters i.e. Non-compete period (by means of the JVC construction);
d. The option to purchase additional capacity once the initial allocation is completed (by means of allowing JVC members to acquire capacity from the Pool, after no market interest from non JVC members);
e. As recommended in Section 3.3.3, any NBTC funding for the National and Local deployments should be based on matched funding (the public funding may be from a USO fund).

3.3.5 Support organization

Figure 44 shows an overview of the options and considerations. The option in red is the recommended option.



Source: ITU

FIGURE 44: OPTIONS AND CONSIDERATIONS ON SUPPORT ORGANIZATION

Options

In the international benchmark report the following support organization functions are listed (see also Section 2.3.5):

1. Industry body to coordinate marketing, technical and political activities on behalf of the broadcasters;
2. Listener engagement measurement;
3. Receiver and retailer support;
4. Automotive support;
5. Marketing support.

Considerations

No other considerations as discussed in Section 2.3.5.

Recommendations

The following is recommended on the support organization (as a continuation of the recommendations as proposed in Section 2.3.5):

1. Continue the activities of the industry supporting body, including commercial and public entities, with the following activities (dependent on the available financial means):
    a. Industry body to coordinate marketing, technical and political activities on behalf of the broadcasters;
    b. Listener engagement measurement;
    c. Receiver and retailer support;
    d. Automotive support;
    e. Marketing support.
2. Listener engagement measurements should be carried regularly and over a long period (for example in Australia 6 measurements are carried out per year for over 5 years);
3. Listener engagement measurements, receiver, retailer and automotive support could be organized as a sub-committee of the industry body;
4. The marketing effort should be continued by the Service licensees and the industry body. These efforts can be split in the sense that (a) the industry body covers the general or market wide marketing (for example promoting the uptake of DAB receivers) and (b) the service licensees program or service specific marketing.

3.4 Licensing procedures

In this Section the following aspects of the DAB licensing procedures are addressed:

1. Assignment instruments;
2. Operating models.

3.4.1 Assignment instruments

Figure 45 shows an overview of the options and considerations. The option in red is the recommended option.

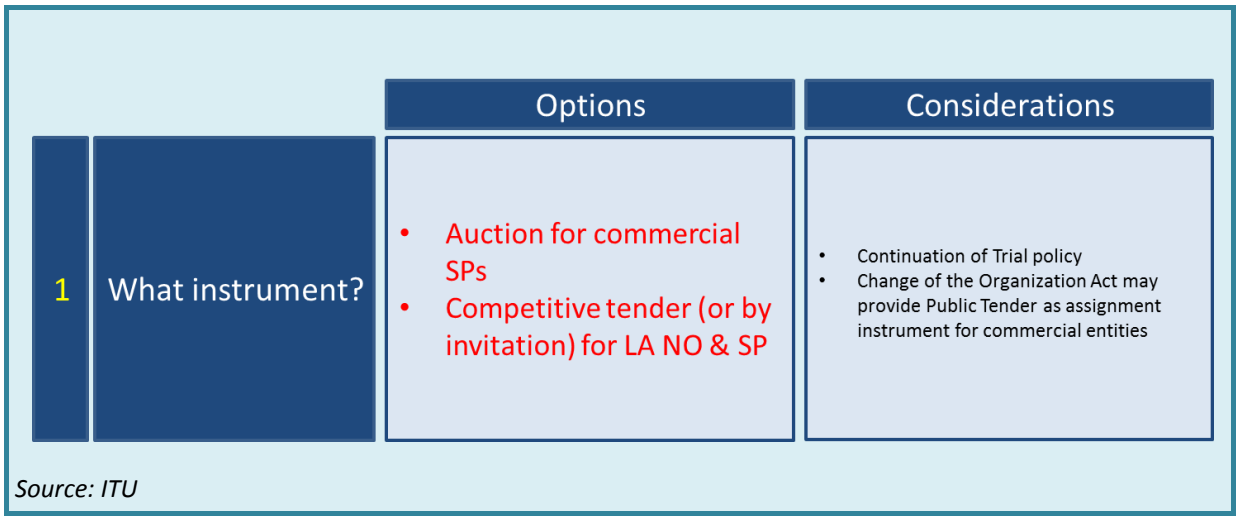


FIGURE 45: OPTIONS AND CONSIDERATIONS ON ASSIGNMENT INSTRUMENTS

Options

In Section 2.5.1 (i.e. License duration and renewal) the assignment procedures for after the Trial have been addressed and recommended.

Considerations

No other considerations as described in Section 2.5.1.

Recommendations

The following is recommended on assignment instruments (see also Section 2.5.1):

1. Do not end the Trial licensing regime before the ATV ASO in VHF Band III takes place. This is currently assumed to take place at the start of 2020. With an assumed Trial start late 2016 or at the beginning of 2017, this would result in a 3-year Trial duration. A longer Trial duration is preferred as no Government funding will be likely available for the Trial. The Trial duration is a typical element for negotiations between the market parties and the NBTC;
2. Ensure that the National JVC keeps operating all National multiplexes and sites when migrating from the Trial to regular licensing regime;
3. Assign regular Service licenses either in an auction or public tender[56] (for commercial broadcasters) for all available National capacity slots (at the start of the regular licensing period). It could be considered to provide a further initiative to Trial Service licensees by reserving a defined amount of capacity for incumbents (i.e. the Trial licensees) in the Service license auction;
4. When introducing a Local layer (dependent on demonstrated market demand accompanied with enough funding resources), assign a Trial Service license in combination with a Network license of 15 years, to a Local JVC for the distribution and provisioning of Local services in a single LA. This is the same assignment procedure as described in Section 2.4.1;

[56] See also footnote 49.

5. Ensure a spectrum efficient and coordinated network deployment between the National and Local JVCs, by having the National network deployment leading the Local deployment.
6. Do not allow a fragmented establishment of a few single sites (in MFN configuration) in LAs across the country.

3.4.2 Operating models

In Section 2.4.2 (Operating models) different operating models have been addressed as described in the international benchmark report. One operating model was recommended that accompanies the proposed licensing procedure. In this Section the changes to the operating model are indicated due to the changes in the regulatory framework (when migrating from the Trial to the regular licensing regime). No fundamental changes occur or are recommended.

Options

No different options are proposed as the operating model recommended in Section 2.4.2.

Considerations

No other considerations as mentioned in Section 2.4.2.

Recommendations

Table 12 as included in Section 2.4.2 is repeated here and an extra column is added to indicate the changes to the operating model. In Table 19, SL stands for Service Licensee and FL for Facility Licensee. The changes are indicated in Italic.

Characteristics	Operating model		
	Mixed 3 (AUS)	**Thailand Trial**	**Thailand Regular**
Spectrum ownership / licence	Broadcaster / JVC	Trial SLs	*SLs*
Broadcaster licence	Broadcaster / content provider	Trial SLs	*SLs*
Tower access	3rd Party	FLs have rental contract with JVC	FLs have rental contract with JVC
Antenna system	3rd Party	provided by JVC to Tower FLs	provided by JVC to Tower FLs
Transmitters	JVC	provided by JVC to Tower FLs	provided by JVC to Tower FLs
Distribution (Sat)	JVC	JVC, sub-contracted to FLs/contractor	JVC, sub-contracted to FLs/contractor
Ensemble multiplexer	JVC	provided by JVC to Site FLs	provided by JVC to Site FLs
Studio	Broadcaster	Trial SLs	*SLs*

Characteristics	Operating model		
equipment /contribution			
Configuration Control of slot	Broadcaster	Trial SLs	*SLs*
Operations and maintenance DAB NO	Controlled by JVC – can be broadcaster or 3rd party	JVC, sub-contracted to FLs	JVC, sub-contracted to FLs

TABLE 19: PROPOSED OPERATING MODEL FOR DAB

3.5 License terms and conditions

It is noted that a range of license terms and conditions for the regular licensing have already been addressed in previous sections 3.1 and 3.2. This section only addresses those license terms and conditions not specifically addressed yet.

In this Section the following aspects of the DAB licensing terms and conditions are addressed:

1. Service level requirements;
2. License fees.

3.5.1 Service level requirements

Figure 46 shows an overview of the options and considerations. The option in red is the recommended option.

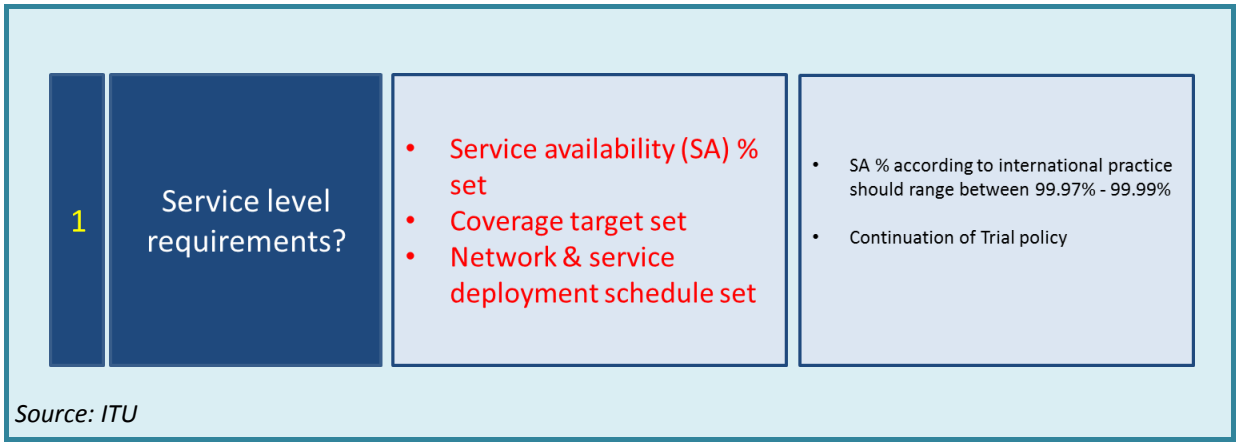


FIGURE 46: OPTIONS AND CONSIDERATIONS ON SERVICE LEVEL REQUIREMENTS

Options

As stated in Section 2.5.2, the following service level requirements could be set by the Regulator:

1. Service Availability (SA);

2. Coverage target (in % of population or households);
3. Network and service deployment schedules.

This Section addresses the options of regulating or not regulating the above listed service level requirement when regular licenses are issued. For the second and third service level requirement it was already recommended to set such a requirement (see Sections 3.1.4 and 3.1.5).

Considerations

Although in the Trial one of the objectives was for the network and service providers to learn about the reliability and performance of the various network elements, for the regular license period a defined SA% can be set.

In Section 2.5.2 it was already recommended to set after one year of Trial operations SA levels. The Regulator was recommended to set a SA% for both the network operations and the service provisioning (i.e. studio output). At the start of the regular licensing period these set SA levels can be evaluated and if necessary adjusted.

According to international practice SA levels range between 99.97 and 99.99%.

Recommendations

The following is recommended on service level requirements (see also Sections 3.1.4 and 3.1.5):

1. Evaluate the set SA% requirement for studio output and network availability after the Trial and, if necessary, set adjusted SA% for the regular licensing period;
2. Set a coverage target, as this will provide clarity for the receiver and car industry about the potential market size;
3. At the end of the Trial and after consulting the market at that time, do not set the maximum coverage target but a lower target. On the basis of the presented data in this report, it is recommended to set the coverage target initially at 80% (which is exceeding by far the best FM national network coverage);
4. At the time of a FM ASO announcement the network coverage target can be increased to 95%, dependent on:
    a. A FM ASO announcement;
    b. DAB market success, and;
    c. Public financial resources available at that time;
5. In consultation with the Network operator, the following deployment schedules are recommended (in order of preference):
    a. 90 sites in 3 years in the most populated areas first;
    b. 200 sites in 4 years in the most populated areas first.
6. Any requirement for the introduction of Local services in other then the most populated areas, should be accompanied with a sound business case (including revenues from Local commercial broadcasters and public funding for CS), showing enough funding in the long term.

3.5.2 License fees

Figure 47 shows an overview of the options and considerations. The option in red is the recommended option.

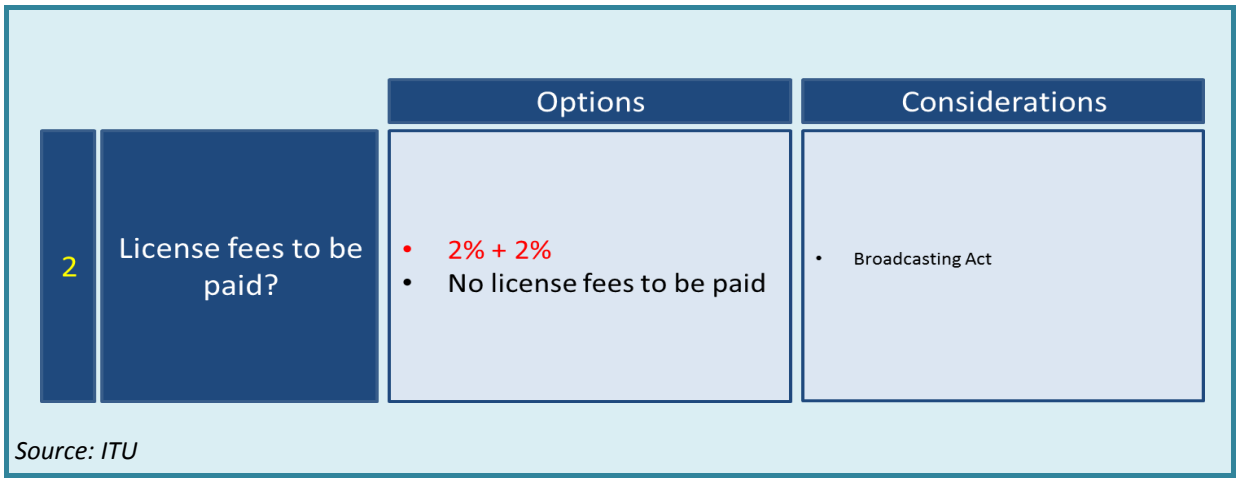


FIGURE 47: OPTIONS AND CONSIDERATIONS ON LICENSE FEES

Options

The options under consideration here are; (a) no license fees to be paid, or (b) the regular license fees of 2% + 2% (of the DAB revenues) should be paid during the regular licensing period.

Considerations

The Broadcasting Act stipulates the payment of license fees.

The Network license is assigned at the start of the Trial (to the JVC) for a period of 15 years. The same applies for the LA Network license of 15 years which is issued at the start of a Trial period in a LA. Hence the Network license will continue into the regular license period (see also Figure 26 and Figure 27). This implies that although no Network license fees are paid during the Trial (see also Section 2.3.4), during the regular licensing period the normal license fees have to be paid. This change in license fees payable should be included in the Network license terms and conditions (at the moment of inviting bidders to bid).

Recommendations

The following is recommended on license fees:

1. Levy the stipulated license fees to be paid (currently 2% + 2% of the revenues generated with the license). However, if new legislation would allow, it would be better if a threshold could be established, below which the broadcaster don't or pay reduced license fees. This license fee waiver may only be applied on the DO services;
2. Include the change in license fees payable (when the regular licensing period starts) in the Network license terms and conditions, at the moment of inviting bidders to bid (i.e. at the start of respectively the National and LA Trial).

4. Regulatory impact assessment

This Chapter evaluates the proposed strategy deployment options, as described in Chapter 2 and 3, in terms of their regulatory impact on market and industry. This impact is considered for the long term (not the Trial alone)[57]. It will consider the impact on the radio markets in Thailand, including radio services distributed over analogue radio, DTTB and Internet/IP networks. Also mitigation measures will be addressed as to rebalance the impact. It will draw from observations from abroad and will specifically address the issues of:

1. Market development;
2. Level playing field;
3. Market access;
4. DAB distribution fees.

This Chapter is structured accordingly:

4.1 Market development

In this Section the following aspects on DAB market development will be addressed:

1. Market capacity and shares;
2. DAB coverage and reach;
3. Mitigation.

4.1.1 Market capacity and shares

With the technical feature of DAB carrying 18 to 20 audio services per multiplex, any DAB introduction will result in introducing additional capacity into the market. Especially when considering that a possible FM ASO is expected much later.

For a Regulator it is important to address that this additional DAB capacity should not overfeed the market. Overfeeding of the market could result in a market shake-out whereby broadcasters go into insolvency. Hence any additional capacity should be in line with expected market growth. This market growth is for radio services the growth in ADEX. ADEX growth is driven by several factors, including:

1. GDP growth (as explained in Section 1.3);
2. Increased audience reach, either by new content (i.e. DO content) or extended market reach (which is dependent on the network coverage of the current FM networks, see also Section 1.3).

Whether overfeeding will occur is also dependent on any market demand that has not been met. The high number of FM broadcasters in Thailand may indicate that some demand may not have been met

[57] For a regulatory impact of the Trial, please refer to ITU report "Roadmap for the Introduction of Digital Terrestrial Radio Services in Thailand", dated 28 February 2014, section 5.1.

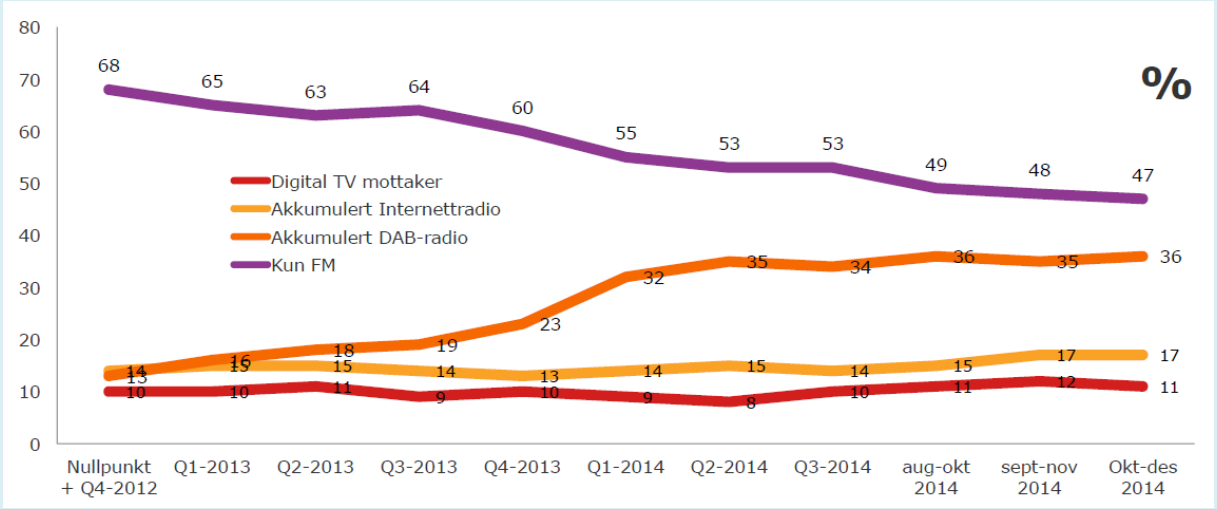
yet. However, one should consider the nature of this possible unmet demand. FM technology is very cheap for a single broadcaster and hence the market entry barrier is very low. For DAB networks the entry barrier is higher as DAB networks are only efficient if the majority of the multiplex are loaded with (radio) services. So a grouping of unmet demand will be important. Hence it is recommended to group this demand in a JVC, especially for the LAs (see Section 2.5.1)

Hence the introduction of radio capacity should be planned with care and increased in steps (as proposed in this report; start with two national multiplexes and an initial deployment target of 80% pop). Also in the countries as mentioned in the benchmark study (see Section 1.2), the deployment came in stages. Additional multiplexes and further network coverage extensions came after the initial deployment stage.

With the introduction of an additional radio distribution platform, listening shares (and hence ADEX shares) will shift between the various platforms available in a country:

1. DTTB;
2. Internet (mobile and fixed);
3. DAB;
4. Analogue (FM/AM).

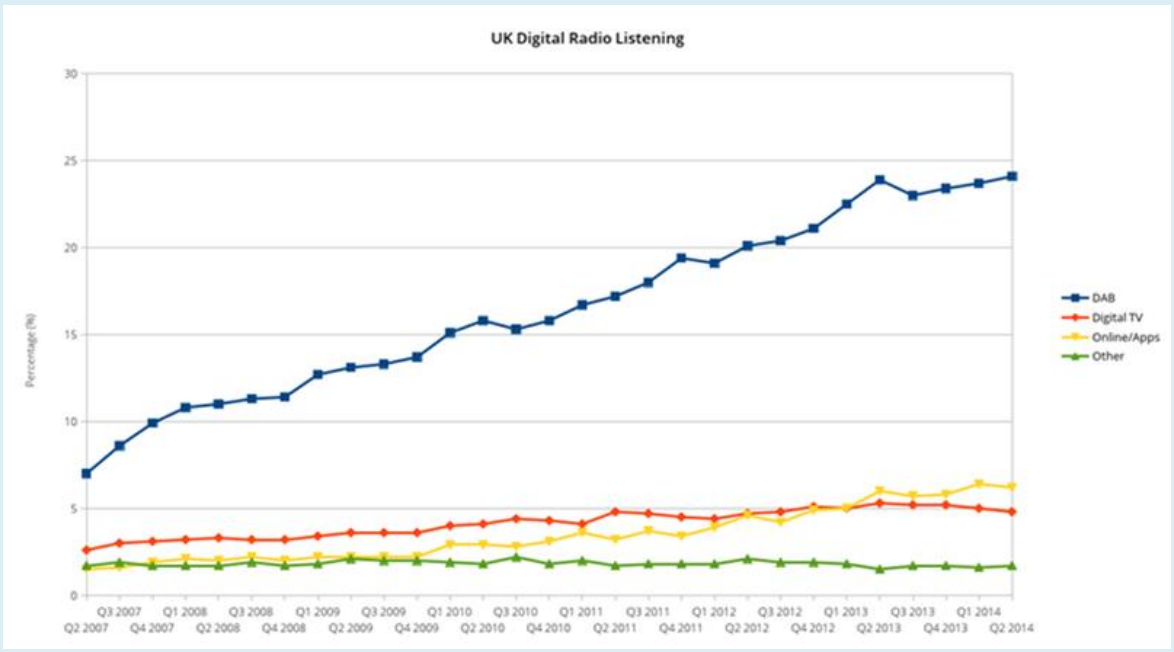
Figure 48 shows the shift in market shares in Norway. The shares are depicted in the same order as the list above. Please note that AM radio services do not exist in Norway anymore.



Source: TNS Gallup

FIGURE 48: SHIFT OF LISTENING SHARES IN NORWAY

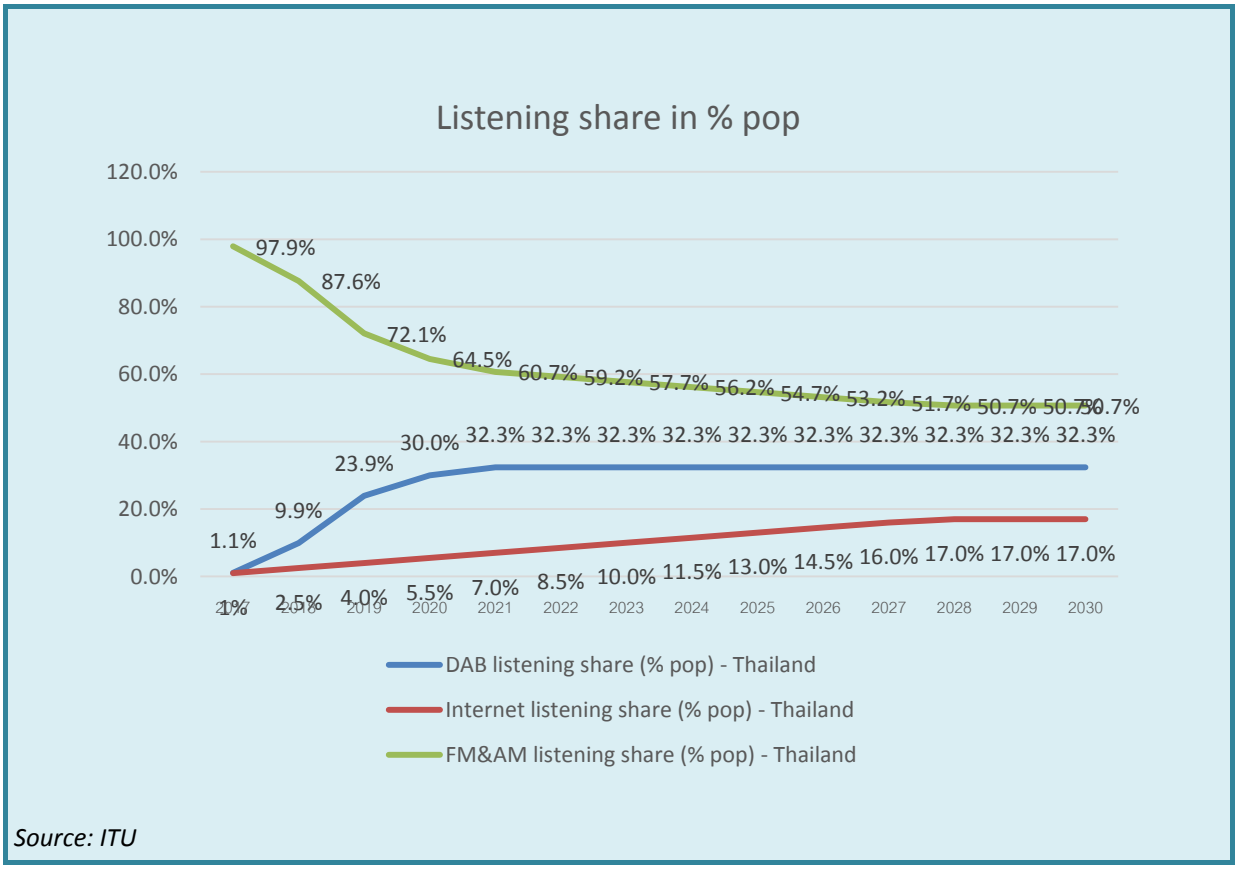
Figure 49 shows the listening shares between the various platforms in the UK. It shows that most digital listening takes place on the DAB platform. Remarkably IP listening is below 10%. A similar figure can be observed from Figure 48; IP listening stands at approximately 17%.



Source: Ofcom

FIGURE 49: DIGITAL RADIO LISTENING IN THE UK

In the valuation model this shift has been modelled (see for example Figure 63 and Figure 67). In this valuation model also an FM ASO announcement and FM ASO date have been modelled for the base case scenarios (as presented in Section 1.3.3), accelerating the shift from Analogue (FM/AM) to DAB. The shift without an ASO for scenario N1 is depicted in Figure 50. Please note the following; (a) that the time scale is in years and not quarters as in Figure 48, and (b) that radio services are not carried over DTTB in Thailand.



Source: ITU

FIGURE 50: LISTENING SHARES CHANGES WITHOUT FM ASO.

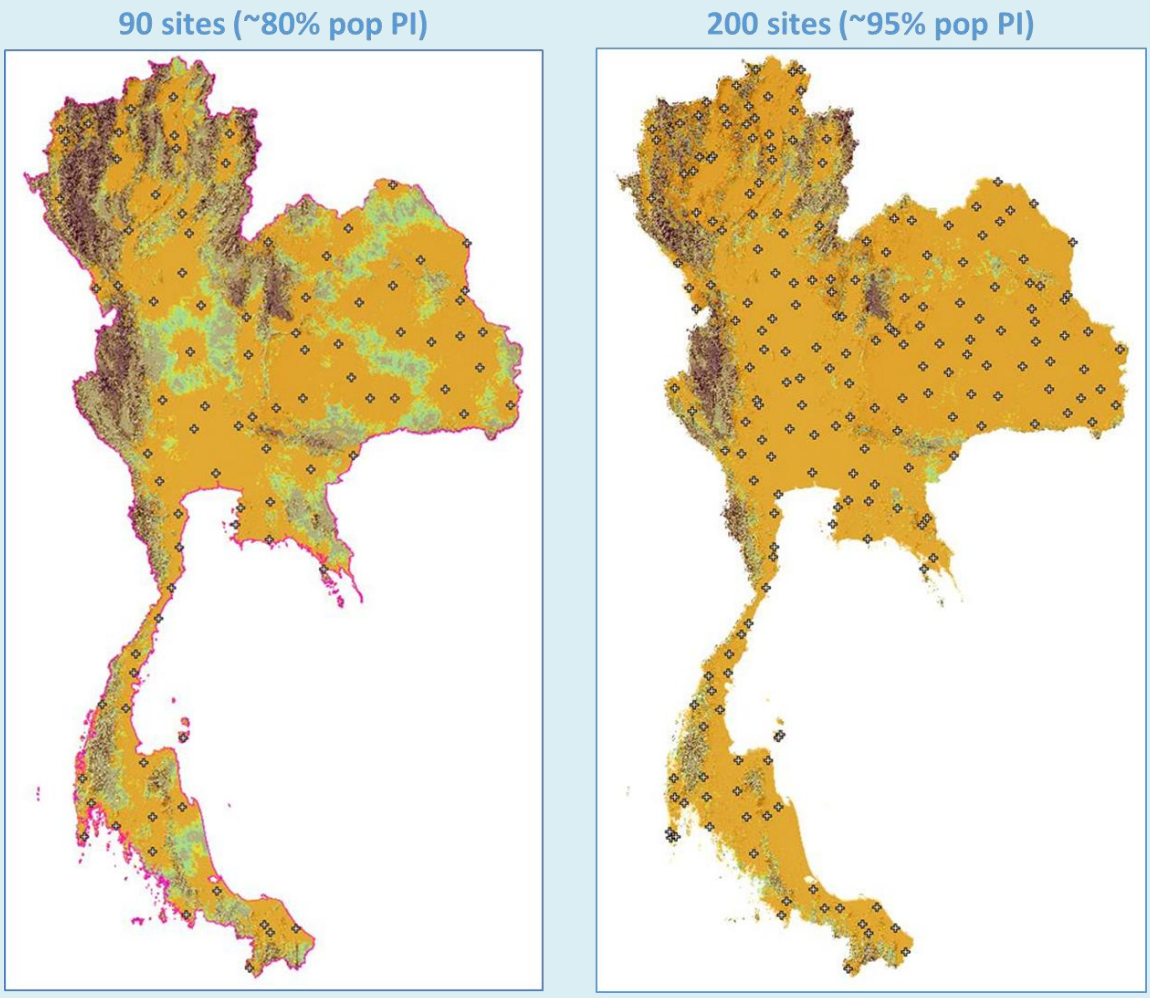
Comparing Figure 50 with for example Figure 63, makes evident the impact on the market when an ASO data is set and announced.

For assessing the impact on incumbent broadcasters one should differentiate between incumbents remaining in the FM market (and not migrating to DAB) and incumbents migrating to DAB. The latter group is likely to include the Main FM stations as they have the means and financial resources. A positive impact on their earning capacity will be minimal in the beginning (during the Trial) and will be large at later stages (especially when an ASO is set). However, this will come with additional investments in the DAB infrastructure for them. For the remaining FM stations, the impact is the reverse at later stages as advertisers will shift to DAB, reducing the market for FM ADEX (see Figure 50).

In addition, the introduction of DAB capacity could entail the introduction of new radio broadcasters, i.e. the Digital Only (DO) service providers. The introduction of new DO service providers will in the long run negatively impact all FM broadcasters as they will claim a share of the total ADEX available in the market.

4.1.2 DAB coverage and reach

As said before one of the advantage of DAB for Thailand is that DAB network coverage will be larger than that of the best performing FM network (assessed to be 70% of the households[58]). Clearly this will result in an additional reach and ADEX for broadcasters (in the longer term). Figure 51 provides a PI coverage map for deployment scenario N1 and N2 (see Section 1.3.3).



Source: ITU

FIGURE 51: NOISE LIMITED COVERAGE MAPS FOR 90 AND 200 DAB SITES

It is important to note that the availability of receivers should follow these network deployment scenarios. Hence it is important that an industry body, as recommended in Section 2.3.5, is established.

[58] See footnote 52.

The above discussed release of DAB capacity is also regulated with the deployment speed. In this report a deployment speed, dependent on the number of sites, is recommended to be 3 years for 90 sites and 4 years for 200 sites (see also Section 3.1.5). The deployment speed also drives in which pace market shares change.

4.1.3 Mitigation

If deemed necessary the following changes could be considered to rebalance market capacity, shares and network coverage (between brackets it is indicated what the addressed change impacts):

1. The number of National and Local multiplexes - (market capacity);
2. The number of new DO service providers and the number of new DO services they will introduce into the market (market capacity);
3. Announcing and setting a FM ASO date - (market shares);
4. Network coverage target (coverage, but also market shares as with a larger DAB coverage the relative strength of DAB is higher as compared to FM, see also the valuation model);
5. Deployment speed - (market capacity and shares).

4.2 Level playing field

In regulatory terms a level playing field refers to a situation in which market parties offering similar services in the same relevant market compete under the same regulatory conditions (i.e. the same regulatory obligations and rights).

In this Section the following aspects on a level playing field in the radio market will be addressed:

1. Level playing field balance;
2. Mitigation.

4.2.1 Level playing field balance

A perfect level playing field does not exist. A Regulator will have to balance creating a level playing field with other factors.

In the case of DAB **Service licensing** and knowing that the business case is challenging, creating a level playing field has to be balanced against providing an attractive enough business case for the JVC investors. An attractive enough proposition has to be offered to the JVC investors to enter the DAB market. With the proposed structure of the JVC two elements are balanced:

1. Creating a level playing field. For this purpose:
    a. The Pool is created, the size of the Pool can be set at for example 50% of the total available capacity (and this is typically a negotiation item between industry and the NBTC), and;
    b. A termination of the non-compete clause at the end of the Trial is recommended. After the Trial the available SLs will be assigned either by public tender or in an auction;

2. Providing an attractive enough business case. For this purpose, capacity is exclusively reserved for the JVC and a non-compete term arranged for the duration of the Trial.

For the **Network licensing** the principle is adopted of promoting competition at service provisioning level and collaboration at network operations. Network deployment efficiency is deemed to be paramount. The following was balanced in the proposed licensing policy:

1. Creating a level play field. For this purpose:
    a. Other JVCs are proposed for the LAs, allowing other network operators to enter the market;
    b. A public tender if the assignment procedure 'by invitation' is rejected or unsuccessful;
    c. A regulated distribution fee to be paid by JVC and non-JVC members;
2. Efficient network deployment. For this purpose:
    a. A single JVC, operating all network sites and multiplexes, in a LA or nationwide;
    b. The National deployment and JVC is made leading and any DAB antenna has to be shared between all services.

4.2.2 Mitigation

If deemed necessary, the following changes could be considered to rebalance the level playing field (between brackets it is indicated what the addressed change impacts):

1. Change the reserved capacity for the JVC and the Pool - (business case attractiveness versus level playing field);
2. Change of the non-compete duration. However, it should be realised that this can only take place at the end of the Trial (hence the Trial duration should be changed) or at the end of the regular Service license duration - (business case attractiveness versus level playing field);
3. Start with a public tender (and skip the 'by invitation') for selecting a JVC to participate in the DAB market. Such a change will reduce the business attractiveness as negotiations on certain business elements are not possible any longer – (business case attractiveness versus level playing field).

4.3 Market access

Market access is closely related to creating a level playing field and market capacity. Access to the market is enlarged when the market capacity increases. Equally, re-balancing the level playing field by introducing a non-compete clause limits market access.

In this Section the following aspects on radio market access will be addressed:

1. Market access balance;
2. Mitigation.

4.3.1 Market access balance

Considering the discussion as addressed in the previous Sections 4.1.1, 4.1.2 and 4.2.1, with the proposed DAB licensing policy market access is balanced as follows:

1. Market access is enlarged for service providers by offering 2 or more DAB multiplexes (in the period before FM ASO) and deploying near nationwide DAB networks. Market access is especially enlarged for local/rural broadcasters as the network will reach further into the country;
2. Within the enlarged market access for service providers, the market access is somewhat limited by reserving capacity for the JVC and introducing a non-compete clause temporarily (both for the benefit of improving the business attractiveness);
3. Market access is somewhat reduced for network operators by starting the assignment procedure 'by invitation' and having only one JVC for the national distribution or per LA (for the benefit of improving the business attractiveness and network deployment efficiency). However, this market access limitation is counter balanced by the JVC subcontracting parts of the network provisioning and operations to its members.

4.3.2 Mitigation

If deemed necessary, the following changes could be considered to rebalance market access:

1. Changing the number of multiplexes. However, the following should be considered:
    a. A larger number of multiplexes may increase access but may also lead to market overfeeding (see Section 4.1.1);
    b. A smaller number may reduce market access but not ensure enough programming for consumers to change to DAB;
2. Change the reserved capacity for the JVC and the Pool. A larger Pool may increase market access but will limit the market attractiveness for entering the DAB market;
3. Start with a public tender (and skip the 'by invitation') for selecting a JVC to participate in the DAB market. As said before (see Section 4.2.1), such a change will reduce the business attractiveness as negotiations on certain business elements are not possible any longer;
4. Change the number of new DO service providers and the number of new DO services they will introduce into the market (see also Section 4.1.3).

4.4 DAB distribution fees

As deploying DAB networks is capital intensive, the distribution fees to be paid by the service providers will be a critical cost component in their business case.

It is important to note that the NPV calculations, as presented in Section 1.3, do not include the distribution fees to be paid. A NPV calculation projects cash out and cash in (i.e. cash flows). A cash out is the purchase of equipment and not the annual depreciation. A transmission fee is cost based and will need an annual depreciation (based on economic life) for each network element. It is noted however that the cash flow projection also uses this economic life to project when replacement equipment has to be purchased.

This Section is structured as follows:

1. Calculation model and distribution fees;
2. Mitigation.

4.4.1 Calculation model and distribution fees

For an initial calculation of the distribution fee (per deployment scenario) the following basic model is applied:

*Annual Distribution fee per 64 kbps slot = (Annual Depreciation costs for each network element + (Annual OPEX of network operations * profit margin)) / (number of multiplexes * 18)*

It is noted that this calculation model is a simplified model as it does not include a margin on the annual deprecation costs (as this will imply a decision on the WACC) and doesn't follow exactly the principles of the Long-Run Incremental Cost (LRIC) model, as for example was stipulated by the NBTC when regulating the DTTB distribution fees[59].

The following basic assumptions were made for calculating the distribution fees:

1. Economic life for the various network elements as included in the valuation model;
2. Straight line deprecation method and no remaining value at the end of economic life;
3. No price change when replacing equipment;
4. Annual OPEX as included in the valuation model;
5. OPEX margin of 15%;
6. 100% occupancy rate of all multiplexes;
7. All networks fully deployed;
8. All slots are 64 kbps (in National and Local layer, by selecting 18 audio services per multiplex in the Dashboard).

Table 20 shows the annual distribution fees for various scenarios (see also Table 9).

Ref.	# sites	% greenfield sites	Pop %	# MUX	# SPs	Average annual fee per National slot	Average annual fee per Local slot
N1	200	15%	95%	2+0	18+0	$752,871	-
N2	90	0%	80%	2+0	18+0	$336,797	-
N4	90	0%	80%	3+0	27+0	$347,338	-
NL2	90	0%	80%	2+1	18+351	$350,636	$12,600

TABLE 20: INITIAL DISTRIBUTION FEES PER 64 KBPS FOR DIFFERENT SCENARIOS

It is important to note that the distribution fees as included in Table 20, are based on the assumption that all multiplexes are fully deployed and loaded (no empty slots are assumed to occur). If

[59] For more details on this model please refer to Annex D.

multiplexes are not fully loaded, then this under-utilization risk and associated losses are incorporated by the Network operator. This is especially relevant for the LA network operators. A LA network should only be deployed when it can be fully loaded. Again a fragmented approach within a LA of just launching on the basis of a few service providers and sites should be avoided. Alternatively, the normal utilization rate should be set at for example 50% which will double the transmission fees as included in Table 20.

These annual distribution fees to be paid do have a significant impact on the business of service providers. Considering the 'long tail' character of ADEX revenues, a careful approach should be follow here.

4.4.2 Mitigation

The impact on the business case of the service providers can be mitigated as follows:

1. Provide financial support from public sources (see Section 2.3.2 and 3.3.2);
2. Change the cost drivers in the network design, in the following order:
    a. Number of sites (hence the more cautious deployment target of 80% was recommended);
    b. Number of multiplexes (initially not exceeded 2 National and a Local only when additional public funds are available);
    c. Reduce redundancy (please note that the assumed configuration in the base case scenarios is already the bare minimum).

5. Conclusions and recommendations

This Chapter includes the following Sections:

1. Conclusions;
2. Recommendations;
3. Next steps.

5.1 Conclusions

On the basis of the presented DAB information in this and previous reports (see Introduction), the following can be concluded:

1. As the international benchmark study has demonstrated DAB has been introduced successfully in several countries. This success is reflected in the fact that in the selected countries a FM ASO date is set (Norway) or a conditional FM ASO date or plan is proposed (UK/Switzerland) or discussed (Australia);
2. Experience in those selected countries have demonstrated that DAB brings several benefits. The listeners will benefit from having access to more content types and better quality as well as new features such as multimedia information and interactivity (hybrid services). The broadcasters will benefit from having lower operating costs and improved value of their content and services. Also for the listener a hybrid DAB/IP solution will offer significant costs savings, as audio (and other data) is not streamed but broadcast to the receiver/smartphone[60];
3. The DAB business is a long term business. Although referred to frequently, the UK and Norway are not the best references today. Both countries introduced DAB 20 years ago and can be considered early adopters. A better current case is Australia. An uptake of more than 25% of listening share was achieved in 6 years in this country;
4. DAB is capital intensive and the main DAB market entry barrier is the investment in the network. A carefully planned network design and deployment, maximizing infrastructure sharing, is a requirement;
5. An industry supported business case is necessary to overcome this hurdle. As demonstrated the business case is challenging and only a few deployment scenarios show a positive NPV. The business case of LA DAB cannot be carried on ADEX or other commercial income alone. For the introduction of a Local layer additional Government support will be needed;
6. As the benchmark study has shown DAB's success rate is significantly improved when the principle of '*promoting competition on service provisioning and collaboration on network operations*' is applied;
7. The production of digital-only (DO) DAB services and programming has proven to be an important factor for adding value. For Thailand a specific additional benefit of DAB has to be

[60] In Annex F an overview is provided of the key advantages of DAB+ for Thailand.

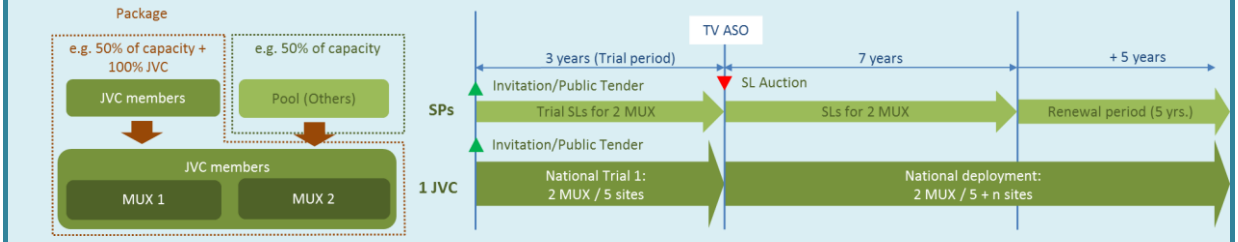
mentioned. A DAB network will provide more and better national coverage as compared to best performing FM networks in Thailand[61];

8. DAB introduction will mainly have a positive impact on the Thai market as distribution capacity is increased and more (innovative) services are possible. Any negative impact can be mitigated by adjusting several parameters in the proposed DAB deployment strategy and licensing policy (see Chapter 4).

5.2 Recommendations

A wide range of recommendations are provided for the DAB deployment strategy and licensing policy, for both the Trial as the final phase when National and Local networks are deployed. For the various recommendations please refer to the '*Recommendations*' Sections in Chapter 2 and 3.

The essence of the recommended deployment strategy and policy is reflected in Figure 52



Source: ITU

FIGURE 52: ESSENCE OF THE RECOMMENDED DAB DEPLOYMENT STRATEGY AND POLICY

5.3 Next steps

As discussed in the Introduction, following their BMP it is assumed that the NBTC has the ambition to introduce DAB before the end of their current term (i.e. September 2017). Also considering the results from the broadcasters visits and the public consultation, the following immediate next steps are proposed as to promote a timely and successful DAB introduction in Thailand:

1. Industry stakeholders (i.e. broadcasters, network operators, equipment suppliers and car manufacturers) are invited to send a letter to the NBTC expressing their interest (or not) in exploring ways for a DAB launch in Thailand;
2. NBTC drafts the key terms and conditions under which it wishes to see DAB launched in Thailand, including:
    a. Minimum number of services, multiplexes and coverage targets;
    b. Infrastructure sharing requirements and common network operations (JVC);
    c. Licensing 'Package' (for Trial and National services);
3. Industry stakeholders establish a representative body[62] and formulate their business plan (including their terms and conditions) for a DAB launch in Thailand. The NBTC may

[61] See also Annex F.

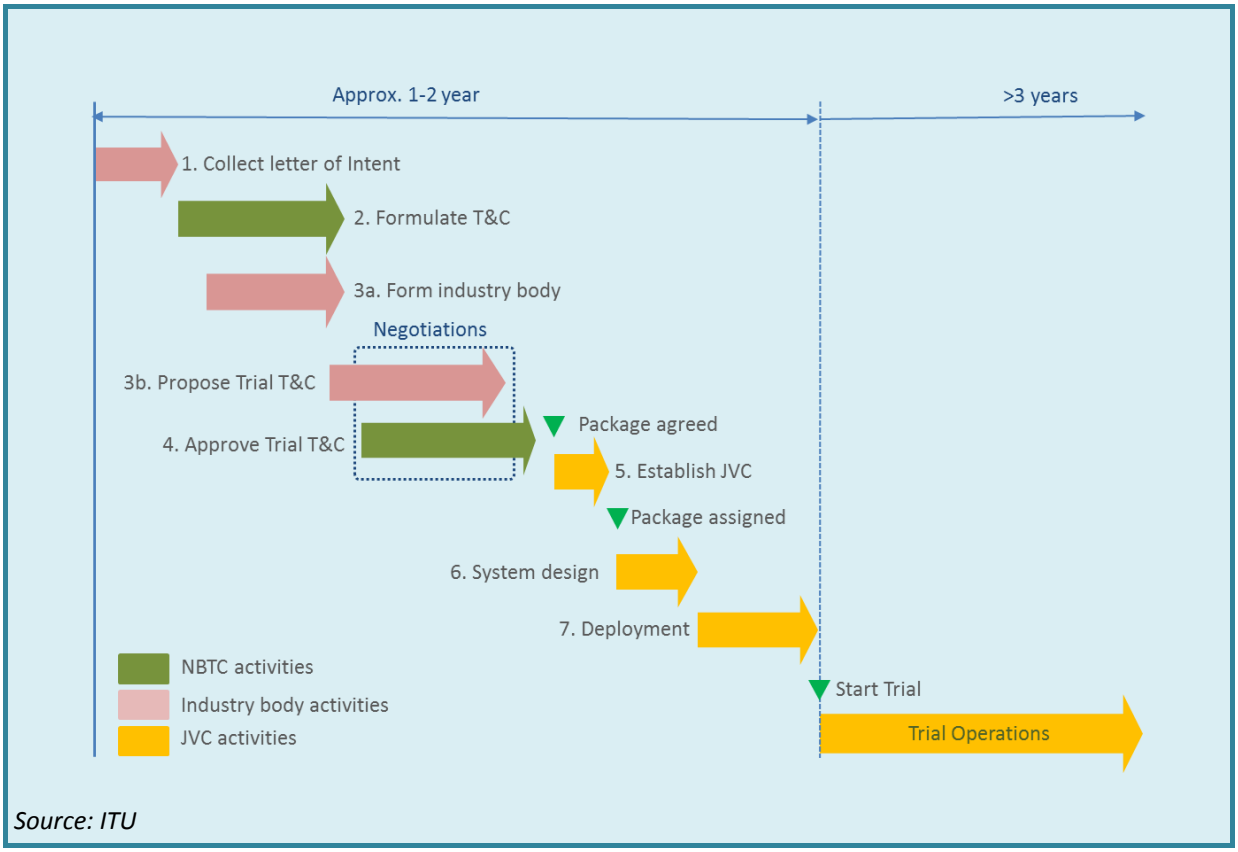
coordinate the establishment of the representative body and support the drafting of the business plan by making available the various reports on DAB[63];

4. NBTC invites the representative body to negotiate the licensing 'Package' and supporting measures. Items for negotiations can include:
    a. Trial duration, and hence the non-compete period (see Section 2.1.2);
    b. JVC variant (see Section 2.4.1);
    c. Percentage of capacity reserved for Pool (see Section 2.4.1);
    d. License fees to be paid (see Section 3.5.2);
    e. Number of DO service providers and services (see Sections 2.2.2, 2.2.3, 2.2.4 and 4.1.3);
    f. License conditions on the extension of analogue licenses (see Section 2.3.4);
5. After agreement on the licensing 'Package' and the supporting measures, the JVC can be established;
6. After establishment of the JVC the Network and Service Trial licenses can be assigned to respectively the JVC and JVC members.

Figure 53 shows the timeline of the above listed next steps. It is noted that this timeline does not consider the time needed for any notification process.

[62] See Section 2.3.5.

[63] For an overview of the various reports please refer to the Introduction.



Source: ITU

FIGURE 53: TIMELINE OF NEXT STEPS

Glossary of Abbreviations

AAC	Advance Audio Coding
ADEX	Advertising Expenditure
ASO	Analogue Switch Off
ATV	Analogue Television
BMP	Broadcasting Master Plan
CAPEX	Capital Expenditure
CRA	Commercial Radio Australia
CS	Community Service
DAB	Digital Audio Broadcasting
DO	Digital Only
DR	Digital Radio
DSB	Digital Sound Broadcasting
DSL	Dynamic Service Link
DTTB	Digital Terrestrial Television Broadcasting
EEP	Equal Error Protection
ERP	Effective Radiated Power
EWS	Emergency Warning System
FCF	Free Cash Flow
FIC	Fast Information Channel
FIG	Fast Information Group
FL	Facility License or Licensee
GDP	Gross Domestic Product
JVC	Joint Venture Company
LA	Local Area
LRIC	Long Run Incremental Cost
MFN	Multi Frequency Network
NBTC	National Broadcasting and Telecommunications Commission (of Thailand)
NO	Network Operations
NPV	Net Present Value
ONBTC	Office of the NBTC
OPEX	Operating Expenditure
PAD	Program Associated Data
PBS	Public Broadcasting Service
PPP	Public Private Partnership
PSB	Public Service Broadcasting
SA	Service Availability
SFN	Single Frequency Network
SL	Service license or Licensee
SP	Service Provisioning

THB	Thai Bath
UHF	Ultra High Frequency (Band)
US	Universal Service
USO	Universal Service Obligation
VHF	Very High Frequency (Band)
WACC	Weighted Average Cost of Capital

Annex A: List of visited companies and key observations

This Annex includes the following:

1. The list of companies visited in the periods 18 – 22nd of January and 9 – 26th of May 2016;
2. The list of participants of the public consultation meeting (focus group meeting) on 27th of May 2016;
3. Key observations from the company visits.

List of companies visited

Table 21 includes the list of companies visited in the periods 18 – 22nd of January and 9 – 26th of May 2016.

TABLE 21: LIST OF COMPANIES VISITED

No.	Organisation
1	PRD
2	MCOT
3	Royal Thai Army
4	Coolism Co. Ltd.
5	Independent Communication Network Co. Ltd
6	A-Time Media Co., Ltd.
7	The Thai Automotive Industry Association (TAIA)
8	Samart Corporation Plc.
9	BEC-Tero Radio Company Limited
10	Thai PBS

List of participants of the public consultation meeting

Table 22 includes the participants in the public consultation meeting (focus group meeting) on the 27th of May 2016.

TABLE 22: LIST OF PARTICIPANTS

No.	Organisation
1	Public Relations Department
2	MCOT
3	Thai PBS
4	Ministry of ICT
5	Ministry of Education

No.	Organisation
6	The Secretariat of the House of Representatives
7	Office of the Prime Minister
8	Royal Thai Army
9	Royal Thai Army
10	Royal Thai Air Force
11	Royal Thai Navy
12	Royal Thai Police
13	Independent Communication Network Co., Ltd.
14	A-Time Media Co., Ltd.
15	BEC-Tero Radio Company Limited
16	Coolism Co. Ltd.
17	The Federation of Thai Industries
18	The Thai Automotive Industry Association
19	Toyota Motor Thailand Co.,Ltd.
20	Toyota Motor Asia Pacific Engineering & Manufacturing Co.,Ltd.
21	BMW Thailand
22	Sharp Thailand
23	Samart Corporation Plc.
24	Confederation of Consumer Organization
25	Siang-dham Foundation

Key observations

Figure 54 to Figure 56 show the key observations from the company visits carried out in the periods 18 – 22nd of January and 9 – 26th of May 2016.

Source: ITU

FIGURE 54: KEY OBSERVATIONS - SUMMARY

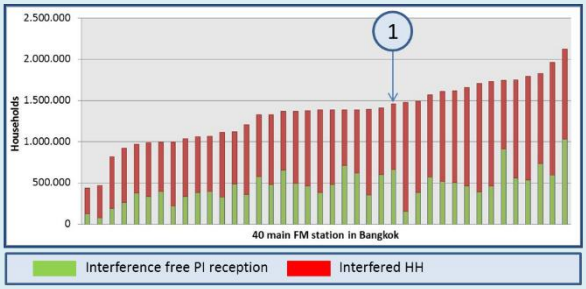
Source: ITU

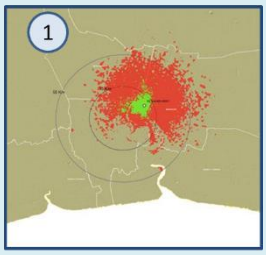
FIGURE 55: KEY OBSERVATIONS – INDUSTRY DYNAMICS

3. Current Situation in Thailand

C. FM services

- Current FM reception is extremely poor, particularly in the Bangkok area, due to high levels of interference
  - NBTC / ITU are formulating a plan to resolve FM interference
  - Executing the plan may take several years
- Broadcasters want a committed plan for resolving FM coverage and licensing issues before considering Digital Radio:
  - Ensuring (future) income, which can then fund digital listening (DAB and IP)
  - 'Doing nothing' will deteriorate revenues further





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Source: ITU

FIGURE 56: KEY OBSERVATIONS –FM SERVICES

Annex B: Outputs of valuation scenarios

This Annex includes the following:

1. The Dashboard (as described in Section 1.3.2) for each scenario (as described in Section 1.3.3), showing the key parameters entered in the model and the resulting CAPEX and NPV[64];
2. The associated graphs for each calculated National and Local scenario, including:
    a. Listening shares over time;
    b. Cumulative FCF over time.

Trial Scenarios

Scenario T1

Network deployment (CAPEX) Dashboard

		Pop coverage	
Frequency Plan	ITU Trial	16%	10,712,000
Total # sites	8	parameter should be "ITU Trial" when Trial	
Number of National MUX (layer)	2		
Number of Local MUX (layer)	0	parameter should be "0" when Trial	
Number of Local areas	39		
# audio services in national ensemble	18		
# audio services in local ensemble	0	parameter should be "0" when Trial	
% greenfield sites	0%	parameter should be "0" when Trial	
	National	**Local**	
Redundant encoder	no	no	
Redundant multiplexer	yes	yes	
Redundant distribution	no		
Redundant transmitter	no		

Source: ITU

FIGURE 57: INPUT WINDOW DASHBOARD – SCENARIO T1

[64] See footnote 16

CAPEX Output

SP	NATIONAL	LOCAL
CAPEX/SP	$24,600	$0
Total SP CAPEX	$442,800	$0
Total CAPEX all SPs	$442,800	

NO	NATIONAL	LOCAL
	per MUX	per MUX per LA
Head-end	$122,450	$0
Distribution	$362,500	$0
Transmission	$1,334,500	$0
Total	**$1,819,450**	**$0**
	all national MUXs	All local MUXs
Total NO CAPEX	$3,638,900	$0
Total CAPEX all MUX	$3,638,900	
	check = ok	

Source: ITU

FIGURE 58: OUTPUT WINDOW DASHBOARD – SCENARIO T1

Scenario T2[65]

Network deployment (CAPEX) Dashboard

		Pop coverage	
Frequency Plan	ITU Trial	15%	9,750,000
Total # sites	5	parameter should be "ITU Trial" when Trial	
Number of National MUX (layer)	2		
Number of Local MUX (layer)	0	parameter should be "0" when Trial	
Number of Local areas	39		
# audio services in national ensemble	18		
# audio services in local ensemble	0	parameter should be "0" when Trial	
% greenfield sites	0%	parameter should be "0" when Trial	
	National	**Local**	
Redundant encoder	no	no	
Redundant multiplexer	yes	yes	
Redundant distribution	no		
Redundant transmitter	no		

Source: ITU

FIGURE 59: INPUT WINDOW DASHBOARD – SCENARIO T2

[65] This scenario needs changing the number of sites in the worksheet "Network coverage & sites" – ITU Trial section.

CAPEX Output

SP	NATIONAL	LOCAL
CAPEX/SP	$24,600	$0
Total SP CAPEX	$442,800	$0
Total CAPEX all SPs	$442,800	

NO	NATIONAL	LOCAL
	per MUX	per MUX per LA
Head-end	$122,450	$0
Distribution	$239,500	$0
Transmission	$836,500	$0
Total	**$1,198,450**	**$0**
	all national MUXs	All local MUXs
Total NO CAPEX	$2,396,900	$0
Total CAPEX all MUX	$2,396,900	

check = ok

Source: ITU

FIGURE 60: OUTPUT WINDOW DASHBOARD – SCENARIO T2

National and Local scenarios

Scenario N1

Network deployment (CAPEX) Dashboard

		Pop coverage	
Frequency Plan	T1 National	95%	61,750,000
Total # sites	200	parameter should be "ITU Trial" when Trial	
Number of National MUX (layer)	2		
Number of Local MUX (layer)	0	parameter should be "0" when Trial	
Number of Local areas	39		
# audio services in national ensemble	18		
# audio services in local ensemble	0	parameter should be "0" when Trial	
% greenfield sites	15%	parameter should be "0" when Trial	
	National	**Local**	
Redundant encoder	no	no	
Redundant multiplexer	yes	yes	
Redundant distribution	no		
Redundant transmitter	no		

OPEX and Revenue Dashboard (NA for Trial)

	National	Local	
DAB only serivces (% of total number of services)	50%	50%	
NBTC licence fees (% of DAB revenues)	4%		
Radio ADEX growth rate (= forecasted GDP growth %)	2%		
DAB critical listening share (% of total market)	10%		
ASO for FM (Yes/No)	y		
FM ASO announcement year		2029	FM ASO year
DAB National/Local revenue split (% National)	100%	Allocate 100% to National!	
WACC	12%		

Source: ITU

FIGURE 61: INPUT WINDOW DASHBOARD – SCENARIO N1

CAPEX Output

SP	NATIONAL	LOCAL
CAPEX/SP	$24,600	$0
Total SP CAPEX	$442,800	$0
Total CAPEX all SPs	$442,800	

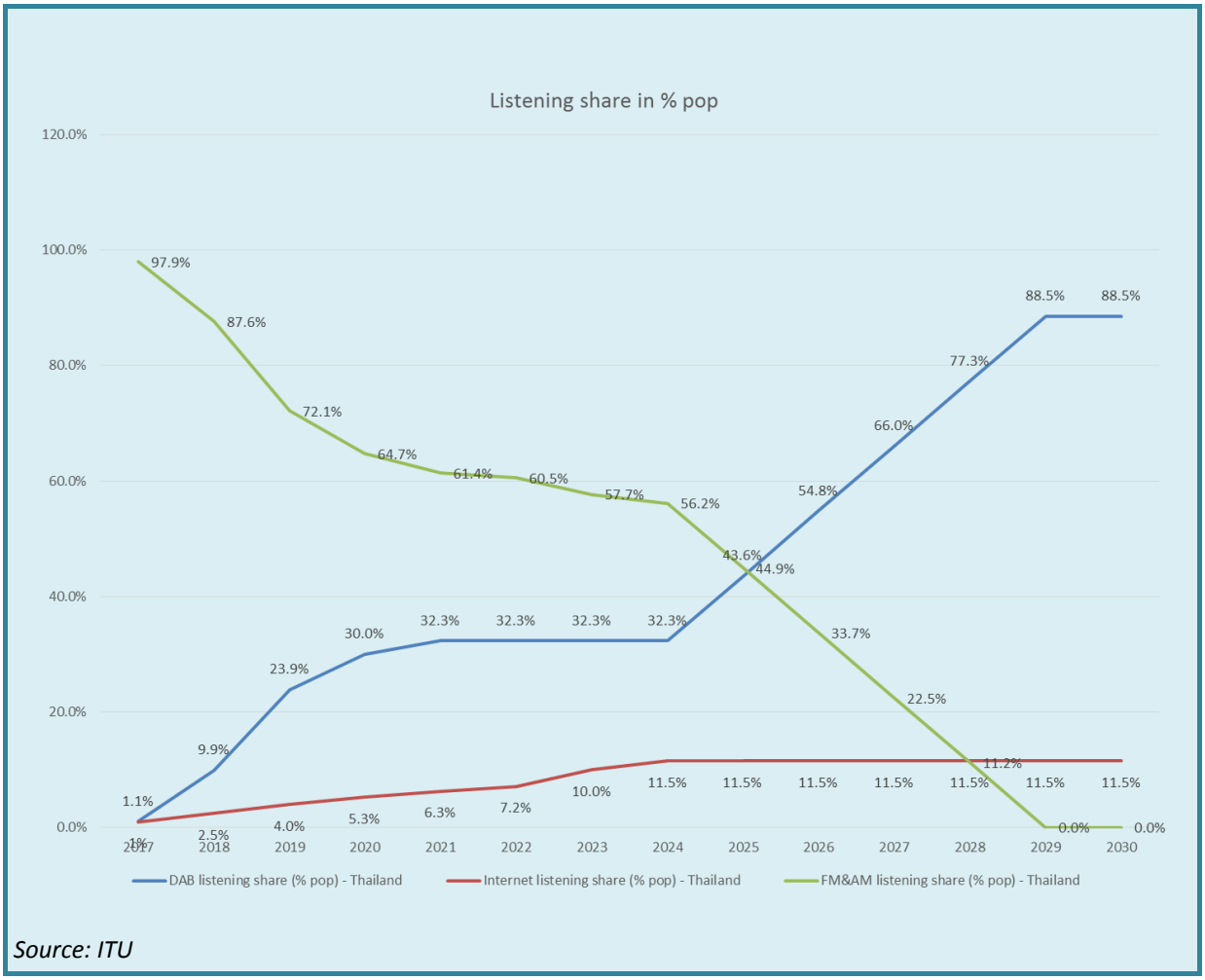
NO	NATIONAL	LOCAL
	per MUX	per MUX per LA
Head-end	$122,450	$0
Distribution	$8,826,450	$0
Transmission	$33,181,140	$0
Total	**$42,130,040**	**$0**
	all national MUXs	All local MUXs
Total NO CAPEX	$84,260,080	$0
Total CAPEX all MUX	$84,260,080	
	check = ok	

NPV Output (NA for Trial)

NPV Total market	$190,502,461
NPV per National SP	$10,583,470
NPV per Local SP	NA

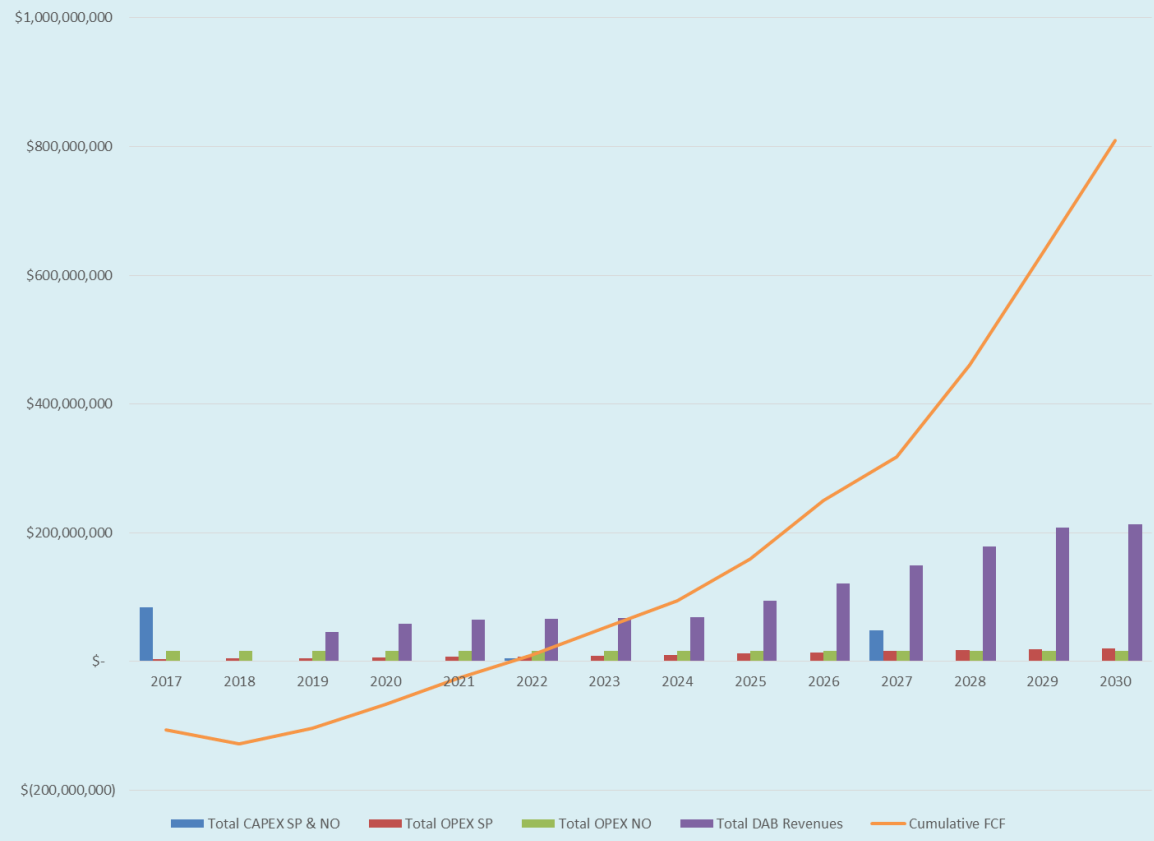
Source: ITU

FIGURE 62: OUTPUT WINDOW DASHBOARD – SCENARIO N1



Source: ITU

FIGURE 63: LISTENING SHARES – SCENARIO N1



Source: ITU

FIGURE 64: CUMULATIVE FCF TOTAL MARKET – SCENARIO N1

Scenario N2

Network deployment (CAPEX) Dashboard

		Pop coverage	
Frequency Plan	T2 National	80%	52,000,000
Total # sites	90	parameter should be "ITU Trial" when Trial	
Number of National MUX (layer)	2		
Number of Local MUX (layer)	0	parameter should be "0" when Trial	
Number of Local areas	39		
# audio services in national ensemble	18		
# audio services in local ensemble	0	parameter should be "0" when Trial	
% greenfield sites	0%	parameter should be "0" when Trial	
	National	**Local**	
Redundant encoder	no	no	
Redundant multiplexer	yes	yes	
Redundant distribution	no		
Redundant transmitter	no		

OPEX and Revenue Dashboard (NA for Trial)

	National	Local	
DAB only serivces (% of total number of services)	50%	50%	
NBTC licence fees (% of DAB revenues)	4%		
Radio ADEX growth rate (= forecasted GDP growth %)	2%		
DAB critical listening share (% of total market)	10%		
ASO for FM (Yes/No)	y		
FM ASO announcement year		2029	FM ASO year
DAB National/Local revenue split (% National)	100%	Allocate 100% to National!	
WACC	12%		

Source: ITU

FIGURE 65: INPUT WINDOW DASHBOARD – SCENARIO N2

CAPEX Output

SP	NATIONAL	LOCAL
CAPEX/SP	$24,600	$0
Total SP CAPEX	$442,800	$0
Total CAPEX all SPs	$442,800	

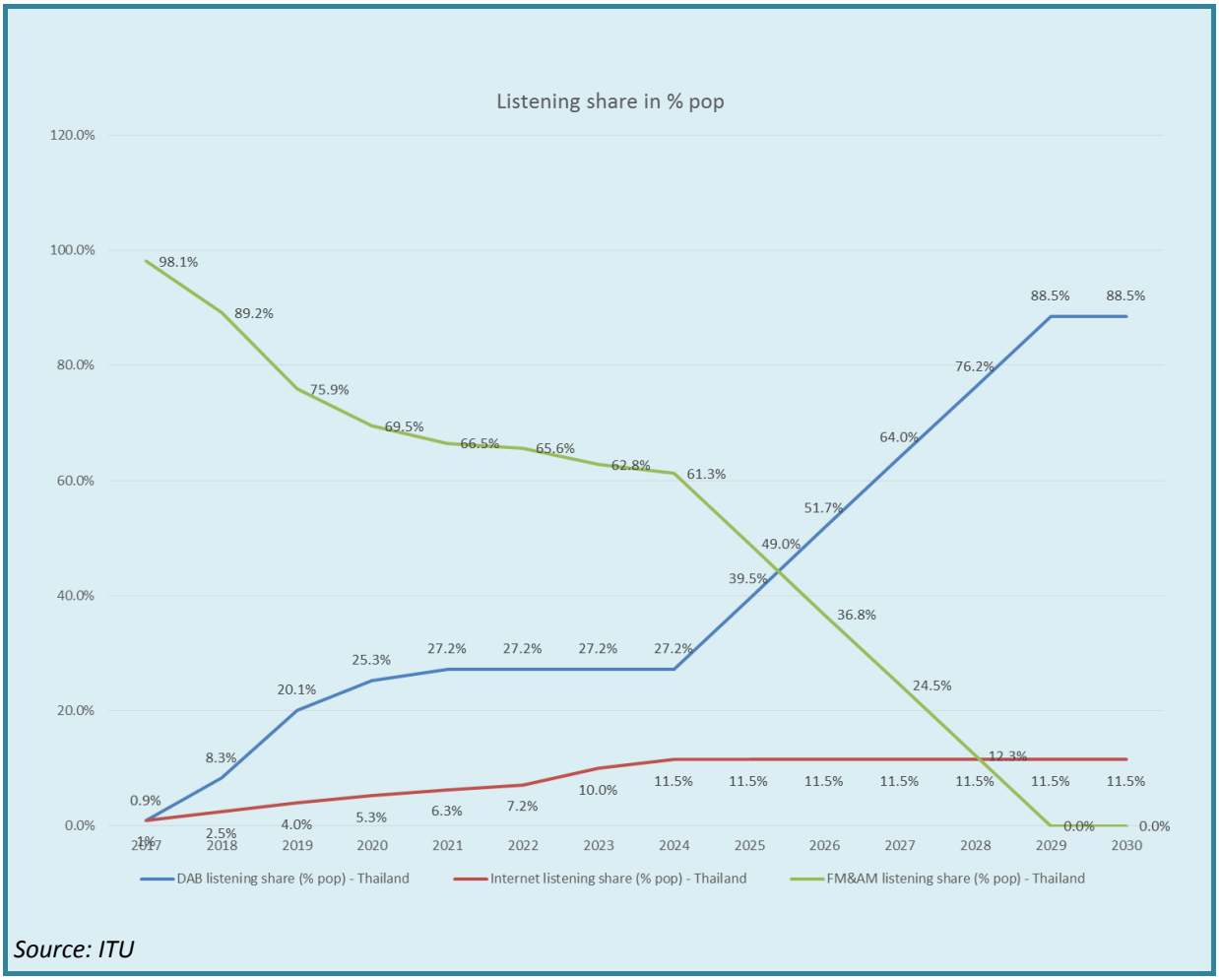
NO	NATIONAL	LOCAL
	per MUX	per MUX per LA
Head-end	$122,450	$0
Distribution	$3,721,950	$0
Transmission	$14,921,140	$0
Total	**$18,765,540**	**$0**
	all national MUXs	All local MUXs
Total NO CAPEX	$37,531,080	$0
Total CAPEX all MUX	$37,531,080	
	check = ok	

NPV Output (NA for Trial)

NPV Total market	$266,538,766
NPV per National SP	$14,807,709
NPV per Local SP	NA

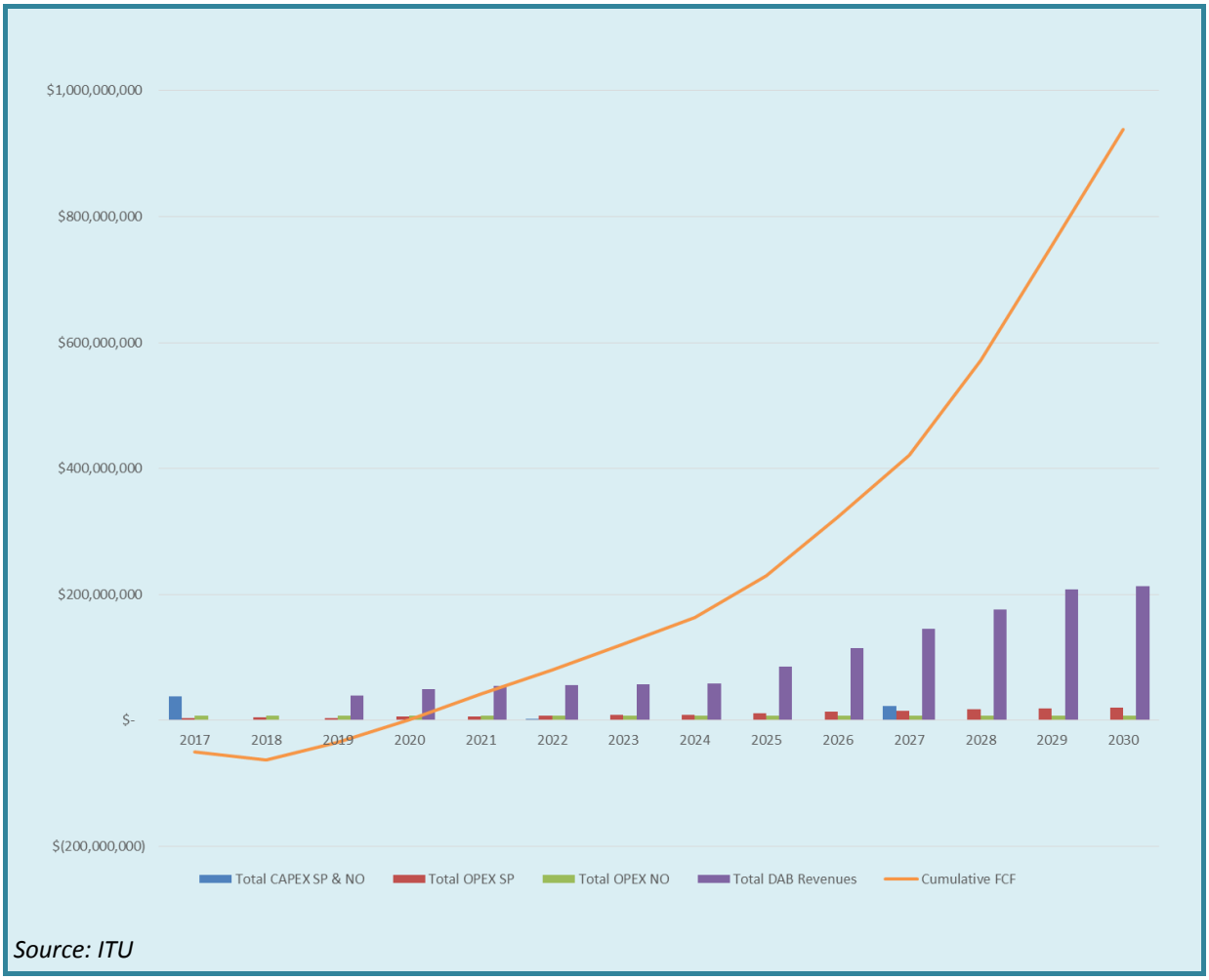
Source: ITU

FIGURE 66: OUTPUT WINDOW DASHBOARD – SCENARIO N2



Source: ITU

FIGURE 67: LISTENING SHARES – SCENARIO N2



Source: ITU

FIGURE 68: CUMULATIVE FCF TOTAL MARKET – SCENARIO N2

Scenario N3

Network deployment (CAPEX) Dashboard

		Pop coverage	
Frequency Plan	T1 National	95%	61,750,000
Total # sites	200	parameter should be "ITU Trial" when Trial	
Number of National MUX (layer)	3		
Number of Local MUX (layer)	0	parameter should be "0" when Trial	
Number of Local areas	39		
# audio services in national ensemble	18		
# audio services in local ensemble	0	parameter should be "0" when Trial	
% greenfield sites	15%	parameter should be "0" when Trial	
	National	**Local**	
Redundant encoder	no	no	
Redundant multiplexer	yes	yes	
Redundant distribution	no		
Redundant transmitter	no		

OPEX and Revenue Dashboard (NA for Trial)

	National	Local	
DAB only serivces (% of total number of services)	50%	50%	
NBTC licence fees (% of DAB revenues)	4%		
Radio ADEX growth rate (= forecasted GDP growth %)	2%		
DAB critical listening share (% of total market)	10%		
ASO for FM (Yes/No)	y		
FM ASO announcement year		2029	FM ASO year
DAB National/Local revenue split (% National)	100%	Allocate 100% to National!	
WACC	12%		

Source: ITU

FIGURE 69: INPUT WINDOW DASHBOARD – SCENARIO N3

CAPEX Output

SP	NATIONAL	LOCAL
CAPEX/SP	$24,600	$0
Total SP CAPEX	$664,200	$0
Total CAPEX all SPs	$664,200	

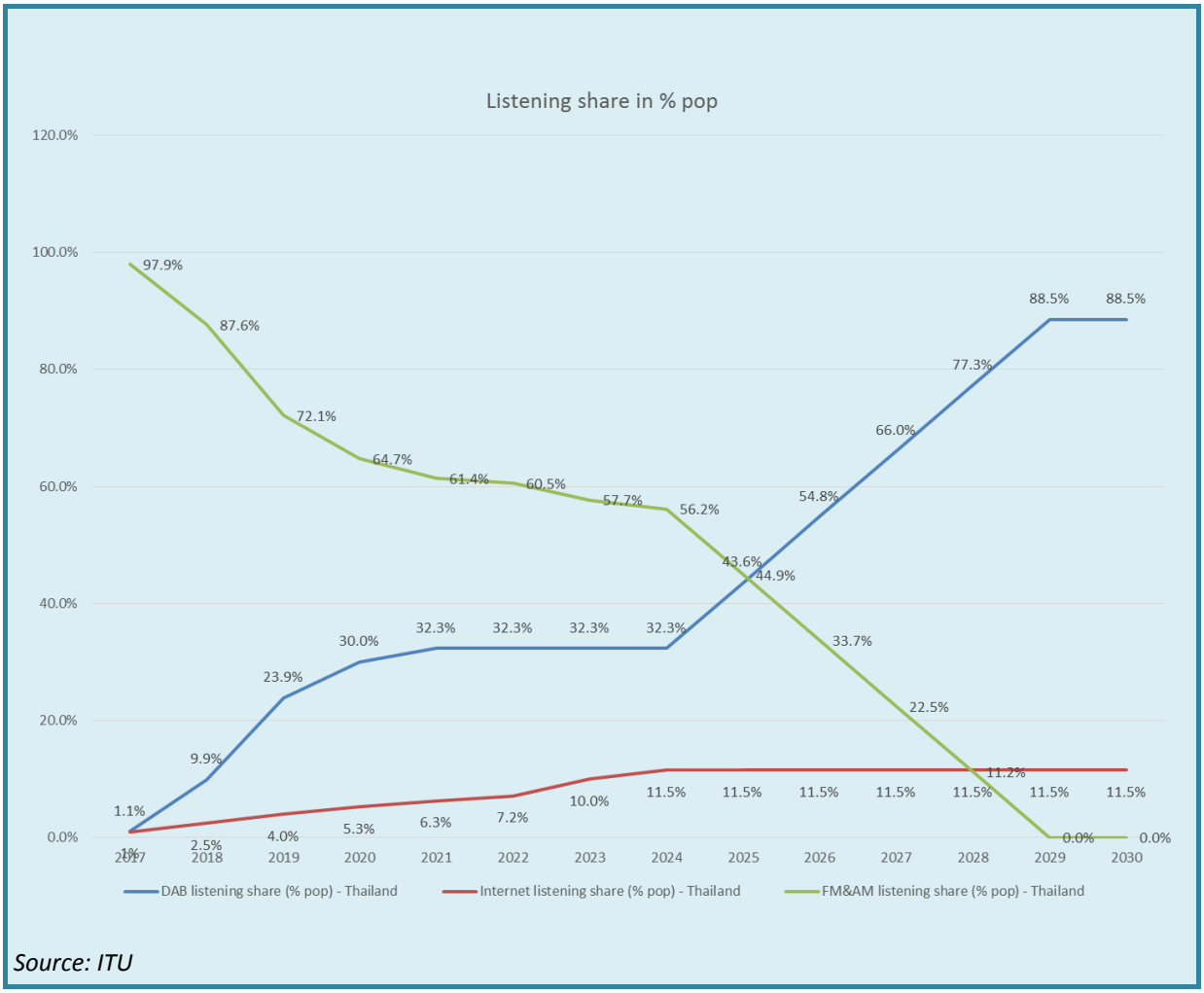
NO	NATIONAL	LOCAL
	per MUX	per MUX per LA
Head-end	$110,250	$0
Distribution	$5,884,300	$0
Transmission	$37,727,973	$0
Total	**$43,722,523**	**$0**
	all national MUXs	All local MUXs
Total NO CAPEX	$131,167,570	$0
Total CAPEX all MUX	$131,167,570	
	check = ok	

NPV Output (NA for Trial)

NPV Total market	$67,201,171
NPV per National SP	$2,488,932
NPV per Local SP	NA

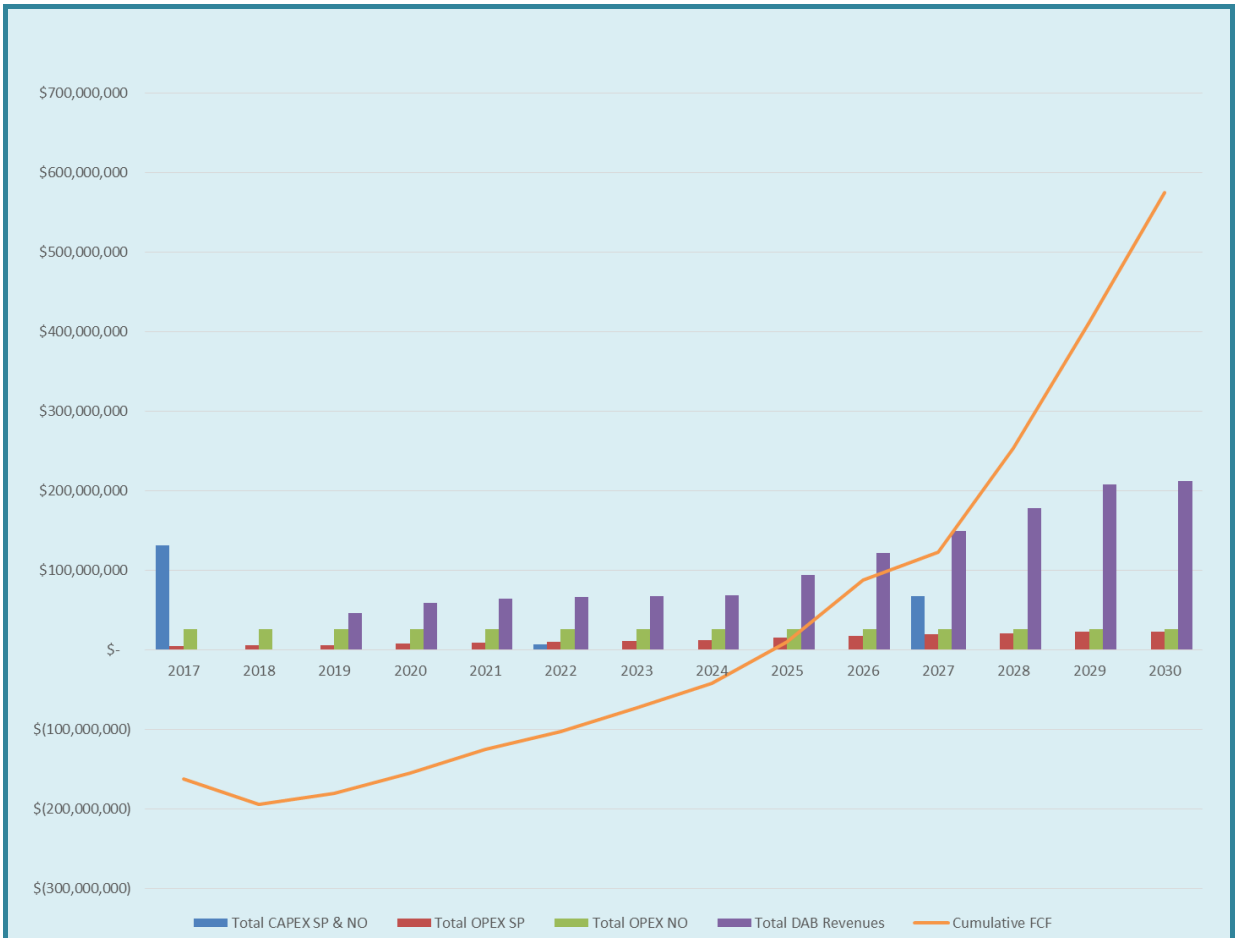
Source: ITU

FIGURE 70: OUTPUT WINDOW DASHBOARD – SCENARIO N3



Source: ITU

FIGURE 71: LISTENING SHARES – SCENARIO N3



Source: ITU

FIGURE 72: CUMULATIVE FCF TOTAL MARKET – SCENARIO N3

Scenario N4

Network deployment (CAPEX) Dashboard

		Pop coverage	
Frequency Plan	T2 National	80%	52,000,000
Total # sites	90	parameter should be "ITU Trial" when Trial	
Number of National MUX (layer)	3		
Number of Local MUX (layer)	0	parameter should be "0" when Trial	
Number of Local areas	39		
# audio services in national ensemble	18		
# audio services in local ensemble	0	parameter should be "0" when Trial	
% greenfield sites	0%	parameter should be "0" when Trial	
	National	**Local**	
Redundant encoder	no	no	
Redundant multiplexer	yes	yes	
Redundant distribution	no		
Redundant transmitter	no		

OPEX and Revenue Dashboard (NA for Trial)

	National	Local	
DAB only serivces (% of total number of services)	50%	50%	
NBTC licence fees (% of DAB revenues)	4%		
Radio ADEX growth rate (= forecasted GDP growth %)	2%		
DAB critical listening share (% of total market)	10%		
ASO for FM (Yes/No)	y		
FM ASO announcement year		2029	FM ASO year
DAB National/Local revenue split (% National)	100%	Allocate 100% to National!	
WACC	12%		

Source: ITU

FIGURE 73: INPUT WINDOW DASHBOARD – SCENARIO N4

CAPEX Output

SP	NATIONAL	LOCAL
CAPEX/SP	$24,600	$0
Total SP CAPEX	$664,200	$0
Total CAPEX all SPs	$664,200	

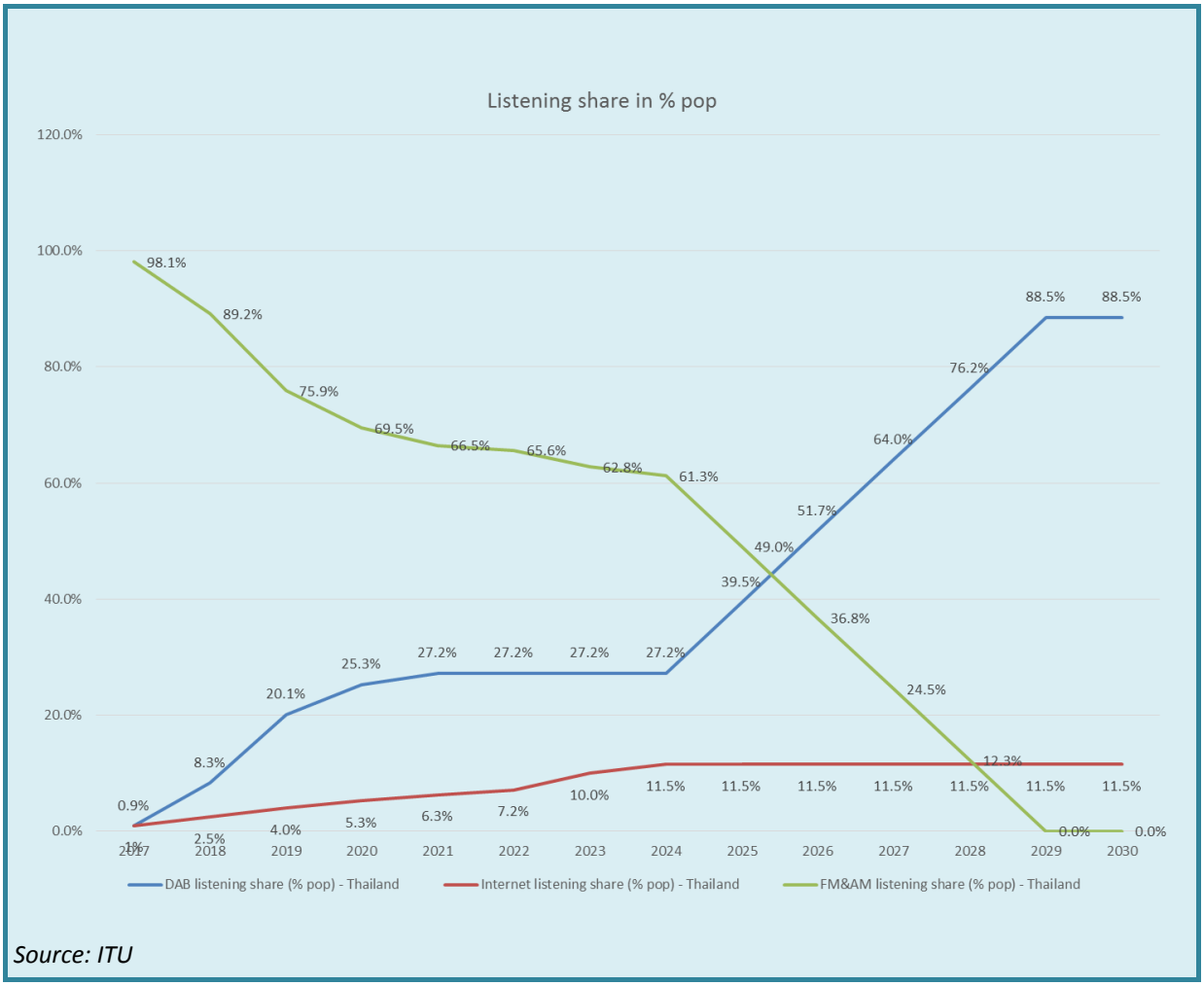
NO	NATIONAL	LOCAL
	per MUX	per MUX per LA
Head-end	$110,250	$0
Distribution	$2,481,300	$0
Transmission	$16,937,973	$0
Total	**$19,529,523**	**$0**
	all national MUXs	All local MUXs
Total NO CAPEX	$58,588,570	$0
Total CAPEX all MUX	$58,588,570	
	check = ok	

NPV Output (NA for Trial)

NPV Total market	$204,157,121
NPV per National SP	$7,561,375
NPV per Local SP	NA

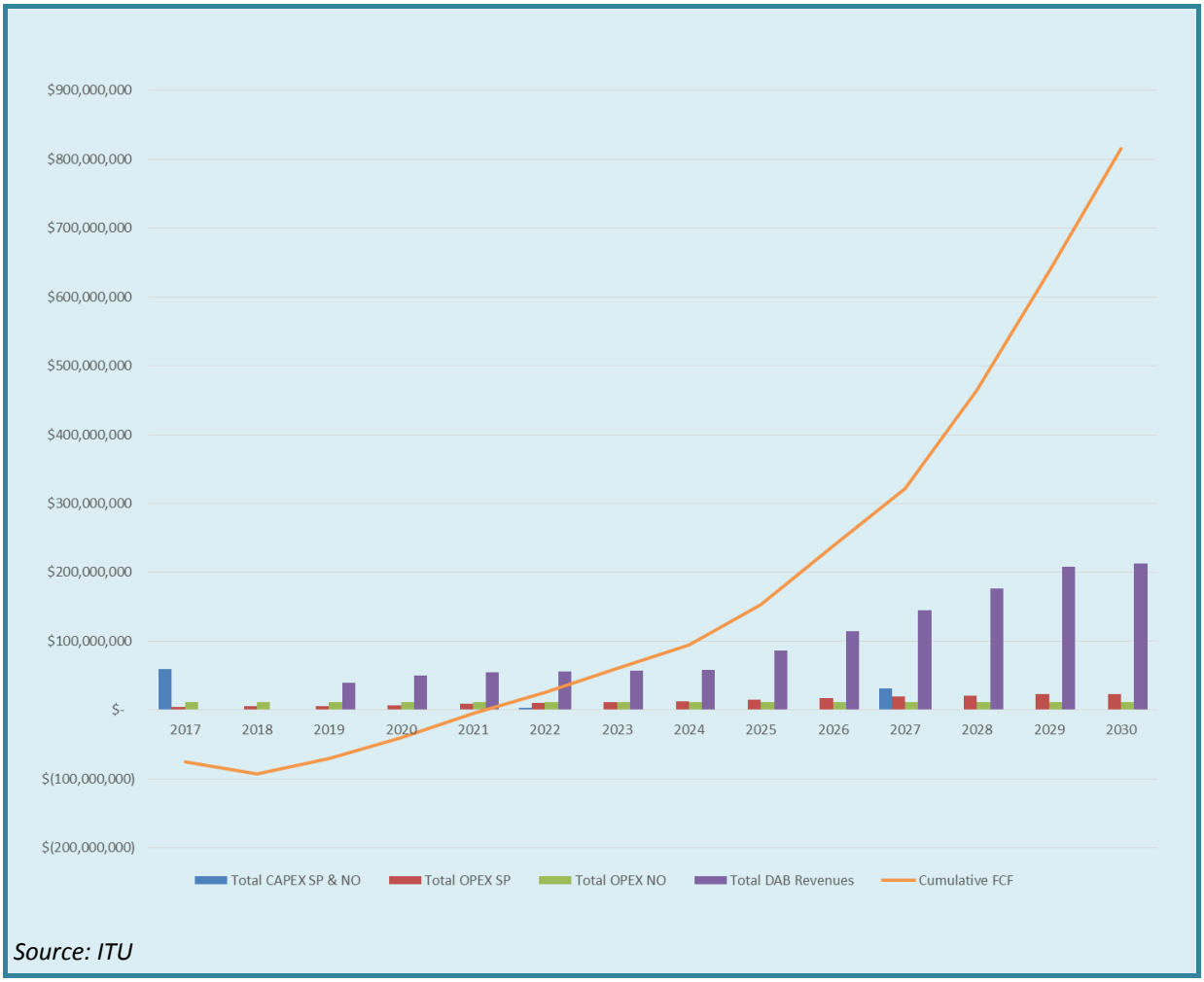
Source: ITU

FIGURE 74: OUTPUT WINDOW DASHBOARD – SCENARIO N4



Source: ITU

FIGURE 75: LISTENING SHARES – SCENARIO N4



Source: ITU

FIGURE 76: CUMULATIVE FCF TOTAL MARKET – SCENARIO N4

Scenario NL1

Network deployment (CAPEX) Dashboard

		Pop coverage	
Frequency Plan	T1 National	95%	61,750,000
Total # sites	200	parameter should be "ITU Trial" when Trial	
Number of National MUX (layer)	2		
Number of Local MUX (layer)	1	parameter should be "0" when Trial	
Number of Local areas	39		
# audio services in national ensemble	18		
# audio services in local ensemble	18	parameter should be "0" when Trial	
% greenfield sites	15%	parameter should be "0" when Trial	
	National	**Local**	
Redundant encoder	no	no	
Redundant multiplexer	yes	yes	
Redundant distribution	no		
Redundant transmitter	no		

OPEX and Revenue Dashboard (NA for Trial)

	National	Local	
DAB only serivces (% of total number of services)	50%	50%	
NBTC licence fees (% of DAB revenues)	4%		
Radio ADEX growth rate (= forecasted GDP growth %)	2%		
DAB critical listening share (% of total market)	10%		
ASO for FM (Yes/No)	y		
FM ASO announcement year		2029	FM ASO year
DAB National/Local revenue split (% National)	85%	Allocate % to National!	
WACC	12%		

Source: ITU

FIGURE 77: INPUT WINDOW DASHBOARD – SCENARIO NL1

CAPEX Output

SP	NATIONAL	LOCAL
CAPEX/SP	$24,600	$24,600
Total SP CAPEX	$442,800	$8,634,600
Total CAPEX all SPs	$9,077,400	

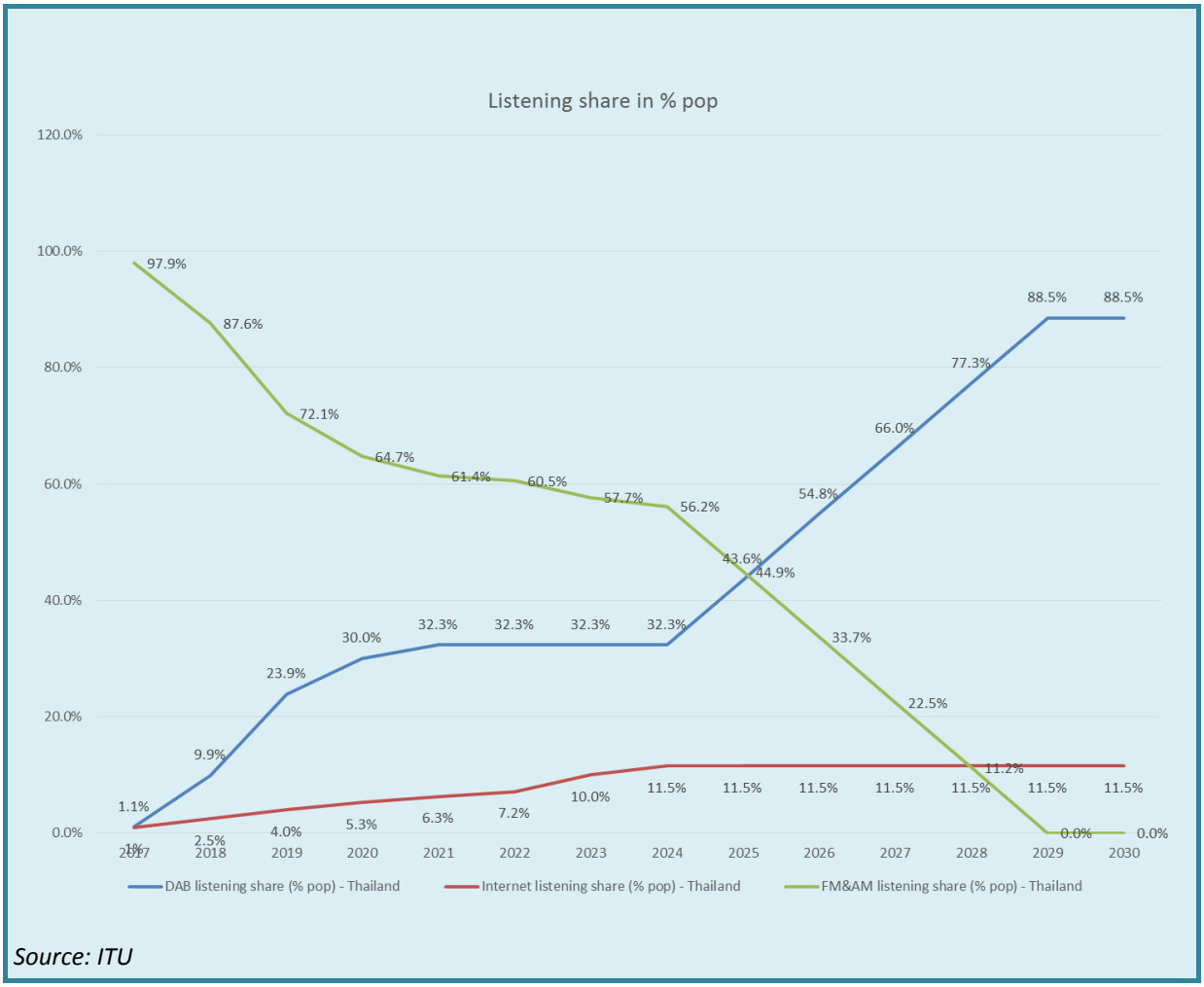
NO	NATIONAL	LOCAL
	per MUX	per MUX per LA
Head-end	$122,450	$159,050
Distribution	$6,228,133	$133,247
Transmission	$37,896,973	$971,717
Total	**$44,247,557**	**$1,264,014**
	all national MUXs	All local MUXs
Total NO CAPEX	$88,495,113	$49,296,557
Total CAPEX all MUX	$137,791,670	
	check = ok	

NPV Output (NA for Trial)

NPV Total market	-$434,513,538
NPV per National SP	$6,710,995
NPV per Local SP	-$1,149,838

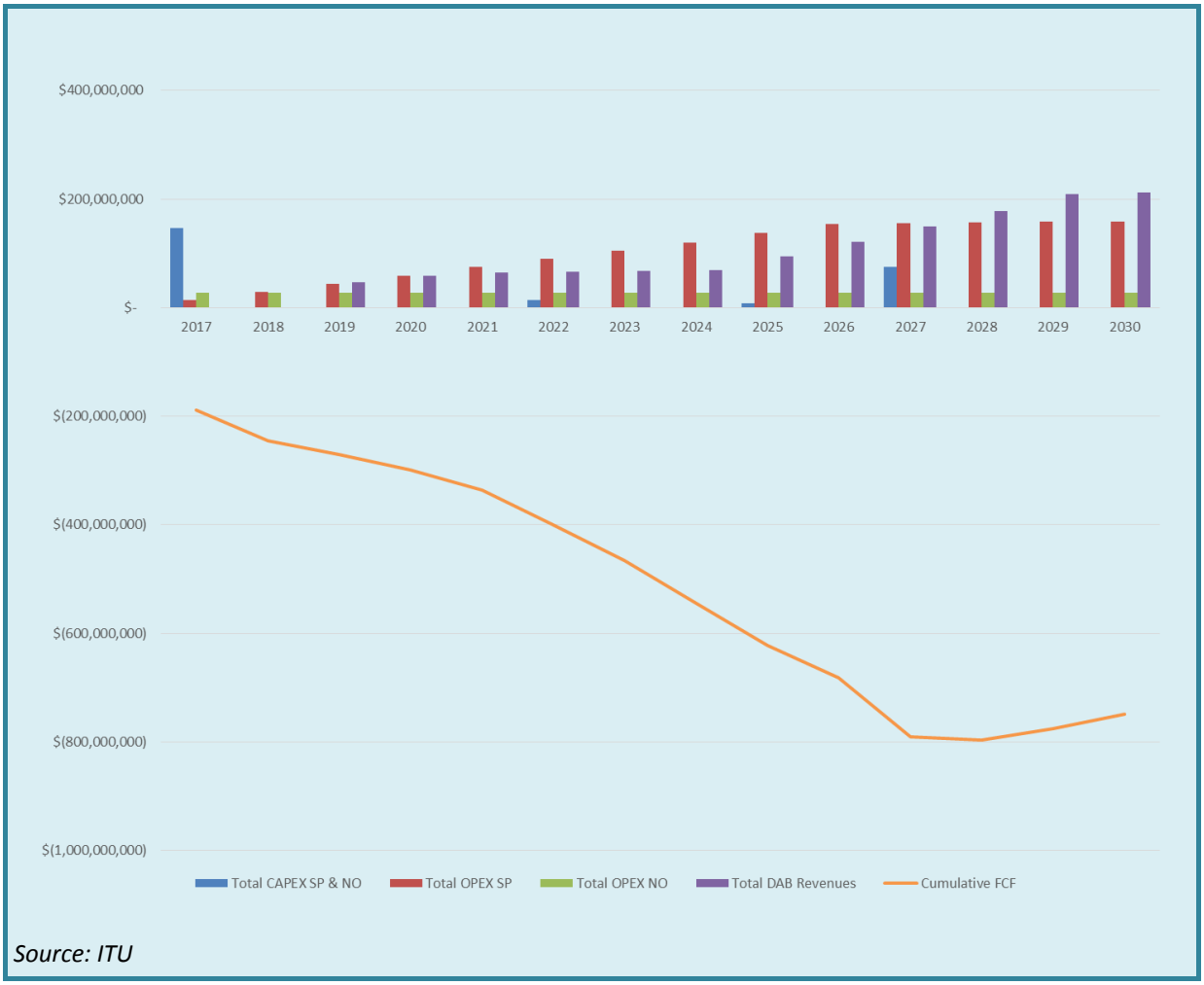
Source: ITU

FIGURE 78: OUTPUT WINDOW DASHBOARD – SCENARIO NL1



Source: ITU

FIGURE 79: LISTENING SHARES – SCENARIO NL1



Source: ITU

FIGURE 80: CUMULATIVE FCF TOTAL MARKET – SCENARIO NL1

Scenario NL2

Network deployment (CAPEX) Dashboard

		Pop coverage	
Frequency Plan	T2 National	80%	52,000,000
Total # sites	90	parameter should be "ITU Trial" when Trial	
Number of National MUX (layer)	2		
Number of Local MUX (layer)	1	parameter should be "0" when Trial	
Number of Local areas	39		
# audio services in national ensemble	18		
# audio services in local ensemble	18	parameter should be "0" when Trial	
% greenfield sites	0%	parameter should be "0" when Trial	
	National	**Local**	
Redundant encoder	no	no	
Redundant multiplexer	yes	yes	
Redundant distribution	no		
Redundant transmitter	no		

OPEX and Revenue Dashboard (NA for Trial)

	National	Local	
DAB only serivces (% of total number of services)	50%	50%	
NBTC licence fees (% of DAB revenues)	4%		
Radio ADEX growth rate (= forecasted GDP growth %)	2%		
DAB critical listening share (% of total market)	10%		
ASO for FM (Yes/No)	y		
FM ASO announcement year		2029	FM ASO year
DAB National/Local revenue split (% National)	85%	Allocate % to National!	
WACC	12%		

Source: ITU

FIGURE 81: INPUT WINDOW DASHBOARD – SCENARIO NL2

CAPEX Output

SP	NATIONAL	LOCAL
CAPEX/SP	$24,600	$24,600
Total SP CAPEX	$442,800	$8,634,600
Total CAPEX all SPs	$9,077,400	

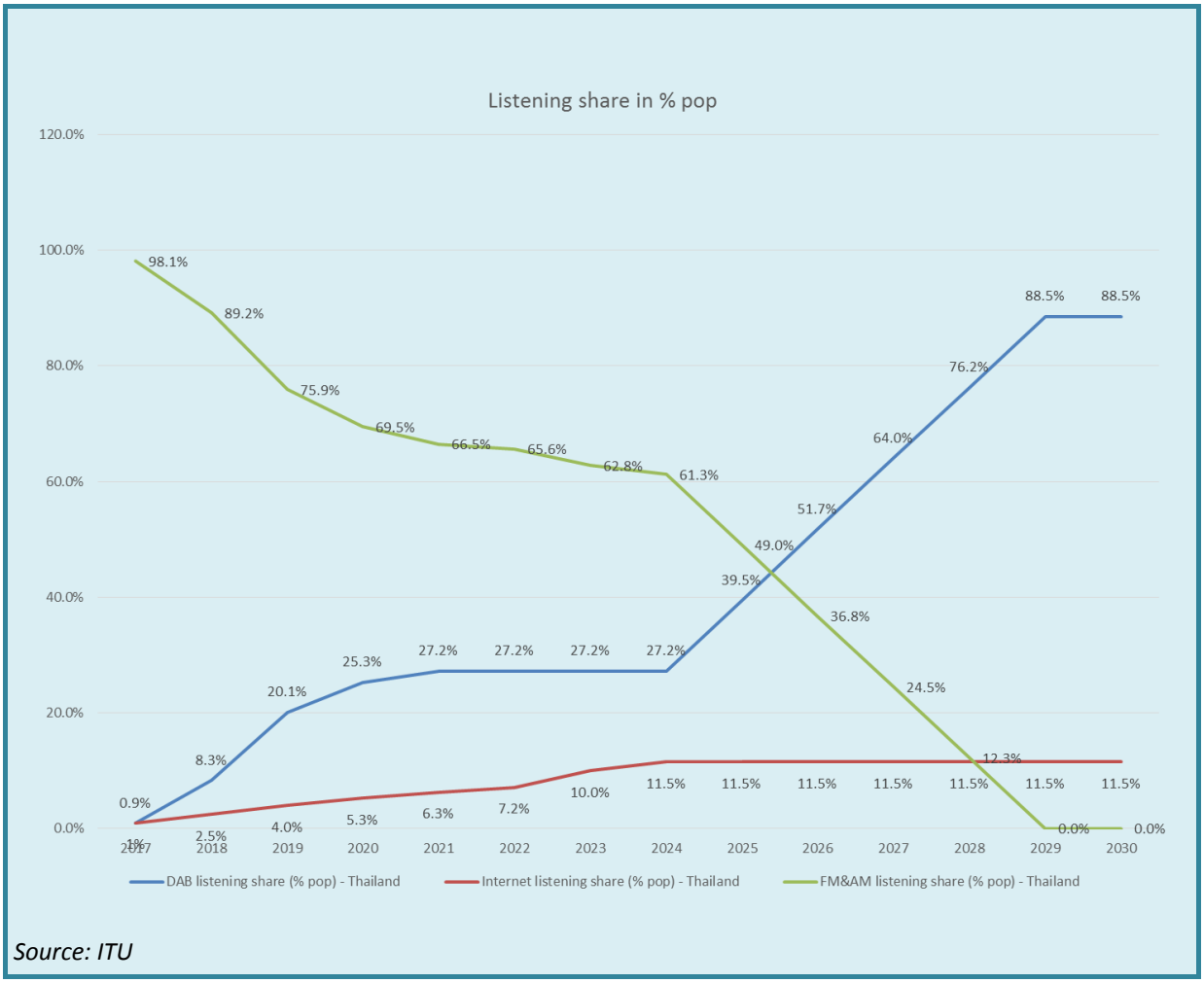
NO	NATIONAL	LOCAL
	per MUX	per MUX per LA
Head-end	$122,450	$159,050
Distribution	$2,806,800	$46,931
Transmission	$17,106,973	$438,640
Total	**$20,036,223**	**$644,621**
	all national MUXs	All local MUXs
Total NO CAPEX	$40,072,447	$25,140,223
Total CAPEX all MUX	$65,212,670	
	check = ok	

NPV Output (NA for Trial)

NPV Total market	-$297,557,588
NPV per National SP	$11,411,848
NPV per Local SP	-$1,000,720

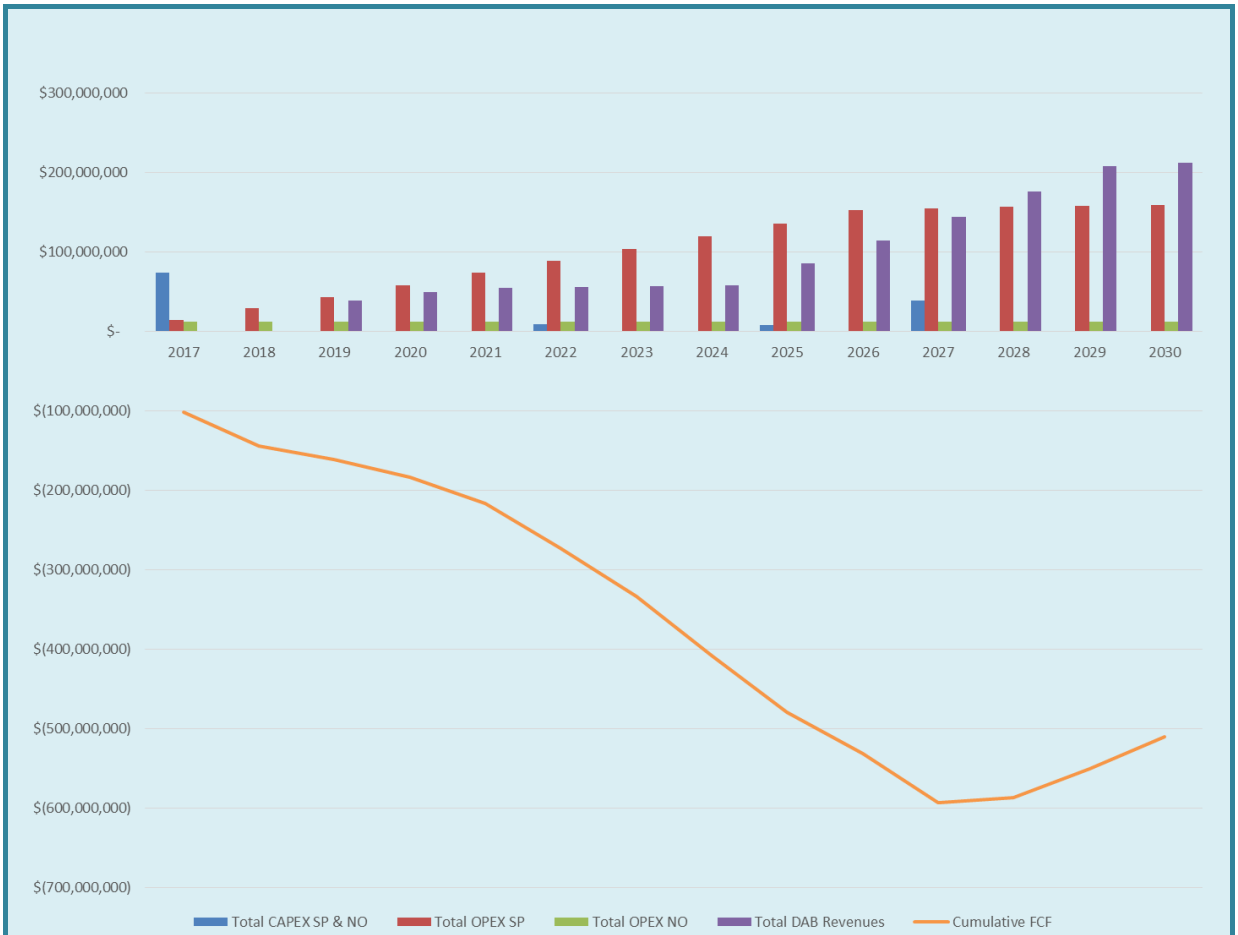
Source: ITU

FIGURE 82: OUTPUT WINDOW DASHBOARD – SCENARIO NL2



Source: ITU

FIGURE 83: LISTENING SHARES – SCENARIO NL2



Source: ITU

FIGURE 84: CUMULATIVE FCF TOTAL MARKET – SCENARIO NL2

Annex C: Summary of FM congestion analysis

In this Annex a summary is provided of the key results of the FM congestion analysis that was carried out by the ITU and NBTC in the period January – May 2016. For the full details of this analysis please refer to ITU report "Analysis of congestion in the FM band", dated 18 May 2016.

This summary comprises the following Sections:

1. Main and Local FM stations[66] in Thailand;
2. Main FM stations current coverage and interference levels;
3. FM congestion maps and conclusions.

Main and Local FM stations in Thailand

Figure 85 shows the number of FM stations in the Bangkok province as well as the number of stations outside the Bangkok province. It also shows the channel spacing in Bangkok; 500 kHz between Main stations and also between Local stations, whereby the Local stations are interleaved with the main stations (i.e. a local station sits 250 kHz apart from the Main station). Outside Bangkok the channel spacing is 250 kHz between all stations. Figure 85 also shows the high frequency re-use of Local stations:

1. 11 times the same frequency is used in the relatively small Bangkok province, and;
2. 94 times the same frequency is used across Thailand.

[66] A Main station is defined as a station that operates its broadcasting business under a spectrum authorization. 313 FM frequencies are authorized or assigned in Thailand. A Local station is defined as a stations that operates under a FM Trial License and no specific frequency was assigned by the Regulator in the past.

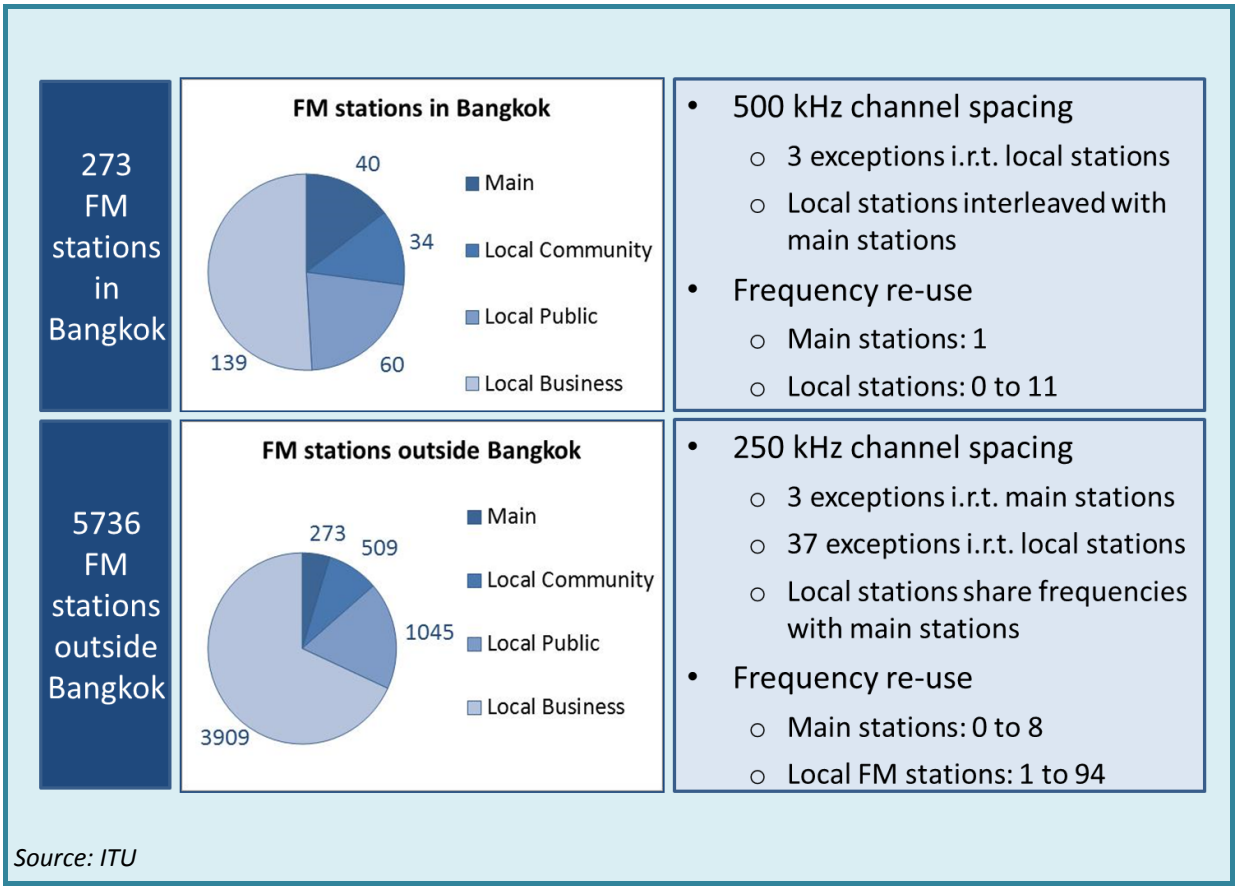
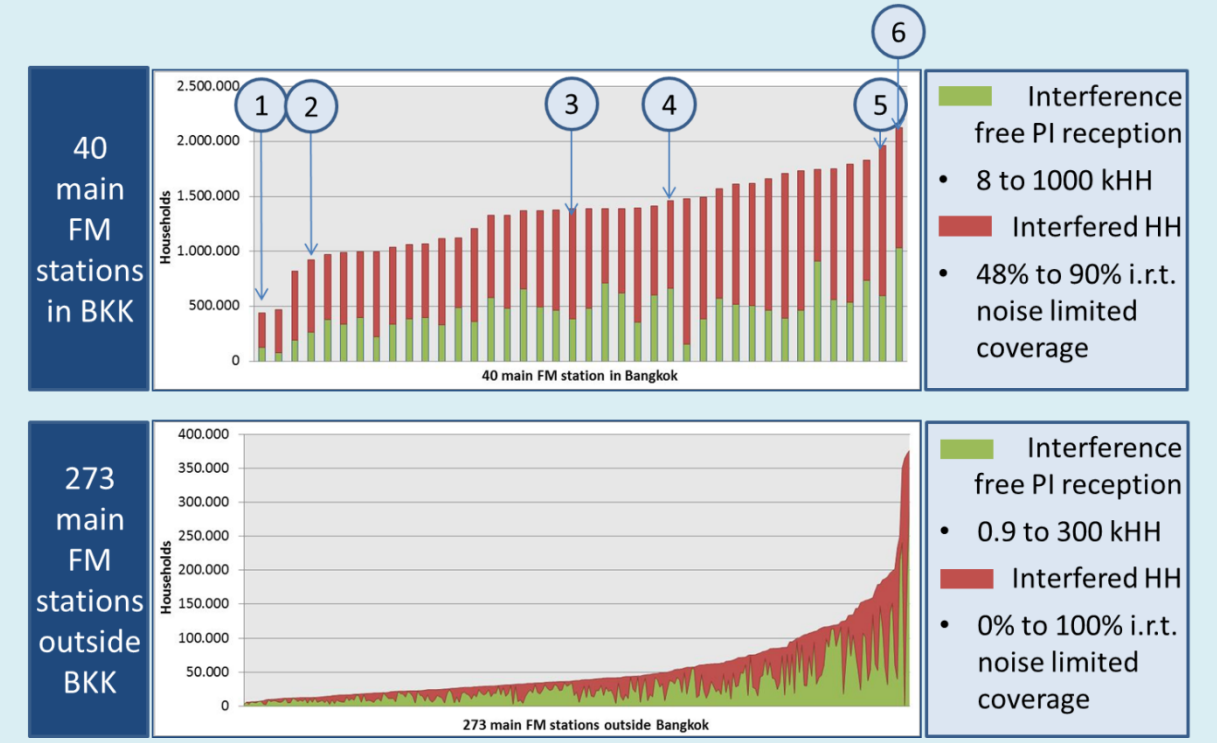


FIGURE 85: NUMBER OF MAIN AND LOCAL FM STATIONS IN THAILAND

Main FM station current coverage and interference levels

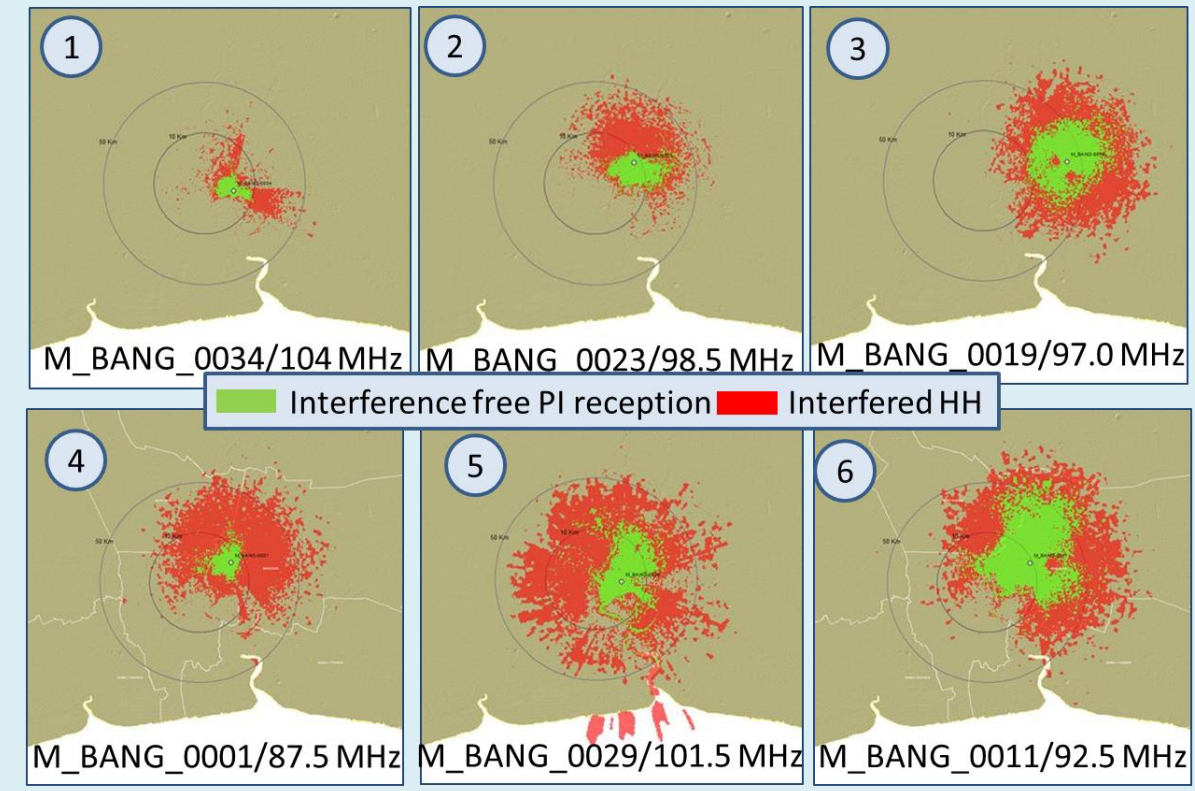
Figure 86 shows the coverage of the Main stations in terms of number of households covered with Portable Indoor (PI) coverage. It also shows the difference in coverage between interference free PI reception and the current interfered PI reception. It is clear from Figure 86 that for most Main stations their coverage is more than halved due to the current high levels of interference. In other words, if congestion levels were to be improved the FM Main station coverage would significantly improve.



Source: ITU

FIGURE 86: MAIN FM STATIONS PI COVERAGE IN HOUSEHOLDS

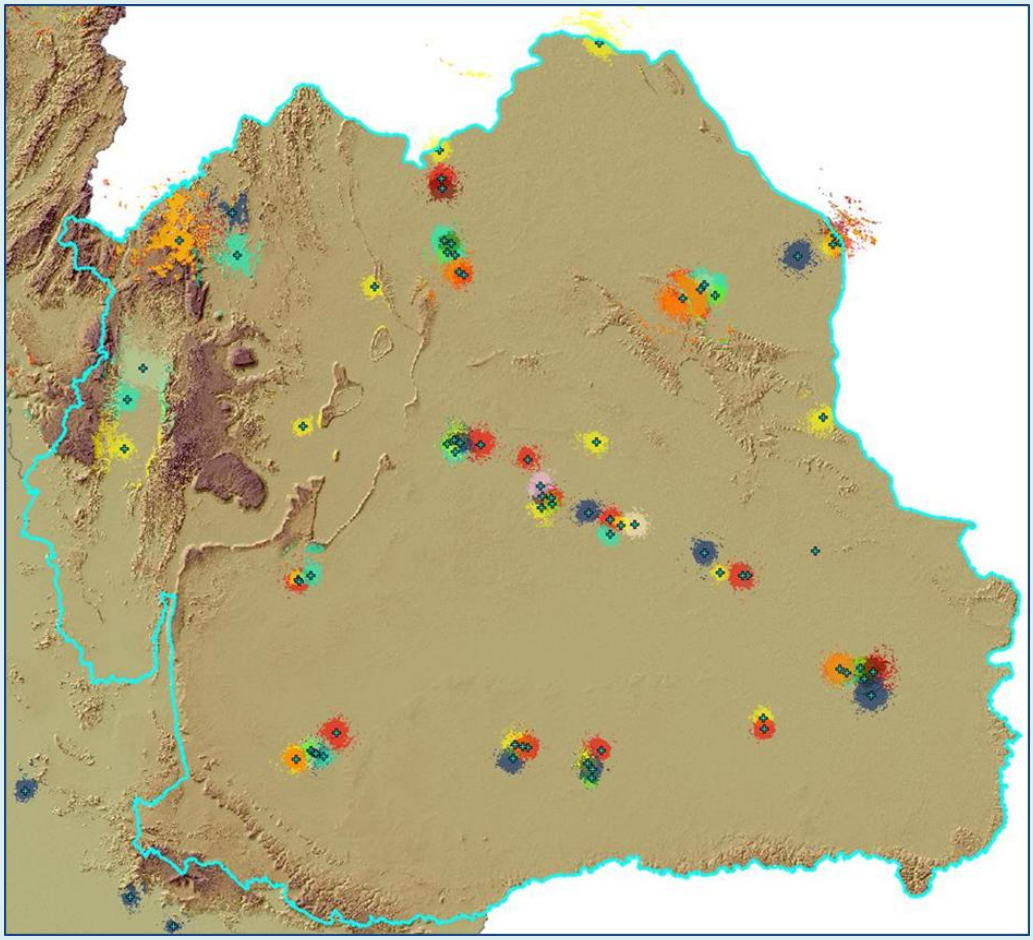
Figure 87 shows the coverage area of six example Main FM station in the Bangkok province. The numbers correspond to the numbers as included in Figure 86. The green areas correspond to the interference free PI reception and the red areas are the interfered areas (i.e. there is no PI reception possible in those areas).



Source: ITU

FIGURE 87: EXAMPLE MAIN FM STATIONS PI COVERAGE AREAS IN BANGKOK

Figure 88 shows the Main FM stations PI coverage in the north east part of Thailand. From Figure 88 it can be observed that the PI coverage is only present around cities and is limited. Figure 88 also shows the different spectrum owners by the different colours.



Source: ITU

FIGURE 88: MAIN FM STATIONS PI COVERAGE AREAS IN NORTH EAST OF THAILAND

From Figure 88 it can be concluded that each FM services has limited coverage, even under the assumption that each spectrum owner broadcasts the same FM service on all its stations. This is clearly not the case as FM services are mostly localized services (with 'local broadcasting windows') and spectrum owners have 3rd party broadcasters operating other services on these frequencies. Given that little information is available on the exact services that are broadcast on each station, it is difficult to assess the coverage for each FM service.

However, assuming that having local broadcasting windows and 3rd party broadcasters do not constitute a different service, one could assess the best performing FM network by adding up the household coverage of all FM stations of a single spectrum holder. By summation of the households per station it is also assumed that no coverage overlap exists between individual stations. In other words, such a summation would result in the best possible household coverage per FM service.

Table 23 shows the best possible household coverages of the three spectrum owner with the most assignments/stations (i.e. RTA, PRD and MCOT)[67]. Under the above discussed assumptions these numbers could represent the household coverages per FM service.

TABLE 23: BEST POSSIBLE NATIONAL HOUSEHOLD COVERAGES PER SPECTRUM OWNER

Spectrum Owner	Number of Sites	Total interference limited PI coverage (no of HH)	Total interference limited PI coverage (% of HH)
RTA	48	7,300,643	35%
PRD	88	6,883,628	33%
MCOT	58	4,991,599	25%

In the situation that FM congestion would be resolved, the figures as include in Table 23 could be doubled as more than half of the current PI coverage of the Main FM stations is interfered (see Figure 86). This would result theoretically in a best performing FM network of having 70% PI coverage across the country.

FM congestion maps and conclusions

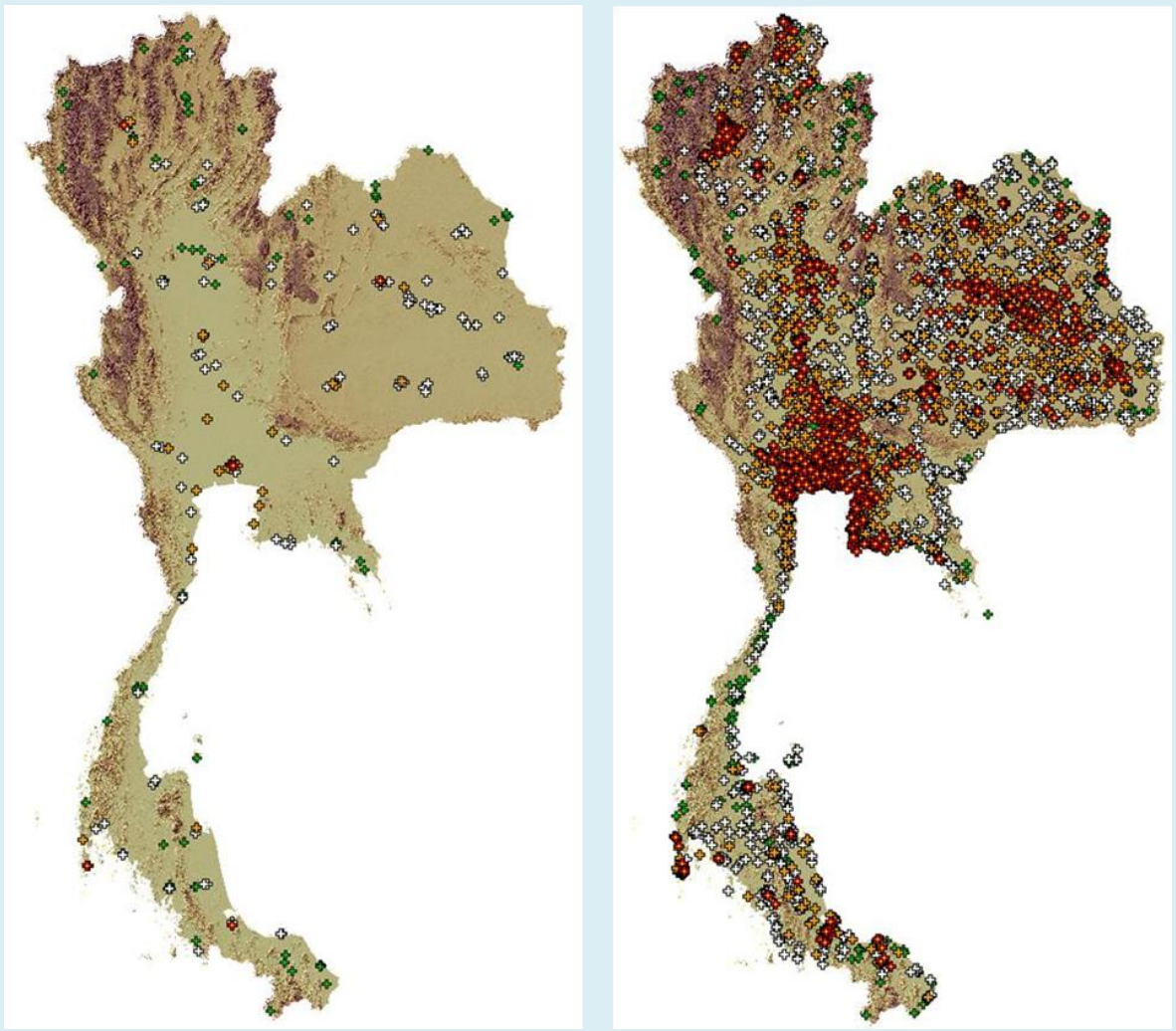
The congestion analyses can be summarised by means of maps showing the congestion classes in different colours as indicated in Table 24.

TABLE 24: COLOUR SHADING OF CLASSES OF CONGESTION

Eu range	Classification of congestion	Colour shading in presentation of congestion
Eu > 86 dBµV/m	Severe congestion	Red
76 dBµV/m < Eu ≤ 86 dBµV/m	High congestion	Orange
66 dBµV/m < Eu ≤ 76 dBµV/m	Low congestion	White
Eu ≤ 66 dBµV/m	No congestion	Green

Figure 89 show the classification of congestion related to Main FM stations (including interference by Local FM stations) and Local FM stations respectively. The Main and Local FM stations are depicted left and right respectively.

[67] Table 23 cannot be found in ITU report "Analysis of congestion in the FM band", dated 18 May 2016. It can be however constructed from the table as included in Annex 5 of this report by selecting respectively all stations of RTA, PRD and MCOT and adding up the households per station as mentioned in column E.



Source: ITU

FIGURE 89: CONGESTION OF MAIN AND LOCAL FM STATIONS

The general conclusion is that congestion in the FM band is “high” or “severe” (orange and red shaded marks) in many parts of Thailand and in particular in the central, northern and eastern part of Thailand. Congestion is caused by:

1. The great number of local stations, often closely located together;
2. The relative small channel spacing (250 kHz), with 82 channels and the irregular use of these channels;
3. The high frequency re-use factor in many cases.

The congestion analysis shows furthermore that:

1. In Bangkok congestion related to 53% of the 40 Main FM stations and 99.6% of the 233 Local FM station is classified or “high” or “severe”, because of:

   a. Main FM stations interfered by Local FM stations operating at adjacent channels and co-channels;
   b. Local FM stations interfered by Main FM stations operating at adjacent channels and Local FM stations operating at co-channels;
2. Outside Bangkok congestion related to 12% of the 273 Main FM stations and 46% of the 5463 Local FM stations is classified as “high” or “severe”, because of:
   c. Main FM stations mainly interfered by Local FM stations operating at co-channels;
   d. Local FM stations interfered by Main FM stations and Local FM stations operating at co-channels;
3. Without Local FM stations, congestion related to none of the main FM stations in Bangkok and outside Bangkok is classified as “low”, “high” or “severe”.

The reason for the congestion should therefore be attributed to the high number of Local FM stations. It should be noted that the actual situation may be different in view of:

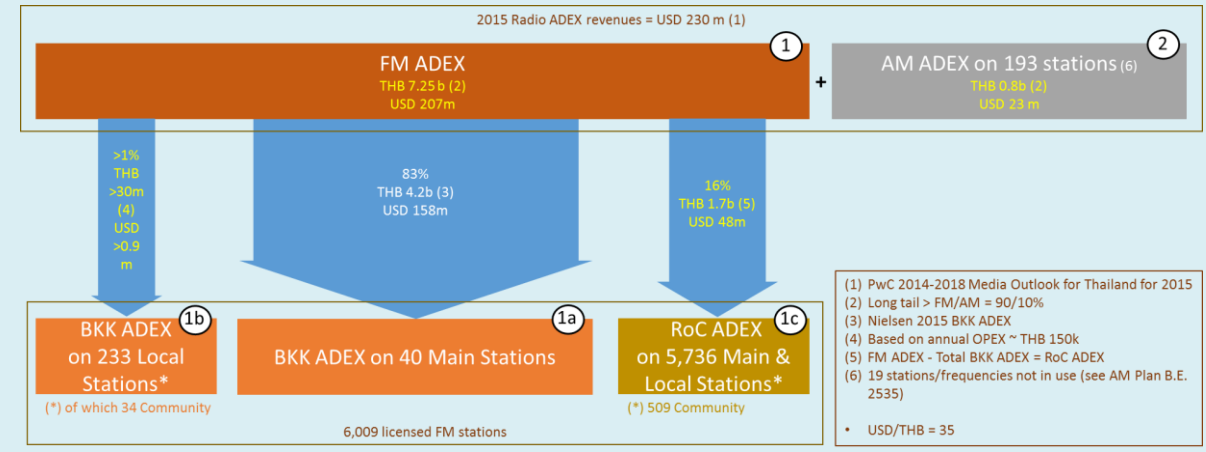
1. The inaccuracies of the characteristics of local FM stations and the existence of illegal FM stations;
2. Some FM stations may not be in operation any more or not operate on a 24/7 basis;
3. Receiving conditions may deviate from those assumed in the congestion analysis.

Annex D: Radio market structure and revenues

This Annex provides more insight into Thai radio market structure, key market players and their revenues. It is noted that the data on revenues is based on several public sources, including the AC Nielsen listening and revenue data. The AC Nielsen revenue figures are deemed to be based on the standard rate cards for advertising. It is unknown what the negotiated rates are but these are considered to be significantly lower than the standard rates.

It is also noted that the available data lacks many data points (like the revenues in the AM radio market, the revenues from concession contracts or the FM revenues outside Bangkok) and hence several figures are estimates and are indicated in yellow.

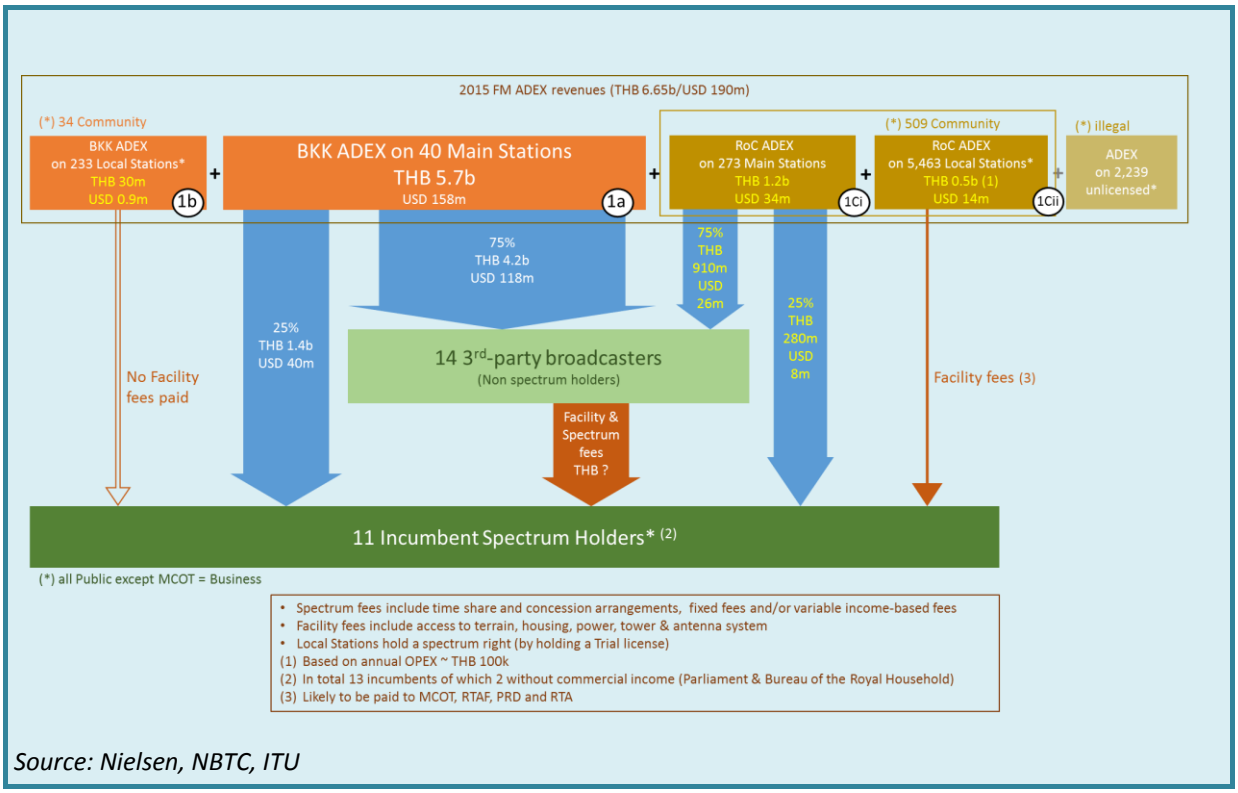
Figure 90 includes an overview of the 2015 radio ADEX split between AM and FM.



Source: PwC, Nielsen, NBTC, ITU

FIGURE 90: 2015 RADIO ADEX SPLIT BETWEEN FM AND AM

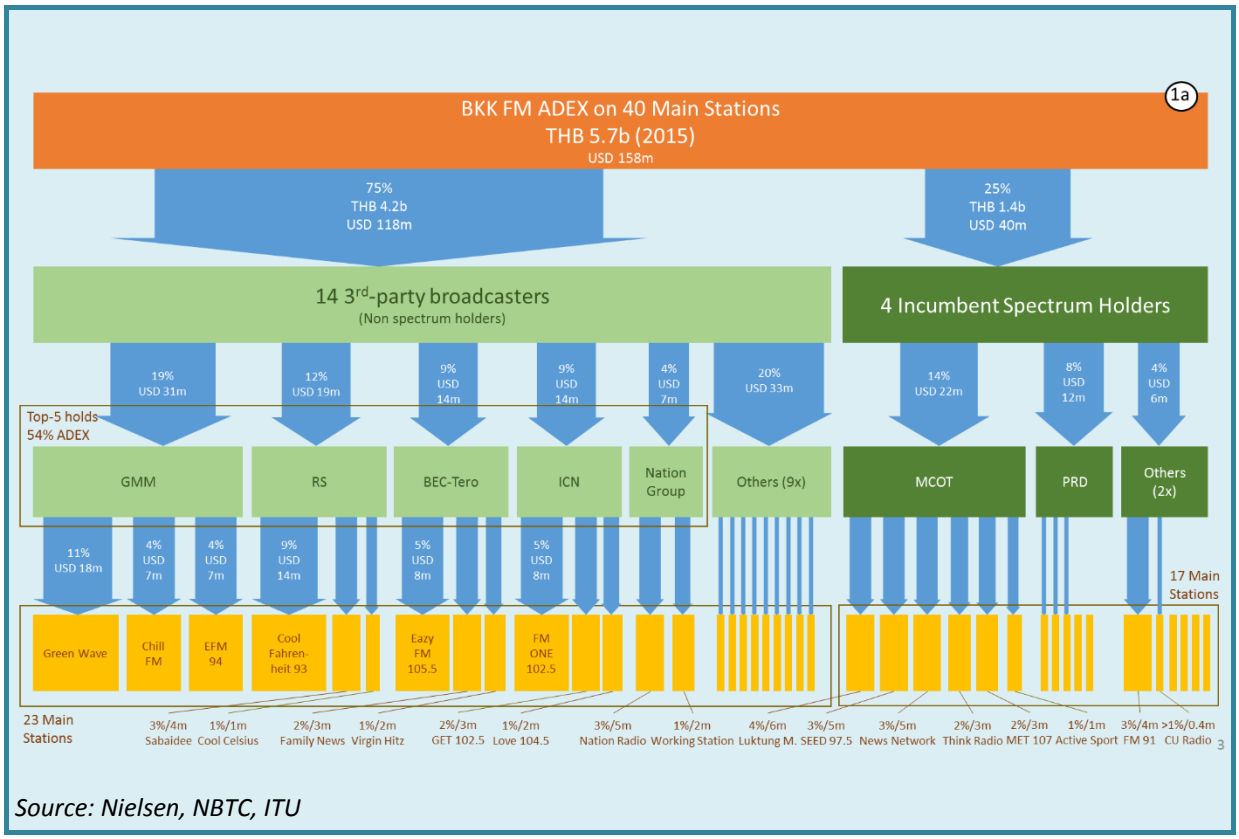
Figure 91 shows the FM revenue split between Main and Local FM stations in Bangkok and outside Bangkok (Rest of the Country = RoC). It also shows that of the 13 incumbent FM broadcasters (i.e. entities holding spectrum rights), 11 have commercial income from 3rd party broadcasters (i.e. commercial entities without spectrum rights) by collecting spectrum and facility fees from these 3rd party broadcasters (i.e. the agreed price to be paid as included in the concession agreement).



Source: Nielsen, NBTC, ITU

FIGURE 91: 2015 FM ADEX BREAKDOWN

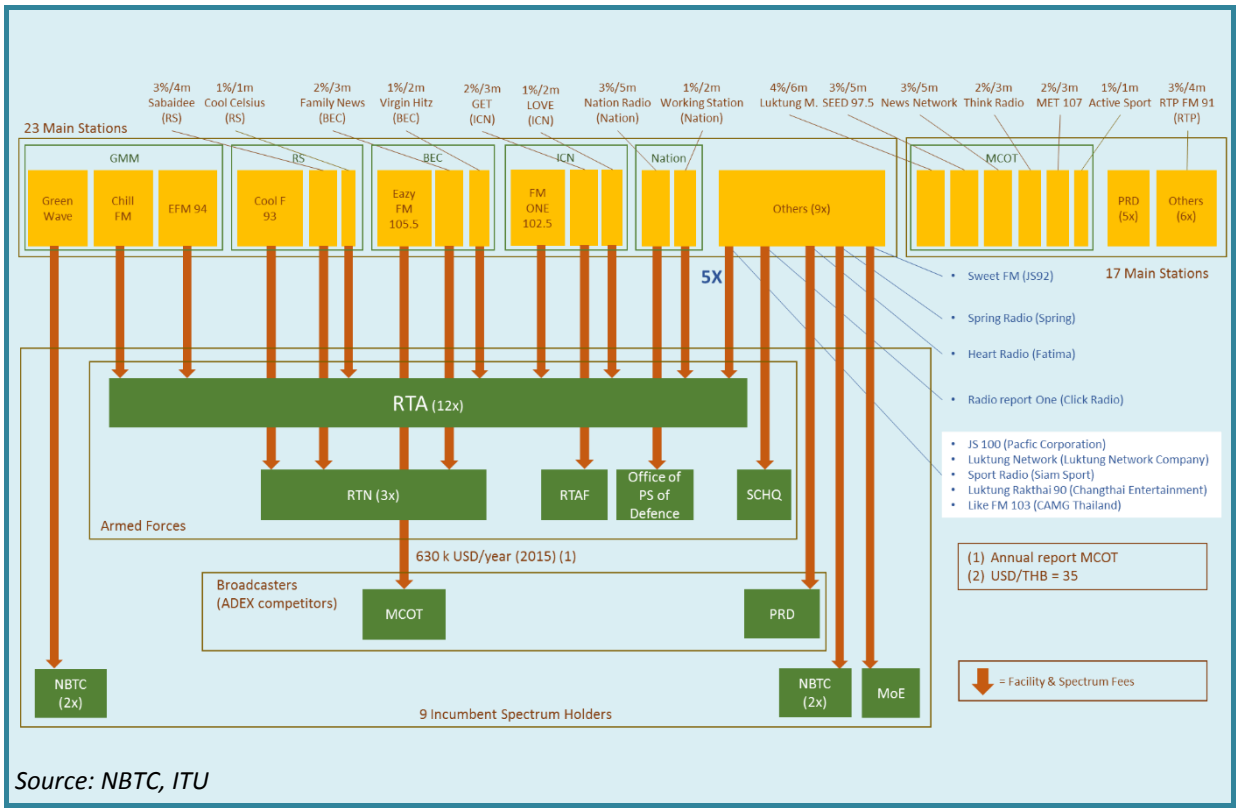
Figure 92 includes the revenue breakdown of the estimated FM revenues generated in Bangkok. It shows that the majority of ADEX is generated by the 3rd party broadcasters and that the Top-5 of these FM broadcasters generate approximately 54% of the ADEX in Bangkok. It also shows that these 3rd party broadcasters operate 23 FM services. The other 17 FM services are operated by the incumbent broadcasters (i.e. all public entities, except MCOT).



Source: Nielsen, NBTC, ITU

FIGURE 92: FM ADEX SPLIT FOR BANGKOK

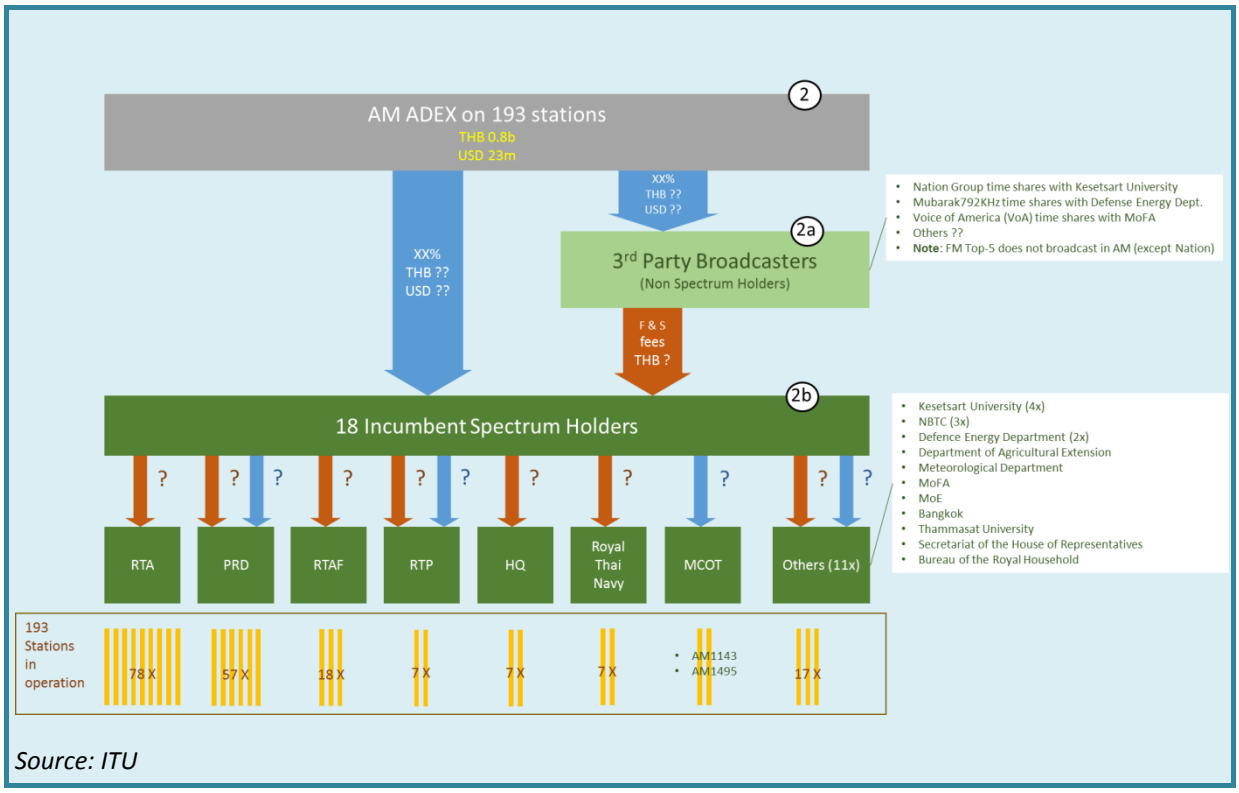
Figure 93 shows the essence of the FM concession system in Thailand. 9 incumbent FM broadcasters, of which 5 are part of the Thai Armed Forces, have concession agreements in place for all the 23 commercial (3rd party broadcaster) FM services. Two (MCOT and PRD) of these 9 incumbent broadcasters are also ADEX competitors as they operate commercial FM services as well. Also the NBTC has two concession agreements in place with GMM/Green Wave and Spring News.



Source: NBTC, ITU

FIGURE 93: CONCESSION SYSTEM

Figure 94 shows the AM market structure. It is noted that little data is available on this market. The available data shows that 193 AM stations are in operation and 18 entities (all public, except MCOT) hold the spectrum rights for these AM stations. Also the available data seems to suggest that AM ADEX is small and is generated by only a few commercial broadcasters. In addition, only a few concession agreements seem to be place (e.g. the Voice of America with the Ministry of Foreign Affairs or Nation Group with Kesetsart University).



Source: ITU

FIGURE 94: AM MARKET STRUCTURE

Annex E: LRIC model

This Annex provides some more details on the applied LRIC model as mentioned in Section 4.4.1 by showing the LRIC model as used for regulating the DTTB distribution fees.

The costing methodology for calculating cost of the minimum service should be based on long run incremental cost (LRIC). The LRIC modeling incorporates assumptions of modern efficient technology, current investment cost and efficient service provision. The increment of the minimum service is defined as a DTTB service. LRIC of the minimum service should be reported on a per unit basis measuring change in total cost associated with a specific increase or decrease in output. The below Figure illustrates the formula used for LRIC calculation of Minimum service.

The following paragraphs explain the calculations for each cost element of the LRIC model.

Capital Expenditure and Cost of Capital

Capital expenditures of assets which are directly relevant to the provision of the minimum service should be evaluated according to gross replacement cost (GRC) principle based on current cost accounting (CCA) valuation method. The following methodologies can be applied:

1. Indexation based on historical investment cost and price trend;
2. Absolute valuation;
3. Modern equivalent asset (MEA).

The capital expenditure evaluated in the previous step should be annualized based on tilted annuity calculation taking into account asset life, price trend and cost of capital, as reflected in the formula included in Figure 95.

$$TA = GRC * \left[\frac{(WACC - PT)}{1 - \left[\frac{(1+PT)}{1+WACC} \right]^{N}} \right]$$

Source: Detecon

FIGURE 95: TILTED ANNUITY FORMULA

The following notations apply for the formula as included in Figure 95:

TA = tilted annuity cost

GRC = gross replacement cost

WACC = pre-tax weighted average cost of capital

PT = price trend

N = asset life

The following asset lives and price trends should be applied for each asset category in the tilted annuity cost calculation. These lives and price trends are included in Table 25.

TABLE 25: ASSET LIVES AND PRICE TRENDS

Asset category	Life (in years)	Price trend (%)
Multiplexer	10	-5%
Transmitters	10	-5%
Tower	20	2%
Antenna system	20	2%
Combiner	10	-5%
TVRO	10	-5%
Site buildings	20	2%
Tools & Instruments	10	-5%
Monitoring system	10	-5%

Operating Expenditure

The operating expenditure includes annual operating costs which are directly relevant to the provision of the minimum service. Costs that can be included in the calculation are:

1. Transponder lease;
2. Satellite / Fiber bandwidth lease;
3. Electric power;
4. Operation and maintenance;
5. Site rental;
6. Site security;
7. Direct and indirect staff cost.

Costs which cannot be included in the calculation are:

1. Marketing and sale costs;
2. Other costs incurred from inefficient operation e.g. bad debt.

Common Cost

The common cost includes annual costs which are relevant to the business operation but cannot be directly or indirectly allocated to Minimum service. Costs that can be included in the calculation are

1. General and administration;
2. Business and spectrum license fees;
3. Contribution to NBTC Fund.

The distribution of common costs to Minimum service should be based on equal proportional mark up (EPMU) method.

Annex F: Key advantages of DAB+ for Thailand

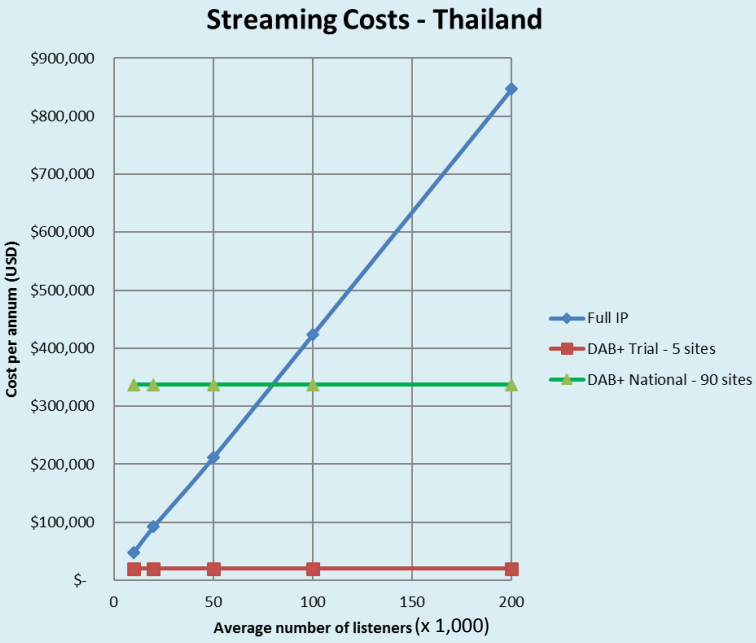
In this Annex the key advantages of DAB+ for Thailand are summarized. Table 26 lists the key advantages.

No	Key Advantage
1	Provides new business models and increased content value leading to improved income and opportunities: • New markets e.g. children – Kindlering (Australia), FunKids (UK) • Dedicated retailer channels – Chemist Warehouse (Australia) • Capture/aggregate markets – Sky Sports, ABC Extra (Australia), Bundesliga (Germany) • Direct IP links/URLs to web content
2	Delivers high quality, interference free audio at lowest cost; see IP streaming cost comparison below in Figure 96
3	Is free to air – no data charges for audio: • 80 hrs/month (~ 4.6 GB/month) via mobile phone in Bangkok costs currently 400 THB/month
4	Leads to, and supports a full suite of digital assets to cost effectively deliver compelling content: • Provides direct linkage to internet assets through inbuilt URLs • Australian commercial broadcaster income up 4.6% in 2H15
5	Has much lower transmission OPEX than FM - approximately 1/10th
6	Has over 500 different available receivers and is increasingly included in vehicles: • UK now has over 75% of new vehicles with standard DAB fit • Smartphones with advanced Radio Apps are now available in-store and on-plan in UK, Norway, Netherlands, Germany, Switzerland, Australia, etc.
7	The cost of doing nothing is reduced revenues and inability to compete with on-line start-ups like e.g. Spotify, iTunes radio, Pandora and Apple CarPlay
8	DAB provides much better indoor coverage than FM and true nationwide services; see Figure 97 below

TABLE 26: KEY ADVANTAGES OF DAB+ FOR THAILAND

Figure 96 shows an IP streaming cost example of streaming an audio service of 64 kbps to an increasing numbers of listeners, with a total of 18 hours of listening per week. These costs are compared to the costs of distributing this same audio service over DAB+ for respectively the situation of having a network with 90 sites (80% population coverage) or 5 sites (15% population coverage)[68]. The other key assumptions are listed at the right in Figure 96.

[68] For the cost details see Section 4.4 and for the frequency planning details Section 1.1.



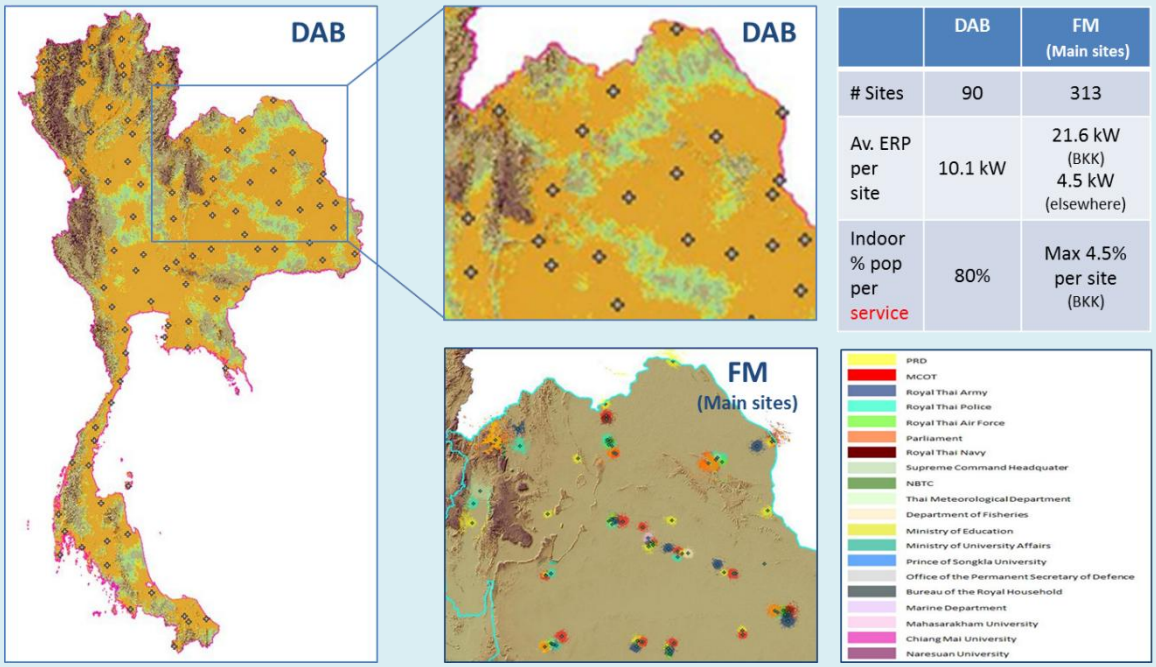
- A 64 Kbit/s service is assumed + 18 hrs/week
- IP streaming costs based on CDN77 pricing
- Annual DAB costs based on 90 sites deployment and detailed cost model
- Top-10 BKK radio broadcasters have listener bases ranging from 2,300k to 300k (source Nielsen)
- DAB will provide true national coverage and hence larger listener bases

Source: CDN77, ITU

FIGURE 96: IP STREAMING COST EXAMPLE

Figure 97 compares the DAB to FM coverage and shows that DAB will provide a much better coverage with a significantly lower number of sites. DAB will provide truly nationwide radio services; which the current FM stations are not capable of delivering[69].

[69] For more details on the FM coverage please refer to Annex C.



	DAB	FM (Main sites)
# Sites	90	313
Av. ERP per site	10.1 kW	21.6 kW (BKK) 4.5 kW (elsewhere)
Indoor % pop per service	80%	Max 4.5% per site (BKK)

Source: ITU

FIGURE 97: DAB VERSUS FM COVERAGE