Roadmap for the transition from analogue to digital terrestrial television in Thailand

June 2013

The roadmap for the transition to digital terrestrial television in Thailand has been prepared by the International Telecommunication Union (ITU) experts Peter Walop and Jan Doeven in the framework of the ITU digital broadcasting project. This objective of this project is to assist countries in the Asia-Pacific region to shift smoothly from analogue to digital terrestrial television broadcasting (DTTB) and to introduce mobile TV (MTV). ITU would like to thank the National Broadcasting and Telecommunication Commission (NBTC) in Thailand and the Korea Communications Commission (KCC) in facilitating the work of the ITU experts.

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Executive summary

The roadmap for transition from analogue to digital television in Thailand has been prepared by the Thailand National Roadmap Team (NRT) secretariat and ITU experts in the period from September to October 2012.

The method for developing the roadmap is described in the ITU Guidelines for the transition from analogue to digital broadcasting[1] (hereinafter ITU Guidelines).

The main observations and conclusions regarding the scope of the roadmap are summarized below, followed by recommendations on the five most critical topics.

Scope of the roadmap

a. The roadmap for transition from analogue TV to digital terrestrial television broadcasting (DTTB) in Thailand covers the activities managed by the National Roadmap Team. The roadmap does not include the introduction of Mobile TV (MTV) and Digital Terrestrial Audio Broadcasting (DTAB). The preparations of a roadmap for the introduction of MTV and DTAB will likely start in 2013.

b. The roadmap for transition to digital terrestrial television starts with an analysis of the current TV situation. The television market in Thailand is characterized by a great number of Thai services (>100) distributed via satellite and cable. The penetration of satellite and cable TV platforms is growing fast. Consequently the number of viewers on the analogue terrestrial TV platform is decreasing rapidly. Terrestrial analogue TV is considered as inferior to satellite and cable TV due to the limited number of services and the often poor reception quality. Currently about 46 per cent of the TV households depend on terrestrial television. Regarding the DTTB introduction the following observations can be made:

   - The window of opportunity for the introduction of DTTB is limited due to the fast growth of satellite TV viewers.
   - The unique selling points of DTTB are the easiness of reception with simple antennas at outdoor and indoor locations, low costs for viewers and service providers and the possibility to transmit local services.
   - Even with high capacity DVB-T2 multiplexes DTTB cannot compete with satellite on the number of services. The DVB-T2 system should therefore be configured to optimize good reception, rather than a very high number of services.
   - Good picture quality and an interesting package of services in standard definition (SD) and high definition (HD) quality is a must have on the DTTB platform.

c. The aim of the roadmap is indicated by the digital switch-over (DSO) objectives. The DSO objectives are defined for the transition period and for the period after analogue switch-off (ASO). The DSO objectives are included in Table 1.

[1] www.itu.int/ITU-D/tech/digital_broadcasting/project-dbasiapacific/Digital-Migration-Guidelines_EV7.pdf

Table 1: DSO objectives

No	Objective	Transition period	>ASO
1	Smooth transition from analogue to digital	• 50%, 80%, 90%, 95% (= ATV coverage) rooftop reception + in rooftop areas included municipalities having indoor reception (a municipality area is defined). In total there are about 200 municipalities • All existing analogue terrestrial services must be carried on DTTB • Simulcasting (period not defined yet) • Phasing (but the model still to be determined) • Start DTTB 2013	
2	End of analogue transmission	• End of ASO still to be determined, taking into account duration of existing concessions • Intention to comply with ASEAN recommendation (by the of end 2020)	
3	More services	• 20% , 60%, 20% of capacity of 5 muxes to be allocated to public, commercial and community services (Mux payload tbd) • EWS service (must carry)	• 30% , 50%, 20% of capacity of 6 muxes to be allocated to public, commercial and community services (Mux payload tbd)
4	Extended population coverage	• None	• None
5	Better picture quality	• Presentation format up to the market, HD is 16:9, SD can be either 16:9 or 4:3 • Public and community TV service in SD or HD if capacity permits • Business service in SD (and HD if there is interest)	• Business service in SD (and HD if there is interest)
6	Compensation for viewer	• Financial support for all affected viewers • Installation aid is for the market to pick up (training to the installation companies could be provided)	
7	Compensation for analogue broadcasters	• No simulcast Opex compensated (under study)	• Compensation for investments
8	Digital dividend		• Allocate spectrum above channel 48 for IMT/LTE – no decision yet

d. The duration of the transition process from analogue to digital television cannot yet be determined. The analogue TV switch-off (ASO) date has not been decided yet. The National Roadmap Team wishes to comply with the Association of Southeast Asian Nations (ASEAN) recommendation to switch-off all analogue terrestrial television services by 2020. However, account should be taken of the duration of existing analogue TV licences, especially of two commercial broadcasters.

e. The activities in the roadmap take account of a separation of the following functions:

- service provisioning, with three types of service providers (public TV, community TV and business TV);
- network provisioning, with the possibility of up to five network providers (six after analogue switch-off);
- facility provisioning.

f. The roadmap has been divided in four phases:

- Phase 1: DTTB policy development;
- Phase 2: Licensing policy and regulation;
- Phase 3: Planning and execute auctions and tenders;
- Phase 4: DSO communication and supervision.

g. The Phases 1, 2 and 3 should be carried out in parallel and be finalized before the assignment of licences starts. Phase 4 starts as soon as the network provider(s) start the planning and implementation of the DTTB networks and continues until analogue switch-off has been completed.

h. The status of the decisions on the key topics and choices in Phases 1, 2 and 4 of the roadmap and the activities required to prepare the decisions that are still pending, are indicated in Annexes 1 to 3. Activities related to Phase 3 are not specified in detail because these activities are not addressed in the ITU Guidelines.

i. The execution of the activities of Phase 1 and 2 of the roadmap is in a very advanced stage. All key topics and choices have been considered thoroughly and have been well documented. Phase 1 is nearly finalized. In Phase 2 about half of the key topics and choices have been decided. Main areas of work to be carried out are related to licence terms and conditions, analogue switch-off planning and verification of the initial DTTB frequency plan.

Recommendations

In the roadmap a number of critical topics have been identified. The five most critical key topics and choices are described in Section 4. In addition the timing of the activities in the roadmap is critical because the Phases 1, 2 and 3 should be finalized before the assignment of licences starts. And the envisioned licensing calendar is ambitious. The current DTTB licensing schedule is:

- licences for network providers based on a tender procedure before the end of 2012;
- licences for public service providers based on a tender procedure before the end of 2012;
- licences for commercial service providers based on auctioning in 2013;
- licences for community TV services based on a tender procedure in 2013.

In order to resolve the top five most critical topics in time, it is recommended to consider the items indicated below. More information on the items can be found in Section 4.

1. The interrelation between the various license categories is complex; the license conditions need to be carefully defined and tested.
2. Multiple network providers will result in inefficiencies in Opex and Capex and may also restrict an efficient loading of the various multiplexes. Licensing a single network provider should be balanced against gains from platform competition, taking into account that a network provider will be required to calculate its tariffs on the basis of a costs plus margin model.
3. Business TV services licences are envisaged for national regional and local services depending on interest and several programme categories. The many options make the auction process complex. A reduction of the number and type of business TV service licences needs to be considered.

4. The unique selling points of DTTB, such as reception at outdoor and indoor locations with simple antennas (usability) and low costs for viewers and service providers should be leading considerations in many decisions on key topics and choices included in the roadmap.

5. The analogue switch-off (ASO) date has not yet been decided. Postponing setting an ASO date will reduce the 'window of opportunity' for DTTB, will reduce clarity about the analogue TV and DTTB market and may result in the loss of momentum and viewers' attention. It also increases the simulcasting costs. Setting a defined ASO date and model needs therefore to be considered.

A world-wide frequency allocation for International Mobile Telecommunications (IMT) in the upper part of the UHF broadcasting band (channels above 48) has been agreed in ITU. Subject to confirmation by the ITU World Radiocommunications Conference in 2015, this allocation will become effective in 2015. The allocation will facilitate the introduction of fourth generation (4G) mobile telecommunication services such as LTE. It cannot be excluded that within the licence period of the DTTB services, IMT (4G) services will be introduced in Thailand. The DTTB frequency plan needs therefore to take into account a possible introduction of IMT by assigning (as far as possible) channels 26 to 48 to the transmitters that will be licensed before analogue switch-off.

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1. Introduction

ITU has published guidelines for the transition from analogue to digital broadcasting[2]. These guidelines provide assistance to member countries to smoothly migrate from analogue to digital broadcasting. In a further effort to help countries to switch over to digital broadcasting ITU has selected a number of countries for assistance in developing a national roadmap for the digital switch-over (DSO) process. Thailand is one of the beneficiary countries for this assistance.

The roadmap for transition from analogue to digital terrestrial television broadcasting (DTTB) in Thailand has been jointly developed by a team of ITU experts consisting of Peter Walop and Jan Doeven and the secretariat of the National Roadmap Team (NRT) in the months September and October of 2012.

The introduction of DTTB in Thailand is in an advanced stage of preparation. Key topics and choices have been considered thoroughly and have been well documented. The organizational framework is in place and performs well. A draft notification on the introduction of DTTB has been prepared and submitted for public consultation, describing:

a. the transmission standard (DVB-T2);
b. the receiver specifications;
c. the initial DTTB frequency plan;
d. a risk impact assessment (RIA) of the transition from analogue TV to DTTB.

In the following sections, first the current situation and digital switch-over (DSO) objectives will be addressed (Section 2). Section 3 shows the national roadmap for achieving the DSO objectives. Section 4 gives considerations regarding the top five key topics and choices.

Annexes 1 to 3 show in detail the decisions taken, partly taken and not yet taken on the key topic and choices regarding the DSO process in Thailand. Also the activities required to prepare the decisions that are still pending, are indicated.

2. Current TV market and DSO objectives

The development of the roadmap for transition to digital terrestrial television starts with an analysis of the current TV market structure, analogue TV networks and regulatory framework, described in Section 2.1 to Section 2.3.

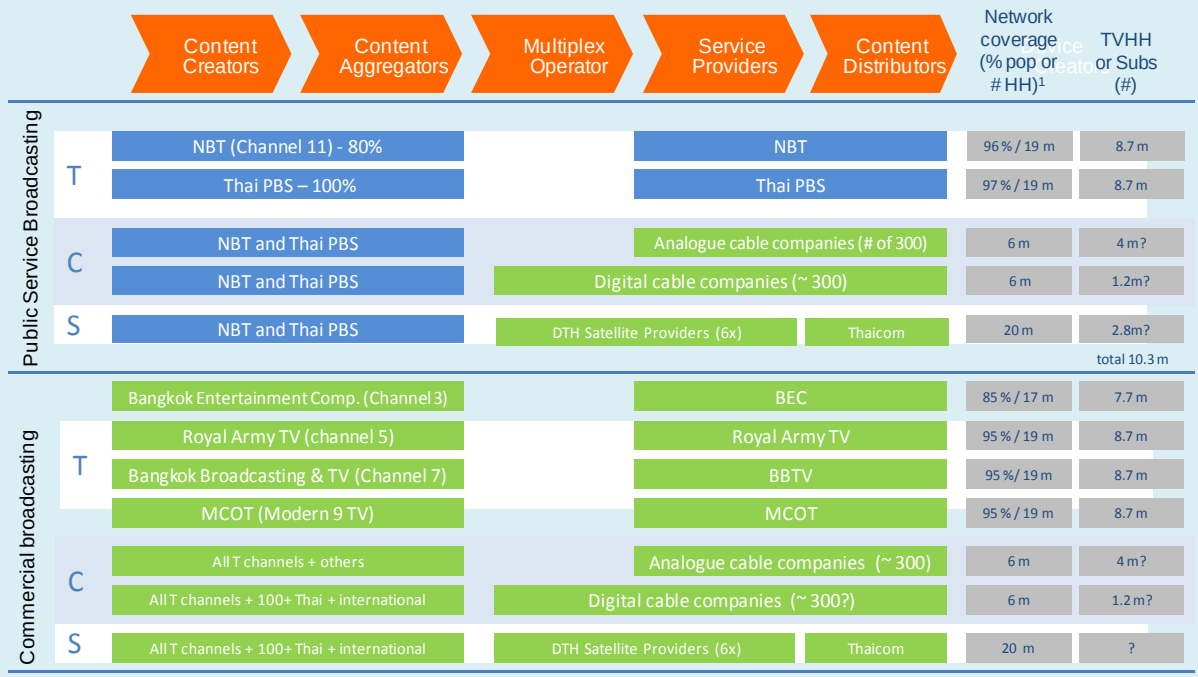
The aim of the roadmap is indicated by the digital switch-over (DSO) objectives, as described in Section 2.4.

[2] www.itu.int/ITU-D/tech/digital_broadcasting/project-dbasiapacific/Digital-Migration-Guidelines_EV7.pdf

2.1 Market structure

The Thailand television market structure is shown in Figure 2.1.

Figure 2.1: Thailand TV market structure



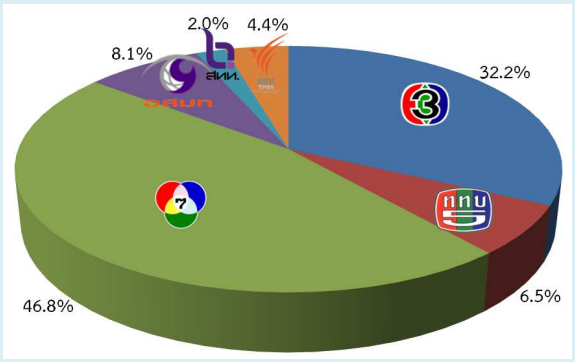
1. Thai population = 65 m and ~ 20 m HH (av. HH size ~ 3.25) and ~ 19 m TVHH

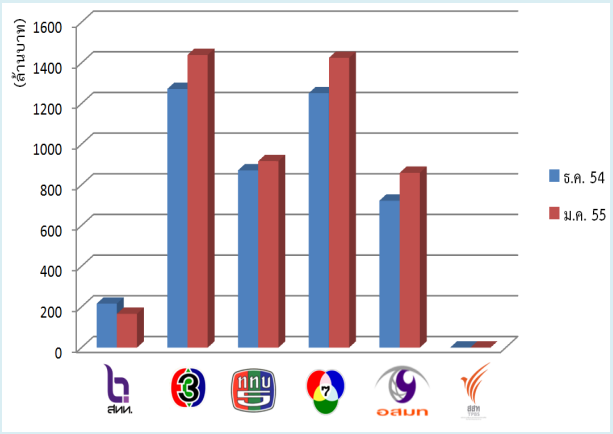
Source: ITU

It is estimated that the total population in Thailand is approximately 65 million. It is assumed that the average household consists of 3.25 people and that all households within the analogue TV coverage areas (about 95 per cent of the households) have a TV set. Consequently, the total number of TV households (TVHH) has been estimated at about 19 million.

About 46 per cent of the TVHH depends on terrestrial television with six analogue networks having 85 per cent to 97 per cent population coverage. The commercial broadcasters BEC (also referred to as Channel 3) and BBTV (also referred to as Channel 7) have the largest market share. An overview of the market share of the six terrestrial analogue TV broadcasters (also present on the satellite and cable platforms) is shown in Figure 2.2.

Figure 2.2: Market shares of analogue TV broadcasters





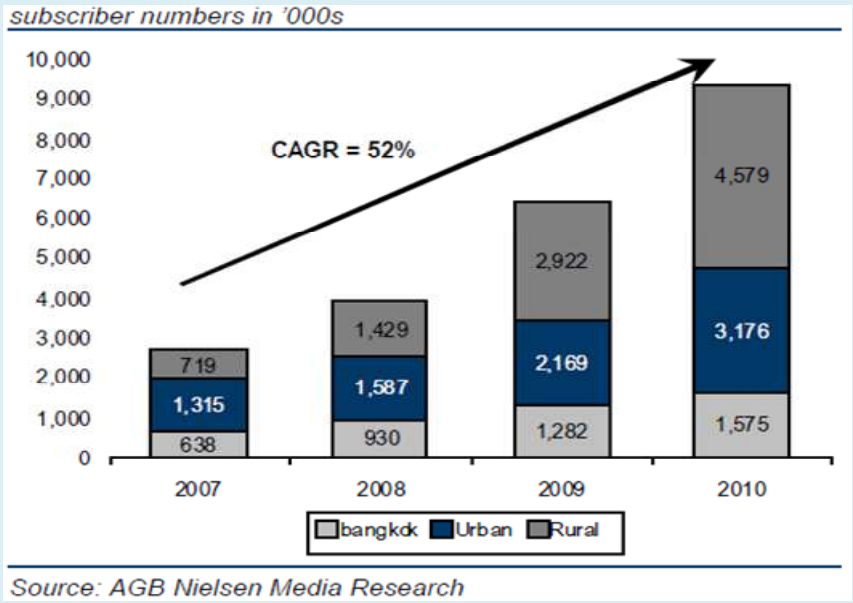
Viewers

Revenue

Source: NBTC

The satellite and cable TV market is characterized by a great number of Thai services (>100) offered by six satellite service providers. The penetration of satellite and cable TV is growing fast as illustrated in Figure 2.3.

Figure 2.3: Growth of non-terrestrial TV



Source: AGB Neilsen Media Research

Satellite TV transmissions are in C-band (3.6 GHz) and Ku-band (12 GHz). Reception of the C-band transmissions requires the installation of a relative large disk. It was reported that during heavy rains satellite reception is interrupted.

The cost for a satellite receiving installation is estimated at about USD 60 to USD 100. The Thai TV services via satellite can be received Free-to-Air (expect for True who offers next to Free-to-Air services pay-tv packages too). It was noted that the transmission costs for broadcasters (or service providers) for the distribution of one service per satellite is about USD 23 000 per month to USD 40 000 per month for DVB-S and DVB-S2.

Cable TV is offered in many cities. The subscription costs are about:

- analogue cable TV, about 80 services, USD 8 per month;
- digital cable TV, about 200 services, USD 10 per month (the rent of the STB is included in the subscription fees).

Cable and satellite service providers have a must carry obligation for the six incumbent analogue terrestrial services.

Regarding the TV market structure the following observations can be made:

1. Because of the fast expansion of satellite TV reception the 'window of opportunity' for the introduction of DTTB is decreasing rapidly.
2. Even with high capacity DVB-T2 multiplexes, DTTB will not be able to compete with satellite on the number of services.
3. Unique selling points of DTTB are the easiness of reception at outdoor and indoor locations with simple low cost antennas and the possibility for broadcasting local programming.
4. Good picture quality and an interesting package of services in standard definition (SD) and high definition (HD) quality is a must have on the DTTB platform.
5. The cost of a DTTB receiving installation is competitive compared to cable and satellite as the expected DVB-T2 STB price and a simple (UHF) indoor antenna is below USD 40 and paying subscription fees are not required.

2.2 Analogue TV networks

The coverage areas of the analogue TV networks are shown in Figure 2.4. The TV systems are B/PAL in VHF and G/PAL in UHF, with NICAM digital audio.

Figure 2.4: Indication of analogue TV coverage areas

Source: NBTC

In general, each broadcaster operates its own transmitter network. In some cases antenna sharing takes place (see also Table 2.1). In Bangkok for instance, four broadcasters use the Baiyoke tower and two broadcasters share the Army TV site. Most of the indicated areas are covered with three to five services in VHF (Band I and Band III) and one in UHF. However, in some areas there are up to four UHF transmitters in operation, including a replacement of the transmission in Band I.

The number of transmitters per broadcaster is indicated in Table 2.1.

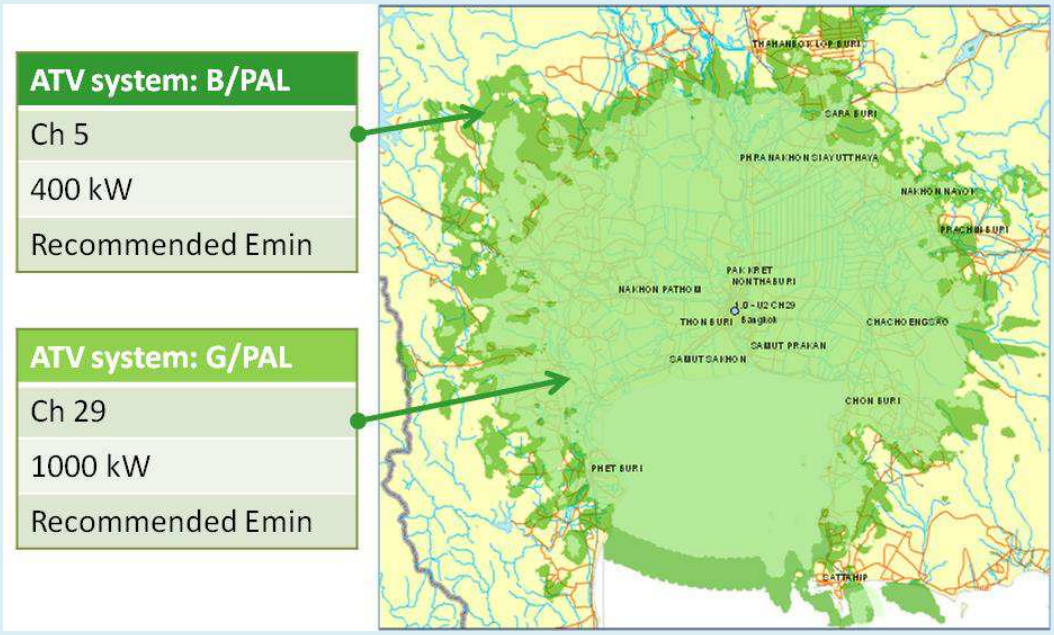
Table 2.1: Sites per broadcaster

Broadcaster	Ch 3	Ch 5	Ch 7	Ch 9	Ch 11	TPBS
Central & Eastern Region	5	7	8	6	11	11
North-eastern Region	6	11	9	9	13	13
Northern Region	11	13	10	11	14	16
Southern Region	10	11	10	10	12	12
VHF	26	31	30	33	32	0
UHF	6	10	7	3	18	52
Sharing Antennas with Thai PBS	1	0	0	1	13	-
Total stations	32	41	37	36	50	52

Source: Thai Public Broadcasting Service (Thai PBS)

The VHF coverage is likely to be larger than the UHF coverage because of the difference in propagation characteristics and the applied effective radiated powers (ERP). This is illustrated in the example of Figure 2.5 showing the noise limited VHF and UHF coverage of the transmitter site at the Baiyoke tower in Bangkok.

Figure 2.5: Example of VHF and UHF coverage [3]



Source: ITU/Progira Communications

[3] The broadcast planning software package Giraplan, has been made available for preparing the coverage plots by courtesy of Progira Communications

There are 68 fill-in stations, up to eight per main transmitter coverage area.

The UHF broadcasting band in Thailand consists of the channels 26 to 60. The channels have been divided into seven channel groups consisting of four to six channels. The channel groups are shown in Table 2.2.

Table 2.2: UHF channel groups (source NBTC)

Group	Channels						Total/group
U1	28	31	35	39	43		(5)
U2	26	29	32	36	40	44	(6)
U3	27	30	33	37	41	45	(6)
U4	34	38	42	46	50	54	(6)
U5	47	51	55	58			(4)
U6	48	52	56	59			(4)
U7	49	53	57	60			(4)

With regard to the analogue TV networks the following observations can be made:

1. In general each broadcaster operates its own transmitter network, therefore the coverage areas could differ from broadcaster to broadcaster.
2. The number of transmitters sites per broadcaster ranges from 32 to 52, whereas population coverage ranges from 85 per cent to 97 per cent.

2.3 Regulatory framework

The regulatory framework with regard to television broadcasting is shown in Table 2.3.

Table 2.3: Regulatory framework

Aspects	Regulator	Ministry	Legislation	Notes/Remarks
Spectrum	NBTC	None, independent	• The Radio Communications Act (1955) • The Broadcasting Business Act (2008) - BBA • Act on Organization to assign Radio Frequencies and to Regulate the Broadcasting and Telecom services (2010) – AOBT	• Broadcast Business Act provides a framework for assigning three basic rights: Service, network, facility and Application licence • Under BBA 2008 draft Notification in preparation for licence terms and conditions (for all three first licence types) • Shared spectrum right assigned to service licensee • Service (network, facility) licence duration <=15 yrs (s. 18 BBA) • OABT 2010 grants NBTC the right to assign the three Rights/four licence types • Spectrum assignment instruments to be drafted in Notification

Aspects	Regulator	Ministry	Legislation	Notes/Remarks
Broadcast	NBTC	None, independent	• BBA 2008	• Service licence assigned to broadcasters (content providers) • All licensee should have Thai nationality (BBA) – qualifying criteria for business service licence (BBA, s. 13) • Advertising is limited to 12 ½ minutes/hr for business service licensee (BBA, s. 23) • Programme content described for all service licensees described (BBA, Chpt. 2) • Content Charter (content requirements) still to be drafted in Notification • In principle FTA but Pay TV is not excluded for all service licensees (BBA, s. 17 -20) – for business service 'subscription fees' are explicitly stated (s.22,23)
Operating	NBTC	None, independent	• BBA 2008	• Network licence assigns operating rights to network Provider • Directive to network licensee which set of frequencies to use (BBA) • Roll-out and coverage obligations for network licensee – Notification to be drafted
PSB	NBTC	None, independent	• BBA 2008	• programme content described for all service licensees described (BBA, Chpt 2), including public service licensees (type 1, 2 and 3) and community TV • Qualify criteria for PSB applicants (BBA, s. 11, 12, 14)
Site sharing	NBTC	None, independent	• BBA 2008	• Site sharing obligation for tower owners (or only network licensees?), arranges for non-discriminatory access and fair pricing • Tower 'companies' providing services to network licensees shall apply for a facility licensee • Facility licence arranges for access, price, and also assures continuity • No explicit antenna sharing obligations, however antenna is a facility
Building permits	Local adm. & NBTC	Ministry of Interior	• BBA 2008 • Telecommunication Business Act (2001)	• NBTC and local administration grants building rights to network licensee • Provisions of Telecom Business Act shall apply to the NBTC building permit

As Table 2.3 shows the main regulatory body is the National Broadcasting and Telecommunication Commission (NBTC). The two most relevant laws are:

- The Broadcasting Business Act of 2008 (BBA);
- The Act on Organization to assign Radio Frequencies and to Regulate the Broadcasting and Telecom services of 2010 (AOBT).

Regarding the regulatory framework the following observations can be made.

1. A draft notification on the introduction of DTTB has been prepared and submitted for public consultation, describing:
   a. transmission standard (DVB-T2);
   b. receiver specifications;
   c. initial DTTB frequency plan;
   d. risk impact assessment (RIA) of the transition from analogue TV to DTTB.
2. The current DTTB licensing schedule is:
   a. licences for network providers based on a tender procedure before the end of 2012;
   b. licences for public service providers based on a tender procedure before the end of 2012;
   c. licences for commercial service providers based on auctioning in 2013;
   d. licences for community TV services based on a tender procedure in 2013.
3. An analogue switch-off date is not yet decided. The end of the licence duration of the analogue TV broadcasters is of importance when considering an ASO date. The analogue TV licence of two commercial broadcasters ends in 2020 and 2023. The end of the licence of the other four analogue TV broadcasters is not specified. However, NBTC is investigating to stipulate an end date.
4. All six analogue terrestrial TV broadcasters have the intention to apply for a network provider licence, possibly by forming a consortium with others.

2.4 Digital switch-over objectives

The short and long term DSO objectives in Thailand are summarized in Table 2.4.

Table 2.4: DSO objectives

No	Objective	Transition period	>ASO
1	Smooth transition from analogue to digital	• 50%, 80%, 90%, 95% (= ATV coverage) rooftop reception + in rooftop areas included municipalities have to have indoor reception (a municipality area is defined). In total there are about 200 municipalities • All existing analogue terrestrial services must be carried on • Simulcasting (period not defined yet) • Phasing (but the model still to be determined) • Start DTTB 2013	

No	Objective	Transition period	>ASO
2	End of analogue transmission	• End of ASO still to be determined, taking into account duration of existing concessions • Intention to comply with ASEAN recommendation (by the of end 2020)	
3	More services	• 20% , 60%, 20% of capacity of 5 muxes to be allocated to resp. public, commercial and community services (Mux Payload tbd) • EWS service (must carry)	• 30% , 50%, 20% of capacity of 6 muxes to be allocated to resp. public, commercial and community services (mux payload tbd)
4	Extended population coverage	• None	• None
5	Better picture quality	• Presentation format up to the market, HD is 16:9, SD can be either 16:9 or 4:3 • Public and community TV service in SD or HD if capacity permits • Business service in SD and HD (and HD if there is interest)	• Business service in SD and HD (and HD if there is interest)
6	Compensation for viewer	• Financial support for all affected viewers • Installation aid is for the market to pick up (training to the installation companies could be provided)	
7	Compensation for analogue broadcasters	• No simulcast Opex compensated (under study)	• (Compensation for des-investments)
8	Digital dividend		• Allocate spectrum above channel 48 for IMT/LTE – no decision yet

With regard to the DSO objectives the following observations can be made:

1. DTTB will be transmitted in UHF only.
2. The intention is to assign five channels (multiplexes) in 41 main areas during transition and six channels after analogue switch-off. However, if IMT services are allocated in the channels above 48 this intention may need to be reviewed.
3. The objective for portable indoor reception is driven by:
   - The wide spread use of simple indoor receiving antennas (rabbit ears). It is estimated that about half of the analogue TVHH uses these receiving devices.
   - The limited use of UHF rooftop receiving antennas. Most analogue TV is transmitted in VHF. Thailand PBS broadcasts in UHF and is in operation since 2008. Although no data are available about the installed base of UHF rooftop antennas, it is expected that the number of UHF rooftop antennas is relatively low.
4. The DSO objectives deal with Digital Terrestrial Television Broadcasting (DTTB) only. Introduction of Digital Terrestrial Audio Broadcasting (DTAB) and Mobile Television (MTV) will be considered at a later stage.

3. National roadmap

After having determined the aim of the roadmap, as described in Section 2, this Section will describe the roadmap itself. Section 3 starts with an introduction on the concept of a roadmap, followed by the description of the construction of the roadmap in Section 3.2. In Section 3.3 the selected functional building blocks of the Thailand roadmap are shown. Section 3.4 describes each of the phases of the Thailand roadmap.

3.1 Roadmap concept

A *roadmap* is a management forecasting tool and is directed to the implementation of strategy and related to project planning.

A roadmap matches short-term and long-term goals and indicates the main activities needed to meet these goals. Developing a roadmap has three major uses:

1. It helps to reach consensus about the requirements and solutions for transition to DTTB.
2. It provides a mechanism to help forecast the key miles stones for the transition to DTTB.
3. It provides a framework to help plan and coordinate the steps needed for transition to DTTB.

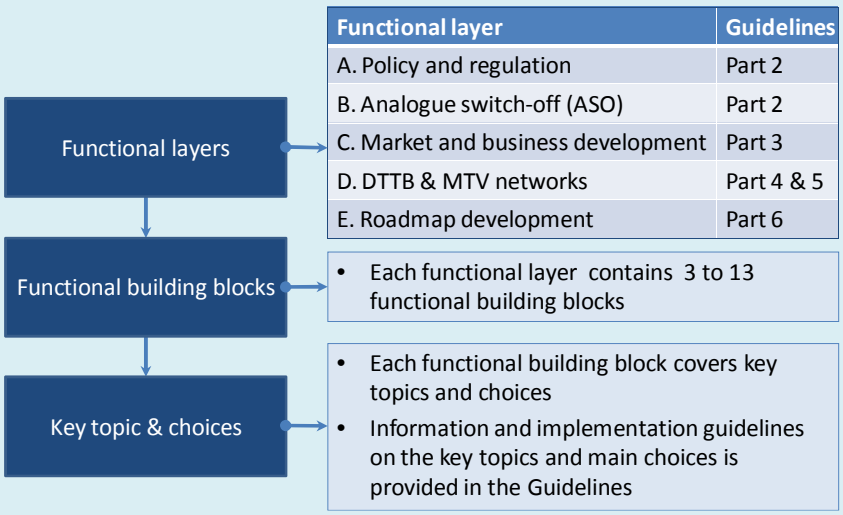
A roadmap consists of various phases, normally related to preparation, development and implementation of the strategy. A roadmap is often presented in the form of layers and bars, together with milestones on a time scale.

3.2 Roadmap construction

Part 6 of the ITU Guidelines for transition to digital television describes a method for developing a roadmap. Also a set of generic roadmaps regarding the whole process of transition to DTTB and introduction of MTV is given. The methodology described in Part 6 of the ITU Guidelines will be followed in the development of the national Thailand roadmap.

The basis construction the roadmap is a functional framework consisting of five layers (see Figure 3.1).

Figure 3.1: Functional framework

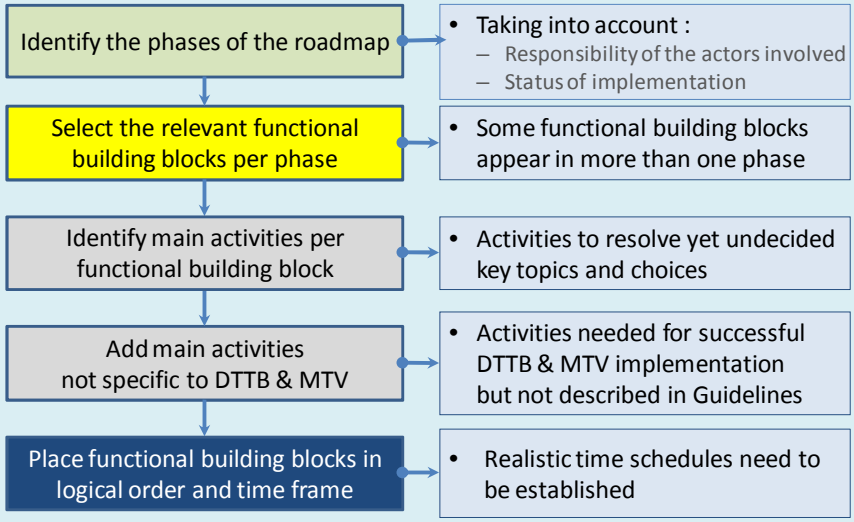


Source: ITU

Each layer consists of a number of functional building blocks. In each functional building block key topics and choices have been identified.

The roadmap is constructed by defining the phases and by placing the relevant functional blocks in each phase in a logical order and in a time frame. For each of the functional building blocks the decisions already taken and the main activities to resolve not yet decided key topics and choices are identified. Figure 3.2 illustrates the construction process.

Figure 3.2: Roadmap construction



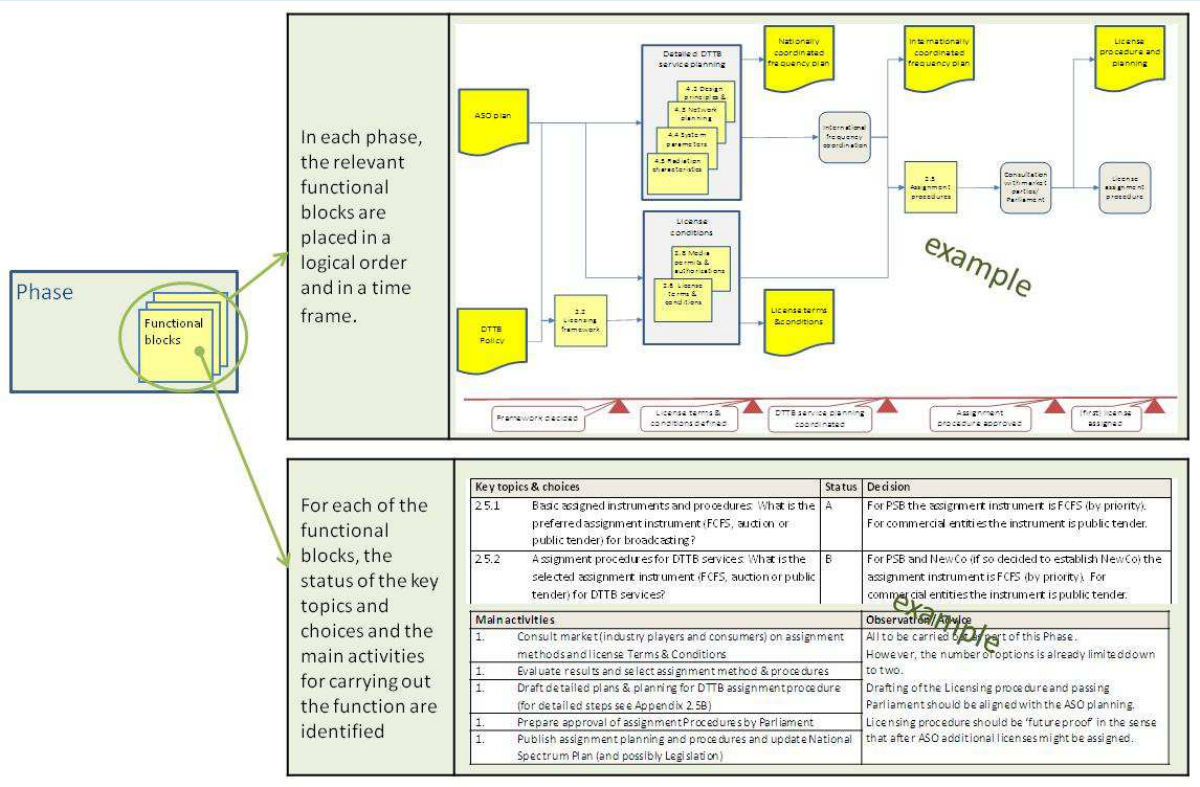
Source: ITU

The result is a roadmap that consists of three levels:

1. phases of the roadmap with the selected functional building blocks per phase;
2. for each phase, the functional building blocks placed in a logical order and time frame;
3. for each functional building block in a phase, the status on key topics and choices and the main activities to be carried out.

The roadmap structure is illustrated in Figure 3.3.

Figure 3.3: Roadmap structure



Source: ITU

The selected relevant functional building blocks are shown in Figure 3.4 in Section 3.3. Key topics and choices related to the selected functional building blocks of functional layers A (Regulation), B (ASO), C (Market and Business Development), and D (Networks) have been considered and it has been identified which decisions have (partly) been taken and which still need to be taken.

An overview of the status of the selected functional building blocks is given in the Annexes 1 to 3.

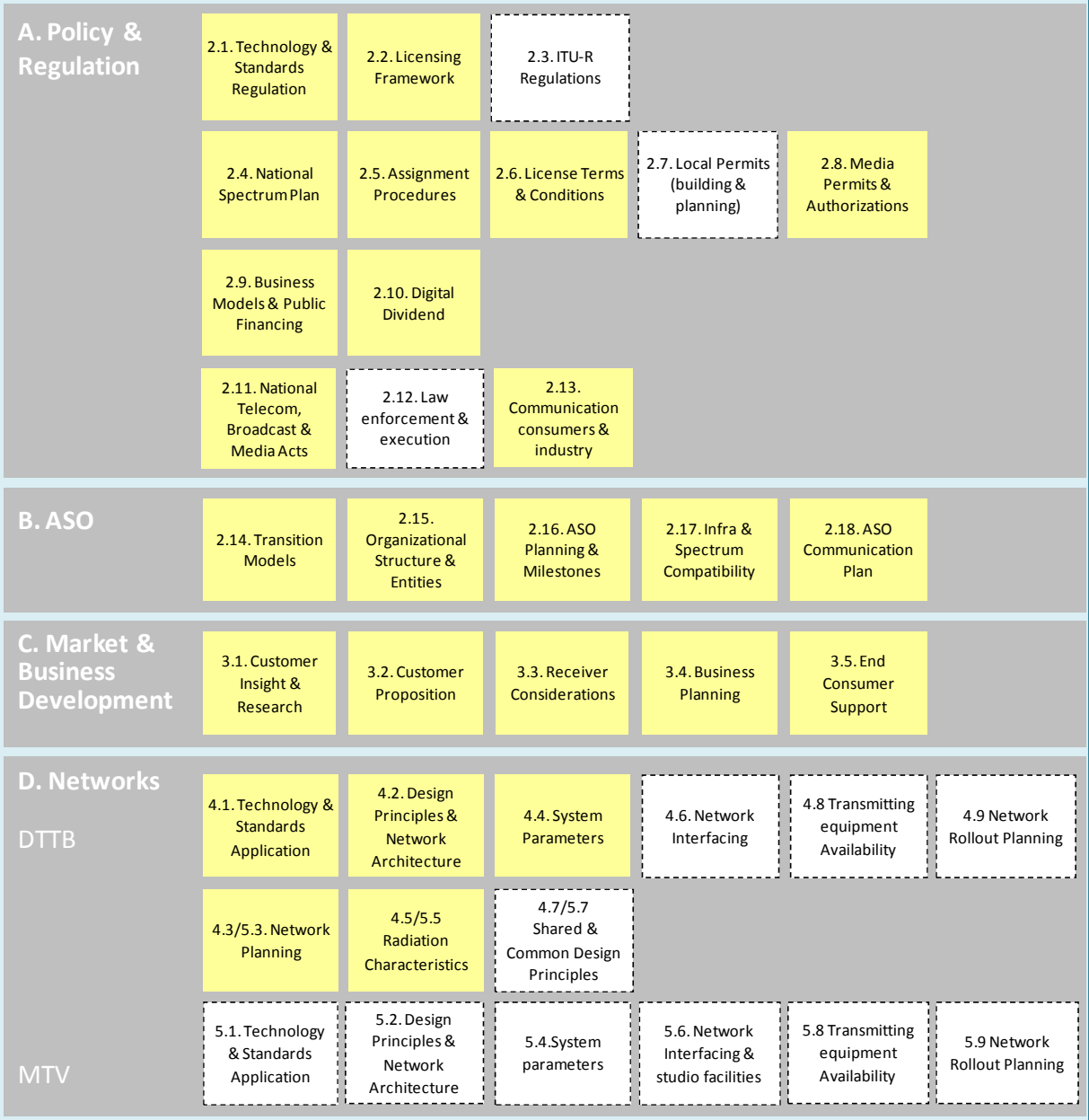
3.3 Functional building blocks relevant to the situation in Thailand

Out of the five functional layers shown in Figure 3.1, layer E is "Roadmap development" and hence covered by this report. The other functional layers A (Policy and Regulation, B (ASO), C (Market and Business Development) and D (Networks) contain in total 38 functional building blocks (see Figure 3.4). Out of the 38 functional building blocks, 25 blocks were selected to construct the Thailand roadmap.

Figure 3.4 shows three types of functional building blocks:

1. **White blocks with dashed frame**
   These blocks are not be included in the Thailand roadmap (see Table 3.1 below).
2. **Yellow blocks without frame**
   These blocks are included in the Thailand roadmap and will be managed by the NRT.

Figure 3.4: Selected functional building blocks (yellow) in the Thailand roadmap



Source: ITU

The reasons for not including the white functional building blocks in Figure 3.4 are given in the Table 3.1.

Table 3.1: Functional building blocks not included in the national roadmap

Not included functional building block		Reason
2.3	ITU-R regulations	There is no ITU DTTB frequency plan for Region 3. The frequency use should comply with the Radio Regulations, but it is not considered as a main topic to be controlled by the NRT.
2.7	Local permits (building and planning)	Local building permits/rights for erecting masts and installing equipment are granted by the NBTC in close cooperation with local administrations. This is common practice.
2.12	Law enforcement and execution	Restructuring of the Regulator (NBTC) was conducted recently and is not considered essential for managing the DSO process
4.6	Network interfacing	Thailand has selected a variant of licensing model B whereby the rights to operate a DTTB network will be assigned by public tender. Hence the detailed network design and implementation is for the network licensee to determine and carry out.
4.7	Shared and common design principles	The introduction of MTV services is considered at a later date and is out of scope of the current roadmap.
4.8	Transmission equipment availability	Thailand has selected a variant of licensing model B whereby the rights to operate a DTTB network will be assigned by public tender. Hence the detailed network design and implementation is for the network licensee to determine and carry out.
4.9	Network roll-out planning	Thailand has selected a variant of licensing model B whereby the rights to operate a DTTB network will be assigned by public tender. Hence the detailed network design and implementation is for the network licensee to determine and carry out.
5.1 to 5.9	MTV networks (all functional building blocks)	The introduction of MTV services is considered at a later date and is out of scope of the current roadmap.

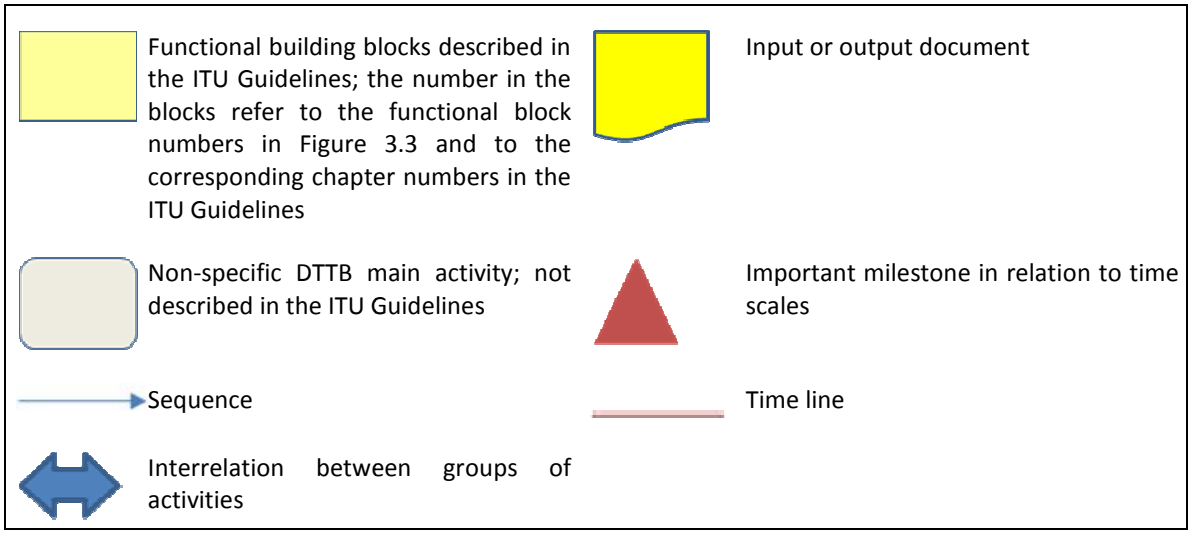
3.4 Description of the Thailand roadmap

In this section the overall roadmap for Thailand is outlined. The roadmap is segmented in several phases. After presenting the overall roadmap outline (Section 3.4.1), each phase is discussed in the following sections (3.4.2 onwards).

The detailed activities and considerations for each phase and its associated functional building blocks are included in Annexes of this report.

The following subsections contain a number of figures. The symbols used in these figures have the following meaning:

Figure 3.5: Symbols used in roadmap figures



Source: ITU

3.4.1 Overall roadmap

The Thailand NRT has not set an ASO date and considers setting an ASO date a few years after the DTTB services have been introduced in the market. However, the ASEAN Member States[4] have recommended a latest ASO date of 2020. The Thailand NRT is intended to comply with this recommendation as an ultimate ASO date for Thailand. If possible an earlier ASO date is pursued. As long as the final switch-off date has not been decided (and politically endorsed), the roadmap duration can vary considerably and could last till 2020[5]. Therefore the duration of the phases in which the DTTB network is rolled out and the analogue transmitters are switched off can span a considerable number of years.

Roadmap phases

A key decision, having a great impact on the roadmap, is the decision on the licensing model. The ITU Guidelines distinguishes two basic models: model A or B[6]. In Thailand, as embedded in the Broadcasting Business Act and its associated Notifications, a variant of model B is devised for the introduction of the DTTB services.

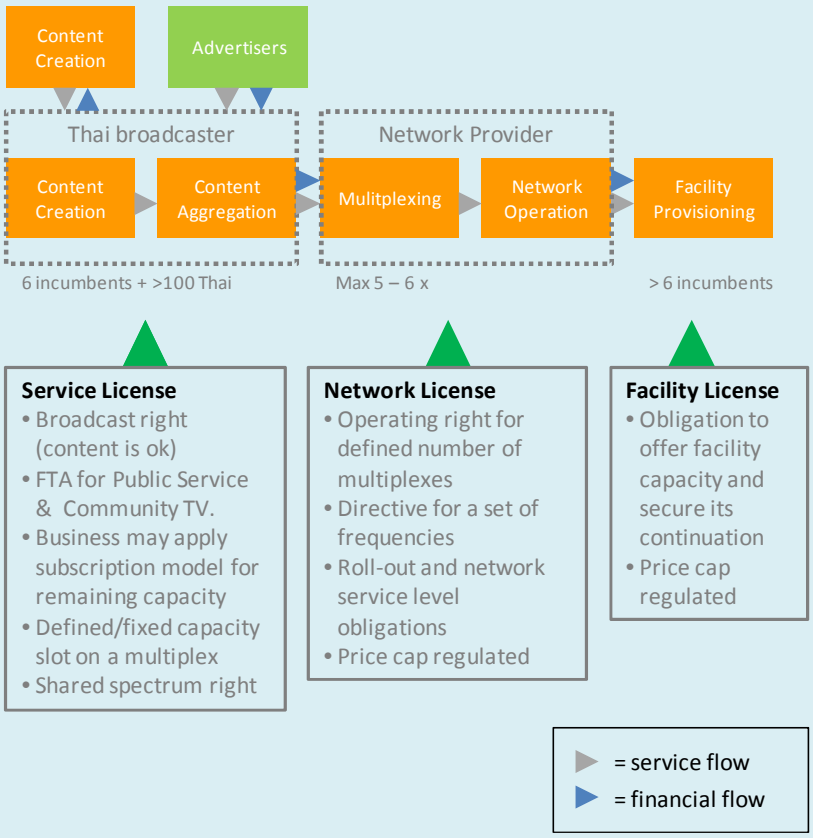
[4] The ASEAN countries include Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam.

[5] Or 2022 if the end of the duration of existing licenses is taken as latest ASO date.

[6] See the ITU Guidelines page 26/27.

An overview of the adopted Thailand licensing framework is depicted in Figure 3.6 below.

Figure 3.6: Overview of the Thailand licensing framework



Source: ITU

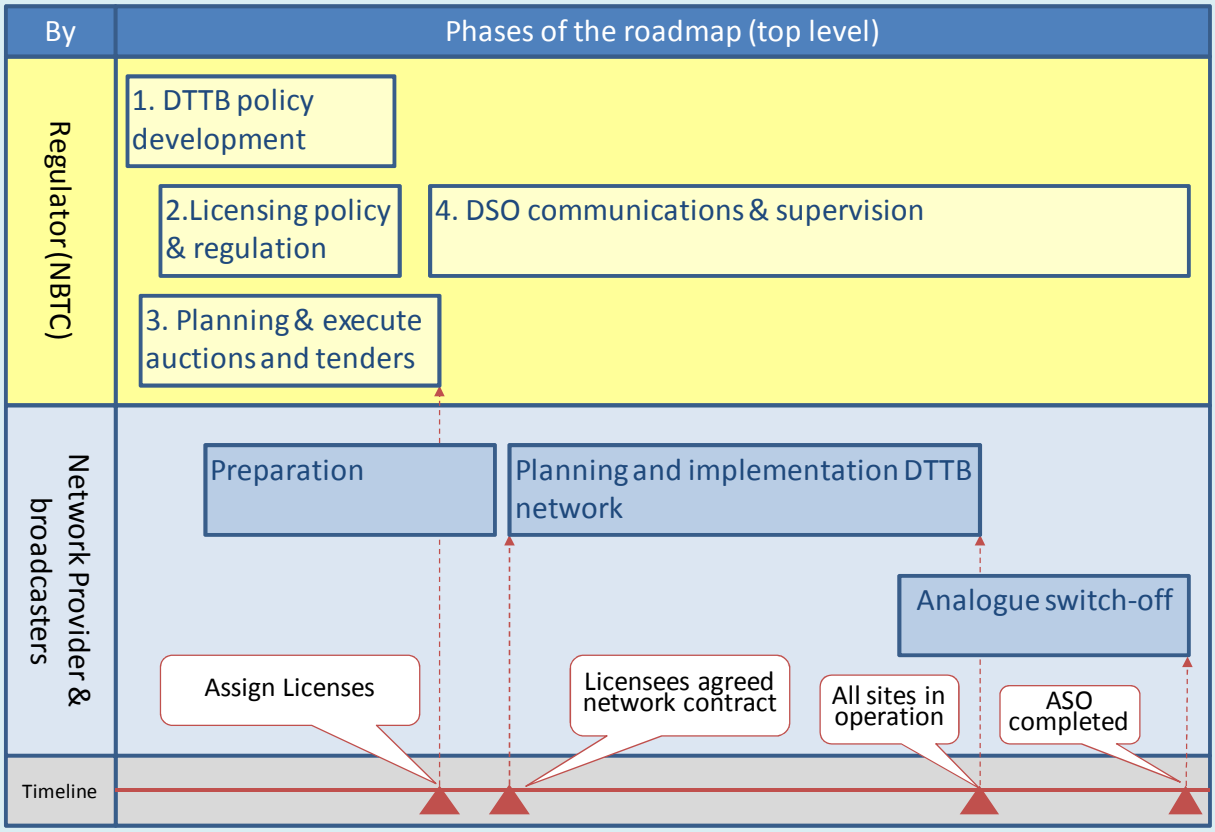
In the Thailand licensing model the NBTC will, by issuing network licences (by public tender), establish one or more common multiplex/network operators who will be responsible for delivering DTTB transmission services in Thailand. Broadcasters and/or service providers, intending to provide digital television services, will first have to obtain a service licence in either a public tender or auction. After having acquired such a service licence, the licensed broadcaster will have to purchase network capacity from the licensed network providers.

Next to having site sharing stipulations in the Broadcasting Business Act, the Thailand licensing framework also provide for a facility licence. Entities wishing to provide broadcasting facilities (like mast or rooftop space) will have to apply for a facility licence. Licensed facility providers can only provide their facilities to licensed network providers.

The actual network roll-out planning and implementation is at the discretion of the newly licensed network providers. The NBTC will monitor the DTTB network roll-out and check whether the licensed network provider complies with the terms and conditions, such as the network coverage and roll-out obligations, of its network licence.

Considering the Thailand adopted licensing framework and not having an ASO date (yet), Figure 3.7 illustrates the resulting phases of the NRT roadmap (i.e. the yellow shaded blocks).

Figure 3.7: Top level Thailand roadmap



Source: ITU

As Figure 3.7 shows, Phases 1, 2 and 3 are likely to be carried out partly in parallel because of the interrelationships between the issues to be decided.

In their current plans the NBTC will first assign the network licence(s) by public tender. Following this network tendering, the service licences for public service broadcasting (including community TV) will be assigned by public tender. Service licences for Business broadcasting (i.e. the broadcasting activities are financed on the basis of commercial income only) will be assigned by means of auction.

The current six analogue terrestrial television broadcasters (i.e. the incumbent terrestrial broadcasters) will have the obligation to provide their signal to the designated network licensee who has a must carry obligation for distributing the existing terrestrial services.

As Figure 3.7 shows the NRT, the candidate DTTB network providers and broadcasters need to prepare for these public tenders and auctions. See roadmap Phase 3 'Planning and execute auctions and tenders' and the blue shaded phase labelled 'Preparation'.

The service licensees will have to agree a network contract for having their DTTB service(s) broadcasted by the network provider. After settling the network contracts between the service and network licensees, the network providers can start planning and implementing the DTTB network (see the roadmap phase labelled 'Planning and implementation DTTB network'). This DTTB network deployment phase will be supervised and accompanied by the NBTC by monitoring licence compliancy and communicating with industry and the general public about the DTTB policy and regulations (see roadmap Phase 4).

As stated before an ASO date has not been set (yet). Consequently, the phase of switching off analogue terrestrial services (see the roadmap phase labelled 'Analogue switch off') can either start after or during the DTTB network deployment phase. In Figure 3.7 the latter situation has been depicted. Terminating the existing analogue terrestrial services is an activity to be carried out by the six incumbent broadcasters by directive and under close supervision of the NRT.

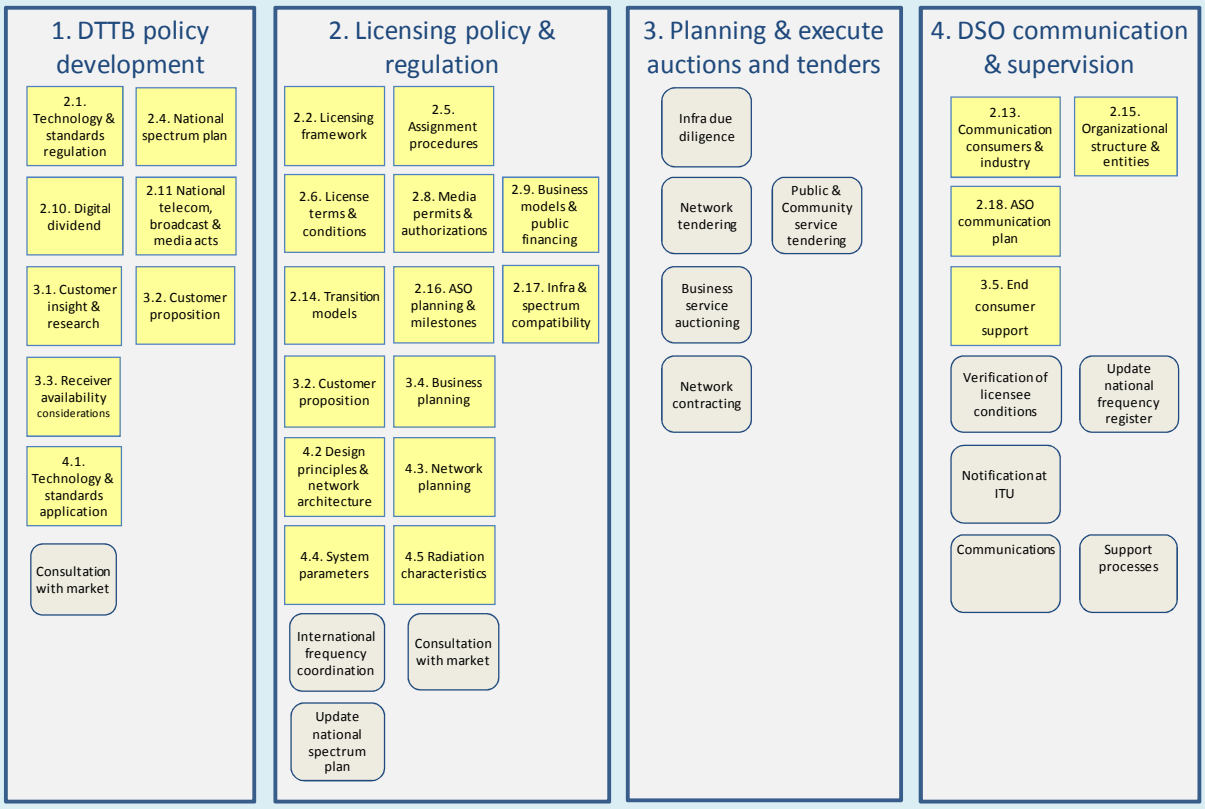
Functional blocks in each phase

The NRT will resume responsibility for the proper establishment of DTTB network provisioning by designing and assigning the network licences. It will also determine and endorse which DTTB services will be launched onto the Thailand television market. In addition, the NRT will determine the network roll-out and the associated planning by including network roll-out obligations in the network licences:

1. Market and business development layer:
    a. Customer insight and research (functional building block 3.1): the NRT will have to investigate what distribution services the multiplex/network operator is going to offer and how they are going to research this market demand.
    b. Customer proposition (functional building block 3.2): the NRT will have to determine the most compelling attributes of the DTTB services, such as coverage areas, number of services, picture quality, reception mode/quality and price tables for the various services (including multiplex capacity reservations).
    c. Receiver considerations (functional building block 3.3): in line with the objective to have an affordable STB for the Thailand market, the NRT will have to determine what functionality this STB will have. This will include aspects such as the transmission and compression standard as well as the presentation format.
    d. Business planning (functional building block 3.4): the NRT will also have to resume responsibility for an economically viable DTTB offering for both network providers, broadcasters and other market parties. Hence the NRT will have to assess the future cash flows of the network providers and broadcasters. And possibly what type of public financing is required.
2. DTTB network layer:
    a. Technology and standard application (functional building block 4.1) to radiation characteristics (functional building block 4.5): all these five technical functional building blocks have to be included as to determine what the required DTTB networks will look like. This includes aspects such as the design of the key network elements (i.e. the head-end/multiplex centre, the distribution links and the transmitter sites), the various system parameters (i.e. transmission mode, guard interval, etc.) and the applied frequencies per site (i.e. ERP, antenna height and diagram).

Figure 3.8 shows the functional building blocks to be included in each phase of the Thailand roadmap. Please note that the yellow shaded blocks are described in the chapters of the ITU Guidelines with corresponding numbering. The grey shaded blocks are not described in the ITU Guidelines. These blocks represent activities that are not specific to the introduction of digital terrestrial television services.

Figure 3.8: Functional building blocks per phase of the roadmap



Source: ITU

3.4.2 Phase 1: DTTB policy development

The DTTB policy development phase of the roadmap is aimed at getting the DTTB policy objectives agreed at a political level. Political consensus and commitment lies at the heart of any successful DSO/ASO project. Politicians will have to commit to the DSO/ASO objectives, deadlines, necessary budget and endorse the establishment of a NRT with a clear mandate to plan and execute the DSO/ASO process.

Inputs

The inputs for this phase are International Agreements, such as agreements made in the Association of Southeast Asian Nations (ASEAN), existing regulatory framework (see Table 2.3) and policy objectives (see Table 2.4) and documents. The policy objectives as included in Table 2.4 still have to be completed for some aspects. For example the exact number of television services and their coverage, still has to be determined. In either a Notification, requiring the Cabinet's approval, or an Information Memorandum, requiring NBTC's Broadcast Commissioner's approval, policy additions will be formulated and made known to the industry and general public.

Outputs

The key output of the DTTB policy development phase is a politically endorsed DTTB Policy documents to be published to the industry and general public (for example in the 'Official Gazette' or on the regulator's website). Such DTTB Policy documents typically include the following items:

- Policy justification. This includes the benefits and necessities of introducing DTTB services in Thailand. The customer and broadcaster benefits from having DTTB services in Thailand should be clearly outlined. By introducing DTTB and switching off analogue services, the digital dividend becomes available and this may also be part of the policy justification (for example it will be possible to introduce new/more mobile services);
- The legal framework. This entails the legal basis (and any necessary changes) for the DTTB service introduction and the ASO;
- Technical framework. Detailing the current spectrum in use by existing broadcasters and the available spectrum for the DTTB services. Also the spectrum available for non-broadcasting services (i.e. the digital dividend) should be clarified;
- DSO and ASO date. Starting (i.e. the introduction of the first DTTB broadcasts) and ending date of ASO process (i.e. switching of the last analogue broadcasts and lifting any restrictions on the DTTB broadcasts). These dates have to be exact as to inform the general public and industry accurately;
- The principle ASO model. This could be either simulcasting or no simulcasting (including the justification for any of the two). Thailand has opted for having a simulcasting period.
- DTTB services. Describing which existing television services (including any regional services) and additional content/services will be distributed on the DTTB platform and at which districts/provinces these services will be made available;
- DTTB standards: what standards (for example the transmission, compression and API standard) will be mandatory and its justification. In Thailand a clear decision has been made for adopting the DVB-T2 and MPEG4 standard for transmission and compression;
- Funding principles. The intention to include selected DSO costs in the Government budgets and the way it is going to be funded (for example by providing subsidies, training and installation aid);
- Communication and plan of action. Outline of how viewers (and other stakeholders) will be informed about the DSO and ASO process and plan of Action with major regulatory and operational milestones (e.g. the establishment date of the NRT, the date of when the Broadcast Act will be changed/updated, the decision on the allocation of the digital dividend, etc).

Most of the above listed items have been decided and published already. The only four policy elements currently not decided (and published) yet, are:

1. ASO date and overall planning. Currently the NRT considers setting an ASO date a few years after the DTTB services have been introduced in the market, so that market information on the DTTB uptake can be included in their ASO policies and plans;
2. Digital dividend size and allocation. The NRT has already decided to plan all DTTB services in UHF channels 26 and 60. However, re-allocation of parts of band to mobile and broadcasting might be considered. After having decided on this realignment the size of the digital dividend is clear. In addition, the reallocation of the resulting dividend should then also be made;
3. Funding principles. The NRT is currently considering several options to help viewers to migrate to DTTB, ranging from subsidizing receivers, providing viewer support services (e.g. call centres and websites) and training to antenna installation companies. At the same time the NRT is considering several options for funding these support activities;

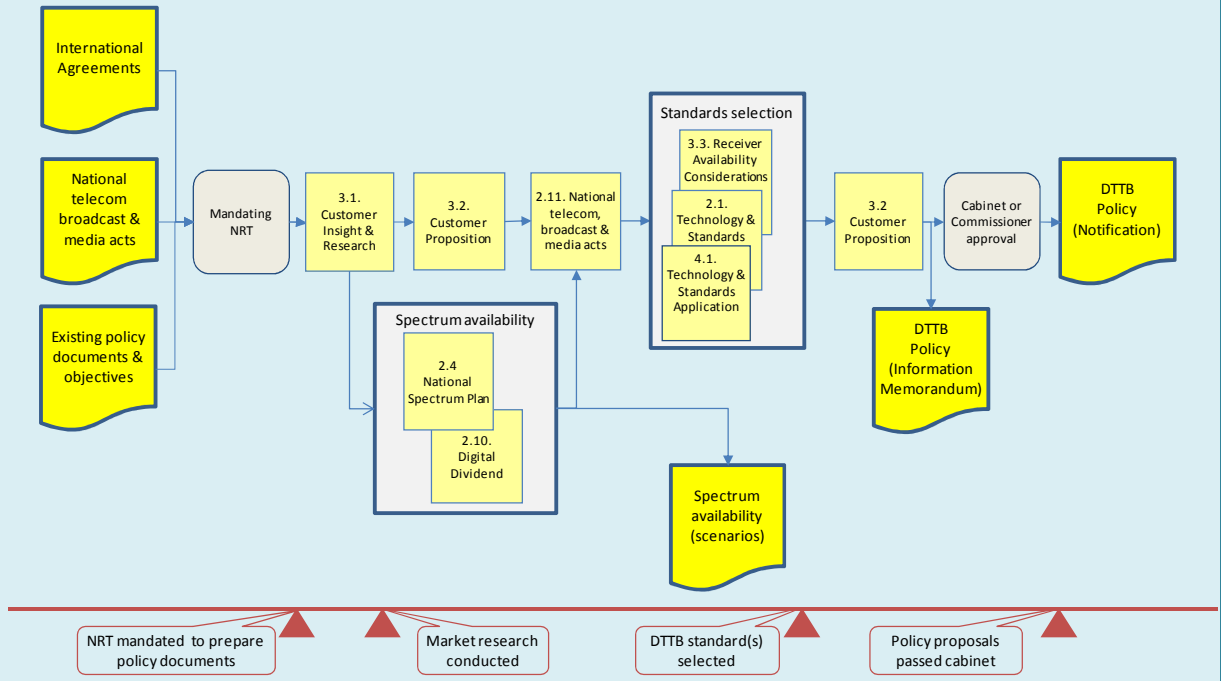
4. DSO communications. These DSO communications will closely follow the above described support activities. As indicated above these support activities have not been decided yet and hence the DSO communications are not defined either.

Roadmap

For Thailand the DTTB policy development phase has been completed for the larger part. Only additional decision taking and further detailing of policy decisions is required. As all functional building blocks are interrelated this additional decision taking may lead to review or revision of already decided DTTB policies.

The roadmap of the DTTB policy development phase and the associated functional building blocks is shown in Figure 3.9. The decisions taken, partly taken and not yet taken on the key topic and choices regarding Phase 1 of the roadmap and the activities required to prepare the decisions that are still pending, are indicated in Annex 1.

Figure 3.9: DTTB policy development phase of the roadmap



Source: ITU

As can be derived from Figure 3.9, the following steps (i.e. functional building blocks and non-DTTB specific activities) are included in the first phase of the roadmap:

1. Mandating the NRT. In Thailand the NBTC has established a NRT (i.e. a subcommittee reporting to the Broadcasting Commissioner), fully endorsed and mandated to prepare and execute the DTTB introduction. In the event the NRT will set an ASO date it will have to re-organize for the decided ASO. The participation and the mandate of the NRT may need to be reconsidered. For example, the NRT membership may be extended with representatives of retailer organizations, satellite/cable television service providers and consumer associations. In Phase 4 of this roadmap, this eventual aspect of preparing for ASO is addressed.

2. Conducting market research of the current television and future DTTB market in Thailand. This step includes the functional building blocks 3.1 and 3.2. Considering that the NRT has already carried out an extensive market analysis, additional market research serves the purpose of providing further support/justification for the DTTB Policy. Because key Thailand broadcasters

(i.e. the six incumbent television broadcasters) are participating in the NRT some of the research data may be readily available. The market research data will have to cover the following elements:

a. *Current* television market in Thailand. A profound and *agreed* understanding of the current television market provides a sound basis for any policy document. This part of the research will include the following:

   i. Current market players (to include broadcasters, content creators, network operators, service providers etc.). Figure 2.1 as included in this report, provides a good start;

   ii. Television viewing 'demographics'. This entails the common market parameters like number of television sets deployed, second television sets, set-top-boxes and satellite dishes deployed, homes passed and connected to cable, the number of viewing hours (per channels), the number of subscriptions, etc.;

   iii. Size of the total television advertising market and the distribution over the various platforms (i.e. cable, terrestrial and satellite) in Thailand. Also the impact of the DTTB introduction on this advertising market should be assessed. Especially the market position of the six incumbent television broadcasters will change as much more terrestrial capacity will become available;

   iv. Current reception situation and conditions. This entails having insight in what the different viewing groups (to include individual viewers, household size, group viewing, hotels, multi-dwelling units, etc.) look like, their numbers and under what conditions current analogue television is received (e.g. the antenna installation and type of television sets). This part should also include the reception from other platforms. Especially under the large number of viewers/subscribers to the cable and satellite networks, the reception conditions should be investigated. For example whether cable and satellite viewers still use analogue terrestrial reception;

   v. Current analogue service coverage. Given the current reception conditions, it should be clarified where what service can be received. This entails an analogue service planning exercise (similar to the DTTB service planning as described in the ITU Guidelines). This part should also take into account the different channel bouquets the various viewers receive. As Figure 2.1 shows the six existing analogue terrestrial networks have different coverage percentages. Furthermore the transmitter locations and installations between the six incumbent broadcasters may be different too;

   vi. Television market logistics and supplies. The current logistic chain for television sets will be important for the distribution of DTTB receivers. An understanding of its structure, volume (e.g. how many outlets where?) and operations will be necessary.

b. *DTTB* market in Thailand. The DTTB Policy document should illustrate that there is a need for DTTB. This part of the market research should provide an insight in what the viewers and industry players expect, including:

   i. Content. To include the number and the type of programmes/channels and other service to be broadcasted (for example the EPG, subtitling, theme channels). Also the willingness to pay for the STB and the television services is an important aspect to include. Knowing this willingness can help to determine any necessary financial support for viewers.

   ii. Supplies. Thailand manufacturers and distributors might show an interest in provisioning DTTB receivers.

   iii. Content creators. Thai content creators (e.g. the over a hundred Thailand broadcasters) might be interested in provided dedicated content for the DTTB platform.

3. Determining the *current available* spectrum for DTTB (functional building blocks 2.4 and 2.10). A clear and shared understanding of the available spectrum will enable the NRT to develop a well-motivated DTTB Policy and determine the spectrum availability scenarios. These scenarios will determine the amount of network planning to be carried out in Phase 2 of this roadmap. The available spectrum for digital terrestrial television services can vary significantly (see also Section 4.4), taking into account:
    a. Neighbouring spectrum usage. Spectrum may not be readily available in Thailand as the same spectrum is in use in neighbouring countries. Additional bilateral/multilateral coordination may be necessary;
    b. Spectrum required for future digital radio and MTV services;
    c. Possible realignment of the UHF broadcasting band, to include allocating:
        i. Broadcasting spectrum to non-broadcasting services, for example spectrum for IMT/LTE services;
        ii. Spectrum for Mobile services to Broadcasting services;
4. Checking compliancy with current legislation and identifying required changes (functional building block 2.11). The Table 2.3 in this report and Table 2.11.1 in the ITU Guidelines provide a good start for this assessment. At this first phase of the roadmap, the assessment is focused on identified areas that might be impacted, how required changes can be achieved (e.g. additional publications of Information Memorandums and Notifications) and what time this will take. During the second phase of the roadmap (i.e. determining the DTTB regulations) specific DTTB regulations are defined (e.g. detailed licensing framework, terms and conditions and procedures), a further detailed assessment of necessary changes may be necessary. Special consideration should be given to the fact that Broadcasting Business Act (2008) and the Act on Organization to assign Radio Frequencies and to Regulate the Broadcasting and Telecom services (2010) are very recent and cannot be changed or amended easily.
5. Selecting DTTB standards. As Figure 3.9 shows the procedure for deciding the DTTB standards is an iterative process between the functional building blocks 4.1 Technology standards application (i.e. addressing the technical performance), 2.1 Technology standards regulation (i.e. considering regulatory aspects) and 3.3 Receiver availability considerations (i.e. dealing with functionality, price and delivery of receivers). In Thailand the television presentation format, transmission and compression standard have already been decided. The NRT has also decided not to set a specific standard for the API, other than that it should be open and be approved by the NBTC. In addition, the NRT has already detailed the receiver specifications or requirements. The only key regulatory decision on standards that remains open, is the decision to regulated (or not) the conditional access system (CAS). Under the current devised licensing framework this is dependent on the whether there will be Business service licence applicants interested in providing subscription based or pay-tv services. As long as this option remains open, the NRT should decide its standard policy on the CAS.
6. Deciding the digital dividend (functional building block 2.11). As said previously deciding the digital dividend will not only be important for justifying the introduction of DTTB but also for determining the frequency planning exercises and hence determining the licensing conditions in the next phase of the roadmap (i.e. licensing policy and regulation). At this phase it should be decided what digital dividend will become available for other services than Broadcasting services. Creating a digital dividend might be an important element for justifying the introduction of DTTB in Thailand. The introduction of new Mobile services might fit in the economic development agenda of Thailand.

7. Determining the first customer proposition. A shared definition of the customer proposition will have to be agreed. This proposition should be as concrete as possible in terms of six dimensions as explained in the ITU Guidelines[7]. It should be consistent as it will have a knock-on effect on other decisions of the NRT in other phases of the roadmap. An evident example is that if picture or reception quality is a key differentiator for DTTB, the number of DTTB services may be reduced and hence the number of service licences to be assigned.
8. Cabinet or Commissioner's approval. In this step (draft) policy proposals are offered to the Cabinet to approve. Only policy proposal that will require a Notification will have to be passed to the Cabinet. Other proposal can be approved by the Broadcasting Commissioner of the NBTC. Both approval processes may include consultation sessions, lobbying and revisions. Sufficient time should be planned for these activities.

3.4.3 Phase 2: Licensing policy and regulation

The objective of this second phase of the Thailand roadmap is to have the required DTTB licences defined and the associated licensing procedure and planning published. In this way, clarity is provided to interested market parties to operate on the Thailand DTTB market. It also services the purpose of ensuring uninterrupted broadcasts, free of any interference from any other spectrum users.

Inputs

The input data for this phase are the DTTB policies and the Spectrum availability scenarios resulting from the first phase of the roadmap. As indicated in Figure 3.7 in this report, the second phase will be executed in parallel to Phase 1 (and 3). This will require a close cooperation between the various NRT members to share and update their work. Such an approach might entail some later changes/revisions of the delivered documents.

Outputs

This second phase has the following output documents, of which the latter two might be published in the Official Gazette, including:

- A frequency plan defining which DTTB frequencies will be used when in which geographical areas. For each frequency in this plan the essential planning parameters are included like maximum ERP, antenna diagram and antenna effective height. This plan determines which frequencies are included in each DTTB network or multiplex. Consequently it is the basis of determining which frequencies are part of which network licence (see Figure 3.6);
- A nationally coordinated frequency plan defining which DTTB frequencies will be used when in which geographical areas. The abovementioned frequency plan will have to be in line with the National Spectrum Plan or reversely made part of this National Spectrum Plan (please refer to functional building block 2.4 of the ITU Guidelines);
- An internationally coordinated frequency plan. As indicated previously this may require bilateral/multilateral coordination. However these administrative procedures may not have to be part of the critical path of the ASO planning;

[7] See the ITU Guidelines, pp 143 -149.

- The DTTB licence conditions and terms:
  - *The network licences*. The frequencies from the abovementioned frequency plan will be distributed over the five to six DTTB networks/multiplexes. To ensure spectrum efficiency and compatibility the network licences will have to specify detailed frequency use. In addition the NRT will have to stipulate open network provisioning (OPN) rules (including capacity access, reservation, pricing and publication rules[8]), roll-out and network coverage obligations for network licensee;
  - *The service licences*. The frequency right in terms of a part/slot of a DTTB multiplex will be assigned to broadcasters (and/or service provider). Together with this spectrum right, the broadcast rights (i.e. the compliancy of the television programming to the regulator's content stipulations[9]) will be granted;
  - *The facility licences*. The network licensees may wish to share broadcast infrastructure with facility providers (e.g. antenna space in a broadcast tower). Although the Broadcast Business Act includes site sharing stipulations, the facility provider needs a facility licence for providing these broadcasting facilities. Like the site sharing stipulations in the Broadcast Business Act, the facility licence terms and conditions will arrange for equitable and non-discriminatory access and fair pricing. In addition the facility licence will include terms and conditions to safeguard professional, durable and long-lasting delivery of the facilities;
- A document describing the assignment procedure and planning:
  - *The network licences*. As discussed in Section 3.4.1, the network licences will be assigned to qualifying bidders (i.e. legal entities that have passed the minimum criteria[10]) by public tender. The procedures and planning for this public tender will have to be published for bidders to prepare their bid books;
  - *The service licences*. The service licences fall into three categories with each a different assignment instrument and hence procedure and planning[11]:
    - Public service licences. Public service broadcasting (PSB) licences will be assigned in a public tender, whereby a ranking of the valid bids will be compiled. Depending on the available PSB service slots only the top ranking bids will be honoured in the first round. In a second round any remaining service slots (i.e. remaining slots for business services) may be granted to the 'second-best' bidders on the ranking list;
    - Community television service licences. These licences will be assigned by means of public tender too. This type of community TV service is described in the Broadcast Business Act, as well as the minimum spectrum that should be made available (i.e. 20 per cent of the available DTTB spectrum);

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8 Access to and fair pricing of 'essential facilities', i.e. infrastructure that cannot duplicated under normal market conditions or infrastructure which operations is uniquely licensed to a single market party. The ONP rules stipulate under what conditions access to this infrastructure should be made available and against what costs/prices. See also the ITU Guidelines p60/61 on ONP rules.

9 These stipulations are described at a top level in the Broadcasting Business Act (2008). A detailed content Charter still has to be drafted.

10 Minimum criteria usually refer to criteria ensuring that the bidding parties qualify in terms of professional conduct, legal and financial viability (e.g. no criminal record or state of bankruptcy).

11 Please note that the six incumbent analogue terrestrial television broadcasters will have the obligation to provide their signal to the designated network licensee who has a must carry obligation for distributing the existing terrestrial services (see also Section 3.4.1).

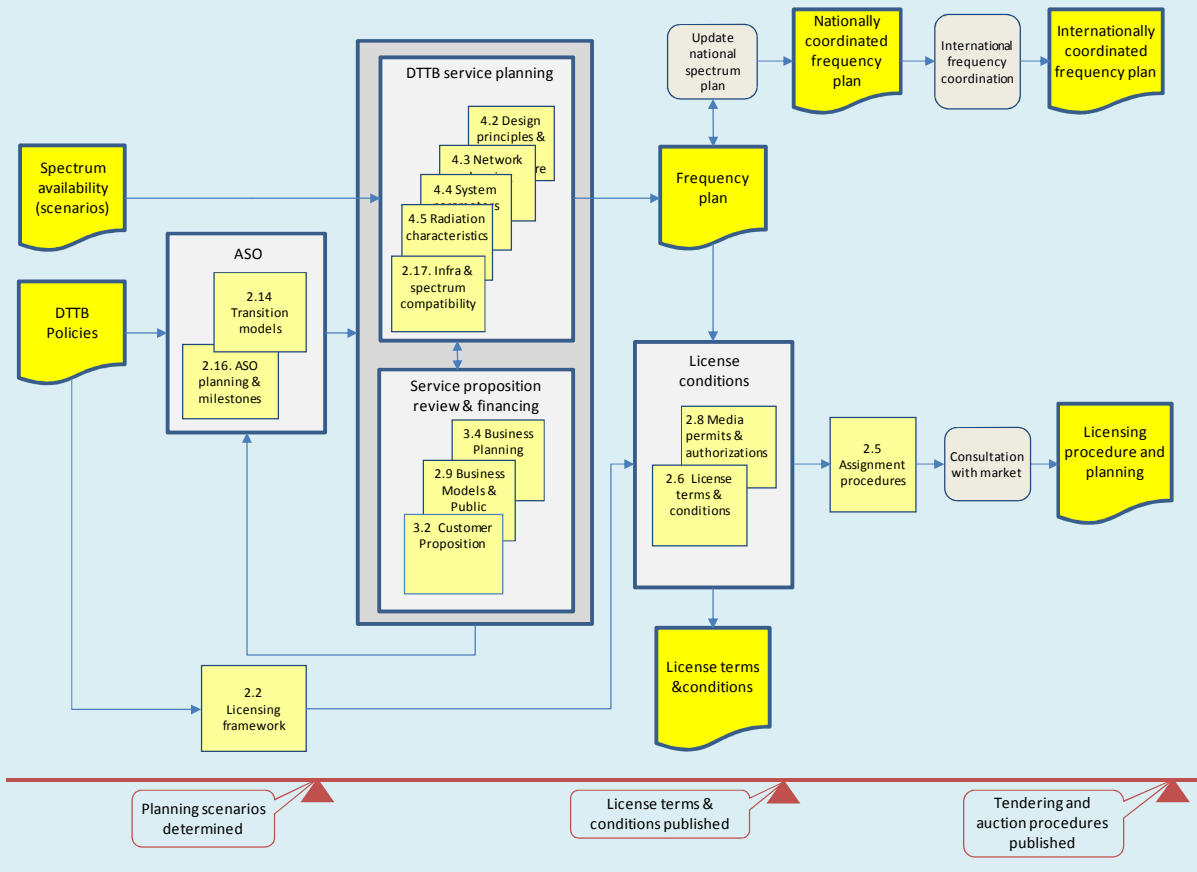
- Business service licences. Business service licences are assigned by auction. After passing the minimum requirements (e.g. professional, financial and legal requirements), the highest financial bids will get a business service licence assigned. These business service licences falls into three main sub categories of geographical coverage areas (i.e. National, Regional and Local), to be auctioned simultaneously or time phased. Currently the NRT is considering dividing this National sub category into different 'sub-sub' categories (e.g. services with a certain volume and type of news or kids programming). Any remaining slots (i.e. licences not bid for or no qualifying bidders) will be reallocated to the public services (see above);

– *The facility licences*. These licences will not be assigned in a competitive bidding procedure (i.e. either public tender or auction) but will be assigned upon application. Any applicant complying with the minimum criteria (such professional, financial and legal requirements) and the facility licence terms and conditions will be granted a facility licence. The rules and procedures of this licensing regime will also have to be published upfront for network licensees and facility providers to engage in contract negotiations.

Roadmap

The Licensing policy and regulation phase and the associated functional building blocks are shown in Figure 3.10. The decisions taken, partly taken and not yet taken on the key topic and choices regarding Phase 2 of the roadmap and the activities required to prepare the decisions that are still pending, are indicated in Annex 2.

Figure 3.10: Licensing policy and regulation phase of the roadmap



As can be observed from Figure 3.10, the following steps (i.e. functional building blocks and non-DTTB specific activities) are included in the second phase of the roadmap:

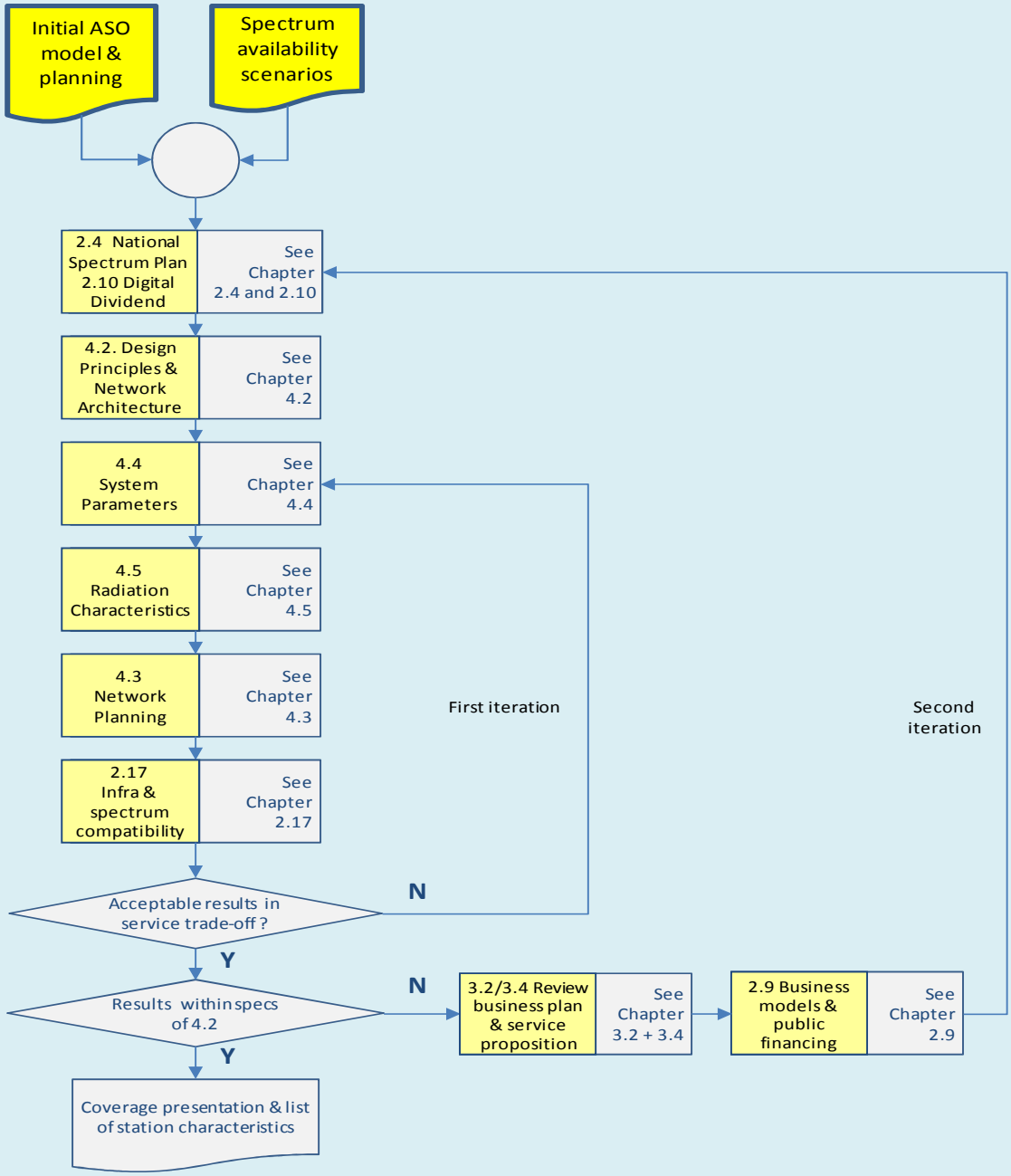
1. Determining an initial transition model and planning (see functional building block 2.14 and 2.16). In the first phase of the roadmap a first understanding of the available spectrum was established. In this phase of the roadmap, the NRT should assess what various ASO models are possible and if any changes of DSO objectives are needed. This assessment together with the implementation guidelines in the ITU Guidelines (see Subsection 2.14.4) on the ASO model decision, an ASO model can be selected (which may vary for served and non-served analogue terrestrial television areas). A principle decision on the ASO model will also imply an initial decision on the overall ASO planning. Having insight in the ASO planning may bring frequency and other logistic bottle necks to light. Such ASO decisions will provide important input for the service planning and to check if enough frequencies are available for reaching the DSO objectives;
2. Balancing DTTB service planning, customer proposition and financing (functional building blocks 2.17, 4.2 to 4.5, 2.9, 3.2 and 3.4). This step entails and iterative process where three elements (i.e. service proposition, network planning and business case) are balanced against each other as illustrated in the Figure 3.1.1 in the ITU Guidelines. Although in the ITU Guidelines this process is explained for a commercial DTTB service provider, the process is in essence no different for the NRT. As Figure 3.10 illustrates, this iterative process consists of two parts:
    a. DTTB service planning (which in turn is an iterative process of five functional building blocks 4.2 – 4.5 and 2.17);
    b. Service proposition review and financing (which are also in turn an iterative process of three functional building blocks 2.9, 3.2. and 3.4);

    Figure 3.11 below provides a flow chart of the two feedback loops that are incorporated in the balancing of these three elements. For example, due to a lack of available spectrum this step may result in a revision of the initially selected spectrum availability scenario (hence the second loop in Figure 3.11);
3. Detailing the licensing framework (see functional building block 2.2). As illustrated in Figure 3.6 the NRT has already devised a comprehensive licensing framework whereby the three elementary rights (i.e. spectrum, broadcast and operating rights) are assigned to the various licence holders. At this stage of the roadmap, the number of each licence type should be carefully determined by balancing the pros and cons of each option. Especially the number of network licensees is a critical decision as the incumbent broadcasters have all expressed an interest in applying for this licence. Also the number of service licences (for the various service types) should be carefully balanced against the available capacity on the DTTB multiplexes. In turn this capacity is driven by the service planning as described in the above paragraphs;
4. Determining the licence terms and conditions. By having a shared spectrum right between the service licensees (see also Figure 3.6) and a frequency directive (i.e. a set of frequencies designated for a specified network/multiplex) for the network licensees, special attention is needed in drafting the licence terms and conditions. They will deviate from the standard licence terms and conditions as described in the ITU Guidelines for the broadcast and spectrum licences[12]. In addition, the NRT is contemplating stipulating a minimum number of DTTB receivers to be supplied by the licensees. Such requirements call for a careful formulation of the licence terms and conditions and they should be checked against competition regulations;

[12] See the ITU Guidelines, chapters 2.6 and 2.8.

5. Detailing the licensing instrument, procedures and planning. As discussed in this section the various licences will be assigned by either public tender, auction or upon request. The procedures for tendering and auctioning will have to be detailed and tested. Various steps are needed to organize a public tender and auction. In addition, for the auction special auction rules needs to be designed and tested. For example, the minimum bid price, aggregation rules, valid bids (for example bids have to be rounded-up/down to avoid signalling), bid increment and stopping rules. The resulting set of licensing procedures has to be planned in time and tested on consistency. As can be observed from the Figure 3.10 a consultation with the market is envisioned before the final licensing terms and conditions, procedures and planning are formally published.

Figure 3.11: Flowchart of planning iterations (chapter and part number refer to the ITU Guidelines)



Source: ITU

In the above Figure 3.11, the first iteration is the so-called service trade-off. In this trade-off transmission costs (given by the number of transmitters and the radiation characteristics), service quality (given by the multiplex capacity) and coverage quality (given by the coverage area which depends in its turn on receiving installation and location probability) are balanced. The optimum solution should be found within the limits given by the decisions taken in the functional building blocks 4.4 (System parameters), 4.5 (Radiation characteristics), 4.6 (Network planning) and 2.17 (Infrastructure and spectrum compatibility). The latter functional building block will require detailed information on the readily available broadcasting infrastructure and its capacity. For example data on the towers' antenna space and wind load capacity should be available. Collecting this data may require a due diligence investigation of this broadcasting infrastructure (see also the third phase of this roadmap).

The second iteration is a further balancing of the service trade-off optimum against the financial possibilities. The financial possibilities are given by the financial capacity of the broadcasting industry to carry costs and financial means made available by the government to support the DTTB uptake (see functional building blocks 3.4 and 2.9). If no satisfactory solutions can be found in the service trade-off, the service proposition and business model may need to be reviewed, resulting in a possible review of functional building blocks 2.4/2.10 (National Spectrum Plan/digital dividend) and 4.2 (Design principles and network architecture).

3.4.4 Phase 3 Planning and execute auctions and tenders

The aim of the planning and executing the auctions and public tenders is to assign the various licences to qualifying bidders, cater for appeal procedures and facilitate the contracting between the network and service licensees and the network licensees and facility providers.

Inputs

In the previously described roadmap phase, the licence types, numbers, terms and conditions, assignment instruments, procedures and planning are determined, as well as the frequencies designated for each network/multiplex. These inputs are reflected in two output documents of previous roadmap phase; the licence terms and conditions and Licensing procedure and planning. Another input of this phase is the DTTB policies (either formulated in Notifications or Information memorandums). These policies will determine in what way sharing of existing infrastructure and aggregation of new infrastructure will be promoted or enforced[13]. This will give important guidance to what data should be made available to bidders for the network licences.

Outputs

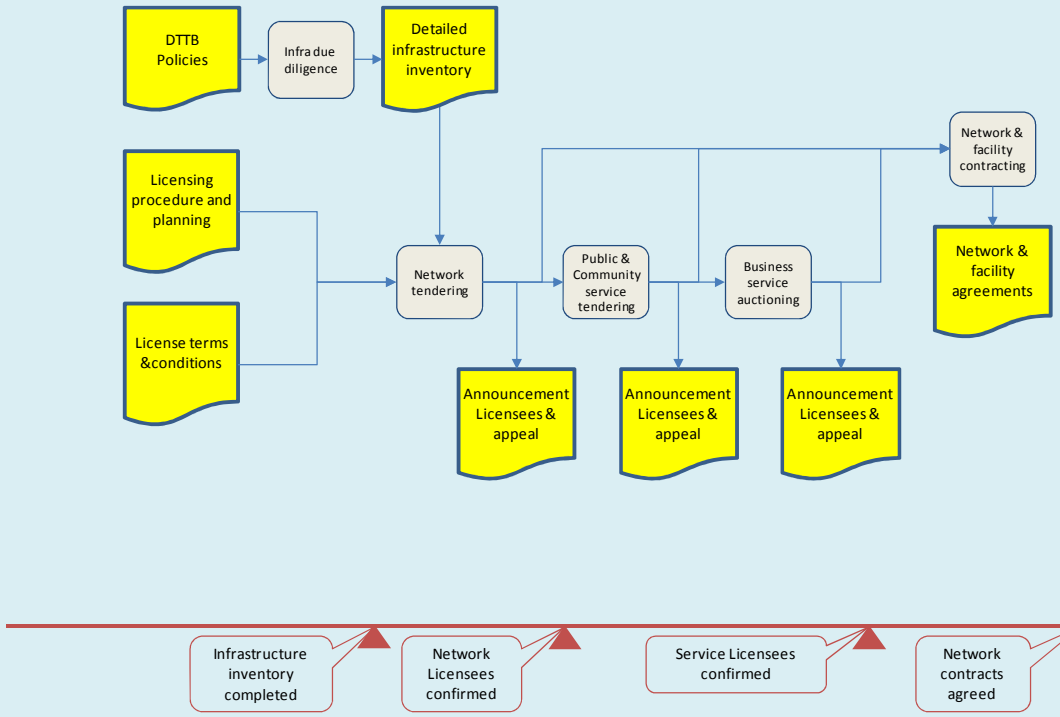
The outputs of this roadmap phase are the official announcements (for example in the Official Gazette) of the newly licensed parties and any received appeals against these rulings. After having licensed the network, service and facility providers, the licensees will have to agree network and facility contracts. Hence the outputs of this phase are these network and facility contracts.

[13] It is noted that in the Broadcasting Business Act (2008) site sharing stipulations are already included.

Roadmap

The Licensing policy and regulation phase and activities are shown in Figure 3.12. As the figure illustrates there are no functional building block included in this phase of the roadmap. However, the included activities have to be carried out and planned in time.

Figure 3.12: Planning and execute auctions and tenders phase of the roadmap



Source: ITU

As Figure 3.12 shows, the following steps are included in the third phase of the roadmap:

1. Carrying out due diligence investigations. These investigations are needed to prepare a complete inventory of the existing broadcasting infrastructure available for deploying the DTTB networks/multiplexes. Depending on the quality and comprehensiveness of the available data amongst the terrestrial broadcasters (this may include radio broadcasters and their infrastructure) these investigations may take a considerable time. Hence it is advocated to start these investigations as soon as the DTTB policies have been completed. Typically information to be part of the infrastructure data made available to bidders are[14]:
    a. Tower locations, height, available antenna space and remaining wind load capacity;
    b. Available antenna systems, including aspects such maximum power, antenna diagram, frequency ranges and combiner specifications;
    c. Available space for transmitter and auxiliary equipment;

[14] It is noted that for offering these facilities pricing regulations will apply (see also Figure 3.6). Consequently, these pricing regulations should result in published pricing tables, also available to the bidders for the network licences.

d. Power supplies and no-break facilities;

e. Cooling facilities and available capacity;

f. Access and maintenance information (how to get access to the site, for example roads, on-site staff and keys);

2. Network licence tendering. Public tendering typically includes several steps before assigning licences. Please refer to Appendix 2.5B in the ITU Guidelines. It should be noted that the included steps in this appendix focus on assigning spectrum rights. For assigning the network licences some additional aspects should be taken care of. Especially the qualifying criteria should be carefully compiled. For example to assess whether a bidder has the technical expertise/ track record to manage a DTTB network, as well as assessing if the bidders have sufficient financial means and a viable business plan. Also the data made available to the bidders should be carefully compiled. As the bidders will base their bids for an important part on this information, incorrect data may result in appeals and legal procedures;

3. Service tendering and auctioning. After having assigned the network licences, the NBTC will assign the service licences by either public tender or auction. Especially organizing and executing auction may take considerable time. For example, depending on the auction design the actual auction alone may take several days to weeks. For example in a multi-round simultaneous auction the stopping rules may allow for a long or short bidding process. All dependent on balancing maximum auction proceeds, avoiding collusion and the 'winners curse';

4. Contracting. After having assigned the service licences the licensees have to agree a network contract with the network licensees. It is important to note here that in this system there exists a risk for deadlock. As long as the network provider does not know its actual number of contracted service licensees and the type of services they would like to acquire (for example regional insertion), the network provider will not be able to provide final prices. In turn these final prices are needed for service licensees to select their network provider. It should be noted that this risks for a deadlock situation is also dependent on the pricing regulations put in place by the regulator (i.e. the Open network Provisioning rules). A similar deadlock risks could arise between the network licensees negotiating a contract with facility providers (for more details see Section 4.1.1).

3.4.5 Phase 4 DSO communications and supervision

The objective of the DSO communications and supervision phase is to help promote the uptake of the DTTB services by providing information and other forms of aid, as well as to check compliancy with the issued licences, to update the National Frequency Register and to notify the ITU of any new DTTB station put into operation.

As discussed in previous sections, the NRT is considering setting an ASO date a few years after the introduction of DTTB services. In this phase of the roadmap it may be necessary to start preparing this ASO process. Hence the objective of this phase may also include the completion of these preparations.

Inputs

The input data for this phase are:

- The DTTB policies. Based on these DTTB policies the NRT can formulate in detail their policy on consumer support as well as their communications on licensing and other regulations. For example in the case a customer call centre will be put into operations, the support messages/information and processes need to be detailed, as well as the training and staffing of these centres. It is important to note that a close cooperation between network and service providers, as well as the retail industry will be required, as to collect update to date information on for example network deployment, service availability and nearest installation support and retail outlets.

- Network agreements and licence terms and conditions. After having their network licences assigned and agreeing their network contracts, the network licensees can start planning their network deployment. In their license terms and conditions they will find the necessary inputs like the set of frequencies they can utilize, the network coverage and roll-out obligations as well as other service level requirements. The network contracts will determine the number, type of services, network capacity and facilities they will have to deploy.
- Market data and additional DTTB policies. Market data will be collected on the update of DTTB services. Especially the number of sold/delivered DTTB receivers (including STBs, IDTVs and other receivers like in-car or UBS keys integrated receivers), the viewing numbers per DTTB service (like market share and number of viewers) and DTTB advertising revenues (and other sources of income) will be important market indicators to collect and analyse. Based on this collected data and any additional DTTB policies formulated during the introduction of DTTB services, the NRT may considering setting an early ASO date. Depending on such an early ASO date the ASO preparations can start.
- Detailed coverage presentations. Detailed coverage presentation and associated information (for example a database at address level with information on the number of DTTB service available and their signal quality) will be necessary for any support information and process, whether their allocated at the network, service provider or the government/regulator.

Outputs

This phase will have the following outputs:

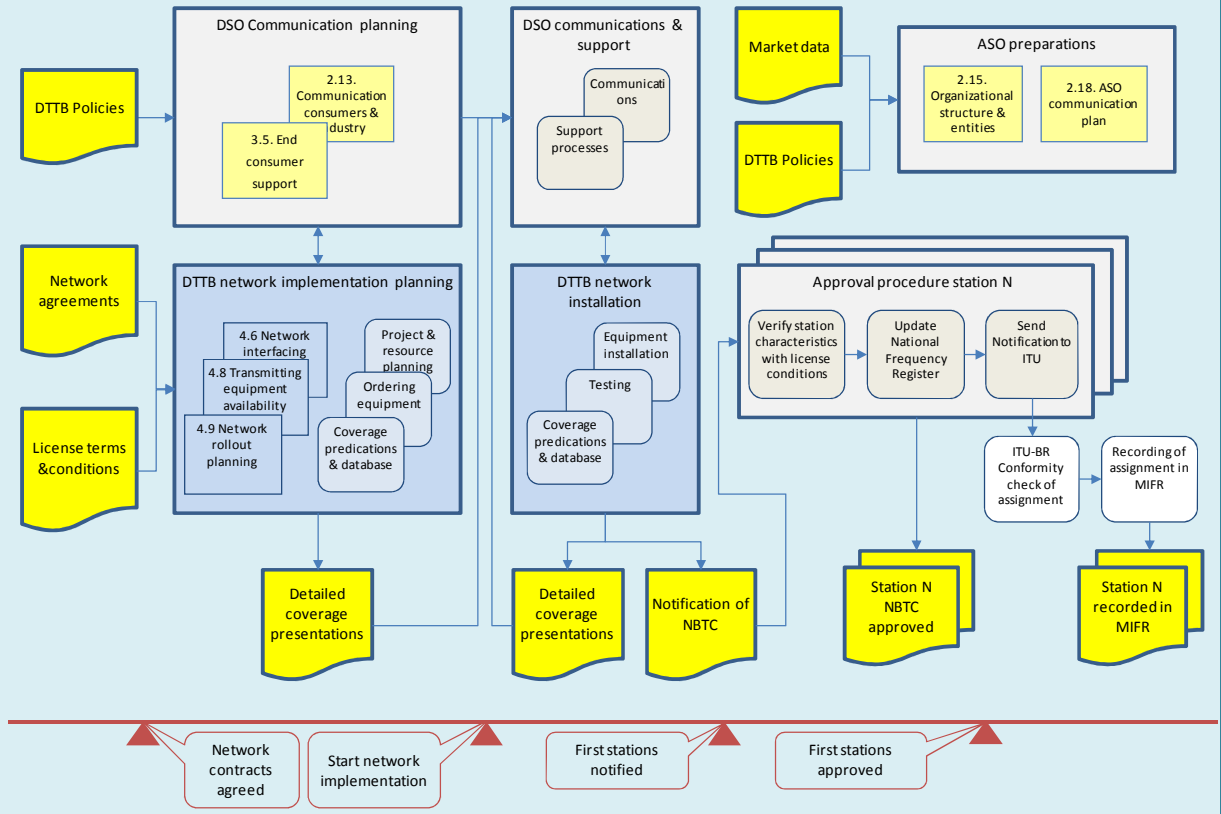
- Detailed coverage presentations. The above mentioned detailed coverage presentations and information will have to made available by the network licensees as they plan and deploy the networks. Hence they will have the most up-to-date and accurate information on the deployment of the services. It is common practice that this information is continuously update and exchanged as the network deployment progresses.
- Notification of the NBTC. Notifications should be submitted to the NBTC when a DTTB transmitter site has been fully installed and is ready to be taken into operations. Moreover the network licensees should inform the NBTC continuously on the progress of their network deployment as to monitor compliancy with the network roll-out obligations.
- Approval by NBTC of the stations. After having checked whether the transmitter station is compliant with the network license terms and conditions NBTC will provide an official approval.
- Recording of the assignment (i.e. station) in the Master International Frequency Register (MIFR). In turn the NBTC will notify the ITU (i.e. Radiocommunication Bureau) of the new DTTB station taken into operation. The ITU will check the station's conformity and will, after approval, record the station/assignment in the MIFR.

Roadmap

The roadmap of the DSO communication and supervision phase and the associated functional building blocks and activities are shown in Figure 3.13. It is noted that the top half, as well as the station approval activities, are in scope of this roadmap. This selection depicts the activities to be carried out by the NRT (i.e. the yellow shaded functional building blocks and the grey shaded activities). The remaining functional building blocks and activities are to be carried out by the network licensees and the ITU (the blue shared blocks and the white activities).

The decisions taken, partly taken and not yet taken on the key topic and choices regarding the yellow shade functional building blocks of Phase 4 of the roadmap and the activities required to prepare the decisions that are still pending, are indicated in Annex 3.

Figure 3.13: DSO communications and supervision phase of the roadmap



Source: ITU

As Figure 3.13 shows, the following activities are included in the fourth phase of the roadmap:

1. DSO communications planning (functional building blocks 2.13 and 3.5). The DSO communications are twofold:

    a. Communications for informing the broadcasting industry and general public on the DTTB policies, licensing terms and conditions, procedures and planning. This process is in essence no different from other policies and regulations the NBTC publishes in other fields (like radio or mobile communications). Although consistency checks should be made that the information provided is balanced, transparent, timely and equally available to interested parties. Also some DTTB specific communication issues may need to be addressed. In Section 2.13 of the ITU Guidelines guidance can be found.

    b. Communications and support addressing (potential) DTTB viewers. Depending on the defined scope of the NRT responsibility in helping viewers, the NRT has to prepare the DSO communications and support. The most evident support would be to help viewers finding the right digital offer (not necessarily the DTTB offer) and how to get access to these services, as well as resolving problems receiving DTTB services. As indicated in the ITU Guidelines (see Section 3.5.3) the most commonly applied methods for offering service availability checks to viewers are SMS-messaging over mobile networks and the Internet/website.

2. DSO communications and support. This step entails the actual execution of the communication and support plans. As long as the scope of the NRT's responsibilities are not defined yet, the activities in this step could range from providing installation support, financial support, impartial information on digital television service, website and call centre support operations. It should be note however that in all cases a close cooperation is necessary with the network, service licensees and the retail industry.
3. DTTB network implementation planning (functional building blocks 4.6, 4.8 and 4.9). Although not in scope of this roadmap, a brief overview is provided what these decisions and activities include. It is important to have a shared understanding of this process as the NRT will be dependent on accurate information on the network deployment and the associated coverage presentations. Developing the network implementation planning entails a large amount of work and the functional building blocks of the ITU Guidelines cover an important part of this work but not all. The ITU Guidelines blocks cover the actual design and implementation of the network infrastructure ranging from the head-end(s), distribution network, transmitter sites, monitoring system and all interfaces of this infrastructure. For developing and executing a DTTB network implementation planning other critical activities will have to be incorporated in the planning, including:
    a. Project management. This includes the project structure and resources, budget management and reporting and progress reporting.
    b. Site acquisition. Although an important part of the transmitter sites are already present, new sites may have to be acquired for completing the network. This may entail long preparations (e.g. meeting/negotiations with local councils, land owners, public hearings, etc.).
    c. Equipment ordering. network equipment ordering is not an off-the-shelve ordering process. Manufacturers tend not to keep transmitters at stock. Production times are lengthily (i.e. 3-6 months and beyond). Also the testing and acceptance procedures take several stages (for example, in-factory testing, on-site testing and end-to-end testing).
4. DTTB network installation. An important part of the installation process is managing the available resources. Especially if the network licence terms and conditions stipulates a rapid network roll-out in large phases (i.e. with many transmitter sites to be switched on), the installation capacity should be well managed. In case the installation process is outsourced to the supplier/manufacturer, this capacity planning will be part of the equipment ordering process. It should also be considered that network licensees will be just established[15] and not all people and processes might be fully in place and hence capacity might initially be limited. The network licensee supplier might be able to help out here and speed up the network implementation.
5. Station approval. Upon receiving the network licensee's request to take a station into operations the NBTC will check the station's compliancy with network license terms and conditions. If all licence terms and conditions have been met (if necessary after NBTC instructions to change the station characteristics), the NBTC will issue an official approval to take the station into operation. NBTC will then update its National Frequency Register and will notify the ITU-BR of the new DTTB station.

[15] Although network licensees may already carry out network operations (for example the incumbent analogue terrestrial broadcasters), it is likely that they will have to reorganize their network operations function as to comply to accounting separations rules and to incorporate the necessary skills to design and deploy a digital broadcasting network.

6. Recording of the assignment in the MIFR. The recording of a frequency assignment in the Master Register is preceded by various checks (done by ITU-BR):
    a. Conformity with the Table of Frequency Allocations and the other provisions of the Radio Regulations (regulatory examination); this examination consists in checking that the assignment (frequency, class of station, notified bandwidth) does indeed correspond to an allocation in the Table of Frequency Allocations in Article 5.
    b. Conformity with the procedures relating to coordination with other administrations applicable to the radiocommunication service and the frequency band concerned.
    c. Conformity with a world or regional allotment or assignment plan and the associated provisions (such as the GE06). For Thailand this conformity check does not apply because such a regional allotment or assignment plan is not in place.

4. Considerations on the five most critical key topics and choices

In this section the five most critical key topics and choices, is discussed in more detail. The order of addressing the topics in this section does not express their level of priority or importance. The planning of these topics is indicated in the roadmap (see Section 3).

Please note that some of the five most critical key topics and choices not necessarily correspond to the complete scope as addressed in the functional building blocks of the ITU Guidelines.

Table 4.1 provides an overview of the five most critical key topics and choices.

Table 4.1: Five most critical key topics and choices

#	Topic	Part functional building block
1	Licensing framework	2.2
2	ASO date and model	2.14, 2.16
3	Customer proposition	3.2
4	Frequency plan	2.4, 2.10, 4.3
5	Network architecture	4.2

4.1 Licensing framework

In Figure 3.6 of this report, the licensing framework is illustrated. As can be concluded from this figure this framework is a variant of Model B[16], whereby more than one network provider will serve the various service licensees (i.e. broadcasters and/or service providers). Some modifications or further decision taking will be necessary to increase effectiveness and reduce operational risks. The following aspects of the current licensing framework are identified:

1. risk of deadlock situations;
2. number of network licensees;
3. definition of the scope of (legal) responsibilities;
4. complexity of the auction and tendering process.

[16] See ITU Guidelines, Section 2.2, pp 23-34.

4.1.1 Risk of deadlock situations

As indicated in the Section 3.4.4, in free negotiations the service providers will contract a network provider for distributing their service over the DTTB network. However as long as the network provider does not know its actual number of contracted service licensees and the type of services they would like to acquire (for example regional insertion), the network provider will not be able to provide final prices. Final pricing will be greatly dependent on sharing the common costs between contracted clients[17]. In turn these final prices are needed for service licensees to select their network provider.

A similar deadlock risks could arise between the network licensees negotiating a contract with facility providers. For example a facility provider offering mast capacity can share the common costs (for example the investment costs in design and constructing the tower) between several clients. Hence the cost per client can fall significantly if the number of clients increases.

It was already noted in Section 3.4.4 that this risks for a deadlock situation is also dependent on the pricing regulations put in place by the regulator (i.e. the Open network Provisioning rules). Pricing regimes whereby the providers has to publish its prices for several utilizations rates (i.e. number of clients) may reduce the risk of deadlocks. It is also observed that the degree in which the negotiations are 'free' may be further reduced by the various network licence terms and conditions there may exist. For example some network licences may include must-carry conditions (for the six incumbent analogue television broadcasters) or stipulations to provide regional or local distribution. In this way the number of network providers the service licensees can select will be reduced.

When the complete set of licence terms and conditions are defined (for both the network and service licences) and a firm decision is taken on the number of network licensees (see next section), the risks of deadlocks can be assessed fully and counter measures can be defined. If the number of network licensees is reduced, evidently the degrees of freedom go down too.

4.1.2 Number of network licensees

Multiple network providers may lead to significant inefficiencies as operational and capital expenditures (Opex and Capex) will increase, as compared to a situation with one single network provider.

Before addressing these inefficiencies, it is important to indicate that whether these inefficiencies are significantly depend on the earning capacity of the industry to carry these inefficiencies. In Section 3.4.2, it was already mentioned that market research data should be made available covering the television advertising market, as well as other sources of income. In the analysis of this data it should be clarified what *additional* income (and costs) will result from the introduction of DTTB services in the Thailand television market.

Opex inefficiencies

With multiple network providers inefficiencies will arise from having multiple operational and maintenance organizations. The total amount of Opex of all network providers will increase as compared to having one single operational and maintenance organization. The most evident areas of these increases are:

- Management overhead. Management overhead costs include items like staffing costs for operational line management, Human Resource management, administration and contract management. These costs barely increase by an increasing size of the network operations (i.e. the number of DTTB networks/multiplexes) and are basically duplicated by each additional

[17] Common costs of a DTTB network service include for example tower infrastructure, antenna systems, redundancy and housing facilities, as well as management and maintenance staff.

network provider. By collecting benchmark figures from other DTTB network operators abroad an indication of the costs (and hence the inefficiencies) can be obtained.

- Maintenance staff and training. Maintaining a broadcast network will require maintenance/operational staff in the network operating centre (NOC) and in the field (located across the country/network). In Thailand the multiplex function is also included in the network provider function and hence the NOC will also monitor the operations of the multiplex centre, next to monitoring the transmitter network. Both at the NOCs and the on-site operations staff will be duplicated if multiple network providers will maintain in total the same amount of broadcasting infrastructure (i.e. the total number of networks/multiplexes). The associated cost inefficiencies can be significant. Even more so when on-site staff is required as supply lines (of spare parts) are too long and centralizing of field engineers is not possible[18]. In addition, the schooling and training efforts to bring maintenance and operational staff up to speed with managing digital networks will be duplicated too. Experience in the past has shown that this effort is considerable as the involved technology is fundamentally different from the applied analogue technology.
- (2nd line) Maintenance contracts. Suppliers of DTTB equipment will provide second line support and this will be agreed with the network providers in a maintenance contract. These contracts have a large amount of fixed costs associated to them, as the supplier will have to arrange for a stand-by operation (the size of this stand-by operation is independent from the number of incident tickets or change requests). The duplication of these costs may be minimized by having the different network providers working together in ordering these maintenance contracts. Evidently this will require that they will have to cooperate in ordering the same equipment too. This will raise the issue how they can differentiate from competing providers and whether real competition can take place. It may even result in anti-competitive behaviour and obstructing the ONP regulations.

Capex inefficiencies

Having multiple network providers may also result in Capex duplications. The most evident areas of Capex inefficiencies are:

- Redundancy facilities. It is common that network providers deliver their services with agreed service levels, including network or service availability figures[19]. Apart from having maintenance staff ready to resolve service interrupts, the network provider will invest in redundant equipment, such as installing back-up encoders, multiplexers, distribution platforms, power supplies and transmitters. Depending on the number of network providers these inefficiencies can be significant. A simple illustration is the on-site transmitter configuration. In the case of having one single network provider, operating five multiplexes, the configuration is likely to be a 5+1 transmitter configuration at each site. One transmitter as back-up for each set of 5 operational transmitters. In a situation of having two network providers, operating 2 and 3 multiplexes, the configurations will look like 2+1 and 3+1 at each transmitter site. With a national network of 41 transmitter sites the inefficiency in this simple example is already 41 additional transmitters.

[18] For example, in the network licence conditions arrangements may be included for maximizing down-time after a service interrupt or delivering average service availability (in percentage of time). The latter is far more complicated in DTTB networks than in analogue transmitter networks as the same DTTB transmitter/antenna system will carry multiple services and a central multiplex centre is included in the service availability figure.

[19] See footnote 18.

- Multiple housing facilities. Although with having multiple network providers the number of encoders and multiplexes in the multiplex centres does not increase, the number of housing facilities does increase. The requirements for the multiplex centre housing facilities are very often demanding and of a high standard. The multiplex centre is the most critical part of the DTTB network, because a multiplex centre failure (for example due to fire) will bring down all services. No-break power supplies and automatic fire extinguishers are often part of the housing facilities. All the investments in these facilities will be duplicated when the number of network providers doubles.
- Multiple (parts of) network distribution facilities. Depending on the network licence conditions and/or qualifying criteria in the tender procedure[20], dedicated distribution networks (delivering the transport streams at the transmitter sites across the country) will also be duplicated, in the situation of having multiple network providers. These inefficiencies can be reduced by having different network providers working together in ordering these distribution facilities. Again this will raise the issue how they can differentiate from competing providers and whether real competition can take place. It may even result in anti-competitive behaviour and obstructing the ONP regulations.

Balancing against on-platform competition gains

After quantifying the above described inefficiencies and the additional DTTB earning capacity, these results should be balanced against the 'on-platform' competitions gains. In economic terms, having multiple network providers make sense if such a situation will result in competition gains as they differentiate themselves (i.e. the service licensees will get real choice) and will bring down prices (i.e. competition will force the providers to offer the lowest prices).

In a first qualitative assessment of these gains, these gains seem limited because:

1. Network providers will have to comply with terms and conditions laid down in their licences and these are likely to include service availability, network coverage and reception quality levels. These are typical service features network providers use to differentiate them from competitors. In the current licensing framework these options do not exist or are at best marginal.
2. Pressure to offer the lowest price does not only come from direct on-platform competitors but also from other platform providers. In Thailand all broadcasters are already on satellite. Setting a (unfair) high price for DTTB distribution will have immediate consequences for any DTTB network provider, even in the case of having only one single DTTB network provider. The relevant market spans across all platforms and not only one platform. In addition, as Figure 3.6 shows, the network pricing will be regulated and unfair pricing is excluded.

Not only economic considerations will come into play when deciding the number of network providers. As indicated before all incumbent analogue television broadcasters have expressed their ambitions in applying for a network licence, very often driven by a desire to secure and continue their operations. Limiting the number of network licences will imply turning down one or more applicants. This may hamper the cooperation of the incumbent operators which is very much needed in a smooth DSO.

[20] It is considered to stipulate in the network licence or in the qualifying tender criteria that dedicated and fully controlled distribution networks should be applied as to ensure network availability. This will exclude the (re)use of DTH satellite distribution ordered and paid for by other entities than the network licensees.

However, the introduction of DTTB may lead to a reconsideration of their core business and may lead to the insight that cost savings can be obtain from having a single network provider. In other countries this insight arose and broadcasters grasped this cost saving opportunity, resulting in them having more money available for producing television content.

It is noted here that there are clear signals in the market that the incumbent broadcasters are willing to share network operations as they have started to form consortia to bid for the network licences. The regulator can generate further trust in limiting the number of providers by ensuring the independent nature of the network provider. By allowing broadcaster equity holdings in the network provider the independent nature of the provider can be further materialized.

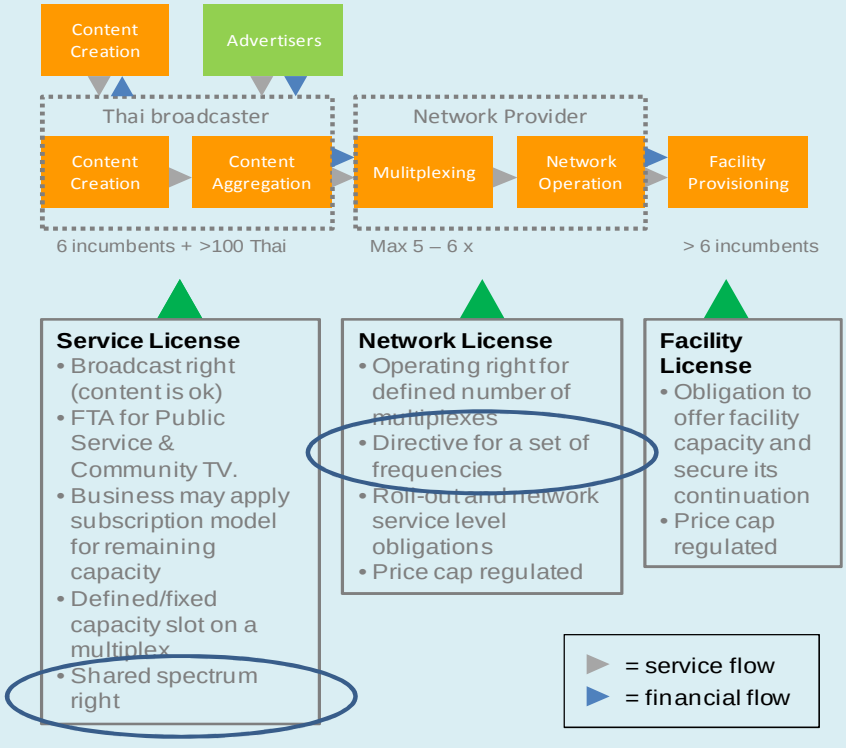
4.1.3 Definition of the scope of (legal) responsibilities

In the current licensing framework, the spectrum rights are assigned to the service licensee (as stipulated in the Broadcasting Business Act). These spectrum rights are shared between the broadcasters as in each service licence only a defined capacity slot on *a* multiplex is assigned to the broadcaster. As several broadcasters will utilize the capacity of one single multiplex the actual spectrum rights (i.e. the right to use certain frequencies in a defined area) are shared between them.

Network licensees receive a NBTC directive stipulating which set of frequencies should be applied in their DTTB network(s). Consequently, only after the service licensees contracting the network providers these shared frequencies rights are exactly known in terms of frequency numbers. As said before broadcasters are free to select their network provider.

In Figure 4.1 this shared spectrum right and distributed stipulations are illustrated.

Figure 4.1: Licensing Framework with distributed frequencies rights and stipulations



Source: ITU

The above illustrated licensing framework will require special attention in formulating the licensees responsibilities. Special attention is needed in case of causing unwanted/harmful interferences. This should be addressed at national and international level. Unwanted interferences may lead to damages and compensation claims. The licensing framework should be tested for such cases and whether the legal responsibilities are unambiguous. Also at an international level foreign administrations will address the NBTC in resolving harmful interference. In turn it should be clear for the NBTC which legal entity is responsible for resolving matters.

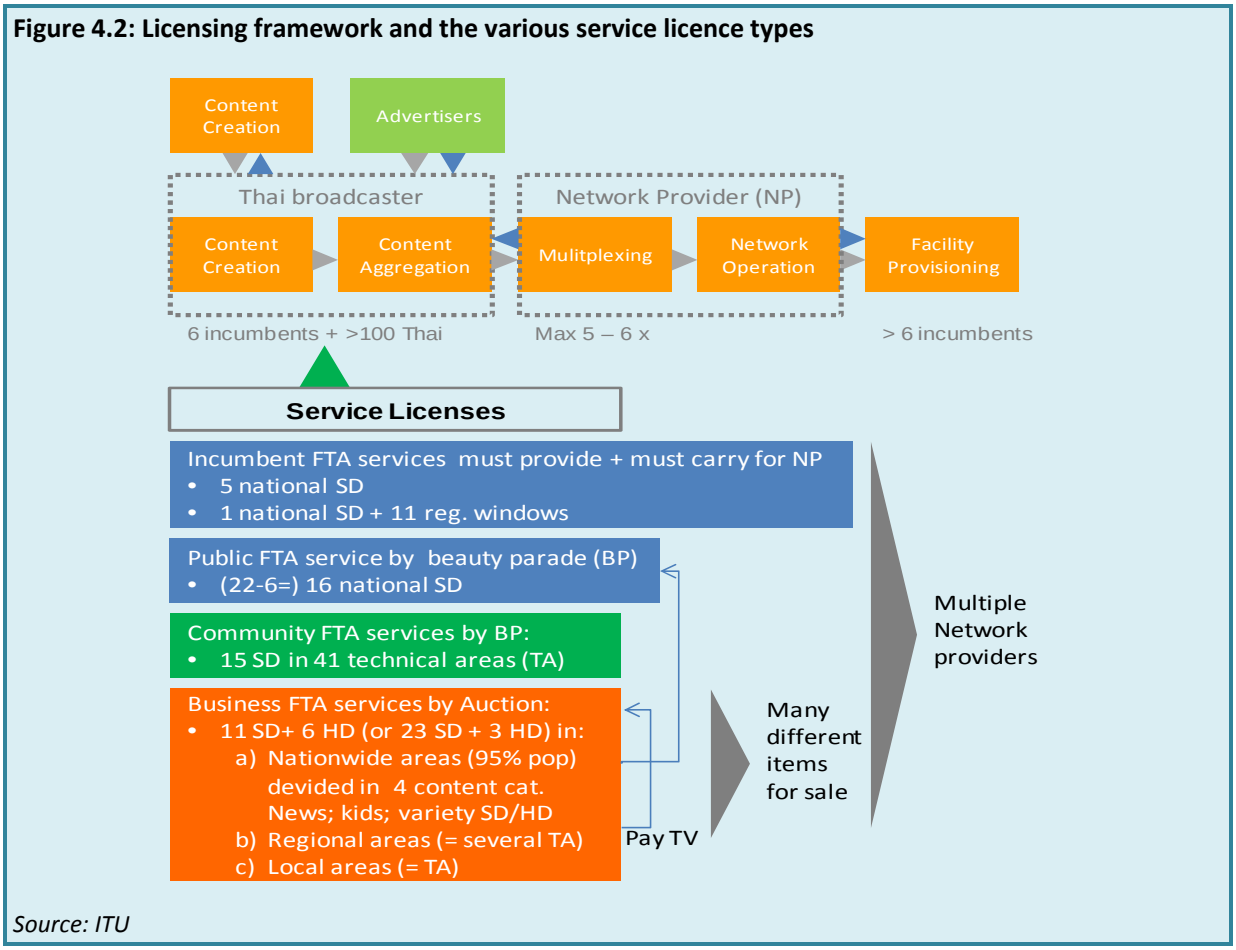
From Figure 4.1 it can also be observed that facility providers have the obligation to offer facility capacity (as is stipulated in the Broadcasting Business Act) which is price regulated. It is commonly understood that this will cover offering mast capacity. Less common is sharing of antenna (system) capacity. As described in the current situation (see Section 2), Thailand PBS has recently deployed an UHF network with antenna systems having spare capacity for DTTB transmitters. It is therefore likely that network licensees would like to make use of these antenna systems.

Experience has shown that antenna sharing is not easily regulated and debate can arise whether 'site sharing' like stipulations apply. Hence it is advised to make these responsibilities of antenna sharing explicit. Also price regulations may become complex and take considerable time. For example the antenna design costs, the antenna life, antenna combiner costs and the acceptable margins can result in long discussions. From an international perspective antenna sharing is rare and no commonly accepted (accounting) practices have been established yet.

4.1.4 Complexity of the auction and tendering process

Figure 4.2 illustrates the licensing framework in combination with the different service licence types.

Figure 4.2: Licensing framework and the various service licence types



Source: ITU

Figure 4.2 also illustrates two feedback loops. These loops can occur if:

1. Regional/local business service licences are not assigned (in the first round auction) and are brought back into a second auction for national business service but now with the possibility to offer subscription or pay-tv based services.
2. National (pay-tv) business service licences are not assigned in the second-round auction and are brought back into the pool available for national public services. As indicated in Section 3.4.3, these remaining business service licences will be assigned to the 'second-best' applicants on the ranking list.

Figure 4.2 also illustrates that the business service licences are divided in three sub categories; national, regional and local licences. Furthermore the national business service licences are further divided into several content categories. With these content categories the regulator wishes to regulate the type of programming offered (like programming mainly addressing children or delivering news).

With these many different licence types to be assigned in different assignment procedures, the complexity of the procedure design needs to be carefully assessed. Especially considering that a significant number of licences will be assigned by means of auctions. As well as that some licences may not be assigned in a single round but may be changed (from FTA to pay-tv) and brought back into a second-round auction or public tender (i.e. assigned to the 'second-best' applicants on the ranking list). Such a system will make the assignment procedures interdependent and the testing will need to be thorough to avoid unwanted results and counter act collusion.

More specifically, bringing in different licence types into a single auction procedure will raise special auction design issues, including:

1. Definition of rounds. Single or multiple rounds and/or simultaneous bidding or not.
2. Aggregation rules. The maximum number and type of licences a single bidder may aggregate in a single procedure or in multiple procedures.
3. Combinatorial bidding and valid bid increments. The valuing of combined bids against single item/licence bids and their increments.
4. Stopping rules. When is the auction considered to be terminated when certain licences are 'dead' but others still 'alive'.

With having these different licence types and also multiple network providers, the network contracting may become complex and long. Hence it is advised to reduce complexity as to keep the licensing procedures manageable and their results predictable. For example it could be considered to eliminate the option of having a separate subscription based (pay-tv) television licence. Also the different content types within the national business service sub category could be reconsidered. It could be argued that specific content requirement, like at a programming level, should be addressed in the domain of public service Broadcasting (PSB). Typically through PSB programme requirements the regulator ensures the universal availability of specifically desired content.

4.2 ASO date and model

In Section 3.4.3 it was indicated that an initial choice for the ASO model and planning is wished for. This choice was needed to be able to carry out the service planning. In Section 3.4.5 and other sections it was also described that the NRT has not set an ASO date yet.

For example this could imply that setting an ASO date could last more than four years from the moment of assigning the network licences. The roll-out obligations stipulate a complete deployment of the network after four years of acquiring the network licence. Although DTTB services will be introduced, uncertainty will remain in the market about when the analogue service will be terminated. This approach may bring the following disadvantages:

1. Reduce the 'window of opportunity' for DTTB. An early ASO date (i.e. closely following the introduction date of DTTB services) will provide an import driver for viewers to migrate to DTTB. Experiences in other countries have shown that viewers will leave the decision to purchase a receiver to the very last moment. The absence of a clear switch-off date will remove an important incentive for viewers to switch. A reduction of the 'window of opportunity' will come with the following consequences:
    a. The DTTB platform will be marginalized as the uptake of satellite and cable will continue in its current rapid pace;
    b. Consequently the regulatory 'grip' on the television market will be significantly reduced. Especially satellite distribution can easily escape the reach of the regular and content can be hardly controlled;
    c. Early Warning System (EWS) reach will be limited as viewers will not have a DTTB receiver (but a satellite or cable receiver). It should be noted anyway that the EWS based on the DTTB networks will never cover the entire population. It may be necessary to consider additional measures to ensure such a nationwide coverage.
2. Reduce clarity about the continuation of analogue television services and the future of the DTTB market (for example the availability of additional multiplexes after ASO) for Incumbent broadcasters, service licensees, network licensees, equipment suppliers and viewers. Incumbent broadcasters will remain uncertain about their (dis-)investments in their analogue network. Service and network licensees will remain uncertain about future competitors/clients and hence their future earning capacity. The latter group, the viewers, will lose attention after a while and when commencing the ASO process this attention will have to be build up again which may entail significant costs.
3. Increase Simulcast costs. A late ASO date will evidently increase simulcast costs for the incumbent broadcasters. They will broadcast the same content on both the analogue and digital broadcasting infrastructure for a longer period. Also in the case these cost will not be compensated for by government, it remains a concern for the regulator. High simulcast costs will leave less financial means for the incumbent broadcasters to promote the uptake of DTTB services (for example to produce additional programming for services on the DTTB platform).

The abovementioned disadvantages should be balanced against the advantages of postponing setting an ASO date. Advantages of postponing include:

1. Market absorbing the DTTB receiver costs. If the NRT does not set an ASO date the responsibility for resolving the problem of forcing viewers to purchase a receiver falls away. In this case it is the market to resume responsibility for overcoming this problem. The possibility of the market (either the industry or the viewer) absorbing the purchasing and distribution of DTTB receivers, depends also on the licensing regime imposed on the market. As indicated in Section 3.4.3, the NRT is contemplating stipulating a minimum number of DTTB receivers to be supplied by the licensees[21]. Under such a licensing regime a significant part of the receiver costs may be transferred to the market. It remains to be seen what the market would like to see in return for such an effort, let alone whether they can actually carry such a commitment.

[21] In such a case it should be determined to which licensees and in what way these stipulations apply. It may be evident that the network licensees should have this obligation. However they are dependent on good programming and services of the network licensees. An attractive DTTB platform increases the willingness to pay for receivers under viewers. Also the aspect of free riders should be addressed in case of more than one network licensee.

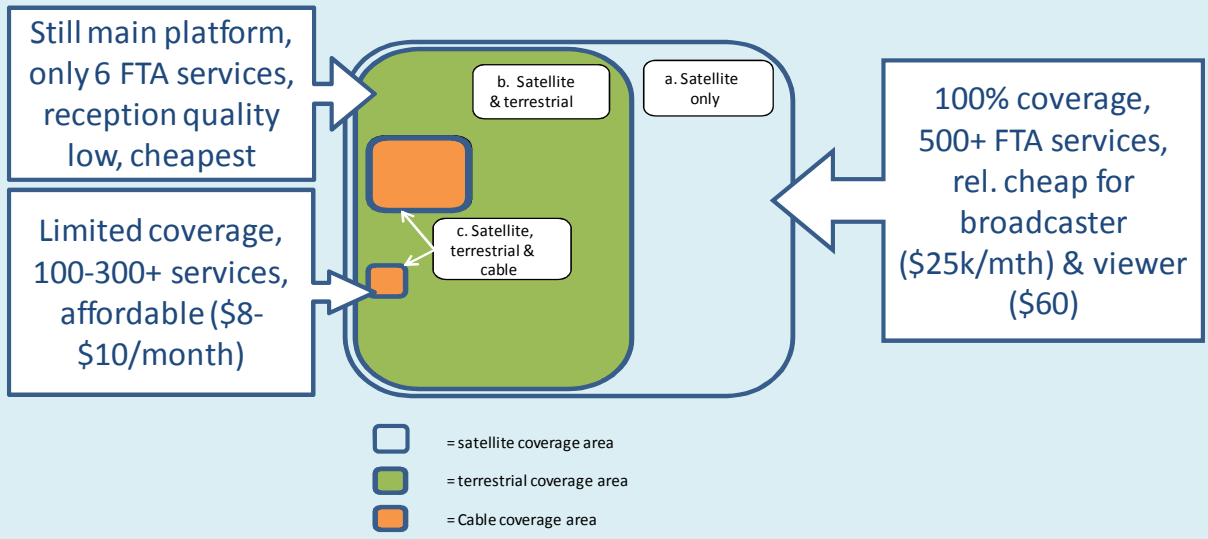
2. Revoking spectrum rights. An early ASO date before the date that the concessions of Channel 7 and 3 terminate, may imply revoking spectrum rights. Hence their compensation claims for disinvestments should be considered.

4.3 Customer proposition

In the ITU Guidelines (functional building block 3.2) the customer proposition is being addressed from a commercial perspective. However the competitive advantage of the DTTB offering will be of equal importance to the DSO process. In any DSO process, the actual attractiveness of the DTTB platform will for a large part determine the success of the DSO operation and the NRT should carefully consider this aspect.

In Section 2.1 an overview of the Thailand television market is provided. Based on Figure 2.1 in this section it can be observed that the Thailand market includes three principle television reception situations. These situations are depicted in Figure 4.3.

Figure 4.3: Different reception situations in Thailand



Source: ITU

Considering that the DTTB network will be deployed in the same coverage areas of the current analogue networks (see Section 2.4 DSO objectives), it can be derived from Figure 4.3 that the DTTB service offering will compete on two basic markets (i.e. it will not compete in the area indicated with the letter 'a' in Figure 4.3):

1. Satellite served areas (indicated with 'b' in Figure 4.3). In these areas analogue terrestrial viewers will compare its current analogue offering (for a large percentage of viewers this offering includes 4 to 6 services[22]) with the costs of switching to satellite or DTTB and the services they will get on the respective platforms (i.e. satellite offers over 500 FTA services and

[22] As Figure 2.1 illustrates the network coverage areas differ between the six incumbent analogue broadcasters. Hence there are areas in Thailand where not the all 6 services are available. As indicated the analogue coverage of the various networks should be calculated to gain insight into these detailed reception situations.

DTTB will offer between 50 to 65 services). The cost comparing entails considering the purchasing costs for a Satellite STB and dish (approximately USD 60 to USD 100) with the DTTB STB (approximately USD 25 to USD 30) and antenna costs (approximately USD 10). For some satellite offerings (e.g. True) the monthly subscription fees should also be considered by the viewer;

2. Cable served areas (situation c). As the footprint of satellite covers the whole of Thailand these cable served areas are also served by satellite. In these areas people will have to decide between the DTTB, the analogue and digital cable offering, as well as the satellite offering. Cleary the advantage of analogue cable is that no STB is needed. For digital cable the price of the STB is included in the monthly charges (USD 10/month rather than USD8/month). In terms of number of services the cable offering is still significantly larger than the DTTB offering (ranging between 100 and over 300 services).

4.3.1 Satellite served areas

The ITU Guidelines (see Section 3.2.1) identifies six competitive advantage categories. Applying these categories to the satellite served areas in Thailand results in the following considerations:

1. *Interactivity/enhanced television services*: the DTTB platform could offer interactive service as a competitive edge. However without any return path, these interactive services are limited to services like the electronic programme guide (EPG), additional programme information and enhanced teletext. Recent market developments show that (mass produced) receivers come available with return path capabilities, such integrated IPTV/DTTB set-top-boxes. But these boxes are relatively expensive and this may be in conflict with having a low cost receiver;

2. *Additional Pay-TV platform/conditional access and billing facilities*: as DTTB platforms can easily be equipped with conditional access and billing facilities, it could provide service providers/broadcasters a platform to launch pay-tv services, such as tiered television packages, pay-per-view offerings and pre-paid facilities. It should be noted that even in the case of a combined pay-tv/FTA offering the possibilities of offering tiered television packages is relatively limited on a DTTB platform (even with 6 multiplexes), let alone the cost consequences for content production. Satellite with over 500 services and all most infinite remaining capacity will outperform the DTTB platform, if not now than in the long run;

3. *Additional services/multi-channel offering*: In Thailand the analogue terrestrial television platform offers only a limited set of services (4 to 6 services). The introduction of a multi-channel DTTB offering could be a key demand driver. However in Thailand several DTH satellite service providers offer multi service packages, FTA, against very competitive prices. Per definition the DTTB platform is faced with a lower distribution capacity. This DTTB service attribute will not provide a long lasting competitive edge;

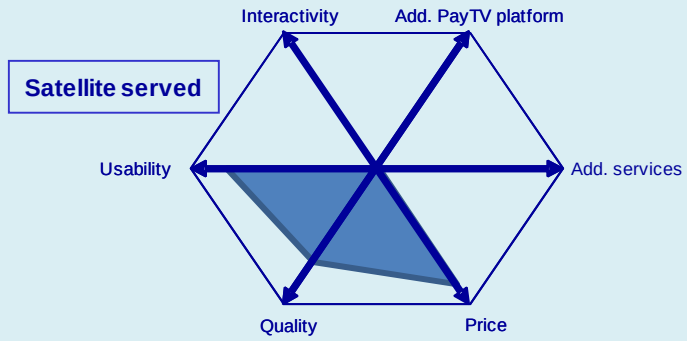
4. *Lower costs (one-off and recurring)*: The DTTB platform in Thailand has the advantage of having lower receiver costs as compared to satellite. DTTB STB retail prices (DVB-T2/MPEG4) are in the range of USD 25 - USD 30. Depending on the existing reception antenna, these costs may go with an additional USD 10 if a new antenna is needed. A satellite reception installation (box and dish) are sold in Thailand between USD 60 and USD 100. Especially one-off costs form a major barrier for consumers to adopt digital television. It should be noted that these DTTB purchasing costs could be even further lowered if the NRT would decide to provide subsidies /vouchers. The recurring cost (e.g. subscription fees) seems no differentiator as both platforms are FTA (except for True);

5. *Picture and reception quality*: The introduction of DTTB could entail for many viewers a significantly better picture quality. Most terrestrial viewers have an indoor reception installation (the so called 'rabbit ears') or band III rooftop antenna[23]. Due these reception installations viewers will have distorted reception and picture quality. Satellite viewers suffer distorted reception at times of heavy rain fall - regular event during the raining season. Hence this attribute could provide a competitive edge for DTTB;

6. *Usability/Portability*: DTTB services are wireless and can be received on compact receivers. DTTB services have the competitive advantage of portability, especially when the receiver comes with a small antenna. In Thailand DTTB can deliver better coverage and in more places of the home. This only under the provision that marketing this competitive edge is accompanied by accurate coverage predictions and coverage is defined for areas with a higher level of reception probability.

From the above considerations the following competitive profile of the DTTB platform in satellite serviced areas can be drawn as shown in Figure 4.4.

Figure 4.4: DTTB competitive profile in satellite served areas in Thailand



Source: ITU

4.3.2 Cable served areas

For the cabled areas a different market evaluation can result. As compared to the satellite served areas the following categories can be evaluated *differently*:

1. *Interactivity/enhanced television services*: as described in previous section the DTTB platform could offer interactive service as a competitive edge. However return path capabilities have to be added, increasing the price of the DTTB set-top-boxes. In addition, it remains to be seen whether such an approach will provide a lasting competitive edge as the interactive functionality of cable platforms will outperform the capabilities of DTTB. Market developments in other countries show that cable compete very effectively with service like 'triple play' package (including telephony, Internet and television services) and all forms of Video-on Demand services;

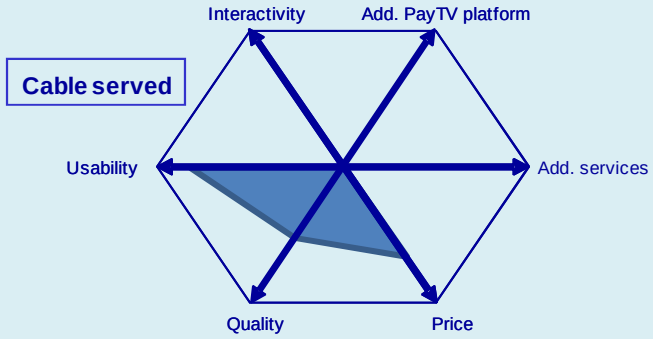
2. *Lower costs (one-off and recurring)*: For analogue cable no STB is needed and hence the one-off costs are significantly lower. If not subsidized the DTTB platform suffers here a competitive disadvantage. However, cable is also quickly migrating to digital and a STB is needed. These STB costs are included in the monthly recurring subscription fees to be paid. Hence for the recurring costs the DTTB platform can have a competitive advantage over cable as DTTB is FTA;

[23] The various reception situations in Thailand still needs to be investigated (see Section 3.4.2).

3. *Picture and reception quality*: For cable subscribers their reference point for picture quality is most likely to be the picture quality of *analogue* cable. DTTB can provide a competitive advantage here if enough capacity is allocated to each service. A better picture quality on the DTTB platform could consist of a more stable picture frame. It is important to note that this not necessarily has to be HDTV. More capacity allocated to each service could result in selecting a less robust transmission modus and hence less coverage per site. It is advised that the NRT has the picture quality investigated of the various cable networks across the country (as part of the market research in the first phase of the roadmap). This research may show that the picture quality on the cable networks tends to be poor. If that is the case picture quality could be a competitive advantage of DTTB even in cabled areas.[24]

From the above considerations the following competitive profile of the DTTB platform in cabled areas can be drawn as shown in Figure 4.5.

Figure 4.5: DTTB competitive profile in cable served areas in Thailand



Source: ITU

If it is concluded that the key competitive advantages of DTTB are price, portable reception and picture quality and not the number of services than it is very important that this conclusion is incorporated in the decision making process of the other functional building blocks. For example, in the service planning (functional building blocks 4.2 to 4.5, see Section 3.4.3) such a competitive DTTB profile will result in allocating available capacity to signal robustness rather than number of services. Also the STB specifications (function building block 3.3, see Section 3.4.2) should result in a low cost DVB-T2 receiver.

4.4 Frequency plan

The aim of a frequency plan is to:

- Provide access to the spectrum to current and planned services;
- Avoid unacceptable interference.

A frequency plan related to the transition from analogue to digital television plans deals with three stages in the VHF and UHF broadcasting bands:

1. The existing analogue TV plan (ATV);

[24] However, if cable evolves to digital quickly, the advantage of DTB, better picture quality, will decrease.

2. A frequency plan for the transition period, when analogue TV services require protection from DTTB transmissions;
3. A frequency plan after analogue switch-off, when only digital TV exits.

During the transition period the analogue TV needs to be protected. This means that the analogue coverage areas are not be reduced due to interference from digital TV transmissions. Depending on the number of analogue TV stations in operation, this requirement limits the number of channels that can be used for digital TV and may also limit the radiated powers of digital transmissions.

Table 4.2 gives an overview of the planning situations in Thailand.

Table 4.2: National TV frequency plan

Stages	Band I and III plan	Band IV/V plan
Existing	• **ATV** • [Non-broadcasting services]	• **ATV** Mobile < 26 and > 60
During transition	• **ATV** • [Non-broadcasting services]	• **ATV** • **DTTB replacing ATV** • **Additional DTTB** • Mobile < 26 and > 60
After ASO	• **DTAB/MTV** • [Non-broadcasting services]	• **DTTB replacing ATV** • **Additional DTTB** • Re-allocation of parts of band to mobile and broadcasting?

In order to avoid unacceptable interference the frequency plans in each band and in each stage should be compatible, not only between the TV stations but also with other services.

The following sections will address the frequency plans in the three stages.

4.4.1 Existing situation (before DTTB introduction)

The analogue TV plan in Thailand contains assignments in VHF (Band I and Band III) and UHF (Band IV and V) related to operational TV stations and planned TV stations. Information on the analogue TV plan is given in Section 2.2.

No information is available on non-broadcasting services in Band I and III, therefore these services are shown between square brackets in Table 4.2.

In UHF mobile services are allocated below 510 MHz above 790 MHz. For that reason the TV channels 21 to 25 and 61 to 69 cannot be used for TV broadcasting.

Attention points regarding the existing analogue TV plan are:

1) Assessment of the current analogue TV coverage areas;
2) Verification of transmitter data.

These points are described below.

1) Assessment of the current analogue TV coverage areas

The analogue TV coverage should be matched by the DTTB coverage (see DSO objectives, Table 2.4). It is therefore necessary to determine the current analogue TV coverage areas in a similar method as for DTTB (including software package, propagation model, terrain and clutter data bases), taking into account the

appropriate minimum field strength values and interference potential from co-channel analogue TV stations.

2) Verification of transmitter data

In order to calculate the current analogue TV coverage areas and to perform compatibility analyses during transition, accurate transmitter station data is needed.

The analogue TV station data of each of the six broadcasters should be verified and be more detailed (such as coordinates, antenna height, ERP and antenna pattern of each site in a town).

4.4.2 During transition

NBTC has developed an initial DTTB plan for the transition period using UHF channels only. The initial plan contains 41 main stations and 140 fill-in transmitters. The channel scheme is shown in Table 4.3.

Table 4.3: DTTB UHF channel groups (source NBTC)

Group								Total/group
D1	28	31	35	39	43	47	51	(7)
D2	26	29	32	36	40	44	48	(7)
D3	27	30	33	37	41	45	49	(7)
D4	34	38	42	46	50	54	57	(7)
D5	52	55	58					(3)
D6	53	56	59					(3)
T-D1	26	30	34	38	42	46	50	(7)
T-D2	28	32	36	40	44	48	52	(7)

The channel scheme has been derived from the analogue TV plan. Channel group T-D1 and T-D2 are used in border areas and reflect the agreement with a neighbouring country on channel use. Channel groups D5 and D6 are spare channel groups, applied in case some channels from the groups D1 to D4 cannot be used at a location for various reasons.

In general, the channels assigned to a station in the analogue TV plan are also assigned to a DTTB station in the same area, excluding the channels of operational analogue TV transmitters in the area. To illustrate the assignment method, Table 4.4 shows the analogue TV and initial DTTB assignments of five main stations. Channel numbers of operational analogue TV stations are shown in light blue shaded cells and printed in bold.

Table 4.4: Comparison of analogue TV plan and initial DTTB plan at some sites

City	Site nr		Channel group	Channels							
Bangkok	ATV	1	U2	26	**29**	**32**	36	40			
	DTTB	1	D2	26			36	40	44	48	
Nakornratchasrima	ATV	9	U3	**27**	30	33	37	**41**			
	DTTB	9	D3		30	33	37		45	49	
Ubon Ratchathani	ATV	12	U3	**27**	**30**	**33**	37	41			
	DTTB	13	D3+D5				37	41	45	48	52
Khonkaen	ATV	15	U2	**26**	**29**	32	36	40			
	DTTB	16	D2			32	36	40	44	48	

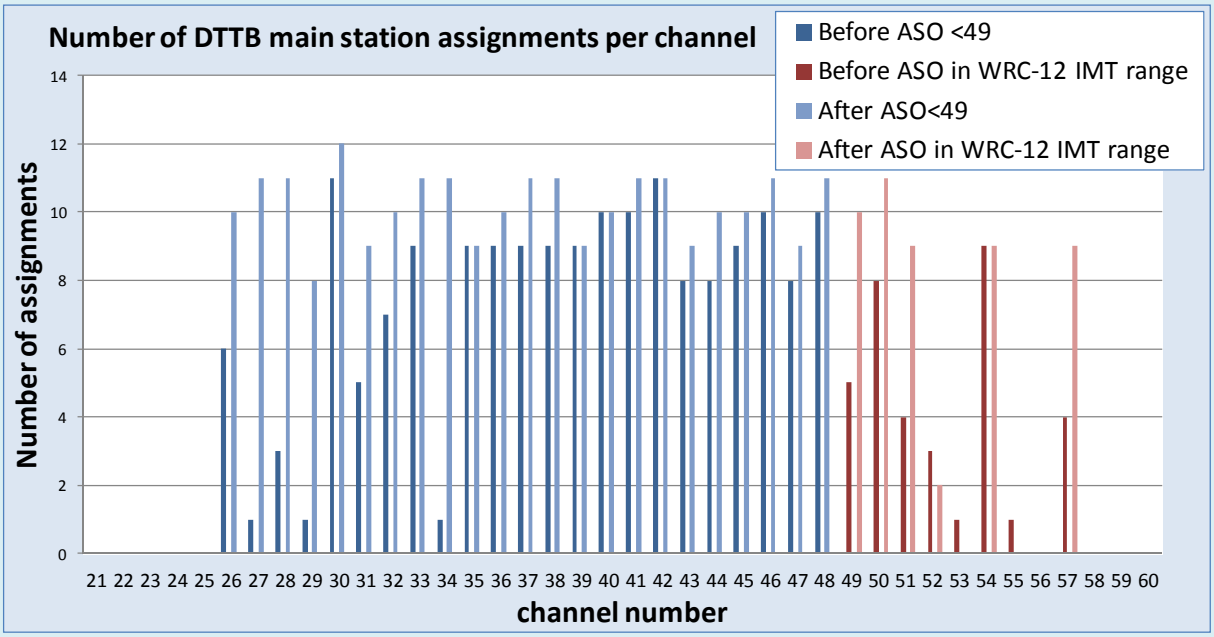
Chiangmai	ATV	19	U4	**34**	**38**	42	46	50	54		
	DTTB	21	D4			42	46	50	54	57	

In the initial DTTB plan five channels have been assigned to each location. Therefore during transition five multiplexes per site can be licensed. In principle more channels per location are possible after ASO when the remaining analogue TV assignments are converted to digital. Licensing of a 6th multiplex is envisaged after ASO. The remaining assignments are considered as spare capacity.

The number of DTTB main station assignments per channel is shown in Figure 4.6. If also the existing analogue assignments are considered (in the figure indicated as DTTB assignment after ASO), channels are in general re-used 8 to 12 times. Exceptions are the channels 52, 53, 55, 56, 58, 59 and 60, mainly from channel groups D5 and D6.

Indicated in red are the assignments of channels above 48, the frequency range that was allocated to International Mobile Telecommunication (IMT) at the WRC-12, subject to confirmation by WRC-15.

Figure 4.6: Number of DTTB main station assignments per channel



Source: ITU

Attention points regarding the frequency plans during transition are:

1) Analogue TV plan during transition;
2) DTTB station characteristics required to match analogue TV coverage
3) Compatibility between the analogue TV and DTTB;
4) Portable indoor coverage;
5) Assignments in channels above 48;
6) Fill-in transmitters;
7) Compatibility of DTTB assignments with non-broadcasting services;
8) DTTB introduction stages;
9) International coordination;
10) Verification of transmitter data.

These attention points are described below and may lead to adjustments to the existing analogue TV plan and initial DTTB plan.

1) Analogue TV plan during transition

NBTC has no intention to license more analogue TV stations than the ones that are in operation now. Therefore the planned but not operational assignments in the analogue TV plan do not require protection from DTTB assignments and should be deleted from the analogue TV plan in the transition stage.

2) Matching analogue TV coverage

One of the DSO objectives is that DTTB coverage should match analogue TV coverage. The optimum set of DTTB transmission characteristics to match analogue TV coverage should be determined by means of the "service trade-off" (see Functional Building Block 4.3). However, some general indications can be given by comparing the required median minimum field strength values of DTTB and analogue TV and difference in propagation loss in UHF and VHF.

An indication of the ERP requirements for matching analogue TV (ATV) coverage in Band III and Band IV by a DTTB transmission from the same site in Band IV and fixed rooftop (FX) reception is shown in Table 4.5. Two DVB-T2 system variants are shown, representing a transmission with a high capacity payload and a very robust transmission.

Table 4.5: DTTB ERP indications for matching analogue TV coverage

DTTB in Band IV	DVB-T2 256 QAM 2/3 - FX	DVB-T2 16 QAM 2/3 - FX
ATV in Band IV	DTTB ERP = ATV ERP (kW) x ≈0.13 (-9 dB)	DTTB ERP =ATV ERP (kW) x ≈0.02 (-17 dB)
ATV in Band III	DTTB ERP = ATV ERP (kW) x ≈3.2 (+5 dB)	DTTB ERP = ATV ERP (kW) x ≈0.5 (-3 dB)
ATV in Band I	DTTB ERP = ATV ERP (kW) x ≈16 (+12 dB)	DTTB ERP =ATV ERP (kW) x ≈2.5 (+4 dB)

From the indications in Table 4.5 it can be concluded that if analogue TV and DTTB are transmitted from the same site:

- It is normally feasible to match analogue TV coverage in Band IV/V with DTTB fixed reception provided that the ERP of the DVB-T2 transmission is at least about 0.13 times the analogue TV ERP;
- It is normally not feasible to match fully ATV coverage in Band III and Band I with DTTB fixed reception and a high capacity payload, unless the ERP of the DVB-T2 transmission is at least about 3 times the analogue TV ERP in Band III and at least about 16 times the analogue TV ERP in Band I.

The DTTB coverage can be improved with a higher ERP (if allowed and technically feasible) or a more robust system variant with a medium or low capacity payload and application of fill-in transmitters.

3) Compatibility between the analogue TV and the DTTB plan

Compatibility between the analogue TV and the digital TV plan should be carefully analysed by using a planning software package. However, some general indications can be given by comparing the protection ratios.

Most of the DTTB assignments in the initial DTTB plan can be considered as conversions from the analogue TV plan (see also Table 4.4). By comparing the analogue TV and digital TV protection ratios, the DTTB ERP can be calculated for the condition that the DTTB assignment does not cause more interference than the analogue assignment it replaces.

An indication of the DTTB ERP requirements of a DTTB assignment replacing an analogue assignment on the same channel and the same site in order to protect analogue TV (ATV) in Band IV/V is shown in Table

4.6. As the value of analogue TV protection ratios depends on the frequency offset difference between two analogue TV transmissions, three offset examples are shown in Table 4.6.

Table 4.6: Indication of DTTB ERP to protect analogue TV in case of converted assignments

Original ATV offset difference	DTTB ERP condition to protect ATV
0	DTTB ERP < ATV ERP x 12.6 (+11 dB)
1/2 line frequency	DTTB ERP < ATV ERP x 0.2 (-7dB)
1/3 line frequency	DTTB ERP < ATV ERP x 0.4 (-4 dB)

From the indications in Table 4.6 it can be concluded that if an analogue assignment is converted to digital, no more interference to analogue TV is caused compared to the situation that the DTTB transmitter was analogue (in any offset condition), if the ERP of the DTTB transmitter is less than 0.2 times the EPR of the analogue assignment it replaces.

The protection of the digital assignment converted from an analogue assignment is considerably better than in the analogue situation because of the low protection ratio for DTTB interfered with by analogue TV. Compared to the analogue situation the interference potential of an analogue TV assignment to the DTTB assignment in a high capacity payload configuration (256 QAM 2/3) reduces with:

- 27.5 dB in case the original analogue TV offset difference was 0;
- 9.5 dB in case the original analogue TV offset difference was 1/2 line offset;
- 12.5 dB in case the original analogue TV offset difference was 1/3 line offset.

It should be noted that the above indicated reductions in interference potential from an analogue assignment to a digital assignment only occurs as long as the interfering analogue assignment is not converted to digital. When two analogue assignments are converted to digital the interference potential may even be higher than in the original analogue situation, depending on the ERP and system variant of the DTTB assignments.

4) Assignments in channels above 48

A world-wide frequency allocation for International Mobile Telecommunications (IMT), on a co-primary basis with broadcasting, in the upper part of the UHF broadcasting band (channels above 48) has been agreed in ITU at WRC-12. Subject to confirmation by the ITU WRC-15, this allocation will become effective in 2015. The allocation will facilitate the introduction of fourth generation (4G) mobile telecommunication services such as LTE.

In many countries there is a great interest in using the frequency range 698-862 MHz (covering the TV channels 49 to 69) for IMT services such as LTE. In Thailand no decision has been taken yet to allocate this band to IMT. However, it cannot be excluded that such a decision is taken within the licence period of the DTTB services.

Figure 4.6 shows that the initial DTTB plan contains 35 assignments with channels above 48. This number represents 17 per cent of the total number of DTTB assignments. If after analogue switch-off the analogue TV assignments are converted to digital, 50 DTTB assignments are on channels above 48.

In case the channels above 48 would be allocated to IMT in the future 17 per cent of the already licensed DTTB assignments would not be available anymore. It was noted that in case the channels above 48 would be allocated to IMT, the reduction of the available spectrum for DTTB could possibly partly be compensated by allocating the channels 21 to 25 (now in use for mobile services) to DTTB.

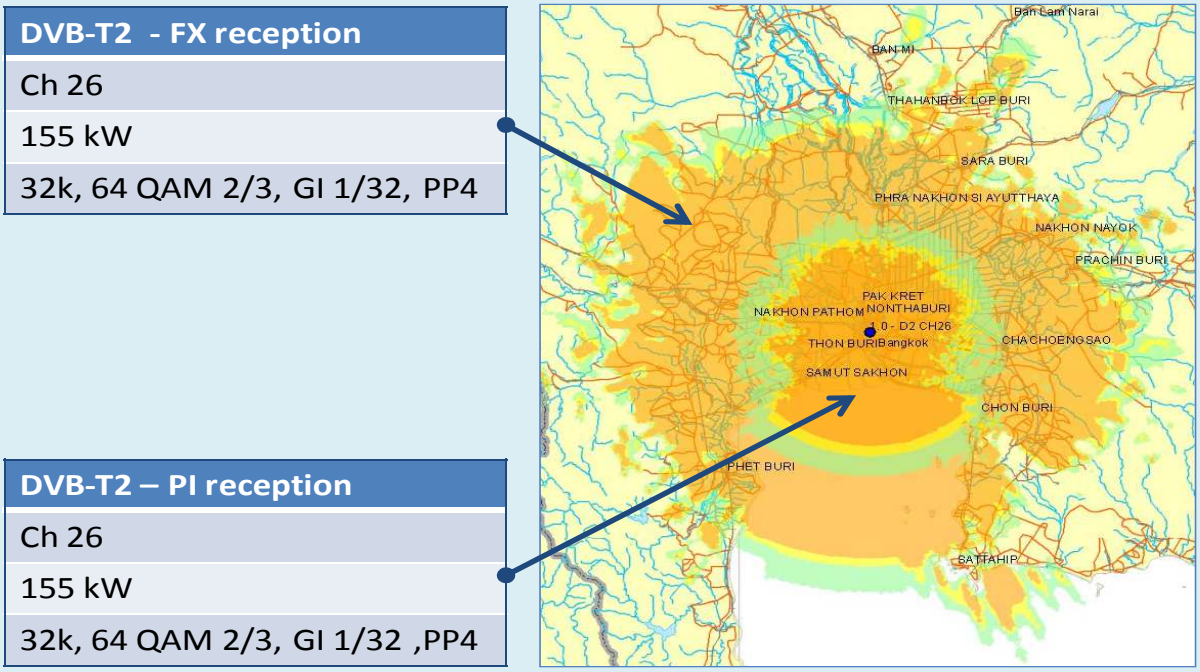
Uncertainties about availability of channels in the licensing procedures should be avoided. Therefore the consequences of re-allocations to mobile services should be investigated before channels are licensed. The initial DTTB plan should be reviewed with the aim to assign five DTTB channels at each site with

channels in the range 26 to 48. The remaining channels could be planned for additional assignments that could be licensed later when decisions have been made on the mobile service re-allocations.

5) Indoor coverage

One of the DSO objectives is portable indoor coverage in about 200 municipalities. It is expected that portable indoor reception is achieved in the municipalities situated near the 41 main stations. This is illustrated by the example in Figure 4.7 showing the DTTB coverage area of the transmitter site at the Baiyoke tower in Bangkok with fixed (FX) rooftop reception and with portable indoor (PI) reception.

Figure 4.7: Example coverage area of a DVB-T2 transmission (32k 64-QAM 2/3 PP4) with fixed and portable indoor reception from site 1.0 [25]



Source: ITU adapted from Giraplan

Portable indoor reception of the remaining municipalities can be achieved by means of additional transmitters near these municipalities operated in a single frequency network (SFN) with the main transmitter in the area. The guard interval needs to be carefully investigated (see Section 4.3.2 of the ITU Guidelines). On the one hand the guard interval should be long enough to avoid internal network interference; on the other hand the guard interval should be as short as possible in order not to reduce unnecessarily the payload of the multiplex.

The initial DTTB plan contains an overview of three possible systems variants. Table 4.7 shows the system variants together with the resulting guard interval, payload, C/N with fixed reception (FX) and C/N with portable indoor (PI) reception. As result of the selected Pilot Pattern (PP), the guard interval in the system

[25] The broadcast planning software package Giraplan, has been made available for preparing the coverage plots by courtesy of Progira Radio Communication AB.

variant indicated in the right hand column (with PP1) is far too long for the case of the additional stations mentioned above.

Table 4.7: Possible system variants indicated in the initial DTTB plan

Characteristics	32k 256-QAM 2/3 PP7	32k 64-QAM 2/3 PP4	16k 64-QAM 2/3 PP1
Guard interval	1/128 (28 µs)	1/32 (112 µs)	1/4 (448 µs)
Payload	40 Mbit/s	28 Mbit/s	22 Mbit/s
C/N – FX reception	20.1 dB	16.1 dB	16.6 dB
C/N – PI reception	23.7 dB	19.3 dB	19.8 dB

Therefore in investigating the optimal duration of the guard interval also other system characteristics, including the FFT size and the Pilot Pattern, should be taken into consideration.

6) Fill-inn transmitters

The initial DTTB plan contains 140 fill-in transmitters, whereas the analogue TV plan contains 68 fill-in transmitters. The number of DTTB fill-in transmitters needs to be reviewed after gaps in the coverage areas have been identified. Therefore detailed coverage assessments have to be carried out of the main stations and the additional stations to provide portable indoor coverage in the 200 municipalities. Furthermore the 95 per cent population coverage target should be taken into account in determining the locations for fill-in transmitters.

In locations where a fill-in transmitter is needed it should be investigated (by means of planning software) if:

- The main transmitter can be received off-air, normally line of sight with the main transmitter is needed;
- The required ERP is technically feasible with a fill-in transmitter in SFN mode (see Section 4.3.3 of the ITU Guidelines); if not feasible the fill-in transmitter should operate on a different frequency than the main station. The fill-in station could still operate in SFN mode with other fill-in stations fed by the same main station.

7) Compatibility of DTTB assignments with non-broadcasting services

Compatibility of DTTB assignments with the mobile services below channel 26 needs to be investigated, taking into account:

- If mobile stations are operational or may become operational on adjacent channels near transmitter sites with channel 26;
- The protection ratios for the kind of mobile service. Protection ratios between DVB-T2 and mobile services are not yet available in ITU-R recommendations. However, for mobile services interfered with by DVB-T2, the DVB-T protection ratios given in Annex 2 of Recommendation ITU-R BT.1368-9 can be used.

Figure 4.6 shows that no DTTB stations are planned on the channels 58, 59 and 60. Incompatibilities with mobile services in channels above 60 will therefore not occur.

If in the future the channels above 48 are allocated to IMT, compatibility between DTTB and IMT needs be investigated. In case of incompatibilities it has be decided who is responsible for eliminating the harmful interference. Compatibility criteria between DTTB and IMT are subject of studies in ITU-R. Preliminary information on protection ratios between DVB-T2 and LTE can be found in EBU report Tech 3348[26]. Similar information can be found in an ITU-R Draft New Report[27].

8) DTTB introduction stages

The DSO objectives indicate four DTTB introduction stages:

1st year: 50 per cent population coverage;

2nd year: 80 per cent population coverage;

3rd year: 90 per cent population coverage;

4th year: 95 per cent population coverage.

In order to check the population coverage data and to provide information on the coverage areas in the introduction stages, it will be necessary to provide detailed coverage data of the DTTB transmitters that will be operational in each of the four stages.

The frequency planning software should include a population data base and be able to calculate the number of households in a coverage area.

9) International coordination

International coordination is in progress and meetings with neighbouring countries are scheduled. It is important to finalize the international coordination before the licensing procedures start and to incorporate the results in the frequency plan. Otherwise there will be uncertainties about the assignments and changes to licensed DTTB stations may be required once the international coordination is completed.

An important principle of international coordination of frequencies is that all countries have equitable access to the spectrum. In the coordination results obtained so far, this principle is applied by dividing the channels evenly on both sides of the border. It should be noted that dividing channels evenly between two countries leads to non-equitable access in cases where a third country becomes involved. In these cases all three countries should agree on a channel division.

In addition to the channels to be used, also other data should be agreed such as:

- The protection criteria (e.g. median minimum field strength at the border or at defined test points);
- The interference potential (e.g. an ERP and an antenna height or a "reference network[28]");
- The calculation method (e.g. propagation model of Recommendation ITU-R P.1546, reference protection ratios and the reception mode).

ITU-BR should be informed about the coordination results (see Article 6.7 of the Radio Regulations).

It should be noted that when a station is brought into operation it should be notified to ITU-BR in accordance to the provision of Article 11 of the Radio Regulations.

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[26] EBU Tech 3348 Frequency and Network Planning Aspects of DVB-T2, Version 2.0; May 2012

[27] Section 3.4.5 of Draft New Report ITU-R BT.[DVBT2PLAN] Frequency and network planning aspects of DVB-T2 (See input document 6/43 of ITU Study Group 6)

[28] Reference networks have been defined in the GE06 Plan to define the interference potential of allotments.

10) Verification of transmitter data

In order to calculate the DTTB coverage areas and to perform compatibility calculations, accurate transmitter station data is needed. The data in the initial DTTB plan should be verified and be more detailed (such as antenna height, ERP and antenna pattern).

4.4.3 After ASO

After ASO, analogue TV has been switched off in Band I, III, IV and V. Analogue TV does no longer require protection and all analogue TV stations should be deleted from the plan. Spectrum used by analogue TV becomes available for additional DTTB services or for other services.

NBTC indicated that after ASO, Digital Terrestrial Audio Broadcasting (DTAB) and Mobile TV (MTV) might be allocated in Band III in the future. A roadmap for introducing DTAB and MTV is likely to be developed in 2013.

The main attention point regarding the frequency plans after ASO is the re-allocation of mobile services in Band IV/V as described in attention point 4) of Section 4.4.2. Depending on the decisions and the review of the initial DTTB plan it may be possible to license one or two additional multiplexes.

4.5 Network architecture

A DTTB network consists of one or more head-ends, the distribution links and the transmitter sites. It is up to the network provider to consider the various options of the network architecture and to decide on cost effective and technically sound solutions that comply with the licence conditions and the requirements of the service licensees. However, in developing licence conditions it should be taken into account that the following items have an impact on transmission costs and efficient use of frequencies:

1) Local and regional services;
2) SFNs;
3) Statistical multiplexing;
4) Distribution links.

1) Local and regional services

Requirements for regional and local services are important design criteria in the network architecture and have an impact on transmission costs. In Thailand the smallest area for local or community services has been defined as the area in which a main DTTB transmitter has been planned. There are 41 of these basic areas. Regional areas consist of two or more basic areas. The requirements for local and regional services are (see also the DSO objectives in Table 2.4):

- Community TV with 20 per cent of the total capacity in each of the 41 basic areas;
- Business TV, if interest is shown, with 10 per cent of the capacity of three multiplexes in regions (combinations of basic areas) to be defined and 10 per cent of the capacity of three multiplexes in one or more of the 41 basic areas.

During the transition period five transmitters per site (five multiplexes) have been planned. The five transmitters per site in a basic area should broadcast the above mentioned local and regional services plus the national public and business TV services. In total, depending on the interest shown in business TV licensees for local and regional services, the requirement is:

- 20 per cent to 32 per cent of 5 multiplexes local and regional services;
- 68 per cent to 80 per cent of 5 multiplexes national services.

One option under consideration is to share the community services (20 per cent of the total capacity) in all five multiplexes. The consequence is that each of the five multiplexes at each of the 41 main sites contains partly local content. Therefore local service insertion and re-multiplexing is required for each of the 205 main transmitters.

Another option is to concentrate local and regional services in one or two multiplexes (one multiplex if there is no interest in business TV local or regional TV services). In this case one or two of the five multiplexes at each of the 41 main sites contains local content. Local service insertion and re-multiplexing is required for 41 main transmitters (in case of one local multiplex) or 82 transmitters (in case of two local multiplexes). The remaining 164 or 123 transmitters can be fed by centrally multiplexed signals.

The latter option is the most cost effective because a lower number of multiplexers is needed.

2) SFNs

Requirements for regional and local services may have also an impact on the size of SFNs because transmitters broadcasting different content at any moment in time cannot be part of the same SFN. In Thailand SFNs are intended for improving coverage within a basic area, either by fill-in transmitters or by transmitters to improve portable indoor coverage in a municipality. Transmitters belonging to an SFN will therefore always have the same content and will under these conditions not be restricted by the local or regional services requirements. There are however network design constraints regarding SFNs, because all transmitters belonging to an SFN should be connected to the T2-Gateway, generating the synchronization information to the transmitters in the SFN.

3) Statistical multiplexing

Efficient use of frequencies is obtained by the application of statistical multiplexing (in short "statmuxing"). In this way a higher bit rate will be automatically allocated to critical scenes and a lower bit rate to less critical scenes. This results in a higher picture quality per SD or HD service. Instead of a higher picture quality, it could also be decided to maintain the original quality by reducing the average bit rate of the services and increase the number of services. Statistical multiplexing is more efficient with a high number of services and different kind of content per service. Efficiency gains of 25 per cent may be reached[29].

With modern multiplexing equipment it is possible to carry out statistical multiplexing with encoders at geographically separated locations provided that high quality IP transmission links are available. There are many different ways to apply statistical multiplexing, e.g. a group of services in a DVB-T2 Physical Layer Pipe (PLP) could be statistically multiplexed. Also statistical multiplexing could take place between PLPs.

4) Distribution links

As for analogue television, distribution of the DTTB signals to the transmitters may be provided by DVB-S2 satellite transmissions. There are several ways to distribute DTTB signals by satellite with different operational and cost aspects.

In some cases transcoders and re-multiplexers are needed for all services at all sites, e.g. in case of DTH reception of excising satellite services. In other cases the received signal can be connected directly to the modulation stage of the transmitter. For example in case the DTTB services are transmitted via the satellite in the T2-MI protocol, which is the DVB-T2 distribution protocol. In the latter case the satellite signal cannot be received with domestic satellite receiving installations or cable TV head-ends. Therefore

[29] See "Spectrum usage and requirements of future terrestrial broadcast applications" Roland Brugger and Abiodun Gbenga-Ilori - Institut für Rundfunktechnik, München – EBU Technical Review 2009 Q4

it should be used in addition to DTH satellite reception, involving doubling of satellite distribution costs for broadcasters.

In theory it also possible to use the encoded signals from a satellite TV head-end for DTTB transmission. In this case the DTTB bit rate determines the satellite TV bit rate, whereas often the bit rate of satellite services is higher than DTTB services because of the higher multiplex capacity.

In developing the licence conditions it should be considered that:

- By letting the choice of the multiplex composition with regard to local and regional services to the network provider, the network provider is able design the most cost effective network architecture;
- In allocating multiplex slots, the use of statistical multiplexing should be taken into account;
- The way of distributing DTTB signals via DVB-S2 satellite could affect satellite and cable TV reception.

5. Recommendations

In the roadmap a number of critical topics have been identified. The five most critical key topics and choices are described in Section 4. In addition the timing of the activities in the roadmap is critical because the Phases 1, 2 and 3 should be finalized before the assignment of licences starts. And the envisioned licensing calendar is ambitious. The current DTTB licensing schedule is:

- licences for network providers based on a tender procedure before the end of 2012;
- licences for public service providers based on a tender procedure before the end of 2012;
- licences for commercial service providers based on auctioning in 2013;
- licences for community TV services based on a tender procedure in 2013.

In order to resolve the five most critical topics in time it is recommended to consider the items indicated below. More information on the items can be found in Section 4.

1. The interrelation between the various licence categories is complex; the licence conditions need to be carefully defined and tested.
2. Multiple network providers will result in inefficiencies in Opex and Capex and may also restrict an efficient loading of the various multiplexes. Licensing a single network provider should be balanced against gains from platform competition, taking into account that a network provider will be required to calculate its tariffs on the basis of a costs plus (a margin) model.
3. Business TV services licences are envisaged for national regional and local services depending on interest and several programme categories. The many options make the auction process complex. A reduction of the number and type of business TV service licences needs to be considered.
4. The unique selling points of DTTB, such as reception at outdoor and indoor locations with simple antennas (usability), low costs for viewers and service providers should be leading considerations in many decisions on key topics and choices included in the roadmap.
5. The analogue switch-off (ASO) date has not yet been decided. Postponing setting an ASO date will reduce the 'window of opportunity' for DTTB, will reduce clarity about the analogue TV and DTTB market and may result in the loss of momentum and viewers' attention. It also increases the simulcasting costs. Setting a defined ASO date and model needs therefore to be considered.
6. A world-wide frequency allocation for International Mobile Telecommunications (IMT) in the upper part of the UHF broadcasting band (channels above 48) has been agreed in ITU. Subject to confirmation by the ITU World Radiocommunications Conference in 2015, this allocation will become effective in 2015. The allocation will facilitate the introduction of fourth generation

(4G) mobile telecommunication services such as LTE. It cannot be excluded that within the licence period of the DTTB services, IMT (4G) services will be introduced in Thailand. The DTTB frequency plan needs therefore to take into account a possible introduction of IMT by assigning (as far as possible) channels 26 to 48 to the transmitters that will be licensed before analogue switch-off.

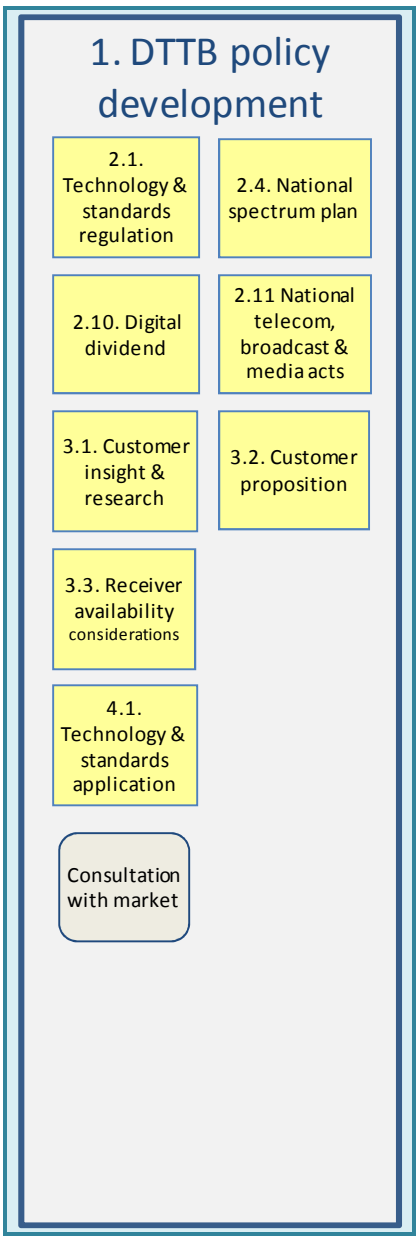
Glossary of abbreviations

16-QAM	16-state Quadrature Amplitude Modulation
256-QAM	256-state Quadrature Amplitude Modulation
4G	Fourth generation mobile telecommunication networks
64-QAM	64-state Quadrature Amplitude Modulation
AOBT	Act on Organization to assign Radio Frequencies and to Regulate the Broadcasting and Telecom services (2010)
API	Application Programming Interface
ASEAN	Association of Southeast Asian Nations
ASO	Analogue switch-off
ATV	Analogue television
AVC	Advanced Video Coding
B/PAL	Analogue TV system in VHF with 7 MHz channel bandwidth and phase Alternating Line colour system
BBA	Broadcasting Business Act (2008)
BBTV	Bangkok Broadcasting and Television
BEC	Bangkok Entertainment Group
BP	Beauty parade
C/N	Carrier to Noise ratio
CA	Conditional Access
Capex	Capital Expenditure
CAS	Conditional Access System
dB	decibel
DSO	Digital Switch Over
DTAB	Digital Terrestrial Audio Broadcasting
DTTB	Digital Terrestrial Television Broadcasting
DVB	Digital Video Broadcasting
DVB-S	Digital Video Broadcasting – Satellite
DVB-S2	Digital Video Broadcasting – Satellite 2nd generation
DVB-T2	Digital Video Broadcasting – Terrestrial 2nd generation
Emed	Median minimum field strength
Emin	Minimum field strength
EPG	Electronic programme Guide
ERP	Effective Radiated Power
EWS	Emergency Warning System

FFT	Fast Fourier Transform
FTA	Free-To-Air
FX	Fixed (rooftop) reception
G/PAL	Analogue TV system in UHF with 8 MHz channel bandwidth and phase alternating line colour system
GE06	Geneva Agreement 2006
GHz	Gigahertz
HD	High Definition Television
HE AACv2	High-Efficiency Advanced Audio Coding version 2
IMT	International Mobile Telecommunications
IP	Internet Protocol
IPTV	Internet Protocol Television
ITU	International Telecommunication Union
ITU-BDT	International Telecommunication Union – Telecommunication Development Bureau
ITU-BR	International Telecommunication Union – Radiocommunication Bureau
ITU-R	International Telecommunication Union – Radiocommunication Sector
LTE	Long Term Evolution, often marketed as 4G
MFN	Multi Frequency Network
MHz	Megahertz
MIFR	Master International Frequency Register
MPEG	Moving Picture Expert Group
MTV	Mobile Television
NA	Not applicable
NBT	National Broadcasting Services of Thailand
NBTC	National Broadcasting and Telecommunications Commission in Thailand
NICAM	Near Instantaneous Companded Audio Multiplex
NOC	Network Operating Centre
NP	Network provider
NRT	National Roadmap Team
Opex	Operational Expenditure
OPN	Open Network Provisioning
PAL	Phase Alternating Line; analogue colour TV system
PI	Portable Indoor reception
PLP	Physical Layer Pipe
PP	Pilot Pattern
PSB	Public Service Broadcasting
RIA	Risk Impact Assessment

RR	Radio Regulations
SD	Standard Definition Television
SFN	Single Frequency Network
SMS	Short Message Service
SSU	System Software Updates
STB	Set-Top-Box
TA	Technical area
tbd	To be decided
TPBS	Thai Public Broadcasting Service
TVHH	Television households
UHF	Ultra High Frequencies (frequency range between 300 and 3000 MHz)
VHF	Very High Frequencies (frequency range between 30 and 300 MHz)
WRC-12	World Radiocommunications Conference 2012
WRC-15	World Radiocommunications Conference 2015

Annex 1: Functional building blocks related to Phase 1 of the roadmap



The selected functional building blocks related to Phase 1 of the roadmap are shown in Figure 3.9 and are reproduced here.

Section 3.4.2 describes Phase 1 of the roadmap.

This Annex gives an overview in the form of tables of the status of each of the selected functional building blocks related to Phase 1 by means of the following codes:

a. the decisions on key topic and choices that are already taken (between brackets the following identifiers: L = Law; n = notification; im = information memorandum and p = in preparation);

b. the decisions on key topic and choices that are partly taken;

c. the activities needed regarding key topic and choices that have not yet been decided;

d. the activities needed regarding key topic and choices that need revision.

For those issues that are not (fully) decided or need revision the main activities are indicated.

The selected functional building blocks are presented in the order of the number of the block. This number refers to the corresponding chapter in the ITU Guidelines, where more information and implementation guidelines can be found.

The grey blocks are not described in the ITU Guidelines and not described in the tables below. These blocks represent activities that are not specific to digital terrestrial television.

2.1 Technology and standards regulation

Brief description	In this section the key *policy* decisions are outlined on adopting or promoting DTTB technology and associated standards.
Objective	This section deals with the question whether a standard should be prescribed/promoted and for what system/network elements.

Key topics and choices	Status	Decision
2.1.1 Television presentation formats: for DTTB platforms either Standard Definition Television (SDTV) and/or High Definition Television (HDTV). Has the presentation format been decided?	A (p)	Public and community TV service in SD or HD if capacity permits; Business TV service in SD (and HD if there is interest)
2.1.2 Transmission standard: for DTTB platforms e.g. DVB-T2 or ISDB-T. Has the standard setting been decided?	A (p)	DVB-T2 for DTTB
2.1.3 Compression technology: for DTTB platforms MPEG2 or MPEG4. Has the compression technology setting been decided?	A (p)	MPEG4, following the DVB-T2 choice
2.1.4 Conditional Access (CA) system (including interoperability between deployed systems). Has the CA standard setting been decided?	C	Pay-TV services are not excluded for business service licensees (yet). Hence as long as this option remains, the NRT would have decide if and in what way they would like to regulate CA.
2.1.5 Application Programming Interface (API) for additional and interactive services (e.g. MHP for DTTB platforms). Has the standard setting been decided?	A (p)	The following regulation of the API is being proposed. If an applicant considers using API it has to ask approval of the NBTC.

Main activities	Observation/Advice
1. Carry out market research/surveys for identifying industry and consumer needs for standardization.	Especially whether potential applicants for the business service licences may be interested in offering pay-tv services
2. Determine minimum set of receiver standards for the DTTB market, based on the market developments and the *planned* licensing procedures, terms and conditions.	For CA the NRT could decide not to stipulate a CA but to leave it to the market. However, like with the API a licensee should first request approval.
3. Map on existing standardization policies/rules and determine additional standardization needs.	
4. Assess impact on industry and end consumers.	
5. Determine receiver requirements and include in frequency licence terms and conditions and/or media permits and authorizations.	The current receiver specifications may need to be changed or specifications may need to be added.
6. Determine communication messages, planning, standardization/testing bodies and methods (including logos and labelling).	

2.4 National Spectrum Plan

Brief description	The National Spectrum Plan reflects the long, medium and short-term planning of the available national spectrum resources for DTTB (and MTV) services in a particular country. It may also include the stipulated assignment procedures for the various services and a national frequency register, including all the assigned licences and licensees.
Objective	With a National Spectrum Plan the Regulator strives to ensure effective and efficient spectrum usage and compliance with international standards. As well as informing market parties on the current and future (intended) use of spectrum.

Key topics and choices	Status	Decision
2.4.1 The context of the national spectrum plan: Is the national spectrum plan, covering the broadcast spectrum, available and is it complete?	A (n)	The Thailand Spectrum Master Plan and the associated Allocation Table have been published in April 2012.
2.4.2 Planning current and future DTTB (and MTV) spectrum use: Has the national spectrum plan/strategic planning process started/completed?	A (n)	UHF channels 26-60. Re-allocation of parts of band to mobile and broadcasting might be considered
2.4.3 National Spectrum Plan publication and DTTB/MTV introduction dates.	A (p)	The current planning: In 2012 the facility/network Provider licences and public service licences will be assigned. In 2013 the business service licences and community TV Licences will be assigned.
2.4.4 General approaches for pricing spectrum usage: (a) One off pricing and/or recurring pricing? (b) cost- or market based pricing?	A (p) A (L)	All licence fees are determined: 2% administration fees + 2% Development Fund contribution. The percentages are applied over the DTTB designated revenues. It should be noted here that this is a form of market pricing. In combination with auctioning the business service licences, it incorporates the risk of being perceived as paying twice the market value. Business service licences have to be assigned through auction.

Main activities	Observation/Advice
1. Make an inventory of current spectrum use in the broadcast bands (bands III, IV and V).	Activities also related to deciding the digital dividend (see next functional building block).
2. Carry out market analyses and consultations and forecast future spectrum needs.	
3. Determine re-farming needs and assess impact on existing and future users (including service and financial impact), possibly reserve budget for re-farming efforts and damages.	Activities also related to decision on setting an early ASO date which may imply revoking spectrum rights.
4. Determine publication content, dates and formats for the National Spectrum Plan.	Already in place.

Main activities	Observation/Advice
5. Determine budget for spectrum management and administrative fees.	Carry out this activity may serve as a further policy justification for collecting the proposed revenue based licence fees (see above).

2.10 Digital dividend

Brief description	The digital dividend is the spectrum in Band III, IV and V that is available after analogue television has been transferred to digital television.
Objective	Freeing up spectrum for more valuable services.

Key topics and choices	Status	Decision
2.10.1 Determining the size of the digital dividend: has the size been determined?	C	
2.10.2 Digital dividend options: have the allocation to the different service been determined (broadcasting or non-broadcasting)?	C	

Main activities	Observation/Advice
1. Analyse current and future market developments and possibly conduct market consultation(s) in the broadcast (and telecoms) industries.	See also the activities mentioned under the previous functional building block.
2. Assess current and future market needs for DTTB and MTV services, possibly based on formulated legislation and Policies.	
3. Assess available spectrum after ASO, based on ASO plans, National Spectrum Plan.	
4. Map spectrum needs on available spectrum and determine priorities and assign spectrum to Broadcasting.	
5. Possibly draft spectrum re-farming plans and compensation schemes (for network and receiver re-tuning activities), reserve budgets.	
6. Update National Spectrum Plan and align licence terms and conditions for DTTB services.	

2.11 National telecom, broadcast and media act

Brief description	This section addresses the compliancy of the intended policy decisions with the existing and relevant regulatory framework. Very often this regulatory framework comprises national Telecommunications, Broadcast and Media Acts.
Objective	To be compliant with existing regulations, which might also include regulations on cross and foreign ownership and state aid.

Key topics and choices	Status	Decision
2.11.1 Checking compliancy with existing national, Telecommunications, Broadcast and Media Acts: is the formulated DTTB/MTV policy in line with the Acts?	D	When licensing framework is completely detailed and finalized.
2.11.2 Checking compliancy with other legislation, especially related to cross and foreign ownership and State aid: is the formulated DTTB/MTV policy in line with the Acts?	C	When tendering of network licences and public/commercial funding is finalised.

Main activities	Observation/Advice
1. Map detailed DTTB licensing framework on current legislation including Media, Telecom and Competition regulations (the latter also covering cross and foreign ownership regulations and State aid).	
2. Identify gaps and draft proposals for additional and/or changes in legislation (based on 'best practices').	
3. Determine planning for changes in the law and determine 'must haves' for launching DTTB.	

3.1 Customer Insight and Research

Brief description	Launching (commercial) DTTB services will require the identification of demand drivers (i.e. customer needs), competitive advantages, service uptake projections and possibly market entry barriers in the local market(s).
Objective	Service providers and network operators will carry out some form of market research for identifying these demand drivers, competitive advantages and service uptake projections. This market insight is however also needed for the NRT.

Key topics and choices	Status	Decision
3.1.1 Overview of the DTTB and MTV markets: market definition, key service and market characteristics	B	Low Cost/Price, as well as usability and picture/reception quality are important competitive advantages for DTTB (see Section 4.3). The willingness to pay for (DTTB) STB should be investigated. For a comprehensive overview of the market data elements see Section 3.4.2.
3.1.2 Market research methods: basic market research approaches and embedding market research in the DTTB/MTV business planning process	C	

Main activities	Observation/Advice
1. Determine need, timing and scope for market research.	
2. Analyse competitive offerings, substitutes and technology developments.	For a large extent this data is already available.
3. Design, develop and agree preliminary DTTB service propositions.	Also needed for the service planning (functional building blocks 4.2 to 4.5) and decision making under other functional building blocks.
4. Draft market research plan, staff and budget market research project.	If concluded that essential data is missing. Data may be available under the incumbent broadcasters.
5. Carry out market research and analyse results, translate into DTTB service propositions.	

3.2 Customer proposition

Brief description	This section focuses on determining the competitive advantage and what the related service attributes could look like.
Objective	Finding the best customer proposition in line with the Business Plan objectives. In the case of Thailand what is best in promoting the update of DTTB services (i.e. supporting the DSO objectives).

Key topics and choices	Status	Decision
3.2.1 DTTB competitive advantage and related service Proposition attributes. Are they key attributes agreed and shared (within the NRT)?	B	Price, usability and picture/reception quality are considered to be the competitive advantage of DTTB. The degree in which this attributes provide a lasting competitive advantage depends on the market segment or reception area (see Section 4.3). These attributes still to be investigated and confirmed.

Main activities	Observation/Advice
1. Analyse earlier DTTB service launches and compare with customer research results/local market conditions.	The analysis of other markets has already been carried out. However the NRT may decide to carry out additional market research (see previous functional building block).
2. Define DTTB service propositions and check feasibility/cost levels with key suppliers, i.e. Distributor (broadcast network operator) and Content Aggregators, Content Creators.	
3. Possibly redefine DTTB service propositions and test in market.	

3.3 Receiver availability and considerations

Brief description	The consideration of the many different DTTB receiver types commercially available today.
Objective	For a service provider or regulator it is important to draft the receiver's functional requirements based on the defined service Proposition(s). Only those requirements supporting the service Proposition should be incorporated. These 'must have' requirements might prove to be too expensive for the business case and therefore receiver considerations might result in a revised service Proposition.

Key topics and choices	Status	Decision
3.3.1 DTTB functional receiver requirements and availability (see receiver model)	A (p)	

Main activities	Observation/Advice
1. Check any prescribed Technologies and Standards, Receiver regulations and analyse market research results	Already completed.
2. Assess and make inventory of availability and roadmaps of various receiver types/attributes	Already carried out but continuous monitoring needed.
3. Check network compatibility and interoperability (radio interfaces and API/applications)	Need continuous monitoring, perhaps not so much for the STB specifications. But attention is needed for the antenna requirements and the assumptions made in the service planning exercise. These two processes should be aligned.
4. Assess and detail ex-factory and retail pricing for various receivers	Already carried out but continuous monitoring needed. In combination with an insight in the willingness to pay for the DTTB STB, an accurate assessment can be made of the costs of subsidizing STB or what financial burden is placed upon licensees with a minimum supply obligation for STBs.
5. Decide key receivers and their attributes, draft receiver/service roadmap	This will include retail planning. Who will organise the retail chain and in what way this chain will be organised and monitored. Labelling and logos for certified STBs may have to be included too.

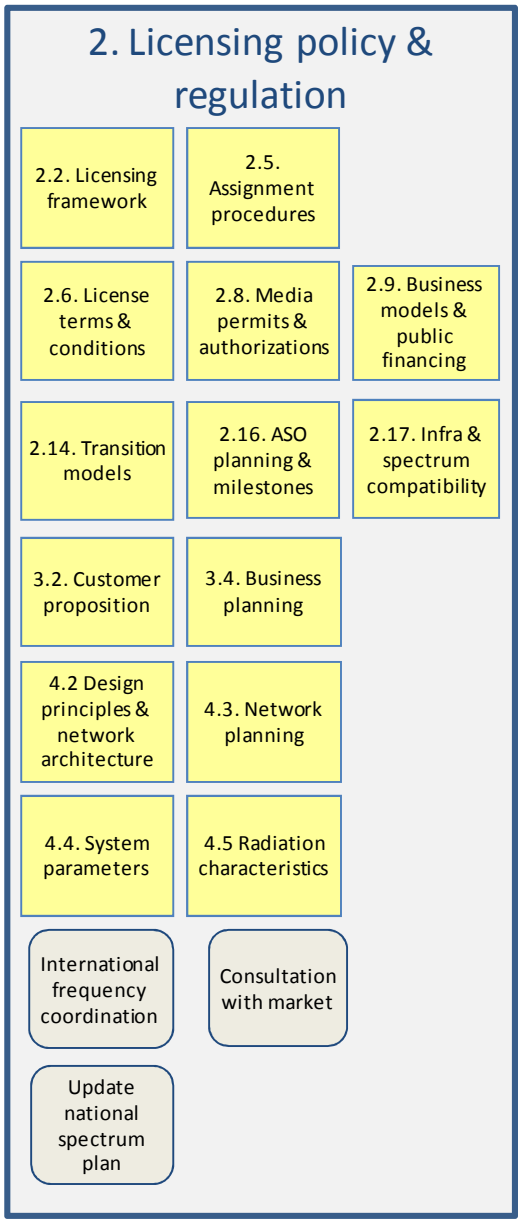
4.1 Technology and standards application

Brief description	Technical comparison of key DTTB standards and the characteristics of associated systems
Objective	Technical evaluation of DTTB transmission standard and choice of systems for required services

Key topics and choices	Status	Decision
4.1.1 Technical tests to verify system parameters	B	Tests will be carried out by network operators. Test conditions to be specified.
4.1.2 SDTV and HDTV specifications	A(p)	• TV Presentation Format: SD and HD • Picture aspect ratio 16:9 and 4:3 • Two channels-stereo or independent audio channels
4.1.3 Selection of DTTB transmission standard	A(p)	• Transmission standard: DVB-T2 • Middleware/API: Not specified, but should be any “open” standard with NBTC approval.
4.1.4 Compression system	A(p)	• Video Compression: MPEG-4 AVC • Audio Compression: MPEG-4 HE AACv2 (Option: Any 5.1 channel)
4.1.5 Encryption system	C	• Conditional Access (CA): as 2.1
4.1.6 Additional services	B	• “Emergency warning system” (EWS) is an obligation that network provider licensees have to implement in the DVB-T2 network; method to be decided • Subtitling • Provisions for System Software Updates (SSU).

Main activities	Observation/Advice
1. Specification of test set-up, conditions and expected results of pilot tests.	Several system variants, including robust and high capacity variants and several PP should be tested with portable indoor reception.
2. Evaluation of conditional access (CA) systems The choice for a conditional access (CA) system is a trade-off between costs of the system and security.	If pay-TV services are considered the use encrypted signals is necessary. In order to save costs and discomfort for viewers the same system should be used by all service providers (otherwise more expensive receivers with a Common Interface or more than one STB has to be bought).
3. Estimation of required bit rate for additional services.	As initial choice the values could be used that are indicated in EBU Technical Report 15 Defining Spectrum Requirements of Broadcasting in the UHF Band. It is recommended to undertake testing of SSU beforehand to avoid risk of problems during live data transmission.

Annex 2: Functional building blocks related to Phase 2 of the roadmap



The selected functional building blocks related to Phase 2 of the roadmap are shown in Figure 3.10 and are reproduced here.

Section 3.4.3 describes Phase 2 of the roadmap.

This Annex gives an overview in the form of tables of the status of each of the selected functional building blocks related to Phase 2 by means of the following codes:

a. the decisions on key topic and choices that are already taken (between brackets the following identifiers: L = Law; n = notification; im = information memorandum and p = in preparation);

b. the decisions on key topic and choices that are partly taken;

c. the activities needed regarding key topic and choices that have not yet been decided;

d. the activities needed regarding key topic and choices that need revision.

For those issues that are not (fully) decided or need revision the main activities are indicated.

The selected functional building blocks are presented in the order of the number of the block. This number refers to the corresponding chapter in the ITU Guidelines, where more information and implementation guidelines can be found.

The grey blocks are not described in the ITU Guidelines and are not described in the tables below. These blocks represent activities that are not specific to digital terrestrial television.

2.2 Licensing framework

Brief description	The licensing framework is the comprehensive set of required licences, authorizations and permits for a market and public introduction of DTTB services.
Objective	The objective of any licensing framework should be to actually implement the defined policy objectives for the introduction of DTTB services, including the analogue switch-off (ASO).

Key topics and choices	Status	Decision
2.2.1 A licensing framework for any television services comprises the assignment of three sets of rights (a) spectrum (b) broadcast and (c) operating rights. For DTTB services has the model been decided?	A (L/n)	Spectrum rights are assigned to broadcasters, i.e. the service licensee. The network licensee will get a directive as to which frequencies can be applied in their network(s). Broadcast rights are assigned to service licensee. Operation rights are assigned to the network licensee and facility Provider licensee. For more details see Sections 3.4.3 and 4.1.
2.2.2 For the extra function of the multiplex operator in the value chain, two basic licensing models can be distinguished for DTTB services: (a) model A (b) model B. Has the basic model been decided?	A (p)	A variant of Model B (see Sections 3.4.3 and 4.1.)
2.2.3 Public service broadcasting (PSB) refers to broadcasting intended for the public benefit rather than for purely commercial objectives. In most cases the broadcast content and spectrum rights are specified in a media or broadcast Act. Has the PBS services and spectrum rights been defined yet (and where) for the DTTB platform?	A (L)	There are service licences reserved for PSB (including community TV and public services). At least 20% of the available spectrum (in each service area) is reserved for community TV.

Main activities	Observation/Advice
1. Make inventory of current licensing framework and check applicability for DTTB service introductions (gaps/conflicts) and the financial viability of the system both for the licensees as the regulator.	
2. Assess and evaluate different options for licensing DTTB services	Some details may need to reconsideration when finalizing the licensing framework, see Section 4.1.
3. Assess compatibility with ASO plans and National Spectrum Plan	See Section 3.4.3 and also the previous functional building block 2.10 digital dividend.
4. Possibly revise current licensing framework and assess impact	
5. (Re)draft planning for licence assignment, framework changes and update National Spectrum Plan (and possibly legislation)	

2.5 Assignment procedures

Brief description	Assigning spectrum rights for DTTB services and the (common) instruments and procedures applied.
Objective	Assign spectrum rights/licences to the best licence holder/market party.

Key topics and choices	Status	Decision
2.5.1 Basic assigned instruments and procedures: What is the preferred assignment instrument (FCFS, auction or public tender) for broadcasting?	A (L) C (p)	Spectrum for business services by auction (resulting in the acquisition of a service licence). Spectrum for Incumbents by Priority. Spectrum for public services by a form of tendering (including a waiting list).
2.5.2 Assignment procedures for DTTB services: What is the selected assignment instrument (FCFS, auction or public tender) for DTTB and MTV?	B	See above. Exact procedures and assignment instruments (auction) still to be designed and tested. See also Section 4.1.

Main activities	Observation/Advice
1. Consult market (industry players and consumers) on assignment methods and licence terms and conditions	
2. Test proposed procedures and evaluate results and select assignment method and procedures	
3. Draft detailed plans and planning for DTTB assignment procedures (for detailed steps see Appendix 2.5B)	
4. Publish assignment planning and procedures and update National Spectrum Plan (and possibly legislation)	

2.6 Licence terms and conditions

Brief description	The licence terms and conditions of the DTTB and MTV frequency or spectrum licences.
Objective	Assigning DTTB frequency rights is carried out in conjunction with assigning the other two types of rights as well. However, broadcast or operator rights could also be included in the spectrum licence, depending on the existing regulatory and legal framework. Hence the objective is to have all rights covered, in the right balance, between the various licence types.

Key topics and choices	Status	Decision
2.6.1 Licensing and fair competition rules: Are the licence terms and conditions in line with the competition rules (transparent and non-discriminatory)?	C	Dependent on finalised detailed licensing framework (including price regulation stipulation, etc.).
2.6.2 Frequency licence terms and conditions: have all licence terms and conditions been determined and is the list of conditions complete?	C	Dependent on finalised detailed licensing framework (including price regulation stipulation, etc.).

Main activities	Observation/Advice
1. Check relevant paragraphs/ entries in legislation/Policies, ASO plans, National Spectrum Plan.	
2. Analyse market conditions and assess 'level-playing-field' requirements/provisions.	
3. Determine a comprehensive list of DTTB licence terms and conditions and align with local Building permit policies and Media permits/authorizations and their planning.	Included in this analysis is also the qualify criteria for the auctions and tender procedures.
4. Update National Spectrum Plan (and possibly ASO plans)	

2.8 Media Permits and Authorizations

Brief description	The right or permission to broadcast television content on a defined broadcast DTTB platform in a designated geographical area and for a specified period.
Objective	In regulating access to the DTTB platforms and/or to determine content composition on the DTTB platforms, the Regulator can avoid unwanted broadcasts, promote defined broadcasts or avoid duplication of content.

Key topics and choices	Status	Decision
2.8.1 Broadcast licensing framework: the different levels of granting broadcast rights, programme or platform level?	C (p)	Dependent on detailed licensing framework and especially number/type of service licences.
2.8.2 Broadcast licensing requirements: have all licence terms and conditions been determined and is the list of conditions complete?	A (L) C	Top level requirements are stipulated in the Broadcasting Business Act. Detailed content Charter is still in preparation.

Main activities	Observation/Advice
1. Draft content Charter and align with stipulations in the Broadcasting Business Act (any other relevant legislation)	
2. Check Technology and Standards Regulation (receiver regulations) and include in media permits policies.	The Charter could include details on scrambling content (i.e. CAS) and certain (mainly sport) events cannot be offered as exclusive content. Such stipulations could be closely related to the receiver requirements.
3. Determine Media permits/authorizations and procedures and align with spectrum licence terms and conditions and planning	
4. Publish policies for media permits and authorizations (may include waivers)	

2.9 Business models and public financing

Brief description	This section addresses the financing of public service broadcasting (PSB). Financing of non-PSB or commercial broadcasters is per definition a matter for the private market to resolve.
Objective	Financially support the DSO and/or ASO in order to have a smooth transition from analogue to digital television broadcasting.

Key topics and choices	Status	Decision
2.9.1 General PSB financing models and sourcing: basic forms already decided, including (a) PSB entity is established by government, with defined PSB services, fully funded by public sources (either through licensing fees and/or general taxes) (b) A PSB entity is established by Government, with defined PSB services, funded by public sources and (later) partly by commercial income (mostly advertising based). (c) A commercial/private broadcaster was established, fully funded by commercial income (either advertising based and/or subscription based) and has a PSB obligation been assigned (d) has the different sources for DSO/ASO been selected and is the budget fully financed?	A (L) C	Public service licensees are allowed to have alternative forms of income (including advertising). Community TV shall be financed from the Development Fund (Act on Organization to assign Radio Frequencies and to Regulate the Broadcasting and Telecom services - 2010). A policy proposal still has to be devised to help/promote covering the costs for community TV.
2.9.2 DTTB specific financing issues: (a) Financing of digital receivers (b) Financing the impact of free-to-air stipulations(c) In case the PSB service is encrypted content rights can be lowered (d) Financing the simulcast period (e) TV licensing fee system might need revision.	C	Financial aid for affected viewers, still be developed (an alternative option is to have licensees deliver a minimum number of STBs); Other forms of support are under consideration (training of installation companies, Opex, disinvestments).

Main activities	Observation/Advice
1. Check existing media legislation, policies and Licensing Framework	
2. Consult public broadcaster(s) on current/future analogue television, DTTB transmissions and the options of financing these broadcasts.	
3. Analyse market situation and assess possible market distortions and assess the capacity of market parties to carry certain licence terms and conditions (and the associated costs).	See also functional building block 3.4 and Section 3.4.3.
4. Define or complete required public service offering on DTTB platform.	
5. Align defined public service offering with other DTTB licence terms and conditions and media permits, and their planning.	
6. Determine and establish budget for public broadcast service offering and/or subsidizing consumer equipment.	

2.14 Transition Models

Brief description	This section deals with the situation that analogue television broadcasts have to be stopped and the existing analogue services are migrated to a DTTB platform in one coordinated effort, led by the national Government. The key element for the analogue switch-off (ASO) process to be initiated is that the Government sets a mandatory date for analogue switch-off. Please note, this situation is fundamentally different from the situation that the national Government decides to introduce a DTTB platform next to any existing analogue services; both the analogue and DTTB services can coexist next to each other and there is no (clear) objective to switch-off the analogue service in the near future.
Objective	Existing analogue services are migrated to a DTTB platform in one coordinated effort and without service interrupts.

Key topics and choices	Status	Decision
2.14.1 DSO objectives and hurdles: What are the DSO objectives (To have a universal television service on the DTTB platform, and/or to securing the future of the terrestrial platform)	A	To have universal television services on the DTTB platform and to securing the future of the terrestrial platform. DSO objectives still to be completed and confirmed (see Section 2.4).
2.14.2 ASO factors: What type of ASO process is envisioned, consider the following factors: (a) Required PSB services; (b) The number of analogue terrestrial television viewers; (c) Availability of spectrum; (d) DTTB service uptake.	C	Not all factors are completely inventoried: The number and location of analogue television viewers is not exactly known; Availability of spectrum still to be reviewed; DTTB services not launched yet. Their likely uptake needs to be assessed for determining the ASO date.

Key topics and choices	Status	Decision
2.14.3 ASO Transition models: Which models is envisioned (a) ASO with simulcast period, with two sub-categories (i) Phased approach to analogue switch-off (ii) National approach to analogue switch-off (b) ASO without simulcast period.	C	

Main activities	Observation/Advice
1. Check existing legislation and policies for public (and commercial) television service (e.g. FTA) and coverage stipulations (e.g. nationwide coverage)	
2. Check existing/formulated receiver regulations for impact on ASO.	
3. Carry out market research on ASO affected viewers/listeners. Identify any hidden viewers/listeners (2nd television sets, regional programming, prisons, etc.), Identify impact and risk areas	
4. Analyse and assess complexity and size of network modifications and receiver transitions	
5. Possibly involve and discuss ASO with the incumbent broadcasters and consumer associations.	
6. Decide transition model (simulcast period and ASO phasing).	At least a preliminary decision is needed for carrying out effectively the service planning (see section 3.4.3).

2.16 ASO planning and milestones

Brief description	Overall ASO planning and its key milestones, managed by the National ASO Committee or equivalent body.
Objective	ASO planning respecting the set dates for ASO and providing a progress monitoring tool for the National ASO Committee.

Key topics and choices	Status	Decision
2.16.1 Outlining the ASO planning: when and where to begin the process and how long the entire operation should last	B	Introduction of DTTB by 2012/13 but ASO date not set or qualified (yet).
2.16.2 Overall ASO planning set-up: including the overall programme structure and the key result paths in an ASO plan	C	

Key topics and choices	Status	Decision
2.16.3 ASO planning phases (in a phased approach): the three phases and their key milestones	C	
Main activities	**Observation/Advice**	
1. Draft comprehensive ASO planning (milestones and activities).		
2. Assess impact on frequency availability, network deployment and the impact on the viewers and their viewing situation.		
3. Identify ASO project risks and draft risk mitigation plans (including fall back and/or roll back scenarios)		

2.17 Infrastructure and spectrum compatibility

Brief description	Infrastructure and spectrum compatibility, or better said incompatibility, happens in the case of having: (a) a simulcast period, having both a digital and analogue service in the same geographical areas, and (b) the analogue and digital plan are not compatible. In that case there is a lack of digital spectrum in a certain area, not necessarily the entire country. In some countries there might only be analogue terrestrial television service in Band I/III and non in Band IV/V.
Objective	Resolving infrastructure and spectrum incompatibilities in order to have a simulcast period in a defined area.

Key topics and choices	Status	Decision
2.17.1 Scoping incompatibility: has been identified where incompatibility can occur?	C	Dependent on # of network Providers, frequency Plan and network Architecture.
2.17.2 Trade-offs with infrastructure incompatibility (see implementation guidelines)	C	Dependent on # of network Providers, frequency Plan and network Architecture
2.17.3 Trade-offs for spectrum incompatibility (see implementation guidelines)	C	Dependent on # of network Providers, frequency Plan and network Architecture

Main activities	Observation/Advice
1. Check legislation, National Spectrum Plan and establish service priorities and acceptable interferences levels.	
2. Assess available antenna space and sites and site/antenna sharing possibilities/options.	This may entail carrying out infrastructure due diligence investigations. These investigations are most likely also needed for preparing the network licence tendering.
3. Calculate inference levels, service coverage and check EMC compatibility. Identify bottle necks.	This data will (largely) be provided by the service planning exercise.

Main activities	Observation/Advice
4. Develop site transition scenarios (including temporarily installation and sites).	
5. Asses costs, time lines and service impact.	

3.2 Customer proposition

Brief description	This section focuses on determining the competitive advantage and what the related service attributes could look like. The results of the service planning may result in changing the customer propositions (see Section 3.4.3).
Objective	To balance customer proposition, business case and network planning (see also Guidelines Section 3.1.2).

Key topics and choices	Status	Decision
3.2.2 Has the customer proposition been checked against the network planning and the business case?	C	Service planning still to be carried out.
Main activities	**Observation/Advice**	
1. Carry out service planning and balance customer proposition, network planning and business case.	This may also involve other revisions of public financing models.	
2. Align customer proposition on the basis of the service planning results.		

3.4 Business planning

Brief description	This section will focus on the first two steps for the DTTB service introduction (a) agreement on business models (b) agreement on business case.
Objective	Agreed business model/case as to acquire the necessary funds for the DTTB service launch.

Key topics and choices	Status	Decision
3.4.1 Business models for DTTB services: which model or combination of models is considered (may vary per multiplex)	A (p)	In first instance it is all FTA, if there is remaining capacity left, business service licensees are allowed to apply for subscription based service licence.
3.4.2 Business case examples: what does the business look like for the DTTB services and the involved license holders?	C	

Main activities	Observation/Advice
1. Assess market up-take and project revenue streams, based on customer research and proposition.	
2. Assess and calculate associated costs (considering concepts of 'total cost of ownership'), project costs ahead.	For all license holders involved, i.e. the service, network and facility licence holders.
3. Carry out profitability and sensitivity analysis, draft business plan scenarios	For all license holders involved, i.e. the service, network and facility licence holders.
4. Quantify total investments and their associated risks, assess financing and public funding possibilities, consider co-operation/joint venture/vendor financing/revenue sharing	For all license holders involved, i.e. the service, network and facility licence holders.

4.2 Design principles and network architecture

Brief description	Implementation priorities and network architecture.
Objective	Initial technical description of the main network elements in relation to service quality, coverage, costs and timing requirements, serving as input document for preparing the initial frequency plan and ASO plan.

Main topics and choices	Status	Decision
4.2.1 Trade-off between network roll-out speed, network costs and service quality.	B(p)	• Roll out with population coverage of 50% (1st year), 80% (2nd year), 90% (3rd year) and 95% (4th year). • Transmitter sites related to the required coverage are to be decided.
4.2.2 Main reception mode and defining receiving installations.	A(p) B(p)	• FX is basis for coverage assessment to: – Match ATV coverage – Achieve population coverage in roll-out requirements • PI reception in each included municipality. Municipalities to be specified
4.2.3 Services for national, regional, or local coverage	A(L) A(L) A(p)	• Public services national • Community services: 41 areas, 20% of total mux capacity • Business services: 80% national • Possibly local and regional, depending on auctions 20% of total business capacity

Main topics and choices	Status	Decision
4.2.4 Frequency plan and network topology	B(p)	• Initial DTTB frequency plan – Main sites MFN – 140 fill-inns in MFN and SFN – Regular UHF channel groups using ch 26-59 – Use of existing sites • Before ASO: 5 muxes per site • After ASO: 6 muxes per site (+1 mux as spare)
4.2.5 Head- end configuration	B(p)/D	Initial choice: • local services as part of each mux • SD only for public and community services • Two sets of SD/HD configurations
4.2.6 Equipment reserve configurations	A(p)	For network provider to decide; to be evaluated as part of tender
4.2.7 Type of distribution network	A(p)	For network provider to decide; to be evaluated as part of tender

Main activities	Observation/Advice
1. Education and training of technical staff.	It is essential to train technical staff in time. Education plans should be developed for each staff category.
2. Determine sites for achieving the roll-out requirements.	Coverage assessment, including population coverage with FX and PI should be made (see Section 4.4).
3. Determine the municipalities to be covered with PI in the 4 stages of the roll-out schedule.	List of municipalities should be provided. Coverage assessment made in main activity 2 will show the areas where PI coverage is needed in the 4 stages of the roll-out scheme (see Section 4.4).
4. Review of DTTB frequency plan.	See Section 4.4.
5. With regard to head-end configuration a. Reconsider initial choice of local services as part of each mux b. Take account of statistical multiplexing.	See Section 4.5. In allocating multiplex slots, the use of statistical multiplexing should be taken into account.
6. Evaluation of distribution network.	See section 4.5. In order to protect satellite TV, cable TV viewers, distribution of DTTB signals should not affect satellite and cable TV reception.

4.3 Network planning

Brief description	Iterative process of achieving optimal coverage and multiplex capacity using several system parameters and varying radiation characteristics. Several network plans are likely to be made (e.g. before and after ASO, for rooftop and indoor reception, with normalized and calculated transmitting antenna characteristics, or for testing different service quality or coverage targets).
Objective	Basis for verifying service proposition and financing (see functional building blocks 2.9, 3.2 and 3.4).

Key topics and choices	Status	Decision
4.3.1 Specification of station characteristics	B	Initial DTTB plan
4.3.2 Coverage analysis	C	
4.3.3 SFN or MFN	A(p) B(p) D	• Main stations MFN • SFN to cover municipalities (to be specified) with PI reception • Fill-in transmitters in MFN an SFN if technically possible
4.3.4 Fill-in transmitters	B	140 fill-in transmitters in initial DTTB plan
4.3.5 Feed back to business plan and service proposition	C	

Main activities	Observation/Advice
1. With regard to frequency planning a. Agree on propagation model and planning method as part of planning software package b. Determination of ERP to match ATV and compatibility analysis.	In order to avoid continued discussions on planning results and coverage presentations the NRT should agree on planning method including propagation model. See Section 4.4
2. Coverage analysis Coverage presentations and a list of stations characteristics are the result of a network planning exercise and form the key tools for analysis coverage.	Coverage plots should be prepared using network planning software that takes into account: 1. Accurate terrain and clutter data; 2. Transmitter database of operational and planned stations (analogue and digital) including stations from neighbouring countries; 3. See also main activity 2 of functional building block 4.2.
3. SFN planning to cover about 200 municipalities with PI reception	Sites identified in main activity 2 of functional building block 4.2. SFN planning, see Section 4.4

Main activities	Observation/Advice
4. Gap-filler planning Gap-fillers, also called fill-in stations, are often fed off-air from a main transmitter but may be fed by satellite. The transmission frequency can be different from the received frequency (MFN operation) or the same as the received frequency (SFN operation).	See Section 4.4 Detailed coverage analysis resulting from main activity 2 and including SFN planning from main activity 3, will show areas where coverage can be improved by means of gap-fillers. In general the receiving antennas of gap-filler need line-of-sight with the main transmitter. In case of SFN operation, the power of gap-fillers is restricted, depending on the isolation between input and output signal. Gapfiller planning (including SFN power levels and line of sight calculations) is often part of planning software package.
5. Carrying out "service trade-off" Radiation characteristics, multiplex capacity coverage quality are interrelated.	The "service trade off" should be carried out to find the optimum balance between multiplex capacity and coverage quality. If no satisfactory solutions can be found in the "service trade-off" a review is needed of costumer proposition, business case and/or design principles and network architecture.

4.4 System parameters

Brief description	Parameters related to the DTTB transmission standard.
Objective	Selecting system parameter by trading-off between coverage, multiplex bit rate and radiation characteristics, serving as input in the initial network planning.

Key topics and choices	Status	Decision
4.4.1 FFT size	B(p)	16k or 32k
4.4.2 Carrier modulation and code rate	B(p)/D	Three possible system variant are indicated in the initial DTTB plan. To be verified and possibly modified by "service trade-off" (see 4.3.1).
4.4.3 Guard interval and Pilot Pattern (PP)	B(p)/D	Initial choice is a result of the three possible system variant indicated in the initial DTTB plan (28 µs, 112 µs or 448 µs). Pilot pattern: PP7, PP4 or PP1

Main activities	Observation/Advice
1. Evaluation of carrier modulation, code rate, guard interval and Pilot Pattern	See Section 4.4. Coverage analysis and evaluating the net bit rate of the multiplex through the "service trade off" should verify the initial choice (see main activity 5 of functional building block 4.3). Characteristics (including guard interval) should be the same for all transmitters fed by a TS.

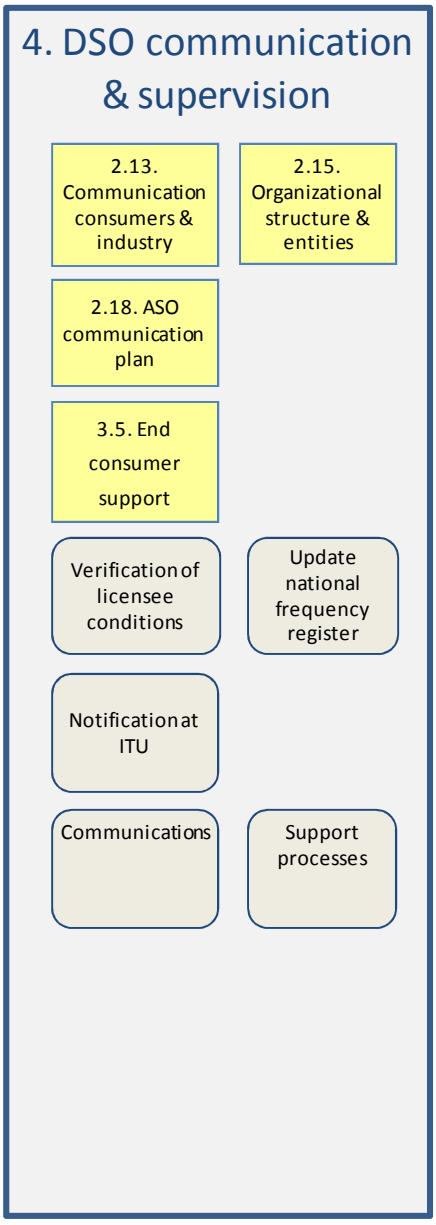
4.5 Radiation characteristics

Brief description	Determination of transmitter power and transmitting antenna gain in order to achieve the required or allowed effective radiated power and configuration of the optimum antenna diagram and polarization.
Objective	Specification of transmitter power, antenna gain and antenna diagram as input for initial network planning.

Key topics and choices	Status	Decision
4.5.1 Transmitter power and transmitting antenna gain	B(p)	As in initial DTTB plan.
4.5.2 Polarization	C	
4.5.3 Use of existing antennas or need for new antennas	A(p)	In order to achieve low cost operations as much as possible, licensees are encouraged to use existing transmitting infrastructure. Choice to be made by network provider.

Main activities	Observation/Advice
1. Verification of transmitter power and antenna gain.	To be verified and may be modified by "service trade-off" (see 4.3.1). See Section 4.4. ERP should be sufficient to match ATV coverage and to achieve PI requirements.
2. Determining the polarization of the transmitting antennas.	As indoor antennas are mainly vertically polarized and in case there are very few (horizontally polarized) existing rooftop antennas, vertical polarization of transmitting antennas could be considered. However, if existing transmitting antennas are used, polarization will be horizontal. See also ITU Guidelines Section 4.5.2.

Annex 3: Functional building blocks related to Phase 4 of the roadmap



The selected functional building blocks related to Phase 4 of the roadmap are shown in Figure 3.13 and are reproduced here.

Section 3.4.5 describes Phase 4 of the roadmap.

This Annex gives an overview in the form of tables of the status of each of the selected functional building blocks related to Phase 1 by means of the following codes:

a. the decisions on key topic and choices that are already taken (between brackets the following identifiers: L = Law; n = notification; im = information memorandum and p = in preparation);

b. the decisions on key topic and choices that are partly taken;

c. the activities needed regarding key topic and choices that have not yet been decided;

d. the activities needed regarding key topic and choices that need revision.

For those issues that are not (fully) decided or need revision the main activities are indicated.

The selected functional building blocks are presented in the order of the number of the block. This number refers to the corresponding chapter in the ITU Guidelines, where more information and implementation guidelines can be found.

The grey blocks are not described in the ITU Guidelines and are not described in the tables below. These blocks represent activities that are not specific to digital terrestrial television.

2.13 Communication to end-consumers and industry

Brief description	Informing the public at large and the television industry about the changes in the areas of legislation, policies and regulations (related to the introduction of DTTB) is a government led task.
Objective	Informing the end-consumers and the industry is an important element of policy execution. Providing adequate and timely information will ensure and support a rapid service take-up, a profound market development (i.e. content development and receiver supply/availability) and a smooth service transition.

Key topics and choices	Status	Decision
2.13.1 Scope of regulator led communications: has the scope been defined?	C	This process is in essence no different from other policies and regulations the NBTC publishes in other fields (like radio or mobile communications).
2.13.2 DTTB communication moments and topics: has the communication moments been identified and determined (see table in this paragraph)?	C	

Main activities	Observation/Advice
1. Make inventory of communication scope.	
2. Determining the key communication moments and topics.	
3. Determine communication tools for each target group/audience.	Could include call centre operations (see Section 3.4.5).
4. Check that the information provided is balanced, transparent, timely and equally available to interested parties.	Especially parties having interests in other television platforms (like satellite and cable) will be critical and will check whether the provided information (and aid) is not favouring a specific platform.
5. Instruct communication bodies and committees.	

2.15 Organizational structure and entities

Brief description	The ASO process is a complex and time consuming operation and a special purpose entity (e.g. Task Force, Committee or separate company) may coordinate the overall process and planning. The ASO process is a joined effort between the Legislator, Regulator(s), Content Aggregators (i.e. public and commercial broadcasters), Distributors (i.e. broadcast network operators for all platforms), Device Creators (i.e. receiver equipment producers and retailers) and end-consumer associations.
Objective	A coordinated ASO process between all involved parties and stakeholders.

Key topics and choices	Status	Decision
2.15.1 Organizational D/ASO structures and entities: D/ASO organization completed and in place?	C	
2.15.2 D/ASO costs and support: D/ASO cost analysed and determined (use table in this section)	C	

Main activities	Observation/Advice
1. Establish overall coordination needs.	These activities will become relevant as soon as the NRT has set (an early) ASO date. So whether these activities have to be carried out is conditional to setting this ASO date.
2. Form or extent special purpose vehicle, establish clear mandate.	
3. Establish budget and communication means (air-time, website, etc.).	

2.18 ASO communication plan

Brief description	This section focuses on ASO communication to the effected viewers.
Objective	To help viewers prepare adequately for ASO. For this purpose the whole broadcast community (including the regulator) needs to address all viewers relying on the analogue terrestrial platform using targeted communication tools that can reach out to diverse population segments.

Key topics and choices	Status	Decision
2.18.1 Communication strategy: including communication messages (related to the communication stage) and target group(see phased model)	C	
2.18.2 Communication tools: the various communication means to reach the listed target groups	C	

Main activities	Observation/Advice
1. Draft communication plan (including target audiences, timing, means, etc.).	These activities will become relevant as soon as the NRT has set (an early) ASO date. So whether these activities have to be carried out is conditional to setting this ASO date.
2. Continuous alignment with ASO planning.	
3. Determine and establish compensation schemes and systems, include in communication plan.	

3.5 End consumer support

Brief description	This section focuses on the key choices to be made when designing the customer/end-consumer service and support processes for DTTB services.
Objective	Design of Consumer Support function that supports the Business Plan or DSO objectives.

Key topics and choices	Status	Decision
3.5.1 Customer call centre operations (as part of the CRM sub-processes of subscription management and customer service and support)	C	
3.5.2 Retail shops and other channels (as part of the CRM sub-process of subscription management)	C	
3.5.3 Service availability checks and tools (as part of the CRM sub-process of subscription management)	C	

Main activities	Observation/Advice
1. Determine the scope of NRT end consumer support responsibilities in terms of target groups as well as in the means of support.	
2. Check possible future relationships with ASO plan and determine impact.	See the functional building blocks 2.14 and 2.16 (in Section 3.4.3 of the second Phase of the roadmap) where an initial ASO model and planning was determined.
3. Consult involved market parties, including the potential service and network licensees, retailers, installation companies and consumer associations.	
4. Draft end-consumer support and communication plan and processes. Determine means and budget. Align with involved market parties and possibly with public finance planning.	