

CAMBODIA

R o a d m a p f o r t h e TRANSITION FROM ANALOGUE TO DIGITAL TERRESTRIAL TELEVISION IN C A M B O D I A



D E C E M B E R 2 0 1 1
Telecommunication Development Sector



Transition from analogue to digital terrestrial television in Cambodia

Roadmap

December 2011



The roadmap for the transition to digital terrestrial television in Cambodia has been prepared in the framework of the ITU digital broadcasting project. This project's objective is to assist countries in setting out their own roadmap and to shift smoothly from analogue to Digital Terrestrial Television Broadcasting (DTTB) and to introduce Mobile Television (MTV).

This report was prepared by the National Roadmap Team (NRT) of the Cambodia Government assisted by ITU experts: Peter Walop, Gu-Yeon Hwang, and Jan Doeven.

Foreword

The process of transition from analogue to digital broadcasting offers advantages in terms of spectrum efficiency, higher video and audio quality and new business opportunities. It also offers the opportunity to allocate part of the broadcasting band to International Mobile Telecommunication (IMT) services and other applications.

In all ITU regions the transition from analogue to digital broadcasting has started. In a number of countries (e.g. the USA and many countries in the European Union) analogue switch-off has been completed. Most developing countries are also considering digital switch-over or have started the process. To support developing Member States to overcome the challenges and migrate smoothly from analogue to digital broadcasting ITU developed a programme to help countries to reap the full benefits of spectrum efficiency, and covers terrestrial TV, mobile TV and sound broadcasting.

In May 2010, the ITU published a comprehensive set of guidelines for the transition from analogue to digital broadcasting under this programme. These guidelines were developed for the Africa region. A version for the Asia-Pacific region will be published soon.

In a further effort to help countries to switch over to digital broadcasting, ITU has been helping countries to draft a roadmap, and Cambodia is one of the countries receiving further assistance.

From March to May 2011, the roadmap for transition from analogue to digital terrestrial television in Cambodia was jointly developed by a team of ITU experts and the National Roadmap Team (NRT) of the Cambodia Government.

I would like to commend the ITU experts, Mr Jan Doeven, Mr Peter Walop and Mr Gu-Yeon Hwang who have developed the roadmap through their excellent expertise and experience, as well as to give special thanks to the Cambodia National Roadmap Team.

Also, I very much appreciate the active support of the Ministry of Information (MOI), Cambodia, Ministry of Posts and Telecommunications of Cambodia (MPTC) and the support of the Korea Communications Commission (KCC) in facilitating the work of the ITU experts.

I am confident that this report will help the Cambodia Government in reaching their digital switch-over objectives.



Brahima Sanou
Director
Telecommunication Development Bureau
International Telecommunication Union

Executive summary

The roadmap for transition from analogue to digital television in Cambodia has been prepared by the National Roadmap Team (NRT) and ITU experts in the period from March to May 2011.

The main observations and conclusions of the Roadmap are summarized below.

Scope of the roadmap

- a. The roadmap for transition from analogue to digital television in Cambodia covers the short-term digital switch-over (DSO) objectives (until about one year after analogue TV switch-off, see also item c) and the activities managed by NRT. The roadmap does **not** include:
 - The introduction of Mobile TV (MTV), because in Cambodia four MTV networks using the T-DMB standard have already been planned and a licence for T-DMB operation in TV channel 10 has been granted to the Cambodia public service broadcaster, TV Cambodia (TVK), as multiplex and network operator.
 - The introduction of digital radio.
- b. The Cambodia television market is characterized by a great number of national TV services and a wide choice of TV platforms (analogue and digital terrestrial, analogue and digital cable, Internet Protocol Television (IPTV) and satellite TV). Thirteen analogue TV services provided by 11 broadcasters can or will be soon received in Phnom Penh and a lower number in other parts of the country. In addition, a package of 60 digital terrestrial TV services provided by cable operator Phnom Penh Cable Television company (PPCTV) is offered in Phnom Penh.
- c. The aim of the roadmap is to help Cambodia to reach the DSO objectives. These objectives are divided into short-term (about 1 year after analogue switch-off) and long-term (5 to 10 years after analogue switch-off) objectives. The objectives are shown in table 1.
- d. The duration of the transition process from analogue to digital television cannot yet be determined. The NRT has the ambition to switch-off all analogue terrestrial television services by the end of 2015 at the earliest (or 2018 as possibly the latest). As long as the final switch-off date has not been decided (and politically endorsed), the roadmap duration varies from five to eight years.
- e. The scope of the activities involved in the roadmap depends on the licensing model that will be adopted. In the digital television value chain a new entity needs to be established: the multiplex operator. The multiplex operator combines the program streams of the broadcasters into so-called Transport Streams to be distributed to the transmitters. The tasks of the multiplex operator together with the tasks of the transmitter network operator can be assigned to each individual broadcaster (licensing model A) or to a common multiplex and network operator (licensing model B). In the latter case the roadmap includes more activities. The two licensing models have distinct advantages and disadvantages.
- f. The input and output documents of the phases of the roadmap related to licensing model B (common multiplex and network operator) are summarized in table 2. In case licensing model A is adopted, the preparation of the output documents indicated in Phase 4 (planning and implementation DTTB networks) is not managed by the NRT, but by the individual broadcasters.
- g. The decisions taken, partly taken and not yet taken on the key topic and choices regarding phases 1 to 4 of the roadmap and the activities required to prepare the decisions that are still pending, are indicated in annexes 1 to 4.

TABLE 1
DSO objectives

No	Objective	Short term (1 year after analogue switch-off)	Long term (5-10 years after analogue switch-off)
1	Smooth transition from analogue to digital	<ul style="list-style-type: none"> All analogue services converted to digital with same coverage areas Simulcasting: <ul style="list-style-type: none"> Phasing Test area 	
2	End of transition in < 2018 (aligned with neighbouring countries)	<ul style="list-style-type: none"> Exact year, date and hour still to be determined 	
3	New entrants/services (after digital frequency plan has been completed)	<ul style="list-style-type: none"> Additional digital service per location (not same bouquet on all locations) May be new digital broadcasters 	<ul style="list-style-type: none"> New digital broadcasters
4	Extended population coverage	<ul style="list-style-type: none"> Additional locations 	<ul style="list-style-type: none"> All locations same services
5	Better picture quality	<ul style="list-style-type: none"> Noise free and stable picture Widescreen (16 x 9) SDTV 	<ul style="list-style-type: none"> (HDTV up to the market, although reserve spectrum)
6	Lower costs	<ul style="list-style-type: none"> Minimize viewer migration costs: <ul style="list-style-type: none"> STB/Antenna Installation 	<ul style="list-style-type: none"> Network operations
7	Digital dividend	<ul style="list-style-type: none"> Reallocation of channels above 48/60 (as decided in APT) 	

TABLE 2
Input and output documents of the phases of the roadmap for licensing model B.

Roadmap Phase	Input documents	Output documents
1. DTTB policy development	<ul style="list-style-type: none"> International Agreements National telecommunication, broadcasting and media acts Existing policy documents and objectives 	<ul style="list-style-type: none"> Digital terrestrial television broadcasting policy
2. Analogue-Switch-Off planning	<ul style="list-style-type: none"> Digital terrestrial television broadcasting policy 	<ul style="list-style-type: none"> Initial frequency plan Analogue-Switch-Off plan
3. Licensing policy and regulation	<ul style="list-style-type: none"> Digital terrestrial television broadcasting policy Analogue-Switch-Off plan 	<ul style="list-style-type: none"> National coordinated frequency plan International coordinated frequency plan Licence terms and conditions Licensing procedure and planning
4. Planning and implementation DTTB networks	<ul style="list-style-type: none"> International coordinated frequency plan Licensing procedure and planning 	<ul style="list-style-type: none"> DTTB implementation plan Detailed coverage presentations Notification at MPTC and MOI Order to put DTTB site into operation
5. Licence administration	<ul style="list-style-type: none"> Notification at MPTC and MOI 	<ul style="list-style-type: none"> DTTB station approval by MPTC DTTB station recorded in ITU- Master International Frequency Register

Recommendations

- a. The NRT is recommended to carry out the following next steps for a smooth transition to digital television broadcasting and switching off the analogue services:
 1. Get the roadmap report approved at either ministerial level and/or political level;
 2. After approval, acquire a mandate to plan and manage the analogue switch-off (ASO) process in accordance to the phases of the roadmap. As indicated in the roadmap report, this mandate may come in stages;
 3. Once mandated, prepare and take the following decisions as the first of the roadmap as these decisions are needed to determine the scope and duration of the roadmap planning:
 - Determine ASO date and the date of the first Digital Terrestrial Television Broadcasting (DTTB) transmissions. The latter is also relevant for the selection of the transmissions standard. An adoption of the DVB-T2 standard will open up more solutions and will significantly impact the frequency planning activities.
 - Determine ASO model (phased simulcasting or not) .
 - Licensing model (model A or B). In the case of model B this decision should also include whether a public-private partnership is envisioned.
 - Determine the date to stop licensing analogue television services. The later decision is taken the more possibilities are excluded and the more complex the ASO will become.
 4. Form a project management office (PMO) and start drafting an initial detailed ASO planning and determine the progress reporting procedures and structures.
- b. Apart from these next steps for the NRT to take, some additional recommendations can be provided which seem to be evident for Cambodia:
 1. Have market research carried out covering the key elements as indicated in this roadmap report (see Phase 1). As indicated some key research data is lacking and starting an ASO process without this data could incorporate a major project risk.
 2. Carry out detailed frequency and service planning (see phases 2 and 3), regardless which licensing (model A/B) and transition model (simulcast or not) is selected. In Cambodia, spectrum is significantly limited by the large number of existing analogue services. Extensive and profound frequency planning will be required to see what is possible.
 3. Reserve capacity for the future services of DVB-T2 and DAB. Without such a capacity reservation it will be extremely difficult (or even impossible) to introduce these services at a later date or only against very high costs.
 4. As for the digital dividend, awaiting the success of the DTTB and mobile (Long Term Evolution (LTE) or IMT) services, the NRT could start the ASO planning process with 40 channels in Band IV/V. Depending on the proven success of the DTTB and mobile services, the number of channels available for broadcasting can be reduced to 29 channels at a later date.
 5. Investigate the possibilities of auctioning mobile (LTE or IMT) spectrum as an important means for financing the ASO process. This also includes the investigation of the possibilities of advancing the ASO costs as the proceeds of the auction will become available after ASO.

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Glossary of abbreviations

16-QAM	16-state Quadrature Amplitude Modulation
64-QAM	64-state Quadrature Amplitude Modulation
API	Application Programming Interface
APT	Asia-Pacific Telecommunity
ASEAN	Association of Southeast Asian Nations
ASO	Analogue switch-off
ATSC	Advanced Television Systems Committee
C/N	Carrier to Noise ratio
CA	Conditional Access
CAS	Conditional Access System
CTN	Cambodia Television Network, commercial broadcaster in Cambodia
dB	decibel
DRM	Digital Rights Management
DSO	Digital switch over
DTMB	Digital Terrestrial Multimedia Broadcast
DTTB	Digital Terrestrial Television Broadcasting
DTV	Satellite TV provider in Cambodia
DVB	Digital Video Broadcasting
DVB-T	Digital Video Broadcasting–Terrestrial
DVB-T2	Digital Video Broadcasting – Terrestrial 2 nd generation
Emed	Median minimum field strength
Emin	Minimum field strength
EPG	Electronic Program Guide
ERP	Effective Radiated Power
FCFS	First come, first served
FFT	Fast Fourier Transform
FTA	Free-To-Air
GDP	Gross Domestic Product
GE06	Geneva Agreement 2006
HDTV	High Definition Television
ID	Identification
IDTV	Integrated Digital Television set
IMT	International Mobile Telecommunications
IPTV	Internet Protocol Television
ISDB-T	Integrated Services Digital Broadcasting – Terrestrial
ITU-D	International Telecommunication Union – Development Sector
ITU-R	International Telecommunication Union – Radiocommunication Sector
LTE	Long Term Evolution, often marketed as 4G
MFN	Multi Frequency Network
MHP	Multimedia Home Platform
MIRF	Master International Frequency Register

MOI	Ministry of Information in Cambodia
MPEG	Moving Picture Expert Group
MPTC	Ministry of Posts and Telecommunications of Cambodia
MTV	Mobile Television
NA	Not applicable
NRT	National Roadmap Team
NSP	National Spectrum Plan
OPN	Open Network Provisioning
PAL	Phase Alternating Line; analogue colour TV system
PMO	Project Management Office
PP	Phnom Penh
PPCTV	Phnom Penh Cable Television company
PPP	Public Private Partnership
PSB	Public Service Broadcasting
QPSK	Quadrature Phase Shift Keying
RR	Radio Regulations
SDTV	Standard Definition Television
SFN	Single Frequency Network
SMS	Short Message Service
SMS	Subscriber Management System
SSU	System Software Updates
STB	Set-Top-Box
T-DAB	Terrestrial – Digital Audio Broadcasting
T-DMB	Terrestrial – Digital Multimedia Broadcasting
TRC	Telecommunications Regulator Cambodia
TVHH	Television households
TVK	TV Cambodia (Cambodia public service broadcaster)
UHF	Ultra High Frequencies (frequency range between 300 and 3000 MHz)
VHF	Very High Frequencies (frequency range between 30 and 300 MHz)
WRC-07	World Radiocommunications Conference 2007
WRC-12	World Radiocommunications Conference 2012

1 Introduction

ITU has published guidelines for the transition from analogue to digital broadcasting¹ (referred to as the Guidelines). The Guidelines provide assistance to Member States to smoothly migrate from analogue to digital broadcasting. In a further effort to help countries to switch over to digital broadcasting ITU helps Members to draft their national roadmaps for this digital switch-over (DSO) process. Cambodia is one of the Member States receiving further assistance.

The roadmap for transition from analogue to digital terrestrial television in Cambodia has been jointly developed by a team of ITU experts consisting of Peter Walop, Jan Doeven Gu-Yeon Hwang and the Cambodia National Roadmap Team (NRT). The NRT is chaired by H.E. Ouk Pratrana, Secretary of State of the Ministry of Information, with Mr Nuth Bophann, Deputy Director General of Information and Broadcasting of the Ministry of Information as permanent Vice Chair. The NRT consists of representatives from the following organisations:

- Ministry of Information (MOI);
- Ministry of Posts and Telecommunications of Cambodia (MPTC);
- TVK (public TV service broadcaster);
- NRK (public radio service broadcaster);
- Bayon TV (commercial broadcaster);
- PPCTV (cable TV operator and DVB-T service provider);
- DMB World Co. (Mobile TV provider);
- CFOCN (Optical Fibre Network and DTMB operator).

Representatives of CTN (commercial broadcaster) attended the meetings with the ITU experts, at the invitation of the MOI.

The Cambodia TV market, with an estimated 2.4 million TV households, is mainly a terrestrial TV market with a very high number of analogue terrestrial TV services (13). There is a wide choice of TV delivery platforms; in addition to analogue terrestrial TV, there is also digital TV satellite, analogue and digital cable TV, IPTV and in Phnom Penh digital terrestrial TV (with an offer of 60 services).

In 2010, the Cambodia Gross Domestic Product (GDP) per capita was USD 814² and continues to grow rapidly. This relatively low GDP figure and the very competitive TV market mark one of the great challenges for the DSO process. Digital switch-over can only succeed if the costs for the government, the broadcasters and the viewers are kept low. On the other hand transition to digital television will offer great advantages. The viewer will have more services and better picture quality, the broadcasters can offer new services and network costs can be reduced. The government can achieve more efficient use of the frequency spectrum and may allocate part of the broadcasting band to mobile communication services.

The ITU assistance to Cambodia consisted of four key activities:

1. Preparation and first country visit to collect information.
2. Drafting roadmap report.
3. 2nd country visit to present and discuss the draft roadmap report.
4. Drafting final roadmap report.

¹ The guidelines for transition from analogue to digital broadcasting can be found at www.itu.int/publ/D-HDB-GUIDELINES.01-2010/en

² World Economic Outlook Database of the International Monetary Fund.

The experts who prepared the Guidelines for the transition to digital broadcasting visited Cambodia from 15 to 24 March 2011 and from 3 to 6 May 2011. During the first visit, the experts together with the NRT prepared:

- an analysis of the TV market and regulatory situation;
- an overview of short-term and long-term DSO objectives; and
- an inventory of decisions (partly) taken regarding key objectives and choices with respect to the functional building blocks in scope.

After the first visit the experts prepared a draft roadmap report. During the second visit, the draft report and the contributions made by the NRT were discussed and evaluated, resulting in an agreed list of changes to the draft report. Finally, the experts prepared the *Roadmap for the transition from analogue to digital terrestrial television in Cambodia*.

In the following sections, the current situation and DSO objectives will be addressed in section 2. Section 3 shows the draft national roadmap for achieving the DSO objectives. Section 4 gives considerations regarding the top-10 key topics and choices.

Annexes 1 to 4 show in detail the decisions taken, partly taken and not yet taken on the key topic and choices regarding the DSO process in Cambodia. Also the activities required to prepare the decisions that are still pending, are indicated.

Additional information regarding DTTB transmission standards, coverage considerations and spectrum requirements is given in the annexes 5, 6 and 7.

2 Current TV market and DSO objectives

The starting point for developing the roadmap for transition to digital terrestrial television is an analysis of the current TV market and regulatory framework, described in section 2.1 and section 2.2 respectively. The aim of the roadmap is indicated by the DSO objectives, as described in section 2.3.

2.1 Market structure

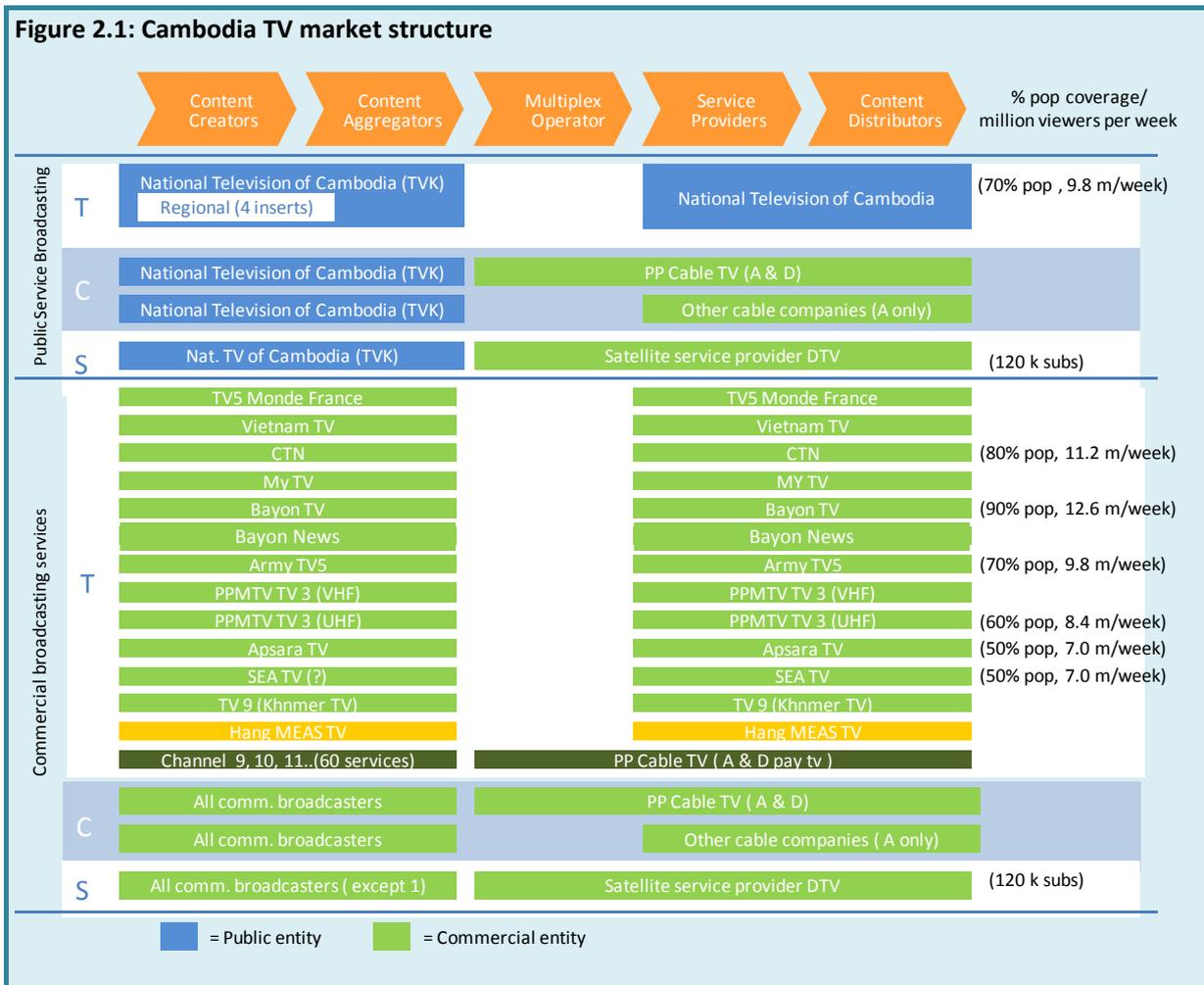
The Cambodia television market structure is shown in the Figure 2.1.

It is estimated that the total population in Cambodia is 15 million, the average household consists of five people and that 80 per cent of households has a TV set. Consequently, the total number of TV households (TVHH) is about 2.4 million.

The TV market is mainly a terrestrial TV market with a very high number of terrestrial TV services. Bayon TV, CTN and TVK are the main players. New services are foreseen; Hang Meas TV will come into operation soon and more TV services are envisaged.

A cable TV company (PPCTV) has been licensed for digital terrestrial TV and has nine DVB-T transmitters (and hence nine multiplexes) in operation in Phnom Penh using the DVB-T standard³. The offer consists of 60 services, 48 in a pay-tv package and 12 national TV services free-to-air. The STBs are PPCTV owned and on loan to subscribers. The installation fee is USD 50 and the subscription fee is USD 10 per month, or USD 50 for a six month service fee.

³ The output signal of the transmitters (each 1.4 kW) is combined in a single antenna of eight tiers at a height of about 120 m. It is understood that, although the compression system applied in the head-end is MPEG2, the STBs are equipped for MPEG4.



An indication of the frequency use of the current and planned analogue and digital TV and MTV services is given in Table 2.1. In addition to the services and channels indicated in Table 2.1, a number of TV assignments have been reserved for future use.

TABLE 2.1
Overview of TV frequency usage

Service	Standard	Number of sites	Channel in PP	Channels in provinces
TVK	B-PAL	6	7	Battambang 7, Kratie 7, Pursat 7, Ratanakiri 7, Sihanouk Ville 7,
CTN	G-PAL	9	21	Banteay Mean Chey 25, Battambang 21, Kampong Cham 24, Kampong Thom 29, Pursat 30, Sihanouk Ville 21, Siem Reap 23 Svay Rieng 26
My TV	G-PAL	9	29	Banteay Mean Chey 23, Battambang 23, Kampong Cham 28, Kampong Thom 22, Pursat 23, Sihanouk Ville 23, Siem Reap 26, Svay Rieng 24
Bayon TV	B/G-PAL	15	27	Banteay Mean Chey 27, Battambang 31, Kampong Cham 12, Kampong Thom 32, Kampot 25, Kratie 23, Preah Vihear 25, Pursat 27, Ratanakiri 23, , Sihanouk Ville 27, Siem Reap 8, Stung Treng 27, Svay Rieng 32
Bayon News	G-PAL	1	50	

Service	Standard	Number of sites	Channel in PP	Channels in provinces
ArmyTV ch5	B-PAL	5	5	Battambang 5, Kratie 5, Sihanouk Ville 5, Siem Reap 5
PPMTV3	B/G-PAL	5	3; 33	Battambang 12, Kampong Cham 10, Sihanouk Ville 12, Siem Reap 12
Apsara	B-PAL	1	11	
Sea TV	G-PAL	3	31	
TV9 (Khmer TV)	B/G-PAL	3	9	Battambang 29, Siem Reap 10
TV5 Monde France	G-PAL	1	23	
Vietnam TV	G-PAL	1	25	
Hang Meas TV	G-PAL	1	46	
PPCTV	DVB-T	1	36-44	
TVK-DMB	T-DMB	1	10	

In principle all terrestrial broadcasters are allowed to provide nationwide coverage, with the exception of PPTCV.

Cross border interference has been experienced in the following situations:

TABLE 2.2
Overview of experienced cross border interference

Channel	Area	Interference from
7	East part of Cambodia	Vietnam
21, 23, 27	Northwest part of Cambodia	Thailand
29	South part of Cambodia	Vietnam

As an example the sites of Bayon TV, the broadcaster with the most extended network, is shown in Figure 2.2.

The satellite platform of DTV offers a pay-TV package for USD 10 per month. The number of subscribers is currently estimated at 120 000.

Cable TV is offered by two companies in Phnom Penh (serving similar areas) and by 102 cable companies in the provinces. The offer is about 60 channels and the subscription fee is USD 10 per month or USD 50 for a six month service fee. The number of cable TV subscribers is estimated to be 30 per cent to 50 per cent of the TVHH.

executive tasks of spectrum management, while the Ministry of Posts and Telecommunications of Cambodia will deal with policy issues.

5. Private Public Partnerships are sources of financing the transition to digital TV in a number of countries (see section 2.9 of the Guidelines). This possibility is not excluded in Cambodia as foreign ownership in broadcasting and/or multiplex companies is allowed provided that it is restricted to a minority share.

TABLE 2.3
Regulatory framework

Relevant legislation	Arranges/Covers	Regulatory body	Assigned rights
Press Law	No impact on television market	Ministry of Information (MOI)	
Telecommunications Act in preparation	Covers all telecom markets, including broadcasting frequency aspects. It also includes competition rules. Telecom act will assign policy tasks to MPTC and executing tasks to Telecom Regulator Cambodia (TRC)	Ministry of Posts and Telecommunication of Cambodia (MPTC)	
Telecommunications Act	National Spectrum Allocation and managing NSP	MPTC/ Telecommunications Regulator Cambodia (TRC)	
Telecommunications Act	Licensing of transmitters	TRC	Spectrum rights
Law on copyrights and related rights	No impact on television market	Ministry of Culture and Fine Arts	
Sub 'decree'	Licensing of broadcasters	MOI	Content / broadcast rights
Proclamation on TV and Radio Standard	Setting transmission standards for digital television (DVB-T , DTMB, T-DMB)	MOI	
	No law or regulations for PSB (nor on tasks or funding)		

2.3 Digital switch-over objectives

The short and long term DSO objectives in Cambodia are indicated in section 2.3.1. The emphasis of these objectives is on DTTB services. As mobile television (MTV) provides a different broadcasting service, the MTV objectives are described separately in section 2.3.2. Digital radio may have an impact on TV spectrum use. For that reason, digital radio objectives are indicated in section 2.3.3.

2.3.1 Short- and long-term objectives

As mentioned in section 2.1, digital terrestrial television has started in Phnom Penh with the nine multiplexes PPCTV is providing. In addition, as a result of the DSO process all current analogue TV services will be digital and new digital services are envisaged. The objectives for DSO are shown in Table 2.4.

TABLE 2.4
DSO objectives

No	Objective	Short-term (1 year after ASO)	Long-term (5-10 years after ASO)
1	Smooth transition from analogue to digital	<ul style="list-style-type: none"> All analogue services converted to digital with same coverage areas Simulcasting : <ul style="list-style-type: none"> – Phasing – Test area 	
2	End of transition in < 2018 (aligned with neighbouring countries)	<ul style="list-style-type: none"> Exact year, date and hour still to be determined 	
3	New entrants/services (after digital frequency plan has been completed)	<ul style="list-style-type: none"> Additional digital service per location (not same bouquet on all locations) May be new digital broadcasters 	<ul style="list-style-type: none"> New digital broadcasters
4	Extended population coverage	<ul style="list-style-type: none"> Additional locations 	<ul style="list-style-type: none"> All locations same services
5	Better picture quality	<ul style="list-style-type: none"> Noise free and stable picture Widescreen (16 x 9) SDTV 	<ul style="list-style-type: none"> (HDTV up to the market, although reserve spectrum)
6	Lower costs	<ul style="list-style-type: none"> Minimize viewer migration costs: <ul style="list-style-type: none"> • STB/Antenna • Installation 	<ul style="list-style-type: none"> Network operations
7	Digital dividend	<ul style="list-style-type: none"> Reallocation of channels above 49/60 (as decided in APT) 	

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

1. A number of objectives (such as the number of services, the coverage of the services, lower costs and digital dividend) may be contradictory. After having analyzed the consequences in spectrum requirements and costs (for the viewer and the broadcaster) a number of objectives may need to be reviewed.
2. Realization of the DSO objective regarding the conversion of all analogue TV services to digital and the continuation of the DVB-T free-to-air services of PPCTV will result in dual coverage of ten national services in Phnom Penh and its surroundings. This situation should be avoided as it is not economic and spectrum efficient (see also section 4.10).

2.3.2 MTV objectives

MTV networks provide services for handheld and mobile receiving devices, using a dedicated MTV transmission standard. The international market prospective of MTV is variable. MTV services using the T-DMB standard are successfully implemented in Korea and Japan. However, in Europe a number of countries started MTV services using the DVB-H standard, and due to limited market take up, these DVB-H services have been stopped or will stop soon. On the other hand, multimedia services via mobile communication networks (3G and 4G) seem more promising.

In Cambodia, four MTV networks using the T-DMB standard have been planned⁴ and a licence for T-DMB operation in frequency block 10A, 10B, 10C and 10D has been granted to TVK as multiplex and network operator. MTV introduction has been planned in a phased approach, as summarized in Table 2.5.

TABLE 2.5
MTV introduction

Phase	Introduction	Frequency block	Location
1	2011	10A, 10B, 10C ^{*)}	Phnom Penh
2	2012	10A, 10B, 10C ^{*)}	Battambang, Siem Riep
3	2013	10A, 10B, 10C ^{*)}	Kampong Cham, Sihanouk Ville
4	2014	10D ^{*)}	Phnom Penh, Battambang, Siem Riep, Kampong Cham, Sihanouk Ville
5	2015	10A, 10B, 10C ^{*)} , 10D ^{*)}	Other regions

Source: Consulting report on Support for T-DMB Commercialization in Cambodia.

* Content to be decided.

With the licence issued and the project plan already drafted (see footnote 3), the purpose of a roadmap for MTV has been met. For that reason MTV networks are not part of the roadmap described in this report.

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

It should be noted that the content of frequency blocks 10C and 10D has not yet been decided. Future T-DMB requirements could therefore (partly) be accommodated in these frequency blocks.

2.3.3 Digital radio objectives

Digital radio is not in the scope of the roadmap for transition from analogue to digital television. However, frequency assignments for digital radio in Band III should be taken into account in the network planning. It is understood that the Ministry of Information is considering digital radio and may reserve one or more channels for T-DAB (or T-DAB+) in Band III.

In this light, it should be noted that the T-DMB multiplex includes a number of digital radio services.

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 Cambodia roadmap are shown. Section 3.4 describes each of the phases of the Cambodia roadmap.

The national roadmap will deal with digital terrestrial broadcasting only. Mobile TV is not included because a licence is granted and a project plan is available (see section 2.3.2).

⁴ See Consulting Report on Support for T-DMB Commercialization in Cambodia, December 2010 by KCC and KBS, directed by Mr Gu-Yeon Hwang.

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:

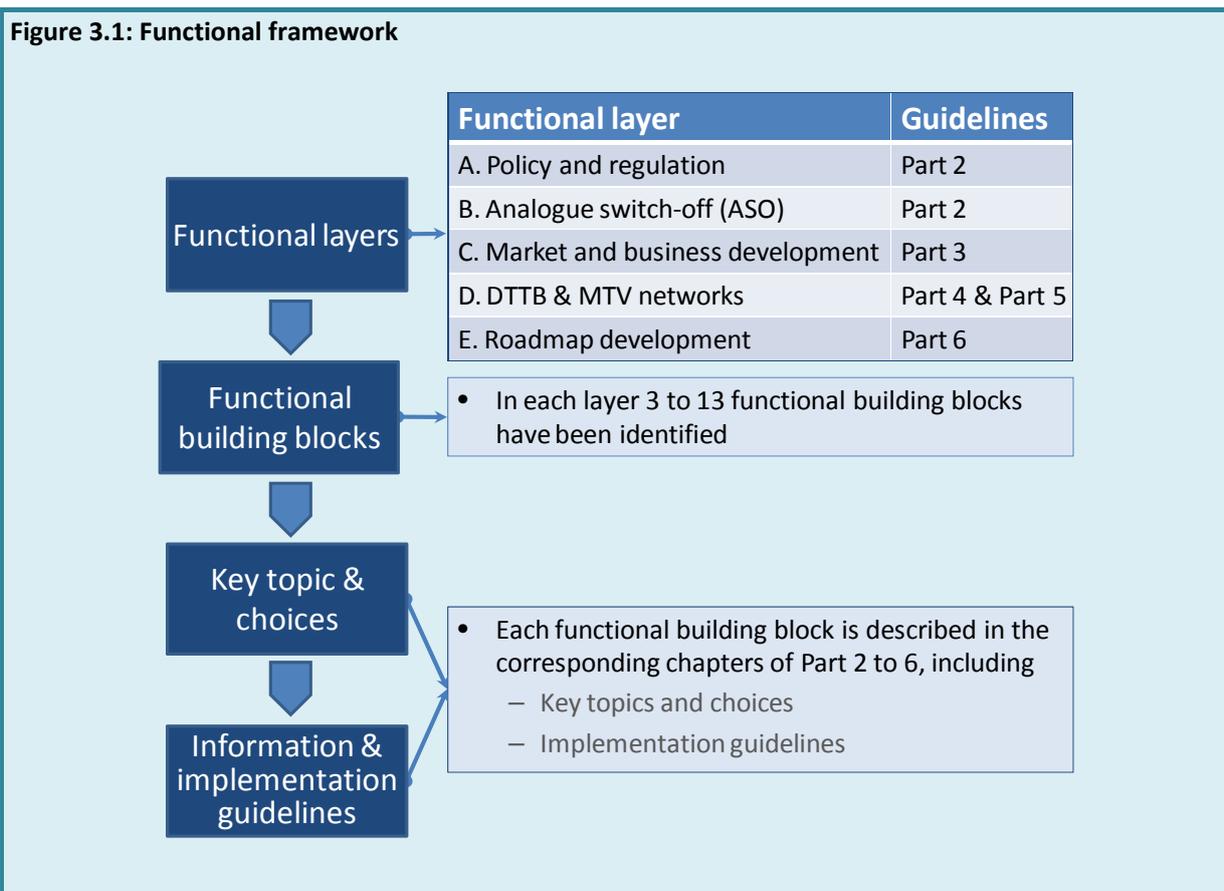
1. It helps to reach consensus about the requirements and solutions for transition to DTTB.
2. It provides a mechanism to help forecast the key miles stones for the transition to DTTB.
3. It provides a framework to help plan and coordinate the steps needed for transition to DTTB.

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

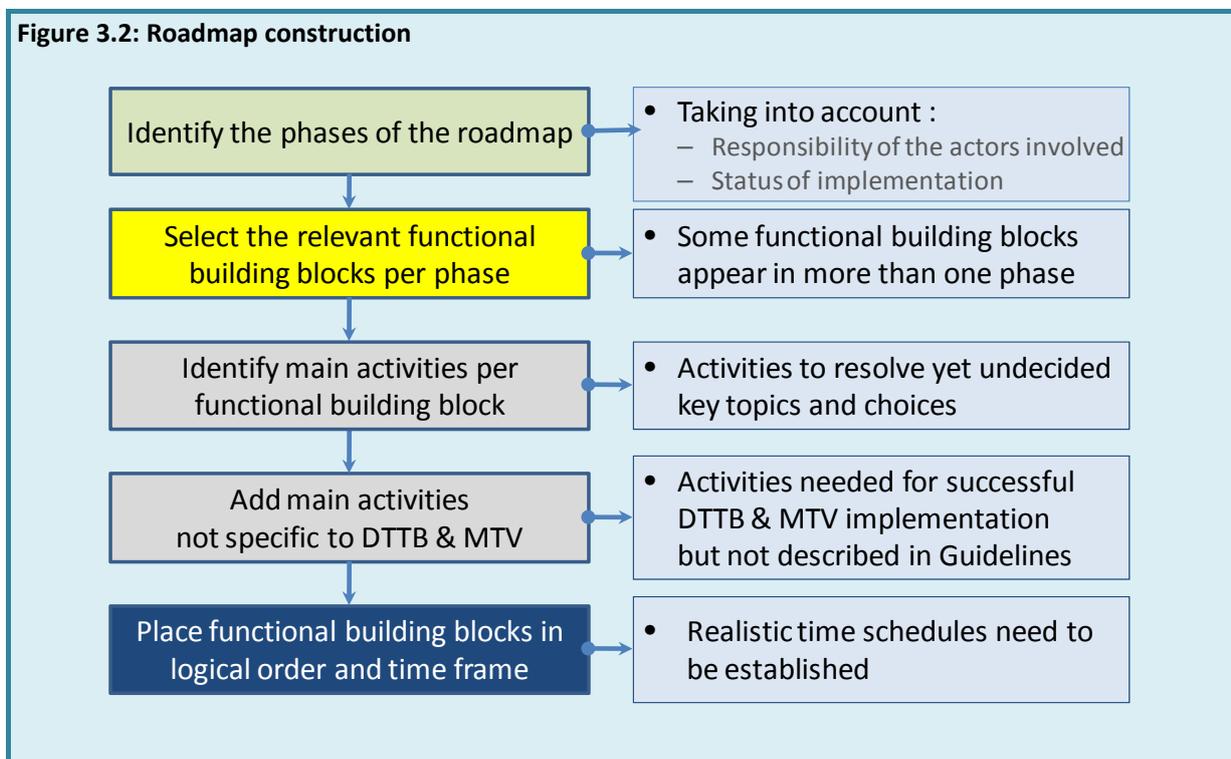
Part 6 of the Guidelines for transition to digital television describes a method for developing a roadmap. Also a set of generic roadmaps regarding the whole process of transition to DTTB and introduction of MTV is given. The methodology described in Part 6 of the Guidelines will be followed in the development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

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



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.



The result is a roadmap that consists of three levels:

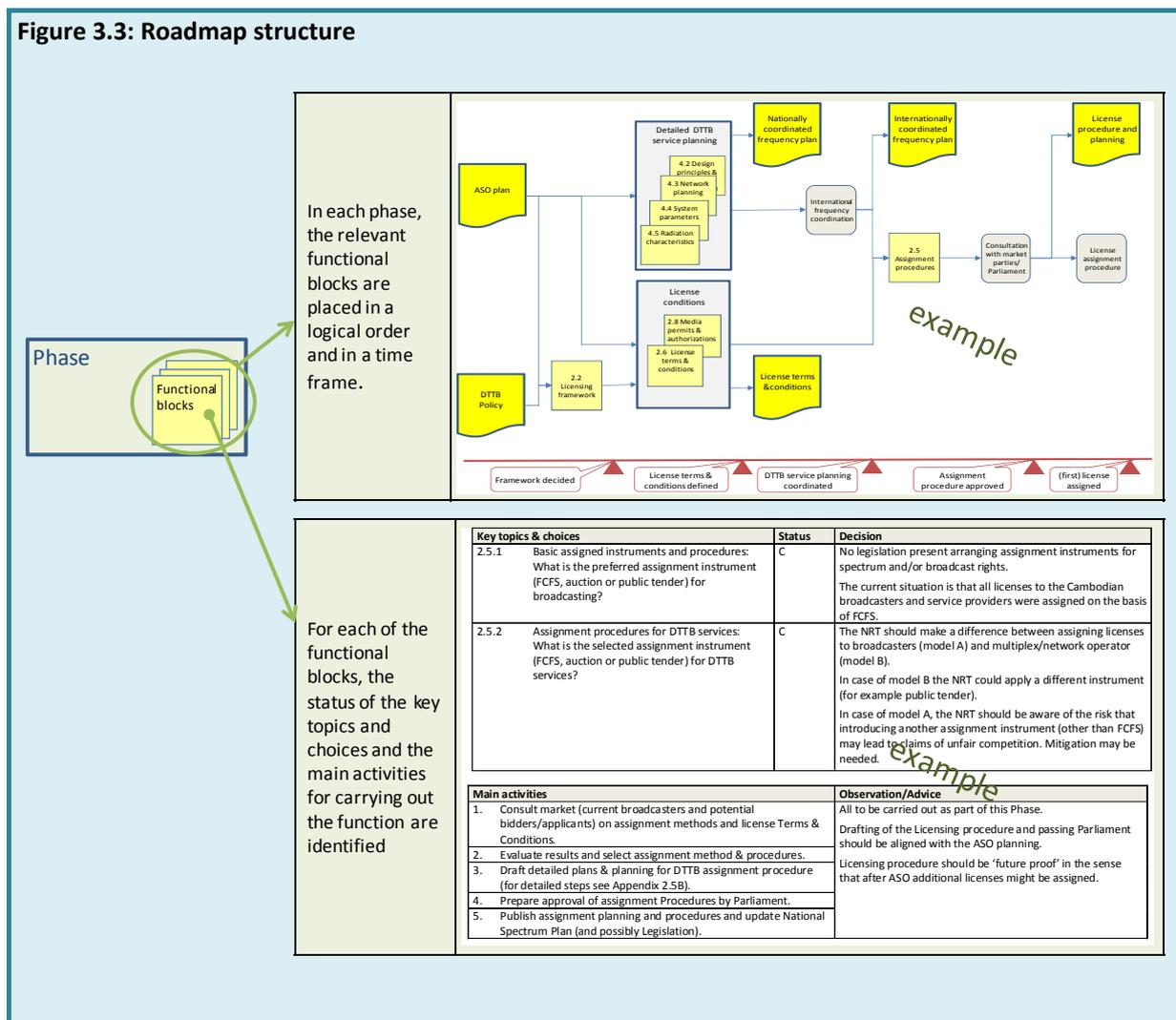
1. Phases of the roadmap with the selected functional building blocks per phase.
2. For each phase, the functional building blocks places in a logical order and time frame.
3. For each functional building block in a phase, the status on key topics and choices and the main activities to be carried out.

The roadmap structure is illustrated in Figure 3.3.

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 (Policy and regulation), B (Analogue switch-off), C (Market and business development), and D (Networks (DTTB and MTV)) have been considered and decisions which have (partly) been taken, and which still need to be taken, have been identified.

An overview of the status of the selected functional building blocks is given in Annexes 1 to 4.

Figure 3.3: Roadmap structure



3.3 Functional building blocks relevant to Cambodia

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 (Analogue switch-off), C (Market and Business Development) and D (Networks (DTTB and MTV)) contain in total 38 functional building blocks (see Figure 3.4). Out of the 38 functional building blocks, 26 blocks were selected to construct the Cambodia roadmap.

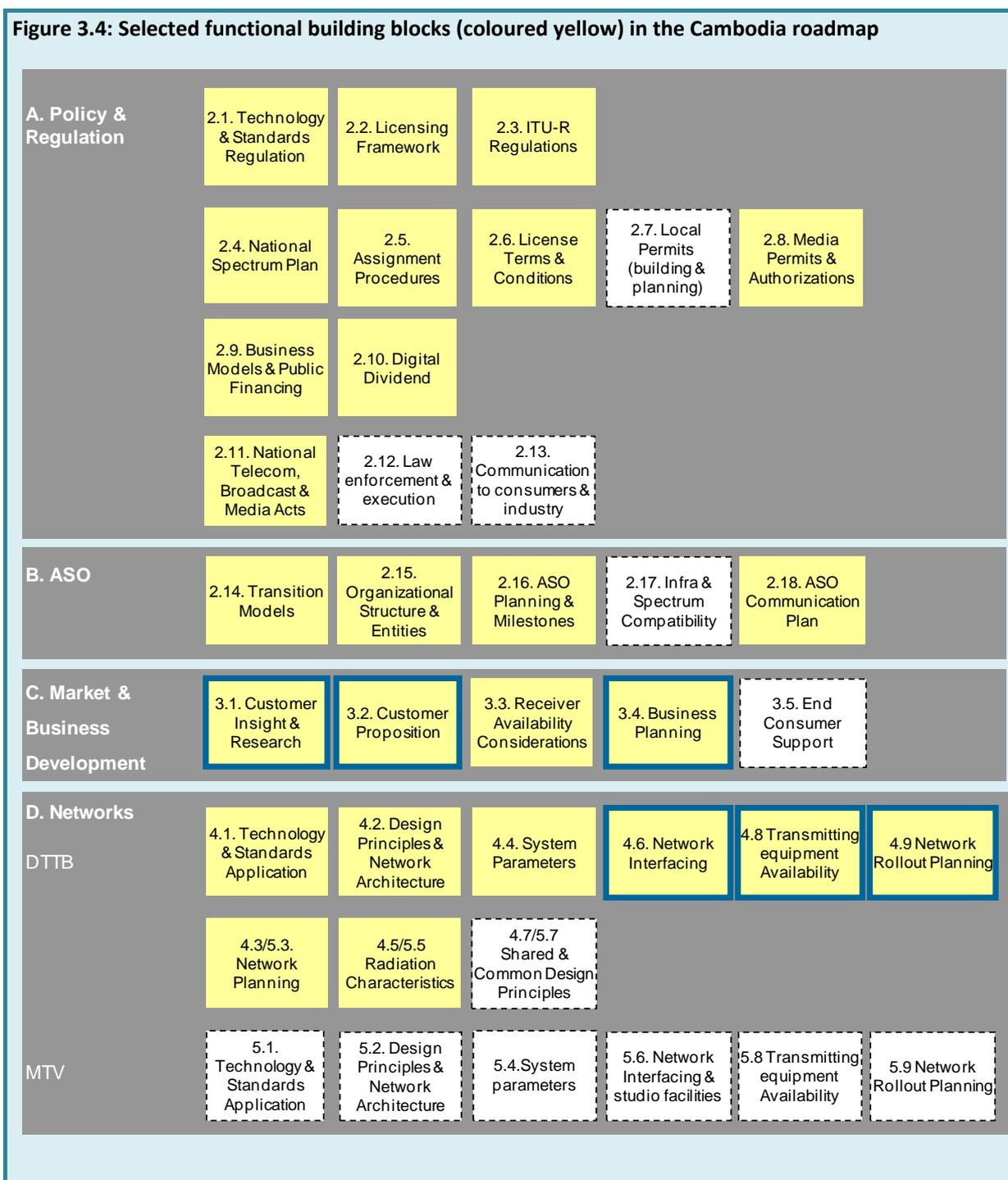
The roadmap covers:

- The short DSO objectives (until one year after ASO) as defined in Table 2.4.
- Activities managed by the NRT.

Figure 3.4 shows three types of functional building block:

1. **White coloured blocks with dashed frame**
These blocks are not be included in the Cambodia roadmap (see Table 3.1).
2. **Yellow coloured blocks without frame**
These blocks are included in the Cambodia roadmap and will be managed by the NRT.
3. **Yellow coloured blocks with a blue frame**
These blocks are included in the Cambodia roadmap and will be managed by the NRT in case licensing model B will be chosen. If model A is chosen these functional building blocks will be carried out by each individual DTTB licensed broadcaster (for more details see section 3.4).

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



The reasons for not including the white coloured 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

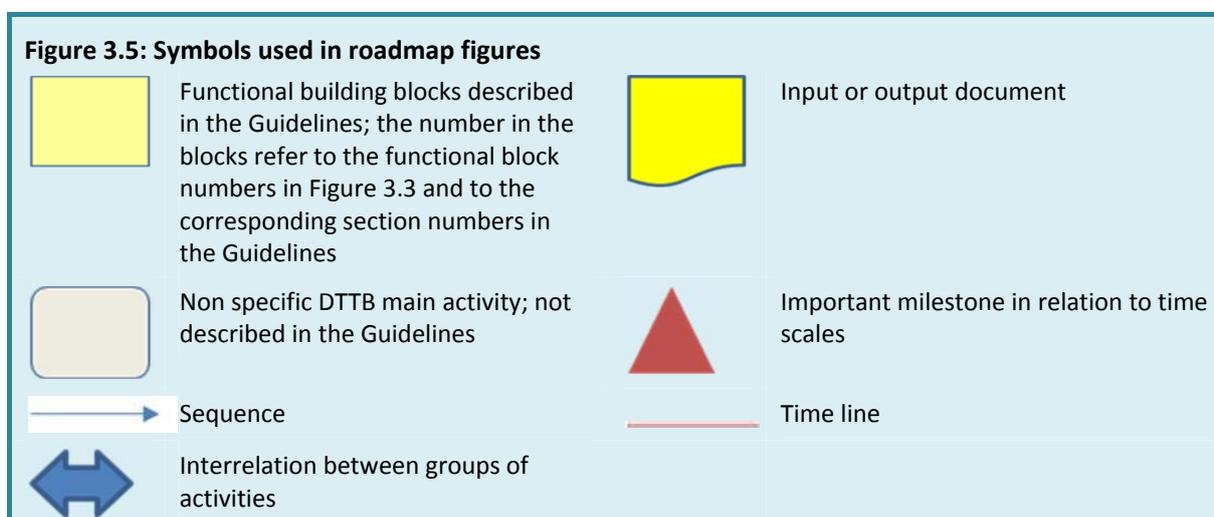
Not included functional building block		Reason
Number	Title	
2.7	Local permits (building and planning)	Limited or no regulatory framework in place in Cambodia
2.12	Law enforcement and execution	Restructuring of the regulatory framework may be considered but is not seen as a condition for the successful transition to digital television
2.13	Communication to consumers and industry	As the policy and regulation activities will all be carried out as part of the transition process, the activities related to 2.13 will be included in 2.18 (ASO communication plan)
2.17	Infra and spectrum compatibility	Infrastructure compatibility is not considered as a major issue in Cambodia. Spectrum compatibility during transition (between analogue and digital TV) will be covered in the national frequency plan
3.5	End consumer support	As the activities related to Market and business development will all be carried out as part of the transition process, the activities related to 3.5 will be included in 2.18 (ASO communication plan)
4.7	Shared and common design principles	The MTV network has been designed already
5.1 to 5.9	MTV networks (all functional building blocks)	Roadmap for MTV is not needed because MTV services have been planned and a licence has been granted (see section 2.3.2)

3.4 Description of the Cambodia roadmap

In this section, the overall roadmap for Cambodia is outlined. The roadmap is segmented in several phases. After presenting the 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 sections contain a number of figures. The symbols used in these figures have the following meaning:



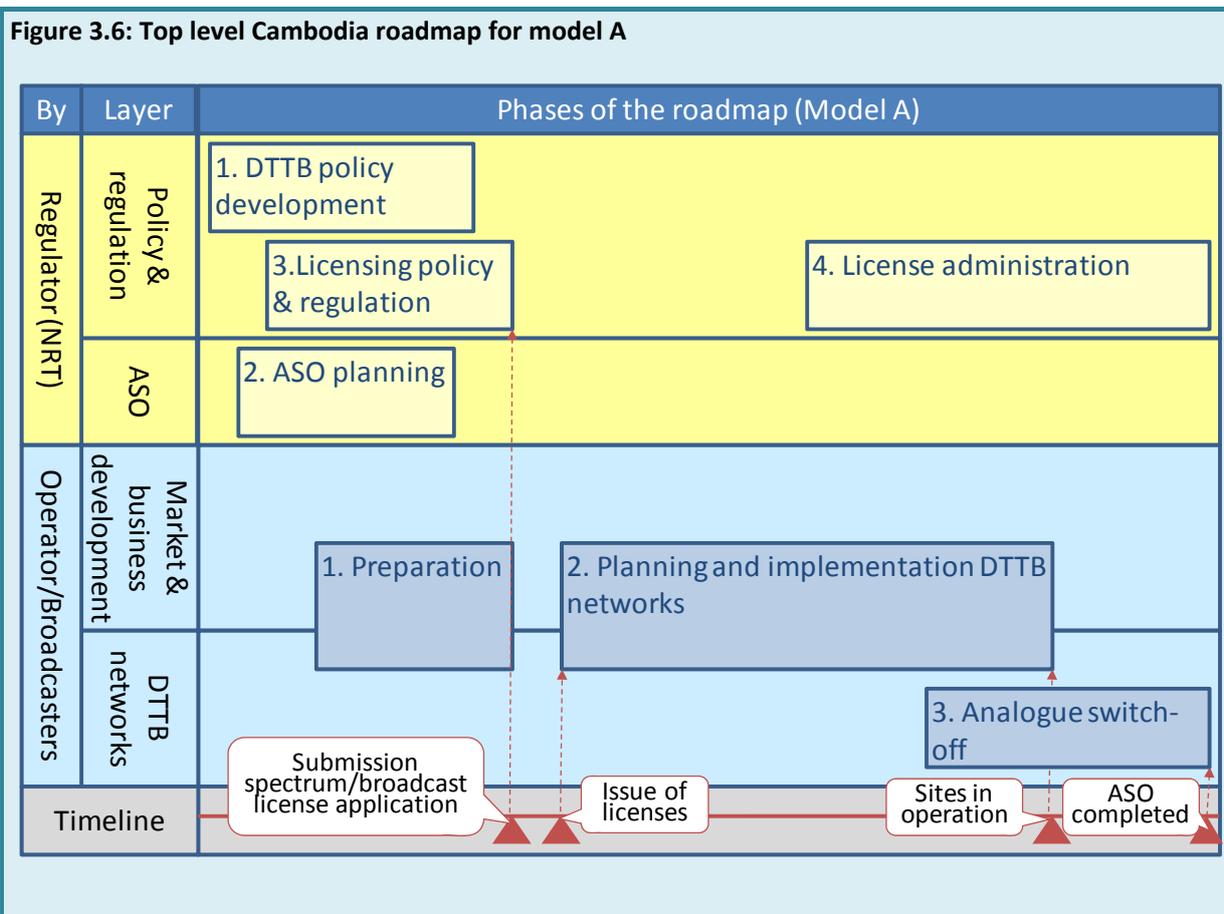
3.4.1 Roadmap overview

As discussed previously, the NRT has the ambition to switch off all analogue terrestrial television services by the end of 2015 at the earliest (or 2018 as possibly the latest). As long as the final switch-off date has not been decided (and politically endorsed), the roadmap duration varies considerably; from five to eight years. Therefore the duration of the phases in which the DTTB network is rolled out and the analogue transmitters are switched off can span a number of years.

Model A or B

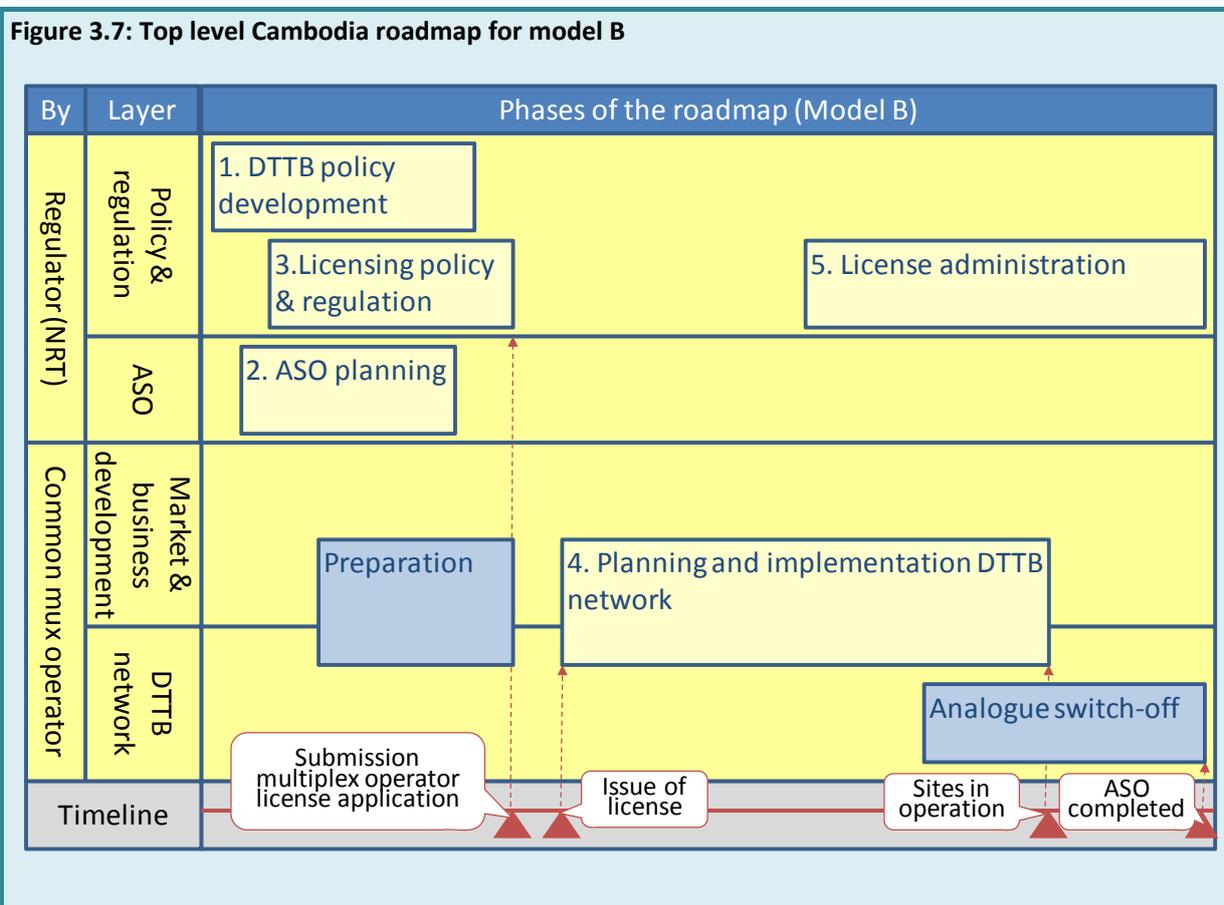
A key decision for the NRT to make is the selection of the licensing model (either model A or B)⁵. Selecting model B will result in additional functional building blocks to be included in the roadmap as the NRT will also resume responsibilities for rolling out a common DTTB network. In this way, after selecting the licensing framework an alternative branch in the roadmap will occur.

The figure below illustrates the various phases of the NRT roadmap for model A (i.e. the yellow shaded blocks). As shown in Figure 3.6, Phases 1, 2 and 3 are likely to be carried out partly in parallel because of the interrelationships between the issues to be decided. The figure also illustrates that the broadcasters assume the responsibility of the actual DTTB network roll-out (i.e. the blue shaded blocks). They prepare for acquisition of the necessary spectrum and broadcast licences (Phase 1 of the network operator), plan the network roll-out and implement the network (Phase 2).



⁵ See the ITU Guidelines for the transition from analogue to digital broadcasting, p. 26.

Figure 3.7 shows the various phases for the NRT roadmap in case model B is selected. As the figure shows the first three NRT phases are the same as in the roadmap for model A. However, after selecting the licensing model (i.e. in Phase 3), the NRT will issue a tender procedure for selecting the common multiplex/network operator. After selecting this multiplex/network operator, the NRT will develop the network roll-out planning together with this newly selected network operator (Phase 4). Also the NRT, in close cooperation with the common multiplex/network operator, will assume the responsibility of rolling out the DTTB network.



Functional building blocks for model A and B

The decision for the licensing model will impact the number of functional building blocks to be included in the roadmap. In model B, the NRT will resume responsibility for the establishment of a common multiplex/network operator and will have to endorse which services will be offered on the market. In addition, the NRT will directly manage the network roll-out and the associated planning. In such a situation the Cambodia roadmap will include activities and decisions typical for a multiplex/network operator:

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 establish the exact attributes of the distribution services, such as coverage areas, number of services, conditional access (in case of pay-tv services) and price tables for the various services (including multiplex capacity reservations).

- c. Receiver available considerations (functional building block 3.3): in line with the DSO objective to have a single cheap STB for the Cambodia 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 conditional access system (which is likely to be embedded to keep costs down).
 - d. Business planning (functional building block 3.4): the NRT will also have to resume responsibility for a economically viable service offering. Hence the NRT will have to assess the future cash flows of the common multiplex/network operator and what type of financing is required. Also the ownership construction will have to be determined, i.e. only public or private partnership or a combination of both in a so called public private partnership.
2. DTTB Network layer:
- a. Technology and standards 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 network will look like. This includes aspects 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).
 - b. Network interfacing (functional building block 4.6), transmission equipment availability (functional building block 4.8) and network roll-out planning (functional building block 4.9): all these three functional building blocks have to be include as the NRT will have to directly manage the planning of the network roll-out.

In case model A is selected, the NRT will leave a number of responsibilities to the individual broadcaster to take care of:

- 1. The actual service offering. The broadcasters can determine the number of services and the coverage areas (if not stipulated) themselves. Consequently, a number of functional building blocks doesn't have to be included in the roadmap:
 - a. Customer insight and research (functional building block 3.1): the broadcasters will carry out their own research as to determined which services to offer on the DTTB platform.
 - b. Customer proposition (functional building block 3.2): the broadcasters will determine the various attributes, including pricing. It should be noted however, that the NRT can still stipulate some minimum service requirements the broadcasters have to comply to. For example the coverage areas and/or the launch windows (when the additional services have to be on air).
 - c. Business planning (functional building block 3.4): the broadcasters will be directly responsible for making the DTTB services economically viable and hence they will carry out their own business planning.
- 2. The actual network roll-out. The broadcasters will resume the responsibility of their network roll-out and hence some blocks don't have to be included in the roadmap:
 - a. Network interfacing (functional building block 4.6): for example the broadcasters will determine how the transport streams are distributed to the transmission sites (e.g. satellite or optical fibre).
 - b. Transmitter equipment availability (functional building block 4.8): the broadcasters will order their own equipment and will consider the available equipment themselves.
 - c. Network roll-out planning (functional building block 4.9): the broadcasters will roll-out their own network and the transmitters will probably been deployed on their existing towers. Although the broadcasters will carry out their own network roll-out the NRT will have to set

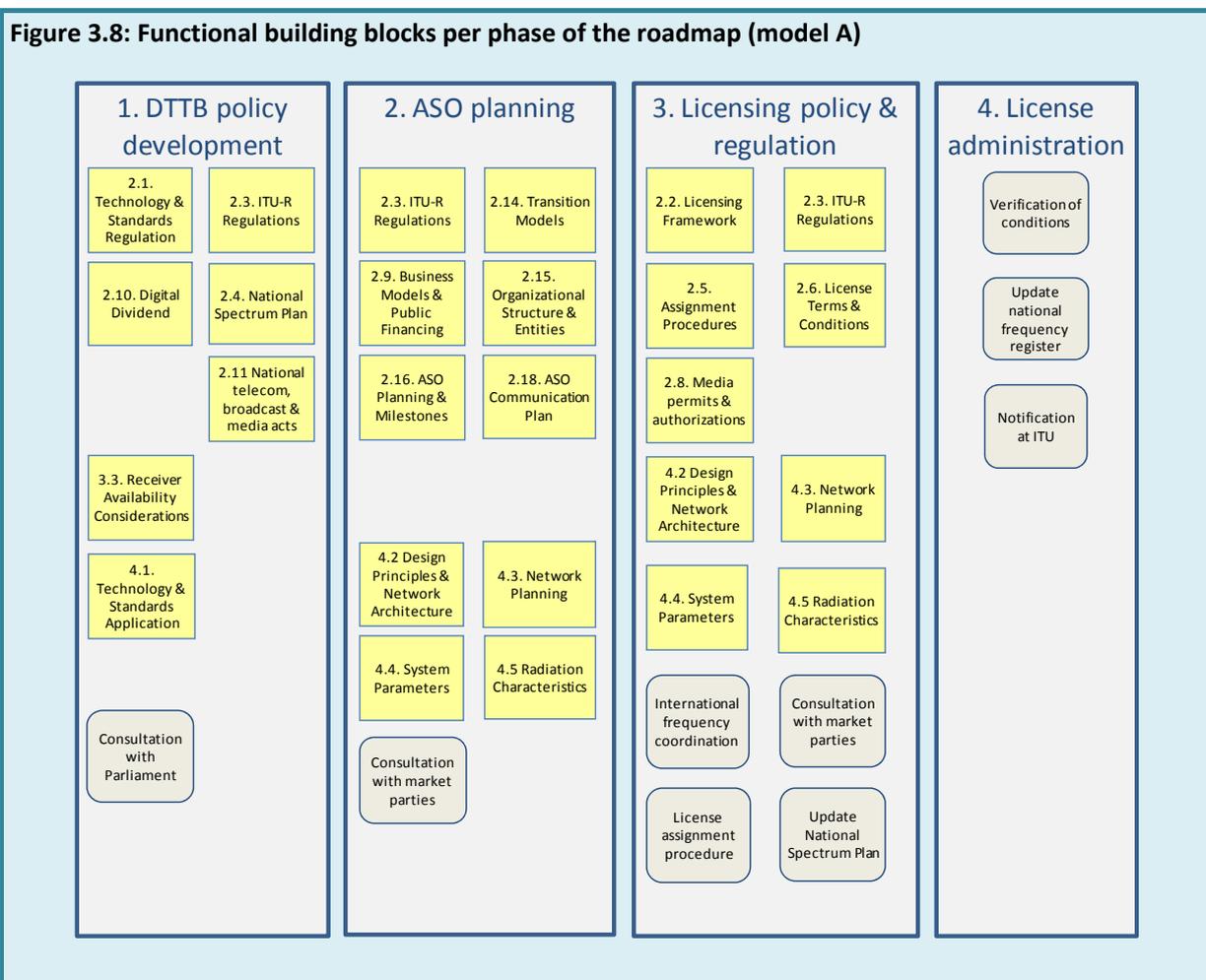
milestones for them to comply to. The broadcasters will have to follow the ASO planning (especially in the case of a phased simulcast model).

It should be noted that in model A, the following building blocks will remain in the Cambodia roadmap:

1. Receiver availability considerations (functional building block 3.3): Although the broadcasters are free to determine their DTTB services, the NRT will have to assure that Cambodia viewers are not confronted with a wide range of STBs. Especially in the case the broadcasters will decide to offer pay-tv services many CA embedded STBs may become available in the market and will cause confusion under the viewers. Consequently, in model A the NRT will have to stipulate a minimum set of STB requirements.
2. Technology and standards application (functional building block 4.1) to radiation characteristics (functional building block 4.5): These five blocks will remain necessary in a model A situation, because these blocks are directly related to the required spectrum. When carrying out the activities in these blocks the NRT can accurately define the spectrum rights for each individual broadcaster and can assure spectrum efficiency (and consequently the digital dividend).

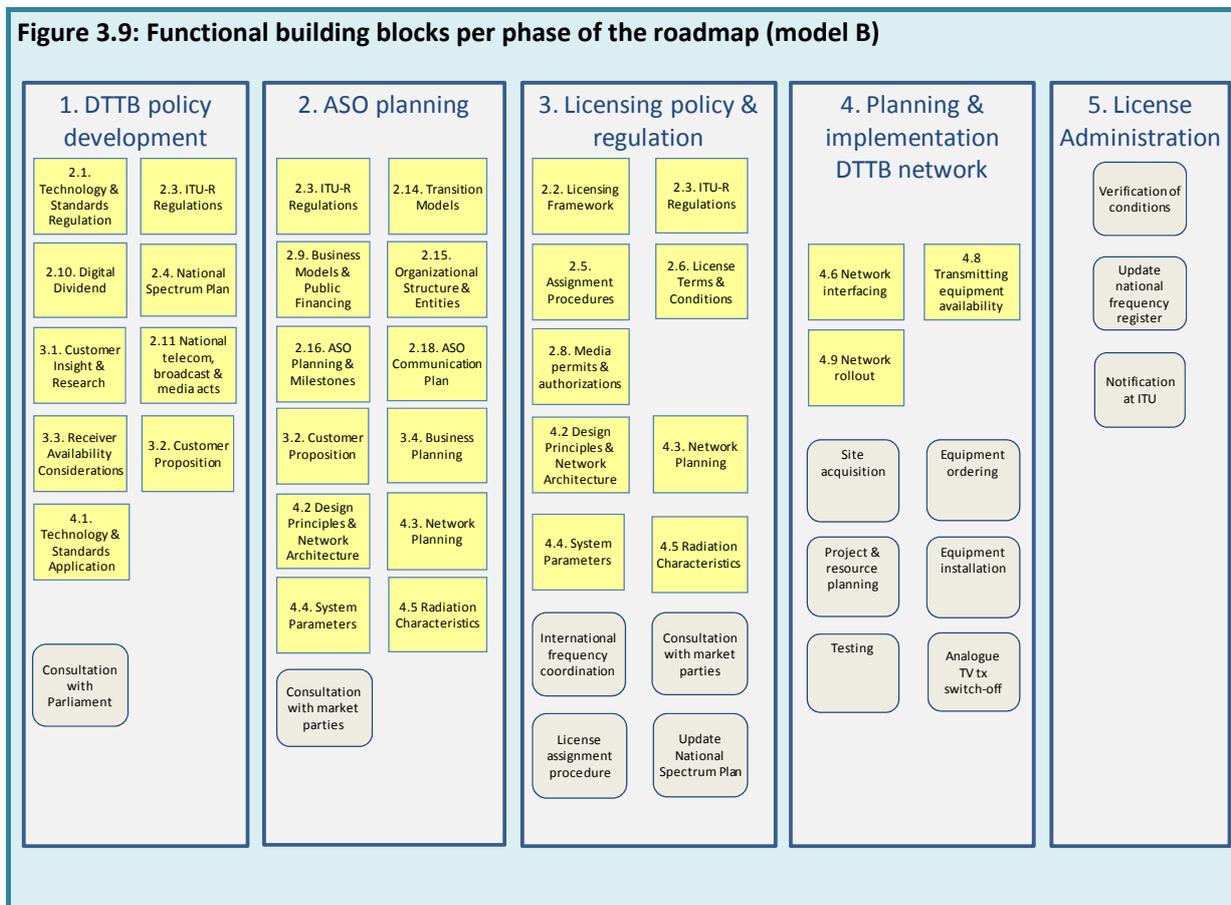
Functional blocks in each phase

As a result from the different building blocks to be included in either model A or B, two sets of functional building blocks can arise in Cambodia. The figure below shows the functional building blocks to be included in case model A is selected. Please note that the yellow shaded blocks are described in the sections of the Guidelines with corresponding numbering. The grey shaded blocks are not described in the Guidelines. These blocks represent activities that are not specific to the introduction of digital terrestrial television services.



The Figure 3.9 shows the functional building blocks to be included in case model B is selected. Comparing this figure with the previous figures shows that both figures are for a large part similar and that model B includes more functional building blocks.

Figure 3.9: Functional building blocks per phase of the roadmap (model B)



To avoid duplication, the remainder of this report will describe the roadmap for model B and will indicate how and when the roadmap will differ for model A. For example, when a functional building block and its associated activities will not have to be included or when the output documents are used for different purposes.

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 ASO project. Politicians will have to commit to the ASO objectives, deadlines, necessary budget and endorse the establishment of a NRT with a clear mandate to plan and execute the 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 (e.g. the Proclamation on Radio and Television standards). The policy objectives as included in Table 2.4 still have to be completed. For example, the exact ASO dates and the minimum number of television services and their coverage have to be determined and endorsed in Parliament.

Outputs

The key output of the DTTB policy development phase is a politically endorsed DTTB policy document to be published to the general public (in the 'Official Gazette'). Such a DTTB policy document typically includes the following items:

- *Policy justification.* This includes the benefits and necessities of introducing DTTB services in Cambodia (including the allocation of the digital dividend).
- *The legal framework.* This entails the legal basis (and any necessary changes) for the DTTB service introduction and the ASO.
- *Technical framework.* Detailing the available spectrum for the DTTB services and the current spectrum in use by existing broadcasters.
- *Starting and ending date of ASO process.* These dates have to be exact as to inform the general public and the industry accurately.
- *The principle ASO model.* This could be either simulcasting or no simulcasting (including the justification for any of the two).
- *DTTB services.* Describing at a high level which existing television services and additional content/services will be distributed on the DTTB platform and at which districts/provinces these service will be made available.
- *DTTB standards.* What standards (for example the transmission and compression standard) will be mandatory and its justification.
- *Funding principles.* The intention to include selected ASO costs in the Government budgets and the way it is going to be funded.
- *Communication and plan of action.* Outline of how viewers (and other stakeholders) will be informed about the 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.).

For an example DTTB policy document, please refer to "Strategy for Switchover from Analogue to Digital Broadcasting of Radio and Television Programs in the Republic of Serbia" as published in the Official Gazette of the Republic of Serbia, No. 55/05, 71/05 – correction 101/07, the Government of the Republic of Serbia, 2 July 2009.

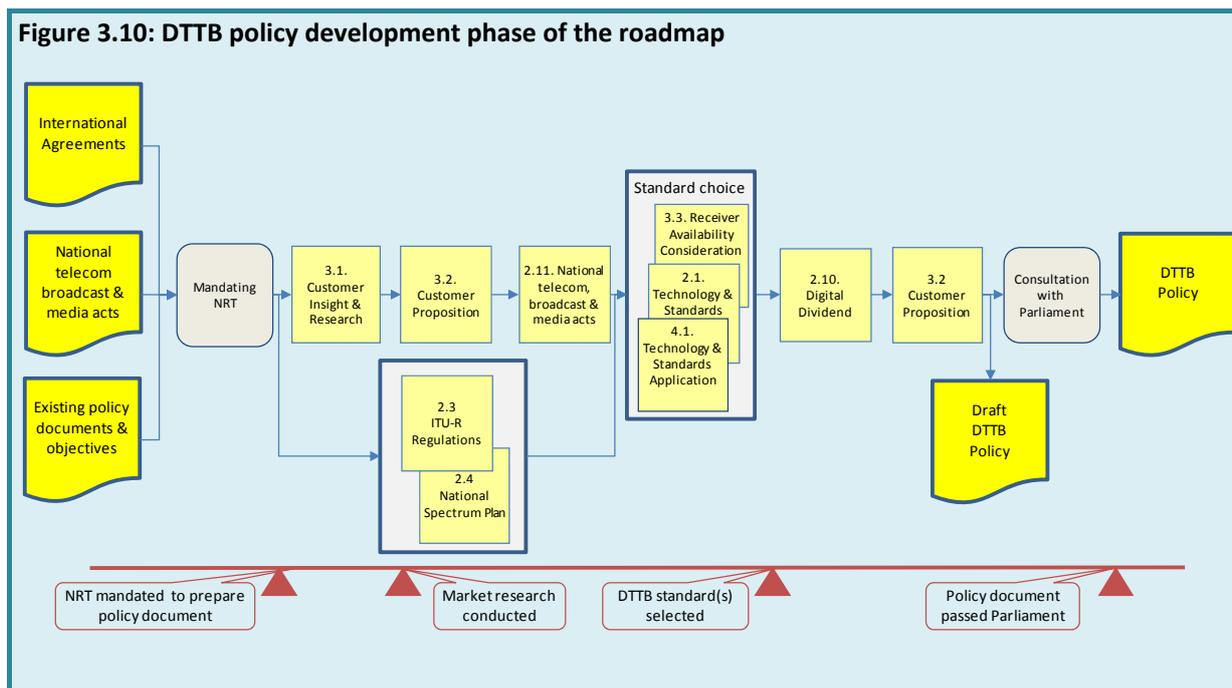
Roadmap

The roadmap of the DTTB policy development phase and the associated functional building blocks is shown in the figure below. 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.

As can be derived from figure 3.10, 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. Although the NRT has been formally established, its mandate should be checked. In order to deliver the aforementioned DTTB policy document it should have at least a clear mandate to do so. After this policy document has passed Parliament, the NRT mandate can be extended to prepare, plan and execute the roadmap. In this phase of the roadmap this NRT can have a limited membership. At the second phase of the roadmap (i.e. ASO planning) the NRT membership can be extended to include all stakeholders in the DTTB value chain (and structured in line with the implementation guidelines of functional building block 2.15).

Figure 3.10: DTTB policy development phase of the roadmap



2. Conducting market research of the current television and future DTTB market in Cambodia. This step includes the functional building blocks 3.1 and 3.2. At this phase of the roadmap, this market research serves the purpose of providing support/justification for the DTTB policy. Because key Cambodia broadcasters (i.e. Bayon TV, CTN, TVK and PPCTV) 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 Cambodia. 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 starting point.
 - ii. Television viewing ‘demographics’. This entails the common market parameters like number of television sets deployed, the number of television households , the number of viewing hours (per channels), the number of subscriptions, etc.
 - iii. Size of the total television advertising market in Cambodia. Also the impact of the ASO and DTTB introduction on this advertising market should be assessed.
 - 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 the number of viewers/subscribers to the many (approximately 102) cable networks in the various provinces.
 - v. Current analogue service coverage. Given the current reception conditions, it should be clarified where what service can be received. This might entail an analogue service planning exercise (similar to the DTTB service planning as described in the Guidelines). This part should also take into account the different regional broadcasts and the different channel bouquets the various viewers might receive.

- vi. Current analogue television distribution to cable head-ends. In Cambodia, there are many cable networks and many of them use the existing analogue television broadcasts to feed their head-end systems. Switching off the analogue television broadcasts will impact this content distribution system. The consequences should be assessed and possible solutions formulated.
- vii. 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 and where?) and operations will be necessary.
- b. *DTTB* market in Cambodia. The DTTB policy document should illustrate that there is a need for DTTB. It is important to note that PPCTV is already providing a digital terrestrial television service in Phnom Penh. Their customer insight data may be helpful, providing that PPCTV is willing to share this information in the NRT. This part of the market research should provide an insight in what Cambodia viewers and industry players expect, including:
 - i. Content. To include the number and the type of programs/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 Cambodia viewers.
 - ii. Supplies. Cambodia manufacturers and distributors might show an interest in provisioning DTTB receivers.
 - iii. Content creators. Cambodia content creators (i.e. in many case the current broadcasters) might be interested in provided dedicated content for the DTTB platform.
- 3. Determining the *current available* spectrum for DTTB (functional building blocks 2.3 and 2.4). A clear and shared understanding of the available spectrum will enable the NRT to develop a well motivated DTTB policy document. As discussed during the first visit, the available spectrum for digital terrestrial television services should be clarified (see also sections 4.9 and 4.10), taking into account:
 - a. Spectrum already assigned (not necessarily in use yet) for analogue and/or digital television services (as indicated/to be incorporated in the National Spectrum Plan and Register).
 - b. Neighbouring spectrum usage. Spectrum may not be readily available in Cambodia as the same spectrum is in use in Thailand, Vietnam and Laos (especially near the borders). Coordinating this spectrum is in the interest of all involved countries and may require bilateral/multilateral coordination.
 - c. Spectrum required for future digital radio services (as indicated/to be incorporated in the National Spectrum Plan and Register).
 - d. Spectrum requirements for non-broadcasting services, for example spectrum for LTE services (as indicated/to be incorporated in the National Spectrum Plan and Register).
- 4. Checking compliancy with current legislation and identifying required changes (functional building block 2.11). A first assessment should be carried out of what parts of the current legislation will be impacted by the introduction of DTTB services. Table 2.3 in this report and Table 2.11.1 in the Guidelines provide a good starting point for this assessment. At this first phase of the roadmap, the assessment is focused on identified the areas that might be impacted, how required changes can be achieved (e.g. legal and parliamentary procedures) and what time this will take. This assessment will then provide input for the plan of action (as part of the DTTB policy document). During the third phase of the roadmap (i.e. determining the DTTB regulations) specific DTTB regulations are defined (e.g. the licensing framework and procedures), a further detailed assessment of changes may be necessary. Special consideration should be given to the fact that currently a new telecommunications law is being passed through Parliament.

5. Selecting the transmission standard (or any other system element). As the above figure shows, the procedure for deciding the transmission standard 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 Cambodia two transmission standards have already been adopted (see the Proclamation on Radio and Television standards); DVB-T and DTMB. The NRT should decide whether it is advisable to have two standards in the ASO process. If concluded that one standard should be adopted, the NRT should balance technical and regulatory aspects. However, selecting the transmission standard is not only a technical and regulatory evaluation. Given the specific situation in Cambodia it should also explicitly include the following elements (next to the considerations provided in the Guidelines):
 - a. Affordable and sufficient supplies of DTTB receivers. Given the public financial resources available and the ability of Cambodia viewers to pay, receivers (including set-top-boxes and IDTVs) should be made available at the lowest possible price levels. Not only in the short term but also the long run pricing should be considered. In Cambodia, the DTTB adoption speed might take a long(er) time and hence the product roadmap of the receiver suppliers should be taken into account. Suppliers should also be committed to provide sufficient quantities in a flexible manner (e.g. according to a rolling forecast). This might need special attention in case a Conditional Access System is stipulated. Even more if specific Cambodian/Khmer language requirements are demanded (e.g. for the EPG and the user interface of the receiver).
 - b. Independent and warranted supplies. Dependency on one single supplier should be avoided. Any DTTB system (head-end and receivers) will incur many changes (e.g. frequency changes, software updates, additional functionality, etc.) during its life span (i.e. 5 – 15 years) and suppliers should support this. One should be in the position to change providers. Changing suppliers is not uncommon in this industry.
6. Deciding the digital dividend (functional building block 2.11). 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 Cambodia. The introduction of new mobile services might fit in the economic development agenda of Cambodia.
7. Determining the first Customer Proposition. As a result of the DTTB policy document a first outline of the Customer Proposition can be drafted. This proposition will be at high level and in terms of the policy document.
8. Consultation with Parliament. In this step a draft DTTB policy document is offered to Parliament to approve. This might include many consultation sessions, extensive lobbying and several revisions. Sufficient time should be planned for these activities. It should be noted that in this set-up of the roadmap, the DTTB policy document should leave room for the NRT to further detail the Customer Proposition, Frequency Plan (including the service planning process) and ASO plan (including the organizational structure, budget and planning). After any simplification/adjustments, the passed DTTB policy document (including the Customer Proposition) can then be published in the Official Gazette as a first communication to the general public and television industry.

3.4.3 Phase 2 ASO planning

The second Phase of the Cambodia roadmap is aimed at providing a detailed insight in the roles and responsibilities of the various involved parties, the process of transitioning from analogue to digital terrestrial television broadcasting, the milestone planning and the communication/support process. The ASO planning Phase also services the purpose of getting support from various involved market parties and Parliament.

Inputs

The key input for this phase is the (passed) DTTB policy document. As the Figures 3.6 and 3.7 in this report suggests, it might be that the second phase of the roadmap can be initiated before the DTTB policy document has passed Parliament. This will depend for some part on the assessment of any likely changes in Parliament and the provided mandate to the NRT. Such an early start might entail some later changes in the resulting documents of this ASO planning phase.

Outputs

The main outputs for the ASO planning phase are an initial frequency plan (based on an initial DTTB service planning) and the ASO plan. In general terms, the initial frequency plan describes how the available spectrum will be utilized in a deployed network and which service (including the number of frequencies and reception mode) will be provided in what areas and with what quality levels (including picture quality and coverage probability). In more specific terms, the initial frequency plan details all the decisions and trade-offs as included in the functional building blocks 4.2 to 4.5.

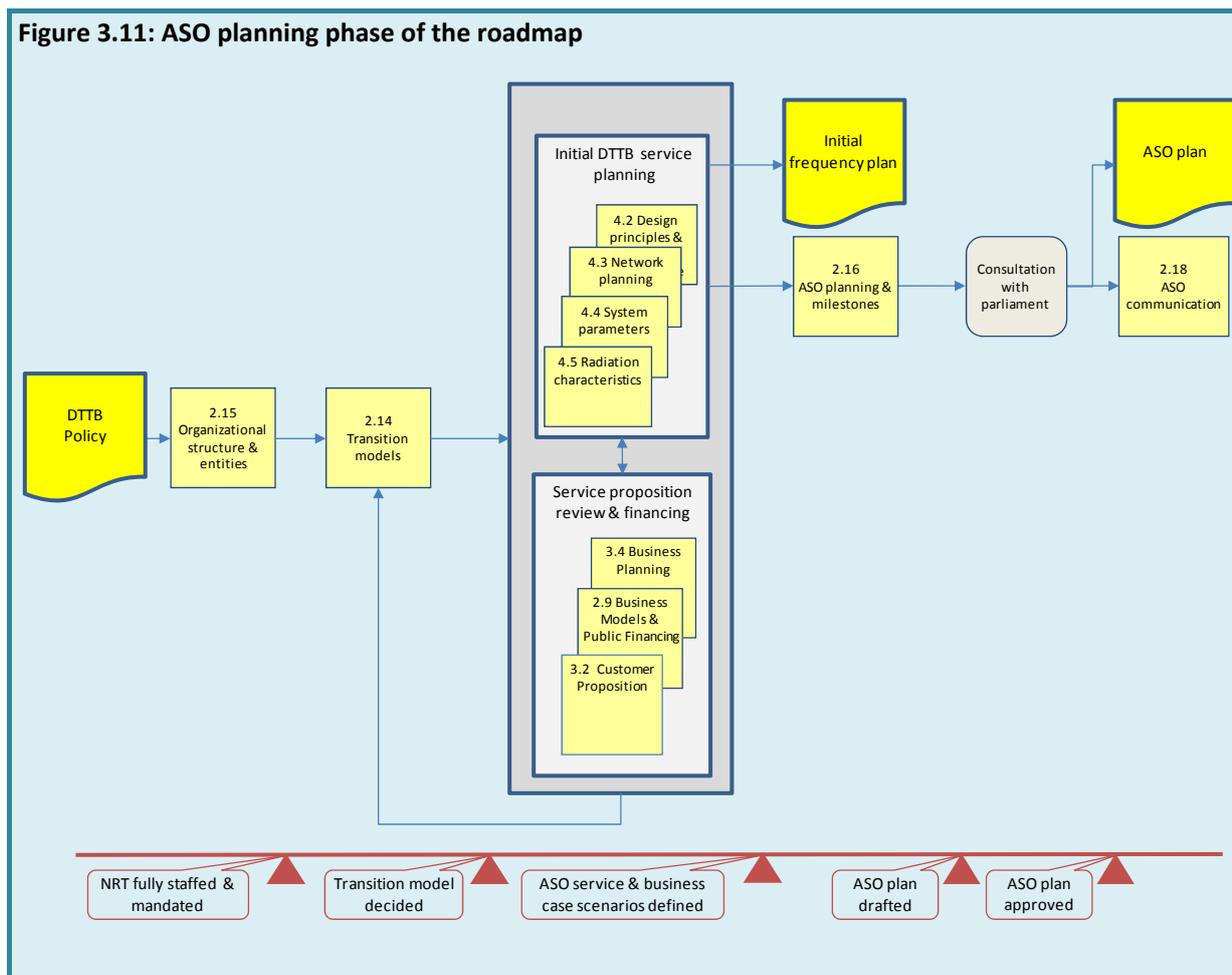
The ASO plan describes in detail the transition process from analogue to digital and will include at least:

- The applied ASO model (see functional building block 2.14). The applied model might be different from area to area. For example, the non-served areas in Cambodia might have a different model to the served areas (i.e. no simulcasting).
- The customer proposition (see functional building block 3.2). Including the details about which services can be received under what conditions (i.e. the reception conditions) in what areas.
- The ASO planning (see functional building block 2.16). This planning describes when a specific customer proposition will be made available and how this proposition will be provided. As indicated in the Guidelines this planning comprises several work streams or result paths, including:
 - communications (further detailed in functional building block 2.18 ASO communication plan);
 - device producers and delivery;
 - network plan and rollout (includes DTTB service delivery details);
 - consumer and market monitoring;
 - regulation and licensing (further detailed in Phase 3 of the roadmap);
 - financial and installation support.
- The business planning and business models and public financing (see functional building block 3.4 and 2.9). A business case should detail what the ASO process will cost (under various scenarios) and what financial resources should be made available (including for example, as indicated in the first meeting, a share of future Cambodia oil revenues). The initial frequency plan will provide the basis for a first estimate of the network costs. Please note that, as Table 2.15.2 in the Guidelines illustrates, the network costs are just one item of the overall budget. Especially the (financial) support provided to affected viewers will be an important decision to be made.

Roadmap

The roadmap of the ASO planning phase and the associated functional building blocks is shown in the Figure 3.11. 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 3.11: ASO planning phase of the roadmap



As can be observed from the above figure, the following steps (i.e. functional building blocks and non-DTTB specific activities) are included in Phase 2 of the roadmap:

1. Establishing the organizational structure and participating entities (see functional building block 2.15). Dependent on the exact mandate of the NRT in first phase of the roadmap, this might include an additional (political) mandate. The participating parties and their responsibilities in the ASO planning process might be political sensitive and needs a further approval. In this step also the reporting structure and escalation procedures should be clarified so that the NRT can efficiently operate and manage the ASO process.
2. Determining an initial ASO transition model (see functional building block 2.14). In Phase 1 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 Guidelines (section 2.14.4) on the ASO model decision, an ASO model can be selected (which may vary for served and non-served areas).
3. Balancing DTTB service planning, customer proposition and financing (functional building blocks 4.2 to 4.5, 3.2, 2.9 and 3.4). This step entails an iterative process where three elements (i.e. service proposition, network planning and business case) are balanced against each other as illustrated in Figure 3.1.1 in the Guidelines. Although in the Guidelines this process is explained for a commercial DTTB service provider, the process is in essence no different for the NRT. As the above figure illustrates, this iterative process consists of two parts:
 - a. Initial DTTB service planning (which in turn is an iterative process of four functional building blocks 4.2 – 4.5).

- 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).

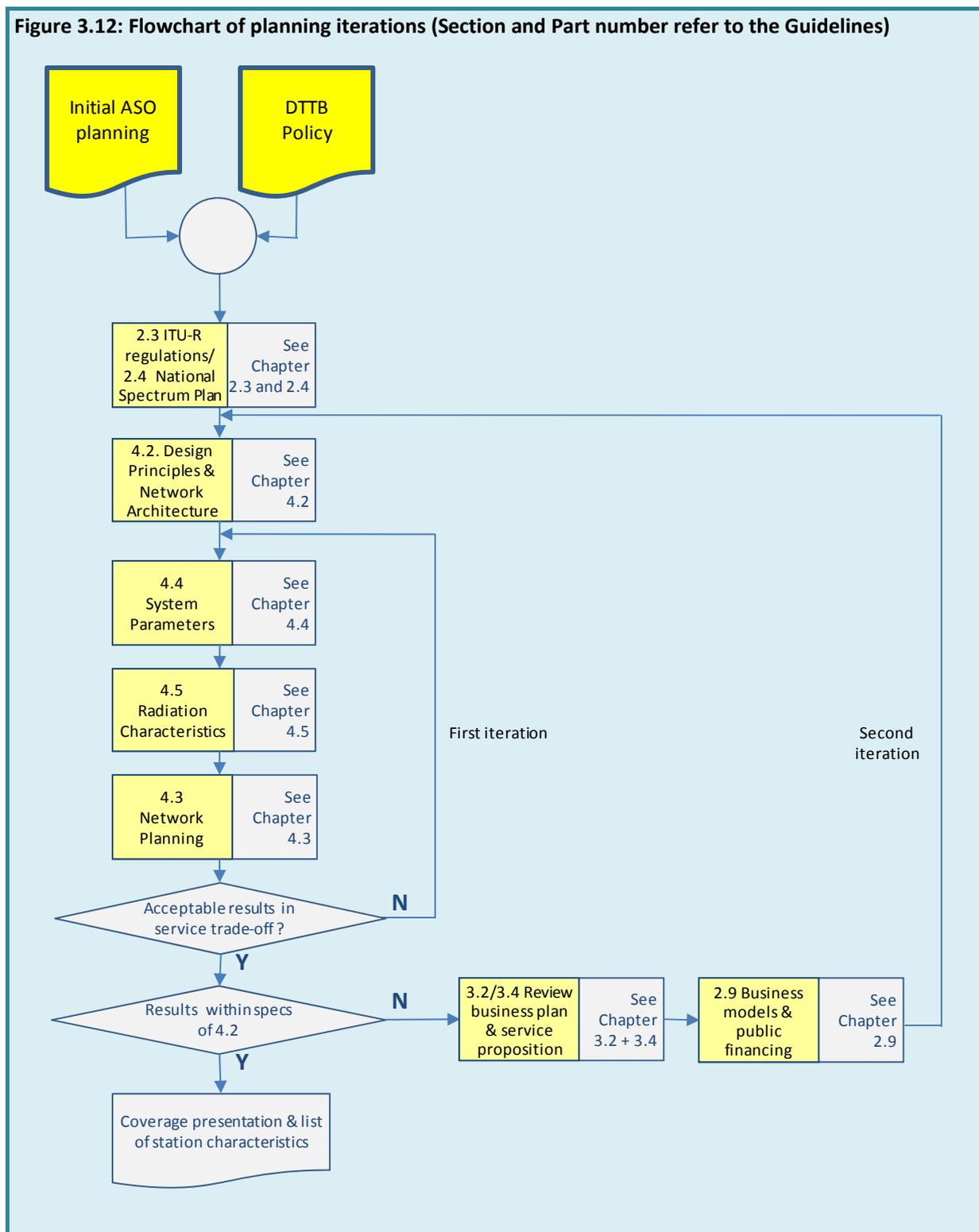
Figure 3.12 below provides a flow chart of the two feedback loops that are incorporated in the balancing of these three elements. For example, due to a lack of available spectrum this step may result in a revision of the initially selected transition model (hence the feedback loop in Figure 3.11).

4. Drafting ASO planning and milestones (see functional building block 2.16). The abovementioned balancing of three elements will result in one optimum scenario to be selected by the NRT. Based on this scenario the initial ASO planning can be drafted. As mentioned before, in case the ASO plan will require a political approval, it is advisable to draft a planning based on one or two additional scenarios, perhaps not in all its details.
5. Consultation with Parliament. In this step, a draft ASO plan is offered to Parliament to approve (with several options). Again this might include many consultation sessions, extensive lobbying and several revisions. Sufficient time should be planned for these activities.
6. Finalization of ASO plan and detailing the ASO communication plan (see functional building block 2.18). After having the ASO plan approved by Parliament, it can be finalized for the selected scenario. This ASO plan will act as the working document for the NRT which will be continuously revised and updated. It will also include the ASO planning on the basis of which the ASO implementation can commence. As discussed previously, one work stream or result path of the ASO planning includes the ASO communication. Following the guidance provided in the Guidelines (functional building block 2.18) a detailed strategy for informing/supporting the viewers and industry parties can be developed (included for each communication target group a planning for the various messages).

In Figure 3.12, 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 4.1 (technology and standards application) and 4.2 (design principles and network architecture).

The second iteration is a further balancing of the service trade-off optimum against the financial possibilities. If no satisfactory solutions can be found in the service trade-off, the service proposition and business plan may need to be reviewed, resulting in a possible review of functional building blocks 4.1 (technology and standards application) and 4.2 (design principles and network architecture).

Figure 3.12: Flowchart of planning iterations (Section and Part number refer to the Guidelines)



3.4.4 Phase 3 Licensing policy and regulation

The objective of this third phase of the Cambodia 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 Cambodia 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 policy document resulting from the first phase of the roadmap and the ASO plan resulting from the second phase. As indicated in Figures 3.6 and 3.7 in this report, the third phase may start in parallel to the execution of Phase 1 and 2. For example, the NRT could start working on the activities in this phase before the DTTB policy document and ASO plan have passed Parliament. Such an approach might entail some later changes/revisions of the resulting documents.

Outputs

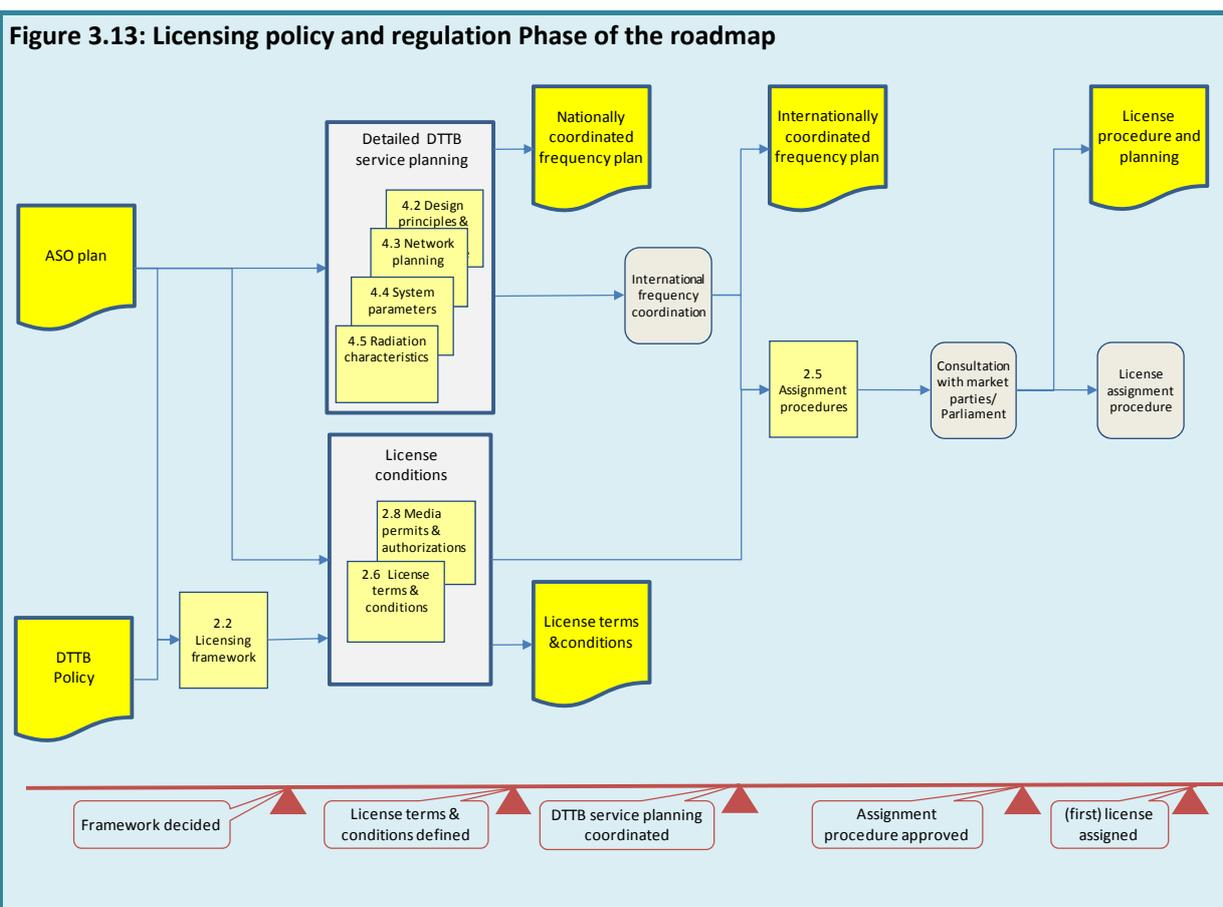
This third phase has the following output documents, of which the latter two might be published in the Official Gazette, including:

- A nationally coordinated frequency plan defining which DTTB frequencies will be used when in which geographical areas. This 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 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.
- The DTTB licence conditions and terms. Depending on the selected licensing model (either model A or B) this might entail different licences (differentiating broadcast and spectrum rights) for the various value chain entities:
 - In model A: spectrum and broadcast licences will be assigned between existing (and possibly new) broadcasters. To ensure efficient and compatible spectrum usage, the spectrum licence will have to specify the exact frequencies, their locations and characteristics (such as antenna height, ERP, antenna diagram, broadcast modus, etc.).
 - In model B: the spectrum licence will be assigned to the common multiplex/network operator. Again to ensure spectrum efficiency and compatibility the spectrum licence will have to specify detailed frequency use. The broadcast licence (i.e. the assignment of a part/slot of the DTTB capacity) will be assigned to broadcasters (and/or service provider). The NRT will have to decide which entity can decide the assignment of these capacity slots. This can be either the common multiplex operator (after approval of the content by the MOI) or the MOI (i.e. the MOI approves the content and assigns a slot).
- A document describing the assignment procedure and planning (for an example document, please refer to the Guidelines footnote 97 on page 50). Depending on the selected licensing model, the output will be different:
 - Model A: For the existing analogue broadcasters the assignment procedure is likely to be renewal. They will have their analogue spectrum rights renewed into digital spectrum rights. Special attention is needed for those broadcasters that already have digital spectrum rights assigned. Based on the national/internationally coordinated frequency plan (see above), these rights may need revision. In line with the formulated DSO objectives of having new market entrants for digital television services, it may be necessary to also organize a public tender (next to the renewals).
 - Model B: The NRT will have to organize tender procedure for selecting the best party to fulfil the role of common multiplex/network operator. It will have to stipulate what entities are allowed to bid (for example consortia of existing broadcasters, foreign partnerships and public private partnerships). In addition, it will have to publish Open Network Provisioning (OPN) rules (including capacity access and pricing rules) for this common multiplex/network operator. For re-using existing infrastructure (like towers or antennas), it may be necessary to impose site sharing rules to ensure cooperation from broadcasters. In this context, it is important to note that such site sharing rules already apply to mobile network operators in

Cambodia. For organizing a tender procedure, we refer to Appendix 2.5B in the Guidelines. This appendix shows the elementary steps in any assignment procedure. For a practical example of an invitation to apply for a multiplex licence we refer to an Independent Television Commission (now part of Ofcom) document “ Multiplex Service Licences: Application Documents”⁶.

Roadmap

The roadmap of the Licensing policy and regulation Phase and the associated functional building blocks is shown in the Figure 3.13. The decisions taken, partly taken and not yet taken on the key topic and choices regarding Phase 3 of the roadmap and the activities required to prepare the decisions that are still pending, are indicated in Annex 3.



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

1. Detailing DTTB service planning (see functional building blocks 4.2 – 4.5). After having agreed the ASO plan (including the initial DTTB service planning) a detailed service planning can now be drafted. This detailed planning is different from the initial planning as on the basis of this planning either:
 - a. In model A: The specific spectrum and broadcast licence terms and conditions can be specified. For the spectrum licence, the terms and conditions related to the permitted spectrum use will be based on this planning. For the broadcast licences, this planning will

⁶ www.ofcom.org.uk/static/archive/itc/latest_news/multiplex_licence/dtt_multiplex_licence_tender.asp.html

- ii. Support from other industry parties, other than the current broadcasters, may be needed and this may entail foreign investment.
4. Licence conditions and procedures (see functional building blocks 2.6, 2.8 and 2.5). Only after having a clear decision on the licensing model, the licence conditions and procedures can be defined. Clearly the licence conditions will vary under two different models, as discussed above under Outputs.
5. Consultation with market parties and Parliament. Before actually deciding the licensing regime (to include licensing framework, conditions and procedures), the NRT can organize a market consultation to check the validity and market support for its plans. First, the other broadcasters not represented in the NRT should be consulted. Given the number of directly involved market parties on the Cambodia television market (see also Figure 2.1 in this report) this might be organized in a closed set-up with invited parties only. After market consultation, the NRT can support its proposal to Parliament with the feedback acquired in this consultation. Finally, before the licensing regime can be officially published the regime should be endorsed by Parliament. Sufficient time should be incorporated in the ASO planning for this endorsement.

3.4.5 Phase 4 Planning and implementation DTTB network

This Phase is only part of the Cambodia roadmap in the case licensing model B is selected. In the case of adopting model A this phase is left to individual broadcasters to take care off. It should be noted however, although the individual broadcasters will deploy their own DTTB network and services, their network roll-out planning should be in line with ASO planning and follow the milestones in this planning strictly. Otherwise, no coherent ASO information can be communicated to the viewers and the transition carried out smoothly. Hence the broadcaster will have to notify the NRT when they wish to bring a DTTB site into operation or to switch off an analogue transmitter. For reasons of proper spectrum management they also have to notify the MPTC and MOI when bringing a transmitter either into or taking out of operation.

The aim of the DTTB implementation Phase is to have the DTTB network deployed and all sites in operations and switched-off in accordance with the ASO plan (including the planning and the budget). In this implementation Phase the (inter)nationally coordinated frequency plan is translated into a network rollout or implementation planning. As mentioned in the second ASO Phase, the ASO planning comprises a network plan and roll-out work stream or result path. This network implementation planning feeds into this work stream.

It should be noted that this implementation Phase only covers the steps to be taken for the DTTB network rollout. The other work streams or result paths in the ASO planning will need further detailing too and all result paths will have to be kept coordinated with the progress of the network implementation planning.

Inputs

The input data for this phase are the licence procedure and planning (including the licence terms and conditions which also provide the timing of frequency (de)activation) and the (inter)national coordinated frequency plan from Phase 3.

Outputs

The output of Phase 4 is a set of documents describing:

- DTTB implementation plan. Other than the actual DTTB network rollout planning, this plan also includes the project management structure and resources (including tasks, responsibilities, escalation procedures), detailed and broken down project budget and operational and financial progress reporting.
- Detailed coverage presentations. As the network roll-out progresses the coverage predictions become definite (i.e. when the sites have been equipped and no changes can occur any more). This detailed coverage predictions or presentations will feed into work stream communication of the ASO plan. Please refer to section 5.3 of the Guidelines for more details on service availability

checks and tools. As discussed in the first visit, coverage presentations can also be distributed in printed format. In this case, network changes should be kept to a minimum and sufficient time should be taken into account for distribution.

- Notifications to MPTC and MOI that stations have been installed. The MPTC as the national spectrum manager should be notified by the common multiplex/network operator that stations are ready to be taken into operations. The MOI should be notified so that the ministry can check compliancy with the issued broadcast licence. In the ASO planning, a timely reporting of these notifications to the MPTC and the MOI should be taken into account as to avoid that this activity will be part of the critical path.
- Notifications to MPTC and MOI that an analogue TV transmitter has been switched off by the analogue terrestrial broadcasters. For the purpose of updating its National Frequency Register the MPTC also has to be notified when the analogue transmitter (sites) are taken out of operation. Also the MOI should be notified.
- Order to put DTTB site into operation. After checking compliancy with the ASO planning the NRT issues an order to the common multiplex/network operator to bring the site into operation.

Roadmap

The roadmap of the planning and implementation DTTB network phase and the associated functional building blocks are shown in Figure 3.14. The figure also shows the relationship with the other work streams or result paths, which should be coordinated with the planning and implementation of the DTTB network roll-out (see the grey blocks in the top half of the figure). The decisions taken, partly taken and not yet taken on the key topic and choices regarding Phase 4 of the roadmap and the activities required to prepare the decisions that are still pending, are indicated in Annex 4.

As Figure 3.14 shows, the following steps (i.e. functional building blocks and non-DTTB specific activities) are included in Phase 4 of the roadmap:

1. Developing and executing the DTTB network implementation planning (see functional building blocks 4.6, 4.8 and 4.9). Developing the network implementation planning entails a large amount of work and the functional building blocks of the Guidelines cover an important part of this work but not all. The 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 (not only to the project team members but also to the NRT).
 - 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). In addition, in Cambodia the network equipment ordering might be closely related to the receiver ordering process.

3.4.6 Phase 5 Licence administration

The objective of the licence administration phase is to check compliancy with the issued licence, to update the National Frequency Register and to notify ITU of any new DTTB station put into operation. However, as explained above these notifications are also important for the MOI to commence its task of verifying compliancy with the terms and conditions of the broadcast licence.

The same procedure also applies for changing the station characteristics (e.g. when restrictions on the digital transmissions have been lifted after switching off analogue transmitter stations) and when taking stations out of operation. In the latter situation no approval will be issued by the MPTC. However, as indicated before, the NRT will have to approve of switching off analogue television transmitters.

Inputs

The input data for this phase are the notifications of the common multiplex/network operator at the MPTC and MOI (model B). In case model A applies, these notifications will be provided by the DTTB licensed broadcasters.

Outputs

The phase will have two outputs:

- Approval by MPTC of the stations. After having checked whether the transmitter station is compliant with the DTTB spectrum licence terms and conditions the MPTC will provide an official approval;
- Recording of the assignment (i.e. station) in the Master International Frequency Register (MIFR). In turn the MPTC will notify ITU (i.e. Bureau Radio) of the new DTTB station taken into operation. ITU will check the station's conformity and will, after approval, record the station/assignment in the MIFR.

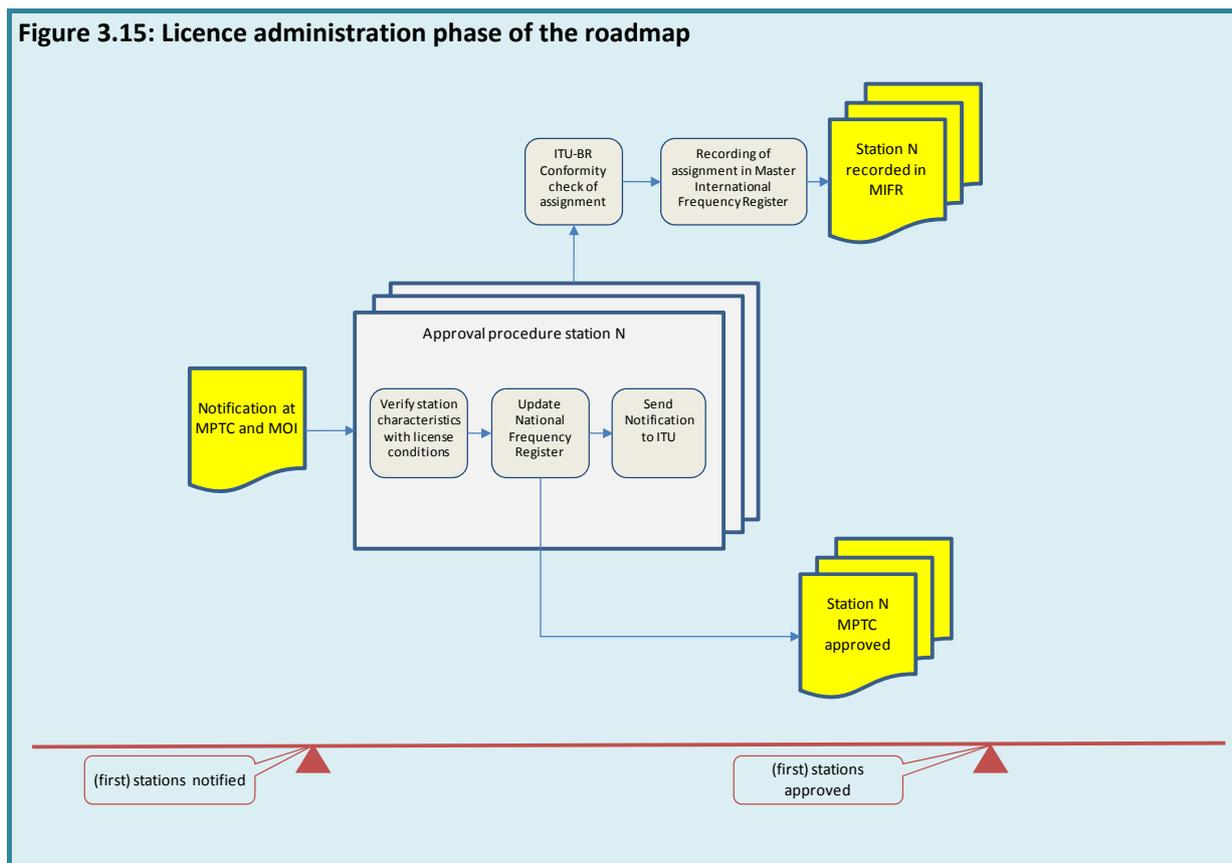
Roadmap

The roadmap of the licence administration phase and the associated activities is shown in Figure 3.15.

As the Figure 3.15 shows, the following activities are included in Phase 5 of the roadmap:

1. Approving the subsequent DTTB stations. After having checked respectively the spectrum and broadcast licence compliancy the MPTC and MOI will issue an approval to the common multiplex/network operator and the individual broadcasters who have a capacity slot on the multiplex(es). The MPTC will then update its National Frequency Register and will notify ITU-BR of the new DTTB station.
2. Recording of the assignment in the MIFR. The recording of a frequency assignment in the Master Register is preceded by various checks:
 - 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 Cambodia, this conformity check does not apply because such a regional allotment or assignment plan is not in place.

Figure 3.15: Licence administration phase of the roadmap



4 Considerations on the top-10 most critical key topics and choices

In this section, the top-10 most critical key topics and choices, will be discussed in more detail. The order of addressing the topics does not express their level of priority or importance. This priority is determined by the ASO planning and whether the topic is on the critical path of the ASO planning.

Please note that some of the top-10 most critical key topics and choices not necessarily correspond to the complete scope as addressed in the functional building blocks of the Guidelines.

Table 4.1 provides an overview of the top-10 most critical key topics and choices.

TABLE 4.1
Top-10 most critical key topics and choices

No	Key choices/decisions to be taken	(Part of) Block
1	Single and low costs STBs	2.1, 4.1
2	Customer proposition (services and coverage)	3.2
3	Licensing model A or B	2.2
4	Required and available budget (for ASO process)	2.9, 2.15, 3.1 3.4
5	ASO model (simulcasting phases and areas)	2.14
6	ASO planning and milestones (e.g. switch-off date)	2.16
7	ASO communication plan	2.18
8	Business model and conditional access	3.3, 3.4
9	Digital TV frequency plan	2.10/2.4/4.3
10	Allocation to mobile services (LTE)	2.10

4.1 Single and low cost STB

On the Cambodia market all analogue terrestrial broadcasters operate their own network and some of them have already digital broadcast rights assigned to them. In addition, the two market leaders (i.e. CTN and Bayon TV) have expressed the possibility of offering a digital pay-tv bouquet on the Cambodia market. Moreover, PPCTV already operates a pay-tv digital service in the Phnom Penh area (on the basis of DVB-T and Irdeto Conditional Access System – CAS).

In case no further regulation is considered, a situation can arise in which every broadcaster will select its own STB with a different transmission standard (i.e. DVB-T and DTMB) and CAS⁸. To limit the risk of customer confusion and market fragmentation the NRT should set a single standard for the transmission system and the CAS. This stipulation of the transmission and CAS standard applies for both model A and B, although for model B it is simpler to enforce. Only the common multiplex/network operator is issued a spectrum licence which stipulates these standards. In model B, the NRT could even decide not to set a CAS standard and let the single multiplex/network operator decide.

Considering also the specific DSO objectives of having a low cost STB for Cambodia (see Table 2.4 in this report), a single transmission and CAS standard can push down prices significantly as ordered volumes can be large.

4.1.1 Transmission standard

Following the Guidelines, stipulating a transmission standard involves regulatory and technical considerations (respectively functional building block 2.1 and 4.1). Hence, this section is structured accordingly.

Together with the additional considerations as discussed in section 3.4.2, the provided regulatory and technical considerations should be included in an evaluation matrix where the appropriate importance/weights can be assigned to them in the NRT.

Regulatory considerations

The Guidelines provide an implementation guideline for regulating the transmission standard for DTTB services. Please note that the guideline text below is shortened and adapted for Cambodia. Following this guideline the following observations can be made:

- “Stipulate the DVB-T transmission standard for new DTTB services because safeguarding the public interest (Universal Service) will be required *and* there is only a small down side risk of setting the wrong DTTB transmission standard”:
 - a. Setting a single standard will provide clarity in the Cambodia market and will reduce consumer confusion as Cambodia still has to realize the ASO and a current offering is already in the market. For a successful ASO consumer choice should be limited and the ASO process itself manageable. Especially for the Cambodia market this could apply as the communication means are limited (limited Internet access and use). Not favouring any of the two standards (DVB-T and DTMB), however for the DTMB it should be noted that there are two versions (single carrier system and a multi-carrier system) and the risk of consumer confusion should be checked (as parallel and uncontrolled import of receivers will take place).
 - b. Setting the DVB-T standard will provide the largest possible economies of scale as DVB-T is the most widely adopted standard for DTTB services. Consequently, this will result in the lowest receiver prices (currently up € 10 retail price, with MPEG2 and without CAS), making

⁸ Given the relatively high costs of the Common Interface Module, the STBs are expected to have an embedded CAS making them service provider/broadcaster specific. For more info, please refer to section 3.3.3 of the Guidelines.

DTTB services affordable for the largest population possible which seems for Cambodia a key factor to consider.

- “Reconsider setting the DVB-T transmission standard only in circumstance where” (de-facto the Cambodia market is on DVB-T as PPCTV has already commenced services on this standard):
 - a. The planned time of licensing new DTTB services is close to the time that different standards will be available and are proven technologies (perhaps as far as beyond 2015 in case the ASO date is selected to be 2018). This consideration could be applied to the DTMB standard as this standard has less of a “track record” than DVB-T standard. Also, when the DTTB introduction date is some years away, DVB-T2 standard can be considered. This standard is far more efficient than the other currently available standards (see next section Technical considerations). Today DVB-T2 STBs retail at approximately USD 70 which may be far too high for the Cambodia market. Hence some time is needed to wait for prices to drop to current DVB-T levels.
 - b. In the Cambodia market there is no significant market share for the DVB-T standard yet. PPCTV’s market share is currently very limited (below 10,000 STBs) and hence it could be possible to change to the DTMB standard. However, PPCTV should be informed as quickly as possible after such a change of the regulatory regime. The longer this decision is postponed the higher the costs will be for PPCTV to migrate to the newly set standard (and consequently the claim for financial compensation).

Technical considerations

Annex 5 gives a summary of technical information on transmission standards obtained from ITU and other sources. From the information in this annex the following observations can be made:

- The DTMB standard has two versions, a single carrier system and a multi-carrier system. The standard can be applied in 7 MHz and in 8 MHz channels. It is advised to consider the multi-carrier version only, because multi-carrier standards provide maximum ruggedness against multipath interference⁹. This is important in case of reception with simple antennas, a means of reception commonly used in Cambodia.
- The multi-carrier version of DTMB seems to have in general similar technical features than DVB-T. However, DTMB is less suitable for SFN operation because of the limited number of guard intervals and the shorter maximum guard interval (55.6, 78.7, 125 μ s) compared to DVB-T (28, 56, 112, 224 μ s). It is expected that SFN deployment is not a requirement in Cambodia (see also Annex 3, functional building block 4.3). However, detailed service planning may show the need for it (see section 3.4.3 of this report).
- Information on protection ratios of the DTMB standard is currently not available in the Preliminary Draft Revision to Recommendation ITU-R BT.1368, an update is expected in May 2011.
- Comparison of the provisionally DTMB data with the DVB-T data for two similar system variants shows that net bit rates and co-channel protection ratios (DVB-T interfered with by DVB-T and DTMB interfered with by DTMB respectively) do not deviate considerably.
- A relatively new standard is the DVB-T2 standard. This standard is by far the best standard in terms of capacity, robustness and power efficiency. In terms of network costs DVB-T2 is also more efficient as fewer transmitters are needed and its combiners are simpler. In Table 4.2 a comparative overview is provided.

⁹ See Appendix 4 to Annex 1 of Recommendation ITU-R BT. BT.1306-4 Error-correction, data framing, modulation and emission methods for digital terrestrial television broadcasting,

TABLE 4.2
Comparative overview of transmission standards (see also Annex 5)

Feature	DVB-T	DVB-T2	DTMB
Multiplex capacity	**	***	**
Robustness	**	***	**
Power economy	**	***	**
SFN use	**	***	*
Reception at high speed	**	***	*
Current STB price	≥ USD 14	≥ USD 70	?

4.1.2 Conditional access

Table 2.1.1 of the Guidelines shows that Regulators refrain from stipulating a standard for the CAS. The underlying reason for this neutral regulatory stance is that in most countries pay-tv operations on a DTTB platform are offered by one single service provider (either operating one or more multiplexes), mostly a commercial market party. The risk of consumer confusion and market fragmentation is limited as subscribers to the DTTB pay service can only go to one provider.

However, in model A where every DTTB licensed broadcaster can launch its own pay-tv services (in the case no further regulations are set), the risk of market confusion and market fragmentation does arise. Whether the CAS standard should be stipulated depends therefore for a large extent on the selected licensing model. In case of selecting model A, the NRT should seriously considering setting a CAS standard. In model B, the necessity of setting a CAS standard is less eminent as only one multiplex/network operator will be present in the market and the choice could be left to the single multiplex/network operator. In this way this operator can set the market standard.

In selecting a CAS system the following considerations could be taken into account:

- The business case for offering a pay-tv service should be clarified. The additional revenues that can be generated, next to the free-to-air (FTA) and PPCTV’s DTTB services should be quantified. These additional revenues should then be compared to the additional costs of having DTTB receivers with embedded CAS. In the case of financial compensation for viewers (e.g. set-top-box vouchers) the pay-tv decision will directly impact the required ASO budget.
- The need and willingness to pay for additional pay content and the associated production costs (to include in the above mentioned business case clarification). Ideally on the basis of market research such a need for additional pay content should be identified (see also the functional building block 3.2 in Phase 1 of the roadmap).
- The intended date of launching these pay-tv services. A service launch beyond the ASO planning (i.e. beyond 2015 or 2018) might open up the possibility to wait and see what the PPCTV service uptake will look like. In case of a successful service take-up, a ‘standard’ would be already adopted in the market and CAS regulation might not be necessary.
- The production numbers of embedded STBs. It is advisable to make an inventory of the productions numbers (i.e. the number of clients and deployed smartcards) of the various *set-top-box* suppliers. Economies of scale applies here too: set-top-box production lines with a large number of single embedded CAS boxes will be cheaper.
- The smartcard costs and their delivery volumes/schedules. Smartcard prices can vary significantly between suppliers and also the way they can be ordered (the possibilities of rolling forecasts and minimum committed order size).
- The risk of hacking the CAS. Efforts to hack a smartcard are directly related to value of the pay-tv package. In addition, smartcards are often only temporarily hacked and rarely cards have to be

recalled. Verify the CAS supplier’s track record and the way they have organized recovery procedures (including the costs and who will have to bear what cost in case cards have to be recalled).

4.2 Customer proposition

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

Table 4.3 provides an overview of the network coverage area of the main platforms in Cambodia, expressed in household (HH) percentages. It also includes an estimate of the service uptake per platform, expressed in the actual number of viewers or subscribers and as percentage of television households (TVHH).

TABLE 4.3
Overview of the main television platforms in Cambodia

Platform	Network coverage area % households		Service uptake	
	% HH	HH (k)	Subs or TVHH (k)	% TVHH ¹⁰
Satellite (DTV)	100%	3,000	120 k	5%
Cable (102+ companies)	23-40%	700-1,200 ¹¹	700 – 1,200	30%-50%
Digital terrestrial (PPCTV) – PP area ¹²	24%	700	75 k	3%
Analogue terrestrial:				
– CTN network (11 sites)	76%	2,280	1,824	76%
– Bayon TV network (15 sites) ¹³	84%	2,520	2,016	84%
– TVK (6 sites) ¹⁴	52%	1,560	1,248	52%
– TV5 and TV3 (5 sites)	48%	1,440	1,152	48%
– TV9 and Sea TV (3 sites)	43%	1,290	1,032	43%
– Hang Meas and Apsara (1 site)	32%	960	768	32%

From Table 4.3 above, it can be concluded that:

1. satellite has a footprint covering the whole of Cambodia and it offers a service bouquet including all Cambodian channels (except one). However, its price level makes it beyond the reach of many Cambodian households (see its limited service uptake);
2. the two main platforms are analogue terrestrial and cable having respectively a maximum network coverage of 84 per cent and 40 per cent;

¹⁰ The Cambodia population is approximately 15 million people and with an average household size of five Cambodia has approximately 3 million households. The *national* average penetration of television sets is assessed at 80%, resulting in approximately 2.4 million television households.

¹¹ Houses passed are assumed to be the same as the actual cable subscribers.

¹² Coverage area assumed to be the same as CTN’s analogue television coverage area of its PP site.

¹³ Applying a Pareto principle it is assessed that the last additional sites add 2% additional household coverage as compared to CTN’s coverage.

¹⁴ Data taken from CTN network: first six largest sites in terms of population coverage.

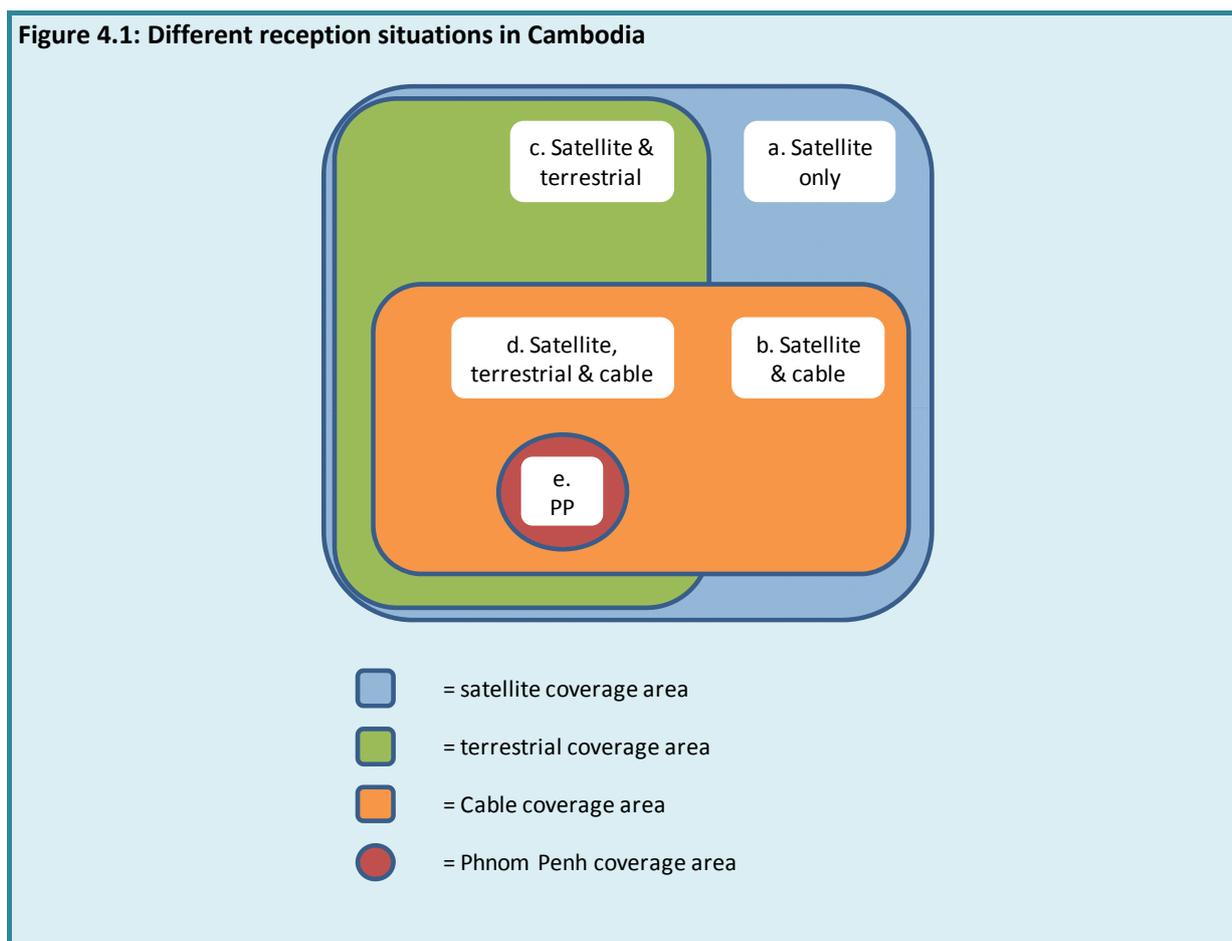
3. the analogue terrestrial network area varies considerably between the services/broadcasters ranging from 84 per cent to 32 per cent, implying a varying service bouquet across the country;
4. there are five principle reception situations for households in Cambodia (illustrated in the Figure 4.1):
 - a. areas with just satellite reception (with a relative large number of services). Given the high service coverage of analogue terrestrial and cable networks these areas are limited and theoretically 16 per cent at the most (i.e. 100 per cent – 84 per cent, assuming a complete overlap between terrestrial and cable networks) but most likely to be below 10 per cent;
 - b. areas with satellite and cable reception. Given the terrestrial network coverage of 84 per cent (and still growing as new sites are planned) this situation can only apply up to a maximum of 16 per cent of the Cambodian territory;
 - c. areas with satellite and analogue terrestrial (with a varying number of channels, but in most areas just two to three services);
 - d. areas with satellite, analogue terrestrial and cable reception (with a relatively large number of services);
 - e. Phnom Penh area with satellite, analogue terrestrial, cable (including IPTV) and digital terrestrial reception¹⁵.

Not considering the first, second and fifth reception situation (because they are respectively small or already DTTB served), the DTTB service offering has to compete on two basic markets:

1. Non-cabled areas (situation c). In these areas analogue terrestrial viewers will compare its current analogue offering (for a large percentage of viewers this offering includes just two to three channels) with the costs of switching to satellite or DTTB (next to comparing the channel line-up). This is comparing the purchasing costs for a DTTB STB and antenna (including any subsidies/vouchers) to the satellite STB and dish. Please note that for analogue terrestrial viewers with also satellite/DTV this trade off will be different (they may decide not to switch to DTTB).
2. Cabled areas (situation d). In these areas people will have to decide between the DTTB and the analogue cable offering. Clearly the advantage of analogue cable is that no STB is needed.

¹⁵ In the Phnom Penh area it is estimated that 20% of the population rely on analogue terrestrial television reception (approximately 200,000 households). Consequently also in Phnom Penh a considerable transition effort is required.

Figure 4.1: Different reception situations in Cambodia



4.2.1 Non-cabled areas

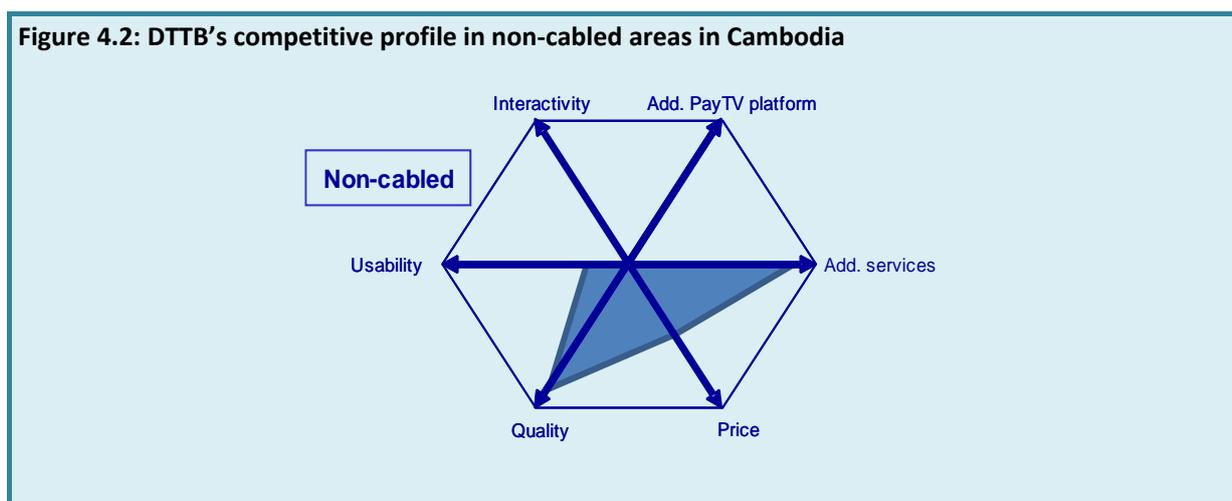
The Guidelines (see section 3.2.1) identifies six competitive advantage categories. Applying these categories to the Cambodian served areas results in the following considerations for non-cabled areas (where satellite is the only alternative after switching off analogue terrestrial services):

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 Program Guide (EPG), additional program 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 given the low ability to pay in Cambodia, this seems not to be an option.
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 or 9 multiplexes), let alone the cost consequences for content production.
3. *Additional services/multi-channel offering*: In Cambodia, the analogue terrestrial television platform offers only a limited set of services (i.e. 2 to 10 services in PP only). The introduction of a multi-channel DTTB offering could be a key demand driver. It should be noted however that in Cambodia DTV offers a multi-service, too (pay-tv satellite) and the DTTB platform is faced with a lower distribution capacity. However, DTV operates in a much higher price range (i.e. receiver installation and subscription prices) and does not directly compete with DTTB.

4. *Lower costs (one-off and recurring)*: The DTTB platform in Cambodia has the advantage of having lower receiver costs as compared to satellite. STB retail prices are in the range of € 10-20, implying ex-factory between € 5-15. Especially these one-off costs form a major barrier for consumers to adopt digital television. It should be noted however, as the DTTB launch is part of an ASO process (a government led operation), the lowest purchasing costs (including subsidies/vouchers) for the Cambodian people is really a prerequisite rather than a competitive edge.
5. *Picture and reception quality*: The introduction of DTTB could entail for many Cambodian viewers a significantly better picture quality. Most terrestrial viewers have an indoor reception installation (the so called ‘rabbit ears’) in a rooftop designed network. Hence, due to multipath propagation viewers will have distorted reception and picture quality. This does less apply to viewers with rooftop antennas. However, the number of rooftop antennas is limited in Cambodia. Hence this could provide a competitive edge for DTTB.
6. *Usability/Portability*: DTTB services are wireless and can be received on compact receivers. Hence, DTTB services have the competitive advantage of portability, especially when the receiver comes with a small antenna. In Cambodia, 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 non-cabled areas can be drawn:

Figure 4.2: DTTB’s competitive profile in non-cabled areas in Cambodia



4.2.2 Cabled areas

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

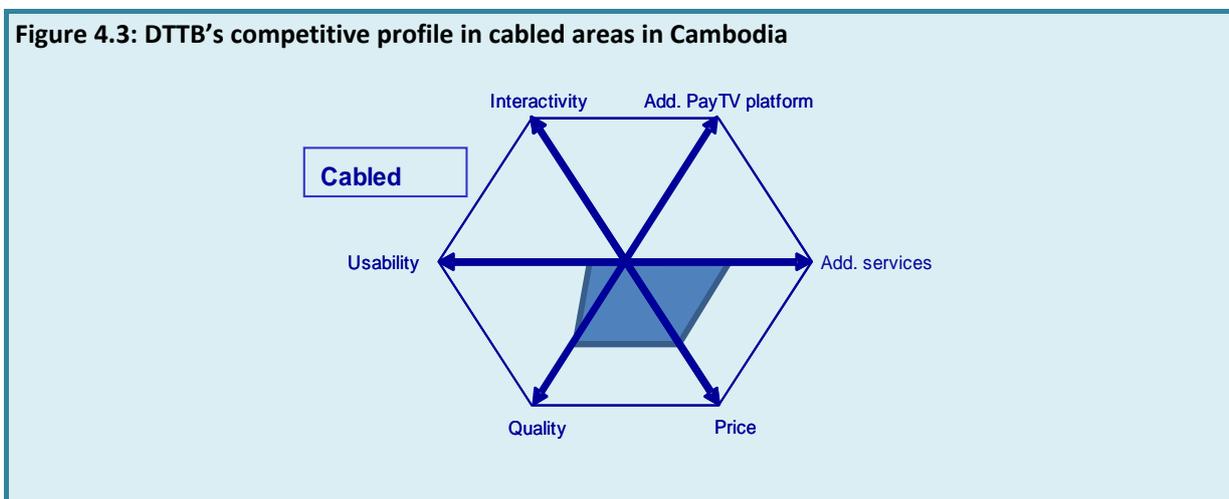
1. *Additional services/multi-channel offering*: As said the introduction of a multi-channel DTTB offering could be the key demand driver. For people in the cabled areas this argument seems to be less strong. The cable networks offer a service bouquet of 15-30 services. In areas where the cable offering have been in the market for some years the window of opportunity may be gone as people have already switched from analogue terrestrial television to cable. Consequently, additional services may be a weaker competitive edge for DTTB.
2. *Lower costs (one-off and recurring)*: As indicated above, 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. For the recurring costs the DTTB platform can have a competitive advantage over cable in the case where it is offered FTA. Whether this is possible depends largely on the licensing model and the total television advertising market in Cambodia. In model B, a FTA

offer is more likely as the distribution costs can be shared between broadcasters. No data is available on the total television advertising market (especially when introducing DTTB) and should be investigated (see section 3.4.2 of this report). In summary, only under conditions the DTTB platform could have a price advantage.

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 does not necessarily have 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 Phase 1 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.

From the above considerations the following competitive profile of the DTTB platform in cabled areas can be drawn:

Figure 4.3: DTTB’s competitive profile in cabled areas in Cambodia



4.3 Licensing framework model A or B

The Guidelines includes several considerations for selecting either model A or B. Please note that the guideline text below is shortened and adapted for Cambodia. Following this guideline the following observations can be made:

1. *“Spectrum management objectives*: In order to increase spectrum efficiency the Regulator would like to avoid content duplication”. In both models this can be accomplished if:
 - a. In (a variant of) model A: the spectrum rights are awarded in combination with an obligation to provide a defined bouquet of channels, for example as proposed in the bid book or stipulated by the MOI. This bouquet should make use of all available capacity (so no capacity left unused) and between broadcasters services should not be duplicated. It may also be necessary to stipulate the quality of services as to avoid unwanted content or many repeats. Also the spectrum licence conditions should be specified on the basis of a detailed service planning (see section 3.4.4) stipulating exactly the spectrum use (including site location, antenna height, ERP, and antenna diagram). This may imply changing already assigned digital spectrum rights. It seems doubtful if the broadcasters can provide a viable business plan for

- b. In model B: reserving capacity on the available multiplex capacity for the existing analogue terrestrial services. Also with the stipulation to cover the same area as the analogue service.

As the above considerations show, model A seems either to run into financial problems (as the network costs are too high) and/or cause considerable spectrum inefficiency (as broadcasters cannot finance the content production costs and multiplexes will not be utilized). Model A seems to be only possible if major concessions are made to the DSO objectives.

It should be noted that in terms of costs for the Government there is no difference between model A or B. Also in Model B it is possible that in a Public Private Partnership, the private partner will bear all costs of the network roll-out and even the promotion of the DTTB service, including subsidizing the STB.

The NRT should draft for each model a balance with the pros and cons of that model. Also the appropriate importance/weights have to be assigned to all pros and cons. In Figure 4.4 an initial overview is provided.

Figure 4.4: Initial overview of the pros and cons of model A and B

Model A		Model B	
Pros	Cons	Pros	Cons
	Spectrum inefficient	Spectrum efficient	
	More investments in infrastructure needed	Significantly less investments in infrastructure needed	
	Impacts PPCTV business model as Broadcasters will roll-out their own service		With out regional insertion, regional/small broadcasters are distributed nationally
Competition between Broadcasters is possible over (different) network coverage & quality			Less/no competition between Broadcasters in terms of network coverage & quality
Re-use of switched off analogue equipment easier			Re-use of switched off analogue equipment will require co-operation of Broadcasters
Site sharing rules less needed			Site sharing rules may be required if Broadcasters don't cooperate

4.4 Required and available budget

As mentioned in the ASO planning phase of the roadmap, the ASO phase will have to deliver a business case detailing the costs and the financial resources. In this section considerations on both costs and 'revenue' side are included.

4.4.1 Cost considerations

The Guidelines provide in Table 2.15.2 an overview of the relative impact on the size of the ASO organization and costs, depending on what responsibilities the NRT takes on board. Below an adjusted table is provided including considerations for Cambodia.

TABLE 4.4
ASO activities and budget impact for Cambodian ASO process

No	ASO Activity	ASO organization function	Considerations for Cambodia situation	Relative cost/budget indication
1	Migrating viewers to digital	<p>Logistic function for administrating and handing-out vouchers</p> <p>Logistic function for aerial retuning and installation</p> <p>Contact centre function for (technical) assistance</p> <p>Consumer communication function</p> <p>Media and Public Affairs function</p>	<p>Depends on the actual/final coverage of the DTTB network. Assuming an 84% coverage target (i.e. the largest terrestrial network coverage) this could entail a considerable operation.</p> <p>Financial impact can be limited if financial compensations is minimized (see brackets in next column):</p> <ol style="list-style-type: none"> 1. Only existing analogue terrestrial viewers are financially compensated; 2. Selection of cheap set-top-boxes; 3. Partly financial compensation (not the whole purchase costs) or loan system (please note this will include interest/finance charge for the government); 4. Roll-out indoor coverage network, as to avoid roof-top antenna purchase costs. 	++(++)
2	Transmitter network migration efforts	Network planning function	<p>Depends on the actual/final coverage of the DTTB network.</p> <p>Costs will arise from additional transmitters (in the case of simulcasting), head-end systems, additional distribution capacity and additional sites (for example to provide better/indoor coverage).</p> <p>Especially adding sites can entail significant costs (see brackets in next column)</p>	++(+)
3	Re-farming of spectrum efforts and compensations	Network planning function	<p>According to the current information provided (but should be double checked) there are no existing spectrum users to be migrated. Although some digital licences may need to be revoked or changed. Without knowing the exact licence conditions it is difficult to assess these costs. Also the consequences of ASO on the distribution to cable head-ends should be assessed (see also 3.4.2). This may also result in compensation claims</p>	+(?)

No	ASO Activity	ASO organization function	Considerations for Cambodia situation	Relative cost/budget indication
4	Simulcast period for analogue terrestrial services	Broadcast network roll-out monitoring function	<p>Depends on the decision of having a simulcast period. But even in the case of simulcasting the costs (i.e. network operating expenses) can be limited if (if conditions are not met significant costs can arise – see brackets):</p> <ol style="list-style-type: none"> 1. A thorough service planning is conducted and the service bouquet is balanced – most likely in model B. 2. In case the largest analogue network coverage has to be reproduced the number of sites is limited to 15 (and possibly extensions of the analogue networks are stopped); 3. The simulcast period is limited to a maximum of four years (only in the case the ASO is 2015 and not for example 2018). 	+(++)
5	Managing the ASO process	<p>Broadcast network roll-out monitoring function</p> <p>Market monitoring and research function</p> <p>Consumer communication function</p> <p>Industry communication functions</p>	<p>Assuming all functions (see left column) will be included in the NRT responsibilities and NRT members will be mainly Government entities, the managing efforts and costs can be relatively low.</p> <p>Given the low penetration rate of Internet access and use in Cambodia, communication costs might be relatively high (e.g. printed materials, mobile and more radio broadcasts)</p>	+
6	Setting mandatory certification and labelling	Industry liaisons function	<p>These costs could be minimized by:</p> <ol style="list-style-type: none"> 1. Stipulating a widely accepted and proven transmission standard; 2. Not stipulating a CAS standard; 3. Implementing a voucher system for a single standard receiver (i.e. set-top-box). 	+
7	Cost for resolving any DTTB interference	Contact centre function	Interference issues can occur in Cambodia, given the presence of widespread cable networks and home installations. Costs can be minimized if cable operators are willing to use spectrum not in use by DTTB. That will imply that network operators will have to change their so-called network raster and subscribers have to retune their television sets.	0

4.4.2 Budget considerations

An inventory should be made of the possible sources for financing the abovementioned ASO costs. The Guidelines provides guidance on sources for funding (see section 2.9.1). The table below provides some first considerations on the various sources.

TABLE 4.5
Funding sources for the ASO in Cambodia

No	Source	Considerations for Cambodia
1	General Taxes	<p>When financing the ASO from general taxes the following should be taken into account:</p> <ol style="list-style-type: none"> 1. Given the 84% target population coverage as implied in the DSO objectives, 16% of the population will pay towards the ASO but will not directly benefit from DTTB. This may constitute a political barrier; 2. This is a form of indirect financing of activities (not through a purpose specific tax levy). The ASO costs and benefits have to be balanced against other national priorities (e.g. building schools or roads). This political process might be long and the ASO plan should take this into account when deciding to include this source in its financial planning.
2	TV licence fees	<p>Introducing the TV licence fee can be option to finance the ASO process. However in Cambodia such a system is currently absent. Experiences in the past have shown that such fees are heavily debated and people tend to resist such an introduction. This may cause significant political debate. Also law enforcing has shown to be very difficult as people hide television sets and regular checks are necessary. Perhaps not the best option to consider.</p>
3	Spectrum usage/industry levies	<p>The number of licensed spectrum users is relatively high in Cambodia (9 mobile network operators, over 10 television broadcasters and many commercial radio/FM broadcasters). Hence there seems to be a basis for additional spectrum usage levies.</p> <p>Special industry levies for equipment suppliers will be problematic for (inter)national competition rules and policies. Moreover this may work adversely as equipment prices will go up.</p>
4	Spectrum auctions or tenders	<p>As can be learned from the Guidelines spectrum auctions and tenders procedure with substantial upfront payments are rarely seen for DTTB licences.</p> <p>In addition, In Cambodia at least one commercial DTTB licence has already been assigned without substantial payment.</p> <p>However, auctioning ‘digital dividend’ spectrum (for example for LTE services) may prove to be a source of financing the ASO costs. It should be noted however, that the revenues/proceeds of this auction will become available after ASO. Hence ASO costs may have to be advanced.</p>
5	International organizations/loans (ITU/NGO/Worldbank, other countries, etc)	<p>Seems limited but no practical information available. In the case of international loans the ability to pay back should be seriously considered.</p>

No	Source	Considerations for Cambodia
6	Commercial participation and/or Public Private Partnerships (PPP)	<p>As indicated in the Guidelines, different forms of PPPs can be applied:</p> <ol style="list-style-type: none"> 1. A commercial and independent party (e.g. this party could be formed by the current broadcasters, together with other parties) rolls-out the common network/service and the current terrestrial services are carried in a FTA bouquet (a form of model B). In return for its investment efforts the commercial party is allowed to use the remaining multiplex capacity and can generate revenues from a pay-tv service; 2. A commercial and independent party roll-out the common multiplex/network and rents out all the available capacity to any commercial broadcaster or service provider interested in DTTB distribution (a form of model B); 3. The Cambodian government and a commercial network operator jointly finance the DTTB network (PPP), providing a free-to-air and pay-tv DTTB services. Remaining capacity will be rented out to any other commercial broadcasters (a form of model B). <p>In Cambodia foreign ownership rules are applicable. A foreign commercial party or a PPP financing structure may require revision of these rules (as to make it interesting enough for foreign parties to participate). The ASO planning should facilitate time for any such change.</p>

From the table above it can be concluded that financing the ASO will take a considerable effort, for any of the abovementioned funding sources, to generate substantial money. This should be carefully balanced against the ASO cost items (and the possibilities to minimize them).

4.5 ASO model

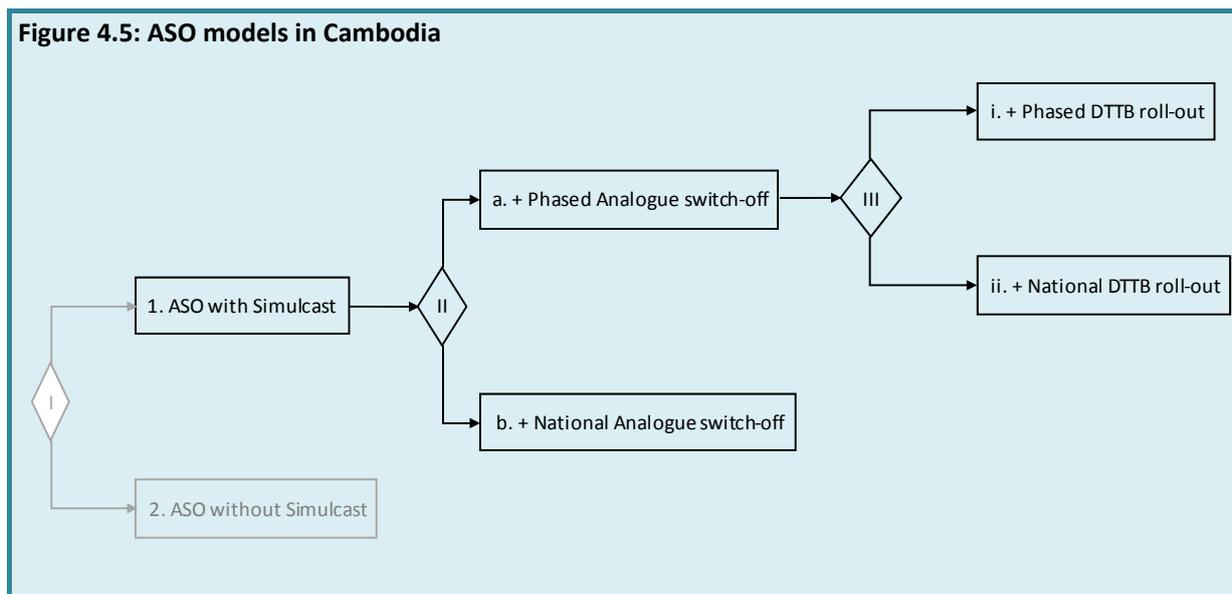
As discussed under the DSO objectives (see section 2.3) a simulcast period for the current analogue terrestrial services is wished for. The DSO objectives also indicate the possibility of having extended population coverage. In other words there will be areas in which there is currently no analogue terrestrial television coverage (for a maximum of approximately 16 per cent of the population) and the new DTTB network will deliver new terrestrial television services. Consequently, in case the DTTB network coverage will be larger than the current analogue terrestrial coverage, two situations have to be considered:

1. non-served analogue TV areas;
2. served analogue TV areas.

For the non-served areas, it is advised just to introduce the DTTB service directly as a new service. So in those areas there will be no simulcasting. The potential viewers in these non-served areas should be informed about the new possibility to receive DTTB services (possibly next to other options such as cable and satellite). Communication to this group of viewers should therefore be part of the ASO communication plan too.

Other than the decision to have simulcasting in the served areas, the NRT will have to further specify what this simulcast period will look like. Following the Guidelines, two remaining decisions will have to be taken. In Figure 4.5 these remaining decisions have been illustrated (see also Figure 2.14.4 in the Guidelines).

Figure 4.5: ASO models in Cambodia



Following the figure above, the following can be said about the remaining decisions (II) and (III):

1. Decision II: A phased analogue can be considered:
 - a. As the number of analogue terrestrial television viewers is relatively large. As observed before Cambodia's two main platforms for television services are analogue terrestrial and cable having respectively 2 to 1.2 million viewers. The impact of failure would be large.
 - b. As the number of broadcasters/network operators involved is large. In both licensing models (A and B) they have to switch off the analogue transmitters. Although the number of sites per broadcaster is limited (maximum 15 – 19 sites), by having so many networks the number of sites is relatively large. The installation/engineering capacity may not allow for switching off at one moment.
 - c. As the number of phases can be limited to two to three in order to minimize complexity. It should be noted that this is a region by region approach and not broadcaster by broadcaster, also in model A. Before any region is being switched-off, it is advisable to test ASO in a closed user group. This not only to test the working of the new DTTB network but also the receivers, the retuning and installation at home, the customer contact processes, etc.
2. Decision III: A phased rollout of the DTTB network can be considered:
 - a. As available spectrum may be limited and frequencies have to be re-used (see also section 4.9 in this report).
 - b. As the broadcasters' installation and engineering capacity may be limited and a network roll-out at once (i.e. a limited period of time) may not be possible. This seems only to apply in the case model A is applied. In the case of model B, capacity limitations can be reduced if a common multiplex/network operator is selected who proved to have sufficient resources to roll-out the network in a timely manner.
 - c. As broadcasters may insist on re-using transmitters or other infrastructure in order to reduce their investment costs. This will require a phased roll-out of the DTTB network. In such an approach the broadcaster re-uses switched off analogue transmitters (depending on the type of analogue transmitter, see also section 4.9 in this report) of one region in the next region. Obviously this will extend the simulcast period considerably and hence the simulcast (operational) costs. This consideration applies in both model A and B. In model B, the common multiplex/network operator will re-use switched off equipment from the broadcasters. Broadcasters are likely to cooperate as they will still get some income from equipment which cannot be used anymore.

4.6 ASO planning and milestones

A key element for the ASO planning is that it is well coordinate and facilitates cooperation throughout the value chain. The table below provides an overview of possible result paths of the ASO planning and the key tasks associated to them.

Next to the different result paths (in the table below eight result paths are suggested), the ASO planning should specify the key milestones on each result path and the interdependencies between them. In the table some example milestones are provided for each result path.

In this way this table can form the basis of an initial ASO planning.

TABLE 4.6
Cambodia ASO planning and milestones

No	Result path	Key tasks	Example milestones	Planning considerations for Cambodia
1	Regulation and Political Approval	<ul style="list-style-type: none"> Government providing mandate to the NRT Government approving the DTTB policy document Government endorsing the ASO planning and DTTB licensing regime Government approving any necessary regulatory changes 	<ul style="list-style-type: none"> DTTB policy document approved (see Phase 1) ASO planning approved (see Phase 2) DTTB licence terms and conditions agree (see Phase 3) Regulatory framework changed (see Phase 1) 	<ul style="list-style-type: none"> The NRT team should include a 'liaison officer' to quickly check and monitor political issues and considerations Staged approach, in which first a DTTB policy document is agreed (see section 3 in this report) and later the ASO plan
2	Frequency planning and coordination	<ul style="list-style-type: none"> The NRT should manage and have a frequency planning carried out Also the coordination efforts to free-up (temporarily) spectrum and to ensure interference free broadcasts should be included. 	<ul style="list-style-type: none"> Initial DTTB service plan agreed (see Phase 2) Detailed DTTB service plan agreed (see Phase 3) 	<ul style="list-style-type: none"> Likely to be a task of the NRT. Especially considering the remarks in section 3 on the need for clarifying the available spectrum and the broadcast and mobile requirements

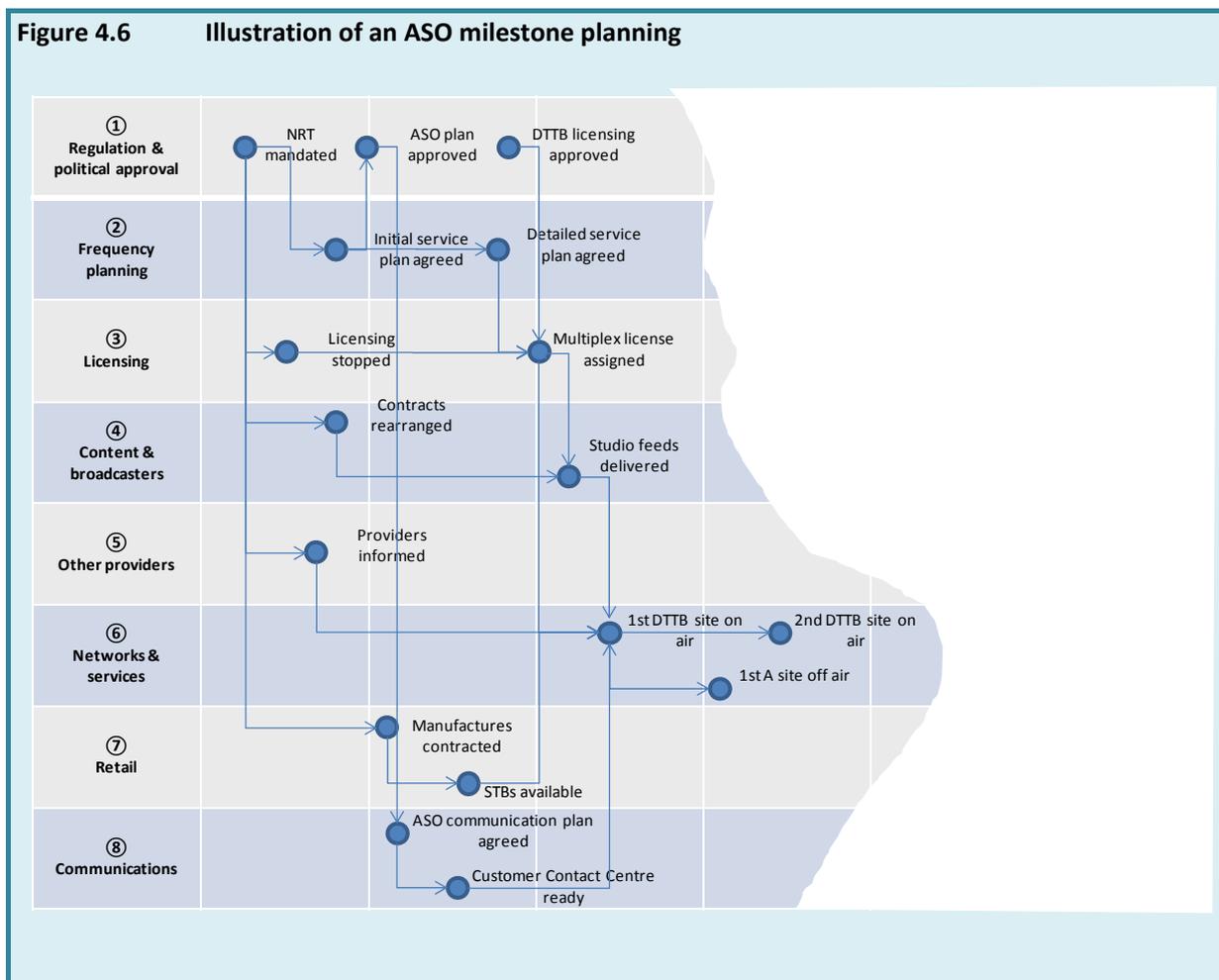
No	Result path	Key tasks	Example milestones	Planning considerations for Cambodia
3	Licensing	<ul style="list-style-type: none"> • The MOI and MPCT have to stop licensing analogue terrestrial licences • The MOI and MPCT need to assign the required DTTB media and frequency licences (to either a common network operator or individual broadcasters) • The MOI and MPCT may need to revise assigned licences to make the ASO planning possible • Regulator(s) might need to take away any obstacles in the acquisition of building permits (in case new sites or temporarily transmitter sites have to be erected quickly) or any other permits 	<ul style="list-style-type: none"> • DTTB licences assigned (see Phase 3) or Multiplex/network operator licence assigned (see Phase 3) 	<ul style="list-style-type: none"> • Evidently tasks to be overseen by the NRT
4	Content and Broadcasters	<ul style="list-style-type: none"> • Broadcasters need to be informed about the ASO timetable and the impact on their production chain • Broadcasters need to communicate to their viewers about the ASO (by incorporating items in their own programming) • In model B, broadcasters need to deliver their studio feeds to the common multiplex/network operator • In model B, existing distribution arrangements may change. For example, DTV and PPCTV distribute the broadcasters' content free of charge 	<ul style="list-style-type: none"> • All studio feeds delivered at multiplex centre (see Phase 4) • Business model agreed and distribution contracts rearranged 	<ul style="list-style-type: none"> • Broadcasters may have to deliver different studio feeds • Broadcasters distribution network to the transmitter sites may change (also including cable network head-ends) • Content rights may be impacted. Purchased content may only be distributed in a certain area of Cambodia and/or only in analogue format • It could be considered to involve DTV, although not as a NRT member

No	Result path	Key tasks	Example milestones	Planning considerations for Cambodia
5	Other Multiplex operators/Service providers (PPCTV, DTV and Cable operators)	<ul style="list-style-type: none"> • Making sure that the marketing around analogue switch-off does not favour the digital terrestrial platform only. Viewers should be informed about opportunities for television reception across all platforms • Information of their offerings should be exchanged and coordinated in the NRT • In model B existing distribution arrangements may change. For example, DTV and PPCTV distribute the broadcasters' content free of charge 	<ul style="list-style-type: none"> • Information exchange with other providers agreed • Distribution contracts rearranged 	<ul style="list-style-type: none"> • DTV, PPCTV and Cable operators provide an alternative platform and hence they could contribute to the NRT • In model B PPCTV's offering may be part of the common multiplex/network operator. This may require agreeing a different business model
6	Networks and services	<ul style="list-style-type: none"> • Broadcasters/ Network operator need to detail the network planning and the associated service roll-out planning • Broadcasters/ Network operator need to carry out the DTTB network and service roll-out • Broadcasters have to switch off analogue transmission at the right time in the right area(s) 	<ul style="list-style-type: none"> • Network and service roll-out planning drafted and agreed (see Phase 4) • DTTB Transmitter site in region A taken in operations (see Phase 4) • First analogue transmitter in region A switched off (see Phase 4) 	<ul style="list-style-type: none"> • In both models (A or B), representatives of the broadcaster/network operator function are evidently need in the NRT

No	Result path	Key tasks	Example milestones	Planning considerations for Cambodia
7	Retail (STB and other receivers)	<ul style="list-style-type: none"> Manufacturers need to supply sufficient quantities of DTTB receivers in regions In case of pay-tv, CAS suppliers need to supply smartcards Manufactures may be required certify compliancy with any set standard (see section 2.1) and to provided proper or specific labelling 	<ul style="list-style-type: none"> Contract agreed for certifying and labelling STBs First batch of STB available in selected retail shops in region A 	<ul style="list-style-type: none"> This will include the retail chains as well. STB Manufactures are not likely to participate in the NRT, but a good 'liaison officer' will be needed Representatives of logistic chain providers (shops, post offices) are likely to be included in the NRT Labelling/certification will require a trusted organization to do so. Given the limited means for communications this should ideally be an organization already know to the Cambodian public. Such an organization is likely to participate in the NRT
8	Communications (Viewers and other target groups)	<ul style="list-style-type: none"> Setting acceptable timetables and understanding local issues Formulated adequate messages and executing communications through various means/tools 	<ul style="list-style-type: none"> ASO communication plan agreed (see Phase 2) Customer/viewer contact centre operational 	<ul style="list-style-type: none"> Representatives of the various viewer groups are likely to be consulted in the NRT Will include a customer/viewer contact centre

The Figure 4.6 provides and impression of what an ASO planning could look like.

Figure 4.6 Illustration of an ASO milestone planning



4.7 ASO communication plan

As indicated in the Guidelines, the ASO Communication Plan is a strategy on how to inform the public at large and the involved market players in several successive stages. One of the main deliverables in preparing this plan is a matrix which matches:

- the different target groups; and
- the different messages (per stage).

As discussed in section 4.2, in Cambodia there are served and the non-served (with analogue terrestrial television) areas. Consequently, the communication messages between these two groups will differ significantly.

In the served areas, five different reception situations do exist:

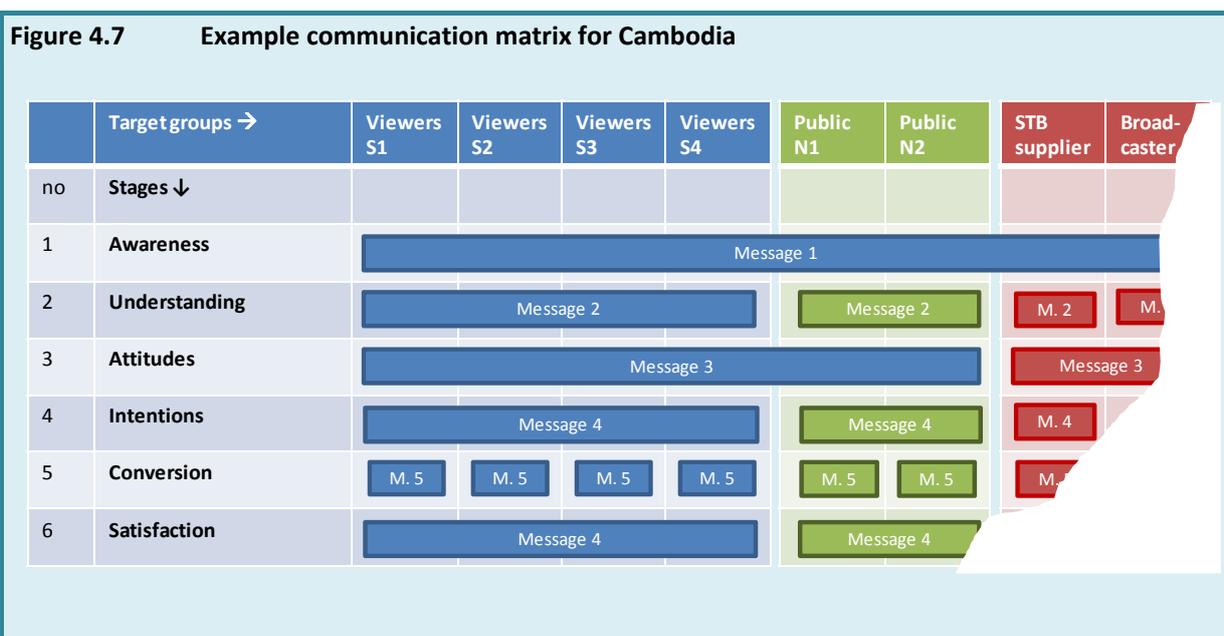
- areas with just satellite reception (with a relative large number of services);
- areas with satellite and cable reception;
- areas with satellite and analogue terrestrial (with a varying number of channels, but in most areas just two to three services);
- areas with satellite, analogue terrestrial and cable reception (with a relatively large number of services);
- Phnom Penh area with satellite, analogue terrestrial, cable (including IPTV) and digital terrestrial reception.

All these different reception situations will imply different messages, although some messages can be common (e.g. in the awareness phase of communications). But definitely at the conversion stage, in which the viewers have to be explained in detail what he/she has to do to change to digital, the message will differ.

Next to the target group ‘the public’ the involved market parties have to be informed too. Depending on the responsibilities the ASO organization will take on board (for example whether or not a voucher system will be implemented), the following target groups could be included in the matrix:

- STB suppliers and retailers;
- certification and labelling institutes/organizations;
- broadcasters;
- content creators;
- landlords and public places (with television sets);
- government entities (e.g. local councils, regulatory bodies, etc.);
- voucher (or loan) supplier.

In Figure 4.7, matching the different target groups with the different communication stages and messages is illustrated.



As part of the ASO planning and more specifically the Communications work stream, the NRT should complete and detail the above illustrated matrix. Subsequent steps will include:

- Determining the communication tools per stage and target group. For example, the non-served public will rely heavily on the radio to be informed whilst served viewers can easily be reached with the broadcasts of the commercial/public broadcasters.
- Mapping the communication matrix on the network roll-out planning as to determine the exact dates for communicating (especially the conversion and satisfaction/monitoring stage).

4.8 Business model and conditional access

Agreement on the business model between the involved parties in the value chain will be a key decision to be made. This choice cannot be considered separately from the decision on the licensing model.

In the case model A is decided, the broadcasters will be free to adopt any business model. For the DTTB services this is basically the choice between pay-tv services or FTA services (or any combination). Although the NRT is not involved in selecting a business model for the DTTB service, the NRT should consider setting standards for the CAS (see section 4.1 in this report).

In case model B is selected, the NRT will have to decide a business model for the common multiplex operator. This operator can offer:

1. Distribution (or network) services only: the broadcasters (or any other service provider) will have to pay a distribution fee for the service of broadcasting their program(s) in specified areas (against a set of agreed service levels, including picture quality, network availability, etc.). The impact on the broadcasters will be relatively limited as the broadcaster can still broadcast FTA. Alternatively the broadcasters can encrypt their content and deliver this encrypted content to the multiplex/network operator for distribution¹⁷. In this way the broadcasters can also offer pay-tv services;
2. Distribution and television services: here the multiplex/network operator offers next to distribution services also its own television services (i.e. its own television content and mostly likely as a pay-tv service) directly to the viewers in Cambodia (see also section 4.4.2 in this report). In this model the multiplex/network operator is also service provider/broadcaster. In the case these pay-tv services are reserved for the multiplex/network operator (for example for having a single pay-tv bouquet and not to fragment the market too much), the existing broadcasters cannot offer pay-tv services¹⁸.

The Guidelines provides some guidance for broadcasters in selecting a business model for DTTB services. As said above, considering the DTTB business model the key question is really whether to launch a multi-channel offering on the basis of a free-to-air (i.e. a business model on the basis of advertising income) or a pay-tv model (i.e. a business model on the basis of subscriptions).

As the Guidelines indicate whether a FTA or a pay-tv offering can be success depends on various factors, including:

1. For FTA models:
 - a. Additional viewers or viewing hours. Any FTA proposition will have to add additional viewers (or viewing hours) not previously addressed by existing platforms. In most cases, in the FTA model the network transmission costs of the DTTB network have to be financed by the additional advertising income on the DTTB platform. As discussed in section 4.3, this may not be the case in model A. Adding viewers or viewing hours is not necessarily restricted to non-served viewers (e.g. because the channels are not broadcast on widely distributed on analogue networks), but can also be driven by additional (viewing) value for the end consumers. In France for example, new viewers were attracted by offering a multi-channel HDTV offering. As discussed in section 4.2.1, in Cambodia improved picture quality (although not likely to be HDTV) can add additional viewing.
 - b. Absolute volume of the advertising market and market share for television advertising. Some markets may have limited advertising budgets, which may not cover the additional cost of setting up and running a DTTB services. Please note that also the advertising budget distribution should be considered. In some markets the advertising spend might be proportionally larger than for other media (e.g. such as radio or newspapers). As advertisers are known to be conservative, changing these spend patterns might be a lengthy process.

¹⁷ Special attention should be given to a secure way of delivering the encrypted content to the head-end of the multiplex operator.

¹⁸ This will require a solution for the current pay-tv services offered by PPCTV. See also section 3.4.4 in this report.

2. For pay-tv models:

- a. Other existing pay-tv offerings in the market and their bouquet composition. Existing pay-tv service providers might address only the top segment of the market with relatively expensive packages. There might be room in the market for offering lower-tier packages without exclusive/expensive content. This situation seems not to exist in Cambodia as analogue cable, with over 1.2 million subscribers, already serve a considerable part of the market with a cheap offering. In addition, existing service providers might provide a (perceived) bad service, providing a driver for viewers to switch to an alternative television offering (not observed during the first visit).
- b. Existing free-to-air offerings. The potential market share for pay-tv service might be limited by the existence of widely adopted free-to-air offerings with Cambodian relevant content (the only offering in Cambodia is the analogue terrestrial services).
- c. Existing television content contracts in the market. Especially exclusive content deals might limit the possibility of creating attractive pay-tv packages. For example exclusive live football broadcast rights. Conversely, the absence of such exclusive contracts might create an opportunity (no information available).
- d. Willingness to pay for television content. The willingness to pay is very often historically and culturally determined. Pay-tv service providers should carefully investigate paying patterns for television services. As said in section 3.4.2, this is an aspect that still needs to be researched for the Cambodia market.

4.9 Digital TV frequency plan

A frequency plan for digital television contains frequency assignments to digital TV transmitting stations that are licensed or will be licensed in the future. During the transition period the plan also contains assignments of analogue TV stations which are licensed or will be licensed in the future. All assignments in the frequency plan should be compatible, which means that no unacceptable interference will be caused to any of the services resulting from assignments in the plan.

In this section the need for a digital TV frequency plan will be addressed, followed by the conditions for developing a digital TV frequency plan, coverage considerations and the construction of the plan.

4.9.1 Need for a digital TV frequency plan

An overview of the current analogue and digital television frequency use in Cambodia is shown in Table 2.1. Furthermore, in the framework of the digital switch-over process new channels have to be assigned to enable digital broadcasting of:

1. the existing and already planned analogue TV services;
2. new services;
3. existing and possibly new services from additional sites;
4. future HDTV services.

Also account should be taken of channels needed for:

1. existing and planned T-DMB services;
2. new T-DMB services;
3. possibly digital radio services;
4. mobile communication services in the upper part of Band V.

In order to accommodate all these requirements in the available frequency bands in a compatible way, a frequency plan is needed. There are basically two approaches for developing a frequency plan:

1. evolutionary frequency plan;
2. A-priori frequency plan.

An evolutionary frequency plan starts from an existing situation and is developed by adding assignments when needed. In case of an a-priori frequency plan all known and expected (long term) requirements are planned at once. In both cases, interference calculations are carried out and a station is only entered into the plan when it is compatible with the other plan entries.

Table 4.7 shows some of the features of the two approaches.

TABLE 4.7
Frequency plan approaches

Issue	Evolutionary frequency plan	A-priori frequency plan
Equitable access of services	New plan entries are included on a first come, first served basis. Service requirements in a later stage may not be accommodated, or with restrictions	All current and future requirements are treated at an equitable basis. In case spectrum demands exceed the capacity of the bands, restrictions affect all requirements.
Plan entries	Only assignments of existing stations and stations planned for the short term are included in the plan	All existing and future stations are included in the plan
Compatibility	All plan entries are compatible	All plan entries are compatible
Coverage prediction	Coverage of plan entries (which are only existing stations and short term requirements) can reliably be predicted and will in principle not change; coverage of future requirements (not entered in the plan yet) cannot be predicted	Coverage of all plan entries (including long term requirements) can reliably be predicted and will in principle not change.
Flexibility	As long as the capacity of the frequency bands is not exceeded full account can be taken of changing and future requirements (including policy and technology changes)	Future requirements that differ considerable from the plan entries are difficult to implement
International relationship	Frequency use may be severely restricted if neighbouring countries are first in implementing analogue and digital TV (ITU RR art 11 notifications give rights on a first come, first served basis)	Provided that the plan is developed in consultation with neighbouring countries, equitable access to the bands is provided. This aspect is one of the main reasons for making international frequency plans such as the GE06 Agreement.
Establishment	Need for limited frequency planning activities with each new or changing requirement; preferably with help of frequency planning software	Once, a considerable frequency planning effort is required. Frequency planning software is essential. Several planning exercises will be needed to come an optimal plan (iterative process)
Spectrum efficiency	The plan is based on the current analogue situation; initially the digital plan may not be optimal in frequency use. Eventually, the plan is likely to converge to an optimal plan.	The plan is optimal from the start

In Cambodian, the evolutionary plan approach is advised because:

- it is closest to the current practice of assigning frequencies;
- analogue switch-off date is planned between 2015 and 2018, the latter year is still well ahead and long term requirements may change in the mean time;
- short term requirements and transition of current analogue TV services could be planned on the basis of the existing analogue TV planning.

In order to overcome some of the disadvantages of the evolutionary approach it is advised:

- to establish bi- or multilateral agreements with neighbouring countries on the use of TV channels in border areas. The Joint Technical Committee between Cambodia and its neighbouring countries may be a good platform for coordinating cross border interference;
- to reserve a number of channels for future requirements (see section 4.10.2).

4.9.2 Conditions for developing a digital TV frequency plan

The following considerations should be taken into account for preparing a digital frequency plan.

TABLE 4.8
Conditions for a digital frequency plan

Condition	Situation in Cambodia	Action by NRT
Defined frequency bands and channel arrangement during and after transition	<ul style="list-style-type: none"> • Band III: 174 – 230 MHz; 8 channels of 7 MHz • Band IV/V: 470 to 698 or 790 MHz; 29 or 40 channels of 8 MHz 	Decision on upper limit of Band V for broadcasting (see also section 4.10)
Assignments to be protected during transition	<ul style="list-style-type: none"> • Existing analogue and digital TV services (see Table 2.1) • Planned but not yet operational assignments of analogue or digital television service (to be decided) 	Decision on the size of the analogue TV coverage areas to be protected Decision on need of protection of planned but not yet operational TV services (see also section 4.9.3); planned analogue service could be introduced directly as digital
Assignments in neighbouring countries that need to be protected	<ul style="list-style-type: none"> • Not known 	Investigation of assignments having right of protection according to ITU Radio Regulations Agreement with neighbouring countries on digital TV frequency use in border areas
T-DMB assignments in Band III	<ul style="list-style-type: none"> • Channel 10 (frequency blocks A, B, C and D) is allocated to T-DMB nationwide 	
Accurate and detailed data of transmitting stations: Existing analogue and digital Planned but not yet operational analogue and digital	<ul style="list-style-type: none"> • Basic data available at MOI 	Verification if existing data bases are adequate (see Table 4.11)

Condition	Situation in Cambodia	Action by NRT
Planning criteria and method	<ul style="list-style-type: none"> Not yet established 	Decision on planning criteria (see also section 4.9.4)
Planning software	<ul style="list-style-type: none"> Not available; some broadcasters may have means to prepare coverage plots 	Investigation of planning software package for calculation of compatibility and coverage; or alternatively outsourcing of calculations

For frequency planning reasons a plan should be made for Band III and Band IV/V because of the different propagation characteristics and channel bandwidths in these bands. The plans should be developed for two situations:

1. A frequency plan for the transition period, when analogue TV and existing digital TV services require protection from new digital transmissions.
2. A frequency plan after Analogue Switch-Off, when only digital TV exists.

During the transition period the analogue TV and existing digital TV needs to be protected. This means that the existing coverage areas should not be reduced due to interference from digital TV transmissions. Obviously, this requirement will greatly limit the number of channels that can be used for digital TV and the radiated powers of digital transmissions. In this respect it is important that no new analogue TV licences are granted.

Table 4.9 gives an overview of the planning situations.

TABLE 4.9
Overview of planning situations

Situation	Band III	Band IV/V
Currently	List of assigned ¹ stations <ul style="list-style-type: none"> Analogue TV T-DMB 	List of assigned ¹ stations <ul style="list-style-type: none"> Analogue TV Digital TV
During transition	Plan taking into account: <ul style="list-style-type: none"> Current list Planned but not yet operational analogue TV (if so decided) Digital services replacing existing and planned analogue TV New digital services 	Plan taking into account: <ul style="list-style-type: none"> Current list Planned but not yet operational analogue TV (if so decided) Digital services replacing existing and planned analogue TV New digital services
After ASO	Plan taking into account: <ul style="list-style-type: none"> Digital services replacing existing and (if so decided) planned analogue TV New digital services and sites Additional digital services and sites Additional T-DMB requirements T-DAB requirements (if any) 	Plan taking into account: <ul style="list-style-type: none"> Digital services replacing existing and (if so decided) planned analogue TV New digital services and sites Additional digital services and sites

¹ See Table 2.1.

4.9.3 Coverage considerations

The key objective in the ASO process is reducing the risk of service interruption. Hence, the coverage area of a digital TV service should be at least the same as the coverage of the analogue service it replaces.

In the preparation of the digital frequency plan it is therefore necessary to assess the analogue coverage areas. A difficulty in doing so is that in Cambodia analogue TV viewing takes place under conditions well below the recommended minimum field strength values in ITU¹⁹. It should be decided on which basis analogue TV coverage should be accessed, e.g. based on:

1. experience and practical knowledge of receiving conditions;
2. calculations with either the recommended ITU minimum field strength values, or the values indicated by ITU as reception limits²⁰.

It should be noted that the larger the analogue coverage areas are determined, the more demanding the protection requirements are against digital television. Consequently digital television transmissions will be more restricted and the transition process will be more complex.

Annex 6 shows a few calculation examples in order to get an impression of the coverage area of an analogue and a digital TV transmitting station.

A summary of the conclusions of the examples given in Annex 6 is:

- The ERP of a digital transmission (expressed as mean power) replacing an analogue service is in most cases less than the ERP of the analogue transmission (expressed in peak envelope power). However, if the analogue coverage area would be defined by the limit of reception value, the ERP of the digital transmission should be about 1.5 times higher than the analogue ERP. Table 4.10 shows the ERP ratios for three DVB-T system variants.

TABLE 4.10
ERP ratio of digital TV transmitting stations to replace an analogue coverage area

DVB-T variant	Analogue coverage situation according to recommended minimum field strength	Analogue coverage situation according to limit of reception
64QAM 2/3	Digital power about 6 x less	Digital power about 1.5 x more
16QAM 2/3	Digital power about 25 x less	Digital power about 2.5 x less
QPSK 2/3	Digital power 100 x less	Digital power about 10 x less

- In some cases, existing analogue transmitters can be converted to digital. The mean power of a digital transmission from a converted analogue TV transmitter is about 1/5 to 1/3 of the analogue peak envelope power.
- From a frequency planning point of view it is possible to convert an analogue transmission to digital without inverse impact on the compatibility situation if the ERP of the digital transmission is five times less than the analogue ERP.
- Indoor reception areas are much smaller than with rooftop reception, but most of not all of the Phnom Penh area will be able to receive DTTB with a simple antenna at indoor locations.

As a first approach it could be estimated that the ERP of a digital transmission (expressed in mean power) to replace an analogue one (expressed in peak envelope power) is a five times less compared to the analogue transmission.

¹⁹ See Recommendation ITU-R BT.417-5 Minimum field strengths for which protection may be sought in planning an analogue terrestrial television service.

²⁰ See Annex 1 of Recommendation ITU-R BT.417-5. In this annex it is noted that the public begin to lose interest in installing television reception equipment when the field strength falls much below the indicated levels in this annex.

With this ratio it is possible:

- to use an existing analogue transmitter converted to digital (with reduced power);
- to achieve compatible analogue and digital transmissions (in the assumption that the original analogue transmissions were compatible);
- to cover an area at least the size of the analogue coverage based on the recommended ITU values for rooftop reception in the absence of interference other noise;
- to provide stable indoor reception in Phnom Penh and other towns where digital TV transmitters will be located.

4.9.4 Construction of a frequency plan

In Cambodia there are a great number of existing and planned analogue and digital TV transmitters.

The establishment of the frequency plans indicated in Table 4.9 is therefore complex. It is advised to use planning software for preparing the frequency plan and calculating the coverage areas, following the guidance given in section 4.3 of the Guidelines.

In constructing the digital frequency plan it should be taken into account that:

- frequency changes to digital assignments (either existing or introduced during the transition period) should be kept to a minimum in order not to confuse the viewers (as they have to retune their STB);
- at existing sites digital frequencies should preferably be assigned close to analogue frequencies (e.g. adjacent channels) in order to be able to use the existing transmitting and receiving antennas;
- the ERP of digital stations should comply with the guidance given in section 4.9.3.

The resulting frequency plans consist of:

- The list of characteristics of each TV transmitting station (see Table 4.11 below).
- Coverage prediction of the TV transmitting station of the network to which the station belongs. The coverage presentation shows coverage probability (in the presence of noise and interference) in the wanted service area, if possible the number of people or household obtaining the required coverage quality, the system variant and bit rate of the multiplex.

The list of characteristics of a TV transmitting station should at least include:

TABLE 4.11
TV transmitting station characteristics

Characteristic	Analogue TV transmitting station	Digital TV transmitting station
Identification	Reference number, station name, network name	Reference number, station name, network name
Location	Geographical coordinates	Geographical coordinates
Frequency	Channel number and frequency offset	Channel number
Standard	Analogue TV standard	Digital TV standard, carrier modulation, code rate
Radiation characteristics	Maximum ERP, antenna height above ground level, polarization, antenna pattern	Maximum ERP, antenna height above ground level, polarization, antenna pattern
Network type	Not relevant	In case of SFN, the SFN identification number and guard interval

4.10 Allocation of mobile services (LTE)

Allocation of mobile services in broadcasting bands is part of the digital dividend considerations. Digital dividend is a term to express the spectrum efficiency gains due to the switch-over from analogue to digital television. As a result of the transition to digital TV, spectrum will become free because digital television is more spectrum efficient due to:

- digital compression techniques;
- advanced modulation and coding of the digital signal;
- planning methods of digital TV networks.

The digital dividend can be used for:

- new broadcasting services and coverage extensions;
- new types of broadcasting services , e.g. mobile TV and HDTV;
- non-broadcasting services, e.g. mobile communications.

Spectrum requirements for mobile services are well documented and are not described in this section^{21, 22}.

The main choice regarding the digital dividend is the service allocation in the frequency range that becomes free after the existing analogue TV transmissions has been converted to digital. In most if not all countries, the digital dividend will be partly used for new broadcasting services and/or new types of broadcasting services and will be partly allocated to mobile communications.

The choice on the amount of spectrum to be allocated to new broadcasting services and mobile communications is a trade-off between long term requirements of TV services and non-broadcasting services, taking account of:

- the cultural, educational and public information benefits of additional broadcasting services;
- economic benefits of introduction of broadcasting and mobile services;
- spectrum requirements of both services;
- international frequency harmonization in the Asia-Pacific Telecommunity (APT) and ITU and in particular WRC-12.

If the frequency requirements of both broadcasting and mobile communications can be met, the decision is straight forward. However, in many countries including Cambodia this is not the case (see section 4.10.2). Therefore, the government will have to make a decision that does justice to all interests.

The order in which the decisions for the allocation of the digital dividend should be taken is illustrated in Figure 4.8.

²¹ The report “Socio-economic impact of allocating 700 MHz band to mobile in Asia Pacific” from the Boston Consulting Group, October 2010, describes the mobile requirements with an emphasis on the economic and social advantages.

²² See APT REPORT On HARMONISED FREQUENCY ARRANGEMENTS FOR THE BAND 698-806 MHZ, No. APT/AWF/REP-14 Edition: September 2010; Adopted by the 9th APT Wireless Forum Meeting, 13 – 16 September 2010, Seoul, Republic of Korea.

Figure 4.8: Order in making decisions on the allocation of digital dividend

1	Frequency bands	<ul style="list-style-type: none"> Determine the frequency bands
2	Converted analogue TV	<ul style="list-style-type: none"> Determine spectrum requirements of analogue TV converted into digital TV
3	New digital TV	<ul style="list-style-type: none"> Determine spectrum requirements of more and new types of broadcasting
4	Non-broadcasting	<ul style="list-style-type: none"> Determine spectrum requirement of non-broadcasting services (LTE)
5	Trade-off between requirements	<ul style="list-style-type: none"> Trade-off between long term needs of new digital TV and non-broadcasting services, taking account of <ul style="list-style-type: none"> Cultural, educational and economic benefits Spectrum requirements International frequency harmonization

In the following sections frequency bands, spectrum requirements and the trade-off between requirements will be addressed.

4.10.1 Frequency bands

The frequency bands under consideration in Cambodia are:

- Band I (47-64 MHz);
- Band III (174-230 MHz);
- Bands IV/V (470-790 MHz²³).

The situation in these bands with regard to digital dividend in Cambodia is summarized in Table 4.12.

The overview given in Table 4.12 shows that the available amount of spectrum is:

- 8 channels in Band III;
- 28 or 40 channels in Band IV/V;
- in total 36 or 48 channels.

²³ According to article 5 of the Radio Regulations, the upper limit of the band is 960 MHz, however in Cambodia no broadcasting is envisaged above 790 MHz.

TABLE 4.12
Broadcasting and mobile interest in Band I, III and IV/V

Frequency band	Situation in Cambodia
Band I (47- 64 MHz)	<ul style="list-style-type: none"> • 3 channels of 7 MHz, one channel in use • Will become free after ASO • Not of interest for digital television • No interest by non-broadcasting services
Band III (174 – 230 MHz)	<ul style="list-style-type: none"> • 8 channels of 7 MHz • Channel 10 allocated to T-DMB • Some channels may be reserved for allocations to: <ul style="list-style-type: none"> – New T-DMB providers – Digital radio (T-DAB) • Remaining channels likely to be used for digital television • No interest by non-broadcasting services
Bands IV/V (470 – 790 MHz)	<ul style="list-style-type: none"> • 40 channels of 8 MHz • Claim from mobile service for spectrum above 698 MHz in addition to spectrum above 790 MHz <ul style="list-style-type: none"> – Remaining channels for use by digital television, in case of this mobile claim, is channel 21 to 48 (28 channels)

4.10.2 Spectrum requirements

In Annex 7 the broadcast spectrum requirements have been assessed for the following situations:

- A. Spectrum needed for accommodating the existing and already planned analogue services in digital format, being:
 1. The digital TV services converted from the 13 existing and planned analogue TV services provided by 11 broadcasters.
 2. The existing digital PPCTV services.
 3. The planned T-DMB services.
- B. Spectrum needed for accommodating the long term digital broadcasting requirements, being
 1. The digital TV services converted from the 13 existing and planned analogue TV services provided by 11 broadcasters at all sites.
 2. The existing digital PPCTV services.
 3. The planned T-DMB service.
 4. New T-DMB/T-DAB services.
 5. New TV services.

A summary of the broadcast spectrum requirements in and around Phnom Penh, expressed in the number of channels, is shown in Table 4.13. Not all of the indicated channels will be transmitted from Phnom Penh; a number will be transmitted from sites around Phnom Penh but cannot be used in Phnom Penh for compatibility reasons.

The indicated spectrum requirements are based on theoretical studies and a number of assumptions. The numbers in Table 4.13 are not precise figures but indications of the required spectrum.

TABLE 4.13
Summary of broadcast spectrum requirements

Situation	Spectrum requirement with licensing model A	Spectrum requirement with licensing model B
A.1 Conversion of existing and planned analogue TV services	20 channels ¹⁾	11 channels
A.2 PPCTV in Phnom Penh	9 channels ²⁾	9 channels ²⁾
A.3 Planned T-DMB services in channel 10	1 channel	1 channel
Total	30 channels	21 channels
B.1 Conversion of existing and planned analogue TV services with extended geographical coverage of 70% or 100%	33/44 channels	12/18 channels
B.2 PPCTV in Phnom Penh	9 channels ^{2), 3)}	9 channels ^{2), 3)}
B.3 Planned T-DMB services in channel 10	1 channel	1 channel
B.4 New T-DMB/T-DAB services in Band III	2 channels	2 channels
B.5 New TV services (to be decided)	X channels	Y channels
Total	45/56 + X channels	24/30 + Y channels
Capacity of frequency bands	48 channels	48 channels

NOTES

- ¹⁾ 20 channels are needed with licensing model A, if a low multiplex capacity is assigned to each broadcaster. If each broadcaster would use a high multiplex capacity, the spectrum requirement increases to 36 channels and the total requirement with model A to 46 channels (see Table A.7-6 in Annex 7).
- ²⁾ If the existing and planned analogue TV services are converted to digital and PPCTV continues to broadcast the same services as part of its package, there is duplication of coverage in Phnom Penh and surroundings. This can in principle be avoided in several ways:
- In model A by not assigning multiplexes to the 11 existing and planned broadcasters in Phnom Penh, by which the spectrum requirement reduces by 11 channels;
 - In model B by not assigning two multiplexes in Phnom Penh to the common multiplex operator for broadcasting the package of 13 existing and planned services, by which the spectrum requirement reduces by two channels;
 - In model A and B by not broadcasting the 13 existing and planned services in the PPCTV package and reducing the number of PPCTV multiplexes (channels) by two, by which the spectrum requirement reduces by two channels.
- ³⁾ If PPCTV would be allowed to extend geographical coverage to 70 per cent or 100 per cent of Cambodia, the number of channels needed for the PPCTV services increases to 54 or 81 channels respectively. The capacity of the frequency bands would then be exceeded by far.

Taking into account that the capacity of the broadcasting bands is 36 or 48 channels depending of the upper limit of Band V (698 MHz or 790 MHz), the following conclusions can be made:

a. Licensing model A or B

- Model A is considerably less spectrum efficient than model B.
- Only a very limited number of new services can be achieved in the long term with model A and only in case the upper limit of Band V is 790 MHz and a low multiplex capacity (sufficient to broadcast two services) is assigned to each broadcaster;
- In model A, the application of DVB-T2 would not reduce the spectrum requirements. The multiplex capacity is not the limiting factor, but the number of channels needed to plan the services.

b. *Conversion of existing and planned analogue TV services*

- In both model A and model B it is possible to accommodate the existing and planned services in digital format in the available bands after ASO, even if the upper limit of Band V is set at 698 MHz. However, this would not be the case with model A if a high capacity multiplex is assigned to each broadcaster.

c. *Simulcasting period*

- In the Phnom Penh area, 30 or 21 digital TV channels are needed with licensing model A or B respectively, while 13 analogue TV channels are already in use and planned. During the simulcasting period the total amount of channels needed in Phnom Penh and surroundings is 43 or 34 with licensing model A or B respectively. Taking into account the total band capacity of maximum 36 or 48 channels, the amount of channels needed in the simulcasting period can be met with licensing model A if the upper limit of Band V is maintained at 790 MHz during transition.
- If in model A each broadcaster would use a high capacity multiplex, 46 digital TV channels are needed. Simulcasting in the Phnom Penh area would therefore not be possible.
- The spectrum requirement during the transition period with model B, can about be met if the upper limit of Band V is set at 698 MHz. However, it would leave not much planning flexibility. Hence, reallocation of the upper part of Band V could better be considered after analogue switch-off.

d. *Long-term requirements*

- A meaningful package of long term requirements can only be achieved with licensing model B and in the assumption that PPCTV services remain restricted to Phnom Penh and the surrounding areas.
- With licensing model B and a geographical coverage requirement of 70 per cent, 24 channels are available for new TV services. The 24 channels could for instance be assigned to:
 - four new multiplexes with 70 per cent geographical coverage, containing 24 of more new services;
 - two new multiplexes with 70 per cent geographical coverage, containing 12 of more new services and 11 channels to mobile services (IMT).
 - additional requirements, either to extend coverage, to increase the number of services or to implement HDTV, can only be met if more advanced standards are used e.g. DVB-T2.
- Introduction of DVB-T2 in a market with DVB-T/MPEG2 STBs is difficult. DVB-T2 STBs are not backwards compatible; therefore introduction of DVB-T2 requires a transition period and simulcasting. One or two of the new multiplexes mentioned above could be assigned for introduction of DVB-T2.
- If duplication with PPCTV services in Phnom Penh is avoided, two more channels are available with model B.

e. *Free-to air services of PPCTV*

- The spectrum requirements have been assessed in the assumption that existing analogue TV services are converted to digital and that the PPCTV digital services in Phnom Penh, including the free-to-air services, are continued. However, this will result in dual coverage of 13 national services in Phnom Penh and its surrounding. If this dual coverage is avoided, the spectrum requirements could be reduced by eight channels in case of licensing model A and two channels in case of licensing model B.

f. *Digital dividend*

- Digital dividend is the spectrum that becomes free after the existing analogue TV has been converted to digital. The digital dividend in Cambodia is summarized in Table 4.14.

TABLE 4.14
Overview of spectrum requirements and digital dividend

#	Digital spectrum requirement	Licensing model A	Licensing model B
A	Total band capacity	48 channels	48 channels
B	Existing and planned services (from Table 4.13 and alternatively no duplication with PPCTV services)	Max. 30 channels Min. 22 channels	Max. 21 channels Min. 19 channels
C	Digital dividend (A-B)	Max. 26 channels Min. 18 channels	Max. 29 channels Min. 27 channels

Demands for using the digital dividend are:

1. *Coverage extensions of the existing and planned TV services*

The spectrum requirement in the Phnom Penh area for extending existing and planned TV services to 70 per cent or 100 per cent geographical coverage of Cambodia is:

- with licensing model A, 13 or 22 channels respectively (see Table 4.13, situation B1 minus A1);
- with licensing model B, 1 to 7 channels respectively (see Table 4.13, situation B1 minus A1).

2. *New broadcasting services*

The spectrum requirements for new T-DMB/T-DAB can be estimated at two channels in Band III. As the type and number of new TV services has not yet been determined, no spectrum requirement can be assessed. However, from Table 4.13 it can be derived that the available spectrum for new TV services is:

- in case of model A, three channels with 70 per cent geographical coverage (100 per cent geographical coverage cannot be achieved with model A);
- in case of model B, 24 or 30 with 70 per cent or 100 per cent geographical coverage respectively.

3. *Mobile services*

The spectrum claim for mobile services (IMT) is 12 channels in addition to spectrum above 790 MHz.

The demands for the digital dividend in the Phnom Penh area are summarized in Table 4.15.

4.10.3 Trade-off between requirements

From the overview in Table 4.15 it can be concluded that new broadcasting requirements and the mobile requirements exceed the size of the digital dividend (that is the available spectrum when existing analogue TV has been converted to digital) in case licensing model A would adopted. With licensing model B there is a modest number of 14 to 6 TV channels available for new TV services if 12 channels are allocated to mobile services.

In order to obtain flexibility in the trade-off between long term requirements of TV services and non-broadcasting services, it could be considered to:

- Start mobile services after ASO in the frequency range above 790 MHz²⁴.
- Concentrate as much as possible digital broadcasting in the frequency range below 698 MHz.
- Stop with licensing new analogue TV services in order to allow a smooth transition to digital broadcasting.
- Reserve a number of channels for future introduction of an advanced digital broadcasting standard (DVB-T2) in order to broadcast more services in the available frequency spectrum.
- Decide at a later stage, on the date that the range 698 MHz to 790 MHz can be used exclusively for mobile services.

TABLE 4.15
Demand for use of the digital dividend

Services	Licensing model A	Licensing model B
Extended geographical coverage of existing and planned services to 70% or 100 %	13 / 22 channels	1 / 7 channels
New TV services	X channels	Y channels
New T-DMB/T-DAB services in Band III	2 channels	2 channels
Mobile services (IMT)	12 channels	12 channels
Total demand	27/ 36 + X channels	15 / 21 + Y channels
Size of the digital dividend	18 to 26 channels	27 to 29 channels

5 Recommendations

When writing this report, Cambodia NRT had been formally established and was mandated to draft this report, together with the ITU experts. Given this situation and the information collected/provided during the two country visits, the NRT is recommended to carry out the following next steps for a smooth transition to digital television broadcasting and switching off the analogue services:

1. Get the roadmap approved at either ministerial level and/or political level.
2. After approval, acquire a mandate to plan and manage the ASO process in accordance to the phases of the roadmap. As indicated in the report, this mandate may come in stages.
3. After being mandated, prepare and take the following decisions as the first of the roadmap as these decisions are needed to determine the scope and duration of the roadmap planning:
 - Determine ASO date and the date of the first DTTB transmissions. The latter is also relevant for the selection of the transmissions standard. An adoption of the DVB-T2 standard will open up more solutions and will significantly impact the frequency planning activities.
 - Determine ASO model (phased simulcasting or not).
 - Licensing model (model A or B). In the case of model B this decision should also include whether a Public Private Partnership is envisioned.

²⁴ After the second visit of the ITU experts, the MPTC expressed its disagreement with this consideration. The NRT should therefore readdress the trade-off between broadcasting and mobile requirements.

- Determine the date to stop licensing analogue television services. The later decision is taken the more possibilities are excluded and the more complex the ASO will become.
- 4. Form a project management office (PMO) and start drafting an initial detailed ASO planning and determine the progress reporting procedures and structures.

Apart from these next steps for the NRT to take, some additional recommendations can be provided which seem to be evident for Cambodia:

1. Have market research carried out covering the key elements as indicated in this Roadmap report (see Phase 1). As indicated some key research data is lacking and starting an ASO process without this data could incorporate a major project risk.
2. Carry out detailed frequency and service planning (see Phase 2 and 3), regardless which licensing (model A/B) and transition model (simulcast or not) is selected. In Cambodia, spectrum is significantly limited by the large number of existing analogue services. Extensive and profound frequency planning will be required to see what is possible.
3. Reserve capacity for the future services of DVB-T2 and DAB. Without such a capacity reservation it will be extremely difficult (or even impossible) to introduce this services at a later date or only against very high costs.
4. As for the digital dividend, awaiting the success of the DTTB and mobile (LTE) services, decide at a later stage on the date that the range 698 MHz to 790 MHz can be used exclusively for mobile services.
5. Investigate the possibilities of auctioning mobile (LTE) spectrum as an important mean for financing the ASO process. This also includes the investigation of the possibilities of advancing the ASO costs as the proceeds of the auction will become available after ASO.

Annex 1

Functional building blocks related to Phase 1 of the roadmap

DTTB policy development

<div style="border: 1px solid #0070c0; padding: 5px;"> <h3 style="text-align: center; margin: 0;">1. DTTB policy development</h3> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="background-color: #ffffcc; text-align: center; padding: 5px;">2.1. Technology & Standards Regulation</td> <td style="background-color: #ffffcc; text-align: center; padding: 5px;">2.3. ITU-R Regulations</td> </tr> <tr> <td style="background-color: #ffffcc; text-align: center; padding: 5px;">2.10. Digital Dividend</td> <td style="background-color: #ffffcc; text-align: center; padding: 5px;">2.4. National Spectrum Plan</td> </tr> <tr> <td style="background-color: #ffffcc; text-align: center; padding: 5px;">3.1. Customer Insight & Research</td> <td style="background-color: #ffffcc; text-align: center; padding: 5px;">2.11 National telecom, broadcast & media acts</td> </tr> <tr> <td style="background-color: #ffffcc; text-align: center; padding: 5px;">3.3. Receiver Availability Considerations</td> <td style="background-color: #ffffcc; text-align: center; padding: 5px;">3.2. Customer Proposition</td> </tr> <tr> <td style="background-color: #ffffcc; text-align: center; padding: 5px;">4.1. Technology & Standards Application</td> <td></td> </tr> </table> <div style="border: 1px solid #0070c0; border-radius: 15px; width: fit-content; margin: 10px auto; padding: 5px; text-align: center;"> Consultation with Parliament </div> </div>	2.1. Technology & Standards Regulation	2.3. ITU-R Regulations	2.10. Digital Dividend	2.4. National Spectrum Plan	3.1. Customer Insight & Research	2.11 National telecom, broadcast & media acts	3.3. Receiver Availability Considerations	3.2. Customer Proposition	4.1. Technology & Standards Application		<p>The selected functional building blocks related to Phase 1 of the Roadmap are shown in Figure 3.9 and are reproduced here.</p> <p>Section 3.4.2 describes Phase 1 of the roadmap.</p> <p>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:</p> <ul style="list-style-type: none"> A. the decisions on key topic and choices that are already taken; 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. <p>For those issues that are not (fully) decided or need revision the main activities are indicated.</p> <p>The selected functional building blocks are presented in the order of the number of the block. This number refers to the corresponding section in the Guidelines, where more information and implementation guidelines can be found.</p> <p>The grey coloured blocks are not described in the Guidelines and not described in the tables below. These blocks represent activities that are not specific to digital terrestrial television.</p>
2.1. Technology & Standards Regulation	2.3. ITU-R Regulations										
2.10. Digital Dividend	2.4. National Spectrum Plan										
3.1. Customer Insight & Research	2.11 National telecom, broadcast & media acts										
3.3. Receiver Availability Considerations	3.2. Customer Proposition										
4.1. Technology & Standards Application											

2.1 Technology and Standards Regulation

Brief description	In this section the key <i>policy</i> 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
2.1.1	Television presentation formats: for DTTB platforms either Standard Definition Television (SDTV) and/or High Definition Television (HDTV)?	A
2.1.2	Transmission standard: for DTTB platforms e.g. DVB-T or ATSC. Has the standard setting been decided?	A/D
2.1.3	Compression technology: for DTTB platforms MPEG2 or MPEG4. Has the standard setting been decided?	C
2.1.4	Conditional Access (CA) system and Digital Rights Management (DRM): interoperability between deployed systems for DTTB. Has the standard setting been decided?	C
2.1.5	Application Programming Interface (API) for additional and interactive services: for DTTB platforms e.g. MHP.	C

Main activities	Observation/Advice
1. Carry out market research/surveys for identifying industry and consumer needs for standardization.	To be included in the market research as suggested in this phase (see section 3.4.2).
2. Determine minimum set of receiver Standards for the DTTB market, based on the market developments.	See section 3.4.2.
3. Assess impact on industry and end consumers.	As part of the analysis of the market research results (as indicated in section 3.4.2).
4. Determine receiver requirements and include in frequency licence terms and conditions and/or media permits and authorizations.	See section 3.4.2.
5. Determine communication messages, planning, standardization/testing bodies and methods (including logos and labelling).	The selected STB (e.g. DVB-T MPEG2) functionality and specs are important input for the communication plan (see Phase 2 of the Cambodia roadmap) and the ASO planning (e.g. the work stream 'Financial and installation support' can include the logistics of the labelling of the STB as to support the viewer). For more details see section 4.7 in this report.

2.3 ITU-R Regulations

Brief description	ITU-R regulations entail the Radio Regulations (RR) and in particular the table of Frequency Allocations (Region 3) and the relevant provisions of the World Radiocommunications Conference 2007 (WRC-07).
Objective	In this phase of the roadmap, to identify at a high level the spectrum availability and requirements for DTTB (and other services)

Key topics and choices	Status	Decision
2.3.1 The international context of the ITU-R regulations: Are the different entries in the GE06 plan considered (allotment/assignment)?	NA	A plan like the GE06 plan is not available for Region 3.
2.3.2 Applicability and implications of ITU-RR: (a) what frequencies or allotments will be assigned for what type of service (for example two allotments/multiplexes for DTTB services and one for MTV services)? (b) In what combinations these frequencies or allotments will be assigned (for example two separate allotments/multiplexes to be licenced to two different licence holders or two allotments to one single licence holder)?	C	All three sub-choices (a-c) still to be decided. Available spectrum and spectrum requirements for DTTB and MTV needs to be clarified (initially at a high level).

Key topics and choices	Status	Decision
(c) When these frequencies or allotments will be licenced or can be taken into operation? For answering these questions process steps are defined in this section.		

Main activities	Observation/Advice
1. Determine frequency availability and DTTB requirements considering (a) the planned <i>national</i> and regional DTTB services (b) ASO process (especially considering any simulcasting areas) and (c) the <i>operational</i> analogue TV services.	As said in section 3.4.2 of this report, a clear and shared understanding of the available spectrum will enable the NRT to develop a well motivated DTTB policy document. At this first phase of the roadmap, this understanding should be established.
2. Determine necessary changes to <i>planned</i> licensing procedures, terms and conditions for DTTB services and ASO plans.	As (preliminary) input for Phase 3.
3. Determine necessary changes to <i>assigned</i> frequency (and possibly content) licences for operational DTTB and Analogue TV services.	Especially the assigned DTTB licence to broadcasters and PPCTV needs to be evaluated.
4. Determine notification to ITU.	As discussed in section 3.4.6 the actual execution of these procedures need not to be part of the critical path.
5. Possibly determine necessary budget for compensations and network retuning activities.	Compensations might be needed in case assigned DTTB licences will have to be changed.

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?	C	With the adoption of the Telecommunications Law the management of the NSP will be part of the MTPC responsibilities. This new Law still has to pass Parliament.

Key topics and choices	Status	Decision
2.4.2 Planning current and future DTTB and MTV spectrum use: Has the national spectrum plan/strategic planning process started/completed? (for process see this section).	C	See comments with the previous functional building block (2.3 ITU-R).
2.4.3 National Spectrum Plan publication and DTTB/MTV introduction dates.	C	Awaiting adoption of Parliament (Telecom Law).
2.4.4 General approaches for pricing spectrum usage: (a) One off pricing and/or recurring pricing? (b) cost-based or market based pricing?	C	Current pricing regime may need changes. Especially when introducing licensing model B the number of transmitter sites will be reduced and hence the income from licence fees may go down.

- a. Already decided
- b. Partly decided
- c. Not decided yet
- d. Revision needed

Main activities	Observation/Advice
1. Make an inventory of current spectrum use in the broadcast bands (bands III, IV and V).	Still to be clarified. Also the already assigned licences which are not being used will have to be listed.
2. Register use and provide rules for (self) registration.	The division of tasks and activities between the MOI and MPTC has to be clarified. Especially the procedure for assigned broadcast and associated frequency rights.
3. Carry out market analyses and consultations and forecast future spectrum needs.	Can be part of the market research to be carried out in Phase 1 of the roadmap (see also functional building block 2.10 below).
4. 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.	To be carried out in this phase of the roadmap. In Phase 2 of the roadmap to be further detailed.
5. Determine publication content, dates and formats for the National Spectrum Plan.	To be checked if this has already been defined in the new Telecommunication Law (still to be passed). If not, then this publication schedule should be determined and published (for example, with the first official publication of the NSP).
6. Determine budget for spectrum management and administrative fees.	As part of the introduction of the new NSP. Administrative fees may need to be re-established when changing the licensing framework (see also functional building block 2.2). Preferably, such a new pricing regime is determined and included in the

Main activities	Observation/Advice
	licence conditions (in both licensing models A/B). However if this activity will become part of the critical path, a temporarily pricing regime can be published with the note that the regime may be changed.

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	Dependent on the spectrum requirements for broadcasting and mobile services. This is still not determined.
2.10.2 Digital dividend options: have the allocation to the different service been determined? (broadcasting or non-broadcasting).	B	For non-broadcasting services (e.g. LTE) it is either above channel 48 or 60. This upper limit is still to be decided and is dependent on international agreements. Also any other spectrum requirements for non-broadcasting services still to be determined.

Main activities	Observation/Advice
1. Analyze current and future market developments and possibly conduct market consultation(s) in the broadcast (and telecoms) industries.	As the size and allocation of digital dividend is part of the DTTB policy document, supporting evidence and motivation is needed. Market research and further study is likely to be need. A close cooperation between the MOI and MPTC will be required.
2. Assess current and future market needs for DTTB and MTV services, possibly based on formulated Legislation and Policies.	To be carried out as part of Phase 1 of the roadmap.
3. Assess available spectrum after ASO, based on ASO plans, National Spectrum Plan and ITU-R Regulations.	To be carried out as part of Phase 1 of the roadmap.
4. Map spectrum needs on available spectrum and determine priorities and assign spectrum to broadcasting.	To be carried out at a high level in this phase of the roadmap. Later to be detailed in Phase 2 and finalized in Phase 3 (see respectively section 3.4.3 and 3.4.4).
5. Possibly draft spectrum re-farming plans and compensation schemes (for network and receiver re-tuning activities), reserve budgets.	To be checked if necessary.

Main activities	Observation/Advice
6. Update National Spectrum Plan and align licence terms and conditions for DTTB services.	A check of current licence terms and conditions for both broadcast and frequency licences will be necessary. Also the PPCTV licence for DTTB should be included, as well as the other already assigned DTTB licences. National Spectrum Plan will need to be updated accordingly (as a regular spectrum management activity, not specific for this roadmap).

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. For Cambodia the relevant regulatory framework is given in Table 2.3 of this report.
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	The new Telecommunications Law should be checked. Also any other current legislation, e.g. the Proclamation on TV and Radio Standards (see Table 2.3 in section 2.2 of this report). This analysis may show that there is a need to introduce new legislation. Although this may not need to be on the critical path of the roadmap.
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	Foreign and cross ownership rules do exist in Cambodia. The DSO strategy has to be checked on compliancy (especially in the case of model B and PPP – see also section 3.4.4).

Main activities	Observation/Advice
1. Make inventory of current Legislation.	The Table 2.3 in this report could form a starting point.
2. Identify gaps and draft proposals for additional and/or changes in Legislation (based on ‘best practices’).	As described in section 3.4.2 in this report, this entails a first assessment. Results of this assessment will provide input for the plan of action (included in the DTTB policy document). During Phase 3 of the roadmap (DTTB Regulations), the gaps and necessary changes can be further detailed.

Main activities	Observation/Advice
3. Determine planning for changes in the law and determine 'must haves' for launching DTTB/ASO and MTV.	As part of the plan of action of the DTTB policy document.

3.1 Customer Insight and Research

Brief description	Launching a commercial PSB DTTB service, 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	The NRT will have to carry out some form of market research for identifying these demand drivers, competitive advantages and service uptake projections.

Key topics and choices	Status	Decision
3.1.1 Overview of the DTTB markets: market definition, key service and market characteristics.	B	The broadcasters in NRT have great knowledge of the Cambodia market. This knowledge should be utilized. Willingness to pay for STB should be investigated. Hence the following attributes should be investigated: (a) recurring payments (b) one-off payment (c) number of channels and (d) the television content (e.g. theme channels). Also the current television market has to be analyzed/researched (see also section 3.4.2 for more details).
3.1.2 Market research methods: basic market research approaches and embedding market research in the DTTB business planning process.	C	Apply low cost methods to research the Cambodia market.

Main activities	Observation/Advice
1. Determine need, timing and scope for market research.	See also section 3.4.2 for more details.
2. Draft market research plan, staff and budget market research project.	Utilize resources and staff from the participating broadcasters in the NRT.
3. Analyze competitive offerings, substitutes and technology developments.	Utilize resources and staff from the participating broadcasters in the NRT.
4. Design and develop preliminary DTTB service propositions.	As part of the market research.
5. Carry out market research and analyze results, translate into DTTB service propositions, if necessary carry out additional market research.	As part of the market research. The results will be used for justification or supporting evidence for the DTTB policy document but also for the initial DTTB service planning as described in section 3.4.3. (ASO planning) in this report.

3.2 Customer Proposition

Brief description	This section focuses on determining the PSB DTTB competitive advantage and what the related service attributes could look like.
Objective	Finding the best customer proposition in line with the business plan objectives (see initial DTTB service planning in Phase 2 of the roadmap).

Key topics and choices	Status	Decision
3.2.1 DTTB competitive advantage and related Service Proposition attributes.	B	Better picture quality, more channels and maybe price were identified as possible attributes that could provide DTTB a competitive edge (during the first visit). For more detailed considerations see section 4.2 in this report. Attributes still to be decided/defined (e.g. coverage and number of channels).

Main activities	Observation/Advice
1. Analyze earlier DTTB service launches and compare with customer research results/local market conditions.	As a start the PPCTV service launch could be analyzed. Also service launches in other countries could be considered. For example in the neighbouring countries.
2. Define DTTB service propositions and check feasibility in terms of network planning and business case.	As part of the second Phase of the roadmap.
3. Possibly redefine DTTB service propositions and test in market again, i.e. additional market research.	Redefining of DTTB service proposition will occur. However testing such revised offerings in the market will probably take up to much time (given a possible DTTB service launch in 2012) and budget.

3.3 Receiver Availability and Considerations

Brief description	The consideration of the many different DTTB receivers commercially available today.
Objective	For a Service Provider 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).	C	For ASO budget limitations and the low ability to pay in the market, the functionality will be to provide the basic set of functions (to include, zapping, EPG, software updates and standard compliancy). Please note that including (embedded) CAS will increase the price.
3.3.2 MTV functional receiver requirements and availability.	NA	

Main activities	Observation/Advice
1. Analyze earlier DTTB service launches for STB supplies and functionality requirements.	This market survey exercise is to address the aspects as included in the Guidelines but also the additional Cambodia specific issues as included in section 3.4.2 (i.e. independent and warranted supplies and affordable and sufficient supplies).
2. Check any prescribed Technologies and Standards, Receiver regulations and analyze market research results.	As part of the DTTB Policy development process (first phase of the roadmap) the standard setting is mutually dependent on the receiver requirements.
3. Assess and make inventory of availability, product roadmaps and supply planning of various receiver types/attributes.	Especially the supply planning of the various STB suppliers might be a key input for the ASO planning and might impact the decision on the setting receiver functionalities.
4. Check network compatibility and interoperability (radio interfaces and API/applications).	The DTMB system might need extra attention. Extra testing of interoperability between network and STB might be necessary (not such much for the interface but aspects like frequency/network changes and software updates).
5. Assess and detail ex-factory and retail pricing for various receivers.	This activity should also include the assessment of the suppliers' cooperation to work together with the local retail in Cambodia.
6. Decide key receivers and their attributes, draft receiver/service roadmap.	This might be limited to one type of STB. Functionality/attributes for IDTVs could be considered to be left to the market. Although labeling and the inclusion of IDTV information in the ASO Communication plan is strongly advised.

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 evaluate system performance	B	DTTB transmissions with the DVB-T standard are operational. The DVB-T standard could be evaluated in practice. Tests to evaluate the technical performance of DTMB standard are not needed; however technical information on the DTMB standard in ITU-R Recommendations is currently far from complete. It is advised to study the relevant ITU-R Recommendations (when available), before deciding to implement the DTMB standard.
4.1.2 SDTV and HDTV specifications	B	SDTV and one sound channel. Bit rate for services still to be decided. Picture ratio 16:9.
4.1.3 Selection of DTTB transmission standard	B	Both the DVB-T and DTMB standard are permitted for use in Cambodia. DVB-T is in operation by PPCTV. In principle DTMB could be selected by operators, however it should be avoided that viewers need more than one STB.
4.1.4 Compression system	A	MPEG2 is the optimal choice considering the costs of MPEG4 and DVB-T2. However in the long term transition to DVB-T2 may be necessary for accommodating all long term DSO objectives.
4.1.5 Encryption system	C	Only applicable if pay-tv was decided to be included in the service proposition.
4.1.6 Additional services	C	There are no teletext services in Cambodia and there is not a requirement for implementing teletext on the digital platform. For Access services there are no requirements (yet). Provisions for System Software Updates (SSU) are likely to be necessary.

Main activities	Observation/Advice
1. Studying technical characteristics and planning criteria of DTMB standard when this standard is considered to be implemented	Currently in ITU-R work is in progress regarding the DTMB standard in Recommendations ITU-R BT.1306 and BT.1368. (In ITU-R, the DTMB standard is

Main activities	Observation/Advice
	<p>referred to as “System D”).</p> <p>Please note:</p> <ul style="list-style-type: none"> • The DTMB standard has two versions, a single carrier system and a multi-carrier system. The standard can be applied in 7 MHz and in 8 MHz channels. • It is advised to consider the multi-carrier standards only, because multi-carrier standards provide maximum ruggedness against multipath interference. This is important in case of reception with simple antennas, a means of reception commonly used in Cambodia. • DTMB is less suitable for SFN operation because of the limited choice and shorter maximum guard interval (55.6, 78.7 and 125 μs) compared to DVB-T (28, 56, 112, 224 μs).
<p>2. Estimate required bit rate of SDTV services (including sound channels)</p> <p>The bit rate of the multiplex is trade-off between picture quality and multiplex capacity. Final estimation can only be made after design principles and network architecture (see functional building block 4.2 in Phase 2) and network planning (see functional building block 4.3 in Phase 2) have been considered.</p>	<p>First estimate could be:</p> <p>Video bit rate: ≥ 3 Mbit/s (MPEG2), depending on the kind of program, because good picture quality is an objective.</p> <p>Audio bit rate: 192 kbit/s (MPEG1 layer 2) for a stereo channel and 96 kbit/s for a mono channel.</p>
<p>3. Evaluation of conditional access (CA) systems</p> <p>The choice for a conditional access (CA) system is a trade-off between costs of the system and security.</p>	<p>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).</p> <p>The use of CA systems must be supported by the transmission standard; in case of DTMB this has to be checked.</p>
<p>4. Estimation of required bit rate for SI and need for SSU</p> <p>Service Information (SI) is needed for constructing the EPG in the receiver. System Software Updates (SSU) is likely required to be able to upload new software to the receivers.</p>	<p>The Service Information required for the EPG may take about 0.5 Mbit/s.</p> <p>It is recommended to undertake testing of SSU beforehand to avoid risk of problems during live data transmission.</p> <p>The use of additional systems must be supported by the transmission standard; in case of DTMB this has to be checked.</p>

Annex 2

Functional building blocks related to Phase 2 of the roadmap

ASO planning

<p style="text-align: center;">2. ASO planning</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="background-color: #ffffcc; text-align: center;">2.3. ITU-R Regulations</td> <td style="background-color: #ffffcc; text-align: center;">2.14. Transition Models</td> </tr> <tr> <td style="background-color: #ffffcc; text-align: center;">2.9. Business Models & Public Financing</td> <td style="background-color: #ffffcc; text-align: center;">2.15. Organizational Structure & Entities</td> </tr> <tr> <td style="background-color: #ffffcc; text-align: center;">2.16. ASO Planning & Milestones</td> <td style="background-color: #ffffcc; text-align: center;">2.18. ASO Communication Plan</td> </tr> <tr> <td style="background-color: #ffffcc; text-align: center;">3.2. Customer Proposition</td> <td style="background-color: #ffffcc; text-align: center;">3.4. Business Planning</td> </tr> <tr> <td style="background-color: #ffffcc; text-align: center;">4.2 Design Principles & Network Architecture</td> <td style="background-color: #ffffcc; text-align: center;">4.3. Network Planning</td> </tr> <tr> <td style="background-color: #ffffcc; text-align: center;">4.4. System Parameters</td> <td style="background-color: #ffffcc; text-align: center;">4.5 Radiation Characteristics</td> </tr> </table> <div style="border: 1px solid black; border-radius: 15px; padding: 5px; margin-top: 10px; background-color: #e0e0e0;"> <p style="text-align: center;">Consultation with market parties</p> </div>	2.3. ITU-R Regulations	2.14. Transition Models	2.9. Business Models & Public Financing	2.15. Organizational Structure & Entities	2.16. ASO Planning & Milestones	2.18. ASO Communication Plan	3.2. Customer Proposition	3.4. Business Planning	4.2 Design Principles & Network Architecture	4.3. Network Planning	4.4. System Parameters	4.5 Radiation Characteristics	<p>The selected functional building blocks related to Phase 2 of the Roadmap are shown in Figure 3.9 and are reproduced here.</p> <p>Section 3.4.3 describes Phase 2 of the roadmap.</p> <p>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:</p> <ul style="list-style-type: none"> A. the decisions on key topic and choices that are already taken; 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. <p>For those issues that are not (fully) decided or need revision the main activities are indicated.</p> <p>The selected functional building blocks are presented in the order of the number of the block. This number refers to the corresponding section in the Guidelines, where more information and implementation guidelines can be found.</p> <p>The grey coloured blocks are not described in the Guidelines and not described in the tables below. These blocks represent activities that are not specific to digital terrestrial television.</p>
2.3. ITU-R Regulations	2.14. Transition Models												
2.9. Business Models & Public Financing	2.15. Organizational Structure & Entities												
2.16. ASO Planning & Milestones	2.18. ASO Communication Plan												
3.2. Customer Proposition	3.4. Business Planning												
4.2 Design Principles & Network Architecture	4.3. Network Planning												
4.4. System Parameters	4.5 Radiation Characteristics												

2.3 ITU/R regulations

Brief description	ITU-R regulations entail the Radio Regulations (RR) and in particular the table of Frequency Allocations (Region 3) and the relevant provisions of the World Radiocommunications Conference 2007 (WRC-07).
Objective	In this phase, to determine what possible ASO model are possible given the insight of the first phase.

Key topics and choices	Status	Decision
2.3.3 The international context of the ITU-R regulations: Are the different entries in the GE06 plan considered (allotment/assignment)?	NA	A plan like the GE06 plan is not available for Region 3.
2.3.4 Applicability and implications of initial inventory (see Phase 1): what are the possible ASO models given the available spectrum and initial spectrum requirements.	C	As part of the ASO planning process. Please note that simulcasting is a requirement, although the exact model is not decided yet.

Main activities	Observation/Advice
1. Map the preferred transition models on the available spectrum for DTTB services. Select on the basis of this analysis the most optimal transition model.	To be carried out as part of Phase 2. See also functional build block 2.14 and the details provided in section 4.5 on transition model selection.
2. Determine necessary changes to <i>planned</i> licensing procedures, terms and conditions for DTTB services and ASO plans.	As input for Phase 3.
3. Determine necessary changes to <i>assigned</i> frequency (and possibly content) licences for operational DTTB and Analogue TV services.	Especially the assigned DTTB licence to broadcasters and PPCTV needs to be evaluated.

2.9 Business models and public financing

Brief description	As part of the DTTB service planning, the associated costs and funding for the ASO process (including the PSB DTTB offer) should be established.
Objective	Financing the ASO in order to have a smooth transition from analogue to digital television broadcasting. To equip the NRT with sufficient resources to plan and manage the ASO process.

Key topics and choices	Status	Decision
2.9.1 General ASO financing models and sourcing. Has the different sources for DSO/ASO been selected and is the budget fully financed?	C	Still to be analyzed and decided in the ASO planning Phase. For more considerations see section 4.4 in this report.

Key topics and choices	Status	Decision
<p>2.9.2 DTTB specific financing issues:</p> <ul style="list-style-type: none"> 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	<p>All still to be addressed in the ASO planning Phase:</p> <ul style="list-style-type: none"> a. STB financing options to be considered (including a common multiplex/network operator providing and subsidizing the single cheap STB). b. Additional FTA (TVK) channels on digital platform still to be determined. c. Still to be considered. Although no current stipulations on FTA. d. Still to be considered. e. NA.

Main activities	Observation/Advice
1. Consult public broadcasters and government on possibilities to contribute to financing the ASO process.	During the first visit it was suggested that TVK may be positioned as a PSB (like Telecom Cambodia). It should be investigated whether such a decision would come with additional financial resources.
2. Analyze market situation and assess possible market distortions.	Due to the high number of television service providers (see figure 2.1 in section 2.1 in this report) and their relative market share (see Table 4.2 in section 4.2), market distortions are likely.
3. Define or complete required (public) service offering on DTTB (if not defined in Legislation yet).	Current legal framework does not quantify the required DTTB services. Here the NRT has some degree of freedom. Although the ASO plan will need approval in Parliament.
4. Align defined public service offering with other DTTB licence terms and conditions and media permits, and their planning.	Special care should be given to the PPCTV licence and other assigned DTTB licences.
5. Determine and establish budget for ASO plan.	The ASO plan should pass Parliament and hence should be well prepared and introduced in Parliament (lobby).

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 (i.e. the ASO process). This section deals with what ASO or transition model will be applied where in Cambodia.
Objective	Existing analogue services are migrated to a DTTB platform in one coordinated effort and without service interrupts.

Key topics and choices	Status	Decision
<p>2.14.1 ASO objectives and hurdles: What are the ASO objectives (To have a universal television service on the DTTB platform, and/or to securing the future of the terrestrial platform).</p>	B	<p>Partly because NRT would like to see additional services on DTTB and MTV. See also ‘DSO objectives’ in section 2.3 in this report.</p> <p>Still the exact number of additional services to be decided. Also what type of service coverage the NRT would like to see (this could include Universal coverage).</p>
<p>2.14.2 ASO factors: consider the following factors:</p> <ul style="list-style-type: none"> a. Required (PSB) services. b. The number of analogue terrestrial television viewers. c. Availability of spectrum. d. DTTB service uptake. 	C	<p>When considering the current analogue viewing situation, the NRT should include the impact of ASO on cable companies feeding their head/ends over the air. See also section 4.4.1 in this report.</p>
<p>2.14.3 ASO transition models: Which models is envisioned:</p> <ul style="list-style-type: none"> a. ASO with simulcast period, with two sub-categories: <ul style="list-style-type: none"> i) Phased approach to analogue switch-off. ii) National approach to analogue switch-off. b. ASO without simulcast period. 	B	<p>Although the NRT has decided on a simulcast model, it should still define the exact model. For more considerations see section 4.5 in this report.</p>

Main activities	Observation/Advice
<p>1. Check existing Legislation and policies for Public television service (e.g. FTA) and coverage stipulations (e.g. nationwide coverage).</p>	<p>Current legal framework does not explicitly states a minimum coverage percentage. This provides a degree of freedom for the NRT.</p>
<p>2. 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.</p>	<p>To be carried out in the previous Phase of the roadmap (DTTB Policy). See section 3.4.2 on the market research of the current market. The result of this market research can be used here for this activity.</p>
<p>3. Analyze and assess complexity and size of network modifications and receiver transitions.</p>	<p>In the first visit it was concluded that spectrum and infrastructure incompatibilities were unlikely to occur. Given the many networks (although with a relatively low number of transmitters) in operations, the complexity of the ASO process can be high (in terms of many parties working together).</p>
<p>4. Involve and discuss ASO with broadcasters, other service providers and consumer associations.</p>	<p>To be included in this phase of the roadmap as part of the NRT.</p>
<p>5. Decide transition model (simulcast period and ASO phasing).</p>	<p>To be included in this phase of the roadmap.</p>

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. In Cambodia this task is assigned (not formally yet) to the NRT.
Objective	A coordinated ASO process between all involved parties and stakeholders.

Key topics and choices	Status	Decision
2.15.1 Organizational ASO structures and entities: ASO organization completed and in place?	B	The NRT has been established in Cambodia. Her exact mandate has to be specified yet. Also membership of the NRT might have to be extended in the future (for example to include major retailers or other broadcasters).
2.15.2 ASO costs and support: ASO cost analyzed and determined (use table in this section).	C	Detail inventory necessary as part of the process of balancing DTTB service planning, Customer Proposition and financing (see section 3.4.3 of this report).

Main activities	Observation/Advice
1. Establish overall coordination tasks and needs.	All to be included as part of this phase of the roadmap. For more details see section 3.4.3 and 4.4.1 of this report.
2. Establish clear mandate (which is politically approved).	
3. Establish budget and communication means (air-time, website, etc).	

2.16 ASO planning and milestones

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

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	Switch off date is set to be between 2015 and 2018. The PPCTV operation provides already simulcasting in PP. Consequently the ASO process has already started. If this operation may become part of the ASO planning, the operation may have to be secured (as to limited the risk that the ASO process is dependent on the business success of one single company).

Key topics and choices	Status	Decision
2.16.2 Overall ASO planning set-up: including the overall program structure and the key result paths in an ASO plan.	C	For more considerations see section 4.6 of this report.
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) and assign tasks and responsibilities (including core project management team).	All to be included as part of this phase. An example ASO report can be found on: www.digitaluk.co.uk/_data/assets/pdf_file/0009/19791/Digital UK Ofcom Q2 2007 FIN AL.pdf
2. Establish ASO project monitoring framework and reporting structure.	
3. Identify ASO project risks and draft risk mitigation plans (including fall back and/or roll back scenarios).	

2.18 ASO Communication Plan

Brief description	This section focuses on communication to the viewers and other stakeholders in the DTTB value chain.
Objective	To help viewers prepare adequately, the whole broadcast community 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	The establishment of a ‘trusted brand’ for labelling certified/approved receivers will be necessary.
2.18.2 Communication tools: the various communications means to reach the listed target groups.	B	The main tools are likely to be (a) Radio and Television (b) printed media (c) SMS coverage checker (d) social Cambodian structure (neighbours helping each other).

Main activities	Observation/Advice
1. Draft communication plan (including target audiences, timing, means, etc.).	All to be included in this phase of the roadmap. For more details see section 3.4.3 and section 4.7 of this report.
2. Continuous alignment with ASO planning.	
3. Determine and establish compensation schemes and systems, include in communication plan.	

3.2 Customer Proposition

Brief description	This section focuses on determining the competitive advantage and what the related service attributes could look like. In this phase it is part of the service planning and service proposition review and financing cycle.
Objective	Finding the best customer proposition in line with the business plan objectives (i.e. ASO plan and budget).

Key topics and choices	Status	Decision
3.2.2 DTTB competitive advantage and related Service Proposition attributes determined.	C	Competitive advantage already established in previous Phase. Attributes still to be defined.

Main activities	Observation/Advice
1. Define DTTB service attributes and check network feasibility and cost levels.	As part of the service planning, service proposition review and financing cycle as described in section 3.4.3. See also considerations in section 4.9 in this report. Review Table 3.2.1 in the Guidelines for example service proposition attributes.

3.4 Business planning

Brief description	This section will focus on agreement on business case (budget) for the ASO plan.
Objective	To have the ASO plan successfully passing Parliament.

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).	C	All business models are under consideration for DTTB services: (a) FTA only, (b) pay-tv only and (c) any combinations.
3.4.2 What does the business case look like for the ASO plan?	C	The business case = ASO plan budget. Still to be drafted and decided.

Main activities	Observation/Advice
1. Assess market up-take and project revenue streams, based on customer research and proposition.	All to be carried out as part of this phase. For more considerations see section 3.4.3 and sections 4.4 and 4.8 of this report.
2. Assess and calculate associated costs for different ASO plans.	
3. Carry out sensitivity analysis, draft business case /ASO plan for scenarios. For example yes/no simulcast; indoor/outdoor (i.e. different quality levels) or yes/no pay-tv services.	
4. Quantify total investments and their associated risks, assess financing and public funding possibilities, consider co-operation/joint venture/vendor financing/revenue sharing.	
5. Prepare approval of ASO budget by Parliament (as part of the ASO plan).	

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.

Key topics and choices	Status	Decision
4.2.1 Trade-off between network roll-out speed, network costs and service quality,	C	
4.2.2 Main reception mode and defining receiving installations	B	In principle the objective is to plan DTTB services for rooftop reception. Indoor reception will be possible closer to the transmitter; see example in Annex 6.
4.2.3 Services for national, regional, or local coverage Insertion of regional programs at a site requires a remultiplexer at that site. Alternatively the regional programs could be transported to a central multiplex centre and the transport stream distributed to each site, where the appropriate transport stream will be selected and broadcasted (see also section 4.2.3 of the Guidelines)	A	TVK has regional windows (regional programs at a site replacing national programs).
4.2.4 Frequency plan and network topology	C	

Key topics and choices	Status	Decision
4.2.5 Head- end configuration	C	
4.2.6 Equipment reserve configurations	C	
4.2.7 Type of distribution network	B	Distribution of signals is currently provided by satellite and optic fibre. This type of distribution can in principle be used for distribution of digital signals, but the capacity needs to be reviewed.

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 roll-out scheme for head-ends, transmitting stations and distribution links	Installation of head-ends, distributions links and transmitting stations should be in conformity with ASO planning (see functional building block 2.16)									
3. Define receiving installation for estimating coverage In principle it has been decided to plan for rooftop reception.	<p>Unless specific data regarding noise figure, receiving antenna gain and receiving antenna height are required in Cambodia, the receiving installation as defined in Recommendation ITU-R BT.1368 , Annex 2, section 5 could be adopted with regard to DVB-T; these characteristics are:</p> <table border="1"> <thead> <tr> <th>Characteristic</th> <th>Band III</th> <th>Band IV/V</th> </tr> </thead> <tbody> <tr> <td>Noise figure</td> <td>5 dB</td> <td>7 dB</td> </tr> <tr> <td>Antenna gain minus feeder loss</td> <td>2 dB</td> <td>7dB</td> </tr> </tbody> </table> <p>No data are available for DTMB yet.</p>	Characteristic	Band III	Band IV/V	Noise figure	5 dB	7 dB	Antenna gain minus feeder loss	2 dB	7dB
Characteristic	Band III	Band IV/V								
Noise figure	5 dB	7 dB								
Antenna gain minus feeder loss	2 dB	7dB								
4. Evaluation of network topology	<p>Existing sites could be used as far as possible, also depending on the choice of licensing model A or B. Preferably, on a site the digital channels should be close to the analogue channels in order to be able to use the same transmitting and receiving antennas.</p> <p>For use of existing antennas see also functional building block 4.5.</p>									

Main activities	Observation/Advice
<p>5. Drafting multiplex composition plan</p> <p>The bit rate of the multiplex should be lower than the bit rate of the DTTB variant set at the transmitters in order to avoid overflow.</p> <p>Final estimation of the multiplex composition can only be made after network planning (see functional building block 4.3) has been considered.</p>	<p>The initial multiplex composition for the head-end, should take into account the bit rate requirements established in functional building block 4.1.</p> <p>The use of statistical multiplexing is in principle advised, when more than two services of different kind of content are carried in the multiplex. However, implementing statistical multiplexing may impose some technical constraints – for example it would probably be necessary for the MPEG2 coders and the multiplexer to be physically close to each other and controlled by the same computer.</p> <p>In case of DVB-T, a network ID (one per country and operator) should be obtained at the DVB project office.</p> <p>Need and way to obtain a network ID in the DTMB standard has to be investigated.</p>
<p>6. Evaluation of the required operational availability time of transmission equipment</p> <p>The operational equipment availability time is a tradeoff between costs and acceptable off-air time due to failures.</p>	<p>Broadcasters in Cambodia will have their own experience with operation of transmission equipment under the environmental conditions of Cambodia and will have specified the reserve conditions of the existing transmitter stations based on this experience.</p> <p>Solid state transmitters have a build-in redundancy because the power amplification of transmitter has several power amplification units.</p> <p>Additional redundancy can be obtained by:</p> <ul style="list-style-type: none"> • Installing a spare exciter in each transmitter • Installing a spare transmitter in n+1 configuration, in case more than one multiplex (transmitter) is needed at a site. <p>With regard to the head-end, it is advised to install a spare encoder in an n+1 configuration.</p>
<p>7. Evaluation of type of distribution network</p>	<p>Distribution by via a fixed satellite service or optical fibre is possible.</p> <p>The type of digital distribution link must be supported by the DTTB standard.</p>

Main activities	Observation/Advice
<p>8. Review of transmitting station lay out</p> <p>Facilities at sites should be dimensioned in such a way that the DTTB transmitting equipment, plus ancillary equipment, can be accommodated. During ASO also analogue transmitting equipment is operational.</p>	<p>Station lay out may need review to accommodate additional transmitters. The number of transmitters per site will depend on the choice for licensing model A or B.</p> <p>The power supply facilities and electrical features of the antenna need to be checked and if necessary adapted.</p>

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 Service trade-off	C	
4.3.2 SFN or MFN	B	As indoor reception in large areas is not a requirement, there is no apparent need for SFNs
4.3.3 Fill-in transmitters	C	Some fill-in transmitters may be needed in mountainous areas to improve coverage in future.
4.3.4 Feed back to business plan and service proposition	C	

Main activities	Observation/Advice
<p>1. Planning criteria and planning method</p>	<p>In order to avoid continued discussions on planning results and coverage presentations the NRT should agree on the planning criteria and planning method.</p>
<p>2. Coverage analysis</p> <p>Coverage presentations and a list of stations characteristics are the result of a network planning exercise and form the key tools for analysis coverage.</p>	<p>It is advised to prepare coverage plots using network planning software that takes into account:</p> <ol style="list-style-type: none"> 1. The DVB-T and DTMB standard (if so required). 2. Accurate terrain and clutter data. 3. Transmitter database of operational and planned stations (analogue and digital) including stations from neighbouring countries.

Main activities	Observation/Advice
<p>3. Gap-filler planning</p> <p>Gap-fillers, also called fill-in stations, are fed off-air from a main transmitter. The transmission frequency can be different from the received frequency (MFN operation) or the same as the received frequency (SFN operation).</p>	<p>Detailed coverage analysis resulting from main activity 1, is likely to show areas where coverage can be improved by means of gap-fillers.</p> <p>In general the receiving antennas of gap-filler need line-of-sight with the main transmitter.</p> <p>In case of SFN operation, the power of gap-fillers is restricted, depending on the isolation between input and output signal.</p>
<p>4. Carrying out “service trade-off”</p> <p>Radiation characteristics, multiplex capacity coverage quality are interrelated.</p>	<p>The “service trade off” should be carried out to find the optimum balance between multiplex capacity and coverage quality. The multiplex capacity depends on the choice of licensing model A or B. With regard to the radiation characteristics see also the considerations given in section 4.9.3.</p> <p>If no satisfactory solutions can be found in the “service trade-off” a review is needed of customer proposition, business case and/or design principles and network architecture.</p>

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
<p>4.4.1 FFT size</p>	A	<p>DTTB reception at high speed is not a requirement; therefore the 2k option in DVB-T does not need to be considered. Consequently the FFT size is 8k in case of DVB-T and 4k in case of DTMB.</p>
<p>4.4.2 Carrier modulation and code rate</p> <p>Radiation characteristics, multiplex capacity coverage quality are interrelated.</p>	B	<p>The choice will mainly depend on the required multiplex capacity resulting from the adoption of licensing model A or B (see also the considerations in Annex 6. Initially QPSK 1/2 and 64QAM 2/3 could be chosen in case of licensing model A or B respectively.</p>
<p>4.4.3 Guard interval</p>	A	<p>As MFNs are envisaged, the lowest possible interval is sufficient:</p> <ul style="list-style-type: none"> • With DVB-T a guard interval of 28 μs. • With DTMB a guard interval of 55.6 μs.

Main activities	Observation/Advice
<p>1. Evaluation of carrier modulation and code rate</p> <p>Higher order modulation and higher code rates provide more multiplex capacity but at the cost of a higher C/N resulting in more restricted coverage.</p> <p>Lower order modulation and lower code rates provide a more robust coverage at the cost of a restricted multiplex capacity.</p>	<p>Coverage analysis and evaluating the net bit rate of the multiplex through the “service trade off” should verify the initial choice of QPSK 1/2 and 64QAM 2/3 in case of licensing model A or B respectively.</p>

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	C	
4.5.2 Polarization	A	In order to minimize costs for the viewer as much as possible existing receiving antennas should be used; consequently the polarization of transmitting antennas should be horizontal.
4.5.3 Use of existing antennas or need for new antennas	B	In order to achieve low cost operations as much as possible existing transmitting antennas should be used (subject to the DTTB frequency assignments and electrical features of the antenna).

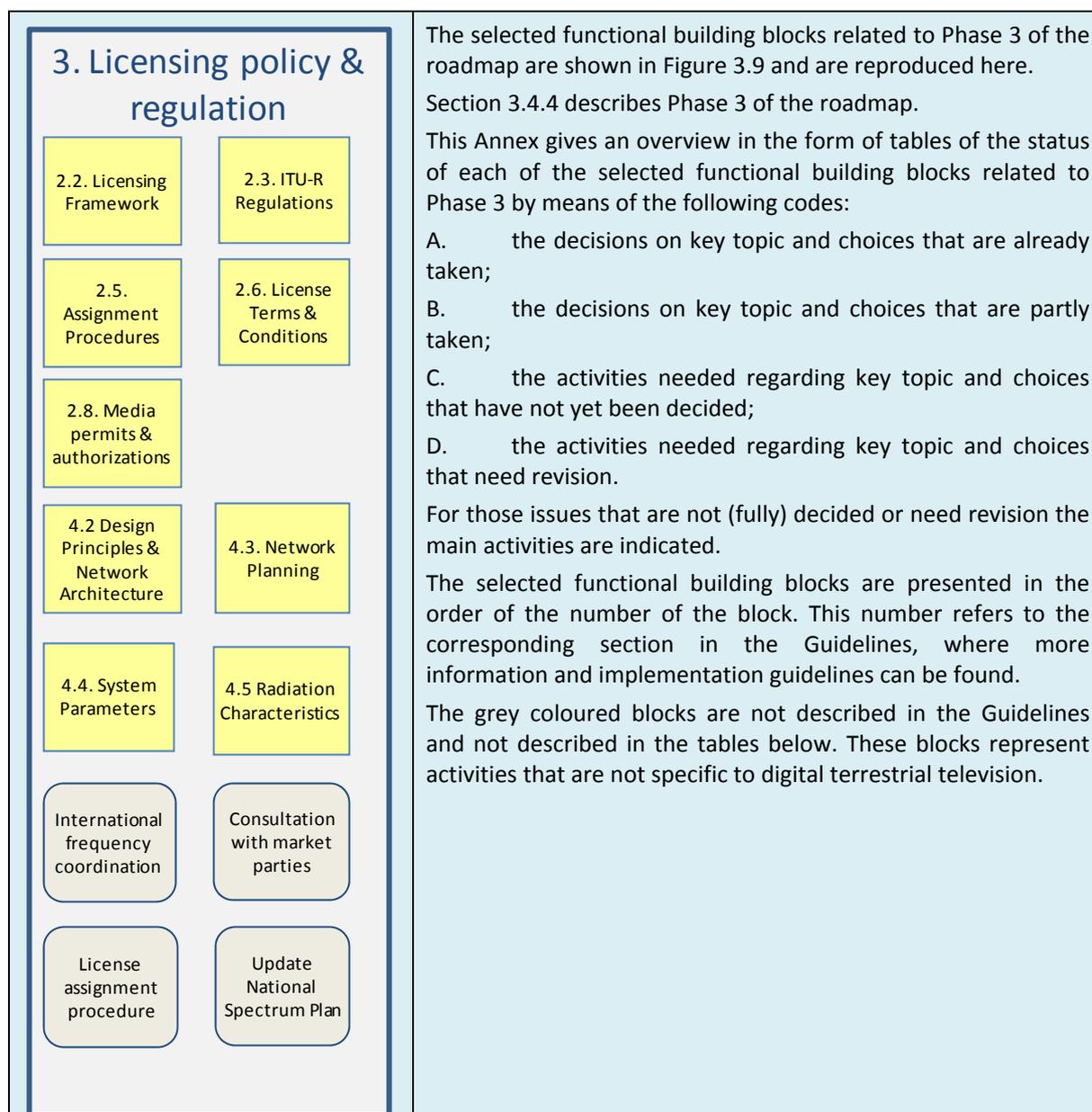
Main activities	Observation/Advice
<p>1. Evaluation of transmitter power and antenna gain</p>	<p>The ERP of a transmitting station is determined by applying the “service trade-off”. The initial choice of ERP could be guided by the values indicated in section 4.9.3.</p> <p>The transmitter power is given by subtracting feeder and combiner losses from the ERP value.</p> <p>If the assigned digital frequency is not close to the frequencies in use, the antenna gain and the antenna pattern is probably not optimal. A new antenna could then be considered.</p>

Main activities	Observation/Advice
2. Calculation of antenna power budget	In case more than one transmitter has to be fed into the same antenna (see functional building block 4.2 Design principles and network architecture), an antenna combiner is needed and the antenna power budget has to be calculated to ensure that allowed mean power and peak voltage of the antenna is not exceeded.

Annex 3

Functional building blocks related to Phase 3 of the roadmap

Licensing policy and regulation



2.2 Licensing Framework

Brief description	For Cambodia the licensing framework concentrates on the selection of the appropriate model; either model A or B.
Objective	The objective of the licensing framework should be to actually implement the defined policy objectives for the introduction of DTTB, 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) local/building rights. For DTTB services has the model been decided?	C	The adoption of the new Telecommunications Law may change the licensing framework for assigning the spectrum rights.
2.2.2 For the extra function of the multiplex operator in the value chain, two basic licensing models can be distinguished for DTTB; model A or B. Has the basic model been decided?	C	For more considerations see section 4.3 in this report.
2.2.3 Has the PBS services and spectrum rights been defined yet (and where) for the DTTB services?	C	Not decided yet. See also considerations in functional building block 2.9.

Main activities	Observation/Advice
1. Make inventory of current spectrum and broadcast rights of licensed broadcasters.	To be carried out on the basis of the results of the functional building blocks 2.3 and 2.4 in first and second phase of this roadmap.
2. Make inventory of current licensing framework and check applicability for DTTB service introductions (gaps/conflicts).	To be carried out on the basis of the results of functional building block 2.11 in the first phase.
3. Assess and evaluate different options for licensing DTTB services.	All to be included as part of this phase of the roadmap.
4. Assess compatibility with ASO plans and National Spectrum Plan.	For more consideration see section 4.3 of this report.
5. Possibly revise current licensing framework and assess impact.	
6. Draft planning for licence assignment, framework changes and update National Spectrum Plan (and possibly Legislation).	

2.3 ITU-R regulations

Brief description	ITU-R regulations entail the Radio Regulations (RR) and in particular the table of Frequency Allocations (Region 3) and the relevant provisions of the World Radiocommunications Conference 2007 (WRC-07).
Objective	In this phase, to perform conformity checks whilst carrying out detailed DTTB service planning.

Key topics and choices	Status	Decision
2.3.1 The international context of the ITU-R regulations: are the different entries in the GE06 plan considered (allotment/assignment)?	NA	A plan like the GE06 plan is not available for Region 3.
2.3.2 Applicability and implications of initial inventory and ASO planning (see Phase 1 and 2): what services are exactly possible given the available spectrum, initial spectrum requirements and financial constraints?	C	As part of the detailed DTTB service planning (see section 3.4.4 of this report).

Main activities	Observation/Advice
1. Carry out a detailed DTTB service planning.	For more details see section 3.4.4 in this report.
2. Determine necessary terms and conditions for <i>planned</i> DTTB services and ASO plans.	For more details see section 3.4.4 in this report.
3. Possibly redefine necessary changes to <i>assigned</i> frequency (and possibly content) licences for operational DTTB and Analogue TV services.	Whether this will be necessary depends on the results of this functional building block in Phase 2 of the roadmap and the detailed DTTB service planning. Especially the assigned DTTB licence to broadcasters and PPCTV needs to be evaluated.

2.5 Assignment Procedures

Brief description	Assigning spectrum/broadcast rights for DTTB services and the common instruments and procedures applied.
Objective	Assign spectrum/broadcast rights to the PSB, commercials broadcasters or any other entity (such as the common multiplex/network operator) in a transparent manner in line with the ASO plan.

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?	C	No legislation present arranging assignment instruments for spectrum and/or broadcast rights. The current situation is that all licences to the Cambodia broadcasters and service providers were assigned on the basis of FCFS.

Key topics and choices	Status	Decision
2.5.2 Assignment procedures for DTTB services: what is the selected assignment instrument (FCFS, auction or public tender) for DTTB services?	C	The NRT should make a difference between assigning licences to broadcasters (model A) and multiplex/network operator (model B). In case of model B the NRT could apply a different instrument (for example public tender). In case of model A, the NRT should be aware of the risk that introducing another assignment instrument (other than FCFS) may lead to claims of unfair competition. Mitigation may be needed.

Main activities	Observation/Advice
1. Consult market (current broadcasters and potential bidders/applicants) on assignment methods and licence terms and conditions.	All to be carried out as part of this phase. Drafting of the Licensing procedure and passing Parliament should be aligned with the ASO planning. Licensing procedure should be ‘future proof’ in the sense that after ASO additional licences might be assigned.
2. Evaluate results and select assignment method and procedures.	
3. Draft detailed plans and planning for DTTB assignment procedure (for detailed steps see Appendix 2.5B).	
4. Prepare approval of assignment Procedures by Parliament.	
5. 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 frequency or spectrum licences.
Objective	Assigning DTTB/MTV frequency rights is carried out in conjunction with assigning the other two types of rights as well. 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)?	NA (yet)	Competition Law for telecom/broadcast market still in development. Compliancy to be checked later/when appropriate.

Key topics and choices	Status	Decision
2.6.2 Frequency licence terms and conditions: have all licence terms and conditions been determined and is the list of conditions complete (see list in this section)?	C	Depends on model A or B. In case of model B the licence conditions are likely to cover other terms and conditions (next to the spectrum usage rights). For example to implement ONP rules. Please note that DTTB licences have already been assigned to PPCTV and other broadcasters. The licence terms and conditions for new assignments should be checked and aligned with these existing rights.

Main activities	Observation/Advice
1. Check relevant paragraphs/ entries in Legislation/Policies, ASO plan and National Spectrum Plan.	All to be carried out as part of the Phase. For details on and example licence terms and conditions check the Guidelines. Depending on the licensing model selected, the frequency rights (in combination with operating rights) could be assigned separately from the broadcast rights.
2. Analyze market conditions and assess 'level-playing-field' requirements/provisions.	
3. Determine DTTB Terms and Conditions and align with Media permits/authorizations and their planning.	
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. In this section we focus on granting media/broadcast permits/authorizations for commercial broadcasters (for public broadcasters see section 2.2.3 in the Guidelines).
Objective	In regulating access to the DTTB platform and/or to determine content composition on the DTTB and MTV 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, program or platform level?	C	Dependent on model A and B. If model A is selected, NRT may continue with current system (although to avoid having different STBs has to be resolved).

Key topics and choices	Status	Decision
2.8.2 Broadcast licensing requirements: have all licence terms and conditions been determined and is the list of conditions complete (see list in this paragraph)?	C	The NRT should considering the exiting digital broadcast rights in the market.

Main activities	Observation/Advice
1. Check existing media legislation, DTTB policy and licensing framework (model A/B).	All to be carried out as part of this phase of the roadmap. For more details check section 2.8.2 in the Guidelines.
2. Check Technology and Standards Regulation (receiver regulations) and include in media permits policies.	
3. Determine media permits/authorizations and procedures and review PPCTV/other DTTB licence terms and conditions.	
4. Publish policies for media permits and authorizations (may include waivers).	

4.2 Design principles and network architecture

Brief description	Implementation priorities and network architecture, based on results of Phase 2
Objective	Detailed technical description of the main network elements in relation to service quality, coverage, costs and timing requirements serving as input document for preparing the national coordinated frequency plan and licence procedure and planning.

Key topics and choices	Status	Decision
4.2.1 Trade-off between network roll-out speed, network costs and service quality,	C	The initial results obtained in Phase 2 (ASO planning) should be verified based on the initial frequency plan and ASO plan.
4.2.4 Frequency plan and network topology	C	
4.2.5 Head- end configuration	C	
4.2.7 Type of distribution network	C	

The main activities are the same as described in Phase 2 (ASO planning) and should be carried out in more detail based on:

- the initial frequency plan; and
- the ASO plan.

4.3 Network planning

Brief description	Based on results of Phase 2 (ASO planning) and the review of design principles and network architecture (see functional building block 4.2 above), network planning is an iterative process to achieve 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	Preparing of list of station characteristics and detailed coverage presentations

Key topics and choices	Status	Decision
4.3.1 Service trade-off	C	The initial results obtained in Phase 2 (ASO planning) should be verified based on the initial frequency plan, ASO plan and review of Network design and network architecture (see functional building block 4.2 in Phase 3).
4.3.2 SFN or MFN	C	
4.3.3 Fill-in transmitters	C	
4.3.4 Feed back to business plan and service proposition	C	

The main activities are the same as described in Phase 2 (ASO planning) and should be carried out in more detail based on:

- the initial frequency plan;
- the ASO plan; and
- the review of network design and network architecture (see functional building block 4.2 in Phase 3).

4.4 System parameters

Brief description	Based on results of Phase 2 (ASO planning), review of 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 detailed network planning

Key topics and choices	Status	Decision
4.4.1 FFT size	C	The initial results obtained in Phase 2 (ASO planning) should be verified based on the initial frequency plan, ASO plan and review of network design and network architecture (see functional building block 4.2 in Phase 3).
4.4.2 Carrier modulation and code rate	C	
4.4.3 Guard interval	C	

The main activities are the same as described in Phase 2 (ASO planning) and should be carried out in more detail based on:

- the initial frequency plan;
- the ASO plan; and
- the review of network design and network architecture (see functional building block 4.2 in Phase 3).

4.5 Radiation characteristics

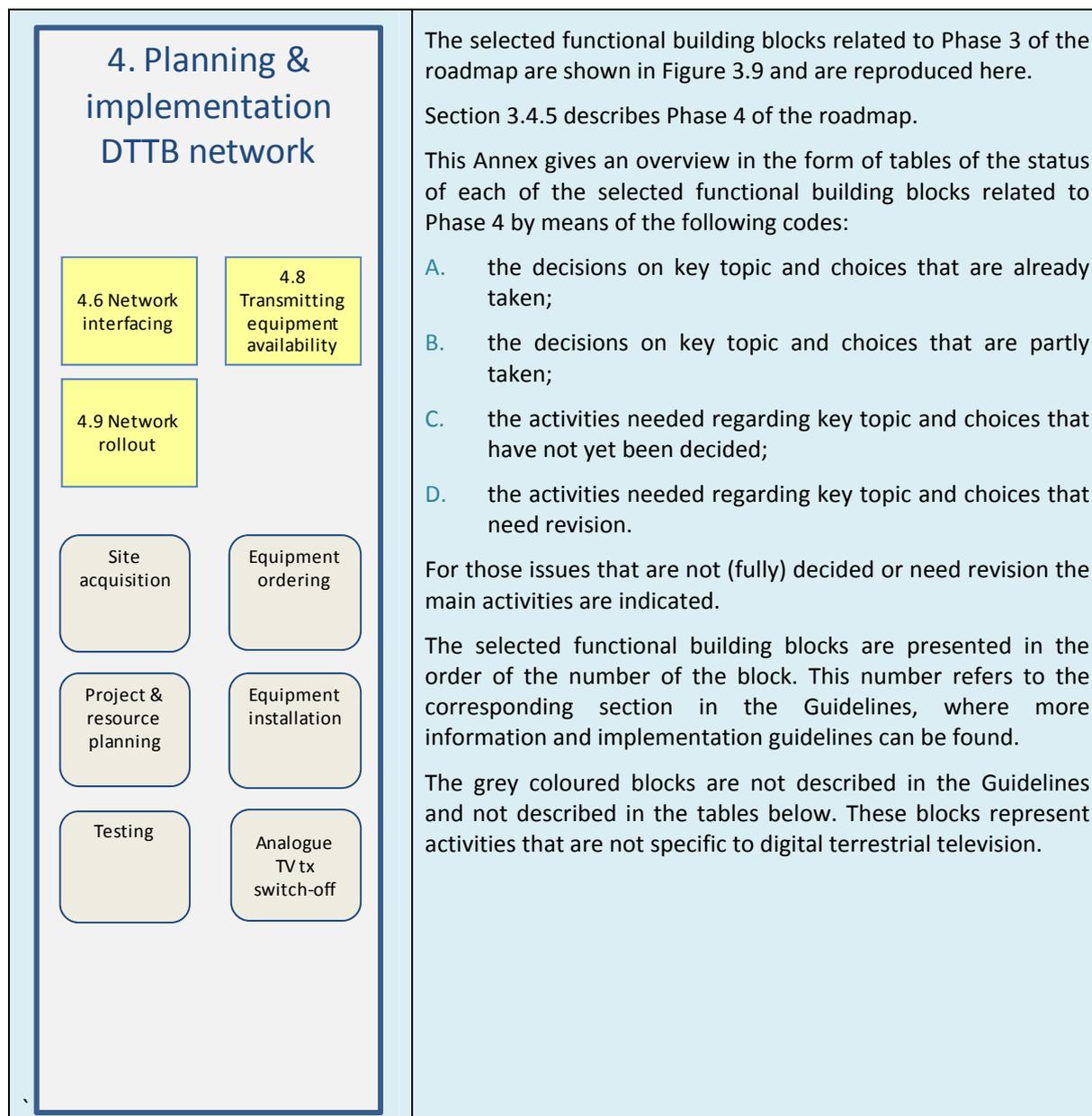
Brief description	Based on results of Phase 2 (ASO planning), review of transmitter power and transmitting antenna gain in order to achieve the required or allowed effective radiated power and configuration of the optimum antenna diagram and polarization
Objective	Specification of transmitter power, antenna gain and antenna diagram as input for detailed network planning.

Key topics and choices		Status	Decision
4.5.1	Transmitter power and transmitting antenna gain	C	The initial results obtained in Phase 2 (ASO planning) should be verified based on the initial frequency plan, ASO plan and review of network design and network architecture (see functional building block 4.2 in Phase 3).
4.5.2	Polarization	C	
4.5.3	Use of existing antennas or need for new antennas	C	

Annex 4

Functional building blocks related to Phase 4 of the roadmap

DTTB implementation



4.6 Network interfacing

Brief description	Interfaces between parts of the network, the studio and the head-end, the transmitting antenna and the receiver and transmitting equipment and the monitoring centre.
Objective	Defining interfaces with network elements in order to obtain satisfactory service delivery.

Key topics and choices	Status	Decision
4.6.1 Interfaces with head-end	C	
4.6.2 Interfaces between parts in the network	C	
4.6.3 Radio interface between transmitting station and receiving installation	C	
4.6.4 Interfaces between transmitter sites and monitoring system	C	

Main activities	Observation/Advice
<p>1. Drafting interface specifications between parts of the network</p> <p>Parts of the network are head-end, distribution links and transmitter sites.</p>	The specifications of the interfaces depend on the chosen transmission standard, type of distributions links and network architecture (see also functional building block 4.2 in Phase 3).
<p>2. Drafting interface specifications between network monitoring system and head end and distribution links</p>	Operational status of head-end equipment and distribution links should be visible at the monitoring centre. The interfaces between the equipment and the monitoring centre should be in accordance with those specified for the transmitters.
<p>3. Describing radio interface</p> <p>The interface between transmitting antenna and receiving installing is the radio interface. It takes into account the receiving installation as defined in functional building block 4.2 in Phase 3.</p>	<p>It is advised to describe the radio interface by means of reception probability. It indicates the probability of good reception in the presence of noise and interference.</p> <p>In order to avoid continuing discussions on coverage results, the method for assessing coverage (including the transmitter databases for different situations, e.g. during and after ASO) should be agreed by the NRT.</p>

4.8 Transmission equipment availability

Brief description	Transmission equipment complying with the chosen transmission standard and systems and fitted to transmit all planned services
Objective	Defining transmission equipment specification complying with network architecture and design principles and network planning

Key topics and choices	Status	Decision
4.8.1 Market research	B	PPCTV has DVB-T transmitters and a head-end in operation. Hence the market research has been carried out. Results may be shared by the NRT. For further transmitting equipment an update of the research would be necessary.
4.8.2 Technical specifications	B	The technical specifications of the PPCTV transmitters, antenna and head-end have been set. Further equipment needs to be specified based on the results of the network planning.

Main activities	Observation/Advice
1. Carrying out market research for head-ends and distribution links	In order to get an impression of prices and ranges of characteristics it is advised to obtain technical data sheets and budgetary prices from a number of suppliers.
2. Drafting specifications of distribution links and head ends	The specifications should include: transmission standard, compression system, CAS and SMS system (if required), reserve configuration and interfaces.

4.9 Network rollout and planning

Brief description	Implementation plan taking into account coverage priorities, services priorities, ASO, equipment availability and capacity of the network operator
Objective	To provide implementation schedule for the DTTB services within budget and time constraints

Key topics and choices	Status	Decision
4.9.1 Test transmissions	C	
4.9.2 Implementation plan	C	
4.9.3 Information to end consumers	C	

Main activities	Observation/Advice
1. Describing pilot tests and demonstrations	Before a site is brought into use it is advised to perform technical tests. After it is assured that the equipment functions perfectly, demonstrations may be arranged in particular in areas where DTTB is broadcast for the first time.

Main activities	Observation/Advice
2. Roll out planning in accordance with ASO plan	The milestones of the roll-out plan are given by the ASO plan. The roll-out plan should take account of the time periods needed for delivery of equipment, installation and testing of equipments, tests and demonstrations.
3. Coverage assessment at each stage of implementation	For each stage of the implementation (before and after ASO) detailed coverage maps should be produced. These maps are needed for managing switch-over and as a basis for communication to viewers.

Annex 5

Information on DTTB standards

In this annex a summary is given of technical information on transmission standards obtained from ITU and other sources.

1 General

The most important ITU-R Recommendations regarding DTTB standards are:

- Recommendation ITU-R BT.1306, Error correction, data framing, modulation and emission methods for digital terrestrial television broadcasting²⁵.
- Recommendation ITU-R BT.1877, Error-correction, data framing, modulation and emission methods for second generation of digital terrestrial television broadcasting systems²⁶.
- Recommendation ITU-R BT.1368, Planning criteria for digital terrestrial television services in the VHF/UHF bands²⁷.

These Recommendations can be downloaded freely from the ITU website by using the indicated hyperlinks. For all other ITU documents mentioned in this annex ITU TIES login and password are required.

Work is in progress on Recommendations ITU-R BT.1306 and ITU-R BT.1368. ITU-R Working Party 6A is carrying forward:

- a Preliminary Draft Revision to Recommendation ITU-R BT.1306 with new information on the DTMB standard;
- a Preliminary Draft Revision to Recommendation ITU-R BT.1368 with new information on the DTMB and DVB-T2 standard.

It is expected to progress this work at the next meeting of Working Party 6A in May 2011²⁸.

2 Current status of Preliminary Draft Revision to Recommendation ITU-R BT.1306

Status of the work

The current status of the work on Recommendation ITU-R BT.1306 is shown in Annex 5 to the chairman's report of Working Party 6A²⁹. In this draft the standards are represented by letters:

- System A is ATSC;

²⁵ See www.itu.int/rec/R-REC-BT.1306-4-200909-I/en

²⁶ See www.itu.int/dms_pubrec/itu-r/rec/bt/R-REC-BT.1877-0-201005-I!!PDF-E.pdf

²⁷ See www.itu.int/rec/R-REC-BT.1368-8-200905-I/en

²⁸ At the time of publishing this Roadmap report the revised Preliminary Draft Revisions to Recommendation ITU-R BT.1306 and ITU-R BT.1368 are not yet available.

²⁹ See www.itu.int/md/choice_md.asp?id=R07-WP6A-C-0454!N05!MSW-E&lang=en&type=sitem.

- System B is DVB-T;
- System C is ISDB-T;
- System D is DTMB.

The information regarding “system D” in the Preliminary Draft Revision to Recommendation ITU-R BT.1306 is based on the following input documents from China:

- 397 Preliminary draft revision of Recommendation ITU-R BT.1306-4 – Error-correction, data framing, modulation and emission methods for digital terrestrial television broadcasting³⁰.
- 287 Chinese digital terrestrial television broadcasting system³¹.

In the Appendices 1 to 4 to Annex 1 of the Preliminary Draft Revision to Recommendation ITU-R BT.1306, a bibliography of each standard is given, showing references to specifications and implementation guidelines.

Observations regarding the DTMB standard

The DTMB standard has two versions, a single carrier system and a multi-carrier system. The standard can be applied in 7 MHz and in 8 MHz channels. It is advised to consider the multi-carrier standards only, because multi-carrier standards provide maximum ruggedness against multipath interference. This is important in case of reception with simple antennas; a means of reception commonly used in Cambodia.

The multi-carrier version of DTMB seems to have in general similar technical features than DVB-T. However, DTMB is less suitable for SFN operation because of the limited number of guard intervals and the shorter maximum guard interval (55.6, 78.7, 125 µs) compared to DVB-T (28, 56, 112, 224 µs).

The specifications and implementation guidelines of the DTMB standard do not seem to be publicly available. However, the English version of GB20600-2006 is provided with the above mentioned Chinese input document 287.

Observations regarding the DVB-T2 standard

The DVB-T2 standard is an improved version of the DVB-T standard. DVB-T2 offers an increased efficiency of 30-50 per cent in its use of spectrum compared to DVB-T. ITU-R Recommendation ITU-R BT.1877 gives information about the DVB-T2 standard.

The specification of the DVB-T2 standard can be downloaded freely³². More high-level information on DVB-T2 can be found in the DVB-T2 factsheets³³. Compared to DVB-T, DVB-T2 can offer:

- a higher bit rate or a more robust signal;
- a lower required power (in the absence of interference other than noise) with the same bit rate;
- larger SFN areas;
- reception at higher speed.

³⁰ See www.itu.int/md/R07-WP6A-C-0397/en

³¹ See www.itu.int/md/R07-WP6A-C-0287/en

³² See www.etsi.org/deliver/etsi_en/302700_302799/302755/01.01.01_60/en_302755v010101p.pdf

³³ See www.dvb.org/technology/fact_sheets/DVB-T2_Factsheet.pdf

In the factsheet referred to above, among others the following data are given:

- Typical bit rate (as used in the UK) DVB-T: 24 Mbit/s DVB-T2: 40 Mbit/s
- Maximum bitrate (at a C/N of 20 dB) DVB-T: 29 Mbit/s DVB-T2: 47.8 Mbit/s
- Required C/N (at 22 Mbit/s) DVB-T: 16.7 dB DVB-T2: 8.9 dB

3 Current status of Preliminary Draft Revision to Recommendation ITU-R BT.1368

Status of the work

The current status of the work on Recommendation ITU-R BT.1306 is shown in Annex 10 to the chairman’s report of Working Party 6A³⁴. It reported that China made the following input document:

- 396 Planning criteria for DTMB digital terrestrial broadcasting system in the VHF/UHF bands³⁵.

The Preliminary Draft Revision to Recommendation ITU-R BT.1368 does not provide information on protection ratios of the DTMB standard; Annex Y only contains a placeholder for information. The chairman of Working Party 6A notes the following regarding the last meeting of Working Party 6A (November 2010) in respect of the Preliminary Draft Revision to Recommendation ITU-R BT.1368:

This document relates to the continuing discussion of the protection ratios of DVB-T versus UTM-T, UMTS and LTE in different adjacent channels as a result of several new measurements reported in this meeting. Further work is still needed. Also some place holders are considered for the protection of DTTB systems other than DVB-T which need future contributions. China also presented Doc. 6A/396 dealing with planning criteria for the DTMB digital terrestrial television broadcasting systems in VHF/UHF bands. China intends to provide its suggestions for revision of Recommendation ITU-R BT.1368 to the next meeting of WP 6A .

Observations regarding the TDMB standard

Information on protection ratios of the DTMB standard is currently not available in the Preliminary Draft Revision to Recommendation ITU-R BT.1368.

Comparison of the provisionally DTMB data with the DVB-T data for two similar system variants shows that net bit rates and co-channel protection ratios (DVB-T interfered with by DVB-T and DTMB interfered with by DTMB respectively) do not deviate considerably; see table below.

System variant	Protection ratio (Ricean and Rayleigh channel) ¹⁾	Net bite rate at shortest guard interval
DVB-T 64QAM 2/3	20/23 dB	24.1 Mbit/s
DTMB 64QAM 0,6	18/20 dB ²⁾	24.4 Mbit/s
DVB-T 16QAM 2/3	14/16 dB	16.1 Mbit/s
DTMB 16QAM 0.6	13/15 dB ²⁾	16.2 Mbit/s

¹⁾ The Ricean channel is representative for fixed reception, the Rayleigh channel for portable reception.

²⁾ Provisional values.

³⁴ See www.itu.int/md/choice_md.asp?id=R07-WP6A-C-0454!N10!MSW-E&lang=en&type=sitems

³⁵ See www.itu.int/md/R07-WP6A-C-0396/en

Observations regarding the DVB-T2 standard

Information on protection ratios of the DVB-T2 standard is currently not available in the Preliminary Draft Revision to Recommendation ITU-R BT.1368. However, detailed information on frequency and network planning is given in EBU Tech 3348 Frequency and Network Planning Aspects of DVB-T2, Geneva May 2011³⁶.

³⁶ See <http://tech.ebu.ch/docs/tech/tech3348.pdf>

Annex 6

Coverage considerations

This annex presents a number of examples of the coverage achieved by analogue and digital transmitting stations and indicates the ratio of the effective radiated power (ERP) of an analogue and digital transmitting station covering the same area. First calculation examples are shown with rooftop reception, followed by considerations regarding indoor reception.

1 Coverage with rooftop reception

Calculation examples of the coverage achieved by an analogue and a digital transmitting station are shown in Figure A.6-1 and Figure A.6-2 respectively³⁷. The radiation characteristics in these examples are given in the table below.

TABLE A.6-1
Radiation characteristics in calculation examples

Characteristic	Analogue TV station	Digital TV station
Frequency band	IV (470 – 582 MHz)	IV (470 – 582 MHz)
Transmitter power	10 kW	1 kW
Antenna gain minus cable loss	10 dB	10 dB
Effective Radiated Power (ERP)	100 kW	10 kW
Antenna height	150 m	150 m
TV standard and modulation	G-PAL	DVB-T: 64QAM, 16QAM, QPSK with code rate 2/3

In the example of analogue TV the minimum field strength values are taken from Recommendation ITU BT.417³⁸ and Annex 1 of that Recommendation with regard to the reception limit³⁹.

In the analogue TV example, the coverage range (distance from the transmitter) in the absence of interference other than noise, is (see Figure A.6-1):

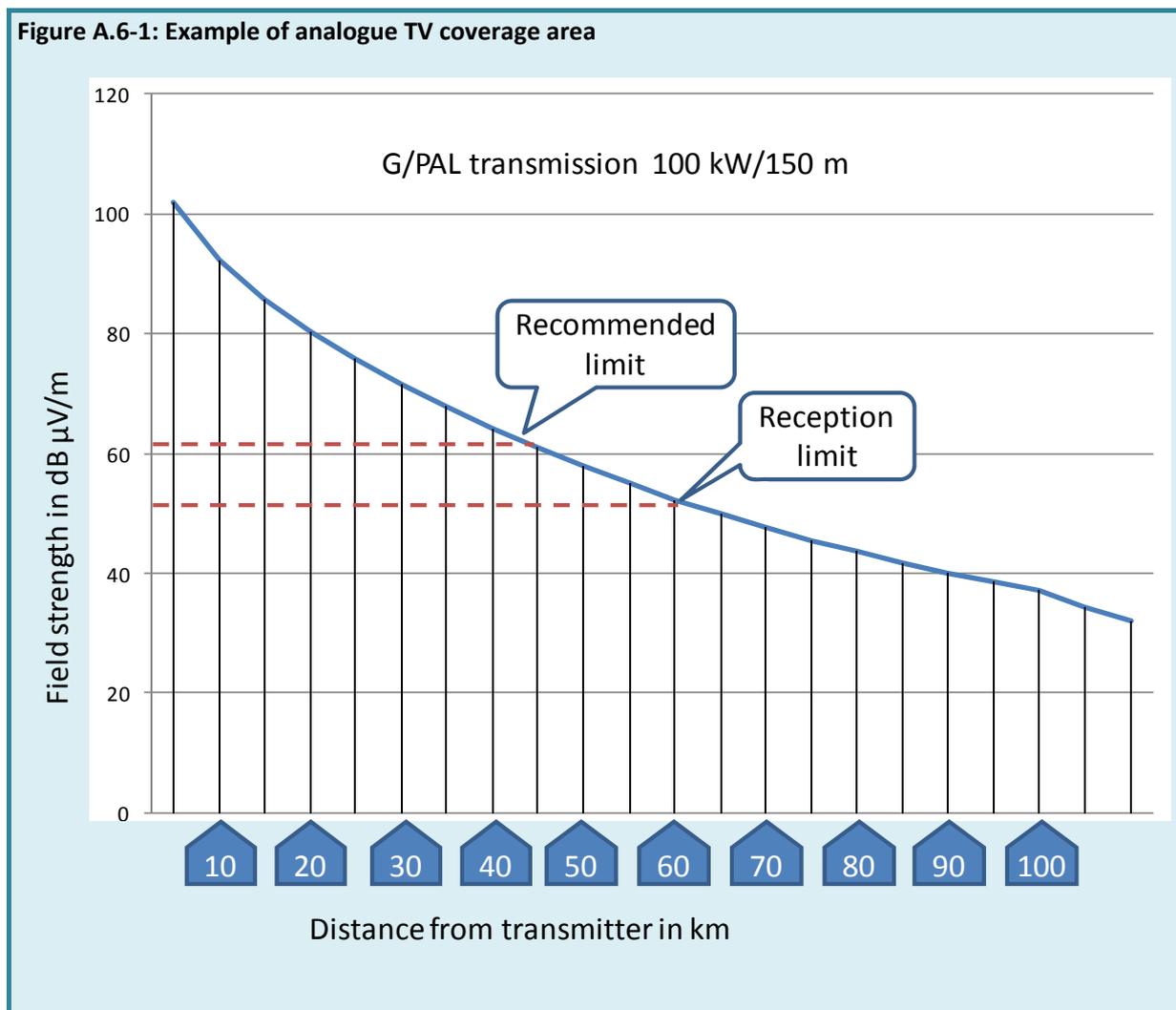
- about 43 km according to the recommended minimum field strength (62 dB μ V/m);
- about 60 km according to the limit of reception (52 dB μ V/m).

³⁷ Field strength prediction is according to Recommendation ITU-R P.1546-4 Method for point-to-area predictions for terrestrial services in the frequency range 30 MHz to 3 000 MHz, Annex 3 Figure 9 (600 MHz, land path, 50% time).

³⁸ See Recommendation ITU-R BT.417-5 Minimum field strengths for which protection may be sought in planning an analogue terrestrial television service.

³⁹ See Annex 1 of Recommendation ITU-R BT.417-5. In this annex it is noted that the public begin to lose interest in installing television reception equipment when the field strength falls much below the indicated levels in this annex.

Figure A.6-1: Example of analogue TV coverage area



With digital television a choice should be made between:

1. a high multiplex capacity (net bit rate) but a relative high minimum field strength requirement;
2. a relative low minimum field strength requirement (robust reception), but a relative low multiplex capacity; and
3. somewhere in between 1 and 2.

With the DVB-T standard, this choice can be made by selecting one out of three carrier modulations (64QAM, 16QAM and QPSK) and for each carrier modulation one out of five code rates. The DTMB standard offers similar choices. In Cambodia, the selection of the carrier modulation and code rate will to a great extent depend on the choice of the licensing model (see section 4.3). In case of model A, a multiplex will only carry a few services which lead to the choice as indicated in point 2. In case of model B, a high number of services need to be carried in a multiplex, which lead to the choice as indicated in point 1.

With regard to reception of digital television it should be reminded that, contrary to analogue television, there is no smooth degradation from good to poor picture quality when the field strength is decreasing. This is the reason that digital television is planned for a high location probability (normally 95 per cent, where analogue TV is planned for 50 per cent).

Because of the high required location probability and the fact that field strength predictions are normally made with a location probability of 50 per cent, the term “median minimum field strength” (Emed) is used for planning DTTB. Emed is the field strength value necessary to achieve the minimum field strength

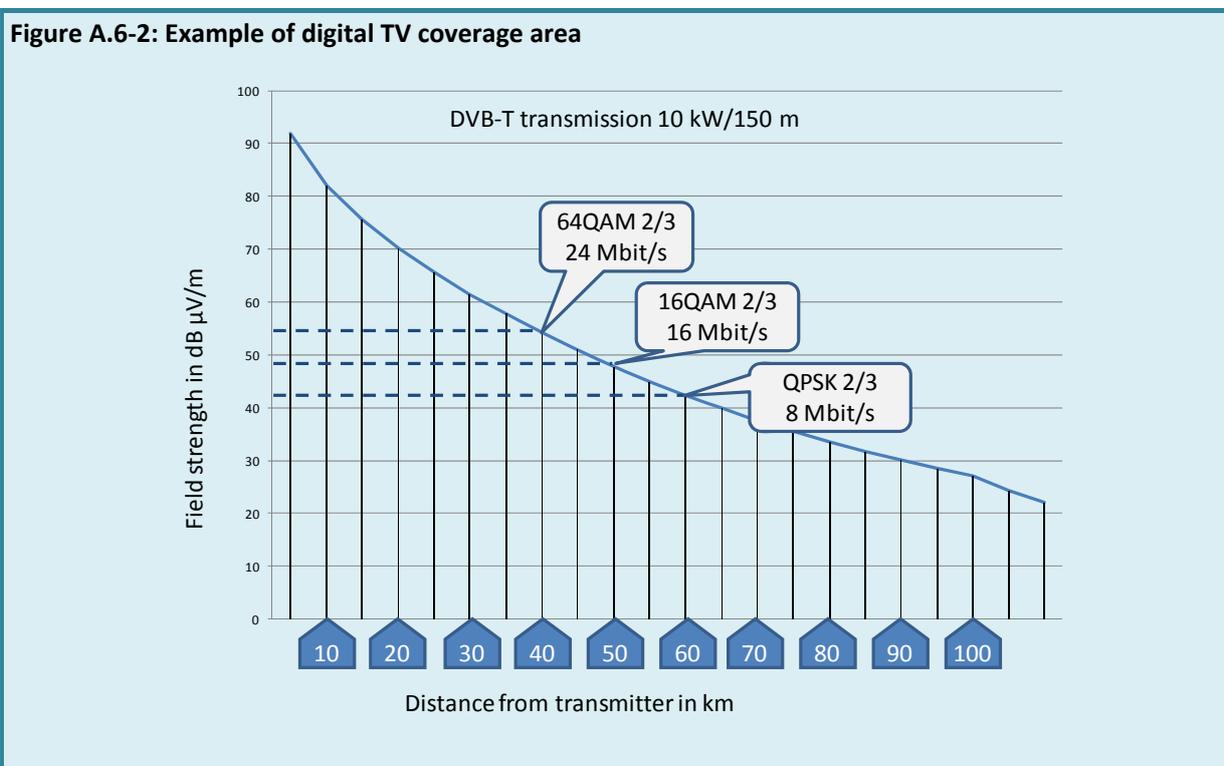
(Emin) at the required percentage of locations (normally 95 per cent). In Recommendation ITU-R BT.1368,⁴⁰ the Emed values are not given, but can be derived from the minimum field strength values using the formulas given in Appendix 1 to Annex 2 of this recommendation. The Emed values for three selected system variants (carrier modulation and code rate) in Band IV are given in Table A.6-2.

TABLE A.6-2
Emed values in Band IV

Factor for determining Emed for rooftop reception (DVB-T standard)	Carrier modulation and code rate		
	64QAM 2/3	16QAM 2/3	QPSK 2/3
Emin at 550 MHz	45 dBμV/m	39 dBμV/m	33 dBμV/m
Location correction factor (μ x c), for 95% location probability and a standard deviation of 5.5 dB: 1.64 x 5.5	9 dB	9dB	9 dB
Emed	54 dBμV/m	48 dBμV/m	42 dBμV/m

In the digital TV example the multiplex capacity and coverage range (distance from the transmitter), in the absence of interference other than noise, is (see Figure A.6-2):

- 24 Mbit/s and about 40 km with 64QAM 2/3, according to recommended median minimum field strength (54 dBμV/m);
- 16 Mbit/s and about 50 km with 16QAM 2/3, according to recommended median minimum field strength (48 dBμV/m);
- 8 Mbit/s and about 60 km with QPSK 2/3, according to recommended median minimum field strength (42 dBμV/m).



⁴⁰ Recommendation ITU-R BT.1368-8 Planning criteria for digital terrestrial television services in the VHF/UHF bands. Annex 2 of this Recommendation deals with DVB-T. No data available yet for DTMB.

The power requirements of a digital transmitter compared to an analogue transmitter covering the same area, in the absence of interference other than noise, can be obtained by comparing the Emed values for digital TV and the Emin value for analogue TV. Table A.6-3 shows this ratio for the three DVB-T variants used in the example above.

TABLE A.6-3
ERP ratio of digital TV transmitting stations to replace an analogue coverage area

DVB-T variant	Analogue coverage situation according to recommended minimum field strength	Analogue coverage situation according to limit of reception
64QAM 2/3	Digital power about 6 x less	Digital power 1.5 x more
16QAM 2/3	Digital power about 25 x less	Digital power 2.5 x less
QPSK 2/3	Digital power 100 x less	Digital power 10 x less

It should be noted that the power of an analogue transmitter is defined as “Peak Envelope Power”, whereas the power of a digital transmitter is defined as “Mean Power”.

In some cases, existing analogue transmitters can be converted to digital by replacing the analogue modulation unit by a digital modulation unit and reducing the power amplification to obtain the required linearity for digital transmissions, taking into account that:

- An analogue TV transmitter with combined video and audio amplification has been equipped with the required 7 or 8 MHz bandwidth filter and can easily be adjusted to digital transmission.
- An analogue TV transmitter with separate video and audio amplification needs to be modified; only the video power amplifier can be used and a band filter should be added.
- Analogue TV transmitters with klystrons are not suitable for digital transmissions because of the non-linear characteristics of the klystron.
- The mean power of a digital transmission from a converted analogue TV transmitter is about 1/5 to 1/3 of the analogue peak envelop power.

From a frequency planning point of view it is possible to convert an analogue transmission to digital without inverse impact on the compatibility situation if the ERP of the digital transmission is five times less than the analogue ERP⁴¹.

2 Coverage with indoor reception

An advantage of digital television compared to analogue TV is the good and stable picture in the presence of reflected signals (no ghost images and loss of synchronization). For that reason good indoor or outdoor reception with a simple antenna (referred to as “portable reception”) or vehicular reception is possible provided that the signal strength is sufficient.

The median minimum field strength values of portable reception are considerably higher compared to rooftop reception, because of:

- the lower receiving height;
- the lower receiving antenna gain;
- the building penetration loss in case of indoor reception.

⁴¹ This value was used in the Chester 1997 Multilateral Coordination Agreement; an agreement by a number of European administrations on the introduction of digital television before the Geneva 2006 Agreement came into force.

In DTTB planning two portable reception modes are defined:

1. *Portable outdoor reception*

with a simple antenna at outdoor locations, in planning a receiving height of 1.5 m is assumed.

2. *Portable indoor reception*

with a simple antenna at indoor locations, in planning a receiving height of 1.5 m is assumed.

The specified reception mode should in principle reflect the actual practical receiving conditions. In Cambodia reception at indoor locations with simple antennas (so-called rabbit ears) is commonly used.

Portable outdoor reception is a balanced compromise for the type of receiving installation normally used in Cambodia, because:

- It represents reception with a simple antenna.
- It is a well defined receiving condition; portable indoor reception would require the establishment building penetration data (mean value and standard deviation), because the absence of measurement data in Cambodia, the Portable indoor reception values would be arbitrary anyway.
- Portable outdoor reception represent also portable indoor reception but with lower reception probability. When reception takes place indoor, an optimal location for the antenna should be sought. Indoor reception is easier relative close to the transmitter, at higher floors and when building penetration losses are minimal.

As for rooftop reception, the median minimum field strength values (E_{med}) can be derived from Recommendation ITU-R BT.1368 by using the formulas given in Appendix 1 to Annex 2 of that Recommendation. The E_{med} values for three selected system variants (carrier modulation and code rate) in Band IV are given in Table A.6-4.

TABLE A.6-4
E_{med} values for outdoor reception in Band IV

Factors for determining E _{med} for outdoor reception (DVB-T standard)	Carrier modulation and code rate		
	64QAM 2/3	16QAM 2/3	QPSK 2/3
E _{min} at 550 MHz	45 dBμV/m	39 dBμV/m	33 dBμV/m
Correction of E _{min} for reception in presence of multipath "Rayleigh channel", taken from Chapter 3 to Annex 2 of the GE06 Agreement	2 dB	2 dB	2 dB
Location correction factor (μ x ζ), for 95% location probability and a standard deviation of 5.5 dB: 1.64 x 5.5	9 dB	9dB	9 dB
Height loss (reception at 1.5 m instead of 10 m), taken from Chapter 3 to Annex 2 of the GE06 Agreement	16 dB	16 dB	16 dB
Difference in receiving antenna gain, taken from Chapter 3 to Annex 2 of the GE06 Agreement	7 dB	7 dB	7 dB
E _{med}	79 dBμV/m	73 dBμV/m	67 dBμV/m

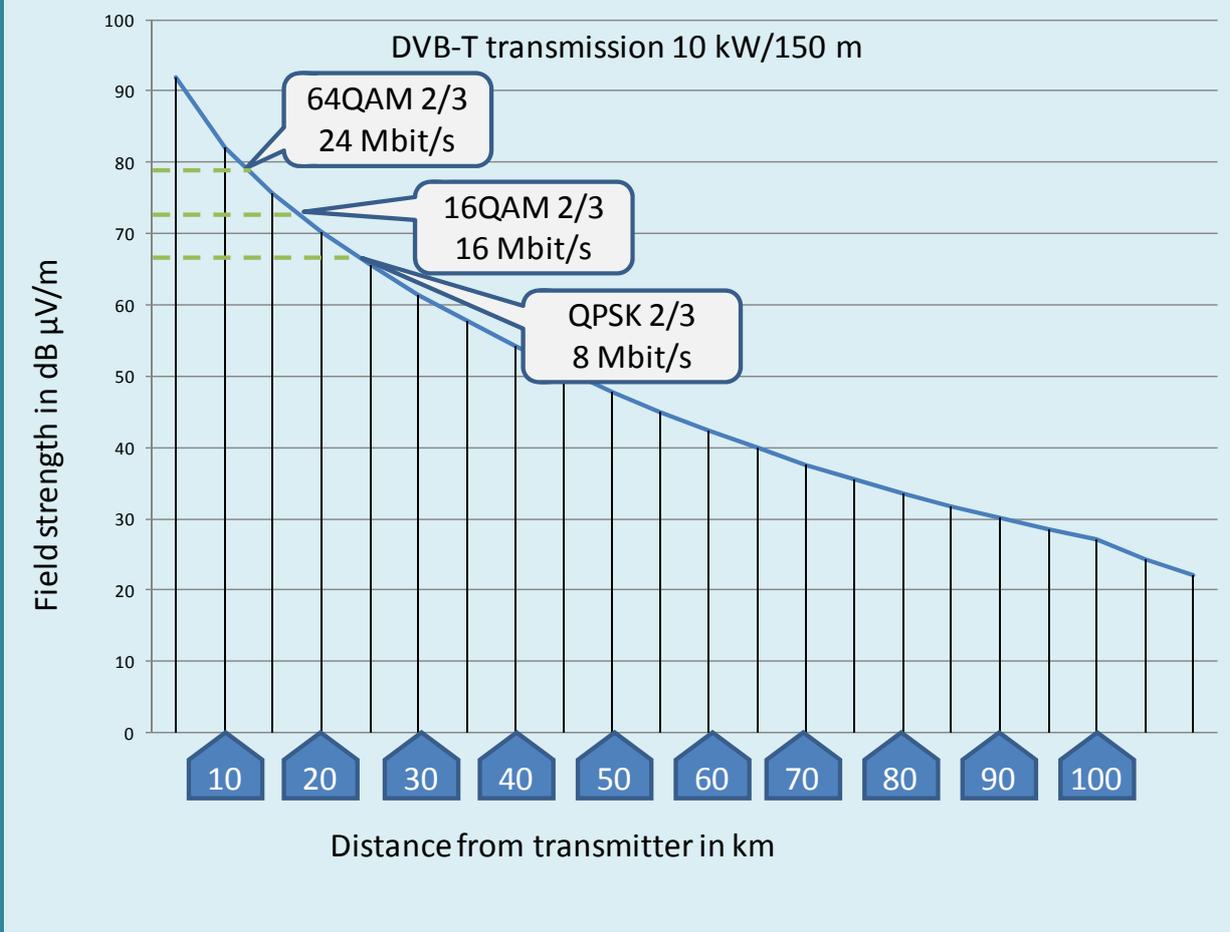
The multiplex capacity and coverage range (distance from the transmitter), in the absence of interference other than noise, of the digital transmitter example given in Table A.6-1 is shown in Figure A.6-3):

- 24 Mbit/s and about 13 km with 64QAM 2/3, according to recommended median minimum field strength (77 dBμV/m);
- 16 Mbit/s and about 18 km with 16QAM 2/3, according to recommended median minimum field strength (71 dBμV/m);

- 8 Mbit/s and about 24 km with QPSK 2/3, according to recommended median minimum field strength (65 dB μ V/m).

Although the reception areas are much smaller than with rooftop reception, in most if not all of the Phnom Penh area and other towns where DTTB transmitted will be located, it will be possible to receive DTTB with a simple antenna at indoor locations.

Figure A.6-3: Example of digital TV coverage area with portable reception



Annex 7

Broadcast spectrum requirements

In this annex the broadcast spectrum requirements in Cambodia are assessed. First a description is given on the approach for assessing spectrum requirements of digital broadcasting. This is followed by the assessment of the digital broadcasting requirements in Cambodia of existing and already planned services and the long term digital broadcasting requirements.

1 Approach for assessing spectrum requirements

The digital television service requirements are indicated in the overview of current TV frequency use (see Table 2.1 in section 2) and the DSO objectives (see Table 2.4 in section 2). The service requirements can be summarized as follows:

TABLE A.7-1
Summary short and long term digital TV requirements

Service requirements	Short term (1 year after ASO)	Long term (5 to 10 years after ASO)
Existing and planned TV services	13 TV services not at all locations, but more locations than presently	13 TV services at all locations
New TV services	Possibly a few at some locations	New TV services at all locations

Factors influencing the spectrum requirements and the assumptions made for Cambodia for assessing the spectrum requirements are indicated in Table A.7-2 below.

TABLE A.7-2
Factors influencing spectrum requirements

Factors influencing spectrum requirements	Assumption for assessing spectrum requirements
Transmission standard and compression system	DVB-T/MPEG2 (see section 4.1)
Picture quality	≥ 3 Mbit/s (see Annex 1 functional building block 4.1)
Coverage target	50%, 70% and 100% geographical coverage
Reception mode	Rooftop reception (see Annex 2 functional building block 4.2)
Type of network	Multi Frequency Networks (see Annex 2 functional building block 4.3)
Licensing model	A and B (see section 4.3)

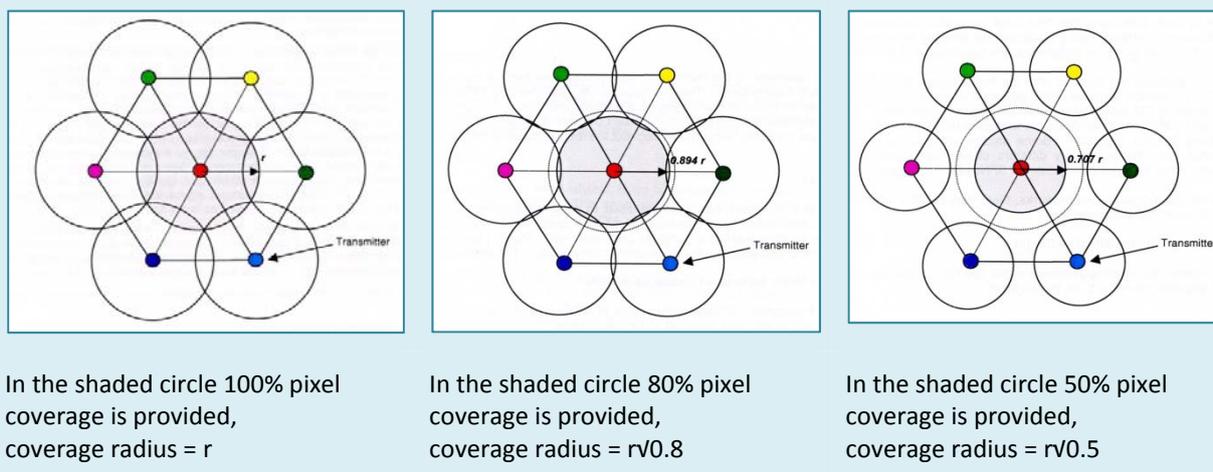
It should be noted that the decision on band allocations (step 5 in Figure 4.6 in section 4.10) refers to Cambodia as a whole and should therefore take account of the area with the highest frequency requirements, which is in Phnom Penh and surroundings.

An indication on spectrum usage for digital television can be obtained from studies made in Europe in 2001⁴². These studies show spectrum requirements for providing a DVB-T/MPEG2 coverage over a large land area for a range of planning criteria such as transmitter separation distance, antenna height, system variants and coverage requirements. In these studies, it is assumed that all transmitters have the same characteristics. The study does not take into account national or regional borders. However, as a very large area is involved it takes into account the requirements of neighbouring countries, albeit with the assumption that all transmitters are the same. In practice the spectrum requirement can be higher or lower than the calculated theoretical values depending on e.g.:

- national and regional borders;
- receiver specifications;
- practical transmitting station characteristics (different antenna height, directional antenna patterns, non-uniform transmitter distances);
- propagation characteristics (such as terrain shielding in mountainous areas);
- presence of sparsely populated areas, with no or a limited number of TV transmitters.

In order to indicate the spectrum requirement for various coverage situations the term “pixel coverage” has been introduced in these studies. 100 per cent pixel coverage is the situation where the signal from at least one transmitter is receivable at any location. Figure A.7-1 illustrates the concept of “pixel coverage”.

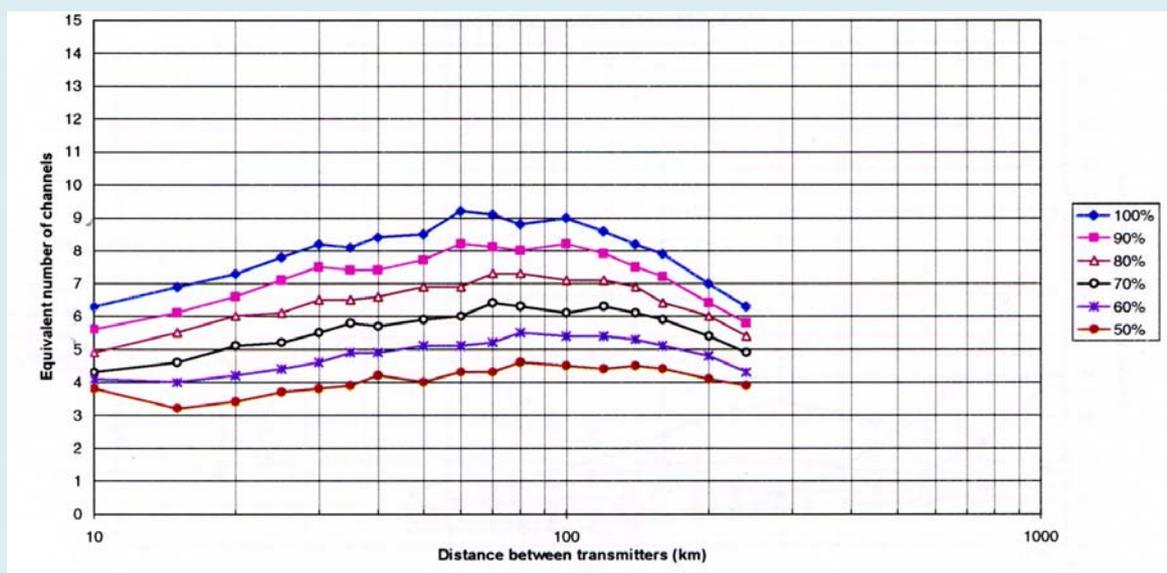
Figure A.7-1: Illustration of concept of pixel coverage (source EBU)



In Cambodia, most transmitting stations have antenna height of about 120 m. The results of the EBU study closest to this, are for an antenna height of 150 m. Figure A.7-2 shows the number of channels needed to provide a data capacity of 20 to 24 Mbit/s, for rooftop reception at different percentages of pixel coverage.

⁴² EBU BPN038 Report from ad-hoc group B/CAI-FM24 to B/MDT and FM PT24 on spectrum requirements for DVB-T implementation.

Figure A.7-2: Number of channels needed for coverage of 20-24 Mbit/, rooftop reception, heff 150 m



Source: EBU

The required number to channels to provide coverage of 20-24 Mbit/s ranges from about 4 to 9 channels, mainly depending on the required “pixel coverage”. Figure A.7-2 is representative in case licensing model B is chosen, when several service are combined in a multiplex to make optimal use of the 20-24 Mbit/s. For making the assessments of the spectrum requirements with licensing model B in the following sections it is taken that:

- a. To achieve 50 per cent geographical coverage, four channels are needed.
- b. To achieve 70 per cent geographical coverage, six channels are needed.
- c. To achieve 100 per cent geographical coverage, nine channels are needed.

In case of model A, each broadcaster has its own digital channel with one or two (CTN/My TV and Bayon TV/Bayon News) services in the multiplex. In this case QPSK with a multiplex capacity of 6 Mbit/s would be sufficient. The EBU studies show in case of QPSK a spectrum requirement of 2 to 4 channels depending on the required “pixel coverage”. For making the assessments of the spectrum requirements with licensing model A in the following sections it is taken that:

- a. To achieve 50 per cent geographical coverage, two channels are needed.
- b. To achieve 70 per cent geographical coverage, three channels are needed.
- c. To achieve 100 per cent geographical coverage, four channels are needed.

2 Digital broadcasting requirements of existing and already planned services

In Cambodia, the geographical coverage of the TV services is not equal. Some TV services have only coverage in Phnom Penh and surroundings, others a considerable part of the country.

In order to estimate the spectrum requirements a number of simplifications and assumptions have to be made. The table below gives an overview of the existing and planned TV services as in Table 2.1 in section 2, with a simplified geographical coverage assumption.

TABLE A.7-3
Overview of assumed geographical coverage and required number of channels

Service	Standard	Number of sites	Assumed geographical coverage
TVK	B-PAL	6	50% of Cambodia
CTN	G-PAL	9	70% of Cambodia
My TV	G-PAL	9	70% of Cambodia
Bayon TV	B/G-PAL	15	70% of Cambodia
Bayon News	G-PAL	1	PP
ArmyTV ch5	B-PAL	5	50% of Cambodia
PPMTV3	B/G-PAL	5	50% of Cambodia
Apsara	B-PAL	1	PP
Sea TV	G-PAL	3	50% of Cambodia
TV9 (Khmer TV)	B/G-PAL	3	50% of Cambodia
TV5 Monde France	G-PAL	1	PP
Vietnam TV	G-PAL	1	PP
Hang Meas TV	G-PAL	1	PP
PPCTV	DVB-T	1	PP
TVK-DMB	T-DMB	1	PP

From the above estimations the digital spectrum requirements can be assessed for accommodating the existing and already planned digital broadcasting services (see step 2 in Figure 4.6 in section 4.10), being:

- the digital TV services converted from the 13 existing and planned analogue TV services provided by 11 broadcasters;
- the existing digital PPCTV services;
- the planned T-DMB services.

Table A.7-4 shows the spectrum requirement in and around Phnom Penh for the above mentioned services in case licensing model A is chosen for digital TV services. Far away from Phnom Penh the spectrum requirement reduces to minimal seven channels (areas around sites that provide the 70 per cent coverage assumption plus the channel for T-DMB).

It should be noted that in case of model A, the multiplex has a capacity of about 6 Mbit/s and contains one or two services. In case of one service, the multiplex is loaded for less than 50 per cent. In these cases an additional service can be transmitted without increasing the spectrum requirement.

Would a multiplex with a high capacity (e.g. 24 Mbit/s) be assigned to each broadcaster, the number of channels to achieve the required coverage increases and the spectrum requirements will increase considerably (see Table A.7-5).

TABLE A.7-4

Spectrum requirements of existing and planned services with model A and a low capacity multiplex

Existing and planned broadcasters and services	Number of digital multiplexes in Model A	Number of channels for achieving required coverage	Spectrum requirement in Model A
Broadcasters with TV services in PP only	4	1	4 channel
Existing broadcasters with 50% geographical coverage	5	2	10 channels
Existing broadcasters with 70% geographical coverage	2	3	6 channels
PPCTV multiplexes in PP	9	1	9 channels
T-DMB multiplexes (4 frequency blocks in TV channel 10)			1 channel
Total			30 channels

TABLE A.7-5

Spectrum requirements of existing and planned services with model A and a high capacity multiplex

Existing and planned broadcasters and services	Number of digital multiplexes in Model A	Number of channels for achieving required coverage	Spectrum requirement in Model A
Broadcasters with TV services in PP only	4	1	4 channel
Existing broadcasters with 50% geographical coverage	5	4	20 channels
Existing broadcasters with 70% geographical coverage	2	6	12 channels
PPCTV multiplexes in PP	9	1	9 channels
T-DMB multiplexes (4 frequency blocks in TV channel 10)			1 channel
Total			46 channels

In model B, with shared multiplexes, 13 services are or will soon be transmitted in Phnom Penh, eight services at additional sites with an assumed geographical of 50 per cent and three services at a few more sites with an assumed geographical coverage of 70 per cent. With a maximum of six services per multiplex, the multiplex composition would be:

1. Mux 1, at all sites (assumed geographical coverage of 70 per cent) with three services.
2. Mux 2, at a number of sites providing an assumed geographical coverage of 50 per cent with five services.
3. Mux 3, in Phnom Penh with five services.

It should be noted that the multiplex capacity is not fully used, without increasing the spectrum requirement additional services can be transmitted.

Table A.7-6 shows the spectrum requirements in and around Phnom Penh for the above mentioned services in case of licensing model B for digital TV services. Far away from Phnom Penh the spectrum requirement reduces to minimal seven channels (areas around sites that provide the 70 per cent coverage assumption plus the channel for T-DMB).

TABLE A.7-6
Spectrum requirements of existing and planned broadcasting services in case of model B

Existing an planned services	Number of digital multiplexes in Model B	Number of channels for achieving required coverage	Spectrum requirement in Model B
Mux 3, with 5 TV services in PP	1	1	1 channel
Mux 2, with 5 TV services at additional sites – 50% geographical coverage	1	4	4 channels
Mux 1, with 3 TV services at additional sites- 70% geographical coverage	1	6	6 channels
PPCTV multiplexes in PP	9	1	9 channels
T-DMB multiplexes (4 frequency blocks in TV channel 10)			1 channel
Total			21 channels

3 Long term digital broadcasting requirements

In the long term all 13 existing and planned services, provided by 11 broadcasters, plus a number of new services should be transmitted from all sites.

The number of new TV services has not yet been determined. However, the need for future T-DMB and T-DAB services is indicated in section 2.3.2 and 2.3.3 respectively. Therefore a future T-DMB/T-DAB requirement of two TV channels in Band III is assumed. Within these two TV channels 8 T-DMB/T-DAB frequency blocks can be accommodated.

Summarized the long term service requirements are:

- the digital TV services converted from the 13 existing and planned analogue TV services provided by 11 broadcasters at all sites;
- the existing digital PPCTV services in Phnom Penh;
- the planned T-DMB services;
- the future T-DMB/T-DAB services;
- A yet not determined number of future TV services.

Table A.7-7 shows the spectrum requirements in and around Phnom Penh for the above mentioned services in case licensing model A is chosen for digital TV services. Far away from Phnom Penh the spectrum requirement is reduced by nine channels (the channels used by PPCTV in Phnom Penh).

From Table A.7-7 it can be concluded that after having accommodated the existing and planned broadcasters with 70 per cent geographical coverage, there are only three channels left for new TV services. The condition is that the coverage of the existing and planned services does not exceed 70 per cent geographical coverage.

Would a multiplex with a high capacity (e.g. 24 Mbit/s) be assigned to each broadcaster, the number of channels to achieve the required coverage increases and the spectrum requirements will exceed by far the band capacity (see Table A.7-8).

TABLE A.7-7
Overview of long term spectrum requirements in case of model A with low capacity multiplex

Broadcasters and services	Number of digital multiplexes in Model A	Number of channels for achieving required coverage	Spectrum requirement In Model A
Existing and planned broadcasters with 70% /100% geographical coverage	11	3/4	33/44 channels
PPCTV multiplexes in PP	9	1	9 channels
T-DMB multiplexes (4 frequency blocks in TV channel 10)			1 channel
New T-DMB/T-DAB services (8 frequency blocks in 2 TV channels in Band III)		2	2 channels
New TV services (type and number to be decided)			X channels
Total			45/56 + X channels
Band capacity			48 channels

TABLE A.7-8
Overview of long term spectrum requirements in case of model A with high capacity multiplex

Broadcasters and services	Number of digital multiplexes in Model A	Number of channels for achieving required coverage	Spectrum requirement In Model A
Existing and planned broadcasters with 70% /100% geographical coverage	11	6/9	66/99 channels
PPCTV multiplexes in PP	9	1	9 channels
T-DMB multiplexes (4 frequency blocks in TV channel 10)			1 channel
New T-DMB/T-DAB services (8 frequency blocks in 2 TV channels in Band III)			2 channels
New TV services (type and number to be decided)			X channels
Total			78/111 + X channels
Band capacity			48 channels

In model B, with shared multiplexes, the existing 13 services can be broadcasted in two multiplexes, one multiplex with six services and multiplex with seven services.

The spectrum requirement in and around Phnom Penh is shown in the table below. Far away from Phnom Penh the spectrum requirement is reduced by nine channels (the channels used by PPCTV in Phnom Penh).

From Table A.7-9 it can be concluded that after having accommodated the existing and planned broadcasters with 70 per cent or 100 per cent geographical coverage, there are 24 respectively 18 channels left for new TV services.

If it would be required to extend coverage of the PPCTV services to all sites, the spectrum requirement of the PPCTV services would be 54 or 81 channels for 70 per cent or 100 per cent geographical coverage respectively. The total requirement would increase to 69 + Y respectively 102 + Y channels (Y is the spectrum requirement for new TV services). This exceeds by far the band capacity.

TABLE A.7-9
Overview of long term spectrum requirements in case of model B

Services	Number of digital multiplexes in Model B	Number of channels for achieving required coverage	Spectrum requirement in Model B
Existing and planned services with 70%/100% geographical coverage	2	6/9	12/18 channel
PPCTV multiplexes in PP	9	1	9 channels
T-DMB multiplexes (4 frequency blocks in TV channel 10)			1 channel
New T-DMB/T-DAB services (8 frequency blocks in 2 TV channels in Band III)			2 channels
New TV services (type and number to be decided)			Y channels
Total			24/30 + Y channels
Band capacity			48 channels



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