ANGOLA

Roadmap for the transition FROM ANALOGUE TO DIGITAL TERRESTRIAL TELEVISION IN ANGOLA

Assessment Report

APRIL 2012

Telecommunication Development Sector

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

April 2012

This report has been prepared by ITU experts Mr Jan Doeven and Mr Peter Walop. The ITU would like to thank to the Angola National Roadmap Team, the active support of the Ministry of Telecommunications and Information Technology (MTTI) and of the Korea Communications Commission (KCC) in facilitating the work of the ITU experts.

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Executive summary

The roadmap for transition from analogue to digital television in Angola has been prepared by the National Roadmap Team (NRT) and ITU experts from June to September 2011.

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

Scope of the roadmap

The roadmap for the transition from analogue to digital television in Angola covers the digital switch-over (DSO) objectives up to 2015, the year that analogue TV switch-off will be completed and the activities managed by the NRT. The roadmap does not include:

1. Functional building blocks related to mobile television (MTV) networks. The government decided to use the ISDB-T standard. This standard allows digital terrestrial television broadcasting (DTTB) and MTV operations within the same transmission. Consequently, no separate MTV network is needed.
2. The introduction of digital radio.

The Angola TV market is mainly a terrestrial TV market with TPA (public broadcaster) as the main player, reaching 1.25 million TV households (TVHH), about half of the population. In addition to analogue terrestrial TV, digital satellite TV services are offered by three service providers. Furthermore, digital cable TV is offered in Luanda and Benguela. The satellite TV and cable TV offerings have however a limited penetration (250 000 and 35 000 TVHH respectively).

The aim of the roadmap is to facilitate the DSO objectives. The DSO objectives are divided into short term (2012 to 2015) and long term (after 2015) objectives. The objectives are shown in Table 1.

Table 1: DSO objectives

No	Objective	2012 – 2015	> 2015
1	Smooth transition from analogue to digital	• All analogue services (TPA1, 2 and TV Zimbo) converted to digital, matching current analogue coverage areas • Three regional inserts (in the current three provinces) • Simulcasting in all areas	
2	End of analogue transmission	• In 2015 (in line with SADC and GE06)	
3	New entrants/services	• Additional SD services when content available and as far as Mux 1 capacity allows • Additional SD + HD services when content available and as far as Mux 2 capacity allows • E-government services (full interactivity) • Three Pay-TV muxes including two mandatory free to air (FTA) services/mux if market interest and as far as spectrum capacity allows • MTV services in 1seg	

No	Objective	2012 – 2015	> 2015
4	Extended population coverage	Matching current analogue coverage areas (see also objective 1)	• Near national coverage • 15 additional regional inserts (with local programming) in other provinces
5	Better picture quality	• Widescreen (16 x 9) • At least 1 HDTV (TPA1)	• Additional HD services
6	Compensation for viewer	• Minimize viewer migration costs (financial aid for a set top box (STB)) • Assist viewers with the migration (installation aid)	
7	Compensation for analogue broadcasters	• Simulcast Opex compensated (TPA and TV Zimbo)	
8	Digital dividend	• Allocate spectrum for IMT > 790 MHz (channel 61 - 69)	

DTTB will be introduced in phases as shown in Table 2. Analogue switch-off (ASO) will take place per area after a simulcasting period of about one year in Area I to about a quarter of a year in Area IV. All five multiplex should, when available, be introduced at the same time.

Table 2: DTTB introduction phases

Year	Area
2012	a. Luanda, Benguela, Cabinda, Lubango, Malange
2013	b. 14 major cities
2014	c. 31 medium cities
2015	d. 40 not yet specified small cities

The Geneva Agreement of 2006 (GE06)[1] does not provide sufficient frequency assignments to broadcast the five multiplexes from each envisaged DTTB site. A new frequency plan has been developed and modifications to the GE06 digital plan will be made following the appropriate procedures of the GE06 Agreement.

The licensing model adopted foresees the creation of a new broadcast transmission operator that will have Angola Telecom and TPA as shareholders. The broadcast transmission operator will combine the free to air programme streams of the broadcasters into transport streams to be distributed to the transmitters. Each pay per view licensed operator will have to invest on its own exciter, multiplexer and transmitter and share tower, energy and transmission between transmitters, operated by the new broadcast transmission operator. In the digital television value chain adopted by Angola, the sustainability of this new operator shall be ensured through the sale of services to pay per view operators and the free to air broadcasting services shall be financed by annual broadcasting fees.

The Government of Angola welcomes private investments and partnerships to further develop the digital television market. In this context, the NRT is working with private local partners (TV-ZIMBO, TV-Cabo, ZAP and UAU!TV) which can help the new broadcast transmission operator to roll out the common digital transmission network and free to air broadcasting. A public tender is already under development by the

[1] The plans for VHF/UHF analogue and digital broadcasting in parts of regions 1 and 3, in the frequency bands 174-230 MHz and 470-862 MHz, Geneva 2006 www.itu.int/ITU-R/terrestrial/broadcast/plans/ge06/index.html

NRT which will select an infrastructure supplier. The public investment will support the establishment of the free to the air broadcasting infra-structure.

The roadmap for Angola has been divided in five phases:

phase 1: DTTB and MTV policy development;
phase 2: ASO planning;
phase 3: Licensing policy and regulation;
phase 4: Network planning and implementation;
phase 5: License administration.

Input and output documents of the five phases are shown in Table 3.

Table 3: Input and output documents of the phases of the roadmap

Roadmap phase	Input documents	Output documents
1. DTTB policy development	• International Agreements • National telecommunication, broadcasting and media acts • Existing policy documents and objectives	• Digital terrestrial television broadcasting policy
2. Planning	• Digital terrestrial television broadcasting policy	• Initial frequency plan • Analogue-switch-off plan
3. Licensing policy and regulation	• Digital terrestrial television broadcasting policy • Analogue-switch-off plan	• Frequency plan • Licensing procedure and planning
4. Planning and implementation	• Frequency plan • Licensing procedure and planning	• DTTB implementation plan • Detailed coverage presentations • Notification to Inacom
5. License administration	• Notification from operator • Licenses	• Station approval • Notification to ITU-BR

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.

Recommendations

The NRT is recommended to carry out the following next steps for a smooth transition to digital television broadcasting and the analogue services switch-off:

1. Seek approval of the roadmap report at either ministerial level and/or political level;
2. After approval, acquire a mandate to plan and manage the ASO process in accordance with the phases of the roadmap. As indicated in the roadmap report, this mandate may come in stages;
3. After being mandated, prepare and take the following decisions as the first step of the Roadmap as these decisions are needed to determine the scope and duration of the roadmap planning including the following steps:
   a) Determine ASO date and the date of the first DTTB transmissions.
   b) Finalize the licensing model, to include:
      - a public tender for the pay-tv/commercial service providers;
      - a model for assigning broadcast licenses (and hence the bandwidth management/assigning slots), in particular for new broadcast transmission operator;

    - ONP rules for the common multiplex/network operator (new broadcast transmission operator).
  - Finalize and agree the DSO objectives (see Table 2.3).
  - Determine the procedure and contract to be awarded to a network operator supplier.
4. Form a project management office (PMO) and start drafting an initial detailed ASO planning and determine the progress reporting procedures and structures.
5. Start preparations for splitting off the TPA network assets and establishing the common multiplex/network operator (new broadcast transmission operator).

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

1. Carry out additional market research covering the key elements as indicated in this roadmap report (see phase 1). The NRT has carried out market research in the past. However, as some market data is lacking, having additional market research available would be an advantage, and would help to manage the ASO process.
2. Carry out detailed frequency and service planning (see phases 2 and 3). Additional frequency planning will be required to see what is possible, especially considering the five multiplexes per site (as formulated under the DSO objectives).
3. Investigate the possibilities of auctioning the mobile (LTE) spectrum as an important means of 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.

1 Introduction

ITU has published guidelines for the transition from analogue to digital broadcasting[2]. These guidelines (hereinafter, ITU Guidelines) provide assistance to ITU Member States to smoothly migrate from analogue to digital broadcasting. In a further effort to help switch over to digital broadcasting, ITU has selected countries to help draft a national roadmap for the digital switch-over (DSO) process. Angola is one of the beneficiary countries for further assistance.

The ITU Secretary General, Dr. Hamadoun Touré, speaking at the recently held workshop on the presentation of the ICT Policy for Angola (White Book for ICT)a, in Luanda, referred to the roadmap development by stating:

> *"I am informed by our regional office in Addis Ababa that our team of experts is currently in Luanda working with you on the 'Roadmap to the Migration of Terrestrial Digital TV Broadcasting', adapting the ITU Guidelines on DTTB to Angolan needs. Let me assure you that we will do our very best to meet your expectations."*[3]

The team of ITU experts, consisting of Peter Walop and Jan Doeven, developed the roadmap jointly with the National Roadmap Team (NRT). The NRT is chaired by H.E. Dr. Aristides Frederico Safeca, Vice Minister for Telecommunications. The NRT consists of representatives from the following organisations:

- Ministry of Telecommunications and Information Technology (MTTI);
- Ministry of Media;
- Ministry of Internal Affairs;
- Ministry of Finance;
- Ministry of Trade;
- Inacom (Regulator);
- Telecom and TV organisations, including TPA (public broadcaster) and TA (incumbent telecom operator, owner of UAU).

The Angola TV market is mainly a terrestrial TV market with TPA (public broadcaster) as the main player, reaching 1.25 million TV households (TVHH), about half of the population. In addition to analogue terrestrial TV, digital satellite TV services are offered by three service providers. Furthermore, digital cable TV is offered in Luanda and Benguela. The satellite TV and cable TV offerings have however a limited penetration (250 000 and 35 000 TVHH respectively).

The MTTI sees DTTB as the means to provide a public television service to all Angolans, guaranteeing quality TV services that are modern, free, open, participatory, interactive, accessible and promoting citizenship. DTTB should become in this way one of the main communication tools for the reduction of the digital divide, the fight against exclusion of information, and access of the population to the benefits of the information society.

In order to realize this vision, MTTI decided on a number of important principles, including:

- Complying with the ITU Geneva 2006 Agreement and the decisions taken in the Southern African Development Community (SADC) to switch-off analogue TV in 2015, at the latest.
- Replacement of at least the current analogue TV coverage by digital.

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

[3] www.itu.int/en/osg/speeches/Pages/2011-06-13.aspx

- Providing a simulcasting period before analogue TV will be switched off.
- Separation of network operations from programme production and establishing a common DTTB multiplex and network operator.
- Freeing a part of the broadcasting band for non-broadcasting services.
- Financing a considerable part of the transition costs such as:
  - the digital TV network investments;
  - simulcasting costs;
  - set top box (STB) subsidies;
  - ASO communication costs.

The ITU assistance to Angola consisted of four key activities:

1. Preparation and first ITU expert mission to collect information.
2. Drafting of the roadmap report.
3. Second expert mission to present and discuss the draft roadmap report.
4. Drafting of the final roadmap report.

The ITU experts Mr Peter Walop and Mr Jan Doeven together with the ITU project coordinator Mrs Mihret Woodmatas visited Angola from 6 to 16 June 2011 and from 18 to 24 August 2011. During the first visit the experts together with the National Roadmap Team (NRT) prepared:

- an analysis of the TV market and regulatory situation;
- an overview of short-term and long-term digital switch-over objectives;
- a set of considerations regarding draft policy documents;
- an inventory of the functional building blocks in scope;
- an inventory of decisions (partly) taken regarding key objectives and choices with respect to the functional building blocks in the first phase of the roadmap dealing with policy development.

Because of the urgency of some of the decisions to be taken by the NRT, the experts prepared an interim report on 28 June 2011, showing:

- the conclusions of the first visit (listed above);
- technical information in response to a number of questions raises during the first visit;
- observations on a number of topics that have been discussed during the first visit.

The draft roadmap report, taking into account the information received in the first visit, was delivered on 27 July 2011.

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

In the following sections, first the current situation and digital switch-over (DSO) objectives will be addressed (Section 2). Section 3 shows the national roadmap for achieving the DSO objectives. Section 4 gives considerations regarding the top ten 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 Angola. Also the activities required to prepare the decisions that are still pending, are indicated.

Annexes 5 to 7 give information on planning criteria of digital TV standards, coverage considerations and multiplex and network architecture. Finally a glossary of abbreviations is given.

2 Current TV market and DSO objectives

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

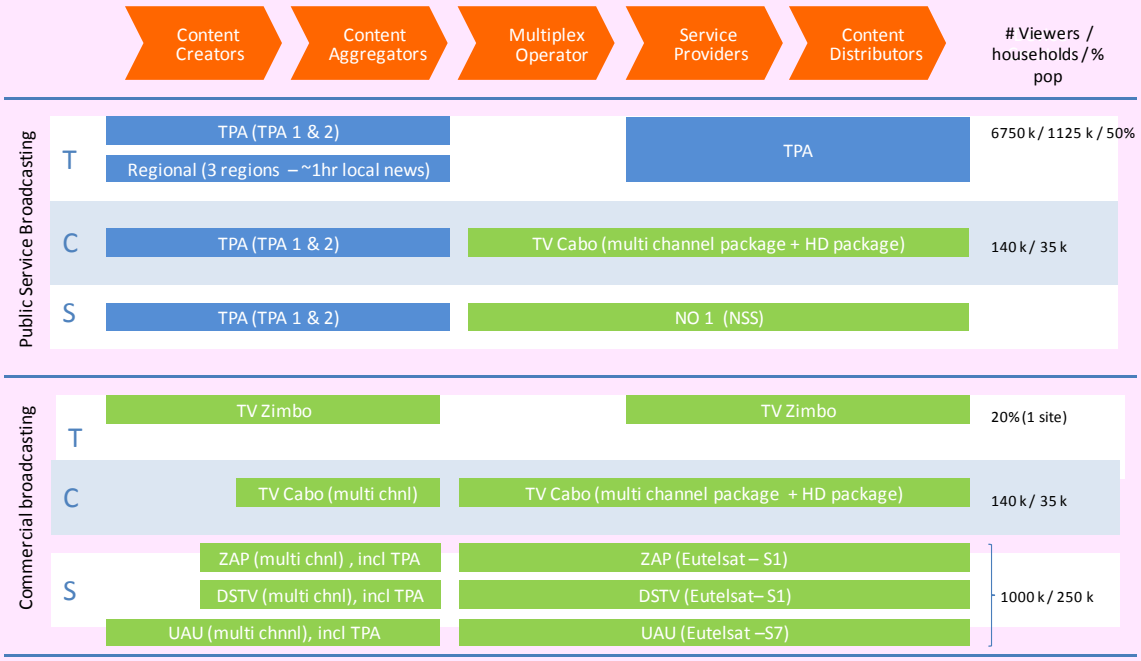
2.1 Current TV market

This section provides an overview of the Angola TV market structure and description of the current terrestrial television networks.

2.1.1 Market structure

The Angola television market structure is shown in Figure 1.

Figure 1: TV market structure in Angola



Source Authors

The TV market is mainly a terrestrial TV market with TPA as main player, serving about half of the population. In addition to analogue TV, digital satellite and digital cable services are offered. The total number of satellite subscribers is currently estimated at 250 000. This market is shared by three providers. A summary of their offerings is shown in Table 2.1.

Cable TV is offered in Luanda and Benguela by TVCabo. TVCabo offers several television packages. Their basic offering is actually the 'Mini' channel bouquet of ZAP TV (see Table 2.1). The subscription fee per month is also AOA 1 450 (USD 15.50). The cost of both the set top box (STB) (not HD) and installation fee are AOA 9 500 (USD 100). The number of cable TV subscribers is currently estimated at 35 000.

Table 2.1: Overview of satellite TV offerings

Service provider	Number of services in basic package (not HD)	Price of basic package per month	One-off costs (STB, dish and installation)
DSTV	30 (Fácil) – including TPA and Zimbo	AOA 1 200 (USD 12.80)	AOA 14 000 (USD 150)
ZAP	30 (Mini) – including TPA and Zimbo	AOA 1 450 (USD 15.50)	AOA 18 600 (USD 200)
UAU	17 – including TPA and Zimbo	AOA 1700 (USD 18.00)	AOA 14 900 (USD 159)

With regard to the market structure the following observations can be made:

1. Analogue TV coverage is extended to all provinces, but no contiguous coverage areas exist. Coverage is restricted to main population centres.
2. Many people receive television by means of simple indoor antennas; some rooftop antennas can be observed in Luanda.
3. When analogue TV is switched-off viewers can chose between one of the three satellite-TV providers and DTTB. In order to be successful, DTTB should be competitive compared to the satellite and cable offerings.

2.1.2 Current terrestrial television networks

An indication of the frequency use of the current analogue TV services is given in Table 2.2.

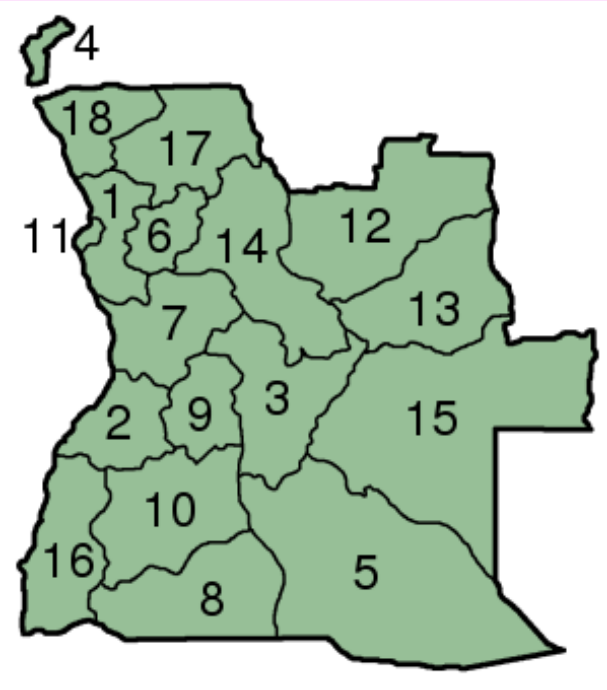
Table 2.2: Overview of TV frequency usage

Province	TPA 1		TPA2		Additional services
	Number of sites	Channel use	Number of sites	Channel use	
Bengo	5	7, 24	-	-	
Benguela	13	9, 7, 20*)	1	5	TPA regional inserts
Bié	9	7, 20*)	1	4	
Cabinda	5	7	1	4	TPA regional inserts
Cuando Cubango	9	7, 20*)	2	4	
Cuanza Norte	9	7, 20*)	7	4	
Cuanza Sul	13	7, 20*)	6	4	
Cunene	8	7, 20*)	5	4	
Huambo	9	7, 20*)	1	9	
Huila	12	4, 20*)	1	6	TPA regional inserts
Luanda	3	9, 29,21	3	4, 26, 24	TV Zimbo
Lunda Norte	8	7, 20*)	1	4	
Lunda Sul	6	7, 20*)	4	4	
Malanje	14	7, 20*)	5	4	
Moxico	7	7, 20*)	4	4	
Namibe	14	6, 7, 20*)	6	1, 4, 9	
Uige	9	7, 9, 20*)	3	4	
Zaire	6	7	6	4	
Total numbers of sites	**159**		**57**		

) Channel 20 is not defined in the GE06 Agreement: see note 2 below

A map showing the Angolan provinces is presented in Figure 2.2.

Figure 2.2: Provinces in Angola



1	Bengo
2	Benguela
3	Bié
4	Cabinda
5	Cuando Cubango
6	Cuanza Norte
7	Cuanza Sul
8	Cunene
9	Huambo
10	Huila
11	Luanda
12	Lunda Norte
13	Lunda Sul
14	Malanje
15	Moxico
16	Namibe
17	Uige
18	Zaire

Source: Wikipedia

It is noted that:

1. Almost all VHF transmitters broadcasting TPA1 are on channel 7. According to TPA, the co-channel transmitters are of low power and sufficiently geographically separated from each other to avoid interference from one to the other.
2. UHF channel 20 is mentioned in the provided frequency list. It was indicated that this channel should not be considered. Channel 20 is not defined in the GE06 Agreements (neither for analogue nor for digital TV). The lowest UHF channel is 21 (470-478 MHz).
3. For historical reasons none of the current frequency assignments complies with the analogue plan of the GE06 Agreement.

As part of the preparations for the introduction of digital television MTTI and TPA are preparing DTTB and MTV test transmissions by means of an SFN consisting of three transmitters on channel 31 in Luanda. The purpose of these tests is to get a feeling of the DTTB/MTV technology.

2.2 Regulatory framework

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

Table 2.3: Regulatory framework

Type of right	Regulatory body	Ministry	White paper/ Law/Legislation	Notes/Remarks
Spectrum *	INACOM (*Instituto Angolano das Comunicações*)	MTTI	Electronic Communications Law 2011	• INACOM manages NSP (in line with GE06 and SADC policies)
Broadcast *	National Directorate for Information	Ministry of Media	Media Law (under revision)	• No cross- and foreign ownership restrictions • TPA tasks and financing
Operating *	INACOM	MTTI	Electronic Communications Law 2011	
Site sharing	NA	NA	NA	• No site sharing regulation • In practice site sharing takes place • ONP rules apply for backbone networks
Building permits	Local government (councils)			• Not strictly applied in practice
	INAVIC			• For aviation safety

(*) rights issued in one license document

The main regulatory bodies regarding television broadcasting are Inacom belonging to the Ministry of Telecommunication and the National Directorate for Information which comes under the Ministry of Media.

With regard to the regulatory framework two observations can be made:

1. The government decided to establish a common multiplex and network operator for the DTTB network (in Chapter 2.2 of the ITU Guidelines this is referred to as licensing model B).
2. It should be checked if the proposed DTTB/MTV policy can be realized within the current legislation or if modifications to legislation and associated regulations are needed.

2.3 Digital switch-over objectives

The objectives for DSO are shown in Table 2.4.

Table 2.4: DSO objectives

No	Objective	2012 – 2015	> 2015
1	Smooth transition from analogue to digital	• All analogue services (TPA1, TPA2 and TV Zimbo) converted to digital, matching current analogue coverage areas • Three regional inserts (in the current three provinces) • Simulcasting in all areas	
2	End of analogue transmission	• In 2015 (in line with SADC and GE06)	

No	Objective	2012 – 2015	> 2015
3	New entrants/services	• Additional SD services when content available and as far as Mux 1 capacity allows • Additional SD + HD services when content available and as far as Mux 2 capacity allows • E-government services (full interactivity) • three Pay-TV muxes including two mandatory FTA services/mux if market interest and as far spectrum capacity allows • MTV services in 1seg	
4	Extended population coverage	• Matching current analogue coverage areas (see also objective 1)	• Near national coverage • 15 additional regional inserts (with local programming) in other provinces
5	Better picture quality	• Widescreen (16 x 9) • At least one HDTV (TPA1)	• Additional HD services
6	Compensation for viewer	• Minimize viewer migration costs (financial aid for STB) • Assist viewers with the migration (installation aid)	
7	Compensation for analogue broadcasters	• Simulcast Opex compensated (TPA and TV Zimbo)	
8	Digital dividend	• Allocate spectrum for IMT > 790 MHz (channel 61 - 69)	

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

Objective 1

The introduction of the services will take place in phases according to the implementation schedule in Table 2.5.

Table 2.5: DTTB implementation schedule

Area	Number of sites	Year	Station names
I	5	2012	Luanda, Benguela, Cabinda, Lubango, Malange
II	14	2013	Ambriz, Huambo, Kuito, Lobito, Luena, Lukapa, Mbanza Congo, Menongue, Namibe, Saurimo, Soyo, Sumbe, Tombwa, Uige
III	31	2014	Andrada, Balombo, Belize, Buco Zau, Caconda, Caiundo, Calomboloca, Cangamba, Castanheira de Pera, Cauncula, Caxito, Cazombo, Cuangar, Cuanco Congo, Cubal, Cuito Cuanavale, Cuvango, Damba, Dundo, Gabellqa, Kamakupa, Kibala, Kirima, Luau, Lumnala Guimbo, Maquela Zombo, Mavinga, Ndalatando, Oncocua, Ondjiva, Xangongo
IV	40	2015	Not yet specified

There is a total of 90 DTTB sites in Table 2.5. Table 2.2 indicates that 159 analogue TV sites are in operation. The NRT will review the analogue frequency plan and verify if the existing analogue coverage areas will be matched by the DTTB stations mentioned in Table 2.5.

Objective 2

The end of the transition period defined in the GE06 Agreement is 17 June 2015. The ASO model, ASO planning and milestones and the ASO communication plan is described in more detail in Section 4.5, 4.6 and 4.7.

Objective 3

The objective with regard to full interactive services means that the NRT is only responsible for providing a fully interactive platform. Fully interactive services may not be available at the start of DTTB transmissions in 2012.

In total, five multiplexes are required (see Table 2.6). Two multiplexes will be publicly financed and operated by a new company (the new broadcast transmission operator) having as shareholder Angola Telecom and TPA. Three multiplexes will be privately financed. Each of the licensed operators will have to invest on its own transmitting equipment and share towers, energy and transmission with the new broadcast transmission operator.

Table 2.6: Required multiplexes

Mux	Financing	Service
1	Public	FTA services TPA 1, TPA 2, Zimbo, (SDTV), E-government services, MTV (1 Seg)
		Additional FTA services (SDTV)
2	Public	Additional FTA services (SDTV and HDTV)
3	Private	Pay-TV service and 2 FTA services
4	Private	Pay-TV service and 2 FTA services
5	Private	Pay-TV service and 2 FTA services

The GE06 plan does not provide sufficient frequency assignments to broadcast the five multiplexes from each envisaged DTTB site. GE06 Article 4 should be applied in order to seek agreement from neighbouring countries to obtain five frequency assignments at each of the DTTB sites (see also Section 4.10);

The government decided to use the ISDB-T standard with an 8 MHz channel bandwidth. This standard allows DTTB and MTV operations within the same transmission. Consequently no separate MTV network is needed. The roadmap will therefore not include functional building blocks related to MTV networks.

Objective 4

Most analogue stations have low power transmitters, whereas GE06 allows high power DTTB transmitters. Extended coverage could be achieved at introduction by directly installing DTTB transmitters of medium or high power (see Section 4.9).

Objective 5

When all multiplexes are fully loaded, it will be difficult to introduce more HDTV services in the longer term. This can only be achieved by:

a. replacing about four SDTV services by one HDTV service;

b. installing an additional multiplex, if the capacity of the band allows it and if the GE06 Article 4 procedure is successfully applied.

Objective 7

Simulcast Opex will be compensated to the analogue TV operators. In addition to masts and power generators it is efficient to transfer the analogue TV transmitter to the new broadcast transmission operator (see Section 3.4.1 and 4.4). In that case simulcast compensation is related to the new broadcast transmission operator.

Objective 8

At the WRC-12, to be held in Geneva from 23 January-17 February 2012, one of the agenda items is the allocation of the frequency range 790 to 862 MHz to International Mobile Telecommunication (IMT) services. In this respect, it is noted that the ITU Secretary General, Dr. Hamadoun Touré, speaking at the recently held workshop on the presentation of the ICT Policy for Angola (White Book for ICT) and the new regulatory framework for the ICT sector, in Luanda on 14 June 2011 stated:

> *"Another important issue currently being pursued by ITU's Member States is the migration of terrestrial TV broadcasting from analogue to digital, which will release some spectrum. ITU Members will have to decide on how best to use this 'digital dividend' in their development priorities, and it is therefore very important for African countries to work together to agree on a common position, as you prepare for next year's World Radiocommunication Conference, WRC-12."*

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

3.1 Roadmap concept

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

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

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

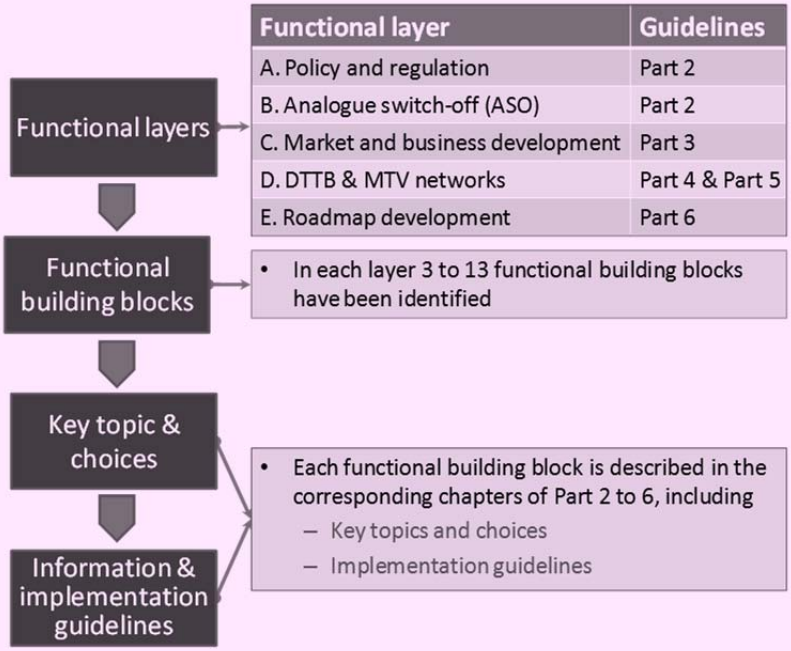
A roadmap consists of various phases, normally related to preparation, development and implementation of the strategy. A roadmap is often presented in the form of layers and bars, together with milestones on a time-line.

3.2 Roadmap construction

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

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

Figure 3.1: Functional framework

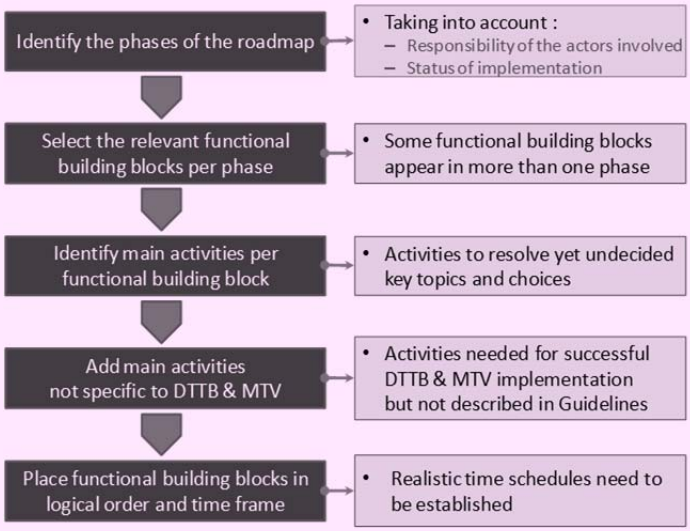


Source: Adapted from ITU Guidelines

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

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

Figure 3.2: Roadmap construction



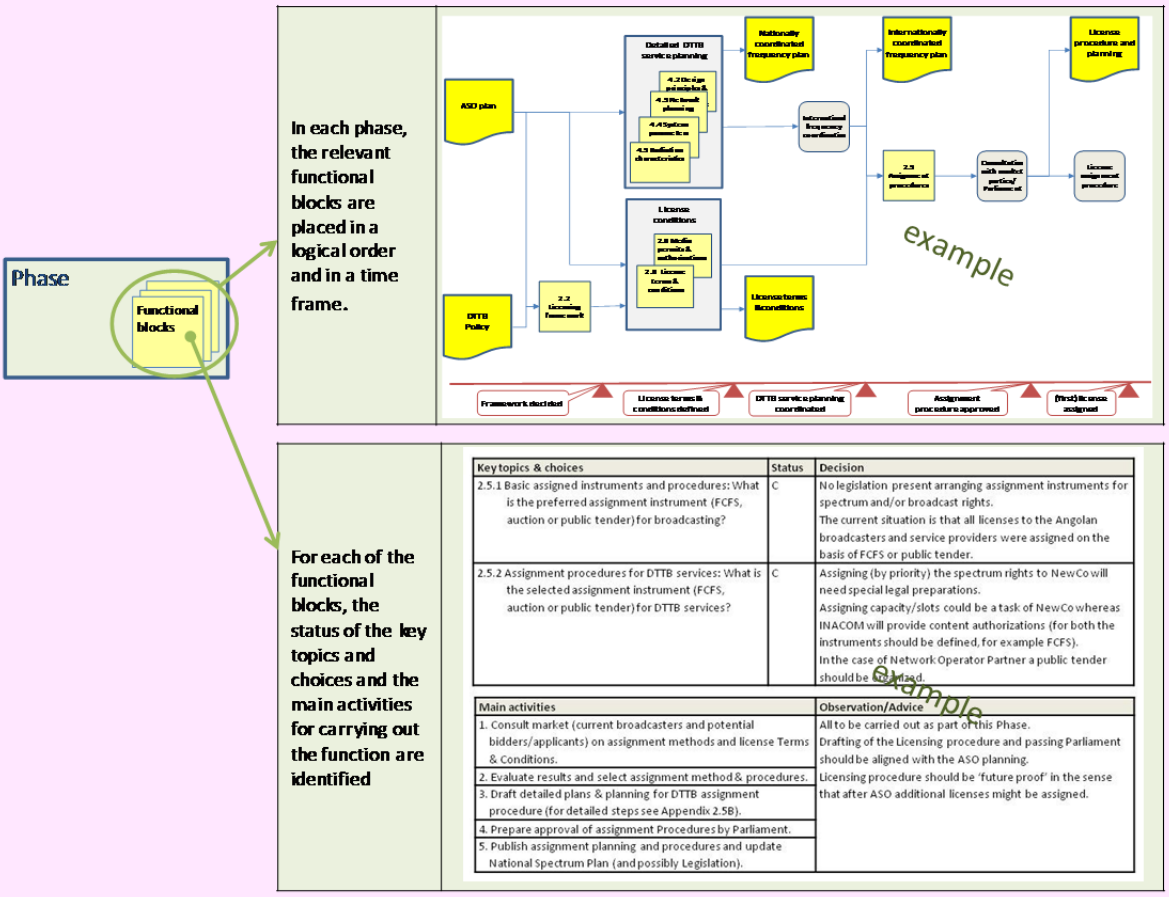
Source: Adapted from ITU Guidelines

The result is a roadmap that consists of three levels:

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

The roadmap structure is illustrated in Figure 3.3.

Figure 3.3: Roadmap structure



Source: Adapted from ITU Guidelines

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

An overview of the 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.

3.3 Functional building blocks relevant to the situation in Angola

Of the five functional layers shown in Figure 3.1, layer E is "Roadmap development" and hence covered by this report. The other functional layers A (Policy and Regulation), B (ASO), C (Market and Business Development) and D (Networks) contain in total 38 functional building blocks (see Figure 3.4). Out of the 38 functional building blocks, 26 blocks were selected to construct the Angola roadmap.

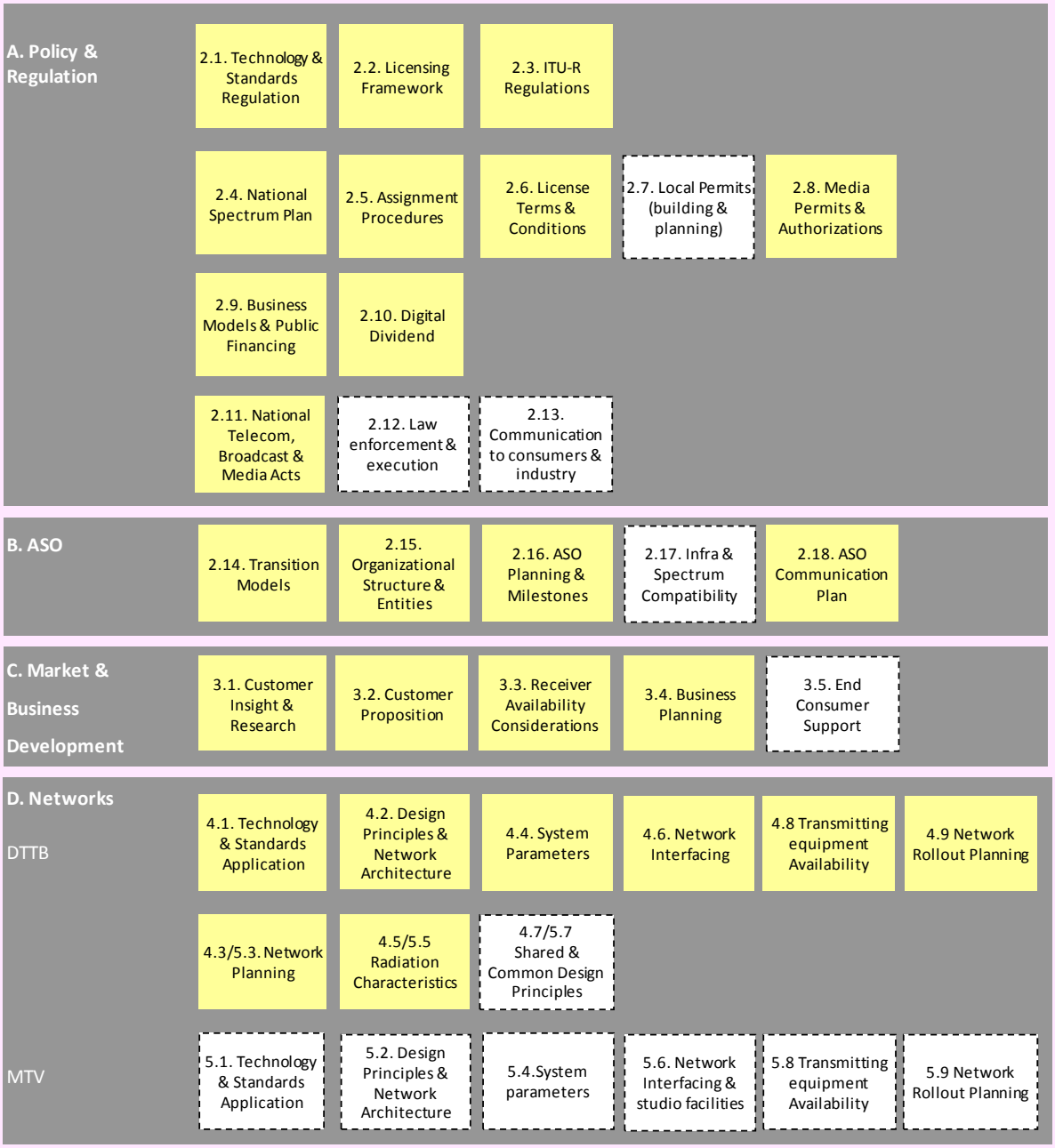
The roadmap covers:

- the DSO objectives (until 2015) as defined in Table 2.4; and
- activities managed by the NRT.

Figure 3.4 shows two types of functional building blocks:

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

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



Source: Adapted from ITU Guidelines

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

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

Not included functional building block		Reason
Number	**Title**	
2.7	Local permits (building and planning)	Local permits are in practice not strictly applied and are not considered as a major issue in developing the regulatory conditions for DTTB and MTV

Not included functional building block		Reason
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 Angola. 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	With the ISDB-T standard no separate MTV network is needed
5.1 to 5.9	MTV networks (all functional building blocks)	With the ISDB-T standard no separate MTV network is needed, all activities regarding MTV will be included in the 4.1 to 4.6 and 4.8 to 4.9

3.4 Description of the Angola roadmap

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

The detailed activities and considerations for each phase and its associated functional building blocks are included in the annexes to this report.

The following subsections contain a number of figures. The symbols used in these figures are defined in Figure 3.5.

Figure 3.5: Symbols used in roadmap figures

Functional building blocks described in the ITU Guidelines; the number in the blocks refer to the functional block numbers in Figure 3.3 and to the corresponding Chapter numbers in the ITU Guidelines

Input or output document

Non specific DTTB main activity; not described in the ITU Guidelines

Important milestone in relation to time scales

Sequence

Time line

Interrelation between groups of activities

Source: Adapted from ITU Guidelines

3.4.1 Overall roadmap

As discussed previously, the Angola NRT plans to switch-off all analogue terrestrial television services in 2015. However, as long as the final switch-off date has not been politically endorsed, the roadmap duration may still vary. With the objective to launch the first DTTB transmissions in 2012, the simulcast period in which the DTTB network is rolled out and the analogue transmitters are switched off will span a number of years.

Roadmap phases

A key decision, having a great impact on the roadmap, is the decision on the licensing model. The ITU Guidelines distinguishes two basic models: model A or B[4]. In Angola, as described in the strategy document, model B is selected for the introduction of the digital terrestrial services (DTTB and MTV).

In this model, the NRT will establish a common multiplex/network operator who will be responsible for delivering all DTTB and MTV network services in Angola. Broadcasters and/or service providers, intending to provide digital television services, will have to acquire network capacity from this common multiplex/network operator.

The Government of Angola has the objective to split off the network operations from TPA, the public broadcaster organisation. Currently TPA owns/rents and maintains the distribution network and the various transmitter sites for broadcasting its analogue terrestrial radio and TV services across the country. These network operations will be separated in a new broadcast transmission operator.

This new operator will act as a common multiplex/network operator for the two multiplexes that will be financed from public sources (see Table 2.6 in Section 2.3). These multiplexes will carry all current analogue services and additional FTA services. The three multiplexes for commercial operations (either subscription or advertising based) will be financed and rolled-out by the private operator/service providers. The role of the new broadcast transmission operator for these commercial multiplexes will be limited by providing site and antenna sharing.

The NRT looks for a partnership with equipment suppliers who can help the new broadcast transmission operator in rolling out the common digital terrestrial network. Considering that designing and rolling out a DTTB network requires specific knowledge, establishing a partnership with an experienced partner can significantly contribute to a successful switch-over. Hence the NRT will issue a tender procedure for selecting a partner/supplier for the common multiplex/network operations.

After selecting the multiplex/network operator supplier, the NRT will develop the network roll-out planning together with the new broadcast transmission operator and this newly selected supplier (phase 4). The NRT, in close cooperation with the common multiplex/network operator, will assume the responsibility of rolling out the DTTB network.

Figure 3.6 illustrates the various phases of the NRT roadmap (i.e. the yellow shaded blocks). As the figure shows, phases 1, 2 and 3 are likely to be carried out partly in parallel because of the interrelationships between the issues to be decided.

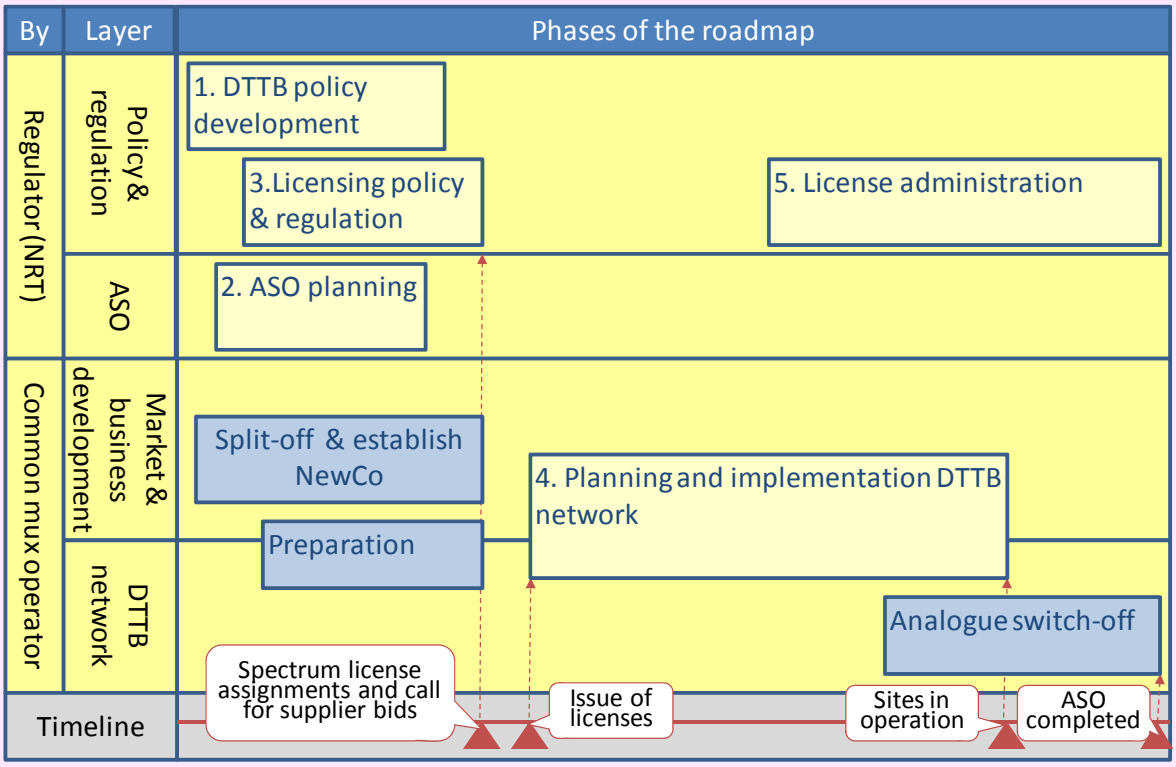
Figure 3.6 also shows that preparations are needed for splitting off the network operations from TPA and establishing a new broadcast transmission operator. This effort may impact the critical path because rolling out the DTTB without this new operator is impossible. The effort should not be underestimated. Such operations includes extensive financial audits/due diligence, assets inventory, legal preparations (for establishing the new operator with the right statute), social plan (people may be made redundant) and drafting a business plan (including the redefining of business processes, defining service portfolio and levels, organizational structure and financing). In addition, appointing management may be a delicate and intricate process.

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

It is important to note that a new operator without spectrum rights cannot effectively build-up DTTB experience, design and rollout the required network. Hence special attention is needed for assigning the spectrum rights to the new broadcast transmission operator. As experience has shown in other countries legislation should be checked extensively and the legal preparations should be not be underestimated[5]. In addition, the (spectrum) licenses for additional commercial multiplexes have to be assigned to pay-tv/commercial service providers, too.

In Figure 3.6, the preparations for splitting off the network activities from TPA and establishing the new broadcast transmission operator are indicated in blue as it is assumed that these activities will be carried out under the direct responsibility of TPA management. However, this will require a formal decision. In either way the NRT will have to get progress reports on the establishment of this new operator and ultimately its management will have to participate in the NRT.

Figure 3.6: Top level Angola roadmap



Source: Adapted from ITU Guidelines

Functional building blocks to be included

As said, 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.

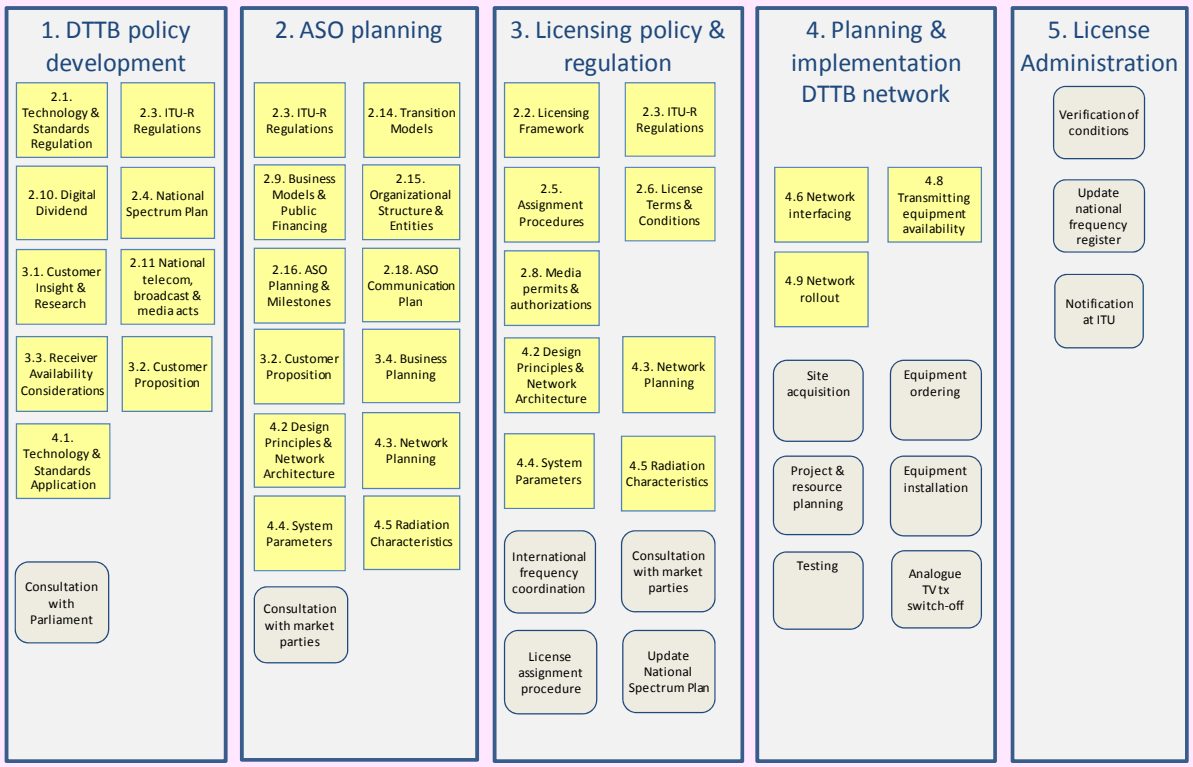
[5] In 2008 in Belgium the public broadcaster also split-off its network operations and established a new company (to be put for sale). Initially the plan was to directly assign the DTTB/MTV spectrum to this new company. However, this turned out to be impossibility as European competition law didn't allow such an operation. Only after a public tender procedure did the new company acquire these rights.

In such a situation, the Angola 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 which 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 considerations (functional building block 3.3): in line with the DSO objective to have a single cheap set top box (STB) for the Angola 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 an economically viable service offering. Hence the NRT will have to assess the future cash flows of the common multiplex/network operator and the type of financing required;
2. DTTB Network layer:
    a. Technology and standard application (functional building block 4.1) to radiation characteristics (functional building block 4.5): all these five technical functional building blocks have to be included as to determine what the required DTTB 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 (effective radiated power), 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): these three functional building blocks have to be include as the NRT will have to directly manage the planning of the network roll-out.

Figure 3.7 shows the functional building blocks to be included in each phase of the Angola roadmap. Please note that the yellow shaded blocks are described in the chapters of the ITU Guidelines with the corresponding numbering. The grey shaded blocks are not described in the ITU Guidelines. These blocks represent activities that are not specific to the introduction of digital terrestrial television services.

Figure 3.7: Functional building blocks per roadmap phase



Source: Adapted from ITU Guidelines

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 the 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 Southern African Development Community (SADC), existing regulatory framework (see Table 2.3) and policy objectives (see Table 2.4). It should be noted that the DSO 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.

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 Angola. The customer benefits/competitive edge of DTTB for the key markets (e.g. terrestrial served and non-served) should be clearly outlined. The digital dividend to become available may also be part of this policy justification (hence it will be possible to introduce new mobile services).
- The legal framework. This entails the legal basis (and any necessary changes) for the DTTB service introduction and the ASO.

- Technical framework. Detailing the current spectrum in use by existing broadcasters and the available spectrum for the DTTB/MTV services. Also the spectrum available for non-broadcasting services (i.e. the digital dividend) should be clarified.
- Starting (i.e. the introduction of the first DTTB broadcasts) and ending date of ASO process (i.e. switching of the last analogue broadcasts and lifting any restrictions on the DTTB broadcasts). These dates have to be exact in order to accurately inform the general public and the industry.
- The principle ASO model. This could be either simulcasting or non-simulcasting (including the justification for any of the two). Angola has opted for having a simulcasting period.
- DTTB services. Describing which existing television services (including any regional services) and additional content/services will be distributed on the DTTB platform and for which districts/provinces these services will be made available.
- DTTB standards. The mandatory standards (for example the transmission, compression and application programming interface (API) standards) and justification for their use. In Angola, a clear decision has been made for adopting the ISDB-T and MPEG4 standard for transmission and compression. The API standard is still under study and the introduction of Pay-TV services is also still to be considered (and hence the necessity of setting a Conditional Access System (CAS) 'standard').
- Funding principles. The intention to include selected ASO costs in the government budgets and the way it is going to be funded (for example by public private partnerships).
- 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.).

A first draft of such a DTTB policy document was drafted for Angola. During the first ITU expert mission, feedback was provided to this document[6]. It was concluded that this document provided a good basis and that it needed some further detailing in some areas. To complete the DTTB policy document the functional building blocks included in the first phase of the roadmap will help the NRT in finalizing their DTTB policy document (also referred to as 'Strategy document').

Also 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 on 2 July 2009.

Roadmap

The roadmap of the DTTB policy development phase and the associated functional building blocks is shown in Figure 3.8. 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.

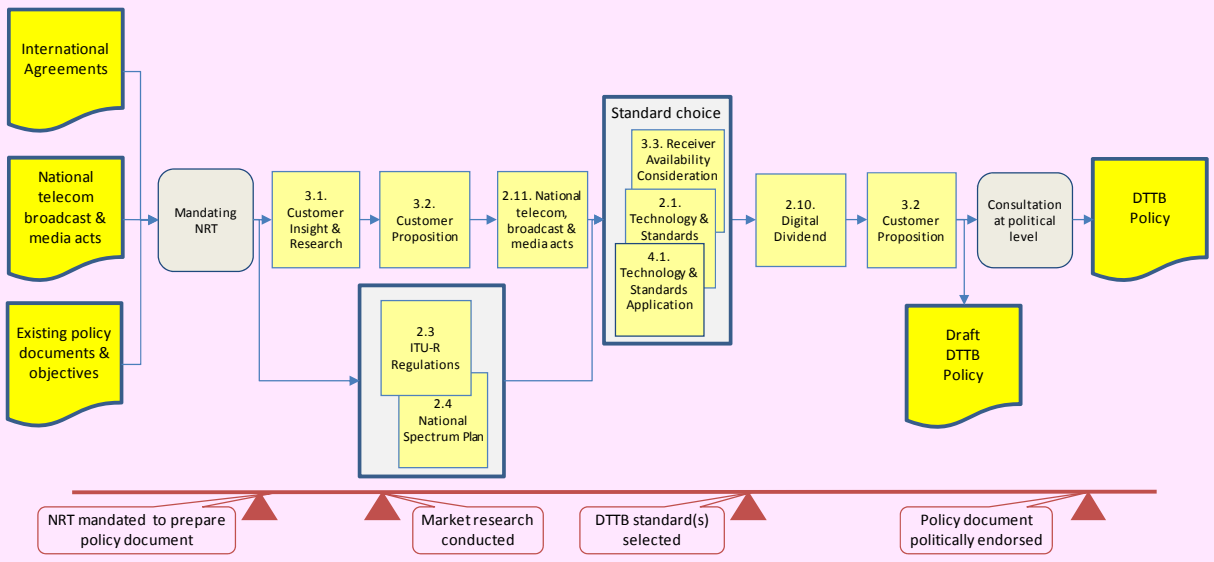
As can be derived from Figure 3.8, the following steps (i.e. functional building blocks and non-DTTB specific activities) are included in the first phase of the roadmap:

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 acquired political approval, the NRT mandate can be extended to prepare, plan and execute the roadmap. In this phase of the

[6] See the PowerPoint presentation titled 'Comments and recommendations on the strategy and implementation documents'.

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 3.8: DTTB policy development phase of the roadmap



Source: Adapted from ITU Guidelines

2. Conducting market research of the current television and future DTTB market in Angola. This step includes the functional building blocks 3.1 and 3.2. At this phase of the roadmap, market research serves the purpose of providing support/justification for the DTTB policy. Because key broadcasters (i.e. TPA and UAU) are represented in the NRT some of the research data may be readily available or have been researched in the past. The available market data will have to cover the following elements:

    a. *Current* television market in Angola. 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.) and their television services. Table 2.1 as included in this report, provides an initial overview of services in the Angola market;

        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 and growth of the total television advertising market in Angola. 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 (cable and satellite);

v. Current analogue service coverage. Given the current reception conditions, it should be clarified where and which service can be received. This might entail an analogue service planning exercise (similar to the DTTB service planning as described in the ITU Guidelines). This part should also take into account the different regional broadcasts and the different channel bouquets the various viewers might receive;

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

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

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

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

iii. Content creators. Content creators (i.e. in many cases 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. The available spectrum for digital terrestrial television services should be clarified (see also Section 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. Spectrum may not be readily available in Angola as the same spectrum is in use in neighbouring countries (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[7] (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 the parts of the current legislation that will be impacted by the introduction of DTTB services. Table 2.3 in this report and Table 2.11.1 in the ITU Guidelines provide a good starting point for this assessment. At this first phase of the roadmap, the assessment is focused on identified areas that might be impacted,

[7] LTE is an application of the International Mobile Telecommunications (IMT) as meant in ITU Radio Regulations RR 5317A.

how required changes can be achieved (e.g. legal and parliamentary procedures), and the 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), and a further detailed assessment of necessary changes may be necessary.

5. Selecting system standards. As the above figure shows the procedure for deciding standards is an iterative process between the functional building blocks 4.1 Technology standards application (i.e. addressing the technical performance), 2.1 Technology standards regulation (i.e. considering regulatory aspects) and 3.3 Receiver availability considerations (i.e. dealing with functionality, price and delivery of receivers). For Angola this iterative process will focus on setting the standard for the API as the standards for the transmission and compression are firmly set already. As for the selected ISDB-T transmission standard it should be noted that although the ISDB-T standard has been adopted and deployed in various countries, the ISDB-T variant as selected in Angola is the 8 MHz variant (in combination with the MPEG4 compression). To date there are no mass production lines readily available for this type of receiver. Currently the NRT is assessing the financial, technical and planning impact on the ASO process of such a standard variant. Furthermore the NRT will also consider:

    a. Long term supplies of DTTB receivers. Given the public financial resources available and the ability of viewers to pay, receivers should be made available at the lowest price levels. Not only in the short term but also in the long run pricing should be considered (perhaps after subsidies are cut). In Angola the DTTB adoption speed might take a long(er) time and hence the strategic 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 the case where a conditional access system is stipulated. Even more so if specific local (other than Portuguese) language requirements are demanded (e.g. for the EPG and the user interface of the receiver);

    b. Independent and warranted supplies. The number of chipset and receiver manufacturers for the ISDB-T standard is relatively limited and 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. It should be possible 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 Angola. The introduction of new mobile services might fit in the economic development agenda of Angola. Angola supports the allocation of frequency channels 61-69 to IMT (International Mobile Telecommunications), in line with the preparatory documents of WRC-12.

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 (see also Section 4.1).

8. Consultation at a political level. In this step a draft DTTB policy document is offered to politicians 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 approved 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 Angola 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 politicians.

Inputs

The key input for this phase is the (approved) DTTB policy document. As Figure 3.6 in this report suggests, it might be that the second phase of the roadmap can be initiated before the DTTB policy document has acquired political approval. This will depend for some part on the assessment of any likely changes 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 Angola, a first version of such a plan was temporarily termed 'Terms of Reference' document. During the first ITU expert mission, feedback was provided to this document[8]. It was recommended to have a separate document for the DTTB testing and to complete the ASO planning part. For completing the ASO plan the functional building blocks included in this second phase of the roadmap will help the NRT in finalizing their ASO plan.

In general terms, an 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 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. To start with, the non-served areas in Angola will have a different model to the served areas (analogue TV): the non-served areas will have no simulcasting. For the served areas it has already been decided to have a simulcast period. In this phase a further decision is needed on the simulcast model (phasing and duration) for the served areas.
- The customer proposition (see functional building block 3.2). Including the details about the services that can be received, under which conditions (i.e. the reception conditions – rooftop/indoor reception) and where;
- The ASO planning (see functional building block 2.16). This planning describes when the customer proposition will be made available and how this proposition will be provided. As indicated in the ITU Guidelines this planning comprises several work streams or result paths, including:
  - regulation and political approval;
  - frequency plan;

[8] See the PowerPoint presentation titled 'Comments and recommendations on the strategy and implementation documents'.

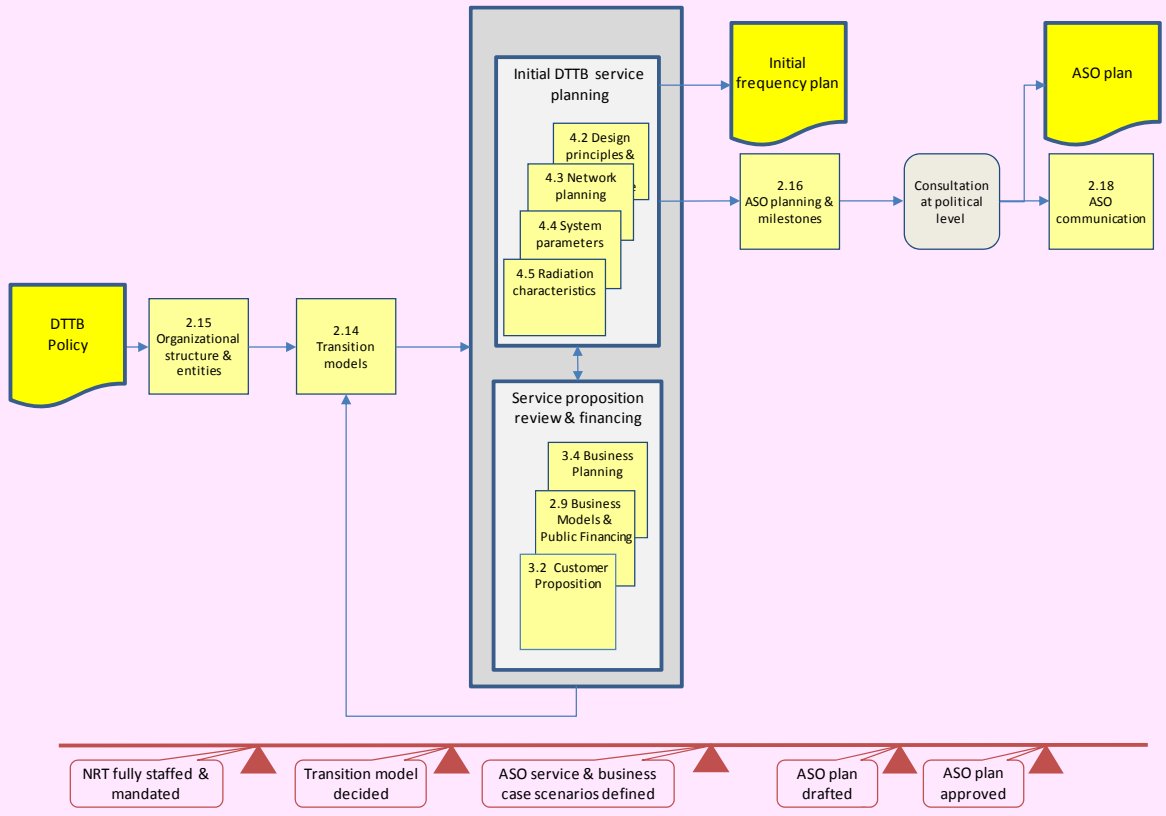
- licensing (further detailed in phase 3 of the roadmap)
- content production and delivery;
- interactive service delivery;
- network roll-out (includes service delivery details);
- STB (set top box and other receivers) delivery;
- communications (further detailed in functional building block 2.18 ASO communication);
- financial and installation support;
- consumer and market monitoring;

- The business planning 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, public private partnerships). 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 ITU Guidelines illustrates, the network costs are just one item of the overall budget. The (financial) support provided to affected viewers will be an important decision to make.

Roadmap

The roadmap of the ASO planning phase and the associated functional building blocks is shown in Figure 3.9. The decisions taken, partly taken and not yet taken on the key topic and choices regarding phase 2 of the roadmap and the activities required to prepare the decisions that are still pending, are indicated in Annex 2.

Figure 3.9: ASO planning phase of the roadmap



Source: Adapted from ITU Guidelines

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 second phase of the roadmap:

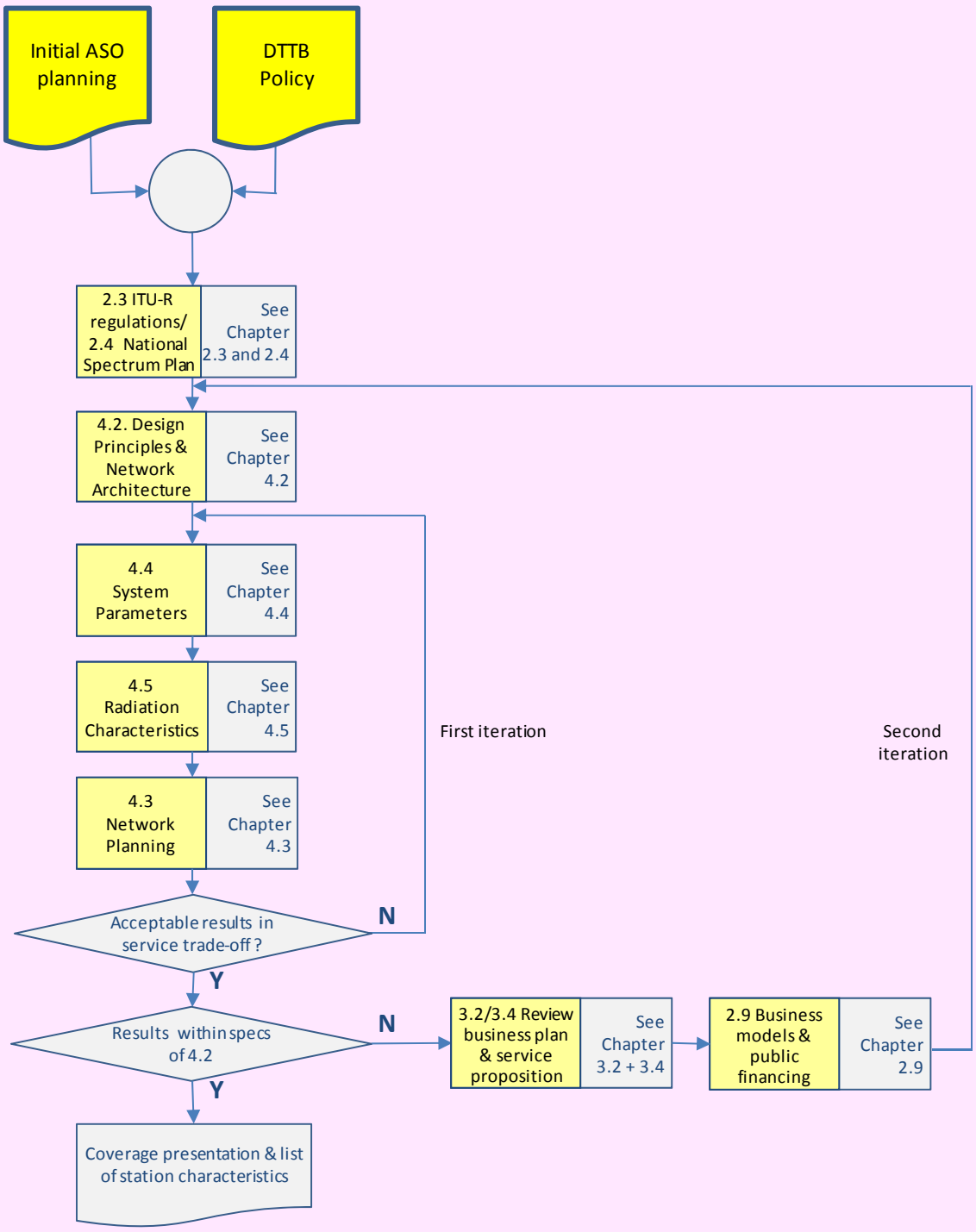
1. Establishing the organizational structure and participating entities (see functional building block 2.15). Dependent on the exact mandate of the NRT in first phase of the roadmap, this might include an additional (political) mandate. The participating parties and their responsibilities in the ASO planning process might be politically sensitive and needs further approval. In this step the reporting structure and escalation procedures should also be clarified so that the NRT can efficiently operate and manage the ASO process.
2. Determining an initial transition model (see functional building block 2.14). In the first phase of the roadmap a first understanding of the available spectrum was established. In this phase of the roadmap, the NRT should assess what ASO models are possible and if any changes of DSO objectives are needed. This assessment together with the implementation guidelines in the ITU Guidelines (see Subsection 2.14.4) on the ASO model decision, an ASO model can be selected (which will vary for served and non-served areas). During the second visit the transition or ASO model was further detailed and four simulcast regions have been identified (see Table 2.5 in Section 2.3 and Section 4.5 ASO model).
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 and 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 ITU Guidelines. Although in the ITU Guidelines this process is explained for a commercial DTTB service provider, the process is in essence no different for the NRT.

   As Figure 3.9 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 3.10 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 3.9);
4. Drafting ASO planning and milestones (see functional building block 2.16). The above mentioned 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 (re)drafted. As mentioned before, in the case where the ASO plan requires political approval, it is advisable to draft a planning based on one or two additional scenarios, perhaps not in all its details.
5. Consultation at political level. In this step a draft ASO plan is set out for political endorsement (possibly with several ASO model 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, the ASO plan 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 ITU 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).

Figure 3.10: Flowchart of planning iterations (chapter and part numbers refer to the ITU Guidelines)



Source: Adapted from ITU Guidelines

In Figure 3.10, 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).

3.4.4 Phase 3: Licensing policy and regulation

The objective of this third phase of the Angola roadmap is to have the required DTTB licenses defined and the associated licensing procedure and planning published. In this way, clarity is provided to interested market parties to operate on the Angola 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 Figure 3.6 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 been endorsed. 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 ITU Guidelines);
- An internationally coordinated frequency plan. As indicated previously this may require bilateral/multilateral coordination. However, these administrative procedures may not have to be part of the critical path of the ASO planning;
- The DTTB license conditions and terms:
  - *The spectrum licenses*. The spectrum licenses will have to be assigned to the common multiplex/network operator (the new broadcast transmission operator) and the (up to) three pay-tv/commercial television services providers. To ensure spectrum efficiency and compatibility the spectrum license will have to specify detailed frequency use. The broadcast license (i.e. the assignment of a part/slot of the DTTB capacity) will be assigned to broadcasters (and/or service provider). However, the NRT still have to decide which entity can decide the assignment of capacity (slots). For the first two multiplexes this can be either the common multiplex operator (after approval of the *content* by the Ministry of Media) or the Ministry of Media (i.e. the Ministry approves the content *and* assigns capacity). For the three commercial multiplexes the full multiplex capacity is assigned to the bidder (i.e. service provider) in a public tender (by INACOM and the Ministry of Media)[9].

[9] In such a tender procedure the assigned license will include the service bouquet the service provider/bidder defined in her bid. The license terms and conditions will also have to stipulate under what conditions (and the procedure) the service provider may change its service bouquet during the licence duration.

In addition the NRT will have to publish open network provisioning (OPN) rules (including capacity access, reservation, pricing and publication rules) for the common multiplex/network operator (the new broadcast transmission operator)[10];

- *The Network Operator supplier contract*. A partnership with an equipment supplier can help Angola in rolling out the common digital broadcasting infrastructure. The selected supplier will acquire a (turn-key) contract in a public tender procedure. This contract will stipulate the obligations (e.g. the network coverage, the minimum number of services, the reception quality, roll-out speed, pricing, change management, etc.);

- A document describing the assignment procedure and planning:
  - *Spectrum licenses*: As discussed in paragraph 3.4.1, it is important that the new broadcast transmission operator will have the spectrum rights assigned. The way this can be organized will depend on the legal basis upon which the new broadcast transmission operator was established and the Electronic Communications Law of 2011. Also the procedure for assigning the license to the pay-tv/commercial service providers have to be determined (for more details see section 4.4 Licensing model and 4.5 ASO model);
  - *Network Operator supplier contract*: The NRT will have to organize a tender procedure for selecting the best party to fulfil the role of common multiplex/network operator supplier. It will have to stipulate what entities are allowed to bid (for example consortia of suppliers and possibly foreign investors) and determine the terms of reference.

Roadmap

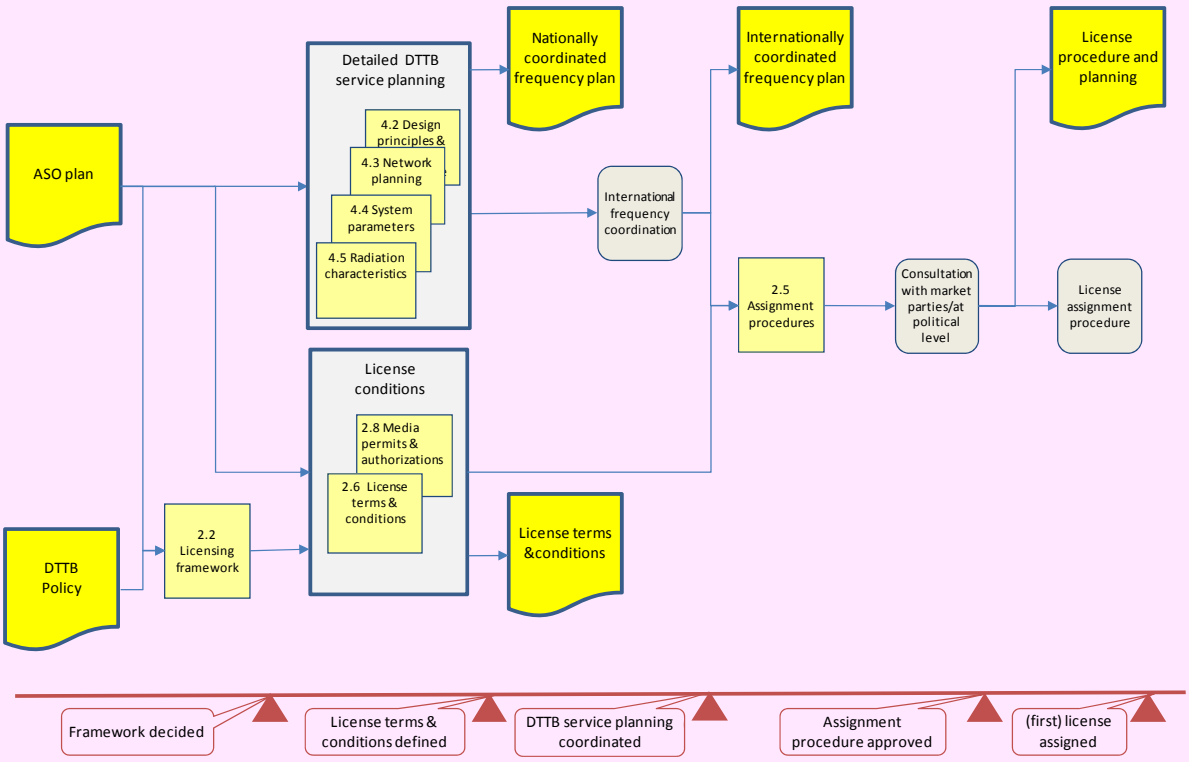
The roadmap of the licensing policy and regulation phase and the associated functional building blocks is shown in Figure 3.11. The decisions taken, partly taken and not yet taken on the key topic and choices regarding phase 3 of the roadmap and the activities required to prepare the decisions that are still pending, are indicated in Annex 3.

As can be observed from the below 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, and includes:
   a. Establishment of license conditions. Hence it will have to consider all characteristics that determine the coverage that should be achieved and the interference potential that should not be exceeded, the ASO plan (in which order will sites have to be put into operation).
   b. Viewers are informed what to do. It will have to provide the details for the communication plan so that viewers know exactly what services they will receive where and what they have to do (e.g. instructions for retuning their exiting rooftop antenna or acquiring a new one).
   c. Network roll-out will be organized. The detailed planning is a working document. During the roll-out changes will take place and the detailed planning will have to be updated. Consequently, the ordering of equipment (a rolling forecast system is also advised here) will have to be updated and the resources to have transmitter sites equipped re-planned.

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

Figure 3.11: Licensing policy and regulation phase of the roadmap



Source: Adapted from ITU Guidelines

2. Coordinating the required spectrum with national and international users. Based on the detailed planning, stipulating the exact spectrum use, the DTTB frequencies can be coordinated with other spectrum users. Coordination should take place at an international and national level. First international frequency coordination will be needed (through GE06 Article 4 Procedure for modifications to the Plans and procedure for coordination of other primary terrestrial) to obtain at each required site five channels in the 470 – 790 MHz range (for more details see Section 4.10). At a national level this is carried out by matching the detailed DTTB spectrum plan with the National Spectrum Plan (NSP) or reversely the NSP should be aligned with this detailed spectrum plan. For example, this might entail changing frequencies in the detailed planning and/or changing existing (digital) spectrum rights;
3. Determining the licensing framework (see the functional building blocks 2.2). As Angola has already decided to have model B as their principle licensing model, the remaining key decisions to be made are (see Section 4.4):
    a. spectrum rights;
    b. bandwidth management;
    c. open network provisioning rules;
    d. service portfolio;
    e. accounting separation;
    f. special duties.
4. License conditions and procedures (see functional building blocks 2.5, 2.6, and2.8). Only after having the above key remaining decisions clear, the license conditions and procedures can be

defined. License terms and conditions will have to be stipulated for the spectrum licence/rights for the new broadcast transmission operator and the pay-tv/commercial service providers;

5. Consultation with market parties and political endorsement. 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. Given the number of directly involved market parties on the Angola 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 the politicians with the feedback acquired in this consultation. Finally, the licensing regime can be officially published after the regime has been endorsed. Sufficient time should be incorporated in the ASO planning for this endorsement.

3.4.5 Phase 4: Planning and implementation DTTB network

As explained in Section 3.4., this phase can only commence when the new broadcast transmission operator has been established and preferably a supplier/partner has been contracted for the DTTB network roll-out and service introduction.

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 license procedure and planning (including the license 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 further changes can occur). This detailed coverage predictions or presentations will feed into work stream communication of the ASO plan. Please refer to Section 5.3 of the ITU Guidelines for more details on service availability checks and tools. In addition coverage presentations may 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 INACOM that stations have been installed. INACOM as the national spectrum manager should be notified by the common multiplex/network operator that stations are ready to be taken into operation. In the ASO planning a timely reporting of these notifications to the INACOM should be taken into account as to avoid that this activity will be part of the critical path.
- Notifications to INACOM that an analogue TV transmitter has been switched off by the analogue terrestrial broadcasters (TPA and Zimbo). For the purpose of updating its National Frequency

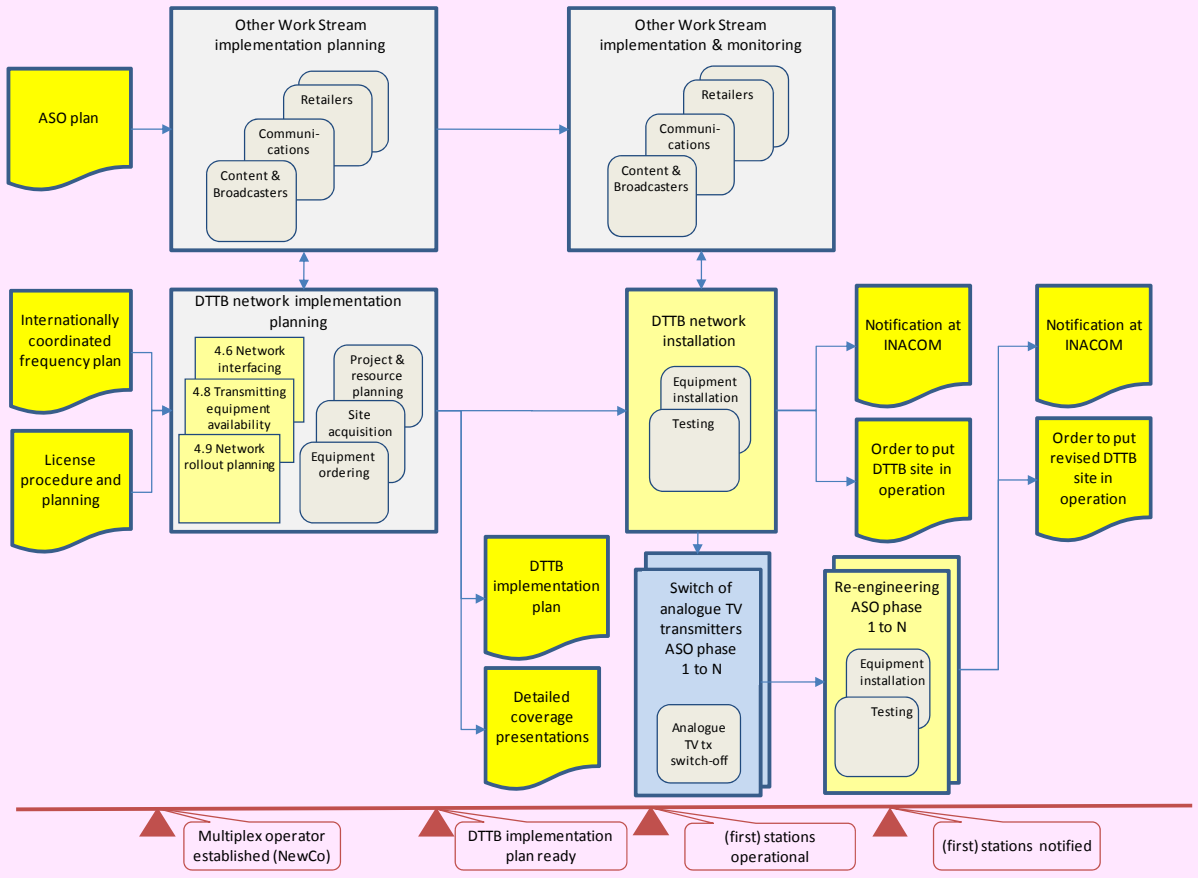
Register INACOM also has to be notified when the analogue transmitter (sites) are taken out of operation.

- 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 operations.

Roadmap

The roadmap of the planning and implementation DTTB network phase and the associated functional building blocks are shown in Figure 3.12. 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.

Figure 3.12: Planning and implementation DTTB network phase of the roadmap



Source: Adapted from ITU Guidelines

As Figure 3.12 shows, the following steps (i.e. functional building blocks and non-DTTB specific activities) are included in the fourth phase 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 ITU Guidelines cover an important part of this work but not all. The ITU Guidelines blocks cover the actual design and implementation of the network infrastructure ranging from the head-end(s), distribution network, transmitter sites,

monitoring system and all interfaces of this infrastructure. For developing and executing a DTTB network implementation planning other critical activities will have to be incorporated in the planning, including:

a. Project management. This includes the project structure and resources, budget management and reporting and progress reporting (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-shelf ordering process. Manufacturers tend not to keep transmitters in 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 Angola the network equipment ordering might be closely related to the receiver ordering process.

2. DTTB network equipment installation. An important part of the installation process is managing the available resources. Especially when the ASO plan stipulates an approach which large phases (i.e. with many transmitter sites to be switched on and off simultaneously), the installation capacity should be well managed. In case the installation process is outsourced to the supplier/manufacturer, this capacity planning will be part of the equipment ordering process. It should also be considered that the new broadcast transmission operator will be just established and possibly not all people and processes will be fully in place and hence capacity might initially be limited. The selected network operator partner could help out here and speed up the network implementation.

3. Switching off stations (by the analogue television broadcasters). As the DTTB network implementation planning is part of the ASO plan (and its associated planning), analogue transmitters will be switched off, too. It is important that this will not only be reported to the INACOM (as they can update their National Frequency Register) but also to the NRT. These reports will feed into the work stream consumer and market monitoring too, where this information will be used to monitor the progress of the ASO process and improve logistics and communications

4. Re-engineering DTTB network sites. When analogue sites are switched off, additional spectrum for the DTTB network might become available. Also foreign spectrum usage restrictions might be lifted during the network roll-out. This could entail frequency changes to sites that are already taken into operation. Re-engineering of these sites might be necessary. Special care should be taken to avoid service interruption. For this reason more complex solutions with temporary sites, transmitter/combiners and carousel like planning methods are not uncommon in network implementation planning. The approval procedures for these re-engineered sites are no different to the approval procedure for new sites, as explained above.

3.4.6 Phase 5: License administration

The objective of the license administration phase is to check compliancy with the issued license (to the new broadcast transmission operator), to update the National Frequency Register and to notify ITU of any new DTTB station put into operation.

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 INACOM. However, as indicated before, the NRT will have to approve the analogue television transmitter switch-off.

Inputs

The input data for this phase are the notifications of the common multiplex/network operator (the new broadcast transmission operator) at INACOM.

Outputs

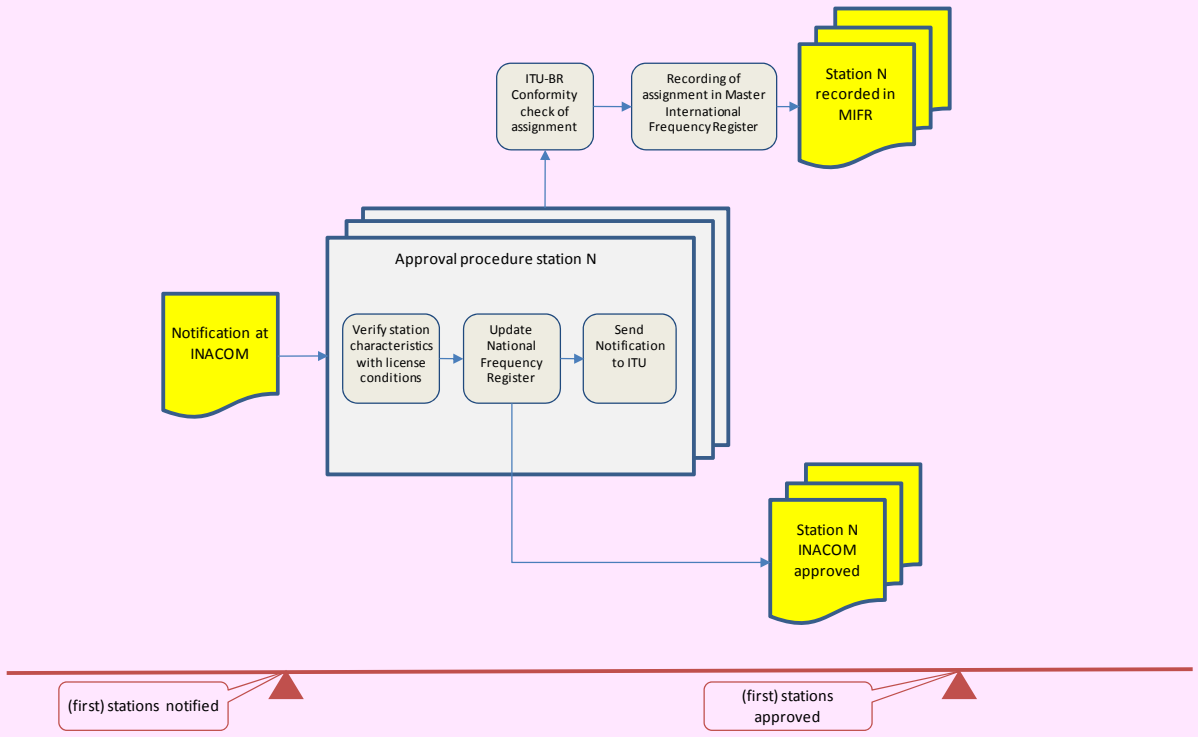
The phase will have two outputs:

- Approval by INACOM of the stations. After having checked whether the transmitter station is compliant with the DTTB spectrum license terms and conditions INACOM will provide an official approval;
- Recording of the assignment (i.e. station) in the Master International Frequency Register (MIFR). In turn INACOM will notify ITU (i.e. Radiocommunication Bureau) of the new DTTB station taken into operation (see also Section 4.10). The ITU will check the station's conformity and will, after approval, record the station/assignment in the MIFR.

Roadmap

The roadmap of the license administration phase and the associated activities is shown in Figure 3.13.

Figure 3.13: Licence administration phase of the roadmap



Source: Adapted from ITU Guidelines

The following activities are included in the fifth phase of the roadmap:

1. Approving the subsequent DTTB stations. After having checked the spectrum license compliancy, INACOM will issue an approval to the common multiplex/network operator. INACOM will then update its National Frequency Register and will notify ITU 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. For Angola this conformity check will apply and conformity will be checked with the GE06 Plan.

4 Considerations on the top ten most critical key topics and choices

In this section the top ten 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 ten most critical key topics and choices do not necessarily correspond to the complete scope as addressed in the functional building blocks of the ITU Guidelines.

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

Table 4.1: Top ten most critical key topics and choices

No	Key choices/decisions to be taken	(Part of) Block
1	Customer proposition	3.1, 3.2
2	Set- top-box requirements	3.3
3	Pay-TV services (Conditional Access)	2.2, 3.4
4	Licensing model	2.2
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	ASO budget	2.9, 2.15
9	Reception mode	4.2
10	Frequency plan	4.3

4.1 Customer proposition

Although in the ITU 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 4.2 provides an overview of the service coverage area of the main platforms in Angola, expressed in household (HH) percentages (i.e. the potential market). 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 4.2: Overview of the main television platforms in Angola

Platform	Service coverage area % households (HH)		Service uptake	
	% HH	HH (k)[11]	Subs or TVHH (k)	% TVHH[12]
Satellite (DSTV)	100%	3 100 - 3 700	110[13]	4.2%
Satellite (ZAP)	100%	3 100 - 3 700	70[14]	2.7%
Satellite (UAU)	100%	3 100 - 3 700	70	2.7%
Cable (TVCabo)	16.5%	510 - 620[15]	35[16]	1.3%
Analogue terrestrial:				
– TPA	> 50%	> 1 125	1 125[17]	43.3%
– Zimbo	14 %	430 - 520[18]	442[19]	17%

From Table 4.2 and the information supplied in Table 2.1 it can be concluded that:

1. Satellite has a footprint covering the whole of Angola and it offers a basic service bouquet ranging from 17 to 20 channels (including TPA and Zimbo – hence with the 'must have' channels).

[11] According to the latest UN estimates (2009) the population in Angola is approximately 18.5 million. As the average household size varies between five and six (according to the response to the ITU questionnaire) the Angolan market comprises between 3.1 and 3.7 million households.

[12] ITU data indicates 14 television sets per 100 inhabitants (2006). Assuming on average one TV set per household (HH) this results in approximately 2.6 million television households (i.e. 14% x 18.5 m). This represents an implied television penetration rate in Angolan households between 70 % and 85% (i.e. 2.6 million TVHH/3.7 million HH and 2.6 million TVHH/3.1 million HH).

[13] Data is taken from strategy document.

[14] Data is taken from response to ITU questionnaire: total number of satellite subscriptions estimated to be approximately 250 k (of which 110 k is DSTV). The remaining 140 k split equally between ZAP and UAU.

[15] TVCabo offers television services in Luanda and Benguela. Assuming that their network covers in potential the whole city, this constitutes a service coverage area of 3.1 million people (i.e. 2.6 million people in Luanda and 0.5 million people in Benguela). As the average household size varies between five and six this constitutes between 510 000 and 620 000 HH.

[16] Data is taken from response to ITU questionnaire.

[17] Data is taken from response to ITU questionnaire. Based on the assumptions made under footnote 12, this number implies a service uptake of 43.3%. This differentiates from the 50% as replied to the ITU questionnaire which may be explained by a different assumed number of TV sets per 100 inhabitants.

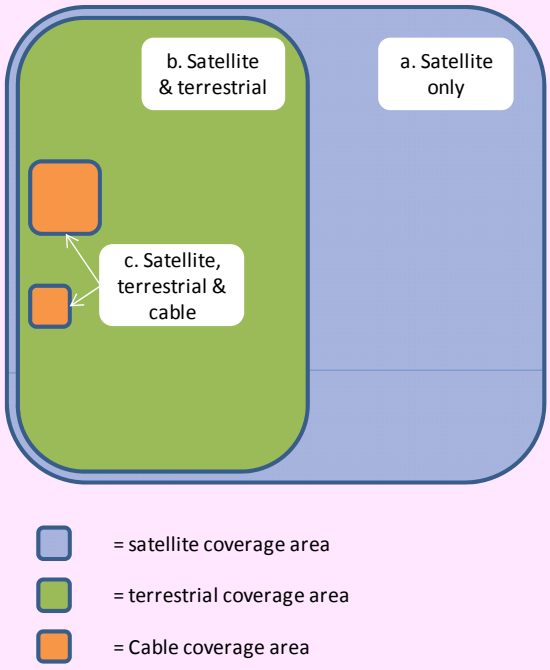
[18] Zimbo operates one transmitter site in Luanda. Assuming this site covers the whole of Luanda, this implies a potential market of 2.6 million people (respectively 430 000– 520 000 HH).

[19] Based on the assumption made under footnote 12, Zimbo's actual maximum service uptake is 85% x 520 000 HH = 442 000 TVHH.

However, its price level (recurring and one-off costs) makes it beyond the reach of many households in Angola (see its limited service uptake).

2. The main platform, reaching most people, is the analogue terrestrial platform having a service uptake of 43.3 per cent (TPA) and 17 per cent (Zimbo). The other platforms have a much less significant service uptake.
3. The vast majority of television viewers watch a limited number of television services: TPA 1, TPA 2 and possibly Zimbo (when living in Luanda).
4. The analogue terrestrial network coverage areas are actually unknown (for both TPA and Zimba).
5. There are three principle reception situations for households in Angola (illustrated in Figure 4.1)[20]:
    a. Areas with just satellite reception (with a relatively large number of services). Given an assumed network coverage of the analogue terrestrial network of 50 per cent and the cable networks only being present in Luanda and Benguela, these areas are theoretically 50 per cent at the most (i.e. 100 – 50 per cent, assuming a complete overlap between terrestrial and cable networks) but possibly be lower as the coverage area of TPA's network might be above 50 per cent;
    b. Areas with satellite and terrestrial reception (approximately 50 per cent, depending on the actual coverage area of the analogue terrestrial network). There are two terrestrial services (TPA 1 and 2) in all areas outside Luanda, and three in Luanda (adding Zimbo). In three provinces (i.e. three main transmitter sites), there are a limited number of hours of regional programming (inserted for one to two hours each day);

Figure 4.1: Different reception situations in Angola



Source: Authors

[20] These reception situations are important to define as they will provide input for the communication to the viewers (especially in the conversion phase when they have to change the cabling of their television set and connect a STB).

c. Areas with satellite, terrestrial and cable reception. These areas are actually limited to Luanda and Benguela because only in these cities TVCabo offers their television services.

Considering the above analysis, the DTTB service offering has to initially[21] compete in two basic markets:

1. Non-cabled areas (situation b). In these areas analogue terrestrial viewers will compare its current analogue offering (for terrestrial viewers this offering includes 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 set-top-box (STB) and antenna (including any subsidies/vouchers) to the satellite STB and dish. Please note that for analogue terrestrial viewers who also have satellite, this trade off will be different (they may decide not to switch to DTTB);
2. Cabled areas (situation c). In these areas people will have to decide between the DTTB, satellite and the digital cable offering.

4.1.1 Non-cabled areas

The ITU Guidelines (see Section 3.2.1) identifies six competitive advantage categories. Applying these categories on the Angolan 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 programme guide (EPG), additional programme information and enhanced teletext (to include also the e-Government services). Recent market developments show that (mass produced) receivers come available with return path capabilities, such as integrated IPTV/DTTB set-top-boxes and Integrated Digital Television sets (IDTVs) with Internet. But these boxes and television sets are relatively expensive and given the low purchasing power in Angola, this seems to be only an option for the long term (when prices have dropped significantly and ability-to-pay has increased);
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 six or nine multiplexes), let alone the cost consequences for content production;
3. *Additional services/multi-channel offering*: In Angola the analogue terrestrial television platform offers only a limited set of services (i.e. up to three). The introduction of a multi-channel DTTB offering could be a key demand driver. As the DSO objectives stipulate (see Section 2.3) Angola intends to launch five multiplexes[22], able to carry up to 50 (SDTV) services. But this advantage should be handled with care as three satellite service providers operate in Angola and they offer a multi-service too (pay-tv satellite). Compared to satellite, the DTTB platform is faced with a lower distribution capacity. However, the satellite service providers operate in a much higher price range (i.e. receiver installation and subscription prices). Hence the DTTB platform does not necessarily have to compete directly with the satellite service providers (especially when DTTB is a free to air offering);

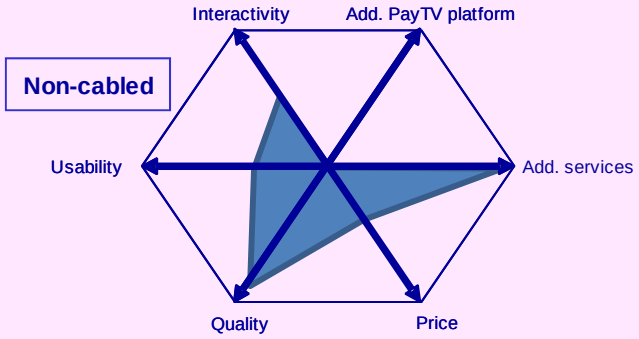
[21] Initially because the DSO objectives state that first all analogue services (TPA1, 2 and TV Zimbo) will be converted to digital, matching the current analogue coverage areas. At a later stage the DTTB network can be extended to non-served areas.

[22] Depending of frequency availability, see section 4.10.

4. *Lower costs (one-off and recurring)*: The DTTB platform in Angola has the advantage of having lower receiver costs as compared to satellite. However, the one-off costs form a major barrier for consumers to adopt digital television (for satellite costs range between USD 150 and USD 200). DTTB STB retail prices are in the range of USD 80 (based on Brazilian retail prices and without subsidies) and don't require any professional installation (and consequently a fee to be paid). 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 viewers is really a prerequisite rather than a competitive edge;
5. *Picture and reception quality*: The introduction of DTTB could entail for many viewers a significantly better picture quality. Most terrestrial viewers have an indoor reception installation (the so called 'rabbit ears') in a rooftop designed network. Hence, due to multipath propagation, viewers will have distorted reception and picture quality. This applies less to viewers with rooftop antennas. However, the number of rooftop antennas is limited in Angola. 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 Angola DTTB can deliver better coverage and in more places of the home. However, when marketing this competitive edge, this needs to be accompanied by accurate coverage predictions and coverage needs to be defined for those 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 Angola



Source: Authors

4.1.2 Cabled areas

Applying the six competitive advantage categories to cabled areas in Angola results in different considerations. The following four categories can be assessed differently:

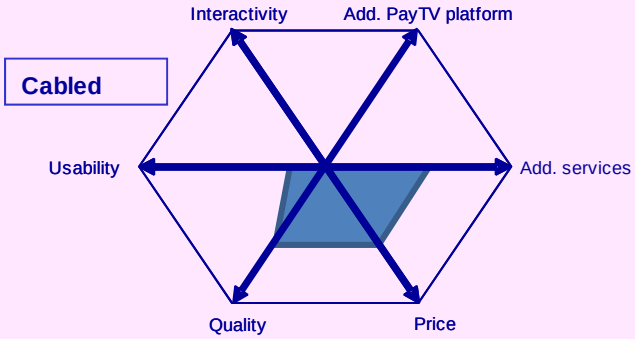
1. *Additional services/multi-channel offering*: As said the introduction of a multi-channel DTTB offering could be the key demand driver. For people in the cabled areas this argument seems to be less strong. The cable networks can offer service bouquets with over 50 services. In areas where the cable offerings 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 less stronger competitive edge for DTTB;
2. *Lower costs (one-off and recurring)*: At the moment, the TVCabo offering is more or less offered at the same price level as the satellite packages: USD 100 for the STB and USD 100 installation fee. The latter fee might change in the near future when DTTB will be launched. The cable STB is really a 'plug and play' device too like the DTTB STB and here there is ample room for the cable

provider to lower the price. For satellite providers the tuning of the dish remains a competitive disadvantage as many consumers find this dish tuning too difficult and will call in help;

3. *Picture and reception quality*: For cable subscribers their reference point for picture quality is most likely to be the picture quality of digital cable. DTTB cannot provide a competitive advantage here as cable will always be able to match the DTTB picture quality (as cable networks have far more bandwidth available than the DTTB platform). Hence the argument of having a better picture quality should be handled with care as competition can easily outperform the DTTB platform on this aspect;
4. *Interactivity/enhanced television services*: Digital cable (like TVCabo offers) has the ability to offer a return channel. Integrated interactive services are well developed for cable offerings (including the application programming interface (API) on the STB) and hence cable has initially a clear advantage over the DTTB platform. Moreover as most digital cable offerings come very often with so-called 'triple-play' packages (i.e. television, telephony and Internet). TVCabo offers 'TV and Net' already and technically there is no reason to assume why in the near future they will not offer telephony services too.

From the above considerations Figure 4.3 shows the competitive profile of the DTTB platform in cabled areas.

Figure 4.3: DTTB's competitive profile in cabled areas in Angola



Source: Authors

4.2 Set-top-box requirements

Today many different DTTB receiver types are commercially available. Also more and more integrated devices, supporting different transmission standards and platforms, become available due to further chipset integration. For the NRT, it is therefore important to determine the type of receivers they will have responsibility for and for which they will have to organize delivery and support in the ASO process.

In addition, for the NRT it is important to draft the receiver's functional requirements based on the defined service proposition (see the previous section). Only those requirements supporting the service proposition should be incorporated. At all times 'nice to have' requirements should be avoided as these will come with a price[23] and may negatively affect the ASO budget. Nevertheless it is possible that the 'must have' requirements might prove to be too expensive for the ASO budget. Consequently the receiver considerations might result in a revised service proposition.

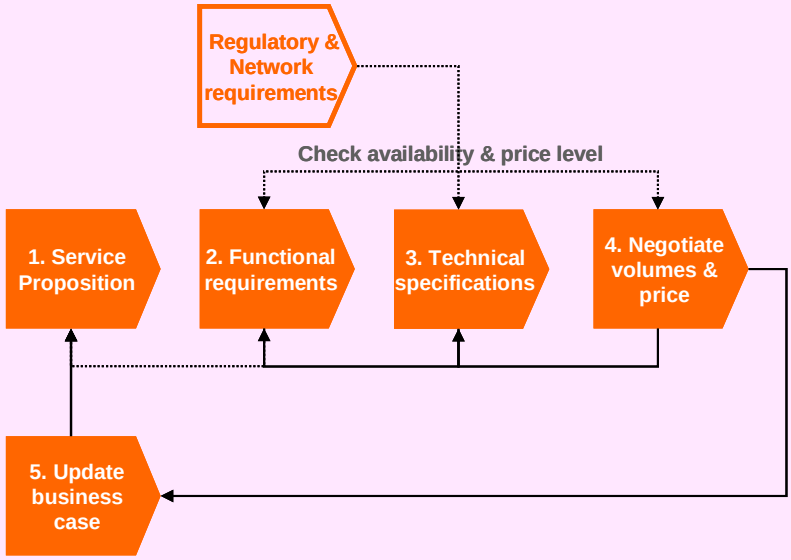
[23] Not only in higher receiver costs, but possibly also in more complicated business processes like receiver management, software updates and testing and customer support processes.

Considering the DSO objectives and service proposition as discussed in the previous section, it may be concluded that the NRT will:

1. Limit the number of receivers to be supported in the ASO process to one: a cheap STB without return path facilities and no conditional access (see also the consideration in Section 4.3).
2. Limit the support for IDTVs and other type of receivers to 'certification and labelling'. In order to reduce the workload and costs for this effort, the NRT can ask manufacturers to guarantee network compatibility and label their receivers before import rights are granted[24].

As discussed before, Angola has adopted the ISDB-T 8 MHz variant for the distribution standard. The NRT will have to detail its requirements and to go through a process as illustrated in Figure 4.4 (see the ITU Guidelines, functional building block 3.3).

Figure 4.4: Typical receiver ordering process



Source: Authors

The above illustrated receiver ordering process might prove to be time consuming (as a minimum 4-6 months) and the NRT should allow time in their ASO planning for this process. It is important to note that the technical specifications are not only driven by the functional requirements. The standards regulations (as set in phase 1 of the roadmap, see functional building block 2.1) include already the ISDB-T (8 MHz), MPEG4 and Ginga technical requirements (able to run BML too).

When specifying the STB requirements the NRT should consider the following points:

1. The common multiplex/network operator may wish to be involved in setting the receiver requirements. It may have to provide DTTB services to more than one service provider (with possibly conditional access requirements).
2. The functional/technical requirements will also be drafted for the purpose of certifying other receivers (like the IDTV).

[24] Whether the NRT is in the position to demand these guarantees depends also on the actual stipulated functional requirements and the potential production volumes.

3. Define a complete set of requirements covering all aspects of the STB. For this purpose we refer to the framework as provided in Section 3.3.1 of the ITU Guidelines.
4. Angola may have special language requirements (other than Portuguese). This 'other' language requirement may prove to be a 'must have' depending on the targeted DTTB viewers (and their ability to read Portuguese). Language requirements affect all levels of the STB (including also the manual and remote) and should not be underestimated.
5. Large proportions of the installed base of television sets is likely to be equipped with RGB connections (and not SCART what most STB manufactures offer on their 'standard' STB). This may have price consequences as both connection types should be on the STB.
6. Depending on the network design decisions (see Section 4.9) a powered aerial connector for an active indoor antenna may be required. This may have price consequences.

4.3 Pay-TV services

Agreement on the business model between the involved parties in the value chain will be a key decision. This choice cannot be considered separately from the decisions on the licensing model. In turn, the decisions on detailing the licensing model discussed in Section 3.4.4 (phase 3 of the roadmap) will be based on an analysis of suitable business models (i.e. FTA and/or pay-TV) for the Angola market.

Considering that common multiplex/network operator will operate two FTA multiplexes and private parties will operate up to three pay-tv/commercial multiplexes (see the DSO objectives as described in Section 2.3), the primary business models and the pay-tv/commercial service providers have to be determined.

For the two public multiplexes, the common multiplex/network operator will be a provider of distribution (or network) services only. Broadcasters (or any other service provider) will have to pay a distribution fee for the service of broadcasting their programme(s) in specified areas (against a set of agreed service levels, including picture quality, network availability, etc.). Individual broadcasters can deliver their content at the head-end of the common multiplex/network operator and can then have their content broadcasted FTA.

For the private parties operating the commercial multiplexes, the NRT should assess the viability of the primary business models available, either FTA or pay-tv (or a combination as stipulated in the DSO objectives, two television services should be FTA).

The ITU Guidelines provides guidance for 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 ITU 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 a FTA model the DTTB network transmission costs have to be financed by the advertising income on the DTTB platform. In Angola the DTTB platform can reach new viewers as the existing platforms (satellite and cable) are too expensive for them. A cheap FTA offer can open up this market. Additional viewers can be also be achieved by offering better (picture) quality television. In France for example, new viewers were attracted by a multi-channel HDTV offering. As discussed in Section 4.1, in Angola improved picture quality 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. As advertisers are known to be conservative, changing these spend patterns might be a lengthy process. For Angola the actual television market and its potential growth is unknown (see also phase 1 of the roadmap where market research into this area is proposed).

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 Angola as competition on the satellite platform is already intensive with relatively cheap options (see Table 2.1).
    b. Existing television content contracts in the market. Especially exclusive content deals might limit the possibility of creating attractive pay-tv packages (e.g. exclusive live football broadcast rights). Conversely, the absence of such exclusive contracts might create an opportunity. In Angola this market seems to be already served by the satellite and cable providers (such as DSTV and TVCabo).
    c. Willingness/ability to pay for television content. As the willingness to pay is very often historically and culturally determined, the ability to pay is directly related to the average income per capita. Pay-tv service providers should carefully investigate paying patterns for television services. However, given the low average income level in Angola, there seems to be little room for pay-tv packages in Angola.

4.4 Licensing model

Angola has decided to adopt licensing model B: the spectrum license is assigned to a common multiplex/network operator. In addition, this common multiplex/network operator will be formed by splitting of the network activities from TPA. These important decisions should be further detailed including its consequences for the DTTB licensing policy and regulation.

In further detailing the licensing model, the NRT should consider the following remaining aspects and decisions:

1. Spectrum rights/licenses. As indicated in Section 3.4.4, licenses should be assigned to the common multiplex/network operator and private parties operating the pay-tv/commercial multiplexes:
    a. The common multiplex/network operator: as said in Section 3.4.1, it is important that the common multiplex/network operator should have spectrum rights assigned, and a legal basis should be found for assigning these rights directly to it. Next to this legislative aspect, the NRT should define:
        i. Duration of the rights. For what period but also when spectrum can be revoked or extended.
        ii. License fees to be paid. The common multiplex/network operator might be exempt from paying any license fees. However, this will require a legal justification as to avoid anti-competition claims.
        iii. Other license conditions. Please refer to the ITU Guidelines section 2.6 (License terms and conditions).
    b. Private parties operating pay-tv/commercial multiplexes: the NRT should have the objective to have a joint roll-out between the FTA multiplexes of the common multiplex/network operator and the commercial multiplexes. In this way a comprehensive and single DTTB offer

can be launched into the market. Hence the licence procedure, terms and conditions should include:

i. Aggregation rules stipulating the number of multiplexes a single bidder/entity can acquiring in subsequent tender procedures. A model can be envisioned whereby in a first tender procedure a single multiplex will be assigned. No longer than a year after this first tender procedure, a second round will be organized in which the incumbent pay-tv provider can participate as well as new bidders. In this second round, the two remaining multiplexes (if spectrum is available) will be either assigned to the incumbent or (a) new operator(s). (See also Section 4.5 ASO model).

ii. Roll-out obligation which stipulates that the license holder rolls-out in the same pace as the common multiplex/network operator. In addition, it is advised that the pay-tv operators participate in the NRT and that the network roll-out is jointly managed between the common multiplex/network operator and the pay-tv operators.

iii. Site share and preferably antenna share obligations. The license holder should use the same site and if technically possible the same antenna as the common multiplex/network operator. This avoids viewers having to point their DTTB antenna in two directions in order to receive all services.

iv. If there is more than one pay-tv operator, a conditional access system (CAS) requirement stipulating that they will either comply to the set CAS standard or as a bare minimum will cooperate to agree a single CAS.

v. Obligation to promote and communicate the DTTB bouquet together with the other FTA services. It is advised that the pay-tv operator participate in the NRT and will help draft the communication plan (see Section 4.8).

vi. Obligation to include two FTA services in their bouquet.

2. Bandwidth management. The NRT will have to decide the framework for assigning the broadcast license and hence the way the available bandwidth is managed, for both the common multiplex/network operator and the pay-tv/commercial service providers.

   a. The common multiplex/network operator. The following two basic systems are possible: the second will best position it as an effective and independent multiplex operator and will give it an incentive to improve its services:

      i. Applicants first apply to the Ministry of Media for bandwidth (or multiplex capacity) which checks availability and approves content. With this slot assignment (and content authorization) the applicant can then request access to multiplex capacity (for that slot) with the common multiplex/network operator.

      ii. Applicants first apply to the Ministry of Media for content approval only. With this content approval the applicant requests capacity/bandwidth from the common multiplex/network operator which checks availability and assigns capacity/slots (in other words the common multiplex/network operator is the bandwidth manager);

   b. Private parties operating pay-tv/commercial multiplexes. It is common practice that in a tender procedure, the full multiplex capacity is assigned to the winning bidder (i.e. service provider). This public tender is organized by INACOM and the Ministry of Media. Bidders have to hand-in a bid-book outlining their roll-out and service offering. The Ministry of Media and INACOM can then select the best bid and assign in one single procedure the spectrum and the broadcast rights. In the license terms and conditions, rules should be included that stipulate how and to what extend the license holder is allowed to change its services.

3. Open network provisioning rules (ONP). When networks have been rolled out exclusively by one party by appointment, as it is in Angola (also in countries like Finland, Serbia and Kenya), it is good practice to formulate some basic ONP rules, including[25]:
    a. grounds for refusing capacity;
    b. maximum (multiplex) capacity to be allocated to one single broadcaster or service provider;
    c. fair and transparent pricing of capacity;
    d. rules for capacity reservation; and
    e. publication of access and pricing rules.
4. Services portfolio. The NRT will have to decide the service portfolio of the common multiplex/network operator. This will be determined largely by what assets and activities (people) will be transferred from TPA to the common multiplex/network operator. Based on experience in other countries (like Belgium, Serbia and the UK), it is common practice to separate all distribution services to include infrastructure and people for television services (including head-end equipment and the distribution network to the transmitter sites). Hence it is advised to transfer all the current analogue transmitter sites and associated activities to the common multiplex/network operator and not only the antennas and towers. In this way the separation is clear and resources will not be shared between TPA and the new operator. In addition, the business planning for the new operator will be easier. This operator should be sufficiently financed to cover all network related ASO costs, including Capex for rolling out the two multiplexes and Opex for running the analogue (simulcasting) and the digital networks.
5. Accounting separation. In the case of a wider service portfolio and in order to provide fair and transparent pricing, a sound financial administrative set-up will be required. This administrative system should allow for accounting separation (i.e. the common costs can be allocated in a transparent way to the individual services or cost 'carriers'). It should be noted here that allocating costs to the different services may not stop at the level of the multiplex. It may be required that clients of the common multiplex/network operator will request capacity in a limited coverage area (not the whole network). Consequently the price per so called 'point of service' (i.e. per site for a specific frequency) should be made available.
6. Special duties. The common multiplex/network operator may have assigned special duties of national interest (for example resolving interference issues). This may cover carrying out investigations and proposing solutions when interference on equipment and other spectrum users occur.

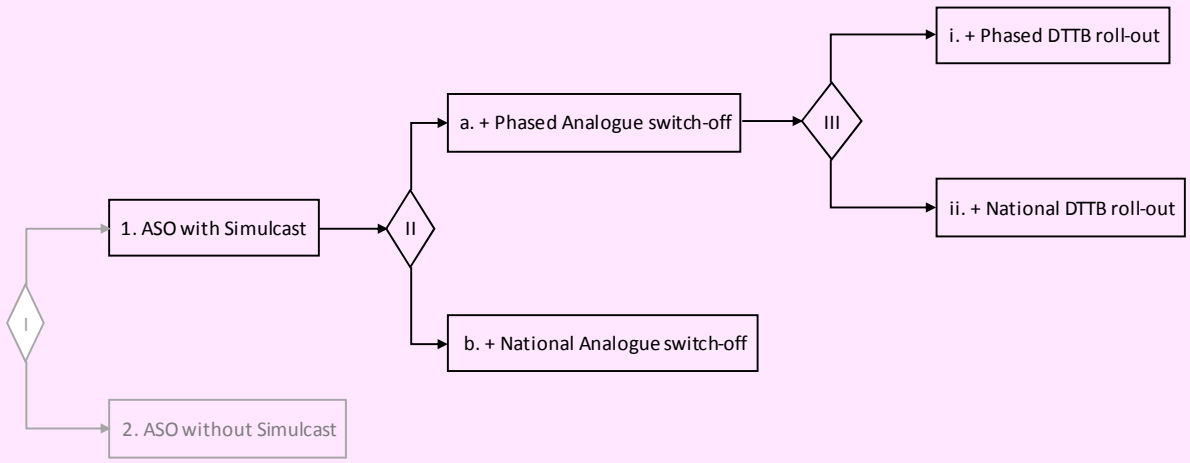
4.5 ASO model

As indicated in the strategy paper and discussed under the DSO objectives (see Section 2.3), a simulcast period for the current analogue terrestrial services (served areas) is wished for.

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. In Figure 4.5, the various ASO models are indicated (see also Figure 2.14.4 in the ITU Guidelines):

[25] See also the ITU Guidelines p60/61.

Figure 4.5: ASO models in Angola



Source:

Reflecting the phased analogue switch-off models in Figure 4.5, the following can be said about the preferred ASO model for Angola:

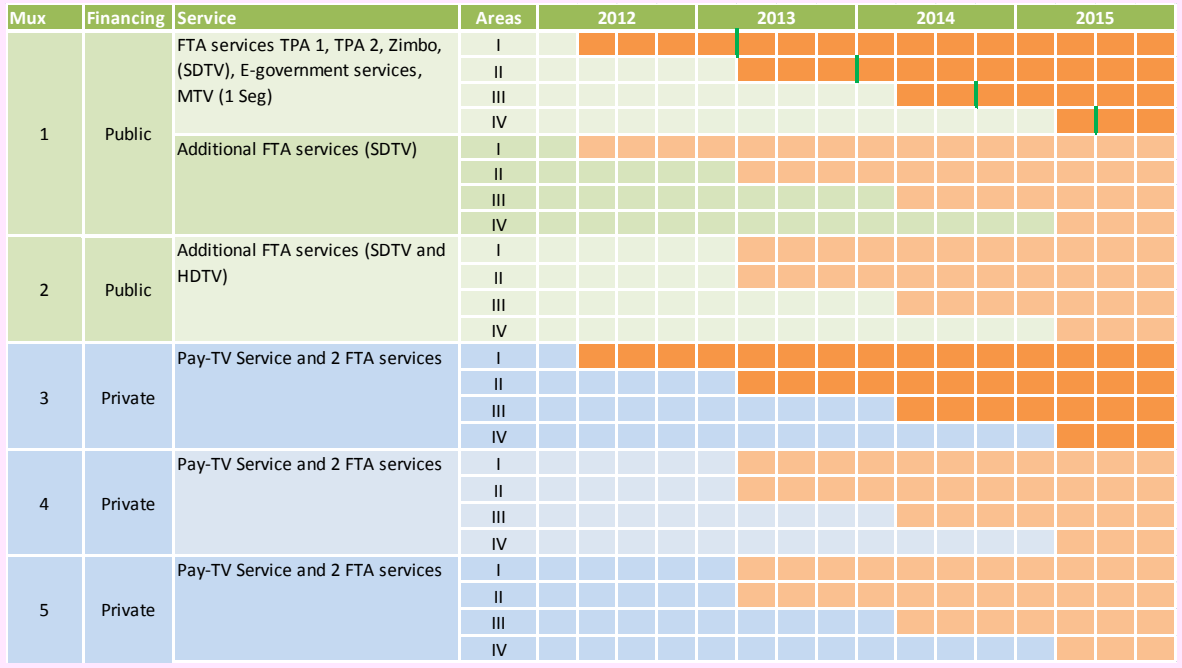
1. Decision II: A phased analogue switch-off is considered[26]:
   a. The number of analogue terrestrial television viewers is relatively large. As observed in Table 4.2, Angola's key platform for television services is the analogue terrestrial network, serving around 43 per cent of the population. The impact of an ASO failure would be significant.
   b. The coverage areas are widespread and installation capacity is not widely available (or centralized). This consideration seems to be applicable for the common multiplex/network operator in Angola (to be checked with its management). However installation know-how and capacity can be in-sourced by the equipment suppliers (but can be expensive).
2. Decision III: A phased rollout of the DTTB network is considered:
   a. The available spectrum may be limited and frequencies have to be re-used (see also Section 4.10 in this report). Whether this is the case in Angola needs to be checked during phase 2 of the roadmap (see Section 3.4.3). In this phase an initial DTTB service planning is scheduled and the available spectrum should be defined. However, spectrum incompatibility seems to be unlikely given the low number of analogue terrestrial services.
   b. The installation and engineering capacity is limited. A complete roll-out of the DTTB network in a limited period of time may not be possible. This seems to apply in Angola (to be checked with the common multiplex/network operator management). Again this can be mitigated by in-sourcing this capacity (see above).

Based on the above considerations it was concluded that for Angola a phased analogue switch-off with a phased DTTB network roll-out is advisable.

Taking into account the DSO objectives as described in Section 2.3, Figure 4.6 further details the selected ASO model. This figure illustrates an initial ASO planning and provides a good basis for further detailed planning.

[26] It should be noted that a phased ASO process is a region by region approach and not broadcaster by broadcaster.

Figure 4.6: Initial ASO planning for Angola



Source: Authors

The following observations can be made from the initial ASO planning as depicted in Figure 4.6:

1. The ASO date is set at mid-2015 (see the green line). The exact ASO date still has to be decided, but has to be set in 2015 (to be in line with the stipulated DSO objectives). This ASO date in combination with the simulcast requirement will entail that the simulcast period will vary per region (for the regions numbered I to VI see Table 2.5 in Section 2.3). In this initial planning the last region (IV) will have three months simulcast. This seems acceptable as this region is the last region and viewers should be well aware that analogue service will be switched off (communication started in this planning as early as 2011).
2. The first FTA multiplex (the common multiplex/network operator) will carry all current analogue services and all additional SDTV services that can fit in the multiplex and for which parties have been found willing to provide content (hence the shaded colour of the bars).
3. As discussed in Section 4.4, the first pay-tv/commercial service provider will roll-out in the same pace as the common multiplex/network operator will roll-out its first multiplex. In this way a comprehensive and single service bouquet is offered to the DTTB viewers. This is also strongly advised from the point of view of having an efficient and well-coordinated roll-out of the transmitters/antennas.
4. The second FTA multiplex (the common multiplex/network operator) will be (preferably) rolled out within a year of the first multiplex. In this way the region II sites (and the subsequent regions) can be equipped straightaway with two transmitters. It should be noted that for the region I sites (five sites) the common multiplex/network operator has to go back to install the second transmitter. This may imply some service interruptions for these region I sites. Consequently, the later the second multiplex is roll-out the more sites the common multiplex/network operator has to go back to (to have the second transmitter installed). This may turn out to be very inefficient (especially when sites are difficult to reach). Also viewers are unlikely to want to wait for the second multiplex to arrive in their region. In their decision process to select a service provider (i.e. platform) they may not consider these (late) additional DTTB services and may decide for a different platform (cable/satellite).

5. The two additional pay-tv/commercial multiplexes are assigned and roll-out at the same time in order to avoid a third public tender procedure. Also, for the same reason as indicated earlier, viewers may not be willing to consider services that arrive beyond one year. Figure 4.6 also shows that these additional pay-tv multiplexes are rolled-out together with the second FTA multiplex. Again for reasons of having an efficient and well-coordinated roll-out of transmitters.

It also advised to test the ASO processes in a closed-user group before any region is switched-off. This is not for the purpose of testing the working of the new DTTB network but mainly to test the receivers, the retuning and home installation and the customer contact and support processes. In addition the number of phases should be limited and the first phase should be chosen close to the DTTB knowledge and installation centre (i.e. headquarters of TPA in Luanda).

4.6 ASO planning and milestones

A key element for the ASO planning is that it is well coordinated and facilitates cooperation throughout the value chain. Table 4.3 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 ten 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 4.3: Angolan ASO planning and milestones

No	Result path	Key tasks	Example milestones	Considerations for Angola
1	Regulation and Political Approval	• Mandating the NRT • Approving (at political level) the DTTB policy document • Endorsing (at political level) the ASO planning and DTTB licensing regime • Approving (at political level any necessary regulatory changes	• DTTB policy document approved (see phase 1) • ASO planning approved (see phase 2) • DTTB license terms and conditions agreed (see phase 3) • Regulatory framework changed (see phase 1)	• 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	• 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.	• Initial DTTB service plan agreed (see phase 2) • Detailed DTTB service plan agreed (see phase 3)	• 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

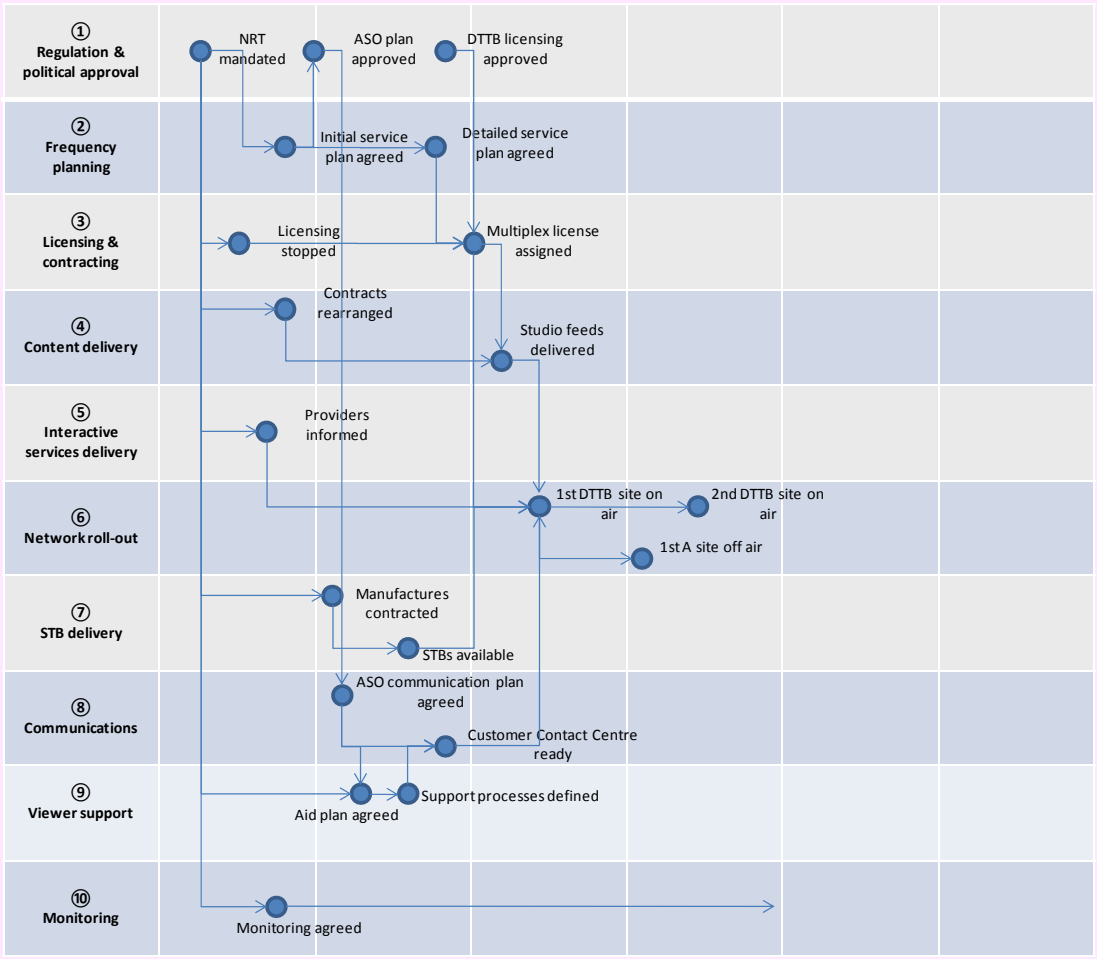
No	Result path	Key tasks	Example milestones	Considerations for Angola
3	Licensing and contracting	• INACOM has to stop licensing analogue terrestrial licenses • INACOM/MTTI needs to assign the required DTTB frequency licenses to the common multiplex/network operator • System for broadcast licenses and the bandwidth management system defined • Network operator supply contract signed • 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	• DTTB licenses assigned to the common multiplex/network operator (see phase 3) • DTTB licenses assigned to pay-tv/commercial operator(s) • Network Operator Partner license assigned • Broadcast assignment procedure implemented	• Evidently tasks to be overseen by the NRT
4	Content delivery	• 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) • TPA and Zimbo need to deliver their studio feeds to the common multiplex/network operator	• All studio feeds delivered at multiplex centre (see phase 4) • Business model agreed and distribution contracts rearranged	• 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 Angola and/or only in analogue format
5	Interactive service delivery	• Defining the interactive services (for local interactivity) • Contracting and agreeing content delivery (from the various governmental bodies) • Setting up content management system and loading databases • Service testing and service release	• Interactive content contracted • Content management system delivered • Interactive services released	• Organizing (i.e. having the participating organizations to deliver) and formatting the content is likely to take a considerable effort • NRT should organize this in a separate working group (as the nature of the work is very different)

No	Result path	Key tasks	Example milestones	Considerations for Angola
6	Network roll-out	• The common multiplex/network operator needs to detail the network planning and the associated service roll-out planning • The common multiplex/network operator needs to carry out the DTTB network and service roll-out • Pay-tv/commercial service provider roll out their multiplex(es) • Broadcasters have to switch off analogue transmission at the right time in the right area(s)	• Network and service roll-out planning drafted and agreed (see phase 4) • DTTB Transmitter site in first region taken in operations (see phase 4) • First analogue transmitter in first region switched off (see phase 4)	• Representatives of TPA, the common multiplex/network operator and the pay-tv operator are evidently needed in the NRT
7	STB delivery	• Manufacturers need to supply sufficient quantities of DTTB receivers in various regions • In case of pay-tv, CAS suppliers need to supply smartcards • Manufactures may be required certify compliancy with any set standard and to provide proper or specific labelling	• Contract agreed for certifying and labelling STBs • First batch of STB available in selected retail shops in first region	• 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 Angolan public. Such an organization is likely to participate in the NRT
8	Communications (Viewers and other target groups)	• Setting acceptable timetables and understanding local issues • Formulated adequate messages and executing communications through various means/tools • 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	• ASO communication plan agreed (see phase 2) • Information exchange with other providers agreed • Website published • Customer/viewer contact centre operational	• Representatives of the various viewer groups are likely to be consulted in the NRT

No	Result path	Key tasks	Example milestones	Considerations for Angola
9	Financial and installation support	• Define financial aid and eligible groups • Define the support processes • Select and contract (installation) suppliers • Implement and test processes (not only in the customer contact centre) – see also comments in previous Section	• Aid programme approved • Installation suppliers contracted • Support processes tested	• Political approval will be required. Defining the eligible groups is very often political sensitive
10	Consumer and Market monitoring	• Define and agree monitoring report and agree how to process the results (example monitoring reports can be found on the Digital UK website – www.digitaluk.co.uk). • Especially the first switch off region will serve as a test case. The monitoring results should be used for the next region	• Monitoring report and procedure agreed • First monitoring report reported	• NRT can use these reports to manage the ASO process and also to inform the public and politics • Different versions may be required. Information may be published on the website too (see Communications result path)

Figure 4.7 illustrates what an ASO planning could look like.

Figure 4.7: Illustration of an ASO milestone planning



Source: Authors

4.7 ASO communication plan

It is important to note that this ASO communication plan should be drafted with the pay-tv/commercial service provider(s) so as to ensure a coherent message and to leverage the commercial efforts these operators will deploy.

As indicated in the ITU 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:

1. the different target groups, and
2. the different messages (per stage).

In Section 4.1, three principle reception situations for households in Angola were defined. In marketing terms these three reception situations form the basis for the different target groups. Taking into account that in three provinces there is a limited number of regional programming on the terrestrial network, four basic target groups can be defined:

1. Areas with just satellite reception (with a relatively large number of services).
2. Areas with satellite and terrestrial reception (national programming only).
3. Areas with satellite and terrestrial reception (with regional programming).

4. Areas with satellite, terrestrial (with national programming only[27]) and cable reception.

All these different reception situations/target groups 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 has to be done to change to digital, the message will differ.

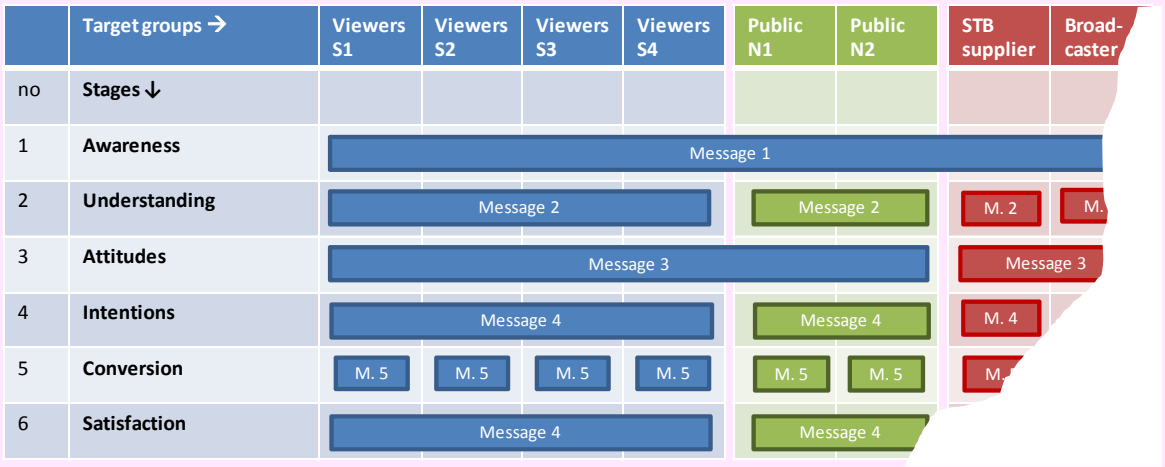
Because there are significant parts of Angola where there is no analogue terrestrial reception (and hence no DTTB in the short term – see DSO objectives and Table 2.4 in Section 2.3) communication should also address the non-served areas. It is important to communicate to the non-served areas to manage expectations (people may expect that they will get DTTB too).

Next to the target group (the public) other involved market parties have to be informed. Depending on the responsibilities that the ASO organization/NRT will take on board (for example whether or not installation aid will be provided), the following target groups could be included in the matrix:

- STB suppliers and retailers (including installation companies);
- broadcasters;
- content creators;
- landlords and public places (with television sets);
- government entities (e.g. local councils, regulatory bodies, etc.).

Figure 4.8 illustrates how the different target groups are matched with the different communication stages and messages.

Figure 4.8: Example of the communication matrix for Angola



Source: Authors

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 be easily reached with the broadcasts of the commercial/public broadcasters. In Angola, because the four ASO

[27] Assuming Luanda and Benguela don't have regional inserts.

regions are spread out over the country (see Table 2.5 in Section 2.3), it is important to note that mass media tools covering a closed geographical area (like radio) will also reach non-served viewers. Hence targeted instruments (like door-to-door mailings or SMS) should be applied too.

- Mapping the communication matrix on the network roll-out planning will determine the exact dates for communicating (especially the conversion and satisfaction/monitoring stage).

4.8 ASO 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. This section includes considerations of both costs and 'revenue'.

4.8.1 Cost considerations

The ITU Guidelines provide in Table 2.15.2 an overview of the relative impact on the size of the ASO organization and costs, depending on the responsibilities of the NRT. Table 4.4 includes considerations for Angola.

Table 4.4: ASO activities and budget impact for the Angola ASO process

No	ASO Activity	ASO organization function	Considerations for Angola situation	Relative costs
1	Migrating viewers to digital	Logistic function for administrating and handing-out vouchers Logistic function for aerial retuning and installation Contact centre function for (technical) assistance Consumer communication function Media and Public Affairs function	Depends on the actual/final coverage of the DTTB network. Assuming a 43 per cent coverage target this could entail a considerable operation. Financial impact can be limited if financial compensation is minimized (see brackets in next column): 1. Selection of the cheapest set-top-boxes; 2. Partly financial compensation (not the whole purchase costs) or loan system (please note this will include interest/finance charge for the government); 3. Roll-out indoor coverage network, as to avoid roof-top antenna purchase costs.	++(++)
2	Transmitter network migration efforts	Network planning function	Depends on the actual/final coverage of the DTTB network. Costs will arise from additional transmitters (for simulcasting and more than one multiplex) head-end systems, additional distribution capacity and additional sites (for example to provide better/indoor coverage). Especially adding sites can entail significant costs (see brackets in next column)	++(+)

No	ASO Activity	ASO organization function	Considerations for Angola situation	Relative costs
3	Re-farming of spectrum efforts and compensation	Network planning function	According to the current information provided, there are no existing spectrum users to be migrated. Also the consequences of ASO on the distribution to head-ends should be assessed. This may also result in compensation claims	+(?)
4	Simulcast period for analogue terrestrial services	Broadcast network roll-out monitoring function	Simulcasting costs are the cost of running an additional DTTB network, in order words the network operating expenses – OPEX. They can be limited if (if conditions are not met more significant costs can arise – see brackets): 1. A thorough service planning is conducted and the service bouquet is balanced (and hence the number of multiplexes is maximized to two multiplexes); 2. The simulcast period is limited to a maximum of 1 year in the first region and in the last region to a few months.	+(+)
5	Managing the ASO process	Broadcast network roll-out monitoring function Market monitoring and research function Consumer communication function Industry communication functions	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. Given the low penetration rate of Internet access and use in Angola, communication costs might be relatively high (e.g. printed materials, mobile and more radio broadcasts)	+
6	Setting mandatory certification and labelling	Industry liaisons function	These costs could be minimized by: 1. Have suppliers guarantee compliancy and label STBs (before they receive an import license); 2. Stipulating a widely accepted and proven transmission 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 Angola, given the presence of 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

From Table 4.4, it can be concluded that the main cost element for the Angola ASO process will likely be the costs of migrating viewers to digital, followed by the provisions for financial compensation. Network costs could also amount to a significant cost item.

4.8.2 Budget considerations

An inventory should be made of the possible sources for financing the abovementioned ASO costs. The ITU Guidelines provides guidance on sources of funding (see Section 2.9 business models and public financing). Table 4.5 provides some first considerations on the various sources.

Table 4.5: Funding sources for the ASO in Angola

No	Source	Considerations for Angola
1	General Taxes	When financing the ASO from general taxes the following should be taken into account: 1. Given the 43 per cent target population coverage as implied in the DSO objectives, 57 per cent 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 license fees	Introducing the TV license fee can be an option to finance the ASO process. However in Angola 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.
3	Spectrum usage/industry levies	The number of licensed spectrum users is relatively high in Angola (Several mobile network operators, satellite service providers and many commercial radio/FM broadcasters). Hence there seems to be a basis for (additional) spectrum usage levies. 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.
4	Spectrum auctions or tenders	As can be learned from the ITU Guidelines spectrum auctions and tenders procedure with substantial upfront payments are rarely seen for DTTB licenses. In addition, Angola has opted for a common multiplex operator being formed from the network operations from TPA. Having this new operator pay substantial amounts for the spectrum license will only imply transferring public money. 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.

No	Source	Considerations for Angola
5	International organizations/loans (ITU/NGO/World bank, other countries, etc.)	Seems limited but no practical information available. In the case of international loans (accompanying equipment and service supplies) the ability to pay back should be seriously considered.
6	Distribution and site sharing fees from the common multiplex operator	The common multiplex operator will operate two FTA multiplexes which will generate income for the state. It will generate income from distribution fees (from broadcasters and/or service providers) and site/antenna sharing offered to service providers operating the three pay-tv/commercial multiplexes.

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. Most promising sources for financing seem to be the auction of 'LTE spectrum' and distribution/site sharing fees from the common multiplex operator. However the latter should be assessed on the basis of an analysis of the advertising market in Angola (see also section 4.3 Pay-tv services). The broadcasters carried on the two FTA multiplexes of the common multiplex operator will have to generate enough advertising income to be able to pay the common multiplex operator distribution fees.

The assessment of the funding sources should be carefully balanced against the ASO cost items (and the possibilities to minimize them).

4.9 Reception mode

This section describes the choice of reception mode for DTTB and MTV, followed by coverage considerations in which the consequences of the choice is indicated with regard to required effective radiated power and coverage.

4.9.1 DTTB and MTV reception modes

Reception modes

In planning DTTB, four reception modes can be distinguished; the reception modes are defined in the GE06 Agreement:

1. Fixed reception (also called rooftop reception), with a fixed mounted antenna on top of the roof.
2. Portable outdoor reception, with a simple transportable antenna in an outdoor location (the TV set connected to antenna is not necessarily transportable).
3. Portable indoor reception, with a simple transportable antenna in an indoor location (the TV set connected to antenna is not necessarily transportable).
4. Mobile reception (also called vehicular reception) at high speed, with a simple antenna mounted on the vehicle (improved reception can be achieved with diversity reception).

With regard to reception of digital television it should be noted 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 (fixed and portable reception normally 95 per cent and mobile reception normally 99 per cent), whereas analogue TV is planned for 50 per cent.

In planning MTV. four reception modes can also be distinguished:

1. Handheld portable outdoor reception, with a simple built-in antenna or an external antenna (e.g. telescopic or wired headsets).

2. Handheld portable indoor reception, with a simple built-in antenna or an external antenna (e.g. telescopic or wired headsets)
3. Handheld reception in a moving vehicle at high speed, with a simple antenna mounted on the vehicle (improved reception can be achieved with diversity reception).
4. Hand held reception in a moving vehicle at high speed, with a simple built-in antenna or an external antenna (e.g. telescopic or wired headsets) inside the vehicle.

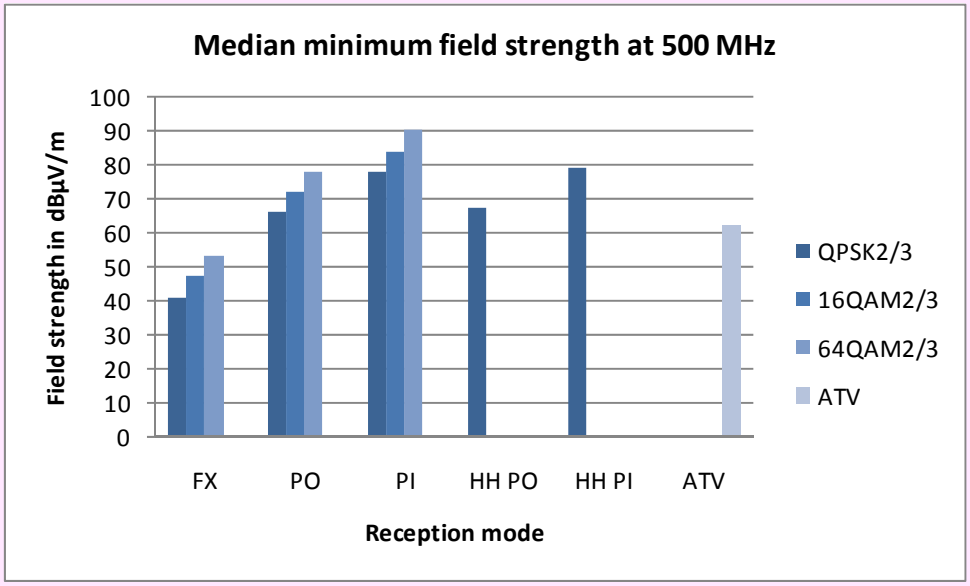
Handheld portable reception is planned for a location probability of 95 per cent, whereas handheld mobile reception is planned for a location probability of 99 per cent.

Portable reception requires much higher field strength values than fixed reception. Figure 4.9 shows:

- The median minimum field strength for DTTB reception with a probability of 95 per cent at 500 MHz[28] with fixed (FX), portable outdoor (PO) and portable indoor (PI) reception at different system variants.
- The median minimum field strength for handheld reception with a probability of 95 per cent at 500 MHz with portable outdoor (HH PO) and portable indoor (HH PO) reception[29] [30]; in the ISDB-T standard the 1seg handheld mode is transmitted at QPSK 2/3.

For comparison, the minimum field strength for analogue TV with a probability of 50 per cent at 500 MHz with fixed reception[31] is shown in Figure 4.9. 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.

Figure 4.9: Median minimum field strength at 500 MHz



Source: Adapted from GE06

[28] Values taken from Table A.3.2-2 of the GE06 Agreement

[29] Derived from the median minimum field strength values of Table A.3.2-2 of the GE06 Agreement, but corrected for the poor reception quality of the small built-in antenna (-12 dB) and the lower bandwidth of one segment (+11 dB)

[30] In practice often a higher building entry loss is taken for handheld reception than the value given in the GE06 Agreement; see table 1.3.8 in EBU report Tech3317 Planning parameters for handheld reception, Geneva July 2007.

[31] The minimum field strength in the absence of interference other than noise taken from Recommendation ITU-R BT.417.

The minimum field strength requirements have an impact on:

1. Radiation characteristics and network topology.
   The higher the minimum field strength, the more power is needed. The power requirements may exceed the power allowed by the frequency plan or may not be feasible in practice. In such cases power distribution by means of an SFN may be chosen.
2. Multiplex capacity.
   A high net data rate of the multiplex results in relative high minimum field strength values of all the reception modes. A low net data rate of the multiplex offers the advantage of relative low minimum field strength values of all the reception modes. For portable and mobile reception, lower net data rates may be chosen in order to reduce the required power.
3. Extend of coverage area.
   With given radiation characteristics and a given net data rate of the multiplex, the coverage area for fixed reception is much larger than for portable or mobile reception.

A balance has to be found between on the one hand the efforts viewers have to undertake to achieve satisfactory reception (e.g. installing a rooftop antenna) and on the other hand costs of the network and service quality.

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.

The receiving conditions of analogue and digital television should therefore be specified in order to be able to predict coverage. Important elements of the receiving conditions are:

- noise figure of the receiver or set-top-box;
- receiving antenna height;
- receiving antenna gain;
- indoor or outdoor reception;
- reception probability.

Analogue TV reception

Analogue television is planned for fixed reception with a reception probability of 50 per cent. However, in practice analogue TV viewing takes place under conditions well below the recommended minimum field strength values in ITU[32]. Portable reception of analogue TV is not defined in ITU and is likely to be dissatisfactory because of lack of field strength and multipath propagation resulting in noisy pictures with several strong ghost images or even loss of synchronization.

It has to be decided on which basis analogue TV coverage has to be accessed, e.g. based on:

1. experience and practical knowledge of coverage areas;
2. calculations with either the recommended ITU minimum field strength values, or the values indicated by ITU as reception limits[33].

It should be noted that the larger the analogue coverage areas that are determined, the higher the ERP of digital transmitters should be in order to match the analogue coverage.

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

[33] 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.

DTTB reception

The specified reception mode should in principle reflect the actual practical receiving conditions. In Angola often television reception takes place at indoor locations with simple antennas. Indoor and outdoor DTTB reception is possible, provided that the field strength exceeds the required minimum value.

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

- It represents reception with a simple antenna.
- It is a well-defined receiving condition; portable indoor reception would require the establishment building entry loss data (mean value and standard deviation) in Angola.
- Portable outdoor reception represents 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 when relatively close to the transmitter, at higher floors and when building penetration losses are minimal.

Fixed reception (rooftop) is normally the basis for the coverage obligation of public broadcasters. In the DSO objectives it is indicated that in the long term near national coverage should be achieved. In network planning two approaches can be adopted to achieve a portable reception target:

1. a lower number of viewers than taken for the coverage obligation (e.g. 70 per cent of that number); and
2. a network plan based on the fixed reception target, but with the aim of achieving the greatest possible portable reception in towns.

In Angola, the second approach has been chosen. In Luanda and possibly other cities SFNs will be planned to improve portable reception. The initial choice of the DTTB system variant is 64QAM 3/4, however depending on the coverage results and multiplex composition a more robust system variant (e.g. 64QAM 2/3 or 16QAM3/4) may be chosen in order to improve portable reception.

MTV reception

MTV reception takes place with handheld devices. These devices have generally built-in antennas with poor reception characteristics compared to DTTB portable reception. However, the poor receiving antenna performance is almost compensated by the smaller noise bandwidth of the 1 seg signal.

The MTV devices currently in use in Angola have extendable telescopic receiving antennas. By extending the antenna reception can be considerably improved.

As with DTTB portable reception, SFNs in towns will also improve MTV indoor reception.

4.9.2 Coverage considerations

Comparison of analogue TV and DTTB coverage

The ERP of a UHF DTTB station with a coverage that matches the analogue TV coverage depends on the:

- basis for defining analogue coverage (recommended minimum field strength or limit of reception);
- frequency band in which the analogue transmissions takes place (VHF or UHF);
- DTTB system variant (carrier modulation and code rate);
- reception mode (FX, PO or PI).

Table 4.6 shows the ERP of a UHF DTTB station that is needed to match analogue coverage based on the recommended minimum field strength in UHF. In Table 4.6 the ERP of the DTTB station has been calculated with fixed reception and at different system variants.

The ERP of the DTTB station is expressed as mean power, whereas the ERP of the analogue TV station is expressed in peak envelope power.

Table 4.6: ERP of digital TV transmitting stations to replace an analogue coverage area

DTTB variant	DTTB ERP in dBW	DTTB ERP in kW
64QAM 3/4	Analogue ERP (dBW) – 7.8 dB	Analogue ERP (kW) x 1/6
64QAM 2/3	Analogue ERP (dBW) – 9.5 dB	Analogue ERP (kW) x 1/9
16QAM 3/4	Analogue ERP (dBW) – 13.3 dB	Analogue ERP (kW) x 1/20
16QAM 2/3	Analogue ERP (dBW) – 14.9 dB	Analogue ERP (kW) x 1/30

The ERP of a DTTB station with other reception modes and different analogue TV coverage situations can be calculated with the following formulas:

1) In dBW $ERP_D = ERP_{DFX} + C_{RM} + C_B + C_A$

2) In kW $ERP_D = ERP_{DFX} \times C_{RM} \times C_B \times C_A$

Where,

ERP_D is the ERP of the DTTB station in dBW (formula 1) or kW (formula 2);

ERP_{DFX} is the ERP of the DTTB station with fixed reception to match UHF analogue coverage based on the recommended minimum field strength, as given in Table 4.6;

C_{RM} is the correction for the digital reception mode as given in Table 4.7;

C_B is the correction for the analogue TV frequency band as given in Table 4.7;

C_A is the correction for the analogue TV coverage basis as given in Table 4.7.

Table 4.7 Digital ERP corrections

Correction		Formula 1	Formula 2
C_{RM}	Digital reception mode FX	0 dB	1
	Digital reception mode PO	25.3 dB	340
	Digital reception mode PI	37.3 dB	5340
C_B	Analogue TV band III	12 dB	16
	Analogue TV band IV/V	0 dB	1
C_A	Analogue coverage; Recommend minimum field strength	0 dB	1
	Analogue coverage; Limit of reception	10 dB	10

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 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.

As a first approach, it could be estimated that the ERP of a digital transmission (expressed in mean power) at 64QAM 3/4 to replace an analogue one (expressed in peak envelope power) is:

- six times less compared to the analogue transmission in UHF;
- 2.7 times more compared to the analogue transmission in VHF.

With this ERP, it is possible:

- To cover an area the size of the analogue coverage based on the recommended ITU values for rooftop reception in the absence of interference or other noise.
- To cover an area with portable (outdoor) reception. This area considerably smaller than the coverage area with rooftop reception. However, in not too large towns where the transmitter is situated close to the town, the portable target may be achieved with this ERP. If the portable reception area is not sufficient, DTTB portable reception can be improved by:
  - Higher ERP (up to the maximum given in GE06);
  - Dense SFN;
  - More robust system variant; e.g. 64QAM2/3 or 16QAM3/4.
- To use an existing UHF analogue transmitter converted to digital (with reduced power).

A few examples are shown in Table 4.8[34].

Table 4.8 Examples of DTTB ERP to match analogue TV coverage

Analogue TV station (estimated characteristics)	DTTB ERP at 64QAM 3/4 (in UHF) to match analogue coverage	Coverage area
Benguela – VHF **ERP: 10 kW at 75 m**	• Recommend Emin: 27 kW • Limit of reception: 270 kW	• Recommend Emin: 35 km • Limit of reception: 55 km • DTTB-PO (with 27 kW) 11 km
Caxito – VHF **ERP: 50 W at 40 m**	• Recommend Emin: 0.13 kW • Limit of reception: 1.3 kW	• Recommend Emin: 9 km • Limit of reception: 15 km • DTTB-PO (with 0.13 kW): 2 km
Luanda Fortaleza – UHF **ERP: 10 kW at 30 m**	• Recommend Emin: 1.7 kW • Limit of reception: 17 kW	• Recommend Emin: 17 km • Limit of reception: 23 km • DTTB-PO (with 1.7 kW): 6 km

The ERP of many of the existing analogue TV transmitters is rather low and consequently the coverage areas are limited. Depending on population distribution and topology installing digital transmitters could be considered, either as MFN or SFN, with the ERP allowed by the assignments in GE06 (most Angolan GE06 assignments have ERPs of 40 kW or 100 kW) at an appropriate antenna height. In this way, an extended coverage is achieved immediately. However, it should be investigated whether the existing masts have sufficient height to cover the extended area and are of sufficient mechanical strength to carry the high gain antenna or if new masts have to be installed.

[34] In these examples the coverage area has been calculated with the propagation method from Recommendation ITU-R P.1546. The application of this method is described in Annex 6 to this report.

The digital ERPs indicated in this section are a first estimation and do not take into account interference other than noise. Coverage assessments, preferable making use of a terrain and clutter data base, should indicate if coverage is acceptable in practical cases.

Comparison of DTTB and MTV coverage

With the ISDB-T 1 seg standard, the MTV services are transmitted in the same multiplex, hence with the same power, as the DTTB services.

Theoretical considerations indicate that (see also Figure 4.8 above and Section 2.3 of Annex 6):

1. MTV coverage (handheld portable indoor and outdoor) is restricted compared to DTTB coverage at 64QAM3/4 or 64QAM 2/3 with rooftop reception; and
2. MTV (handheld) coverage with indoor reception is about the same as DTTB coverage at 64QAM 3/4 or 64QAM 2/3 with outdoor reception.

It should be noted that in the MTV considerations above the building entry loss value given in the GE06 Agreement[35] are taken into account. It is not known if this value is adequate for MTV indoor reception in Angola. It should also be noted that the MTV end-user equipment may have extendable antennas, as the receiving devices used in the MTV tests in Luanda. In case of poor MTV reception, an extended receiving antenna will considerably improve reception. Under such circumstances MTV (handheld) outdoor coverage may not differ too much from DTTB coverage at 64QAM3/4 or 64QAM 2/3 with rooftop reception, as has been confirmed by field tests in Luanda.

4.10 Frequency plan

The basis for the frequency plan is the Geneva 2006 Agreement (GE06). GE06 contains two plans, an analogue plan and a digital plan. After 17 June 2015 the analogue plan will be cancelled. The entries in each of the plans are in principle compatible, which means that no unacceptable interference will be caused to any of the services resulting from assignments in the plan. However, the analogue plan and the digital plan are not necessarily compatible with each other. Therefore, during the transition period when analogue and digital stations are in operation, it should be checked that no interference will occur between analogue and digital TV stations. If so, digital stations need to be restricted (in power or in the date of putting into operation) in order to protect analogue TV reception.

Furthermore, in relation to a number of assignments coordination is required regarding the protection of analogue television assignments in: Democratic Republic of the Congo, Congo (Republic of the) and Namibia (Republic of).

The national frequency plan consists of 2 x 3 plans (see Table 4.9). In each of these all entries should be compatible.

Table 4.9: Frequency plans

Situation	Band III	Band IV/V
Existing	Analogue TV	Analogue TV
During transition	Analogue TV	Analogue TV DTTB replacing ATV Additional DTTB
After ASO	[T-DAB]	DTTB replacing ATV Additional DTTB DTTB network extensions IMT > 790 MHz

[35] See GE06 Agreement Chapter 3 to Annex 2, section 3.2.2.2

In addition, non-broadcasting services (other than IMT) may have been allocated. If so, these services should be taken into account in planning the digital broadcasting services in order to avoid mutual interference. However, it should be noted that Angola has no entries in the list of assignments to other primary terrestrial services of the GE06 Agreement.

In the digital plan of GE06, Angola has also T-DAB (digital radio) assignments in Band III. Digital radio is not in the scope of this roadmap and will not be considered.

The following subsections describe the steps for establishing the national frequency plan:

1. Analogue TV plan.
2. Digital TV plan .
3. Analogue and digital TV plan during transition.

4.10.1 Analogue TV plan

The current analogue TV bands are Band I (47-64 MHz), Band III (174-230 MHz) and Band IV/V (470 -862 MHz). An overview of the current analogue TV stations is shown in Table 2.2. The GE06 Agreement contains analogue assignments for Angola in Band III and Band IV. It is noted that for historical reasons none of the analogue TV frequencies in use complies with the analogue TV assignments in GE06.

Provided that the current analogue coverage is satisfactory and no complaints have been received from neighbouring countries, it is advised to continue the existing analogue TV channel assignments on a non-interference/non-protection basis[36], because:

1. analogue TV will be switched off in 2015 at the latest;
2. frequency changes may confuse viewers; and
3. all management attention and communication efforts should be directed to the process of transition from analogue to digital TV.

In order to be able to calculate the coverage areas of the analogue TV stations and to assess compatibility between analogue and digital TV in the transition period, the transmitter database should also include the effective radiated power (transmitter power plus antenna gain minus feeder loss).

4.10.2 Digital TV plan

GE06 assignments and allotments

The basis for the digital TV plan is the set of assignments and allotments in the GE06 Agreement. Angola has in the digital plan of GE06:

Table 4.10: Assignments and allotments in GE06

Service	Assignments
T-DAB in Band III	16 T-DAB allotments with RPC 5 (indoor reception)
DVB-T in Band III	25 DVB-T allotments with a single linked assignment and no SFN-id with RPC1 (rooftop reception)
DVB-T in Band IV/V	145 DVB-T allotments with single linked assignment and no SFN-id with RPC1 (rooftop reception)

[36] The UHF analogue TV channel "20" should be clarified (see Section 2.1.2); depending on the actual situation it may be necessary to modify the existing UHF analogue channels in order to avoid transmissions outside the broadcasting band.

A plan entry consisting of an allotment with a single linked assignment and no SFN-id means that the allotment boundary defines the area to be protected and the only source of interference is the assignment[37]. The reference network (Reference Network RN1 is given in each of the allotments) has no meaning in this case.

As an example, the assignment data and the allotment area of the plan entry Luanda on channel 48 is shown is Figure 4.10. It shows that the allowed ERP is 40 kW (box 18), the maximum effective antenna height is 300 m (box 22) and the reception mode is rooftop antenna (box 13). The meaning of boxes is given in Annex 1, Table 3.1 of GE06.

Figure 4.10: Assignment and linked allotment area of plan GE06 plan entry Luanda channel 48

DVB-T LUANDA 48

1	47300	12	
2	AGL	13	RPC1
3	DT11307088	14	690 MHz
4	5	15	48
5		16	
6	DT21307088	17	H
7	AGL	18	46 dBW
8	LUANDA	19	
9a	-084900	20	ND
9b	0131500	21	0 m
10	0 m	22	300 m
11			

23									
0°	300	300	300	300	300	300	300	300	300
90°	300	300	300	300	300	300	300	300	300
180°	300	300	300	300	300	300	300	300	300
270°	300	300	300	300	300	300	300	300	300

Source: GE06 assignments and allotments

In the GE06 digital plan, there are 56 sites in UHF, most with three assignments (multiplexes). Eleven sites have one or more channels in the frequency range 61 to 69 (790 to 862 MHz); in total 21 assignments. As it has been decided to allocate this frequency range to International Mobile Telecommunications (IMT), alternative channels have to be found for the DTTB transmitters at these sites.

At six sites in Band III and at six sites in Band IV/V the polarisation is specified as vertical whereas the other sites have horizontal polarization. The reason for this should be investigated.

For each site, the channel for broadcasting a transport stream (multiplex) should be determined. According to the DSO objectives (see Table 2.4) five multiplexes are required. Most sites have three channels in GE06. Consequently the number of assignments per site should be increased to five with channels in the range 21 to 60. Planning excises will be needed to specify the additional assignments so that:

1. no unacceptable interference is caused to other Angola TV stations;
2. no unacceptable interference is caused to a foreign TV station to ensure that the GE06 Article 4 procedure can be successfully applied;
3. the interference from other (national and foreign) TV stations is acceptable; and
4. a similar coverage area is achieved as with the existing assignments.

[37] See section 4.5 in Section II of Annex 4 of GE06

Theoretical studies indicate that the capacity of Band IV/V is more than three assignments per site (see Section 4 of Annex 7). It is therefore possible to obtain additional assignments that fulfil the above mentioned conditions.

Band III and Band IV

In the GE06 digital plan, Angola has at 25 sites a Band III channel in addition to the Band IV/V channels (at most sited three UHF channels). In principle at these 25 sites an additional multiplex can be transmitted. However, in the DSO objectives it is not indicated that in some areas more services are required than in others.

Although Band III is an attractive band from a propagation point of view (less power needed for the same coverage as in Band IV/V), it is advised to plan only Band IV/V channels because:

1. Most analogue transmissions are in Band III, therefore compatibility problems during the transition period are minimized (see also Section 4.10.3).
2. Most households in Angola receive television by means of a simple antenna (portable reception); use of Band IV/V channels only has in this situation the advantage that[38]:
    - Band IV/V has lower man-made noise levels compared to Band III. Because of man-made noise, Band III portable reception could be distorted;
    - Combined Band III/IV/V portable receiving antennas show relatively poor performance in Band III.

MFN and SFN

The DTTB GE06 plan entries for Angola form multi frequency networks. In principle, it is possible to convert a plan entry into a single frequency network (SFN), provided that the interference potential of the SFN does not exceed the interference potential of the assignment from which it is converted. This should be checked with the "conformity check"[39]. The conformity check is a complicated calculation process. A software tool for carrying out the conformity check is available at and can be downloaded from the ITU Radiocommunication Bureau (BR) website[40]. Such a software tool is often also included in commercial digital TV planning software.

In SFN planning internal network interference may occur when the signals from one or more of the transmitters in the SFN are received outside the guard interval; it should be checked carefully by means of network planning exercises if the interference is acceptable or not. The ITU Guidelines in Section 4.3.2 describe SFN planning and a reference is given for more detailed information on SFN planning. Also measures for reducing internal network interference, together with their disadvantages, are indicated.

In the table below maximum separation distances between transmitters in an SFN are shown for different guard intervals of the ISDB-T standard in the 8 MHz version.

As MTV (1 seg) and DTTB services are contained in the same transmission, the guard interval of both the 1 seg and the remaining segments should be the same. However, with QPSK (Quadrature Phase Shift Keying) modulation of the MTV signal and 64QAM modulation of the DTTB signal, the MTV signal is less sensitive to interference. Consequently the internal network interference area of the MTV service is likely to be smaller than of the DTTB service.

[38] See also Table 4.2.7 in Chapter 4.2 of the ITU Guidelines

[39] See Section II of Annex 4 of GE06.

[40] www.itu.int/ITU-R/terrestrial/broadcast/software/ge06calc/index.html

Table 4.11: Guard interval and transmitter separation distances with ISDB-T/ 8 MHz

Length of guard interval in relation to symbol length	Length of guard interval in 8k ISDB-T/8MHz standard	Separation distance when guard interval is exceeded
¼	189 µs	≥ 57 km
1/8	94.5 µs	≥ 28 km
1/16	47.25 µs	≥ 16 km
1/32	23.625 µs	≥ 7 km

DTTB implementation plan

DTTB will be implemented in four phases. The sites related to each of the phases are shown in Section 2, Table 2.5. There are in total 90 DTTB sites of which 40 are yet not identified. Angola has one or more assignments in GE06 in UHF at 56 sites. Consequently, five assignments at 34 sites should be obtained. Planning exercises are needed to establish the characteristics of the assignments in such a way that coverage is acceptable and the GE06 Article 4 procedure can be successfully applied.

GE06 implementation

To summarise the following actions should be taken with regard to the GE06 Plan.

Table 4.12: Actions with regard to GE06 implementation

GE06 procedure	Actions in order to broadcast five multiplexes at each site
Article 4	• Plan additions of two assignments at most of the 56 GE06 sites in the range 21 to 60 • Plan additions of five assignments at 34 new site in the range 21 to 60
Article 4	• Plan modification of 21 channels at 11 sites in the range 21 to 60, to replace channel 61 to 69
Article 5	• Conversion of an assignment into a SFN where needed, complying with the “conformity check”
Article 5	• Agreement regarding protection of analogue assignments of COG on channel 44, 50, 51 and 60 • Agreement regarding protection of analogue assignments of NMB on channel 53

Notification to ITU-R

In Angola, the ISDB-T standard will be used instead of the DVB-T standard, on which the GE06 has been based. From a planning point of view this will not cause problems to neighbouring countries, nor to the Angolan GE06 assignments, because the protection ratios for DVB-T interfered with by DVB-T and DVB-T interfered with by ISDB-T are the same (see Annex 5).

When a station should come into operation it should be notified to ITU-R. In case of a different transmission standard than DVB-T it should be notified in accordance to Article 5.1.3 of GE06 using form GB1[41].

When any difficulty arises with the notification, the Angola administration is welcome to contact the ITU Radiocommunication Bureau (BR)[42].

[41] See the Broadcasting Services Guide on the submission of notices, which can be found at: www.itu.int/ITU-R/terrestrial/docs/notice-forms/ge06/BS_Guide.pdf

[42] email: brbcd@itu.int

It is not necessary to notify test transmission of relatively short duration because normally the administration has already a corresponding assignment in the GE06 Plan. Currently the test transmissions in Luanda take place on channel 31 and will be changed soon to channel 48, one of the GE06 channels.

4.10.3 Analogue and digital TV plan during transition

During the transition period and depending on the ASO plan, analogue and digital transmitters are in operation:

- the analogue TV transmitters in accordance with the analogue TV plan as indicated in Section 4.10.1; and
- the digital TV transmitters in accordance with the digital TV plan as indicated in Section 4.10.2.

During the transition, interference from analogue to digital and vice versa should be avoided. For that reason compatibility calculations should be carried out and as far as necessary digital transmissions need to be restricted, in power or launch date, in order not to affect the analogue TV coverage area.

5 Recommendations

Given the information collected during the two ITU expert missions and the analyses carried out by the experts in this report, the NRT is recommended to carry out the following steps for a smooth transition to digital television broadcasting and the analogue services switch-off:

1. Seek the roadmap report approval 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 roadmap report, this mandate may come in stages.
3. After being mandated, prepare and take the following decisions as the first step 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;
   - finalize licensing model, to include:
     - a public tender for the pay-tv/commercial service providers;
     - a model for assigning broadcast licenses (and hence the bandwidth management/assigning slots), in particular for the common multiplex/network operator;
     - open network provisioning (ONP) rules for the common multiplex/network operator;
   - finalize and agree the DSO objectives (see Table 2.3);
   - determine the procedure and contract to be awarded to a network operator supplier.
4. Form a project management office (PMO) and start drafting an initial detailed ASO planning and determine the progress reporting procedures and structures.
5. Start preparations for splitting off the TPA network assets and establishing the common multiplex/network operator .

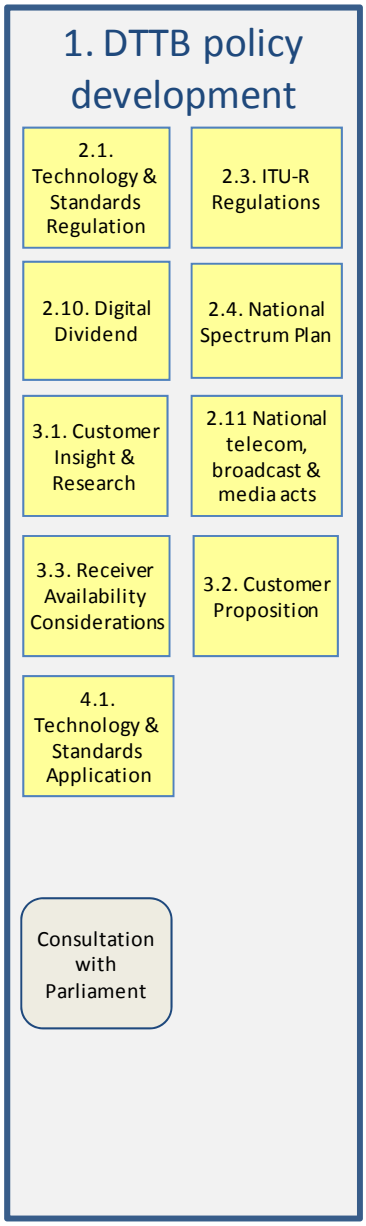
Apart from these next steps for the NRT to take, some additional recommendations can be provided which seem to be evident for the Angolan situation:

1. Carry out additional market research covering the elements as indicated in this roadmap report (see phase 1). The NRT has carried out market research in the past. However, as some market data is lacking, having additional market research available would be an advantage, and would help to manage the ASO process.
2. Carry out detailed frequency and service planning (see phase 2 and 3). Additional frequency planning will be required to see what is possible, especially considering the five multiplexes per site (as formulated under the DSO objectives).

3. Investigate the possibilities of auctioning the mobile (LTE) spectrum as an important means of 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



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

Section 3.4.2 describes phase 1 of the roadmap.

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

A. the decisions on key topics and choices that are already taken;

B. the decisions on key topics and choices that are partly taken;

C. the activities needed regarding key topics and choices that have not yet been decided;

D. the activities needed regarding key topics and choices that need revision.

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

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

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

2.1 Technology and standards regulation

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

Key topics and choices		Status	Decision
2.1.1	Television presentation **formats**: for DTTB platforms either Standard Definition Television (SDTV) and/or High Definition Television (HDTV) and for MTV platforms a minimum bit rate per service. Has the standard setting been decided?	B	One HDTV service (picture quality not decided yet – minimum bit rate should be determined) in the second FTA multiplex (see also Section 4.5 and Annex 7) Additional SDTV services (picture quality not decided yet – minimum bit rate should be determined) in first and second FTA multiplex (see also Section 4.5 and Annex 7) MTV: minimum bit rate per service not determined yet.
2.1.2	Transmission standard: for DTTB platforms e.g. DVB-T or ATSC and for MTV platforms DVB-H or T-DMB. Has the standard setting been decided?	A	DTTB: ISDB-T MTV: ISDB-T (1 seg).
2.1.3	Compression technology: for DTTB platforms MPEG2 or MPEG4 and for MTV platforms e.g. H264/MPEG-4 AVC or open. Has the standard setting been decided?	A	DTTB: MPEG4.
2.1.4	Conditional Access (CA) system and Digital Rights Management (DRM): interoperability between deployed systems for respectively DTTB and MTV platforms. Has the standard setting been decided?	C	Decision depends on a market analysis on the viability of introducing pay-tv services on the DTTB platform (see Section 4.3) and the decision on exclusivity of services of the common multiplex/network operator (see Section 4.4).
2.1.5	Application Programming Interface (API) for additional and interactive services. For MTV platforms specific technical requirements to support integration between broadcast TV and 3G mobile TV networks. Has the standard setting been decided?	A	Ginga (able to run BML) – detailed specification still under study.

Main activities	Observation/Advice
1. Carry out market research/surveys for identifying industry and consumer needs for standardization.	To be included in additional 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 license terms and conditions and/or media permits and authorizations.	See Section 3.4.2.

Main activities	Observation/Advice
5. Determine communication messages, planning, standardization/testing bodies and methods (including logos and labelling).	The selected STB functionality and specs are important input for the Communication Plan (see second Phase of the Angola 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 Sections 4.6 and 4.7 in this report.

2.3 ITU-R Regulations

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/known (allotment/assignment)?	B	Footnotes still to be addressed with neighbouring countries.
2.3.2	Applicability and implications of the GE06 plan and 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 licensed to two different license holders or two allotments to one single license holder? (c) When these frequencies or allotments will be licensed or can be taken into operation?	B§	Partly decided. Total number of multiplexes decided and for what services: 2 multiplexes for FTA services (including at least one HDTV service in the second multiplex) and 3 multiplexes for pay-tv/commercial services (see Section 4.5). Aggregation rules still to be decided (see Sections 4.4 and 4.5)

Main activities	Observation/Advice
1. Determine frequency availability and DTTB requirements considering (a) the planned national and regional DTTB services (b) ASO process (especially considering any simulcasting areas) and (c) the operational 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. Given the DSO objective of having 5 multiplexes at each site the GE06 plan needs to be changed and network planning should be carried out to make an acceptable plan.
2. Determine necessary changes to planned licensing procedures, terms and conditions for DTTB services and ASO plans.	As (preliminary) input for phase 3.
3. Determine necessary changes to assigned frequency (and possibly content) licenses for operational DTTB and Analogue TV services.	Especially the licenses assigned to TPA and Zimbo needs to be evaluated.
4. Determine notification to the 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 analogue licenses 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 licenses 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?	B	NSP is available. Is it updated to reflect the digital dividend decision (i.e. allocating channels 61 -69 to IMT)?
2.4.2	Planning current and future DTTB and MTV spectrum use: Has the national spectrum plan/strategic planning process started/completed?	B	See DSO objectives Table 2.4. Are these objectives reflected in the NSP?
2.4.3	National Spectrum Plan publication and DTTB/MTV introduction: NONE	-	-
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	Especially the assignment of the spectrum rights to the common multiplex/network operator needs special attention. This also included a decision on the license fees to be paid.

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.
2. Register use and provide rules for (self) registration.	The division of tasks and activities between the Ministry of Media and the common multiplex/network operator has to be clarified. Especially the procedure for assigned broadcast and associated frequency rights (see Section 4.4).
3. Carry out market analyses and consultations and forecast future spectrum needs.	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. 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 license conditions. 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	Definition of the digital dividend and its application: NONE	-	-
2.10.2	Determining the size of the digital dividend: has the size been determined?	A	Channels 61 – 69 will be allocated to IMT, in line with the preparatory documents of the WRC12.
2.10.3	Digital Dividend options: have the allocation to the different service been determined? (broadcasting or non-broadcasting)	A	Allocation to IMT

Main activities	Observation/Advice
1. Analyse 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. The preparatory documents of the WRC12 will help in providing this evidence and motivation.
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. Section 4.4 includes an initial ASO planning which also outlines the planning of assignment spectrum.
5. Possibly draft spectrum re-farming plans and compensation schemes (for network and receiver re-tuning activities), reserve budgets.	To be checked if necessary.
6.. Update National Spectrum Plan and align license Terms and Conditions for DTTB services.	A check of current license terms and conditions for both broadcast and frequency licenses will be necessary (see Section 4.4). 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.
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?	B	Checking at the beginning of the process required.
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?	A	Checked and no rules to be (re)considered.

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 Subsection 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 the third phase of the roadmap (DTTB Regulations), the gaps and necessary changes can be further detailed.
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 DTTB and/or MTV services, will require the identification of demand drivers (i.e. customer needs), competitive advantages, service uptake projections and possibly market entry barriers in the local market(s)
Objective	Service Providers and Network Operators will carry out some form of market research for identifying these demand drivers, competitive advantages and service uptake projections.

Key topics and choices		Status	Decision
3.1.1	Overview of the DTTB and MTV markets: market definition, key service and market characteristics	B	Study on going, but to be completed with additional information (see Section 3.4.2). 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).
3.1.2	Market research methods: basic market research approaches and embedding market research in the DTTB/MTV business planning process	B	Study on going, see above.

Main activities	Observation/Advice
1. Determine need, timing and scope for market research.	See also Subsection 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. Analyse competitive offerings, substitutes and technology developments.	Utilize resources and staff from the participating broadcasters in the NRT.

Main activities	Observation/Advice
4. Design and develop preliminary DTTB service propositions.	As part of the on-going market research.
5. Carry out market research and analyse results, translate into DTTB service propositions, if necessary carry out additional market research.	As part of the on-going 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 the second phase 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. For more detailed considerations see Section 4.1 in this report. Attributes still to be decided/defined (e.g. coverage and number of channels).

Main activities	Observation/Advice
1. Analyse earlier DTTB service launches and compare with customer research results/local market conditions.	Service launches in other countries could be considered. For example in the neighbouring countries (or SADC 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 too 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 and a modem to provide return path functionality will increase the price.
3.3.2	MTV functional receiver requirements and availability.	NA	To be considered at the time of commercial introduction.

Main activities	Observation/Advice
1. Analyse earlier DTTB service launches for STB supplies and functionality requirements.	This market survey exercise is to address the aspects as included in the ITU Guidelines but also the additional Angolan specific issues as included in Subsection 3.4.2 (i.e. independent and warranted supplies and affordable and sufficient supplies). Also the return path functionality should be researched. The NRT has already carried research out and negotiated supplies.
2. Check any prescribed Technologies and Standards, Receiver regulations and analyse 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 ISDB-T/8MHz 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 Angola.
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 labelling and the inclusion of IDTV information in the ASO Communication plan is strongly advised.

4.1 Technology and standards application

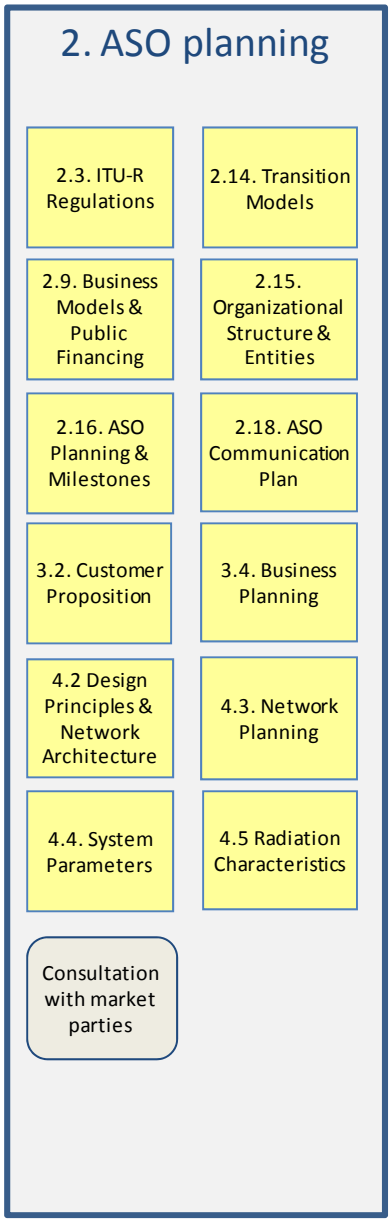
Key topics and choices		Status	Decision
4.1.1	Technical tests to evaluate system performance	B	SFN test in Luanda in progress.
4.1.2	SDTV and HDTV specifications	C	SDTV picture ratio 16:9. Bit rate for SDTV and HDTV services still to be decided.
4.1.3	Selection of DTTB transmission standard	A	ISDB-T; Application Programming Interface (API) (middleware) will be Ginga with support to BML
4.1.4	Compression system	A	MPEG-4
4.1.5	Encryption system	B	The use encrypted signals is necessary in the pay-tv multiplexes. Use of the same Conditional Access System (CAS) with all pay-tv services will be stipulated in the license conditions. The CAS still to be decided

Key topics and choices	Status	Decision
4.1.6 Additional services	C	Interactive e-gov and other services, capacity and presentation to be decided.

Main activities	Observation/Advice
1. Studying technical characteristics and planning criteria of ISDB-T standard	Testing should include receiver performance of: • Picture and sound quality at different bit rates; • Service information handling; • Datacasting and evaluation of the presentation of the data on TV screens. Test should operate on one of the GE06 channels assigned to Luanda (48, 51 or 54).
2. Estimate required bit rate of SDTV and HDTV services (including sound channels) The bit rate of the multiplex is a trade-off between picture quality and multiplex capacity (for maximum multiplex capacity see Section 4.10 and Annex 7). 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.	First estimate could be: • Video bit rate SDTV: ≥2 Mbit/s (MPEG4), depending on the kind of programme. • Video bit rate HDTV: ≥8 Mbit/s (MPEG4), depending on the kind of programme. The above mentioned bit rates are minimum values with MPEG4 compression at not too big screens. Together with statistical multiplexing (as advised in Annex 2 phase 2, functional building block 4.2, Main activity 5) picture quality should be good in most circumstances. As indicated in Main activity 1, tests transmission in Luanda should include subjective picture quality tests with several bitrates. The results will give an impression of the required bit rate at screens expected to be used in Angola and for critical programme material. Audio bit rate: ≥128 kbit/s (AAC) for a stereo channel and 64 kbit/s for a mono channel.
3. Evaluation of conditional access (CA) systems	The choice for a conditional access (CA) system is a trade-off between costs of the system and security.
4. Estimation of required bit rate for SI and e-gov services Service Information (SI) is needed for constructing the EPG in the receiver.	The Service Information required for the EPG may take about 0.2 Mbit/s. The capacity for the e-gov services needs to be determined. An initial guess may be 0.5 Mbit/s.

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

ASO planning



The selected functional building blocks related to phase 2 of the roadmap are shown in Figure 3.9 and are reproduced here.

Section 3.4.3 describes phase 2 of the roadmap.

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

A. the decisions on key topics and choices that are already taken;

B. the decisions on key topics and choices that are partly taken;

C. the activities needed regarding key topics and choices that have not yet been decided;

D. the activities needed regarding key topics and choices that need revision.

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

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

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

2.3 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
2.3.1	The international context of the ITU-R regulations: Are the different entries in the GE06 plan considered (allotment/assignment)?	C	Still to be analysed. The GE06 plan need changes to facilitate 5 multiplexes at each site.
2.3.2	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. The phased approach (see Section 4.4) may open up possibilities to move frequencies around and make it easier to meet the simulcast requirement.

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 the details provided in Section 4.5 on the transition model.
2. Determine necessary changes to planned licensing procedures, terms and conditions for DTTB services and ASO plans.	As input for phase 3.
3. Determine necessary changes to assigned frequency (and possibly content) licenses for operational DTTB and Analogue TV services.	Especially the assigned analogue licenses TPA and Zimbo 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 analysed and decided in the ASO planning phase. For more considerations see Section 4.8 in this report.
2.9.2	DTTB specific financing issues: (a) Financing of digital receivers (b) Financing the impact of free-to-air stipulations (c) In case the PSB service is encrypted content rights can be lowered (d) Financing the simulcast period (e) TV licensing fee system might need revision.	C	All still to be addressed in the ASO planning phase: (a) STB financing options to be considered (including a common multiplex/network operator providing and subsidizing the single cheap STB); (b) Additional FTA channels on digital platform still to be determined; (c) Still to be considered; (d) Still to be considered; (e) May not be applicable.

Main activities	Observation/Advice
1. Consult Public Broadcasters and Government on possibilities to contribute to financing the ASO process.	When establishing the common multiplex/network operator sufficient funding should be allocated to cover OPEX and CAPEX costs for the network site of the ASO process (see also Section 3.4.1 and 4.4).
2. Analyse market situation and assess possible market distortions.	Due to the high number of satellite service providers (see figure 2.1 in Section 2.1 in this report) and their relative market share (see Table 4.2 in Section 4.1), 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 political endorsement.
4. Align defined public service offering with other DTTB license terms and conditions and media permits, and their planning.	NA, no other assigned DTTB licenses.
5. Determine and establish budget for ASO Plan.	The ASO Plan will need political approval and hence should be well prepared and introduced (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 and where in Angola.
Objective	Existing analogue services are migrated to a DTTB platform in one coordinated effort and without service interrupts.

Key topics and choices	Status	Decision
2.14.1 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).	B	For a large part decided. See 'DSO objectives' in Section 2.3 in this report. The exact DTTB introduction and ASO dates (for each region) still to be decided. Also the exact DTTB service coverage should be decided. This will have to be based on network planning and survey of the existing sites.
2.14.2 ASO factors: consider the following factors: (a) Required (PSB) services; (b) The number of analogue terrestrial television viewers; (c) Availability of spectrum; (d) DTTB service uptake.	C	All to be addressed.
2.14.3 ASO transition models: Which models is envisioned (a) ASO with simulcast period, with two sub-categories: i. Phased approach to analogue switch-off; ii. National approach to analogue switch-off; (b) ASO without simulcast period.	A	It was decided to have a phased simulcast and roll-out of the DTTB network (in four regions). For more details see Section 4.5 in this report.

Main activities	Observation/Advice
1. Check existing Legislation and policies for Public television service (e.g. FTA) and coverage stipulations (e.g. nationwide coverage).	Current legal framework does not explicitly states a minimum coverage percentage. This provides a degree of freedom for the NRT.
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.	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.
3. Analyse and assess complexity and size of network modifications and receiver transitions.	It was concluded that infrastructure incompatibilities were unlikely to occur. However for having 5 multiplexes at each site the GE06 plan needs to be changed.
4. Involve and discuss ASO with broadcasters, other service providers and consumer associations.	To be included in this phase of the roadmap as part of the NRT.
5. Decide transition model (simulcast period and ASO phasing).	The initial ASO planning (as provided in Section 4.5) needs to further detailed and checked on feasibility.

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 Angola this task is assigned 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 Angola. 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 analysed and determined (use table in this section).	C	Detailed 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.
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 mid-2015. In addition, the first DTTB broadcasts will start in 2012. Exact dates still to be analysed and agreed (see Section 4.5)
2.16.2	Overall ASO planning set-up: including the overall programme 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.	B	Partly addressed in the initial ASO planning (see Section 4.5). Feasibility still to be checked by drafting a detailed planning with exact start en end dates.

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 reports can be found on: www.digitaluk.co.uk/__data/assets/pdf_file/0009/19791/Digital_UK_Ofcom_Q2_2007_FINAL.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 fo cuses 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. Communication Plan to be drafted and executed in close collaboration with pay-tv/commercial service provider(s). See Section 4.4 and 4.7.
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) Mobile/SMS coverage checker (d) social Angolan 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, 4.4 and 4.7 of this report.
2. Continuous alignment with ASO planning.	
3. Determine and establish compensation schemes and systems and 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
3.2.1	DTTB competitive advantage and related Service Proposition attributes determined.	C	Competitive advantage already established in previous phase. Attributes still to be defined. See also Section 4.1.

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 ITU 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 endorsed.

Key topics and choices		Status	Decision
3.4.1	Business models for DTTB services: which model or combination of models is considered (may vary per multiplex).	A	Two FTA multiplexes and three multiplexes with pay-tv services.
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 Section 4.6 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 vendor financing.	
5. As part of the ASO Plan prepare approval of ASO budget (at political level).	

4.2 Design principles and network architecture

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

Main topics and choices		Status	Decision
4.2.1	Trade-off between network roll-out speed, network costs and service quality	C	
4.2.2	Main reception mode and defining receiving installations	B	The objective is to plan DTTB services for rooftop reception, but with the aim to achieve as much as possible portable reception at least in large cities. Portable receiving conditions for good reception still to be decided.
4.2.3	Services for national, regional, or local coverage A regional coverage is characterized by regional content as part of the multiplex of all transmitters in the regional area. In case of SFNs, transmitters broadcasting different content at any moment in time, should be part of different SFNs	B	TPA has currently regional services for some hours at three sites. In the long term regional windows are needed in each province. The distribution of regional services remains to be decided. Insertion of regional programmes at a site requires a remultiplexer at that site. Alternatively, regional programmes 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 ITU Guidelines)
4.2.4	Frequency plan and network topology	B	Sites for ASO phase I to III are determined (see Section 2.3, Table 2.5); DTTB sites for ASO phase IV yet not specified. Each site needs 5 channels in the range 21 -60. Frequency plans should be made for: 1. Existing situation 2. Transition period 3. After ASO See Section 4.10 of this report.

Main 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	A	Optical fibre.

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. On the job training and knowledge transfer are also requirements in the public tender document as a tool to provide local staff with essential knowledge to run and maintain the network.
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 The technical specifications of receiving installations and the required median minimum field strength values can be found in Chapter 3 of Annex 2 of the GE06 Agreement (see also Section 4.9 of this report).	Fixed reception (rooftop) is normally the basis for determining if the coverage obligation of Public Broadcasters has been fulfilled. In addition coverage should be estimated with the type of receiving installation that is normally used. Portable outdoor reception is a balanced compromise for the type of receiving installation normally used in Angola: • It represents reception with a simple antenna; • It is a well-defined receiving condition; portable indoor reception would require the establishment building entry loss data (mean value and standard deviation) in the Angolan situation. Portable outdoor reception represent also portable indoor reception but with lower reception probability. When reception takes place indoor, an optimal location of the antenna should be sought. Indoor reception is easier relative close to the transmitter, at higher floors and when building entry losses are minimal. See Section 4.9 of this report.
4. Evaluation of network topology	The locations of head-ends (including regional remultiplexes) need to be determined, taking into account regional services (see main topic 4.2.3). DTTB sites in ASO IV need to be determined. DTTB coverage areas should encompass the current analogue TV coverage, taking into account that in total 90 DTTB sites are foreseen, whereas analogue TV is transmitted from 159 sites. Also the basis for the analogue TV coverage to be replaced by DTTB should be determined. See Section 4.9 of this report. At most existing sites analogue TV is transmitted in VHF, where UHF the equipment is in many cases semi professional. In most cases existing transmitters and antennas can therefore not be reused for DTTB. It should be checked if the masts have sufficient height for DTTB coverage of (extended) areas and are of sufficient mechanical strength to carry high gain UHF antennas. Station characteristics should comply with the GE06 Agreement

Main activities	Observation/Advice
	(see also Functional building block 2.3 ITU-R regulations).
5. Drafting multiplex composition plan Final estimation of the multiplex composition can only be made after Network planning (see functional building block 4.3) have been considered.	The initial multiplex composition for the head-end, should take into account the bit rate requirements established in functional building block 4.1 (see also Annex 7of this report). The bit rate of the Transport Stream should be lower than the bit rate of the DTTB variant set at the transmitters in order to avoid overflow. 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: • It would probably be necessary for the MPEG4 coders and the multiplexer to be physically close to each other and controlled by the same computer; • It is not possible with current technology with downstream drop-and-insert multiplexing such as would be needed in a regional network.
6. Evaluation of the required operational availability time of transmission equipment The operational equipment availability time is a tradeoff between costs and acceptable off-air time due to failures.	TPA will have its own experience with operation of transmission equipment under the environmental conditions of Angola and will have specified the reserve conditions of the existing transmitter stations based on this experience. Solid state transmitters have a build-in redundancy because the power amplification of transmitter has several power amplification units. Additional redundancy can be obtained by: • 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. With regard to the head-end, it is advised to install a spare encoder in an n+1 configuration.
7. Review of transmitting station lay out 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.	Instead of the current one or two low power analogue TV transmitters, DTTB sties will consist of five medium or high power UHF transmitters, combined into one high gain UHF antenna. Station lay out needs to be reviewed to accommodate additional transmitters. The existing power supply facilities are likely not sufficient to feed five UHF DTTB transmitters.

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	The Angolan GE06 entries are all in MFN mode. The network design principle is MFN complemented with SFNs in a number of towns to improve portable DTTB reception and handheld MTV reception. The locations of the SFNs still need to be decided.
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	GE06 compliance of planned stations	C	
4.3.5	Feed back to business plan and service proposition	C	See also functional building block 3.2.

Main activities	Observation/Advice
1. Planning criteria and planning method	In order to avoid continued discussions on planning results and coverage presentations the NRT should agree on the planning criteria and planning method. See also Section 4.9 and 4.10 of this report. Advanced network planning software is needed to: • Carry out SFN planning; • Establish the characteristics of the required additional and alternative assignments (see Section 4.10 of this report); • To assess the probability of interference to analogue TV in neighbouring countries of assignments having a remark in GE06 (see Section 4.10 of this report) • Prepare coverage plots (see Main activity 2)
2. Coverage analysis Coverage presentations and a list of stations characteristics are the result of a network planning exercise and form the key tools for analysis coverage.	It is advised to prepare coverage plots using network planning software that takes into account: 1. The ISDB-T standard with 8 MHz channel bandwidth and DVB-T, DVB-T2 standards (to take account of foreign transmissions); 2. Accurate terrain and clutter data; 3. Transmitter database of operational and planned stations (analogue and digital) including stations from neighbouring countries.
3. SFN application A Single Frequency Network is a network of synchronized transmitting stations radiating identical signals in the same RF channel	Depending on the coverage analyses and the available budget, improvement of portable reception in main cities, can be obtained by installing additional transmitting sites in SFN mode. In SFN planning, self-interference should be avoided by choosing the appropriate guard interval and by careful planning (see also Section 4.10 of this report).
4. Gap-filler planning 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).	Detailed coverage analysis resulting from main activity 2, is likely to show areas where coverage can be improved by means of gap-fillers. In general the receiving antennas of gap-filler need line-of-sight with the main transmitter. In case of SFN operation, the power of gap-fillers is restricted, depending on the isolation between input and output signal. See also ITU Guidelines Section 4.3.3.

Main activities	Observation/Advice
5. Performing GE06 (annex 4, section II) conformity check The GE06 Agreement offers considerable flexibility in the application of Plan entries. Deviation from the characteristics of the Plan entry does not always require international coordination according to the Art. 4 procedure.	All DTTB stations should comply to GE06. The Angolan DTTB GE06 plan entries form Multi Frequency Networks. In principle it is possible to convert a plan entry into a Single Frequency Network (SFN), provided that the interference potential of the SFN does not exceed the interference potential of the assignment from which it is converted. This needs to be checked by applying the GE06 conformity check. The conformity check is a complicated calculation process. A software tool for carrying out the conformity check is available at the ITU-R and can be downloaded from the ITU website. Such a software tool is often also included in commercial digital TV planning software. The conformity check is part of Art 5 of GE06 and will be applied by ITU-R when notifying a station. However, it is advised to carry out the conformity check when planning the network, in order to take into account required restrictions in the planning phase.
6. Carrying out "service trade-off" Radiation characteristics, multiplex capacity coverage quality are interrelated.	The "service trade off" should be carried out to find the optimum balance between multiplex capacity and coverage quality. With regard to the radiation characteristics see also the considerations given in Section 4.9.3. If no satisfactory solutions can be found in the "service trade-off" a review is needed of costumer proposition, business case and/or design principles and network architecture.

4.4 System parameters

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

Key topics and choices		Status	Decision
4.4.1	FFT size	C	The ISDB-T standard has three possible FFT sizes with 1405, 2809 or 5617 carriers.
4.4.2	Carrier modulation and code rate Radiation characteristics, multiplex capacity coverage quality are interrelated.	B	The initial choice is • DTTB: 64QAM 3/4 • MTV: QPSK 2/3 The "service trade-off" may result in a different choice.
4.4.3	Guard interval	B	The initial choice is 1/16th of the symbol period, which is 47.25 µs if 5617 carriers are chosen.

Main activities	Observation/Advice
1. Evaluation of FTT size	DTTB and MTV reception at high speed is not a requirement; therefore the option with 1405 and 2809 carriers does not need to be considered and the obvious choice is 5617 carriers, because it provides longer guard intervals and a higher net bit rate at same guard interval duration.
2. Evaluation of carrier modulation and code rate 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.	From a network planning point of view, high code rates are not advised because of the sensitivity to interference. In particular when portable reception is of importance low code rates should be chosen and even lower order modulation (16QAM) may be considered.

Main activities	Observation/Advice
Lower order modulation and lower code rates provide a more robust coverage at the cost of a restricted multiplex capacity.	Coverage analysis, including analysis of the achieved coverage for portable DTTB reception and evaluating the net bit rate of the multiplex through the "service trade off" should verify the initial choice of 64QAM 3/4. All transmitters fed by the same Transport Stream (TS), should have a system variant with a bit rate that is slightly higher than the bit rate of the TS, therefore modulation code rate and guard interval of all transmitters should in principle be the same.
3. Evaluation of guard interval The choice of guard interval is a trade-off between multiplex capacity and restricted coverage due to interference from natural or artificial echo of the transmitted signal.	The initial choice is 1/16th of the symbol period, which is 47.25 µs (with 5617 carriers). The corresponding transmitter separation distance is 16 km. If the separation distance between two or more transmitters of the SFN is exceeded internal network interference may occur (see Section 4.10 of this report). It should be checked carefully by means of network planning exercises if the interference is acceptable or not. The ITU Guidelines in Section 4.3.2 describe SFN planning and a reference is given for more detailed information on SFN planning. Also measures for reducing internal network interference, together with their disadvantages, are indicated. All transmitters fed by the same Transport Stream (TS), should have a system variant with a bit rate that is slightly higher than the bit rate of the TS, therefore modulation code rate and guard interval of all transmitters should in principle be the same.

4.5 Radiation characteristics

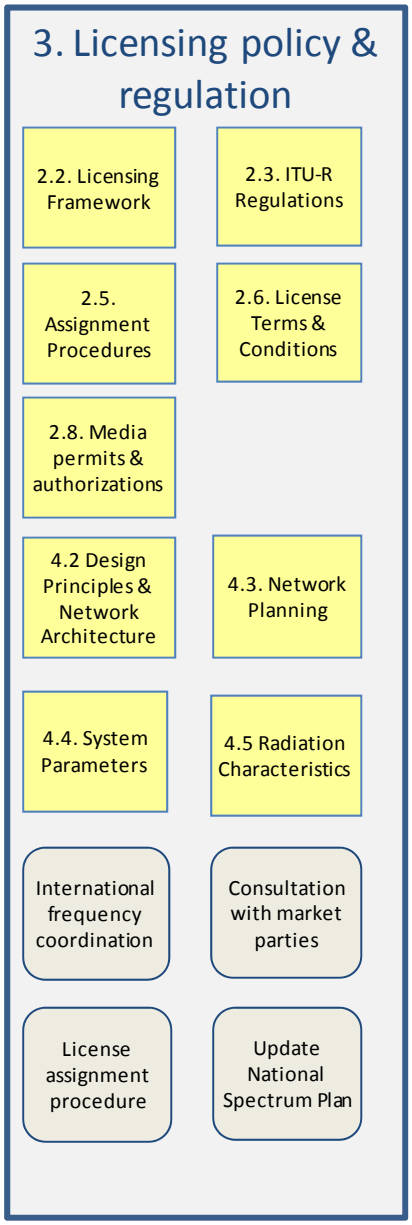
Brief description	Determination of transmitter power and transmitting antenna gain in order to achieve the required or allowed effective radiated power and configuration of the optimum antenna diagram and polarization.
Objective	Specification of transmitter power, antenna gain and antenna diagram as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

Key topics and choices		Status	Decision
4.5.1	Transmitter power and transmitting antenna gain	C	The maximum allowed ERP is specified in the GE06 plan entries. The minimum power is that necessary to match analogue TV coverage.
4.5.2	Polarization	C	Most Angolan GE06 plan entries are specified for horizontal polarization. However, some of the GE06 entries have vertical polarization.
4.5.3	Use of existing antennas or need for new antennas	B	In most cases existing antennas cannot be reused because existing transmissions are in VHF, use semi-professional equipment and are designed for low power transmissions

Main activities	Observations/advice
1. Evaluation of transmitter power and antenna gain The transmitter power is given by subtracting feeder and combiner losses from the ERP value.	The ERP of a transmitting station is determined by applying the "service trade-off". The initial choice of ERP should be guided by the values indicated in Section 4.9.2 of this report.
2. Evaluation of polarization The choice of polarization depends on: • The reception mode, if portable or handheld reception is a major requirement, vertical polarization is preferred; • The polarization of the installed rooftop antennas; • The need to apply orthogonal polarization between co-channel transmissions. (see also Section 4.5.2 of the ITU Guidelines)	Investigations are needed to verify: • The polarization of existing UHF rooftop antennas in each of the existing analogue UHF coverage areas; • The reason for the polarization choice in the Angolan GE06 plan entries. Depending on these investigations it could be decided: • To use horizontal polarization for all transmission, subject to a successful application of Article 4 of GE06 with regard to the Plan entries with vertical polarization; • To use vertical polarization for all transmission, subject to a successful application of Article 4 of GE06 with regard to the Plan entries with horizontal polarization; • To use horizontal and vertical polarization depending on the part of the country. If these parts do not correspond to the Plan entries with horizontal or vertical polarization also in this case the Article 4 procedure has to be applied.
3. Calculation of antenna power budget	At each site five multiplexes are foreseen. It is also the intention that the common multiplex/network operator offers site sharing and possibly antenna sharing. It efficient to combine the five transmitters at a site into one antenna. The antenna power budget has to be calculated to ensure that allowed mean power and peak voltage of the antenna is not exceeded (see Section 4.5.1 of the ITU Guidelines).

Annex 3: Functional building blocks related to phase 3 of the roadmap

Licensing policy and regulation



The selected functional building blocks related to phase 3 of the roadmap are shown in Figure 3.9 and are reproduced here.

Section 3.4.4 describes phase 3 of the roadmap.

This annex gives an overview in the form of tables of the status of each of the selected functional building blocks related to phase 3 by means of the following codes:

A. the decisions on key topics and choices that are already taken;

B. the decisions on key topics and choices that are partly taken;

C. the activities needed regarding key topics and choices that have not yet been decided;

D. the activities needed regarding key topics and choices that need revision.

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

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

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

2.2 Licensing framework

Brief description	For Angola the licensing framework concentrates on further detailing of licensing model B (the common multiplex/network operator).
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 assigning of the broadcast licenses and the bandwidth capacity by the common multiplex/network operator should be defined/balanced (see Section 4.4). Also the public tender procedure and the associated license terms and conditions for assigning the three pay-tv/commercial service providers are still to be defined (see Section 4.4).
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?	A	Angola has opted for model B (see Strategy paper)
2.2.3	Has the PBS services and spectrum rights been defined yet (and where) for the DTTB services?	C	Not decided yet. Dependent on the way the common multiplex/network operator will be established. See also considerations in Section 3.4.1.

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. For more consideration see Section 4.4 and 4.5 of this report.
4. Assess compatibility with ASO plans and National Spectrum Plan.	
5. Possibly revise current licensing framework and assess impact.	
6. Draft planning for license 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)?	C	As part of the detailed DTTB service planning (see Section 3.4.4 of this report).
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 planned DTTB services and ASO plans.	For more details see Section 3.4.4 and 4.4 in this report.
3. Possibly redefine necessary changes to assigned frequency (and possibly content) licenses for operational 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 licenses to TPA and Zimbo 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 licenses to the Angolan broadcasters and service providers were assigned on the basis of FCFS or public tender.
2.5.2	Assignment procedures for DTTB services: What is the selected assignment instrument (FCFS, auction or public tender) for DTTB services?	C	Assigning (by priority) the spectrum rights to the common multiplex/network operator will need special legal preparations. Assigning capacity/slots could be a task of the common multiplex/network operator whereas Ministry of Media will provide content authorizations (for both the instruments should be defined, for example FCFS). For assigning the licenses to the pay-tv/commercial service providers a public tender should be organized too.

Main activities	Observation/Advice
1. Consult market (current broadcasters and potential bidders/applicants) on assignment methods and license Terms and Conditions.	All to be carried out as part of this phase. Drafting of the Licensing procedure and acquiring political approval should be aligned with the ASO planning. Licensing procedure should be 'future proof' in the sense that after ASO additional licenses 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 at political level.	
5. Publish assignment planning and procedures and update National Spectrum Plan (and possibly Legislation).	

2.6 License terms and conditions

Brief description	The license terms and conditions of the DTTB frequency or spectrum licenses.
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 license types.

Key topics and choices		Status	Decision
2.6.1	Licensing and fair competition rules: Are the license terms and conditions in line with the competition rules (transparent and non-discriminatory)?	C	Competition Law may control the assignment of spectrum to the common multiplex/network operator. Compliancy to be checked. The same applies for the licenses for the pay-tv/commercial service provider(s).
2.6.2	Frequency license terms and conditions: have all license terms and conditions been determined and is the list of conditions complete (see list in this section)?	C	The license conditions for the common multiplex/network operator are likely to cover additional terms and conditions (next to the spectrum usage rights as defined in the ITU Guidelines). For example to implement ONP rules.

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 license terms and conditions check the ITU Guidelines. Depending on the licensing model defined, the frequency rights (in combination with operating rights) could be assigned separately from the broadcast rights.
2. Analyse 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 Subsection 2.2.3 in the ITU 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, programme or platform level?	C	Still to be defined. Especially the task division between the Ministry of Media and the common multiplex/network operator.
2.8.2	Broadcast licensing requirements: have all license terms and conditions been determined and is the list of conditions complete (see list in this paragraph)?	C	The NRT should considering the existing broadcast rights in the market (Zimbo).

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 ITU 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 license 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 license procedure and planning.

Main topics & 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.
4.2.2	Main reception mode and defining receiving installations	C	
4.2.3	Services for national, regional, or local coverage	C	
4.2.4	Frequency plan and network topology	C	
4.2.5	Head- end configuration	C	
4.2.6	Equipment reserve configurations	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;
- 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	GE06 compliance of planned stations	C	
4.3.5	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;
- ASO plan;
- 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;
- ASO plan;
- 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.

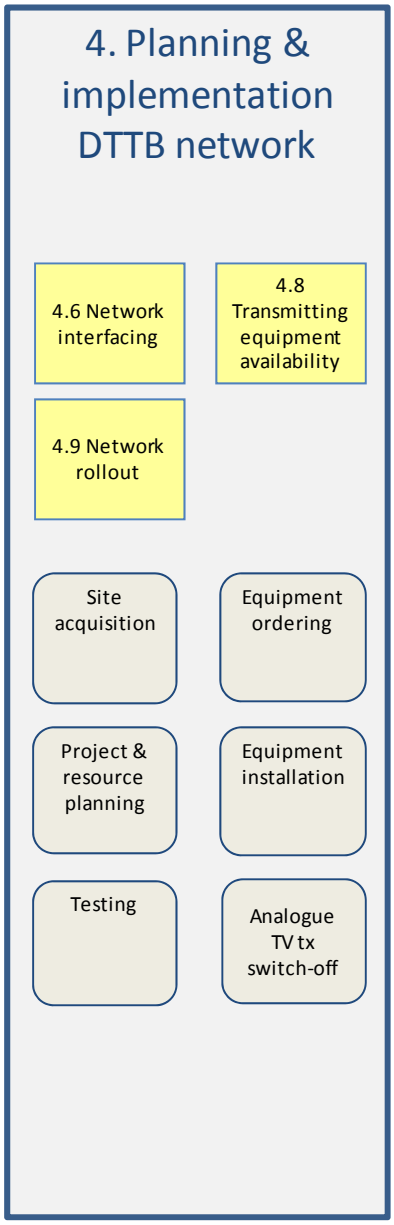
Key topics and choices		Status	Decision
4.5.1	Transmitter power and transmitting antenna gain	C	The initial results obtained in phase 2 (ASO planning) should be verified based on the initial frequency plan, ASO plan and review of Network design and Network architecture (see functional building block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

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;
- ASO plan;
- Review of Network design and Network architecture (see functional building block 4.2 in phase 3).

Annex 4: Functional building blocks related to phase 4 of the roadmap

DTTB implementation



The selected functional building blocks related to phase 4 of the roadmap are shown in Figure 3.9 and are reproduced here.

Section 3.4.5 describes phase 4 of the roadmap.

This annex gives an overview in the form of tables of the status of each of the selected functional building blocks related to phase 4 by means of the following codes:

A. the decisions on key topics and choices that are already taken;

B. the decisions on key topics and choices that are partly taken;

C. the activities needed regarding key topics and choices that have not yet been decided;

D. the activities needed regarding key topics and choices that need revision.

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

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

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

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
1. Drafting interface specifications between parts of the network Parts of the network are head-end, distribution links and transmitter sites.	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).
2. Drafting interface specifications between network monitoring system and head end and distribution links	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.
3. Describing radio interface 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.	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. 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.

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	Some work has been done in preparation of the SFN test in Luanda.
4.8.2	Technical specifications	B	Some work has been done in preparation of the SFN test in Luanda.

Main activities	Observation/Advice
1. Carrying out investigation of available equipment and budgetary prices for head-ends and distribution links	Investigations of available equipment and budgetary prices will be part of the tender document.
2. Drafting specifications of distribution links and head ends	The specifications should include: transmission standard, compression system, CAS and SMS system (in case of the pay-TV multiplexes), 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	Observation/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.
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 equipment, 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: Planning criteria with different DTTB standards

In this annex a summary is given of planning criteria with different transmission standards obtained from ITU and other sources.

1 ITU-R Recommendations

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

- Recommendation ITU-R BT.1306-4, error correction, data framing, modulation and emission methods for digital terrestrial television broadcasting[43]. A revision of this Recommendation with new information on the DTMB standard, has been submitted to ITU Study Group 6 for consideration.
- Recommendation ITU-R BT.1877, error-correction, data framing, modulation and emission methods for second generation of digital terrestrial television broadcasting systems[44].
- Recommendation ITU-R BT.1368-8, planning criteria for digital terrestrial television services in the VHF/UHF bands[45]. A revision of this Recommendation with new information on planning criteria related to the ISDB-T and DTMB standard has been submitted to ITU Study Group 6 for consideration.

The ITU Recommendations are available in Word and Portable Document Format (PDF) in six languages (English, Arabic, Chinese, Spanish, French and Russian) and 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. When the Draft Revisions of Recommendations BT.1306-4 and BT.1368-8 have been adopted by ITU-R Study Group 6, the numbers will be become 1306-5 and 1368-9.

2 Planning criteria

Status of the work

The Draft Revision of Recommendation ITU-R BT.1368 is shown in ITU document 6/352. The draft revision provides information on protection ratios regarding all standards, including protection ratios of one standard interfered by another. Work is in progress on a new Recommendation regarding planning criteria for second generation DTTB standards.

Observations regarding planning criteria

Comparison of the co-channel protection ratios (DTTB interfered with by DTTB) of the three 1st generation multi-channel DTTB standards for similar system variants shows that protection ratios do not deviate considerably; see table below.

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

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

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

Table A5-2 Co-channel protection ratios

Standard	Protection ratio (Gaussian channel)		
	64 QAM 2/3 – 64QAM 0.6	16 QAM 2/3 – 16QAM 0.6	QPSK 2/3 – QPSK 0.6
DVB-T	19 dB	13 dB	7 dB
ISDB-T	19 dB	13 dB	7 dB
DTMB	17 dB	12 dB	5 dB

Of the ISDB-T standard only protection ratios for a Gaussian channel[46] are given. Therefore in the comparison in the table above all protection ratios relate to a Gaussian channel. However, in planning DTTB services, protections ratios should be taken in a Ricean[47] channel, representative for fixed reception, or in a Rayleigh[48] channel, representative for portable reception.

Information on protection ratios of the DVB-T2 transmissions interfered with by DTTB transmissions is currently not available in the ITU working document towards a new Preliminary Draft Recommendation on planning criteria, including protection ratios, for second generation of digital terrestrial television broadcasting systems in the VHF/UHF bands. However, a detailed description of the technical features of the standard and information on frequency and network planning is given in EBU Tech 3348 Frequency and Network Planning Aspects of DVB-T2, Geneva May 2011[49].

Compliance with the GE06 Agreement

The Geneva 2006 Agreement is, with regard to digital television, based on the DVB-T standard. Other standards can be used if the provisions of Article 5.1.3 are fulfilled.

In principle, the application of multi-carrier standards for GE06 Plan entries should not give major problems, provided that the channel bandwidth and the effective radiated power (ERP) is the same as in the GE06 Plan. The reason is that multi-carrier standards have noise-like radiation characteristics; the interference potential should therefore be similar. This is confirmed by new information on the protection ratios for DVB-T interfered with by ISDB-T and DTMB as shown in the Draft Revision of Recommendation ITU-R BT.1368.

An overview of the information regarding protection ratios between multi-carrier standards is shown below.

DVB-T2

One of the criteria in the development of the DVB-T2 standard was that it should be applicable under the GE06 Agreement. Although no protection criteria of DVB-T interfered with by DVB-T2 are available yet in (draft) ITU-R recommendations, no problems are to be expected.

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[46] A Gaussian channel is a propagation mode when only the wanted signal with no delayed signals is present at the receiver input, but taking into account the Gaussian noise only.

[47] A Ricean channel is a propagation mode when a dominant wanted signal together with lower level delayed signals are present at the receiver input, taking into account the thermal noise.

[48] A Rayleigh channel is a propagation mode when several statistically independent signals with different delay times, none of which is dominant, are present at the receiver input, taking into account the thermal noise. Rapid and severe variations of the input signal with locations are observed, caused by multipath propagation.

[49] See http://tech.ebu.ch/docs/tech/tech3348.pdf

ISDB-T

The protection ratios of DVB-T interfered with ISDB-T are shown in the Draft Revision of Recommendation ITU-R BT.1368. In Annex 3, Table 54 and 57 it is indicated that the co-channel and adjacent channel protection ratios for ISDB-T interfered with by ISDB-T (in an 8 MHz channel) apply also for DVB-T interfered with by ISDB-T (in an 8 MHz channel). These values are the same as for DVB-T interfered with by DVB-T, as indicated in Annex 2, Table 14.

Annex 6: Coverage considerations

The first part of this annex describes propagations prediction methods and in particular the application of ITU Recommendation ITU-R P.1546. The second part deals with a number of examples of coverage calculations in which the relevant curves of ITU Recommendation ITU-R P.1546 are applied.

1 Propagation prediction

In principle the field strength from a VHF or UHF broadcasting stations can be assessed by means of two methods[50]:

1. Path specific propagation prediction using terrain data and clutter data;
2. Path general propagation prediction using empirically derived field-strength curves as functions of distance, antenna height, frequency and percentage time.

The second method can be used manually. However, incorporated in a software package more accurate calculations can be performed as a number of corrections based on terrain data can be applied and interpolations between different curves can be made easier.

ITU Recommendation ITU-R P.1546[51] describes the second method and gives a number curves for land and sea paths in different climatic circumstances for a number of frequencies and for several percentages of time. The method is also contained in Chapter 2 of Annex 2 of the Geneva 2006 Agreement[52]. In addition, the curves are also provided in tabulated format[53].

The application of the method is described step by step in Section 4 of Annex 1 of Recommendation ITU-R P.1546.

This annex deals with the application of Recommendation ITU-R P.1546 in UHF and land paths only and describes:

- General application guidance;
- The curves applicable to Angola;
- A number of examples.

1.1 General application guidelines

In general, broadcasting propagation predictions are made for the following situations.

Percentage of time and location

1. Wanted signals, median field strength value for 50 per cent of time (curves for 50 per cent locations and 50 per cent time);
2. Interfering signals, median field strength values for 1 per cent time (curve for 50 per cent locations and 1 per cent time).

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[50] See also Appendix 4.3.A of the Guidelines

[51] See www.itu.int/rec/R-REC-P.1546-4-200910-I/en

[52] There are some differences between some of the curves in the GE06 Agreement and later revisions of Recommendation ITU-R P.1546; moreover the GE06 Agreement contains sets of curves applicable in areas with specific climatic conditions.

[53] See www.itu.int/oth/R0A0400000E/en and the tables embedded in the Word version of the GE06 Agreement in Annex 2.2

Effective radiate power

The curves are shown for a transmitter of 1 kW ERP (Effective Radiated Power). The ERP is the transmitter power, plus the antenna gain minus feeder loss. In order to calculate the field strength for a different ERP, the field strength values should be corrected with the ERP ratio above 1 kW expressed in dB, by using the formula ERP (dBkW) = 10 log (ERP_{kW}). The table below shows a number of ERP corrections.

In the GE06 plans the ERP of analogue and digital TV stations is given in dBW. The value has to be subtracted by 30 to obtain the ERP in dBkW.

Table A6-1: ERP corrections

ERP (kW)	EPR in dB above 1kW
0,1 kW	-10 dB
0,2 kW	-7 dB
0,3 kW	-5 dB
0.5 kW	-3 dB
1 kW	0 dB
2 kW	3 dB
3 kW	5 dB
5 kW	7 dB
10 kW	10 dB
20 kW	13 dB
30 kW	15 dB
50 kW	17 dB
100 kW	20 dB

Effective antenna height

The effective height of the transmitting antenna (heff) is defined as its height in metres over the average level of the ground between distances of 3 and 15 km from the transmitting antenna in the direction of the receiving antenna.

Where the value of effective transmitting/base antenna height (heff), is not known it should be estimated from general geographic information.

Frequencies and land and sea path

The propagation curves represent field-strength at nominal frequencies of 100, 600 and 2 000 MHz, respectively, as a function of various parameters; some curves refer to land paths, others refer to sea paths.

Interpolation or extrapolation of the values obtained for these nominal frequency values should be used to obtain field-strength values for any given required frequency using the method given in Annex 5, paragraph 6 of Recommendation ITU-R P.1546.

1.2 The curves applicable to Angola

Figure 2.2.-1 in Chapter 2 to Annex 2 of the Geneva 2006 Agreement shows the geographical division of the GE06 planning area into propagation zones. Most of Angola is situated in climatic zone 1 (temperate and subtropical regions) whereas the most northern part (about the area of the provinces Cabinda, Zaire and Uige is situated in climatic zone 3 (equatorial regions). The sea area is defined as zone 4.

This annex is restricted to the application of propagation at 600 MHz over land paths and for simplicity reasons only relates to climatic zone 1. The following curves from Chapter 2 to Annex 2 of the Geneva 2006 Agreement are therefore applicable:

1. Prediction of wanted signal (50 per cent time): curves on page 82 of the GE06 Agreement;
2. Prediction of interfering signal (1 per cent time): curves on page 84 of the GE06 Agreement.

2 Examples of coverage calculations

This Section presents a number of examples of the coverage achieved by analogue and digital transmitting stations. First calculation examples are shown with rooftop reception, followed by considerations regarding indoor and MTV reception.

2.1 Coverage with rooftop reception

Calculation examples of the coverage achieved by an analogue and a digital transmitting station are shown in Figure A6-1 and Figure A6-2 respectively[54]. The radiation characteristics in these examples are given in the table below.

Table A6-1: 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	I-PAL	DTTB: 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.417[55] and Annex 1 of that Recommendation with regard to the reception limit[56].

In the analogue TV example the coverage range (distance from the transmitter), in the absence of interference other than noise, is (see Figure A6-1):

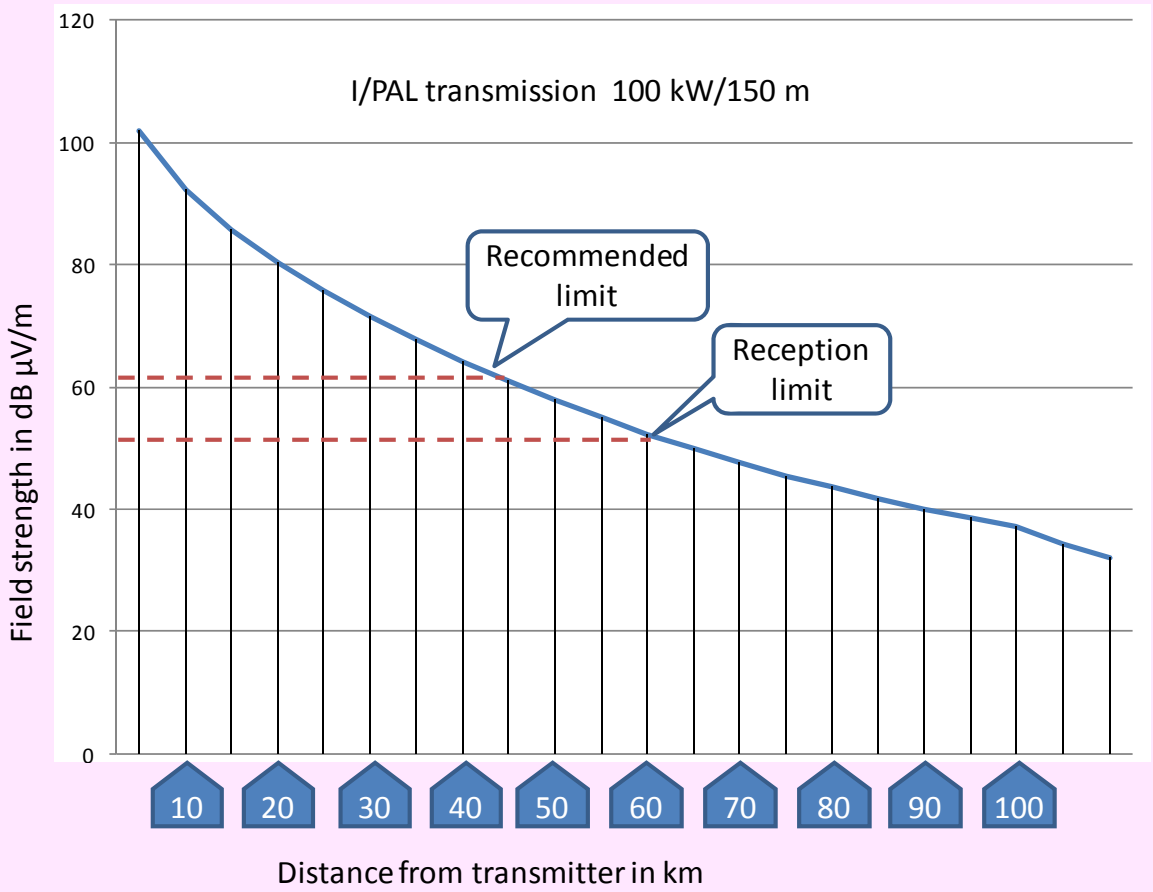
- About 43 km according to the recommended minimum field strength (62 dBµV/m);
- About 60 km according to the limit of reception (52 dBµV/m).

[54] 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).

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

[56] 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 A6-1: 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;
3. Somewhere in between 1 and 2.

With the ISDBT standard in the 8 MHz version, this choice can be made by selecting one out of three carrier modulations (64QAM, 16QAM and QPSK) and for each carrier modulation one out five code rates. The initial choice in Angola is 64QAM 3/4.

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 Table A.3.2-2 of the GE06 Agreement Emed values are given for the DVB-T standard. As the C/N values of DVB-T and ISDB-T in the 8 MHz version are the same, the Emed values can also be used with the ISDB-T standard with regard to Band IV/V. In Band III the values for ISDB-T are 2 dB lower because of the lower noise figure of ISDB-T receivers compared to DVB-T receivers. Also in Band III a correction of about +0.5 dB should be made for 8 MHz bandwidth used in Angola (Table 3.3.2-2 of GE06 is for Band III based on 7 MHz channel bandwidth).

The Emed values for three selected system variants (carrier modulation and code rate) in Band IV are:

64QAM 2/3 53 dBµV/m;

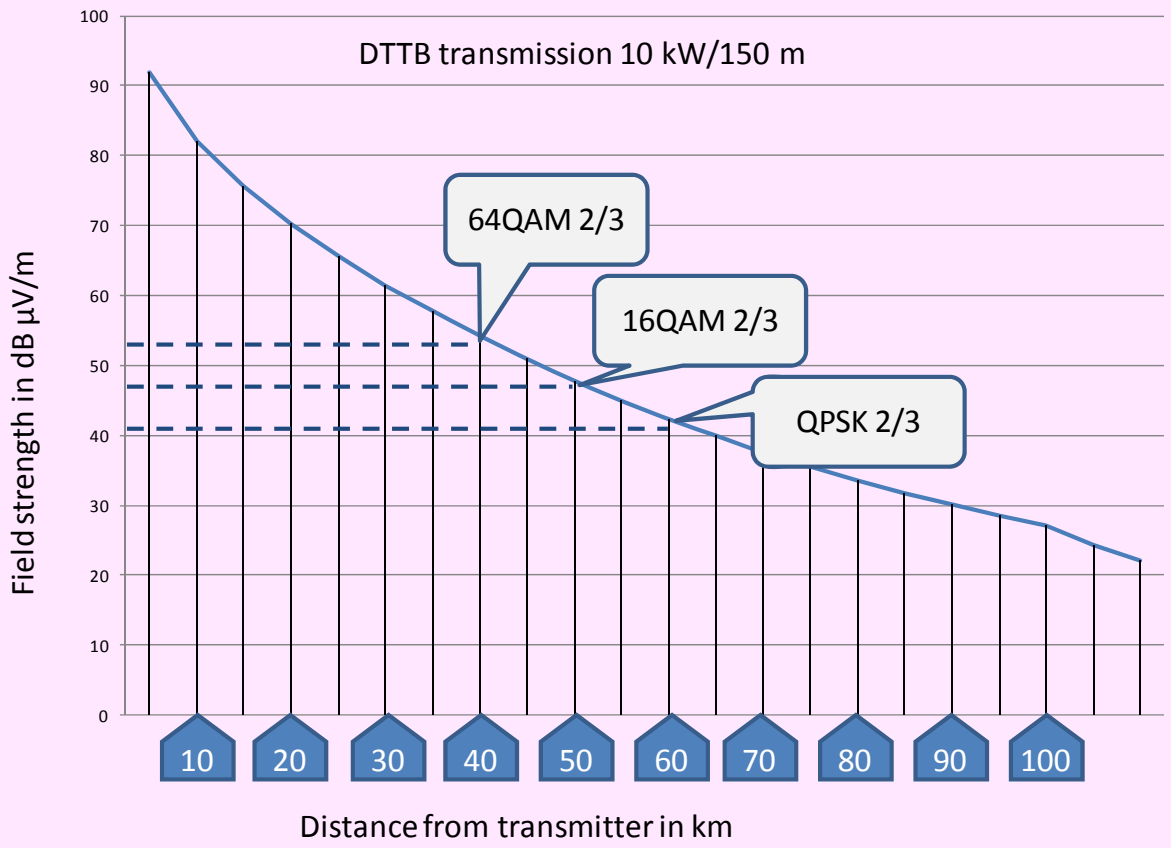
16QAM 2/3 47 dBµV/m;

QPSK 2/3 41 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 A6-2):

- About 24 Mbit/s and about 40 km at 64QAM 2/3;
- About 16 Mbit/s and about 50 km at 16QAM 2/3;
- About 8 Mbit/s and about 60 km at QPSK 2/3.

Figure A6-2: Example of digital TV coverage area with rooftop reception



2.2 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.

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.

In Section 4.9 it is concluded that portable outdoor reception is a balanced compromise for the type of receiving installation normally used in Angola.

As for rooftop reception, the median minimum field strength values (Emed) for outdoor reception can be found in Table A.3.2-2 of the GE06 Agreement. The Emed values for three selected system variants (carrier modulation and code rate) in Band IV are:

64QAM 2/3 78 dBµV/m;

16QAM 2/3 72 dBµV/m;

QPSK 2/3 66 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 A6-1 can be calculated in a similar as in Section 2.1. The result is:

- About 24 Mbit/s and about 13 km at 64QAM 2/3;
- About 16 Mbit/s and about 18 km at 16QAM 2/3;
- About 8 Mbit/s and about 24 km at QPSK 2/3.

Although the reception areas are much smaller than with rooftop reception, in a considerable area in towns where DTTB transmitters will be located, it will be possible to receive DTTB with a simple antenna. The portable reception area can be enlarged, without changing the power, by using 16QAM, but at the cost of reduced bit rate (about 16 Mbit/s instead of about 24 Mbit/s).

2.3 MTV coverage

Services for handheld reception using the ISDB-T 1seg standard use QPSK modulation with code rate 2/3. The median minimum field strength (Emed) values are higher than for portable DTTB reception because of the built-in receiving antenna which has poor reception characteristics.

The Emed value at QSPSK 2/3 can be derived from Table A.3.2-2 of the GE06 Agreement. A correction for the very small built-in antenna (-12 dB) and a correction for the small bandwidth of the 1 segment (+11 dB) should be applied. The value is:

MTV handheld outdoor reception: 67 dBµV/m;

MTV handheld indoor reception: 79 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 A6-1 can be calculated in a similar as in Section 2.1. The result is:

- 554 kbit/s and about 12 km at QPSK 2/3 with indoor reception;
- 554 kbit/s and about 23 km at QPSK 2/3 with outdoor reception.

The MTV reception areas are much smaller compared to DTTB with rooftop reception, but MTV coverage with indoor reception is about the same as DTTB at 64QAM 2/3 with outdoor reception.

Annex 7: Information on multiplex and network architecture

This annex describes DTTB network architecture and in particular the meaning of the "multiplex".

First definitions are given of some of terms that are related to "multiplex". This is followed by a description of the digital broadcasting chain. This part is a copy of Section 1.8.2 of Report ITU-R BT.2140[57]. Section 3 shows an example of a block diagram of the network lay-out and describes the relation between the multiplex at the head end and at the transmitter site. Finally in Section 4 considerations are given about the number of multiplexes in Angola.

1 Definitions

Compression

Compression covers the operations required to reduce the bit rate of each programme component (video and audio signals, etc.), in order that they will require as small a bit rate in the emission channel.

Multiplexing

Multiplexing merges various programme streams together, into a single data stream whose bit rate matches the data capacity of the transmission channel used to deliver the programmes carried in the multiplexed stream. In technical terms the output of the multiplexing process is the MPEG Transport Stream (TS).

Multiplex

The multiplexer is the equipment performing the multiplexing. The package of services in one transmission channel is often called the multiplex. This package (TS) is distributed to the transmitters.

Modulation

In the transmitter the multiplex (TS) is modulated and coded according to the transmission standard and converted to the rf signal on the assigned channel.

Network

The transmitters fed by the same multiplex (TS) form a Multi Frequency Network (MFN) or Single Frequency Network (SFN).

DTTB site

At a DTTB site more than one DTTB transmitter is installed if more than one network is needed. The rf signal from each transmitter is often combined (using a combiner) into one antenna.

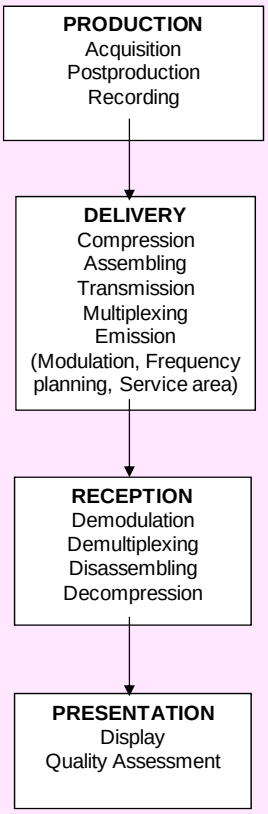
2 The digital broadcasting chain

(*From Section 1.8.2 of Report ITU-R BT.2140*)

Figure 7-1 shows a very simplified basic block diagram of the digital broadcasting chain. It includes four main conceptual blocks, namely the production block, the delivery block, the reception block and the presentation block.

[57] See www.itu.int/pub/R-REP-BT.2140-2-2010

Figure 7-1: Conceptual block diagram of the broadcasting chain



Source: ITU

The production block includes three main conceptual functions, namely: production, postproduction and recording.

Production covers the capture of the various media that form a programme (programme image and the various accompanying sound components) and their transformation from their original state as perceptual stimuli into their representation as digital signals. This block includes the mixing and sequencing of signals from various audio and video sources. It requires, inter alia, expert knowledge of human psychophysical perception to audio-visual stimuli, including knowledge of colorimetry, and of the sampling of audio and video signals.

Recording covers the recording, playback and archiving of audio-visual programmes for their subsequent use. It is used when programme material produced in the production block needs to be re-mixed or re-sequenced, or when it needs to be integrated with programme material produced at different times. It also covers programme archiving, which now attracts the keen interest of broadcasters, in view of the possibility to exploit their asset of recorded programmes, for re-use on the air, or for sale on the national and international programme market. This study requires in-depth knowledge of the available recording technologies, including knowledge of modern tapeless recording (recording on optical discs, solid-state memories and on computer-type memories) and on the ways to manage the access and exploitation of such programme signals.

Postproduction covers all the technical operations required to put the captured programme signals in their final form as a finished programme. It includes the insertion of component elements in the programme, such as the mixing of music and dialogue, the development of special visual effects such as reframing, matting or colouring, the dubbing of programme sound, the insertion of archive material in studio sequences, the development of elements related to multimedia and interactive applications, etc. This study requires, inter alia, expert knowledge of the type and extent of interaction among the various

post processing treatments of image or sound signals, when they are performed in tandem, one after the other, in view of the risk that, cumulating, they may impair the final quality of the image or sound.

The delivery block includes four main conceptual functions, namely: compression, assembling, multiplexing and emission.

Compression covers the operations required to reduce the bit rate of each programme component (video and audio signals, etc.), in order that they will require as small a bit rate in the emission channel, as it is strictly necessary to deliver the intended image and sound quality to the end user. This study requires, inter alia, an in-depth knowledge of bit-rate-reduction mechanisms and of their impact on the perceptual quality of programme material.

Assembling merges the various programme components (video signals, audio signals, signals related to multimedia and interactive applications, etc.), in order that they form a properly structured, single serial data stream, that also carries any ancillary information required to manage the programme, such as information on intellectual property rights, conditional access, copy protection, etc. This study, as the one described below, requires a good familiarity with the digital protocols used to smoothly multiplex various digital streams into a single stream, e.g.: preserving synchronization of audio and video.

Multiplexing merges various programme streams together, into a single data stream whose bit rate matches the data capacity of the transmission channel used to deliver the programmes carried in the multiplexed stream. It also adds the data required to protect those programme signals against errors introduced by the transmission channel. It is at this stage that statistical multiplexing can be best implemented, thus achieving greater exploitation of the bit rate available on the emission channel.

Emission modulates the multiplexed data stream on the channel carrier, in order that it may be broadcast in the foreseen delivery channel. It also studies the frequency plan, the location and design of the emitting antennas and their emitted power. This study requires an excellent grasp of the related spectrum implications, in order to adequately cover the intended service area while complying with the mandated requirements in terms of interference to and from the emissions of other transmitters.

The reception block of the broadcast chain implements functions that are the counterparts of the functions implemented in the delivery block, namely: demodulation, de-multiplexing, disassembling and decompression.

Demodulation operates on the modulated signal received by the receiver at the user premises, recovering the multiplexed bit stream and correcting as far as possible the errors introduced by the transmission channel.

Demultiplexing operates on the multiplexed bit stream, extracting from it the various programme streams that are multiplexed on it.

Disassembling operates on a programme stream selected among those demultiplexed in the previous function, recovering the compressed signals that contain the components of the selected programme (video signal, various audio signals, and data).

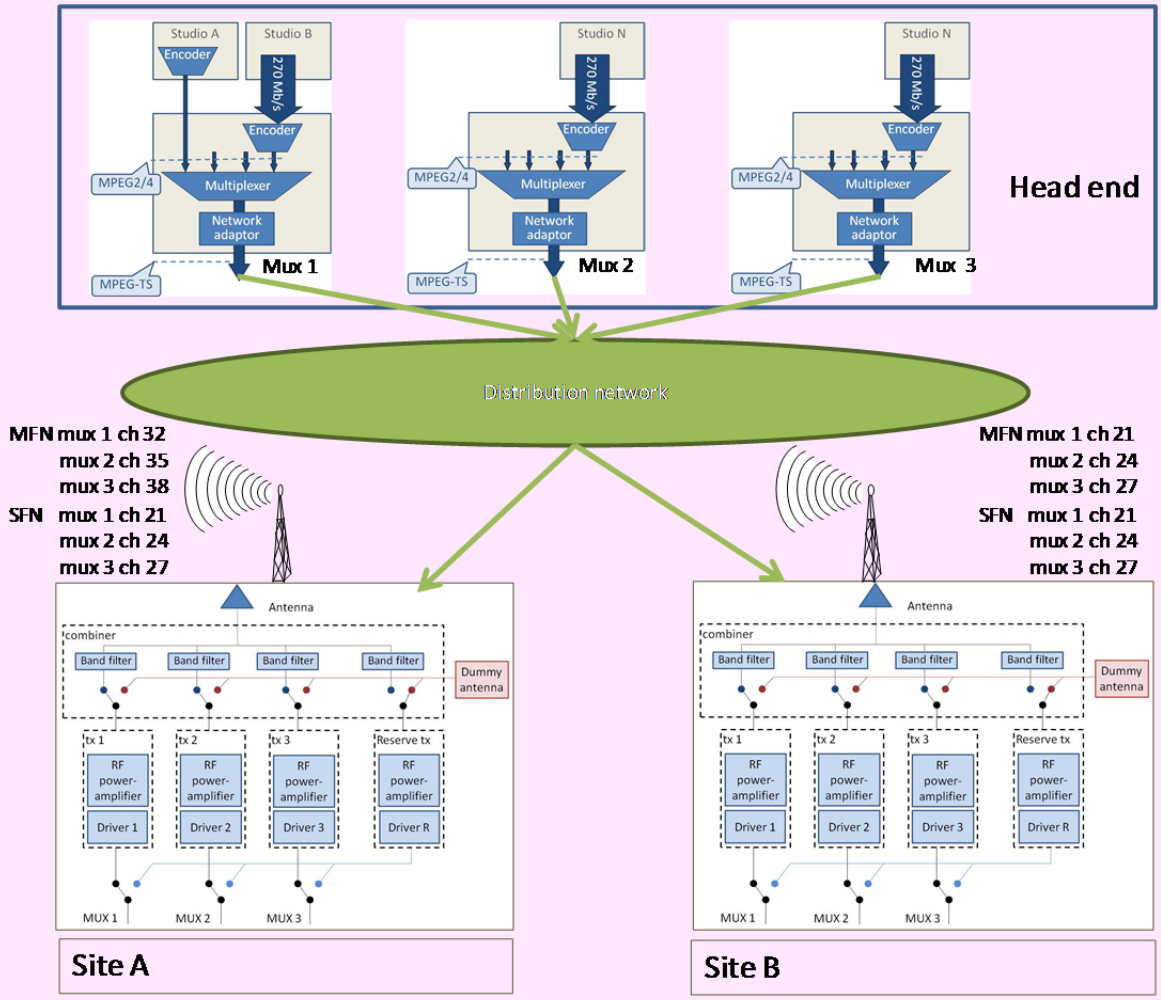
Decompression operates on the compressed signals that compose the selected programme, recovering them in their uncompressed form.

The presentation block operates on the decompressed signals, processing them in such a way that the original audio and video programme material may be properly presented on the set (radio or television) at the end-user premises. This study requires matching the characteristics of the devices originally used to capture the programme, to the characteristics of the user's display. With the current advent of new types of displays, this has become an important challenge.

3 Block diagram of a DTTB network

Figure 7.2 shows an example of a network consisting of a head end with three multiplexers and two sites.

Figure 7-2: Example of a DTTB network consisting of a head end with three multiplexers and two sites



At the head-end the programme streams of the studio are encoded. The incoming studio signals are divided over three multiplexers. Each multiplexer produces an MPEG Transport Stream (TS), which is distributed to one of the transmitters at a site. The bite rate of the TS should be slightly lower than the bit rate of DTTB variant for which the transmitter has been adjusted in order to avoid overflow.

The DTTB variant is the chosen combination of modulation, code rate and guard interval at the transmitter. Each DTTB variant represents specific values of net bit rate and carrier to noise ratio (C/N). As example, the table below shows the net bite rate of a number of ISDB-T system variants[58] when the full channel (all 13 segments combined) is used for DTTB. The C/N values of the ISDB-T standard are only given for a Gaussian channel, whereas network planning should be performed with a Ricean channel in

[58] Net bit rates with all system variants of the ISDB-T standard per segment and for a full channel in the 6 MHz, 7 MHz and 8 MHz version are given in the ISDB-T specification (see Norma ISDB-T 8 MHz)

case of fixed reception and a Rayleigh channel in case of portable reception. Annex 5, Table 5-2 shows that the co-channel protection ratios in a Gausssion channel with DVB-T and ISDB-T are the same. It is not expected therefore that the C/N value in Ricean and Rayleigh channels with ISDB-T are very much different from the DVB-T values. For that reason the C/N values in Table 7-1 are taken from the corresponding DVB-T system variant.

Table 7-1: Net bit rate and C/N of a number of ISDB-T system variants (full channel)

Modulation	Code rate	Net bit rate (Mbit/s) for different guard intervals (GI) at 8 MHz bandwidth				C/N (dB) for different reception modes	
		GI=1/4	GI=1/8	GI=1/16	GI=1/32	Fixed	Portable
QPSK	2/3	6.49	7.21	7.64	7.87	7.9	10.2
QSPK	3/4	7.30	8.11	8.59	8.85	9.1	11.5
16QAM	2/3	12.48	14.42	15.27	15.73	14.1	16.4
16QAM	3/4	14.60	16.23	17.18	17.70	15.7	18.1
64QAM	2/3	19.47	21.64	22.91	23.60	19.5	21.8
64QAM	3/4	21.91	24.34	25.77	26.55	21.2	23.6

In each network, consisting of transmitters fed by the same TS, the DTTB variant of each of the transmitters (e.g. transmitters no 1 at each site in Figure 7-2) should in principle be the same.

In the example of Figure 7-2, a site consists of three transmitters, one for each TS. All three transmitter outputs are combined into one antenna. Each transmitter has its own frequency (channel). If one or more of the transmitters that broadcast a multiplex form an SFN, then all transmitters broadcasting that multiplex must have the same frequency.

4 Number of multiplexes in Angola

Available number of multiplexes

The maximum number of multiplexes per sites is given by the frequency assignments to that site. In the GE06 Agreement most Angola sites have three assignments in UHF; in addition 25 sites have an assignment in VHF.

In theory a higher number of assignments per site would be possible. An indication on spectrum usage for digital television can be obtained from studies made in Europe in 2001[59]. These studies show spectrum requirements for providing DVB-T 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 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;

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

- 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.

The results of the study show that the required number of channels to provide coverage of 20-24 Mbit/s (64QAM 2/3) with antenna heights of 150 m[60], is:

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.

The number of multiplexes that would theoretically be possible per site in UHF is shown in the table below.

Table 7-2: Theoretically possible number of multiplexes in UHF with antenna heights of 150 m

Geographical coverage	Band IV/V with upper limit of 862 MHz (channels 21 – 69)	Band IV/V with upper limit of 790 MHz (channels 21 – 60)
50%	12	10
70%	8	6
100%	5	4

Before additional, not yet planned, multiplexes could be used (if so required) the station characteristics should be determined by means of planning exercises and Article 4 of the GE06 Agreement should be applied.

Required number of multiplexes

An initial indication of the capacity requirements of the two public financed multiplexes (See Section 2.3) is shown in the table below. In the first column "X" is the number of unspecified additional services. The bit rate per service is the minimum bit rate shown in Annex 1, functional building block 4.1.

Table 7-3: Initial estimation of the DTTB capacity requirements of the public financed multiplexes

DTTB service requirement	Estimated bit rate (Mbit/s) per service			Bit rate (Mbit/s) per service requirement
	Video	Audio	Data	
3 SDTV	2	0.064	0.2	2.264
1 HDTV	8	0.128	0.5	8.628
e-gov data			0.5	0.5
X additional SDTV	2X	0.064X	0.2X	2.264X
Total	14+2X	0.32+0.064X	1.6+0.2X	15.92+2.624X

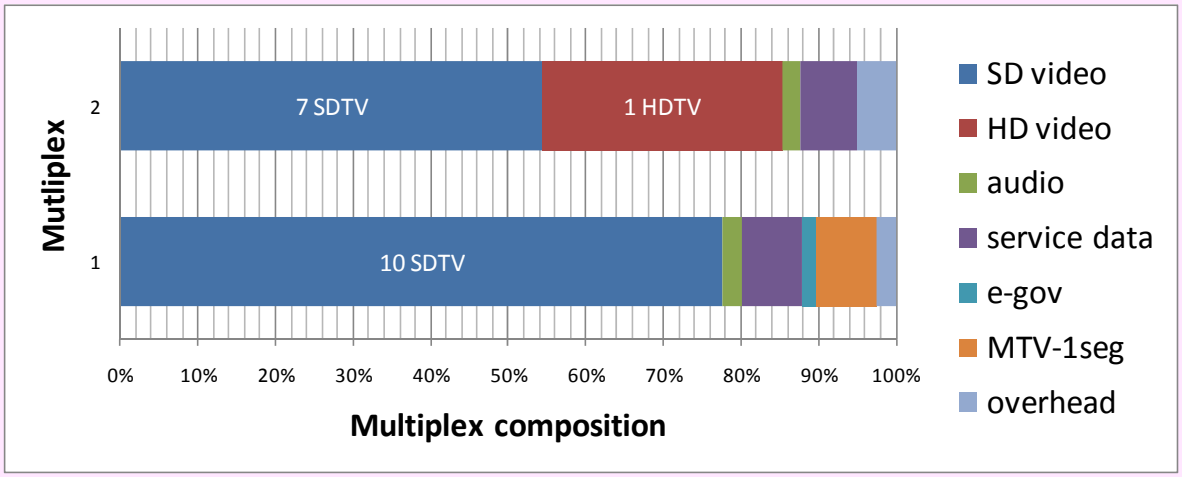
[60] Higher antenna heights will result in more efficient spectrum usage; hence a lower number of channels would be needed.

In addition, in one of the multiplexes one segment is used for MTV services.

The initially chosen DTTB variant is 64QAM 3/4 with a guard interval of 1/16. From the standard specification[61] it can be derived that the full channel capacity in an 8 MHz bandwidth at this variant is 25.772 Mbit/s. In case one segment is used for MTV services the remaining 12 segments have a capacity of 23.79 Mbit/s.

With the requirements shown in Table 7-3 and the use of one segment in one of the multiplexes for MTV services the multiplex composition could be as shown in Figure 7-3.

Figure 7-3: Example multiplex composition



With the bit rates given in Table 7-3, 10 SDTV services can be accommodated in Multiplex 1 in addition to e-government services and MTV. In multiplex 2, 7 SDTV services and 1 HDTV service can be accommodated.

It should be noted that:

- The multiplexes in this example have overhead capacity of 0.65 Mbit/s and 1.3 Mbit/s respectively. Some overhead in necessary in order to avoid overflow. However, a considerable part of the indicated overhead could be used to increase capacity of one or more of the services;
- With the use of statistical multiplexing, a higher bit rate will be automatically allocated to critical scenes. This will result in a higher quality per SDTV and HDTV service. It could also be decided to reduce the average bit rate and increase the number of services.

[61] ABNT NBR 15601 Brazilian standard Digital terrestrial television transmission system; Table 4 and 5 show the bit rate per segment and the total bit rate for different system variants in a 6 MHz bandwidth. The bit rate in an 8 MHz bandwidth has been calculated by multiplying the bit rate values with the ratio of the bandwidth increase (8/6). The net bit rate values in the 8 MHz versions can directly be taken for Table 1-9 of document "Norma ISDB-T 8 MHz".

Glossary of abbreviations

16-QAM	16-state Quadrature Amplitude Modulation
64-QAM	64-state Quadrature Amplitude Modulation
AAC	Advanced Audio Coding
API	Application Programming Interface
ASO	Analogue switch-off
ATSC	Advanced Television Systems Committee
BML	Broadcast Markup Language
C/N	Carrier to Noise ratio
CA	Conditional Access
CAS	Conditional Access System
dB	decibel
DRM	Digital Rights Management
DSO	Digital Switch Over
DTMB	Digital Terrestrial Multimedia Broadcast
DTTB	Digital Terrestrial Television Broadcasting
DVB	Digital Video Broadcasting
DVB-T	Digital Video Broadcasting-Terrestrial
DVB-T2	Digital Video Broadcasting – Terrestrial 2nd generation
Emed	Median minimum field strength
Emin	Minimum field strength
EPG	Electronic Programme Guide
ERP	Effective Radiated Power
FCFS	First come, first served
FFT	Fast Fourier Transform
FTA	Free-To-Air
GE06	Geneva Agreement 2006
HDTV	High Definition Television
ID	Identification
IDTV	Integrated Digital Television set
IMT	International Mobile Telecommunications
INACOM	Angolan Institute of Communications - *Instituto Angolano das Comunicações*
IPTV	Internet Protocol Television
ISDB-T	Integrated Services Digital Broadcasting – Terrestrial
ITU-BDT	International Telecommunication Union – Telecommunications Development Bureau
ITU-R	International Telecommunication Union – Radiocommunication Sector

LTE	Long Term Evolution, often marketed as 4G
MFN	Multi Frequency Network
MIRF	Master International Frequency Register
MPEG	Moving Picture Expert Group
MTTI	Ministry of Telecommunication and Information Technology in Angola
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
PPP	Public Private Partnership
PSB	Public Service Broadcasting
QPSK	Quadrature Phase Shift Keying
RR	Radio Regulations
SADC	Southern African Development Community
SDTV	Standard Definition Television
SFN	Single Frequency Network
SMS	Short Message Service
SMS	Subscriber Management System
STB	Set-Top-Box
T-DAB	Terrestrial – Digital Audio Broadcasting
T-DMB	Terrestrial – Digital Multimedia Broadcasting
TPA	Public Television Angola
TVHH	Television households
UHF	Ultra High Frequencies (frequency range between 300 and 3000 MHz)
VHF	Very High Frequencies (frequency range between 30 and 300 MHz)
WRC-07	World Radiocommunications Conference 2007
WRC-12	World Radiocommunications Conference 2012

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