PAPUA NEW GUINEA

Roadmap for the Transition from ANALOGUE TO DIGITAL TERRESTRIAL TELEVISION BROADCASTING IN PAPUA NEW GUINEA

Report

JULY 2013

Telecommunication Development Sector

Roadmap for the transition from analogue to digital terrestrial television broadcasting in Papua New Guinea

July 2013

The roadmap for the transition to digital terrestrial television in Papua New Guinea has been prepared by the International Telecommunication Union (ITU) expert Mr Colin Knowles in the framework of the ITU digital broadcasting project. The objective of this project is to assist countries in the Asia-Pacific region to shift smoothly from analogue to digital terrestrial television broadcasting (DTTB) and to introduce mobile TV (MTV) although the latter is outside the scope of this roadmap report. ITU would like to thank the Papua New Guinea Minister for Communications and Information and the Korea Communications Commission (KCC) in facilitating the work of the ITU.

Please consider the environment before printing this report.

Executive summary

The *Roadmap for the transition from analogue to digital terrestrial television broadcasting in Papua New Guinea* (the roadmap) was prepared by the Papua New Guinea National Roadmap Team (NRT) and ITU expert in the period from 3 September to 14 November 2012. The main observations and conclusions of the roadmap are summarized below.

Scope of the roadmap

This roadmap sets out a range of activities to be undertaken by the NRT. The roadmap does not include the introduction of mobile TV or digital radio; however, the potential requirements for these services also need to be taken into account.

The Papua New Guinea national television market is served by one commercial broadcaster EM TV and one government owned public broadcaster NBC. A community (religious) broadcaster operates in Port Moresby, and there are 32 licensed cable services (generally located in small villages). Terrestrial coverage is provided in the major population centres. Direct-to-home (DTH) satellite is available across Papua New Guinea for pay television and EM TVs free-to-air (FTA) services. There are pay television providers (one per market) using multichannel multipoint distribution system (MMDS) technology in the 2.5GHz band in Port Moresby (NCD), the Alotau (Milne Bay Province), and Mt Hagen (WHP). These services may be relocated to the UHF television broadcasting band in future, if the 2.5GHz spectrum is needed for other purposes. The programmes carried on the MMDS services are mostly retransmissions of services sourced from various overseas satellites, and local FTA services.

The aim of the roadmap is to guide Papua New Guinea towards the achievement of its digital switch-over (DSO) objectives. These objectives are divided into short-term objectives (from implementation to about one year after analogue switch-off (ASO)) and long-term (five to ten years after ASO). The objectives identified in the initial the NRT workshops, are shown in Table 1.

Papua New Guinea has yet to determine the commencement date for Digital Terrestrial Television Broadcasting (DTTB) and the desired analogue switch-off (ASO) date. Preliminary consideration, by the NRT during the first mission, suggests that a working target date for ASO could be 2016-2017.

To some extent, the complexity of activities involved in executing the roadmap will depend on the licensing model that is adopted for the multiplexing of digital programme streams for distribution and transmission. In the digital television value chain, a new entity appears: the multiplex operator. The multiplex operator combines the programme streams of the broadcasters into what is called a Transport Stream which carries them to the transmitters and all programmes within a multiplex are transmitted through a single radiofrequency transmitter.

The decision framework and the key topic and choices for the various implementation phases of the roadmap (Phases 1 to 4) are contained in Annexes 1 to 4.

At the time of the ITU roadmap missions, the anticipated NRT membership had been assembled for participation in the workshops conducted during mission. The constitution and mandate of the NRT had not been formalized and endorsed by government. However, the following "Objectives" for digital migration were formulated by the NRT workshop participants under the guidance of the ITU expert.

Table 1: Preliminary DSO objectives

No	Objective	Short term (Implementation Phase to about 1 year after ASO)	Long term (5-10 years after ASO)
1	Smooth transition from analogue to digital	All analogue services converted to digital with coverage areas equal to the current analogue services (all FTA have identical coverage). DTTB channels match frequency bands of existing services in a market to facilitate infrastructure sharing and viewer installations. All transmitters installed at current transmission sites within 2-3 years of commencement starting with largest centres first and 2-3 year simulcast.	
2	Analogue switch-off date	A provisional ASO date of 2016-2017 appears practical with services commencing in 2013-2014.	
3	New entrants/services (after digital frequency plan has been completed)	No new analogue services to be licenced. Some consideration may be given to DTTB multiplexes for subscription services post completion of the digital frequency plan, but this has yet to be considered in detail.	This will be further considered in development of the future service delivery options to serve Papua New Guinea needs and growth.
4	Extended population coverage	At present there is limited scope to extend coverage because of the geography, lack of transmission infrastructure, electric power and the population distribution. DTH will always be necessary for comprehensive coverage and distribution. Coverage is subject to licensing terms and conditions.	Once the distribution infrastructure is in place, new transmission sites could be established at relatively low cost, but there needs to be a trade-off between terrestrial and DTH delivery, that takes into account availability of electric power, access for support of an isolated transmitter location, and the number of viewers to be served. In some instances a single satellite downlink with cable distribution may be a more affordable and an easier to maintain option in small isolated communities.

No	Objective	Short term (Implementation Phase to about 1 year after ASO)	Long term (5-10 years after ASO)
5	Better picture quality	Noise free and stable picture Widescreen (16x9) SDTV. The frequency plan will make allowance for future requirements for things like HDTV to the extent that need, demand and cost justifies in the future. The alternative would be to allocate sufficient capacity to each broadcaster to allow for HDTV transmission or multi-channel and allow the market to decide. For this there should be a mandated requirement for all STBs and receivers to be able to decode HDTV content, and to display this in the native format of the receiver which may be SDTV.	Possible arrangements for HDTV and other enhancement should be further considered by the NRT on basis of representations from interested service providers. Such developments should be balanced against public benefit and commercial considerations, and the interest of "future proofing" the system. However, "future-proofing" could well be achieved simply by mandating that receivers are able to decode HDTV formats. This will have a small impact on the price of STBs.
6	Lower costs	Minimize viewer migration costs. Where possible use same frequency bands as analogue for DTTB so as to minimize infrastructure costs. Minimize broadcaster costs by establishment of improved site sharing and access arrangements that give greater predictability to broadcasters about site costs.	DTTB can carry multiple programmes on a single transmitter. There will be capacity available to establish additional FTA content on the multiplex at low marginal cost. Possible examples include education, and specialist government information services, once production capability is established.
7	Equitable access to network multiplex, distribution and transmission	Transparent scheme established and supported by appropriate regulation to ensure current and future new broadcast services can be established on a fair cost and equitable access arrangement to multiplex, distribution, and transmission facilities and sites to provide greater certainty and transparency of cost and fees.	
8	Digital dividend	Immediate needs for accommodation of mobile broadband services etc. above channel 48 have been incorporated into current spectrum planning. Future requirements, to allocate any additional dividend to broadcast or other services, will be considered after ASO. Spectrum plan to consider range of potential future needs such as the possible need for Digital Radio and other services later.	Consider wider impact of digital dividend opportunity and plan accordingly in the light of prevailing knowledge.

No	Objective	Short term (Implementation Phase to about 1 year after ASO)	Long term (5-10 years after ASO)
9.	Capacity building	Develop and deliver training programmes on digital technology to broadcast technical staff, regulatory staff, and installers and incorporate these into the technical training syllabus of universities and technical colleges.	Up-to-date digital curriculum in all universities and technical institutes with access to people having the need for this training. Achieve self-sustaining indigenous Papua New Guinea capability to support and develop all aspects of DTTB and associated digital technologies.
10.	Public awareness to consumers and suppliers	Comprehensive communication campaign and structured communications strategy to support migration activities and ASO	

NOTE: These objectives were developed during workshops conducted during the first ITU roadmap mission and are suggested starting points for more comprehensive consideration by the NRT in development of its proposals to the Papua New Guinea Government.

Recommendations

This report recommends that the NRT commence its activity by taking the following steps towards the transition to digital television broadcasting and switching off the analogue services:

1. Have the roadmap report approved by the Papua New Guinea Government.
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. Prepare and achieve endorsement to the following decisions which influence the scope and duration of the roadmap planning:
    a. establish an ASO date and the date of the first DTTB transmissions;
    b. determine ASO model (phased simulcasting or not);
    c. determine the licensing Model (Model A or B) to be used for multiplexing, distribution and transmission;
    d. confirm that no further analogue television services will be licensed; and
    e. form a project management office (PMO) and start drafting an initial detailed ASO planning and determine the progress reporting procedures and structures.
4. In addition the NRT will need to:
    a. arrange market research into the key elements as indicated in this roadmap report (see Phase 1) to anticipate and plan solutions for potential ASO risks;
    b. determine the number and type of programme streams to make up the DTTB service offering (e.g. Standard Definition TV (SDTV), High Definition TV (HDTV), data services, audio services, possible subscription services) as these will determine the amount of delivery capacity to be established now or in the future;
    c. determine the DTTB system standard to be used for Papua New Guinea. Have this approved by government and commence the standardization process;

d. determine the operational parameters for the selected transmission standard (these involve trade-off between the number and quality of services, coverage at a given transmitter power, and service quality);

e. carry out detailed frequency and service planning for the agreed system; taking into account any required Digital Dividend. The spectrum and service planning work already carried out in Papua New Guinea has already taken into account some of the anticipated DTTB requirements;

f. reserve capacity for the likely future services of such as additional services, HDTV, digital radio, and possible coverage enhancement. Unless these things are taken into account in the DTTB spectrum planning they could prove complex and costly to introduce after DTTB is operating;

g. prepare necessary amendments to legislation to support DTTB implementation; and

h. if required recommend and oversight the delivery of any specified required digital dividend.

Discussion

Discussions between the expert and key stakeholders in Papua New Guinea suggest that Papua New Guinea will be able to move forward with DTTB implementation. The Minister for Communications and Information has expressed strong support for digital migration and progress has been made with spectrum planning to accommodate DTTB services. The immediate needs for digital dividend spectrum to accommodate next generation mobile services can be easily achieved within the current spectrum plan so will not present an impediment or time constraint to the logical implementation of DTTB in Papua New Guinea.

The topography, population distribution and limited terrestrial communications infrastructure of Papua New Guinea makes the use of satellite an essential element of any future network. DTH satellite services can provide access to remote and isolated villages where terrestrial services would be uneconomic. At the same time, there is recognition of the fact that a significant number of villages still have no electricity which makes provision of any television service problematic. Access to isolated villages also presents difficulties for terrestrial equipment maintenance. The reach of television is still very limited with approximately eight (8) television receivers per 1 000 population.

These factors suggest that the preferred model for free-to-air DTTB television services in Papua New Guinea would be a common shared multiplex carrying all FTA services with capacity to add additional services that may be identified over time. There is sufficient spectrum capacity to allow the establishment of separate pay television multiplexes using the same technology. Some legislative amendments may be necessary in order to provide appropriate regulatory framework for shared common multiplexers. Such a multiplex could be operated by a consortium of broadcasters, a third party, or a single broadcaster providing access to others. These options will be further explored by the NRT in development of its plans for Papua New Guinea.

There are various options for assigning capacity on the shared multiplex. One way would be to determine the number of separate broadcasters to be accommodated and the capacity of the multiplex, and then to allocate capacity on the basis of a maximum bit rate. It may also be necessary to specify a minimum bit rate for Standard Definition signals. This might provide the opportunity for broadcasters to new FTA develop multichannel programme services, or perhaps consider HDTV or 3DTV transmissions at some time in the future without the need for restructuring the multiplex licence arrangements. The alternative, more regulated approach is to allocate capacity on a specific bit rate for a specified service. This would however, inhibit innovation and leave little opportunity for broadcasters to offer additional services that may make take up of DTTB more attractive to consumers.

DTTB can carry multiple services on a single transmitter of lower power than existing analogue single channel services. This results in lower marginal cost of adding new services, lower electricity consumption and will open up new opportunities to improve access to, and the variety of services that can be made available to the population.

Some of the key issues facing community access to services in Papua New Guinea are reflected in the following summary from a recent survey[1]:

TV and Internet limited to urban elites

- Home access to TV is on the rise, but its growth is heavily limited to urban centres, due to financial barriers, poor infrastructure and weak signals in many of the rural areas.
- Internet access for now remains primarily limited to the young, educated urban elite. However, due to rapidly growing availability of 3G mobile phones, the falling cost of mobile internet and improved mobile signals across the country, access to mobile internet is also likely to surge in rural areas.

There is scope for the MMDS operators to adopt DTTB technology as well, particularly given that NICTA has planned for MMDS operators to move from the 2.5GHz band into UHF broadcasting Band V, should the 2.5GHz band need to be cleared to accommodate other services. This will require conditional access arrangements and possibly some coordination of standards for both FTA and conditional access STBs. If MMDS operators do adopt DTTB technology then there may be further opportunities for facilities sharing; although the use of a different frequency band to FTA might mitigate against this.

Local programme insertion into the common multiplex would be the easiest way to accommodate community broadcasters who are licensed to serve particular centres only. Such arrangements could also be used for new local broadcasting services as the demand arises in the future.

The 51 terrestrial television transmission transmitter locations across Papua New Guinea all use relatively low transmitter power, which means that the cost of adding DTTB infrastructure will be moderate. A number of sites use broadband transmitting antennas which will allow sharing of the existing antenna systems. Early commencement of DTTB may therefore be a first step towards expanding access to television because there are currently only a relatively small number of receivers that will be affected by ASO.

Considering all of the above factors, and without underestimating the potential difficulties associated with planning and implementing ASO, the suggested ASO timetable of 2016-2017, developed during the workshops of the first mission, appears feasible provided there is an early start in planning the transition process.

Within Papua New Guinea the number of skilled and experience technical staff, with sufficient knowledge of digital technology is limited; the NRT workshop identified the need to develop human resources skills as a high priority. This needs to include enhancement to current programmes within the university and the technical colleges as well as internal programmes for the broadcasters and administration.

The introduction of a shared common FTA multiplex will require a review of the existing legislation and most likely some amendment to address: the rights and obligations of the operator; of broadcasters sharing the multiplex; and provisions for flexible allocation of the multiplex licence (and associated transmitter licences) to either a broadcaster, a consortium of broadcasters, or an independent third party.

[1] Citizens Access to Information: Citizen Survey 2012.

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1 Introduction

The *ITU Guidelines for the Transition from Analogue to Digital Broadcasting*[2] (referred to as the ITU Guidelines) provide assistance to ITU Member States to smoothly migrate from analogue to digital broadcasting. In a further effort to help countries to switch over to digital broadcasting, the ITU helps Member States draft their national roadmaps for this digital switch-over (DSO) process. Papua New Guinea is one of the Member States receiving this assistance.

This *Roadmap for Transition from Analogue to Digital Terrestrial Television in Papua New Guinea* (the roadmap) has been jointly developed by an ITU expert, Mr Colin Knowles, and the Papua New Guinea National Roadmap Team (NRT). The NRT will be chaired by Mr Charles Punaha, Chief Executive Office of the National Information and Communications Authority (NICTA) of Papua New Guinea. At the time of the ITU roadmap missions to Papua New Guinea, the NRT and its membership had not been formally established. The organizations proposed to initially be represented on the NRT, and which participated in the NRT workshops conducted during the ITU missions include:

- Ministry of Communications and Information
- NICTA
- National Broadcasting Corporation (NBC)
- EM TV/Kalang Advertising/PNGFM
- Hitron Channel 8 (MMDS Pay TV Provider in Port Moresby)
- TEPNG/CHM – Radio Dealers/Suppliers
- Telikom PNG, Digicel PNG, B-Mobile (Mobile Telecommunications Service Providers)
- Standards Authority of Papua New Guinea

The NRT is intended to provide a central focal point for all activities associated with of DTTB implementation from policy through to analogue switch-off (ASO). Because of the policy and public interest implications of such a project, the NRT is normally managed by a policy department of government. In Papua New Guinea the NRT will be formally established under the regulator NICTA.

The NRT should be seen as the core group supported by different advisory groups at different points in the implementation cycle. Over the course of the project, the role of the NRT will progress from broad policy and planning questions, to detailed planning and design of the operating framework for digital broadcasting, to licensing and implementation and finally ASO. In each of these phases, different skills, expertise, and information are needed. The NRT is often a series of differently structured groups of people appropriate to the stage being considered (e.g. may involve industry stakeholders, technical planners, retail and other service providers, and communications specialists at various time). The NRT can be seen as the management group, sponsored by the key ministry responsible for policy, and which provides the link to government, and provides overall coordination of the whole project; however, its advisory groups and contributors change over time.

The Papua New Guinea NRT includes a representative group of stakeholders appropriate to the consideration of DTTB policy development and implementation issues. This wide representation of interested parties will considerably assist in creation of a dialogue the Ministry, NICTA, and stakeholders. Such dialogue usually results in discovery of solutions that can make implementation easier.

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

The ITU expert provided briefings to the Minister for Communications and Information (MCI), the Secretary of MCI and Acting CEO of NICTA at the start and end of the mission. The Minister opened the three day workshop expressing strong support for the initiative and again indicated his support in his remarks at the end of the second mission.

The expert also held discussions with the CEOs of the two national television networks EM TV and NBC they both expressed support for the migration initiative and highlighted particular concerns about the cost of transmission site access, lack of a good pool of technical people able to support digital technology, and identified the need for appropriate mechanisms to address programme rights issues.

The ITU assistance to Papua New Guinea consisted of four key activities:

1. preparation and first country visit to collect information;
2. drafting roadmap report;
3. second country visit to present and discuss the draft roadmap report; and
4. production of a final roadmap report.

For the purpose of drafting this roadmap, the expert visited Papua New Guinea from 3 to 7 September 2012 and from 29 October to 1 November 2012 and he was able to discuss various aspects of the current spectrum plan with NICTA engineers, and together with the National Roadmap Team (NRT) examined:

1. the current TV market and regulatory context;
2. short-term and long-term digital switch-over(DSO) objectives;
3. functional blocks that were to be in scope for this roadmap; and
4. the status of any decisions made about key objectives and options to be considered within the specified building blocks.

After the first visit, the expert prepared a draft of this roadmap report. During the second visit, the draft, together with contributions made by the NRT, were discussed and evaluated. Agreed changes have been incorporated into this report.

2 Current TV market and DSO objectives

Papua New Guinea has a population of around 7 million[3] people and an area of about 463 000 sq km of very mountainous terrain, and a number of main islands. There are two main population centres, the capital, Port Moresby (population 254 158, the second largest is Lae (approx 120 000). The next three most populated centres have population of less than 30 000. Approximately 85 per cent of the population[4] live in small coastal or highland villages. Access to modern services is constrained not only by geography and infrastructure, but also by the very large number of language groups across the country. In the West, it shares a national border with Indonesia. In 2011 the Papua New Guinea Gross Domestic Product (GDP) per capita was estimated to be USD 2 694,[5] which means that cost to consumers may be a significant factor in planning migration from analogue to digital television.

[3] 2011 Papua New Guinea National Census.

[4] www.pressreference.com/No-Sa/Papua-New-Guinea.html

[5] World Economic Outlook Database of the International Monetary Fund.

The starting point for developing a roadmap for transition to digital terrestrial television is an analysis of the current TV market and regulatory framework, which are described in Section 2.1 and Section 2.2. The DSO objectives are described in Section 2.5.

2.1 Market structure

The terrestrial Free-to-Air (FTA) TV market in Papua New Guinea is estimated to comprise approximately 42 000 TV receivers[6]; approximately 8.3 receivers per 1 000 people. Local estimates are that about 20 per cent of homes have television.

The country is served by two television networks EM TV which was launched in 1987 and is estimated to reach about 60 per cent of the population terrestrially and the national broadcaster NBC (Kundu2) Television transmissions commenced in 2008 covers about 40 per cent of the population terrestrially. EM TV can potentially reach 100 per cent of the population through its DTH service.

Around 70 per cent of viewers are said to have external receiving antennas and 20 per cent rely on communal antennas.

NBC's capability and facilities are limited at present and it broadcasts around five hours per day and 13 hours on Saturdays and Sundays. NBC has given attention to sourcing local content, as well as covering events of national importance. NBC, has for many years, operated an extensive radio network across Papua New Guinea using FM, AM and shortwave transmissions.

EM TV has 33 transmitters, NBC, 22 and there are three MMDS operators (one in each market – Port Moresby, Alotau and Mt Hagen). There are also 32 cable television operators in various locations. MMDS uses the frequency band 2.5-2.7 GHz. Should there be a need to clear these frequencies for other purposes. The current NICTA plan is to move the MMDS services to Band V channels in the broadcasting band.

The expert understands that no further analogue television licences are going to be approved. Any future services are expected to be delivered by DTTB. How and when any new services are to commence, will be considered within the NRT and its recommendations will be subject to relevant government approval.

Frequency usage in Papua New Guinea is not intense (because of the small number and relatively low power of transmitters in the networks. These transmitters are mostly isolated from one another by the rugged terrain). NICTA has sought to provide consistent channel numbers to broadcasters. While this is convenient to broadcasters for brand identification in the analogue world, it is no longer necessary for digital broadcasting because the receiver will identify services by logical channel number, or by programme identifier irrespective of the transmission frequency. For DTTB, compatibility with existing transmission and reception infrastructure to allow sharing analogue transmission antennas and allowing viewers to use existing receive antennas will be the primary consideration for DTTB planning.

2.2 Coverage

The coverage of each transmitter is limited. The communities to be served are relatively compact, and the terrain limits wider coverage. Twenty five (25) of the FTA transmitters operate with transmitters in the range 100W-2 kW size, and the rest are less than 100 W.

6 www.pressreference.com/No-Sa/Papua-New-Guinea.html

2.3 Electric power

The electric power supplies in most parts of Papua New Guinea are unreliable and regularly suffer both "brown outs" and complete failures. Reliable DTTB services will require the use of uninterruptable power suppliers (UPS) at transmitter locations, to protect the equipment from surges and voltage drops, as well as to avoid issues with synchronization of the digital modulators and input receivers. With the reduced power demand for digital transmissions, the use of solar panels and battery arrangements becomes feasible; however, broadcasters report that there is frequent theft of panels from unattended sites which limits the practicality of such arrangements.

In those villages where there is no electric power, local generators are sometimes operated for a few hours per day. This is not suitable for television transmitters and lack of power will generally limit the purchase of television receivers even if signals are available. For a time into the future, DTH may remain the only affordable way to deliver services to consumers in small isolated villages. The NRT will need to consider the relative economics and appropriate cut-off point for terrestrial delivery when planning its DTTB service.

2.4 Regulatory framework

The main regulatory bodies in Papua New Guinea are set out in Table 2.1.

Table 2.1: Papua New Guinea policy and regulatory agencies

Agency	Broad Functions
Ministry of Communications and Information	Policy department for the sector
National Information Communications and Telecommunications Authority (NICTA)	ICT regulator
The Papua New Guinea Censorship Board	Programme standards and classification of media content including broadcasting, and print
The Papua New Guinea National Institute of Standards and Industrial Technology (NISIT)	National standards

The legislative instruments which support the regulation of television broadcasting are shown in Table 2.2.

Table 2.2: Papua New Guinea regulatory framework for broadcasting

Legislation	Arranges/Covers	Regulatory body
NICT Act 2009	Principal policy and legal foundation for NICTA	NICTA
NICT Operator Licensing Regulations	Regulations concerning Licence Categories, licensing etc.	NICTA
NICT Content Regulation	Regulation concerning content licences (yet to be developed)	NICTA
NICT Radio Spectrum Regulations	Regulations covering licensing of RF transmissions under either spectrum or apparatus licences	NICTA
NISIT Act 1993.	Establishes NIST, and defines it powers and responsibilities	NSIT
Censorship Board Act	Establishes the Papua New Guinea Censorship Board and defines its powers and responsibilities	Censorship Board
ICCC Act 2002	Provision covering consumer and competition issues including market conduct	ICCC

2.5 Digital switch-over objectives

The preliminary draft objectives for DSO are shown in Table 2.3.

Table 2.3: Preliminary DSO objectives

No	Objective	Short term (Implementation phase to about 1 year after ASO)	Long term (5-10 years after ASO)
1	Smooth transition from analogue to digital	All analogue services converted to digital with coverage areas equal to the current analogue services. (All FTA have identical coverage). DTTB channels match frequency bands of existing services in a market to facilitate infrastructure sharing and viewer installations. All transmitters installed at current transmission sites within 2-3 years of commencement starting with largest centres first and 2-3 year simulcast.	
2	Analogue switch-off date	A provisional ASO date of 2016-2017 appears practical with services commencing in 2013-2014.	
3	New entrants/services (after digital frequency plan has been completed)	No new analogue services to be licenced. Some consideration may be given to DTTB multiplexes for subscription services post completion of the digital frequency plan but this has yet to be considered in detail.	This will be further considered in development of the future service delivery options to serve Papua New Guinea needs and growth.
4	Extended population coverage	At present there is limited scope to extend coverage because of the geography, lack of transmission infrastructure, electric power and the population distribution. DTH will always be necessary for comprehensive coverage and distribution. Coverage is subject to licensing terms and conditions.	Once the distribution infrastructure is in place, new transmission sites could be established at relatively low cost, but there needs to be a trade-off between terrestrial and DTH delivery, that takes into account availability of electric power, access for support of an isolated transmitter location, and the number of viewers to be served. In some instances a single satellite downlink with cable distribution may be a more affordable and an easier to maintain option in small isolated communities.
5	Better picture quality	Noise free and stable picture Widescreen (16x9) SDTV. The frequency plan will make allowance for future requirements for things like HDTV to the extent that need, demand and cost justifies in the future.	HDTV and other enhancement to be considered on basis of representations from interested service providers. Such developments should be balanced against public benefit and commercial considerations.

No	Objective	Short term (Implementation phase to about 1 year after ASO)	Long term (5-10 years after ASO)
6	Lower costs	Minimize viewer migration costs. Where possible use same frequency bands as analogue for DTTB so as to minimize infrastructure costs. Minimize broadcaster costs by establishment of improved site sharing and access arrangements that give greater predictability to broadcasters about site costs.	DTTB can carry multiple programmes on a single transmitter. There will be capacity available to establish additional FTA content on the multiplex at very low marginal cost. Possible examples include education, and specialist government information services, once production capability is established.
7	Equitable access to network multiplex, distribution and transmission	Transparent scheme established and supported by appropriate regulation to ensure current and future new broadcast services can be established on a fair cost and equitable access arrangement to multiplex, distribution, and transmission facilities and sites to provide greater certainty and transparency of cost and fees.	
8	Digital dividend	Immediate needs for accommodation of telephony etc. above channel 48 has been incorporated into current spectrum planning. Future requirements, to allocate any additional dividend to broadcast or other services, will be considered after ASO. Spectrum Plan to consider range of potential future needs such as the possible need for digital radio and other services later.	Consider wider impact of digital dividend opportunity and plan accordingly in the light of prevailing knowledge.
9.	Capacity Building	Develop and delivery training programmes on digital technology to broadcast technical staff, regulatory staff, and installers and incorporate these into the technical training syllabus of universities and technical colleges.	Up to date digital curriculum in all universities and technical institutes with access to people having the need for this training. Achieve self-sustaining indigenous Papua New Guinea capability to support and develop all aspects of DTTB and associated digital technologies.
10.	Public awareness to consumers and suppliers	Comprehensive communication campaign and structured communications strategy to support migration activities and ASO.	

NOTES: These objectives were developed during workshops conducted during the first ITU roadmap mission and are a suggested starting point for more comprehensive consideration by the NRT in development of its proposals to the Papua New Guinea Government.

2.5.1 Mobile TV objectives

Mobile Television (MTV) is outside the scope of this roadmap. MTV networks provide services for handheld and mobile receiving devices, using a dedicated MTV transmission standard. The prospective international market for MTV is variable. MTV services, using the T-DMB standard, are operating in Korea and some parts of Europe. Japan has established MTV services using ISDB technology. In Europe a number of countries started MTV services using the DVB-H standard and due to limited market take up, these DVB-H services have been stopped or will stop soon. On the other hand, multimedia services via mobile broadband communication networks (3G and 4G/LTE) seem to be more promising. Note that the absence of MTV in the broadcast bands does not inhibit the provision of video services on LTE and 4G telephony networks. A full discussion of mobile television technology and how it fits within the mobile telephony framework and description of the various technology options can be found in the ITU Guidelines and associated references.

In the longer-term, if MTV became established as a viable service alternative to 4G/LTE or other future technologies, then some channels may then need to be set identified in the broadcast band. This would be possible after ASO. This decision will not impact on present analogue television migration or on the establishment of LTE/4G networks in Papua New Guinea.

2.5.2 Digital radio objectives

Digital Sound Broadcasting (DSB) is not within the scope of this roadmap. If the European DAB+ system were selected for a future DSB service, the preferred channels would be in Band III. Some of the alternative systems can use Band I or Band II frequencies.

The NRT may wish to consider recommending that some of the spectrum available post ASO be reserved for DSB in order to keep the options open for future radio development.

In discussions with the expert, the CEO of NBC asked about the suitability of DRM to provide its service to some of the more remote localities. DRM technology performs very much better than AM shortwave, but unfortunately there is a limited world market for receivers; so receiver costs would be a significant obstacle for listeners compared with the very low cost of FM receivers (which are also built into many mobile telephones). At this point, continuation of the development of satellite networked FM transmitters would appear to be a more suitable option for Papua New Guinea, because it can be delivered at lower cost and be received on a wide range of cheap and readily available devices.

3 National roadmap

This section introduces the concept of a roadmap and its construction.

3.1 Roadmap concept

A roadmap is a management forecasting tool and is directed to the implementation of strategy and related to project planning. A roadmap matches short-term and long-term goals and indicates the main activities needed to meet these goals. Developing a roadmap has three major uses:

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

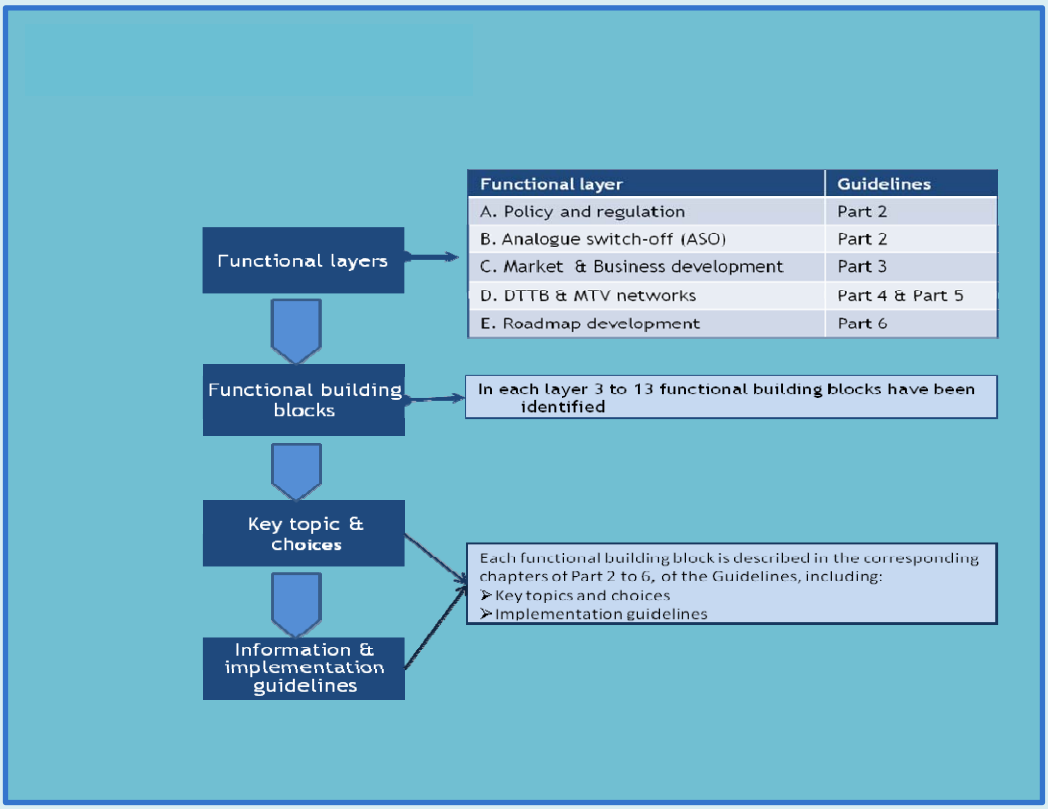
A roadmap consists of various phases, normally related to preparation, development and implementation of the strategy. A roadmap is often presented in the form of layers and bars, together with milestones on a time-scale.

3.2 Roadmap construction

Part 6 of the ITU Guidelines describes a method for developing a roadmap and provides a set of generic roadmaps for the process of transition to DTTB and MTV. The methodology described in Part 6 of the ITU Guidelines has been adopted in the development of this roadmap.

The basic framework has five layers as shown in Figure 3.1

Figure 3.1: Functional framework

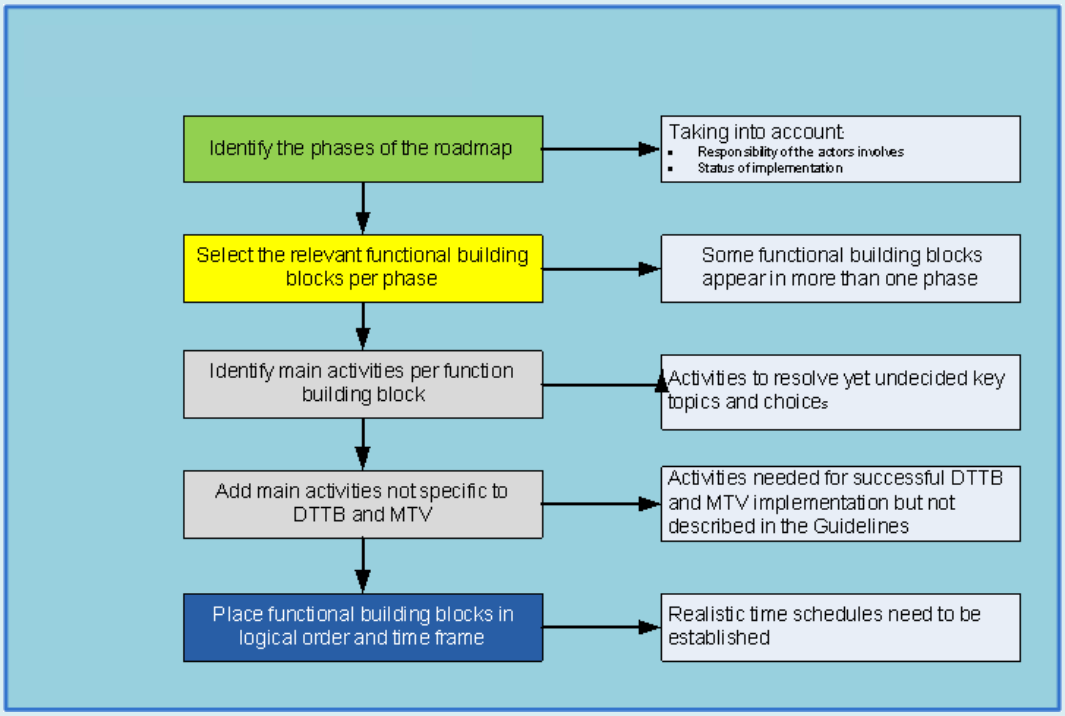


Source: ITU

Each layer has of a number of functional blocks. Each building block identifies key topics and choices to be addressed.

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. The roadmap then identifies the decisions already taken and the main activities and choices involved in resolving the remaining decisions to be made in relation to the key objectives. Figure 3.2 illustrates this process.

Figure 3.2: Roadmap construction



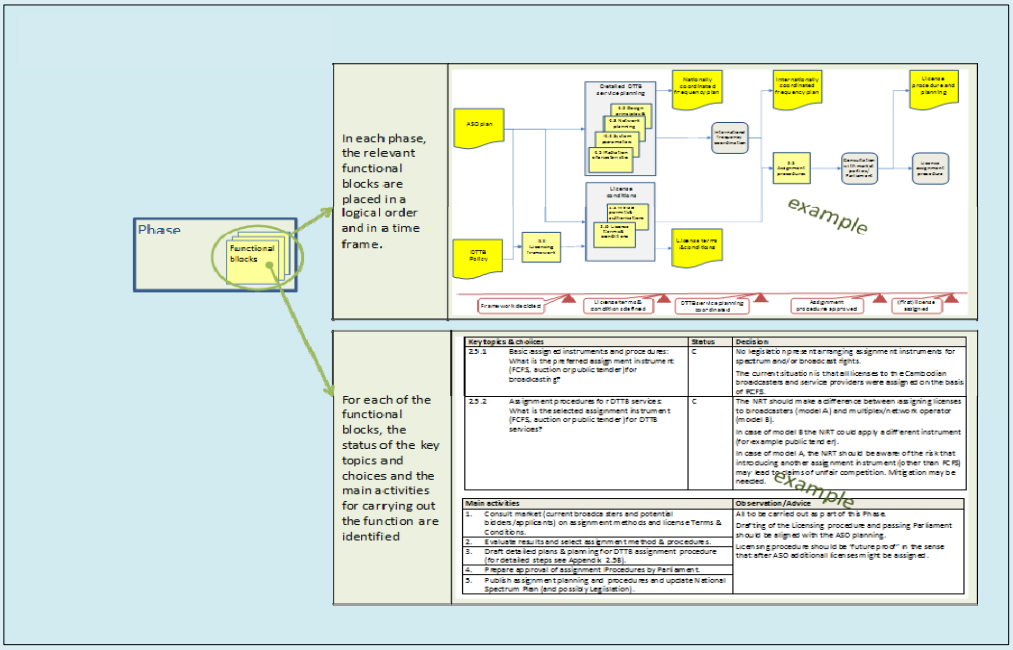
Source: ITU

The result is a roadmap that comprises three levels:

1. phases of the roadmap with the associated functional blocks;
2. for each phase, the functional blocks placed in a logical order and time frame; and
3. for each functional 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: ITU

An overview of the status of the selected functional blocks identified for Papua New Guinea digital migration is given in the Annexes 1 to 4.

3.3 Functional building blocks relevant of the Papua New Guinea roadmap

Functional layer E "Roadmap Development" is covered by this report. The other functional layers A (Policy and Regulation), B (ASO), C (Market and Business Development) and D (Networks) contain the 38 functional blocks shown in Figure 3.4. Out of the 38 functional blocks, 26 blocks were selected to construct the Papua New Guinea roadmap.

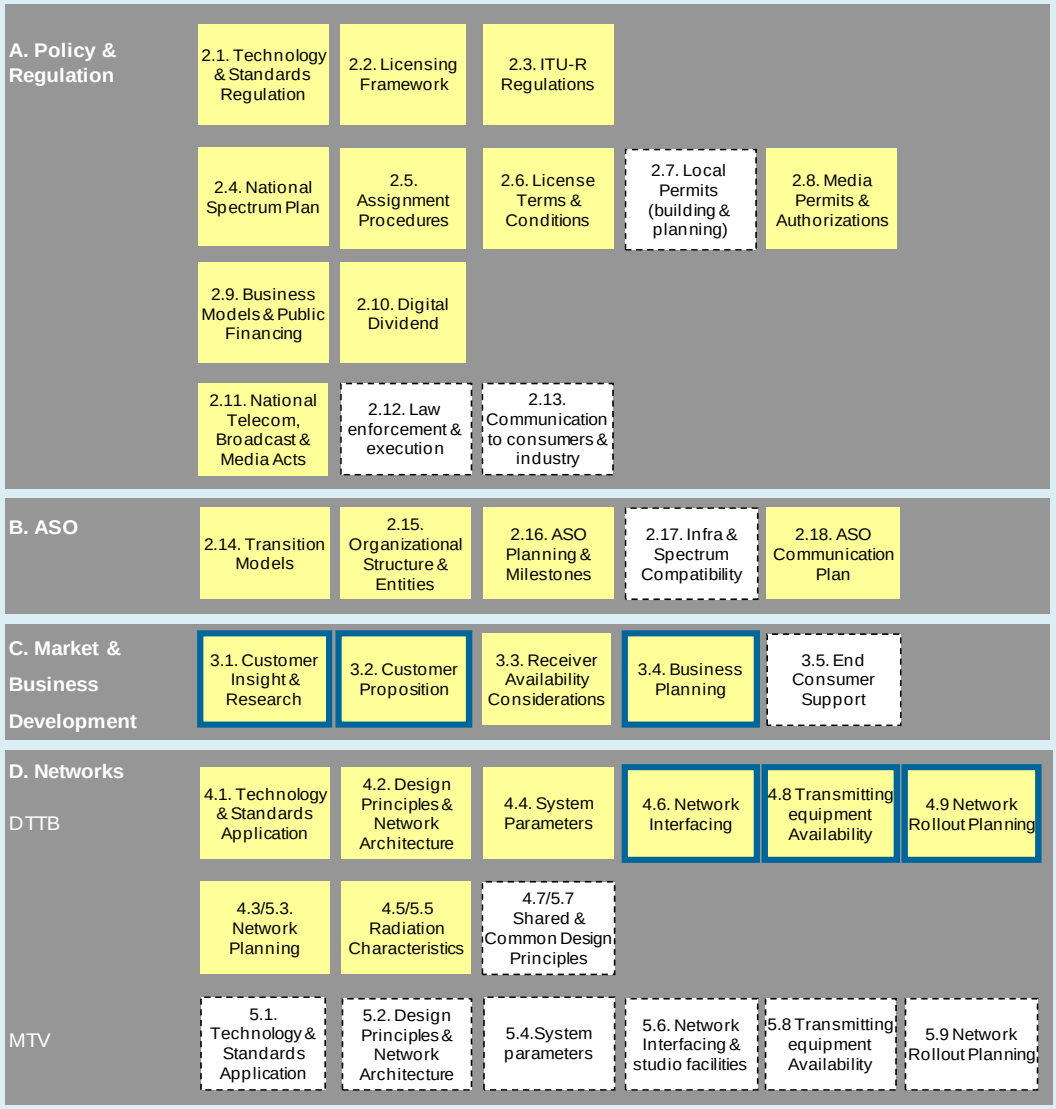
The roadmap covers:

1. short-term DSO objectives (until one year after ASO) as defined in Table 2.3;
2. activities for the NRT.

Figure 3.4 shows three types of functional blocks:

1. **White blocks with dashed frame.**
   These blocks are not included in the Papua New Guinea roadmap (see Table 3.1).
2. **Yellow blocks without frame.**
   These blocks are included in the Papua New Guinea roadmap and will be managed by the NRT.
3. **Yellow blocks with a blue frame.**
   These blocks are included in the Papua New Guinea roadmap and will be addressed by the NRT if licensing Model A will be chosen. If Model B is chosen these functional blocks will be carried out by each individual DTTB licensed broadcaster as outlined in Section 3.4.

Figure 3.4: Selected functional blocks (coloured yellow) in the Papua New Guinea roadmap



Source: ITU

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

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

Not Included functional blocks		
Number	**Title**	**Reason**
2.7	Local permits (building and planning)	Obligation on licensee to obtain relevant approvals, and if denied then legislation provides for mediation process.
2.12	Law enforcement and execution	No changes appear necessary as a precondition to the successful transition to digital television. Current legislation is technology neutral.
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).

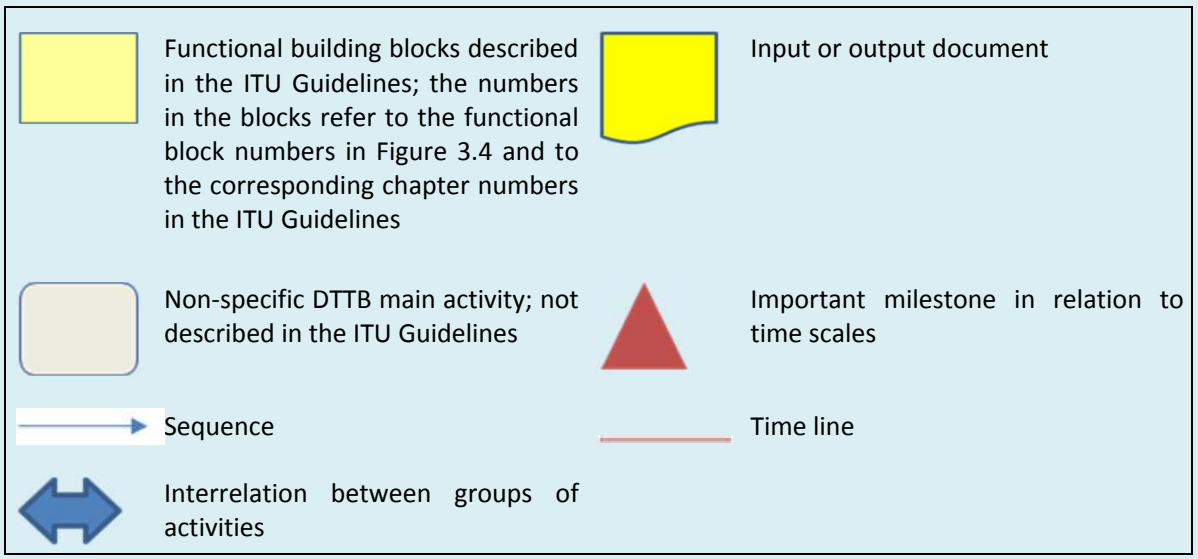
Not Included functional blocks		
Number	**Title**	**Reason**
2.17	Infrastructure and spectrum compatibility	Infrastructure compatibility is not considered an issue spectrum compatibility during transition (between analogue and digital TV) will be covered in the national frequency plan. Nevertheless possible interference between DTTB transmitters and cellular mobile facilities may need consideration and testing at any sites where cellular mobile base stations are located nearby.
3.5	End consumer support	As the activities related to market and business development will all be carried out as part of the transition process, the activities related to 3.5 will be included in 2.18 (ASO communication plan)
4.7	Shared and common design principles	The MTV network has not been considered and is out of scope. There is no MTV network planned or operational to take into consideration.
5.1 to 5.9	MTV networks (all functional blocks)	MTV is not within the scope of this roadmap.

3.4 Description of the digital television roadmap for Papua New Guinea

This section outlines the overall roadmap for Papua New Guinea. Each of the phases is considered. The detailed activities and considerations for each phase and its associated functional blocks are included in Annexes of this report.

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

Figure 3.5: Symbols used in roadmap figures



Source: ITU

3.4.1 Overall roadmap

Early in its deliberations, the NRT should prepare a recommendation to government on the practical DTTB commencement and possible ASO dates. The duration and timing of the phases in which the DTTB network is rolled out and the analogue transmitters are switched off can span a number of years. However, where there are strong incentives and a strong government commitment to ASO, it can occur within a much shorter period. The extent to which new infrastructure is required to deliver DTTB, plays a major part in deciding the earliest feasible ASO date.

Licensing Model A or B

A key decision, for the Papua New Guinea NRT, is the licensing model to be adopted for DTTB. The ITU Guidelines suggest two basic models (Model A or B[7]); however, variations, or a blend, of these basic models are often appropriate. The features of the basic models are discussed at length in the ITU Guidelines Section 2.2. Table 3.2 is a summary of the key features of Models A and B. Depending on what packages of services are proposed, the number of multiplexes and the coverage required, there could be different models for different multiplexes. For example, there is a strong public interest for all primary services to be on a common FTA multiplex, and service the maximum practical number of people. Government might wish to exercise some control over the utilization of capacity on this nationwide FTA network. On the other hand, if a multiplex were allocated for subscription television, then possibly all of the planning and channel selections could be left to the operator who may acquire this capacity through some market driven model (e.g. auction, tender etc.). The coverage of a subscription multiplex may be more limited or rolled out over a different time frame as it would be driven by the commercial viability of the service. A further variant would be to allocate one multiplex per operator to carry both FTA and subscription services.

Table 3.2 Summary of features of licensing Models A and B

Model A	Model B
Spectrum rights assigned to multiplex operator who can decide on allocation of available capacity to various services	Spectrum rights assigned to content distributor but licence holder is ONLY allowed to use defined spectrum. Decisions of spectrum loading determined by the regulator by assigning licences to individual broadcasters
Multiplex operator may be broadcaster or consortium of broadcasters or a third party	In this model the NICTA has the role of the multiplex operator. Broadcast network operator may be a separate entity to the broadcast content provider

Selecting Model B will result in additional functional blocks being included in the roadmap as the NRT will need to take responsibility for additional aspects of establishing a common DTTB network.

[7] See the ITU Guidelines for the transition from analogue to digital broadcasting, Section 2.2.

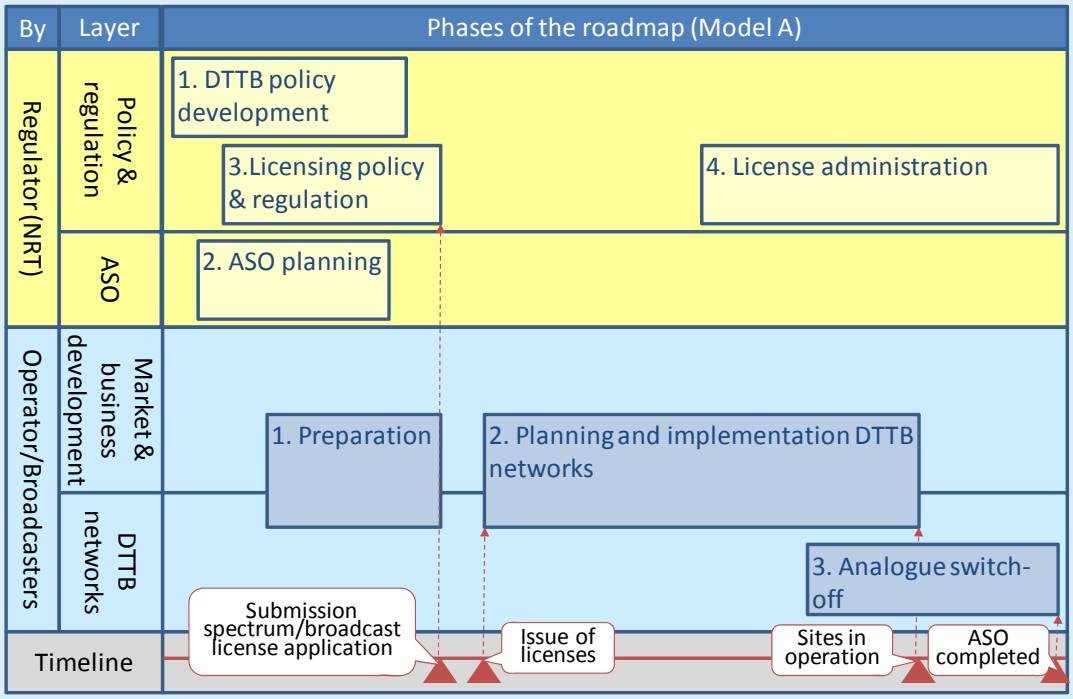
Table 3.3 is a summary of some of the options available for multiplex, distribution network and transmission.

Table 3.3: Summary of multiplex, distribution network, and transmission licence options

Ref	Model	Description	Pros	Cons
1A	Separate independent multiplex and network and transmission for each broadcaster.	Broadcaster issued multiplex/network and transmission licence.	Broadcaster has complete freedom to use Multiplex capacity (to extent provided by legislation/regulation).	Inefficient use of spectrum Higher electricity costs for multiple facilities. Higher infrastructure costs. Any new services will have to replicate infrastructure or negotiate carriage. Unless used for subscription services most broadcasters will be unable to use the available capacity.
1B	Shared multiplex network and transmission (It is possible to have several multiplex operators providing network for separate groups of channels if there is sufficient demand).	One or more multiplexes (could be separate licences) Capacity shared by several broadcasters with multiplex and network provided by multiplex operator. Multiplex operator could be existing broadcaster, consortium or a third party. If transmission provided by multiplex operator then the multiplex operator holds network licence.	Clear end-to-end responsibility for service performance Lower infrastructure costs Lower costs mean more investment in redundancy is possible. Lowest implementation cost. Easier to add additional services in future. HD/SD and other services can be established with optimal use of bandwidth.	Needs agreement between broadcasters and multiplex operator on terms of access and performance.
2A	Broadcaster provides MPEG encoding prior to sending to Multiplex Operator.	Broadcaster sends encoded and compressed video audio and EPG information.	Minimal advantages other than saving network cost for link from studio to multiplex head end.	Cannot take advantage of variable bit rate coding and statistical multiplexing to get higher quality for given bit rate.
2B	Multiplex Operator provides MPEG encoding.	Operator receives full bandwidth video/audio and data from broadcaster.	Full opportunity for variable bit rate coding and statistical multiplexing which maximize transmission performance.	Agreed limits of minimum/maximum bit rate must be established.

Ref	Model	Description	Pros	Cons
3A	Distribution network and transmission provided by multiplex operator.	There is nothing to prevent separation of network distribution from head-end to transmitter being performed by someone other than the multiplex operator, with multiplex operator sourcing transmission from best provider at a site but retaining full responsibility.	Multiplex operator can source network from others (e.g. a telecommunications operator) but remains responsible for end-to-end performance.	Need to avoid multiple interfaces, end-to-end performance should rest with a single provider irrespective of where the services are sourced within the network.
3B	Distribution network provided by one or more other parties	No advantage over 3A in terms of allowing for sourcing of transmitters from best provider at a site.	Additional interfaces and segmented responsibilities frequently result in disputes as to which agent is responsible for poor performance.	Difficult to establish end-to-end performance measures and liability. Reliability and performance are best treated as an end-to-end requirement.
4A	Shared transmission provided by network operator	Network operator also operates or arranges for transmitters for carriage of shared multiplex.	Maintains end-to end performance: Operator can source transmission from any person at a site but still remains responsible for performance.	Equitable access and costs must be established with this potentially monopoly provider.
4C	Shared transmission provided by multiple parties	No direct relationship between network multiplex operator/broadcaster and transmission provider.	No obvious benefit that can't be achieved from 4A.	Problematic to licence; No end-to-end network performance. In practice would probably have to operate per 4A with multiplex operator reaching agreement for provision of transmission and taking responsibility for performance.

Figure 3.6: Top level Papua New Guinea roadmap for Model A



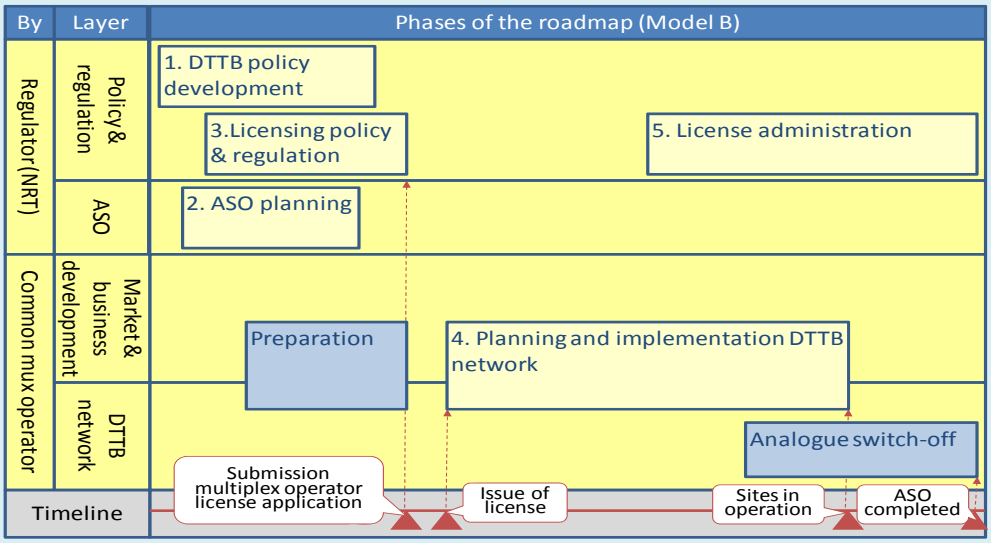
Source: ITU

Figure 3.6 illustrates the various phases of the NRT roadmap for Model A (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. It also illustrates that the broadcasters assume the responsibility of the actual DTTB network rollout (i.e. the blue shaded blocks). They prepare for acquisition of the necessary spectrum and broadcast licences (Phase 1 of the network operator), plan the network rollout and implement the network (Phase 2). This is the model which could be applied to a terrestrial DTTB subscription service where each operator acquired a full multiplex and determined what programmes were included in the service offering.

Figure 3.7 shows the various phases for the NRT roadmap for Model B. This shows that the first three NRT phases are the same as in the roadmap for Model A. However, after selecting the licensing model (i.e. in Phase 3), the regulator might adopt a price based allocation arrangement (e.g. tender, or auction) to decide on the multiplex and network operator. In the case where the government establishes the multiplex and network as part of national infrastructure, then government would normally create an operating company to manage the multiplex and network on its behalf. A scheme like this would perhaps apply to a common FTA multiplex, where the broadcasters to be carried on the multiplex would be determined by the regulator under the normal arrangements for determining the allocation of broadcast (content) licences.

After selecting the multiplex/network operator, the NRT will develop the network rollout plan in collaboration with the selected network operator (Phase 4).

Figure 3.7: Top level Papua New Guinea roadmap for Model B



Source: ITU

Functional building blocks for Model A and B

In Model B, the NRT/NICTA will take responsibility for arranging the establishing a common multiplex/network operator and the NICTA will have to identify and approve the broadcast services to be carried. The NRT/NICTA would arrange the selection of a common network operator and recommend for approval the services to be carried on the common multiplex. It would work with the selected operator to establish the network rollout schedule and the associated planning. In this case, the roadmap would include activities and decisions that under Model A would be left to the multiplex/network operator:

1. **Market and business development layer:**

   a. **Customer insight and research** (Functional Block 3.1). The NRT will have to determine what distribution services the multiplex/network operator is required to offer. In some countries this involves an assessment of market demand, but most DTTB implementations are driven by decisions to move away from analogue TV, and market studies are confined to determining the appropriate priorities for rollout of the network, and network coverage requirement.

   b. **Customer proposition** (Functional Block 3.2). The NRT will have to establish the required attributes of the distribution services, such as coverage areas, number of services, conditional access (in case of pay-tv services). However, the NRT may elect to confine these tasks to FTA services and adopt Model A for a separate subscription service. If FTA and subscription services are combined on a multiplex then clearly all of the above factors need to be addressed. In the event that several subscription television multiplexes are considered (with possibly separate licence holders) then there may be a desirable to try to standardize conditional access (CA) Systems across the platforms. However, this is often challenging because most subscription service providers provide the subscriber with a decoder, and do not want to permit the subscriber to switch service providers using the same decoder. If the consumer were to purchase the decoder under a model involving mixed FTA and subscription services on the multiplexes, then standardization may have to be mandated in the public interest. One factor that limits the usefulness of a mixed solution is that it will most likely fail to provide identical coverage to all FTA services. A feature of DTTB which has strong public interest appeal.

c. Ideally, the shared service provider (even if it were owned by a broadcaster) should be seen to be independent of any broadcast service provider (by being a separate company) to ensure both real and apparent transparency and equity for all services carried on the multiplex and network. The NRT will need to develop an access and pricing model for the shared common multiplex to ensure equity of access for current and any future service providers. It will also need to determine reservations for future services, what if any use may be made of capacity not immediately needed for broadcasting, and the procedure by which future changes will be made to the multiplex services. Future access to multiplexer capacity should be similar to processes for awarding new broadcast television licences as they impact on others in the market - the Minister may reserve the right to introduce or to reserve capacity for new public broadcasting services such as education – Under the "public interest" FTA common multiplex model there is no requirement to immediately use up all of the capacity unless there is a clear demand to do so. However, if the multiplex is to be operated on strictly commercial terms, the operator will need some certainty as to how and when capacity can be used and broadcasters carried on the multiplex will want to know how their costs will change when other broadcasters are taken into the shared multiplex.

d. **Receiver considerations** (Functional Block 3.3). In line with the DSO objective to have a single standard for cheap set-top-boxes (STB) or integrated television receiver for the Papua New Guinea market, the NRT will have to determine what minimum receiver/STB functionality is required. This will include aspects such as the transmission and compression standard as well as the conditional access system if there is market agreement to adopt such a strategy. However, few open market integrated receivers have the facility to add internal CA systems, so the arguments would apply only to STBs. Experience suggests that after the initial migration period for FTA, STBs are mostly used to adapt analogue only receivers to receive DTTB and these quickly get replaced by integrated digital receivers, and/or by digital video recorders (DVRs) which provide both STB and recording functionality. With DTH distribution there may be issues in Papua New Guinea about programme rights being infringed by transborder transmissions which may need to be addressed by providing CA on the satellite distribution. There is not likely to be any issues of transborder coverage from terrestrial transmitters. It may be possible to share uplink and CA systems with a subscription broadcaster to reduce the cost of providing CA for the distribution. If DTH reception is required to address areas that are not serviced by terrestrial transmitters then arrangements will need to be put in place to manage CA access. If subscription television services are to be introduced on the terrestrial platforms, then the NRT should facilitate a conversation with the potential service providers to establish what CA solutions that are feasible and best serve the public and commercial interests of all parties.

e. **Business planning** (Functional Block 3.4). The guidelines suggest that under this model, that the NRT should assume responsibility for a viable service offering. However, if the government objective is to ensure that FTA DTTB services reach the maximum number of viewers and the decided to support this approach, the NRT would then simply be concerned with ensuring that the transmission and distribution networks achieve this objective. This is an appropriate strategy when government considers that all residents have an entitlement to a basic package of FTA services and are prepared to contribute to this objective. Subscription television should then be allowed to proceed on strictly commercial basis and consideration of commercial viability of the service and coverage would be left to the licensed operator. There may be merit in offering the potential for a nationwide service, and then requiring the successful applicants to establish a rollout plan. As only parts of the country may prove viable to serve, spectrum in un-served localities should not be permanently attached to a particular provider, and unused channels should return for possible reallocation if they are not used within a specified time.

2. **DTTB network layer:**

    a. **Technology and standard application** (Functional Block 4.1) to **radiation characteristics** (Functional Block 4.5). All these five technical functional blocks have to be included as to determine what the required DTTB network will look like. This includes aspects as the design of the key network elements (i.e. the head-end/multiplex centre, the distribution links and the transmitter sites), the various system parameters (i.e. transmission mode, guard interval, etc.) and the applied frequencies per site (i.e. ERP, antenna height and diagram), site specifications such as suppression of unwanted spurious emissions; and other parameters necessary to ensure harmonious co-existence and interference minimization for all users for transmission sites.

    b. **Network interfacing** (Functional Block 4.6), **transmission equipment availability** (Functional Block 4.8) and **network rollout planning** (Functional Block 4.9). These three functional blocks have to be included because they influence the rollout methodology timetable and service planning of the network. The detailed work will be influenced by the multiplexing and network model adopted and much of this work could be done by the selected network operator for FTA, and the commercial operator for subscription packages.

Under Model A, (such as a multiplex or multiplexes for subscription services in Papua New Guinea) the NRT would leave a number of tasks to the individual broadcaster. These might include:

1. **The actual service offering.** The broadcasters can determine the number of services and the coverage areas (if not stipulated) themselves. Consequently, a number of functional blocks do not have to be included in the roadmap:

    a. **Customer insight and research** (Functional Block 3.1). The broadcasters will carry out their own research to determine which services to offer on the DTTB platform.

    b. **Customer proposition** (Functional Block 3.2). The broadcasters will determine the various attributes, including pricing. However, the NRT can still stipulate some minimum service requirements with which the broadcasters will be required to comply. For example, the coverage areas and/or the launch windows (when the additional services have to be on air).

    c. **Business planning** (Functional Block 3.4). The broadcasters will be directly responsible for making the DTTB services economically viable and hence they will carry out their own business planning.

2. **The actual network rollout**. The broadcasters will resume responsibility for their network rollout and hence some blocks don't have to be included in the roadmap:

    a. **Network interfacing** (Functional Block 4.6). For example, the broadcasters will determine how the transport streams are distributed to the transmission sites.

    b. **Transmitter equipment availability** (Functional Block 4.8). The broadcasters will order their own equipment and will consider the available equipment themselves.

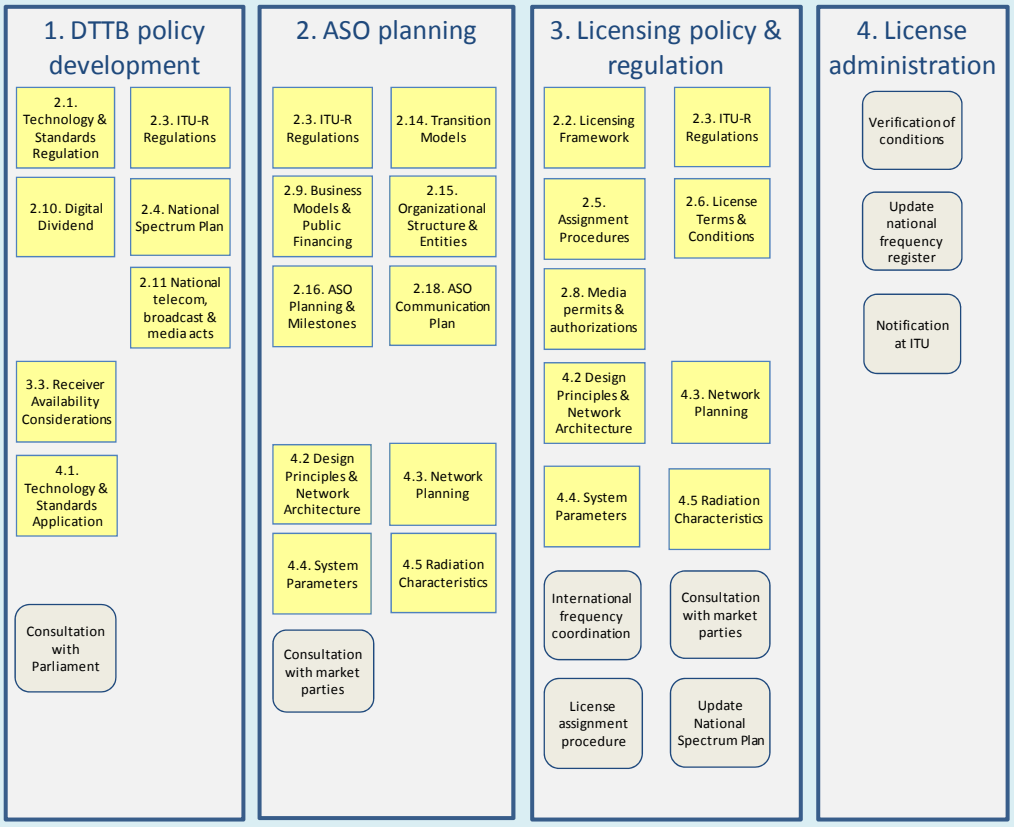
    c. **Network rollout planning** (Functional Block 4.9). The broadcasters will roll out their own network and the transmitters will probably been deployed on their existing towers. Although, the broadcasters will carry out their own network rollout, the NRT will have to set milestones with which they must comply. The broadcasters must follow the ASO plan (especially in the case of a phased simulcast model).

3. Under Model A, the following building blocks would remain in the Papua New Guinea roadmap:

   a. **Receiver considerations** (Functional Block 3.3). The broadcasters are free to determine their DTTB services, but the NRT will have to assure that Papua New Guinea viewers are not confronted with a range of STBs that have different standards. This could occur if the broadcasters are permitted to offer pay-tv services and expect consumers to purchase receivers with embedded CA systems. The national standard should stipulate a minimum essential set of STB requirements to provide protection to consumers and to ensure smooth transition to digital by building strong public confidence that equipment they purchase will work.

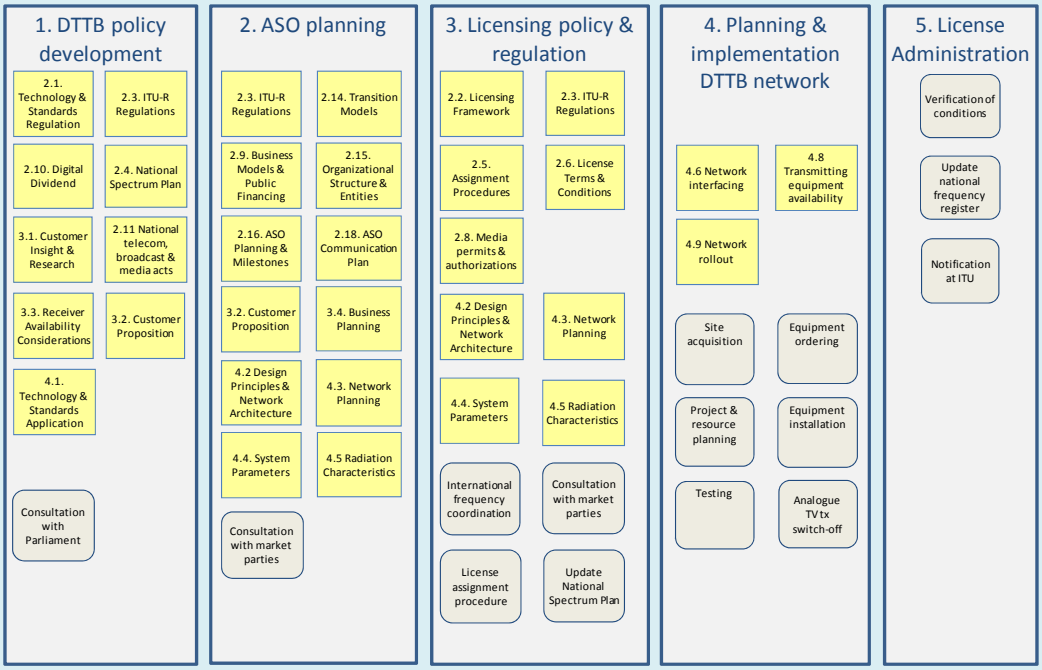
   b. **Technology and standard application** (Functional Block 4.1) to **radiation characteristics** (Functional Block 4.5). These five blocks directly relate to the spectrum plan. When carrying out the activities in these blocks the NRT can accurately define the spectrum rights for each individual broadcaster and can assure spectrum efficiency (and consequently the digital dividend).

Figure 3.8: Functional building blocks per phase of the roadmap (Model A)



Source: ITU

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



Source: ITU

Functional blocks in each phase

Depending on the multiplexing and network model adopted, there will be different sets of building blocks to consider. Figure 3.8 shows the functional blocks to be included for basic Model A. The yellow blocks are described in the ITU Guidelines and correspond to the functional block numbering of the ITU Guidelines. The grey blocks are not described in the ITU Guidelines as they are not specific to the introduction of digital terrestrial television services. They are usual an integral part of the policy development and consultation processes of government. These aspects must be addressed by the NRT and NICTA.

Figure 3.9 shows the functional blocks for Model B. They are similar to Model A, but Model A includes more functional blocks.

In Papua New Guinea, there are two key considerations that will influence the choice of licensing model:

1. The DTTB implementation should, as far as possible, remove differences in the coverage of FTA broadcasters. This suggests the establishment of a common FTA multiplex or multiplexes on the VHF Band which would maximize reach and maximize compatibility with existing. The transmissions could be on the UHF band where that is the prevailing television band in a market and there was no requirement for the existing services to move to provide the digital dividend. The objective is to maintain the same band as far as practical, which is a benefit to broadcasters and to viewers, and to use the migration initiative to improve coverage as necessary and to deliver equal coverage to all FTA broadcasters.

2. There is interest in providing subscription services via DTTB in the VHF or UHF terrestrial television bands in Port Moresby and some other centres. This suggests that one or more subscription multiplexes could be offered. If competitive subscription licences are to be offered then they should ideally have similar specifications and operating bands in each area (although this is not essential as the market would in principal factor in any cost disadvantage of one band over another). It may be desirable for all of the intended licences to be made available at the same time, if there were sufficient indication of genuine demand. The timing of implementation

of a pay service would generally be left to the successful licensees, based on their own assessment of the business viability. If necessary a prescribed latest commencement date could be specified in the bidding documents, and if the service is not commenced by that date the spectrum could revert back to the government (e.g. "use it or lose it" subject to appropriate review mechanisms) so that spectrum cannot be locked out from competition or other uses indefinitely.

Licence Model B would provide the best option for the FTA multiplex and Licence Model A for the subscription services.

3.4.2 Phase 1 DTTB policy development

The DTTB policy development phase of the roadmap is directed at achieving agreement and government endorsement of the national DTTB policy objectives. Political consensus and commitment lies at the heart of any successful ASO project. Government will need to commit to the ASO objectives, deadlines, necessary budget and endorse the establishment of a NRT with a clear mandate that establishes its role in planning and implementation of the ASO process.

The NRT should have agreed terms of reference, which remove any doubt about which matters should result in recommendations for higher approval, and which matters might be left to the NRT. In general, all of the major issues concerning policy, public interest, budget and other major questions will always be limited to consultation, consideration of options, and development of recommendations for subsequent government approval.

Inputs

The inputs for this phase are applicable international agreements, existing legislative and regulatory documents and frameworks (see Table 2.2), the policy objectives (see Table 2.3) and other pertinent documents, such as the established process for declaration of standards etc. At this stage, the policy objectives as set out in Table 2.3 are preliminary ideas developed during the NRT workshops conducted during the ITU mission. For example some important matters are missing: such as the ASO dates, the minimum number of television services, coverage objectives, and so on. The output of this phase should consolidate and finalize recommendations on these matters as well as address the other questions set out below. Eventually they will need to be put to government in the form of recommendations for approval.

Outputs

The key output of the DTTB policy development phase is a government endorsed DTTB policy document that will be published officially. The formulation of this document is likely to involve typical policy development approaches such as the public circulation of discussion papers for comment, progressive representation to the Minister and sometimes the government about key directions and option and other consultation destined to reach realistic levels of stakeholder agreement on the policy direction. Such a DTTB policy document typically includes the following items:

1. **Policy justification** including the benefits and approach to introducing DTTB services (including the allocation of the Digital Dividend).
2. **Technical framework** detailing the available spectrum for the DTTB services and the current spectrum in use by existing broadcasters.
3. **DTTB implementation framework** describing arrangements for multiplex and network operation, rights of broadcasters, and multiplex operator, access rules and arrangements, numbers of services at launch and any expansion over time and the way these things will be regulated and managed (e.g. licence allocation approach etc.).
4. **DTTB services** description stating which existing television services and additional content/services will be distributed on the DTTB platform and in which districts/provinces these service will be made available when.

5. **Further development of digital services during and post ASO** should be explained in terms of opportunity, timing, etc.
6. **What happens to vacated analogue spectrum** on completion of ASO should be explained.
7. **The legal framework** required including any changes to existing legislation that may be required for DTTB implementation, operation and ASO.
8. **Whether any new analogue licences will be granted** during the transition period.
9. **Start and end dates of DTTB implementation and ASO** which should be a firm commitment so that the industry and the general public have a sound basis for purchase decisions.
10. **The ASO model** described including requirements for simulcasting.
11. **DTTB standards** what standards (for example the transmission and compression standard) will be mandatory and its justification.
12. **Funding principles:** the intention to include selected ASO costs in the government budgets and the way it is going to be funded.
13. **Communication plan and action plan**: outline of how viewers (and other stakeholders) will be informed about the ASO process and an outline of the major regulatory and operational milestones (e.g. the establishment date of the NRT, the date of when the Broadcast Act will be changed/updated, the decision on the allocation of the digital dividend, etc.).

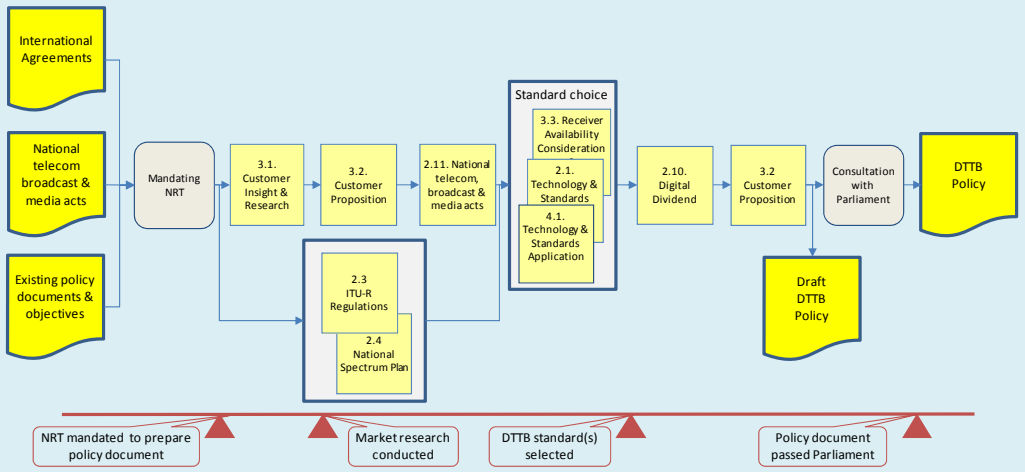
For an example DTTB policy document see "Strategy for Switchover from Analogue to Digital Broadcasting of Radio and Television Programs in the Republic of Serbia"[8].

Roadmap

The roadmap of the DTTB policy development phase and its functional blocks is shown in the Figure 3.10. The decisions taken, partly taken or not yet taken on the key topic and choices in Phase 1 of the roadmap, and the activities required to prepare the decisions that are still pending for this phase, are set out in Annex 1.

[8] "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 2nd July 2009. www.itu.int/ITU-D/tech/OLD_TND_WEBSITE/digital-broadcasting_OLD/Bulgaria_Assistance_Transition/Serbia/Digital_Switchover_Strategy-ENGL.pdf

Figure 3.10: DTTB policy development phase of the roadmap



Source: ITU

1. **Mandating the NRT**. The NRT needs formal terms of reference and an agreed mandate. After this policy document has government approval, the NRT's task will move to preparation, planning and execution of later stages of the roadmap. In this early phase, the NRT could have a limited membership but may still need to consult widely when preparing recommendations. At the second phase of the roadmap (i.e. ASO planning) the NRT membership should be extended to include all stakeholders in the DTTB value chain (and structured in line with the implementation guidelines of Functional Block 2.15);
2. Sound policy formulation requires a proper understanding of the market and the potential impacts of DTTB introduction. This step includes the Functional Blocks 3.1 and 3.2. At this phase of the roadmap this market research is intended to providing support/justification for the DTTB policy. The market research data should cover the following elements:
3. **Current television market in Papua New Guinea**, Including:
    a. Current market players - to include broadcasters, content creators, network operators, service providers etc.
    b. 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.
    c. Size of the total television advertising market in Papua New Guinea. Also the impact of the ASO and DTTB introduction on this advertising market should be assessed.
    d. Current reception situation and conditions (individual viewers, household size, group viewing, hotels, multi-dwelling units, etc.) 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 such as subscription television.
    e. Current analogue service coverage, where and what services can be received.
    g. Current analogue television distribution arrangement to transmitters.
    h. Television market logistics and supplies. The current logistic chain for consumer television sets for the distribution of DTTB receivers. An understanding of its structure, volume (e.g. how many outlets where?) and operations will be necessary.

4. **DTTB market in Papua New Guinea**. The DTTB policy document should describe the drivers for DTTB in Papua New Guinea. It is generally impossible to obtain any useful information from consumers at this stage, particularly when they have little concept of what digital television will deliver. Industry players may have formulated more mature ideas about the market and its potential and their inputs will be important. As DTTB implementation proceeds then soundings of consumer readiness for ASO etc. become very important. This part of the market research should provide an insight in what the Papua New Guinea industry players, and to a lesser extent, viewers and expect, including:
    a. **Content**. To include the number and the type of programmes/channels and other service to be broadcasted, for example the electronic programme guide (EPG), subtitling, theme channels. Also, the willingness/capacity to pay for the STB and or an integrated television receiver. Possible availability of integrated receivers in the market (e.g. existing flat panel receivers that may include an integrated receiver) whether or not any standard has been defined at this point.
    b. **Supplies**. Papua New Guinea manufacturers distributors might show an interest in provisioning DTTB receivers.
    c. **Content creators**. Papua New Guinea content creators (i.e. in many case the current broadcasters) might be interested in provided dedicated content for the DTTB platform.
    d. **Affordability**. Identification of particular groups that may eventually merit assistance with subsidy of STB etc. to allow ASO.
5. **Determining the current available spectrum for DTTB** (Functional Blocks 2.3 and 2.4). The frequency plan for digital terrestrial television services should be established (see also Sections 4.9 and 4.10). Some this information is already included in the Papua New Guinea television spectrum plan currently being developed. This includes such matters as:
    a. spectrum already to be incorporated in the National Spectrum Plan and Register;
    b. spectrum required for possible future digital radio services to be incorporated in the National Spectrum Plan and Register; and
    c. spectrum requirements for non-broadcasting services (e.g. 4G/LTE) and digital dividend etc. in conformance with International Recommendations, and Regulations concerning spectrum use.
6. **Checking compliance with current legislation and identifying required changes** (Functional Block 2.11). A first assessment should be carried out of what parts of the current legislation will be impacted by the introduction of DTTB services. Table 2.2 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 the areas that might be impacted, how required changes can be achieved (e.g. legal and administrative arrangements) and what time this will take. This assessment will then provide input for the plan of action to be included in the DTTB policy document. During Phase 3 of the roadmap (i.e. determining the DTTB regulations) specific DTTB regulations are defined (e.g. the licensing framework and procedures.
7. **Selecting the transmission standard** (or any other system element). Figure 3.9 shows the procedure for deciding the transmission standard. This is sometimes an iterative process between the Functional 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) and relationship of the standards decision to other market factors such as regional cooperation agreements, established digital technologies for other services. Specific considerations would include:

a. **Affordability and availability of DTTB receivers**. Given the public financial resources and the ability of Papua New Guinea viewers to pay, receivers (including set-top-boxes and IDTVs) should be made available at the lowest price levels. As a relatively late market entrant, receiver supply is already geared to high volume production for other countries in the region and this has resulted in a constant fall in prices for equipment. If special requirements such as mandated conditional access systems are included in the specification this may have a significant impact on availability and price. There is merit in giving serious consideration to the types of equipment already available in mass markets to ensure the highest potential for a rapid and successful introduction of DTTB.

b. **Independent and warranted supplies**. Dependency on one single supplier should be avoided. Any DTTB system (head-end and receivers) will incur many changes (e.g. frequency changes, software updates, additional functionality, etc.) during its life span (i.e. 5 – 15 years) and suppliers should support this. Open standards ensure competitive supply of product to the market and remove much of the supply risk.

8. **Deciding the digital dividend** (Functional Block 2.10). In this phase, the digital dividend will become available for other services than broadcasting services post ASO should be determined. Creating a digital dividend has been identified an important consideration in Papua New Guinea and factored into the draft television spectrum plan. It will have minimal impact on existing services because the internationally coordinated part of the UHF band identified for digital dividend is generally not used for television broadcasting in Papua New Guinea.

9. **Determining the initial customer proposition** (Functional Block 3.2). From the DTTB policy document a Initial Customer Proposition can be drafted.

10. **Consultation with government**. In this step a draft DTTB policy document is submitted to government for approval. This might include many consultation sessions, extensive lobbying and several revisions. Sufficient time should be allowed in the plan for these activities. 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 officially published in an appropriate form as the first comprehensive DTTB policy statement to the general public and television industry.

3.4.3 Phase 2 ASO planning

Phase 2 of the roadmap is examines the roles and responsibilities of the various parties involved in the process of transitioning from analogue to DTTB, the milestone planning and the communication/support process. This phase engages support from various stakeholders including government.

Inputs

The primary input for this phase is the approved DTTB policy document. As Figures 3.6 and 3.7 suggest Phase 2 can start before the DTTB policy document has final government approval. How far the Phase 2 work can progress ahead of formal policy approval is a matter of judgment as to whether government is likely to require any significant changes to the policy and the NRT mandate and whether these changes would significantly impact on the work.

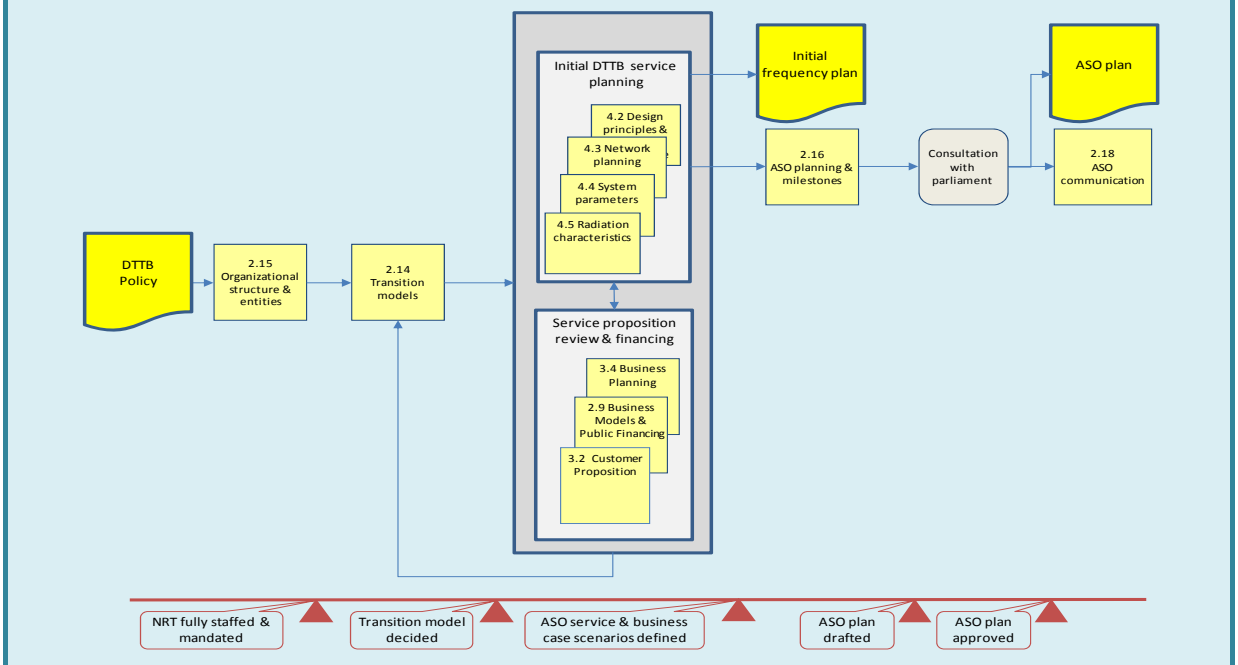
Outputs

The outputs for the ASO planning phase are an initial frequency plan and the ASO plan. The initial frequency plan describes how the available spectrum will be used, which services will be provided where, and the service planning parameters upon which the plan is based. The frequency plan details all the decisions and trade-offs included in the Functional Blocks 4.2 to 4.5.

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

1. **The intended ASO model** (Functional Block 2.14). The model can be different from area to area. For example, a currently un-served area could have services established on digital only and therefore have no analogue/digital simulcast.
2. **Customer proposition** (Functional Block 3.2).
3. **ASO planning** (Functional Block 2.16) which describes how the services making up the Customer Proposition will be delivered. This planning comprises several work streams including:
   a. Communications (see Functional Block 2.18).
   b. ASO communication plan.
   c. Device producers and delivery.
   d. Network and rollout plans for DTTB services.
   e. Consumer and market monitoring.
   f. Regulation and licensing (further detailed in Phase 3).
   g. Financial and installation support.
4. **Business planning and public financing** (Functional Block 3.4 and 2.9). A business case should be prepared which details what the ASO process will cost under various scenarios and what financial resources will be required over what timeframe to implement the changes. The initial frequency plan will provide the basis for a first estimate of the network costs, but as Table 2.15.2 in the ITU Guidelines shows, the network costs are just one item of the overall budget. Management of the transition and proper communication about the changes to affected viewers usually require significant resources.

Figure 3.11: ASO planning phase of the roadmap



Source: ITU

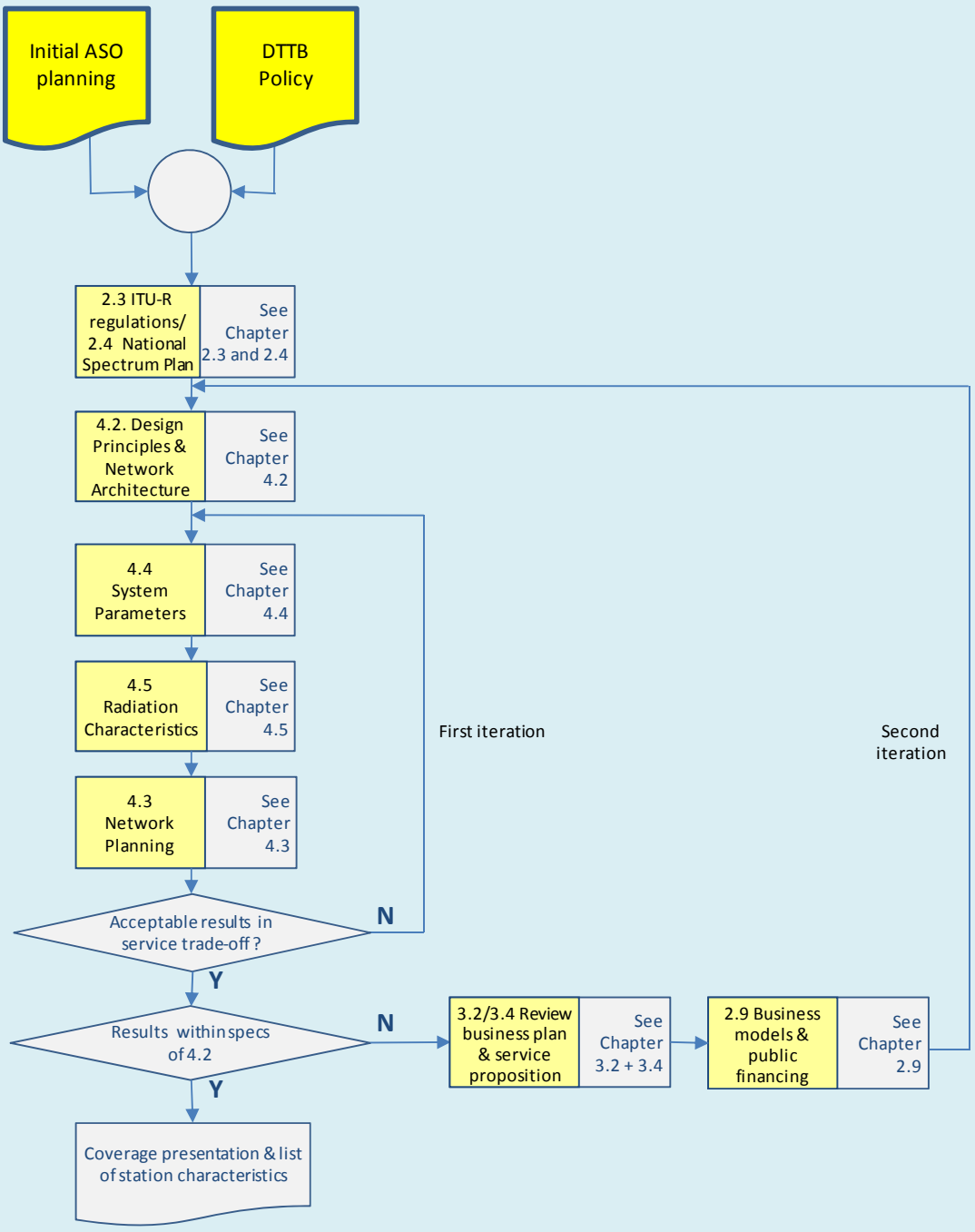
Roadmap

The roadmap for the ASO planning phase and the associated functional blocks is shown in Figure 3.11. The current status of the Phase 2 decisions and the key options involved in the decisions yet to be taken in this phase are set out in Annex 2.

The steps in the Phase 2 of the roadmap include:

1. **Establishing the organizational structure and participating entities** (Functional Block 2.15). The responsibilities of all participants in the ASO planning process should be clearly defined along with the reporting and decision making structure.
2. **Determining an initial transition model** (Functional Block 2.14). In this phase, the NRT should assess various ASO options and where necessary amend the DSO objectives.
3. **Balancing DTTB service planning, customer proposition and financing** (Functional Blocks 4.2 to 4.5, 3.2, 2.9 and 3.4). This step is an iterative process where three elements (i.e. Service proposition, network planning and business case) are balanced against each other as illustrated in Figure 3.1.1 in the ITU Guidelines. Although the ITU Guidelines explain this process for a commercial DTTB service provider, the process is no different for the NRT. The analysis comprises two parts:
    a. i**nitial DTTB service planning** (which in turn is an iterative process of Functional Blocks 4.2 to 4.5);
    b. **service proposition review and financing** (which involve an iterative analysis of Functional Blocks 2.9, 3.2. and 3.4).
4. Figure 3.12 is a flow chart of the two feedback loops that are incorporated in the balancing of these three elements. For example lack of available spectrum may result in a revision of the initially selected transition model (hence the feedback loop in figure 3.11).
5. **Drafting ASO planning and milestones** (Functional Block 2.16). The above analysis should allow selection of an optimal scenario. The ASO plan should be drafted around this. The ASO plan will require a government approval so it is usually preferable for the draft a plan to set out on one or two additional scenarios, perhaps not in all its details.
6. **Consultation with government**. In this step a draft ASO plan is presented for government for approval (with several options). Often this process might include many consultation sessions, extensive lobbying from various parties and several revisions. Adequate time should be allowed in the plan for these activities.
7. **Finalization of ASO plan and detailing the ASO communication plan** (Functional Block 2.18). After having the ASO plan is approved, it will provide the guiding principles for the NRT's ASO implementation. The detailed planning which follows will need to be continuously reviewed, revised and updated as the work proceeds and additional information become available. ASO planning includes the ASO communication and guidance on this important step is provided in the ITU Guidelines (Functional Block 2.18). A detailed strategy for informing/supporting the viewers and industry should be developed which includes information about the target group for each communication, the timing of the messages etc. leading from the implementation stage through to ASO of the last transmitter.

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



Source: ITU

In Figure 3.12, the first iteration is the so-called service trade-off. This involves finding an optimal balance between transmission costs (influenced by the size and the number of transmitters and locations involved), service quality (partly determined by the number of channels in the multiplex and the operating parameters of the multiplex) and coverage. Coverage is also influenced by the reference receiver installation type used for the planning (e.g. external antennas allow good reception at lower signal strengths. Guidance on these matters is contained in the ITU Recommendations and Reports listed in the References[9, 10, 11]. The solution should be framed within context of decisions taken in the Functional 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 costs and funding possibilities. If a satisfactory solutions cannot be found then the service proposition and business plan may need to be reviewed and so on until a workable solution is found.

3.4.4 Phase 3 Licensing policy and regulation

Phase 3 defines the required DTTB licences and the associated licensing procedure and planning which can then be published. In this way all stakeholders seeking to establish DTTB services can be fully informed of the requirements and rules. Such rules and specifications should also set out minimum requirements for site management and operating standards for all services operating at transmission sites so that the risk of interference between and to the DTTB and other radiocommunication services is minimized and should define the mitigation processes, and procedures to resolve any reported interference.

Inputs

The inputs for this phase are the DTTB policy document, from the first phase and the ASO plan from Phase 2. As indicated in Figures 3.6 and 3.7 in this report, Phase 3 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 are approved by government.

Outputs

Phase 3 produces several output documents, some of which will be published according to established practice as defined in local legislation or international agreements. These include:

1. 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 (see building block 2.4 in the ITU Guidelines): International coordination of the frequency plan which may be required, DTTB licence terms and conditions etc. The actual licence documentation will depend on whether licensing Model A or B or other variants are selected.

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9 ITU-R Report BT2140-4 Transition from analogue to digital terrestrial broadcasting
www.itu.int/pub/R-REP-BT.2140-4-2011
www.itu.int/dms_pub/itu-r/opb/rep/R-REP-BT.2140-4-2011-PDF-E.pdf

10 ITU-D Final Report on Question 11-2/2 Examination of terrestrial sound and television broadcasting technologies and systems, including cost/benefit analysis, interoperability of digital terrestrial systems with existing analogue networks, and methods of migration from analogue terrestrial techniques to digital techniques.

11 Recommendation ITU-R BT.1368-9 Planning criteria, including protection ratios, for digital terrestrial television services in the VHF/UHF bands www.itu.int/rec/R-REC-BT.1368-9-201112-I/en

a. **In Model A**: Spectrum and broadcast licences will be assigned between existing (and possibly new) broadcasters. The spectrum licence will have to specify the exact frequencies, their locations and characteristics (such as antenna height, ERP, antenna diagram, broadcast modus, etc.);

b. **In Model B**: The spectrum licence will be assigned to the common multiplex/network operator. An arrangement where the multiplex operator and network operator are separate entities is also possible, in which case the spectrum licences would be assigned to the network operator.

   i. The spectrum licence will have to specify detailed frequency use. The broadcast licence (i.e. the assignment of a part/slot of the DTTB capacity) will be assigned to broadcasters (and/or service provider).

   ii. The NRT will have to decide which entity can decide the assignment of this capacity slots. This might be the common multiplex operator or assigned directly by the NICTA.

   iii. What services may be carried on the multiplex, how will existing broadcasters migrate, what capacity will they have within the multiplex, and what licence documents are to be used.

A document describing the assignment procedure and planning (examples of how this has been done in various countries and other guidance is contained in the discussion of Functional Block 2.5 in the ITU Guidelines). Again, arrangements depend on the particular licensing model.

1. **Model A**: For the existing analogue broadcasters the assignment procedure is likely to be renewal. They will have their analogue spectrum rights renewed into digital spectrum rights if one of the DSO Objectives is to have new market entrants for digital television services, it may be necessary to also organize a public tender (next to the renewals).

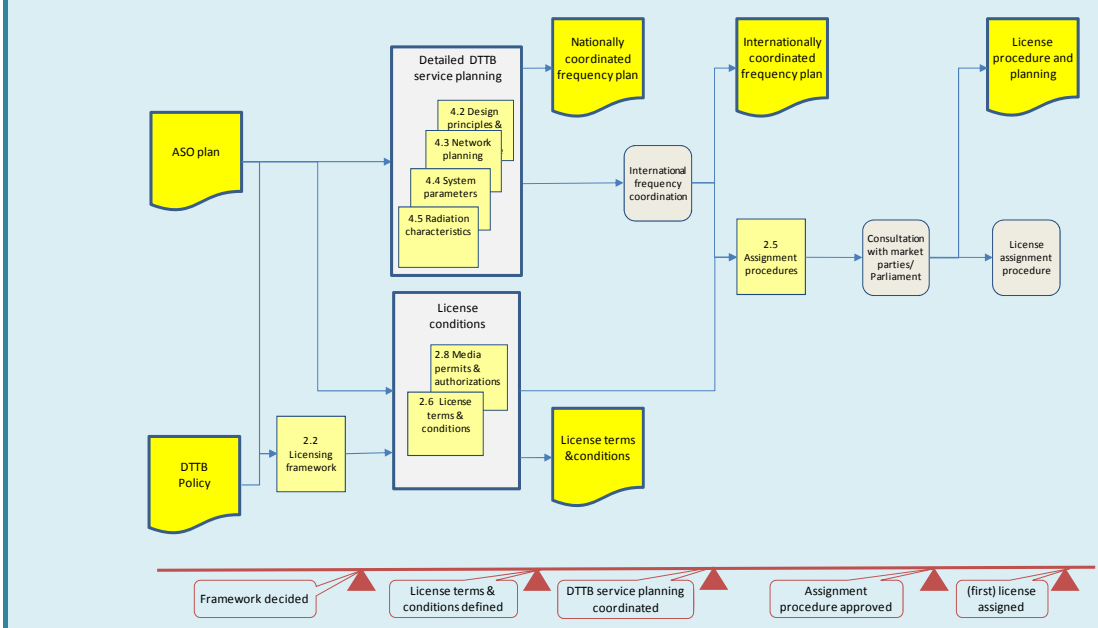
2. **Model B**: The NRT will have to organize procedure for selecting the best party to fulfil the role of common multiplex/network operator. It will have to stipulate what entities are allowed to bid. In addition it will have to publish open network provisioning (ONP) rules (including capacity access and pricing rules) for this common multiplex/network operator. For re-using existing infrastructure (like towers or antennas) it may be necessary to impose site sharing rules to ensure cooperation from broadcasters. Appendix 2.5B of the ITU Guidelines describes a procedure for organizing a tender. For a practical example of an invitation to apply for a multiplex licence is set out in the Independent Television Commission (now part of OFCOM) document" Multiplex Service Licences: Application Documents"[12].

Roadmap

The roadmap of the licensing policy and regulation phase and its associated functional blocks are shown in the Figure 3.13. Annex 3 contains specific details about current status of the decisions and options to be addressed in this phase.

[12] www.ofcom.org.uk/static/archive/itc/latest_news/multiplex_licence/dtt_multiplex_licence_tender.asp.html

Figure 3.13: Licensing policy and regulation phase of the roadmap



Source: ITU

Figure 3.13 shows that the following steps (i.e. functional blocks and non-DTTB specific activities) are included in the Phase 3 of the roadmap:

1. **Detailing DTTB service planning** (see Functional Blocks 4.2-4.5). After having agreed the ASO plan (including the initial DTTB service planning) a detailed service planning can now be drafted. This detailed planning is different from the initial planning as on the basis of this planning either:

   a. **In Model A**: The spectrum licence, the terms and conditions will define the permitted spectrum use. The broadcast licence planning will define amongst other things, the number of licences and what services are included in each licence.

   b. **In Model B**: Assuming that there will be a licence for the establishment and operation of a common FTA multiplex for Papua New Guinea, the plan should fully describe the facilities to be established including the required coverage etc. of each area to be served. All transmitter locations should be specified. Final details such as antennas and related infrastructure decisions can be left to the selected operator to define but might be subject to NICTA approval. There should also be a comprehensive distribution plan. One approach is to have potential providers of this service submit detailed proposals against the coverage requirements and spectrum plan, which set out both technical details, capacity and a rollout programme which could be made a licence condition. This information is important for the licensed broadcasting services to allow them to plan their programming arrangements.

2. **National and International spectrum coordination** in accordance with established procedures. This will include aligning the DTTB spectrum plan with the National Spectrum Plan (NSP);

3. **Determining the licensing framework** (Functional Block 2.2). In this phase the primary decision to be made is about the licensing model (Model A and B). The following aspects should be considered here along with the matters already discussed in Section 3:
    a. **The business model** should also be aligned with any formulated Open Network Provisioning (ONP) rules[13].
    b. **Financial considerations** associated with rolling out the DTTB network, considering:
        i. the limited size of the total television advertising market that would be required to fund a purely commercial rollout;
        ii. potential funding and support from other parties; and
        iii. direct government funding of core FTA services.
4. **Licence conditions and procedures** (see Functional Blocks 2.6, 2.8 and 2.5). The licence conditions and procedures can be defined after the decision on the licensing model.
5. **Consultation with market parties and government**. Before deciding the licensing regime (to include licensing framework, conditions and procedures), the NRT should consult with the key stakeholders in the market to check the validity of and support for its plans. Any stakeholders not represented in the NRT should be consulted. After considering and incorporating relevant ideas from this market consultation, the NRT can submit its proposal to government along with advice about the findings of consultation including opposing views not addressed etc.

3.4.5 Phase 4 planning and implementation of DTTB network

The aim of Phase 4 is to have the DTTB network deployed and all sites in operations and/or switched-off in accordance with the ASO plan through a fully coordinated manner into a network rollout or implementation planning.

Under Model A, Phase 4 would largely be the responsibility of the individual broadcasters. However, their actions cannot be entirely independent. Successful ASO depends on a high degree of coordination and collaboration between all parties so that the general public receives consistent messages about ASO and that ASO is coordinated properly. A number of these requirements, particularly ASO timetable in particular markets etc. can be included as licence conditions and perhaps relevant amendments to legislation.

Inputs

The input data for Phase 4 are the licensing procedure and (Inter) nationally coordinated frequency plan from Phase 3.

Outputs

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

1. **DTTB implementation plan**. This will include the DTTB network rollout plan, the project management plan, structure and resource plan (including a detailed breakdown of tasks, responsibilities, escalation procedures project budget and operational and financial progress reporting).

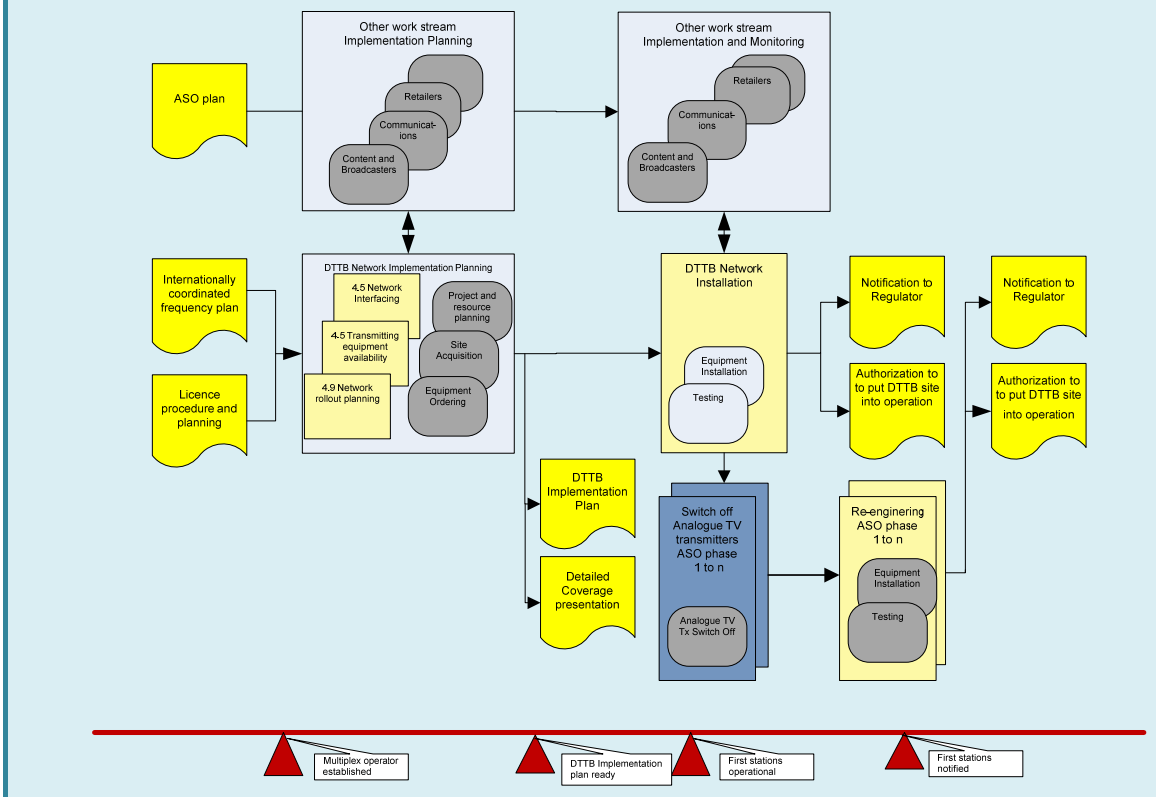
[13] Access to and fair pricing of 'essential facilities', i.e. infrastructure that cannot duplicated under normal market conditions or infrastructure which operations is uniquely licensed to a single market party. The ONP rules stipulate under what conditions access to this infrastructure should be made available and against what costs/prices.

2. **Detailed coverage presentations**. As the network rollout progresses the coverage predictions become definite (i.e. when the sites have been equipped and no changes can occur any more). This detailed coverage predictions or presentations will feed into work stream communication of the ASO plan (See Section 5.3 of the ITU Guidelines for more details on service availability checks and tools). As coverage maps provide a useful guide to informing the viewers about where DTTB services are available so they should be as accurate as possible and relate to the actual installation rather than a proposed one. Such information could be published on the government Internet site so that it is easily kept up to date and widely available to viewers.
3. Notifications to NICTA that stations have been installed. NICTA as the national spectrum manager should be notified by the common multiplex/network operator that stations are ready to be taken into operation. NICTA should be notified so that it can check compliancy with the issued broadcast licence.
4. Notifications to the NICTA that an analogue TV transmitter has been switched off by the analogue terrestrial broadcasters. The national frequency register will then need to be updated accordingly.

Roadmap

The roadmap for Phase 4, planning and implementation DTTB network, with its associated functional blocks, is shown in Figure 3.14. This shows the relationship with the other work streams that need to be coordinated with the planning and implementation of the DTTB network rollout (see the grey blocks in the top half of the figure). Annex 4 provides a more detailed status summary on the decision required and possible options to consider.

Figure 3.14: Planning and implementation DTTB network phase of the roadmap



Source: ITU

Phase 4 includes the following steps:

1. **Developing and executing the DTTB network implementation plan** (Functional Blocks 4.6, 4.8 and 4.9). Developing the network implementation planning entails a large amount of work and the functional blocks of the ITU Guidelines cover an important part of this work but not all. The ITU Guidelines 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. Other critical activities must also be incorporated into the plan, such as:
    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 the NRT).
    b. **Site acquisition**. Although most of the transmitter sites will already exist in the analogue network, new sites may have to be acquired to complete the network coverage. This may be the result of needing to use different frequency bands (e.g. UHF v VHF) or to correct known deficiencies in coverage. This can entail long lead-times (e.g. meeting/negotiations with local councils, land owners, public hearings, etc.).
    c. **System design and equipment ordering**. System design needs to take into account site specific information as well as careful consideration about how the component systems will interoperate. One option that has been used successfully elsewhere (particularly when local resources expertise and experience are limited) is to have system design, equipment specification, acquisition, installation and training carried out by a single systems integrator. A number of equipment manufacturers and independent companies provide this type of service. This approach considerably reduces the risks associated with delivery of an end-to-end service in a short time-frame. The systems integrator might be engaged to prepare system design, and implement the multiplex and the first batch of transmitters, and subsequent transmitters might be installed using local labour, trained by the systems integrator. One benefit of this approach, is that the systems integrator can be tasked with setting up the required national specifications for the transport stream and receivers, and the allocation of logical channel numbers, receiver specifications including full definition of the transport stream and system information, and logical channel numbers etc. that will need to be managed or defined by the NICTA.
2. **DTTB network equipment installation**. An important part of the installation process is managing the available resources.
3. **Switching off stations** As the DTTB network implementation planning is part of the ASO plan.
4. **Re-engineering DTTB Network Sites**. When analogue sites are switched off, additional spectrum for the DTTB network should become available. Spectrum usage restrictions that might be necessary to avoid interference to analogue television might be lifted at or close to the ASO date. Preliminary examination of the spectrum plan suggests this may not be an issue in Papua New Guinea.

3.4.6 Phase 5 licence administration

The Phase 5 objective is to check compliancy with the issued licence, to update the National Frequency Register and to notify ITU of new DTTB transmitters.

Inputs

The input data for Phase 5 include the notification of station completion and commissioning by the licensees.

Outputs

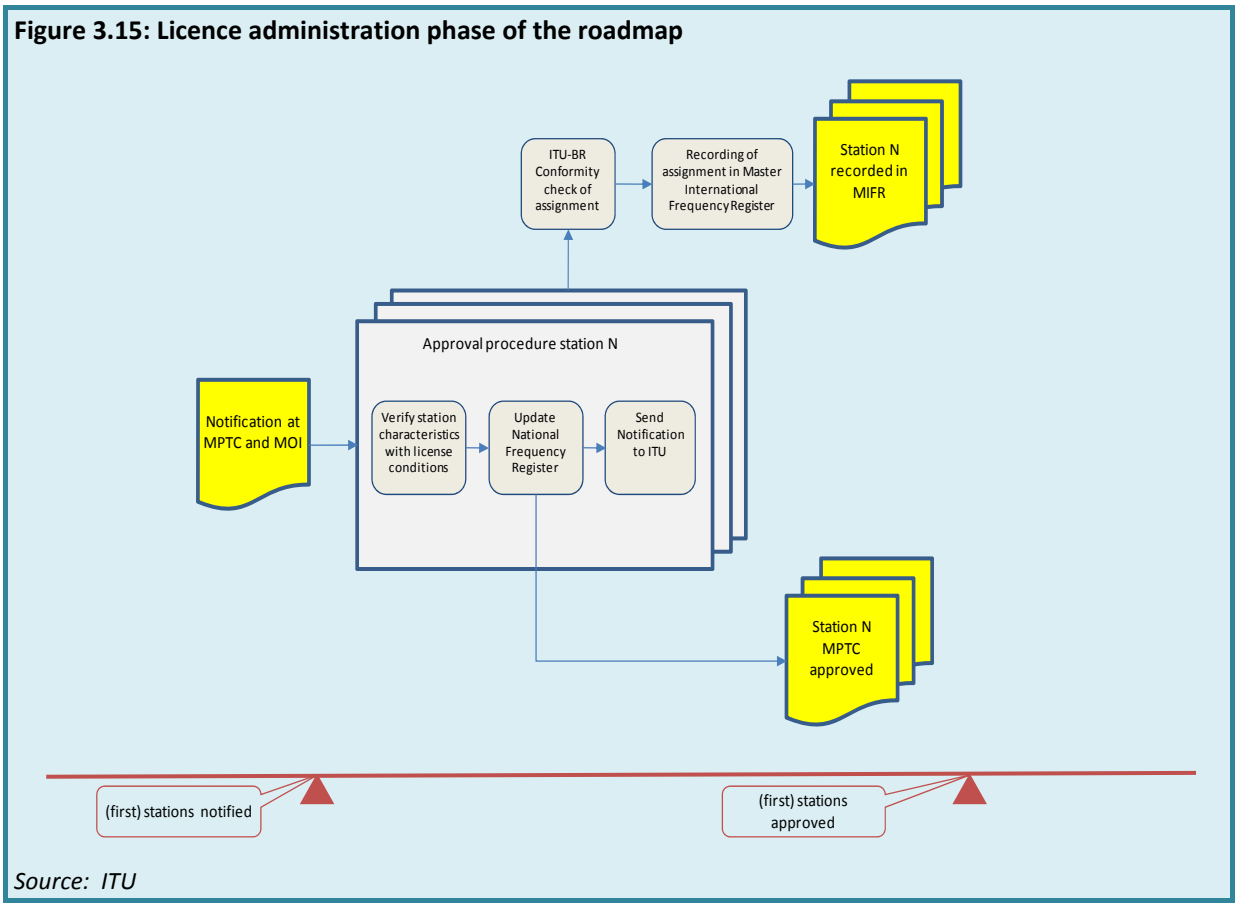
The phase will have two outputs:

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

Roadmap

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

Figure 3.15: Licence administration phase of the roadmap



Source: ITU

The following activities are included in Phase 5:

1. approving the subsequent DTTB stations;
2. registering and recording of the assignment in the frequency registers after completing the necessary licence conformity checks.

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

This section discusses in more detail the top-10 most critical key topics and choices for Papua New Guinea. The order the topics listed below does signify any particular ranking of priority or order of importance. The priorities will be determined by the ASO planning process.

Table 4.1: Top-10 most critical key topics and choices

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

4.1 Transmission standard and receiver availability

Receiver availability is tightly linked to the choice of transmission standard. In markets with more than one multiplex operator (as is the case where broadcasters have their own multiplex), common agreement to standards is essential. The FTA standard is defined by the system standard and both integrated television receivers and STBs must comply with the standard, as too must the transport stream of each multiplex operator so that all viewers are assured of being able to receive all programmes on their receivers.

Some countries choose to have a mix of FTA and subscription television services operating on DTTB, either through a shared or separate multiplex. In this case the subscription television operator usually provides the STB/conditional access decoder which is generally only able to receive the specific service of that broadcaster. While there is nothing to prevent standardization between subscription broadcasters their commercial interests and concerns about protection of their conditional access systems usually result in each subscription broadcaster finding its own solution.

The problem becomes more complex if there is a mix of subscription and FTA services on a multiplex. While it is possible to have some encrypted and some not, this can be complex to manage particularly where there are several mixed service multiplexes serving a single market. Compatibility of the system standards for FTA and subscription DTTB transmission standards is important to spectrum planning and spectrum efficiency; therefore, the same system standard should be used for all services. Differences can be permitted in CA systems because this does not impact on the spectrum, but there would be cost efficiencies for operators if all subscription broadcasters adopted compatible standards for CA.

The primary interest of government is usually to obtain competitive comprehensive coverage of FTA services with most if not all viewers having the same choice. Hence the initial focus of standardization and ease of access should be on FTA. In this case there is an argument for all FTA channels to share a common multiplex and transmission network, and then if subscription services are to be provided then to permit

the subscription service providers to operate their own multiplex. Given there are perhaps 16-20 SD channels available on single DTTB multiplex (using state of the art encoding and transmission standards), a subscription operator would probably wish to fill these with services in order to deliver a commercially viable package. In this case regulatory intervention at the level of the conditional access system would be unnecessary, but the subscription service must use the same transmission standard.

Successful and early DTTB rollout and ASO will depend on there being affordable and available reception options for viewers. These include integrated receivers which have built in DTTB tuners (and usually have analogue as well at present), or digital set top boxes and digital video recorders which have digital tuners and provide either a direct video or a composite analogue output to feed an analogue receiver. The NRT should focus on this aspect. Receivers for some of the newer variants of the DTTB system standards were initially more expensive than the older ones. However, this has changes rapidly. By the time rollout is completed there is likely to be virtually no cost penalty for adopting this new generation of equipment which will provide service benefits. The implications of a requirement to future proof STBs and receivers by requiring that all boxes be capable of decoding HDTV signals should also be considered. The advantage of requiring HDTV compatibility is that legacy boxes will not be an issue if HDTV is to be adopted later.

4.1.1 Transmission standard

Determining a transmission standard involves regulatory and technical considerations (respectively Functional Block 2.1 and 4.1). The regulatory and technical considerations should be included in an evaluation matrix where the appropriate importance/weights can be assigned to them by the NRT.

4.1.1.1 Regulatory considerations

Section 2.1 of the ITU Guidelines provides an implementation guideline for determining the transmission standard for DTTB services. Further information is contained in ITU Report BT.2140 referenced earlier. The key message is that a single standard must be defined in order to safeguard the public interest. It will provide clarity in the market for retailers, consumers, and broadcasters.

4.1.1.2 Technical considerations

Annex 5 is a summary of technical information on transmission standards obtained from the ITU and other sources. From the information in this Annex the following observations can be made: Factors that will be relevant to the system choice for Papua New Guinea include:

1. Current deployment of services using a particular standard: The available standards from which to choose are set out in the documents referenced in the previous section. The DTMB (Chinese Standard) is currently deployed only in China and Hong Kong, China. The Japanese ISDBT system is used in Japan, but despite some countries in the region looking at this as an option, none have yet committed to it. The ATSC system is used in Korea. It is the North American standard, but its adoption outside of North and parts of South America has been limited to Korea which was a very early adopter. The dominant system standard in South East Asia and the Pacific where decisions have been made is DVB-T or T2 and likewise DVB-S/S2 is widely deployed for satellite delivered services across the region. The newer DVB-T2 standard has been the preferred choice of countries now deciding to adopt DVB-T standards and price differentials between DVB-T and DVB-T2 are reducing. The benefits of the later standard are significant in terms of opportunities for the present and the future.
2. Sources of supply of receivers and the benefits of selecting a system that is widely used in the region.

3. The payload (total data rate capacity hence number of services) that can be carried on a multiplex. All of the systems world-wide now support MPEG 4 compression technology which is considerably more efficient than its older cousin MPEG 2. Selection of MPEG 2 for a new system would limit the potential efficiencies available from DTTB. Note that any price differential between MPEG 2 and MPEG 4 reception equipment has been eroding rapidly and many receivers are now MPEG 4 equipped (and MPEG 2 reverse compatible). However, receivers that are MPEG 2 only are not able to decode MPEG 4 transport streams.
4. Systems currently deployed in the market. In Papua New Guinea there are no DTTB systems in use. The subscription television network SKY Pacific-TV uses the DVB-S/S2 satellite standard for delivery of its services[14].

System selection: ITU has prepared a guide to the selection of a DTTB standard which can be found as Appendix 5 to *ITU-R Recommendation BT.1306-6 Error-correction, data framing, modulation and emission methods for digital terrestrial television broadcasting*. Details of the available systems are set out in the ITU Guidelines.

4.1.2 Conditional access

Table 2.1.1 of the ITU Guidelines shows that regulators refrain from stipulating a standard for the conditional access system (CAS). The underlying reason for this neutral regulatory stance is that in most countries pay-TV operations on a DTTB platform are offered by one single service provider (either operating one or more multiplexes). The risk of consumer confusion and market fragmentation is limited as subscribers to the DTTB pay generally sign up with a single provider and the STB (incorporating CAS) is supplied as part of the bundle.

In some deployments the subscription TV operator provides a STB that is able to receive FTA services (unencrypted) as well as the encrypted pay services. Even under this situation there seems little merit in regulatory intervention. On the other hand if the deployment model required the viewers to purchase a STB, and there were the prospect of several providers then it would be in the public interest to try to establish a common standard for CAS, because while multiple CAS solutions do exist, they have a number of issues as well as higher cost. In this case it would be best to encourage the providers to reach some agreement on a common solution.

A similar difficulty could arise under a pure deployment of licence Model A where every DTTB licensed broadcaster had a separate multiplex and were permitted (subject to there being no other regulatory impediment) to launch its own pay-TV, there could be a risk of market confusion and market fragmentation unless some common arrangement were put in place. However, once again, provided the FTA components of the service remained accessible to all viewers (whether or not they use a simple STB not containing any CA system, an integrated receiver which will generally not have integrated CA, or an operator provided STB with incorporated CA, then again the matter of CA could remain an individual decision of the subscription TV operator.

Unless industry consultation identifies some other reason for regulatory intervention to determine a CA standard then DTTB implementation planning should not make this a factor and should allow the pay TV service providers to establish their own solution, irrespective of whether or not they reach some agreement to use a common approach.

[14] Recommendation ITU-R BT.1306-Error-correction, data framing, modulation and emission methods for digital terrestrial television broadcasting.

4.2 Customer proposition

Section 3.2 of the ITU Guidelines provides an overview of the different approaches that have been adopted by various administrations in defining the customer proposition for DTTB. In the Papua New Guinea market, the decision to migrate to digital is not likely to be driven by commercial benefits, and consumer research is unlikely to be a useful guide to eventual take-up. Given the basic decision to move to DTTB, the major benefits probably lie in the following:

1. Ability to provide a full suite of FTA services having identical coverage.
2. Possibility to introduce additional services on digital at very low marginal cost (i.e. one transmitter chain will be able to carry a number of services which substantially exceed the number currently in the market).
3. Within the overall bit-rate capacity of the DTTB network multiplex and transmission design, the multiplex can carry a mix of services ranging from audio only through SD, HD or 3D TV. Thus while the immediate transition question may be migration of the existing terrestrial services, there will be opportunity for some enhanced or additional services to be introduced in parallel with the transition, or left until after the ASO. Should there be sufficient demand, additional multiplexes can be added by using additional channels that will become available after ASO is completed.

4.3 Licensing framework Model A or B

The ITU Guidelines includes several considerations for selecting either Model A or B. These considerations include:

1. spectrum management objectives;
2. competition rules and objectives;
3. market structure and environmental objectives; and
4. media rules and objectives.

The NRT should draft for each model a balance with the pros and cons of that model. Also the appropriate importance/weights have to be assigned to all pros and cons. An initial overview is provided in Table 4.2.

Table 4.2: Initial overview of the pros and cons of Model A and B

Model A	
Pros	**Cons**
	Spectrum inefficient.
	More investment in infrastructure needed.
	Broadcasters will roll out their own service.

Model B	
Pros	**Cons**
Spectrum efficient.	
Significantly less investment in infrastructure necessary.	
	Without regional insertion, regional/small broadcasters are distributed nationally {Note local insertion is easily achieved with transport stream inserter at transmitter location).

Model A	
Pros	**Cons**
Competition between broadcasters is possible over different network coverage and quality.	Viewers may have difficulty receiving all services.
Re-use of switched off analogue equipment easier for broadcasters (older equipment will often not be suitable for use in a DTTB network anyway).	
Site sharing rules may be less important.	

Model B	
Pros	**Cons**
Viewers can access all broadcasters' services with same coverage and quality.	Less/no competition between broadcasters in terms of network coverage and quality.
	Re-use of switched off analogue equipment will require cooperation of broadcasters (older equipment will often not be suitable for use in a DTTB network anyway).
Reduces the total infrastructure needed in the network and allows some site rationalization.	Site sharing rules may be required unless broadcasters can cooperate – it is generally better practice to define minimum requirements so as to provide clarity on rights of access to others in future.

4.4 Required and available budget

The ASO planning phase of the roadmap will have to deliver a business case detailing the costs and the financial resources.

4.4.1 Cost considerations

Table 2.15.2 of the ITU Guidelines provides an overview of the of the ASO organization and costs elements. In most countries a special organization is established to manage the ASO process. It is usually set up by and reports to or is supervised by government because of the significant issues of public impact, possible costs and subsidies and the need for a well-integrated communication strategy engaging all broadcasters, regulatory bodies, and the public.

Table 4.3 sets out some of the cost factors that will need to be considered in the ASO business case. As this work will precede the establishment of any ASO organization, it becomes a task for the NRT to identify and endeavour to quantify the costs for inclusion in its overall submission to government about ASO policy, its implementation timetable, and resources.

Table 4.3 assumes a model which has a common shared FTA multiplex carrying all existing full service broadcasters nationally through a common transmitter network (that does not exclude the possibility of additional or enhanced services being added to the multiplex).

Table 4.3: ASO activities and budget impact on Papua New Guinea ASO plan

No	ASO activity	ASO organization function	Considerations for Papua New Guinea situation	Relative cost/budget indication
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 an 80-90 per cent coverage target (i.e. equivalent to the largest terrestrial network coverage). Financial compensation or subsidy may be necessary to move the last remaining viewers before ASO, but should not be necessary in general if the package of services is attractive, and there is a good communications strategy in place. Experience shows that many viewers will take digital migration as an opportunity to change old receivers or purchase a new digital video recorder, or more cheaply a Set Top Box. Good links between broadcasters, importers, and retailers is critical and funds must be allowed for some education of these people as well as on communication campaigns to the general public. Factors that will reduce costs include: Selection of cheap set-top-boxes; Possibly a voucher system to assist in payment for a Set Top Box; Well planned coverage to remove confusion for viewers about where DTTB services are available (similar to the information provided by cellular mobile companies about their coverage).	++(++)

No	ASO activity	ASO organization function	Considerations for Papua New Guinea situation	Relative cost/budget indication
2	Transmitter network migration efforts.	Network planning function.	Depends on the actual/final coverage of the DTTB network. For Papua New Guinea this will involve the installation of at least 38 DTTB transmitters as well as the provision of satellite distribution to the transmitter sites. Transmitters will in general need to be new, because there will be a requirement to simulcast so analogue transmitters (even if they are digital ready) will need to continue to provide analogue programmes during the simulcast. However, instead of one transmitter at each site per network, only one transmitter will be needed for all existing services at each site. Other costs are involved in establishing the multiplex head-end systems, satellite up links, satellite capacity, and downlinks as well as management of any necessary CA systems.	++(+)
3	Re-farming of spectrum efforts and compensations.	Network planning function.	According to the current information provided (but should be double checked). There are some existing spectrum users in Papua New Guinea to be migrated and the legislation permits the Minister to reassign spectrum without any liability for compensation. NICTA has already initiated steps to arrange clearance of the digital dividend spectrum at the necessary time.	
4	Simulcast period for analogue terrestrial services.	Broadcast network rollout monitoring function.	The simulcast period is limited to about 3 years both to reduce the cost to broadcasters having to maintain two transmission services, and also to avoid the ASO process dragging on with increasing costs for communication etc. If the period is too short then the possible claims by viewers for subsidy will increase.	
5	Managing the ASO process.	Broadcast network rollout monitoring function. Market monitoring and research function. Consumer communication function. Industry communication functions.	ASO Implementation organization should be a government, or government sponsored body, as it will be managing government provided funds. At the same time the functions will involve all broadcasters and should be carried out collaboratively so that a single agreed message is given to the viewers. Confusion would only serve to increase the costs and delay ASO.	

No	ASO activity	ASO organization function	Considerations for Papua New Guinea situation	Relative cost/budget indication
6	Setting mandatory certification and labelling.	Industry liaisons function.	These costs could be minimized by: Stipulating a widely accepted and proven transmission standard; Not stipulating a CAS standard [but there will need to be an agreed CAS standard if the satellite distribution for DTTB requires CA protection, and even more so if the same service is to be used as a DTH service for isolated villages; Having an agreed labelling system such as currently operating in New Zealand and Australia to clearly identify consumer receivers that are able to receive the digital signal.	
7	Cost for resolving any DTTB interference.	Contact centre function.	With proper site management practices and proper engineering of the new DTTB services interference between radiocommunication services should be minimal and the available channel assignments are generally unlikely to give rise to consumer interference issue. Where interference does arise, and cannot be resolved by direct negotiation between the parties, then the standing policy rules about interference rectification responsibility would be applied.	

4.4.2 Budget considerations

Section 2.9 of the ITU Guidelines provides guidance on source for funding. The table below provides some general ideas about the various potential sources of funds.

Table 4.5: Funding sources for the ASO in Papua New Guinea

No	Source	Considerations for Papua New Guinea situation
1	General Taxes	The normal approach to covering the cost of the ASO management and communications process is for this to be funded and managed from a government budget appropriation. This would generally include any subsidy to assist viewers to migrate. The costs can be offset by possible revenues from the sale of released broadcasting band spectrum (under digital dividend) to telecommunications service providers who are significant beneficiaries of this spectrum.
2	TV licence fees	Receiver licence fees are generally recognized as expensive to administer and they do not create transparency in funding. Broadcast licence fees cannot reasonably be increased at a time when the Industry is expected to make a significant investment in infrastructure and simulcasting to allow migration to take place. This source is not useful.

No	Source	Considerations for Papua New Guinea situation
3	Spectrum usage/industry levies	Such imposts on the Industry at a time of transition are not useful and would be strongly opposed. The objective is to engage the Industry to have the transition happen quickly and while new transmitters etc. should be subject to an appropriate rational licence system, the historical anomalies may still not be resolved by the time of ASO, when they will become irrelevant. Taxes of levies on equipment simply make the process more costly for everyone.
4	Spectrum auctions or tenders	Insofar as the FTA DTTB spectrum is concerned, access to appropriate capacity should be a direct transfer in return for the eventual release of the analogue spectrum. The expert is not aware of any country which has sought to impose a transfer fee of this type through a spectrum auction of the DTTB spectrum. It may be appropriate to auction or tender the spectrum released through digital dividend as suggested in Item 1 of this table. A comprehensive discussion of the various allocation models is contained in The ITU Guidelines. There may also be an opportunity to use a price based system to allocate new DTTB capacity for other purposes such as subscription television services.
5	International organizations/loans (ITU, NGO, World Bank, other donor countries, etc.)	The potential for such support is outside of the scope of this report.
6	Commercial participation and/or public private partnerships (PPP)	The ITU Guidelines suggest that various forms of PPPs can be an option: • A commercial and independent party (e.g. this party could be formed by the current broadcasters, together with other parties) rolls-out the common network/service and the current terrestrial services are carried in a FTA bouquet (a form of Model A). If there is sufficient interest, the commercial broadcasters/consortium might be given preferential access to additional DTTB capacity for new services. • A commercial independent party rolls out the common multiplex/network and rents out the capacity to any service provider holding an appropriate content licence (a form of Model A). • The Papua New Guinea Government and a commercial network operator jointly finance the DTTB network (PPP), providing a free-to-air services. Additional DTTB multiplexes for the purpose of Pay TV would be the full responsibility of the Pay TV operator(s) to implement and manage. A price based allocation process may be appropriate for any new multiplexes made available for Pay TV so that the allocation was open and transparent, as well as possibly returning some funds other than general licence fees. • The Papua New Guinea Government could decide to establish the multiplex through some form of independent transmission network provider – such an arrangement would need to be transparent with all broadcasters being treated equally on realistic commercial terms, or equally on concessional terms (should the Government see this is a significant infrastructure development it wished to facilitate).

The acceptability of the various options will be influenced by market, national development objectives, and political considerations

4.5 ASO implementation

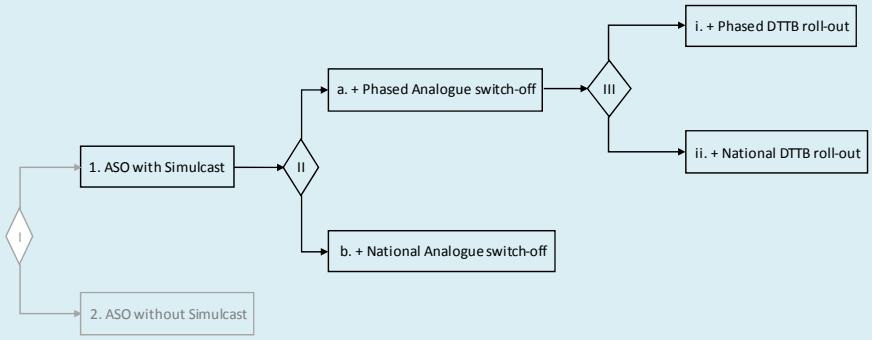
As discussed under the DSO objectives in Section 2.3 a simulcast period for the current analogue terrestrial services is desirable and for Papua New Guinea a necessary step to ensure an orderly and managed transition and ASO.

On the understanding that there is a strong interest in moving forward with DTTB policy and implementation, once any current work on service coverage improvement is completed no new analogue services should be licensed. Commencement of a new service on DTTB only would be an option provided that it was clearly a part of the overall migration plan.

Topography, infrastructure, and small isolated populations mean that all population centres that might realistically be covered terrestrially are mostly already served by analogue television. Once the DTTB service is established, then lower cost per channel to provide transmission might make it possible to consider some additional transmitters. Having regard to access for maintenance, power, and population served, DTH may remain the only practical way of addressing the large number of isolated villages who have the financial resources and electric power infrastructure to receive television within their community. An alternative could be to use a common DTH head end distributed to residents via cable, where the number of households to be served is small and distances between houses is small.

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

Figure 4.1: ASO models in Papua New Guinea



Source: ITU

The following can be said about the remaining decisions (II) and (III) in Figure 4.1

1. Decision II: A phased analogue switch off can be considered:
    a. Papua New Guinea viewers depend on analogue television, or where MMDS is available some viewers use this means to access FTA services. The impact of failure of the ASO transition would be significant in the few centres of significant population, e.g. Port Moresby and Lae, but would largely pass unnoticed by the significant number of people without access to TV.
    b. A phased model is more complex to implement in terms of the communications strategy as different coverage areas would need to be singled out for different messages. The current broadcast infrastructure does not allow separation of messages to different places; and print media would be equally difficult.

c. A national ASO on the same date would probably work best in Papua New Guinea, even though DTTB would be rolled out progressively over what could be a reasonably short period.

2. Decision III: A phased rollout of the DTTB:

a. Installation and engineering capacity may be limited and a network rollout in a limited period of time may not be possible if substantial tower or antenna modifications are needed. All of the transmitters required in Papua New Guinea are relatively low power and widely available in the supply market, apart from some possible issues relating to the capacity of existing towers, antennas, or buildings to accept the DTTB transmitters, there does not seem any significant reason why the installation process would be longer than 12-18 months from commencement.

b. Existing analogue broadcasting transmitters will continue to be in operation until ASO, so modification of those transmitters for an initial DTTB rollout is not practical. Existing transmitters that are digital ready may well form part of some future extension of DTTB services or possibly become back-up transmitters for the network.

The ASO plan should include an assessment of "Digital Readiness" of viewers once DTTB knowledge is in the market place and transmissions commence. This sounding may need to be carried out at several month intervals as the time towards ASO becomes shorter. It provides essential input to the communications campaign as it identifies areas where the take-up is not advancing as rapidly as desired, and also highlights possibly requirements for subsidy.

After careful monitoring of the effectiveness of ASO communications strategies in the early switch off areas of the UK. Digital UK[15], the agency responsible for managing the switch-off, determined that instead of the two year communications campaign in each region ahead of ASO, a more intensive six-month campaign was more effective. Digital UK also worked closely with community groups and local charities to engage with some of the more difficult-to-reach people who already had a relationship with the charity groups. ASO in the UK was completed in October 2012.

4.6 ASO planning and milestones

ASO planning must be well coordinated. Table 4.6 below provides an overview of possible result paths of the ASO planning and the key tasks associated to them. This way this table can form the basis of an initial ASO planning.

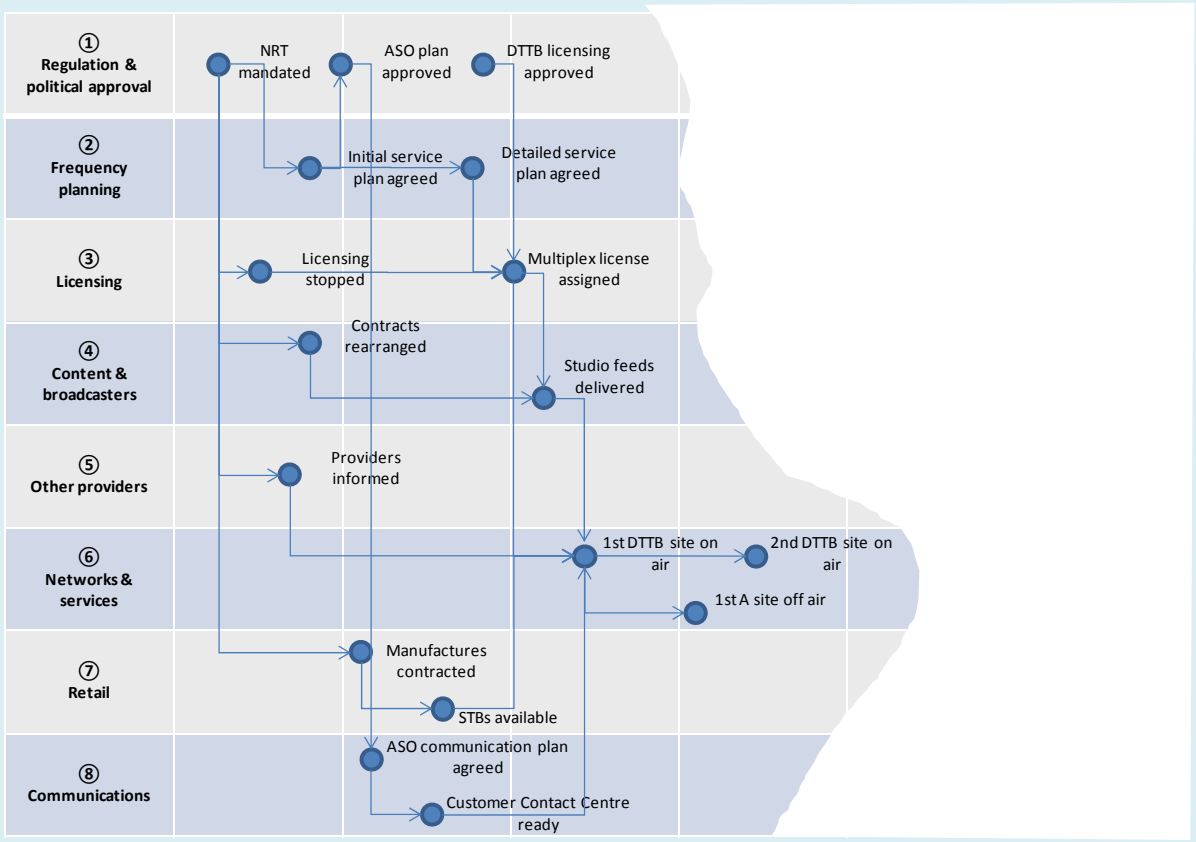
[15] See: www.digitaluk.co.uk for further information about Digital UK and the switchover process.

Table 4.6: Papua New Guinea ASO planning and milestones

No	Result path	Key tasks	Example milestones	Planning considerations for Papua New Guinea
1	Regulation and political approval	Government providing mandate to the NRT/ASO implementation organization. Government approving the DTTB policy document. Government endorsing the ASO planning and DTTB licensing regime. Government approving any necessary regulatory changes.	DTTB policy document approved (see Phase 1). ASO planning approved (see Phase 2). DTTB licence terms and conditions agree (see Phase 3). Regulatory framework changed (see Phase 1).	The NRT team should include a 'liaison officer' to quickly feedback guidance on political 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. See Section 3 on the need for clarifying the available spectrum and the broadcast and mobile requirements. Work already carried out on the television spectrum plan for Papua New Guinea has addressed aspects.
3	Licensing	NICTA should not issue any more e analogue terrestrial licences. NICTA should assign the required DTTB media and frequency licences (to either a common network operator or individual broadcasters). NICTA may need to revise existing licences to make the ASO planning possible.	DTTB licences assigned (see Phase 3) or multiplex/network operator licence assigned (see Phase 3).	Task to be overseen by the NRT. The legislation in Papua New Guinea appears to provide appropriate powers. Multiplexing of multiple services and the rights and obligations of the multiplex operator will need to be written into the legislation.
4	Content and Broadcasters	Broadcasters need to be informed about the ASO timetable and the impact on their production chain. Broadcasters need to communicate to their viewers about the ASO (by incorporating items in their own programming). In Model A, broadcasters 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.

No	Result path	Key tasks	Example milestones	Planning considerations for Papua New Guinea
6	Networks and services	Broadcasters/network operator need to detail the network planning and the associated service rollout planning. Broadcasters/network operator need to carry out the DTTB network and service rollout. Broadcasters have to switch off analogue transmission at the agreed date.	Network and service rollout planning drafted and agreed (see Phase 4). DTTB Transmitter site commences operations on areas by area basis (see Phase 4). Analogue transmitter switched off in accordance with the agreed ASO plan (see Phase 4).	In both models (A or B), representatives of the broadcaster and network operator input are critical to the ASO organization function.
7	Retail (STB and other receivers)	Manufacturers need to supply sufficient quantities of DTTB receivers to retail. Manufactures may be required certify compliancy with any set standard (see section 2.1) and to provide proper or specific labelling.	Agreed arrangements for certifying and labelling STBs put in place. First batch of STB and integrated receivers available in retail shops. Tracking of retail sales as a measure of penetration and take-up rates.	This will include the retail chains. Retailer/Supplier input to the ASO organization /NRT is essential. Representation can be handled through some form of representative consultation forum. Labelling/certification will require a trusted organization to do so as none exists, and depending on the final system choice, Papua New Guinea may be able to take advantage of certification and labelling systems already put in place in other countries of the region.
8	Communications (Viewers and other target groups)	Setting acceptable timetables and understanding local issues. Formulated adequate messages and executing communications through various means/tools.	ASO communication plan agreed (see Phase 2). Customer/viewer contact centre operational.	Representatives of the various viewer representative groups are likely to be consulted or engaged in public forums managed by the ASO organization/NRT. Will include a customer/viewer contact centre as implementation proceeds as a way of handling inquiries and providing supporting advice about ASO, and how to receive the DTTB services.

Figure 4.2: Illustration of an ASO milestone planning



Source: ITU

4.7 ASO communication plan

The ASO communication plan is a strategy on how to inform the public at large and will involve market players in several successive stages. One of the main deliverables in preparing this plan is a matrix which matches:

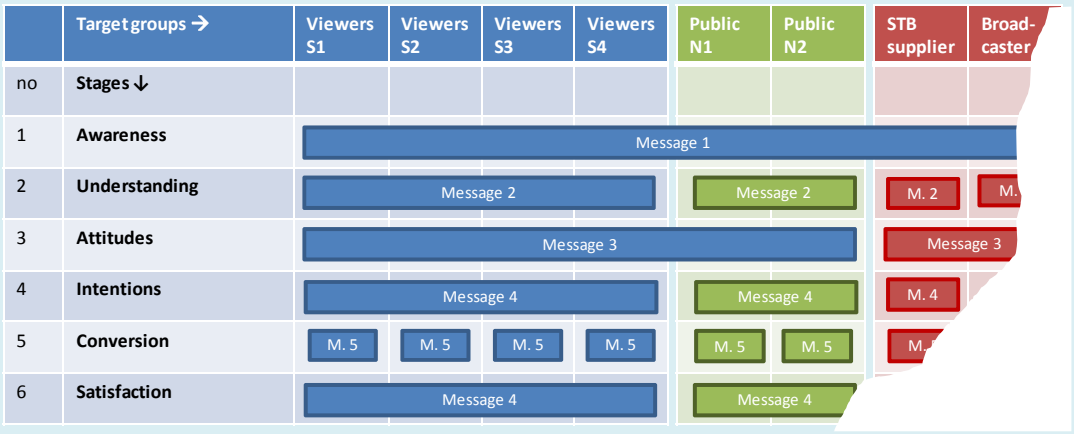
1. the different target groups; and
2. the different messages (per stage).

The general public (viewers) needs to be educated and informed about migration. Depending on the responsibilities the ASO organization will take on board the following target groups could be included in the matrix:

1. STB suppliers and retailers.
2. Certification and labelling institutes/organizations.
3. Broadcasters.
4. Content creators.
5. Landlords and public places (with television sets).
6. Government entities (e.g. local councils, regulatory bodies, etc.).
7. Administration of subsidy or voucher arrangement if applicable.

Figure 4.3 illustrates matching the different target groups with the different communication stages and messages.

Figure 4.3: Example communication matrix for Papua New Guinea



Source: ITU

As part of the ASO planning for the communications work stream, the NRT should complete in detail the above matrix. Subsequent steps will include:

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

4.8 Business model and conditional access

Agreement on the business model between the stakeholders in the value chain will be important. The mechanisms are directly linked to the decision about how the multiplex arrangements will be licensed.

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

Model B is more prescriptive, and the NRT will have to develop a business model in collaboration with the common multiplex operator and industry. This operator can offer:

1. Distribution (or network) services only: the broadcasters (or any other service provider) would pay a distribution fee for the service of broadcasting their program(s) in specified areas (against a set of agreed service levels), the right to obtain carriage should be established directly in the content licence as well as the multiplex licence terms and conditions, access arrangements must be clearly defined in legislation and in the multiplex licence, and access for all should be on an equal and transparent basis.

2. In general, transparency and equity require the common multiplex operator to be at arm's length from any broadcaster. In the case of a consortium of broadcasters providing the multiplex the consortium should be a separate "independent" entity. In the case of a single broadcaster providing the service, the multiplex operator should at least be a separate subsidiary of that broadcaster. The rights of any new content licensee in the future to access multiplex space should be clearly defined in the legislation and reflected in licence conditions.

The ITU Guidelines provide some examples for broadcasters for possible business model for DTTB services. While they suggest the possibility of mixed FTA and pay arrangements, for Papua New Guinea this may be unnecessarily complex and would not provide a proper solution for either FTA or pay. The most elegant solution is to establish a FTA multiplex, and then make available separate pay TV multiplexes and allow those multiplexes to be established, managed and operated by the pay TV provider (that would not preclude the multiplex being managed for that operator by a third party or even the FTA multiplex operator under a commercial arrangement).

This approach allows government to manage the FTA market perhaps more efficiently than an arrangement where capacity gets used up for any manner of services and there is no possibility of promoting particular needs such as education services which could use the multiplex and would also create a barrier to entry for any new services to enter in the future (if the multiplex was simply filled up with no regard for wider needs).

4.9 Digital TV frequency plan

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

4.9.1 Need for a digital TV frequency plan

A fully developed digital television plan should take into consideration:

1. The existing and already planned analogue TV services.
2. New DTTB services to be established in the stage of implementation up to ASO.
3. Possibly provision for new DTTB subscription services to be established either in parallel with DTTB or post ASO.
4. Provision for future services such as HDTV/3D TV etc.

Some of the future services might simply be provided for in proposed DTTB multiplexes used for FTA, or Pay TV, others may require inclusion of separate transmission frequencies in the plan. Pay TV operators should be licensed on a complete multiplex basis and permitted to deliver SD or HD services as they see fit.

The plan should also take account of channels that may be needed for:

1. Future terrestrial digital radio services.
2. Perhaps Digital Terrestrial Multi-media services.
3. Mobile communication services in the upper part of Band V as determined under a digital dividend/international agreements.

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

1. evolutionary frequency plan; or
2. *a-priori* frequency plan.

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

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

Table 4.7: Frequency plan approaches

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

Papua New Guinea has in part already embraced a mixture of these approaches in its first review of the spectrum. It represents an appropriate response to the need:

1. It is closest to the current practice of assigning frequencies.
2. Has allowed rationalization of assignments taking into account Digital Dividend and services needs including DTTB (at least to the point where analogue channels might be reassigned to new DTTB or other services).
3. Analogue switch-off date is possibly going to be somewhere between 2015 and 2017, the latter year is still well ahead and long term requirements may change in the meantime.
4. Short-term requirements and transition of current analogue TV services could be planned on the basis of the existing analogue TV planning.

The plan should reserve channels for future requirements (see section 4.10.2 below).

4.9.2 Conditions for developing a digital TV frequency plan

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

Table 4.8: Conditions for a digital frequency plan

Condition	Situation in Papua New Guinea	Action by NRT/NICTA
Defined frequency bands and channel arrangement during and after transition	Band III: 174 – 230 MHz; 8 channels of 7 MHz Band IV/V: 470 to 698 or 790 MHz; 29 or 40 channels of 8 MHz	Decision on upper limit of Band V for broadcasting has already been made by NICTA (see also section 4.10).
Assignments to be protected during transition.	Existing analogue and digital TV services	While normal protection limits need to be applied to existing analogue services, the limited and geographically constrained coverage of transmitters, means that appropriate protection levels should be easy to achieve if they need to be addressed at all. Protection of co-sited radiocommunication services is more likely to be an issue than protection between television services.
Assignments in neighbouring countries that need to be protected.	While there is a shared border with Indonesia and coastal transmission locations which may have protection requirements, the relatively low power of all transmitters should result in there being no overlap/protection issues with neighbours.	Investigation of assignments having right of protection according to ITU Radio Regulations. Agreement with neighbouring countries on digital TV frequency use in border areas should this be necessary.
Accurate and detailed data of transmitting stations: Existing analogue and digital; planned digital	Basic data available at NICTA.	Verification if existing data bases are adequate (see Table 4.11).
Planning criteria and method.	Not yet established.	Decision on planning criteria (see Section 4.9.4).
Planning software.	NICTA already has access to broadcast planning software that can produce coverage maps.	Further develop capability to use this software to prepare coverage maps to support ASO.

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

1. A frequency plan for the transition period, when analogue TV and existing digital TV services require protection from new digital transmissions.
2. A frequency plan after ASO, when only digital TV will exist.

During the transition period the analogue TV and existing digital TV needs to be protected. This means that the existing coverage areas should not be reduced due to interference from digital TV transmissions.

Table 4.9 gives an overview of the planning situations.

Table 4.9: Overview of planning situations

Situation	Band III	Band IV/V
At Present	List of assigned [1] analogue TV) stations.	List of assigned [1]) analogue TV stations
During transition	Plan taking into account: • Current list; • Digital services replacing existing and planned analogue TV; • New digital services.	Plan taking into account: • Current list; • Digital services replacing existing and planned analogue TV; • New digital services.
After ASO	Plan taking into account: • Digital services replacing existing and (if so decided) planned analogue TV; • New digital services and sites; • Additional digital services and sites; • T-DAB requirements (if any).	Plan taking into account: • Digital services replacing existing and (if so decided) planned analogue TV; • New digital services and sites; • Additional digital services and sites.

4.9.3 Coverage considerations

The coverage area of a digital TV service should be at least the same as the coverage of the analogue service it replaces. In the preparation of the digital frequency plan assess the analogue coverage areas and use the established ITU Recommendations to scale existing services to DTTB, based on frequency difference, and technology differences and requirements. In some places TV viewing takes place under conditions well below the recommended minimum field strength values in ITU[16]. However, because coverage is generally constrained by geography rather than distance the results should be fairly predictable from a desk study. A decision is needed about which basis analogue TV coverage should be assessed, e.g. based on:

1. experience and practical knowledge of receiving conditions; and
2. calculations with either the recommended ITU minimum field strength values, or the values indicated by ITU as reception limits[17].

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

[17] 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.

Annex 6 shows a few calculation examples in order to estimate the coverage area of an analogue and a digital TV transmitting station. If fairly accurate assessments are required there are a range of excellent prediction tools available. NICTA already has some components of suitable tools including digital terrain maps which could be used as is or with suitable additional modules for coverage assessment. Alternatively the specialist supplier of the NICTA software could model the required coverage for actual or proposed operating parameters, sites, and geographic locations.

A summary of the conclusions of the examples given in Annex 6 is that the ERP of a digital transmission (expressed as mean power) replacing an analogue service is in most cases less than the ERP of the analogue transmission (expressed in peak envelope power). However, if the analogue coverage area would be defined by the limit of reception value, the ERP of the digital transmission should be about 1.5 times higher than the analogue ERP. Table 4.10 shows the ERP ratios for three DVB-T system variants.

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

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

1. In some cases, existing analogue transmitters can be converted to digital. The mean power of a digital transmission from a converted analogue TV transmitter is about 1/5 to 1/3 of the analogue peak envelop power.
2. From a frequency planning point of view it is possible to convert an analogue transmission to digital without inverse impact on the compatibility situation if the ERP of the digital transmission is five times less than the analogue ERP.
3. Indoor reception areas are much smaller than with rooftop reception for a given ERP.

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

1. to use an existing analogue transmitter converted to digital (with reduced power) provided they are sufficiently linear (which generally means they have been designed to take digital services once the modulator is replaced);
2. to achieve compatible analogue and digital transmissions (in the assumption that the original analogue transmissions were compatible);
3. to cover an area at least the size of the analogue coverage based on the recommended ITU values for rooftop reception in the absence of interference or other noise; and
4. to provide stable reception to outdoor or indoor antennas as analogue in the places digital TV transmitters will be located. Planning for indoor coverage in Papua New Guinea where metal roofs and reinforced walls are common, is problematic, and therefore, it may be better simply to assume similar conditions to the existing analogue, with perhaps allowance for a little more power than otherwise required if there is to be a significant change in frequency (e.g. VHF market having to move to UHF). Band changes are highly undesirable because they generally require many viewers to change their receiving antennas and often the feeders.

4.9.4 Construction of a frequency plan

The establishment of the frequency plans indicated in Table 4.9 will normally involve the use of planning software for preparing the frequency plan and calculating the coverage areas, following the guidance given in Chapter 4.3 of the ITU Guidelines.

The digital frequency plan it should take into account that:

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

The resulting frequency plans consist of:

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

The list of characteristics of a TV transmitting station should include as a minimum the items set out in Table 4.11.

Table 4.11: TV transmitting station characteristics

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

4.10 Digital dividend

Allocation of mobile services in broadcasting bands is part of the digital dividend. Digital dividend is a term to express the spectrum efficiency gains due to the switch-over from analogue to digital television. Further information on this is contained in ITU report: Digital Dividend: Insights for spectrum decisions published in August 2012[18]. As a result of the transition to digital TV, spectrum will become free because digital television is more spectrum efficient due to:

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

The Digital Dividend can be used for:

1. new Broadcasting services and coverage extensions;
2. new types of Broadcasting services , e.g. Mobile TV and HDTV;
3. non-broadcasting services, e.g. Mobile communications.

Spectrum requirements for mobile services are well documented and are not described in this section[19] [20].

The main choice regarding the digital dividend is the service allocation in the frequency range that becomes free after the existing analogue TV transmissions has been converted to digital. In most countries of ITU Region II (Europe, Africa, and the Arab States), the digital dividend will be used for broadband mobile wireless services.

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

1. the cultural, educational and public information benefits of additional Broadcasting services;
2. economic benefits of introduction of Broadcasting and Mobile services;
3. spectrum requirements of both services;
4. international frequency harmonization in the Asian Pacific Telecommunity (APT) and ITU and in particular WRC-12.

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

The order in which the decisions for the allocation of the digital dividend should be taken is illustrated in Table 4.12.

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[18] ITU Report Digital Dividend: Insights for spectrum decisions published in August 2012 available from: www.itu.int/ITU-D/tech/digital_broadcasting/Reports/DigitalDividend.pdf

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

[20] See APT Report on harmonised frequency arrangements for the Band 698-806 MHZ, No. APT/AWF/REP-14 Edition: September 2010; Adopted by the 9th APT Wireless Forum Meeting, 13 – 16 September 2010, Seoul, Republic of Korea.

Table 4.12: Order in making decisions on the allocation of digital dividend

1	**Frequency bands**	Determine the frequency bands
2	**Converted analogue TV**	Determine spectrum requirements of analogue TV converted into digital TV
3	**New digital TV**	Determine spectrum requirements of more and new types of broadcasting
4	**Non-broadcasting**	Determine spectrum requirement of non-broadcasting services (LTE)
5	**Trade-off between requirements**	Trade-off between long term needs of new digital TV and non-broadcasting services, taking account of: • cultural, educational and economic benefits • spectrum requirements • international frequency harmonization

4.10.1 Frequency bands

The frequency bands under consideration in Papua New Guinea are:

- Band III (174 – 230 MHz);
- Bands IV/V (526 – 854 MHz[21]).

The situation in these bands with regard to digital dividend in Papua New Guinea is summarized in Table 4.13.

Table 4.13: Broadcasting and mobile interest in Band I, III and IV/V

Frequency band	Situation in Papua New Guinea
Band III (174 – 230 MHz)	8 broadcasting channels with 7 MHz channel spacing
Bands IV/V (526 – 854 MHz)	39 broadcasting channels with 8 MHz channel spacing Claim from Mobile service for spectrum above 694 MHz in addition to spectrum above 790 MHz

4.10.2 Spectrum requirements

The current NICTA work on a draft spectrum plan takes into consideration the following:

1. Digital dividend requirements for mobile telephony above 694MHz.
2. Preliminary consideration for accommodation of DTTB multiplexes in existing analogue markets.
3. Possible accommodation on UHF for subscription services.

[21] According to article 5 of the Radio Regulations, the upper limit of the band is 960 MHz; however in Papua New Guinea no broadcasting is envisaged above 694 MHz after spectrum rationalization is completed.

The spectrum plan to achieve this is not yet complete, but from a preliminary examination of the current and planned assignments, one or more common FTA DTTB multiplex could easily be established nationwide as an initial stage of DTTB implementation, along with any additional multiplexes that may be required for subscription services.

5 Recommendations

This report recommends that the NRT commence its activity by taking the following steps towards the transition to digital television broadcasting and switching off the analogue services:

1. Have the roadmap report approved by the Papua New Guinea Government.
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. Prepare and achieve endorsement to the following decisions which influence the scope and duration of the roadmap planning:
    a. establish an ASO date and the date of the first DTTB transmissions;
    b. determine ASO model (phased simulcasting or not);
    c. determine the licensing Model (Model A or B) to be used for multiplexing, distribution and transmission;
    d. Confirm that no further analogue television services will be licensed;
4. Form a project management office (PMO) and start drafting an initial detailed ASO planning and determine the progress reporting procedures and structures.
5. In addition the NRT will need to:
    a. arrange market research into the key elements as indicated in this roadmap report (see Phase 1) to anticipate and plan solutions for potential ASO risks;
    b. determine the number and type of programme streams to make up the DTTB service offering (e.g. standard definition TV (SDTV), HDTV, data services, audio services, possible subscription services) as these will determine the amount of delivery capacity to be established now or in the future;
    c. determine the DTTB system standard to be used for Papua New Guinea. Have this approved by government and commence the standardization process;
    d. determine the operational parameters for the selected transmission standard (these involve trade-off between the number and quality of services, coverage at a given transmitter power, and service quality);
    e. carry out detailed frequency and service planning for the agreed system; taking into account any required digital dividend. The spectrum and service planning work already carried out in Papua New Guinea has already taken into account some of the anticipated DTTB requirements;
    f. reserve capacity for the likely future services of such as additional services, HDTV, Digital Radio, and possible coverage enhancement. Unless these things are taken into account in the DTTB spectrum planning they could prove complex and costly to introduce after DTTB is operating;
    g. prepare necessary amendments to legislation to support DTTB implementation;
    h. recommend and oversight the delivery of any specified required digital dividend if required.

References

International Telecommunication Union ITU Report Digital Dividend: Insights for Spectrum Decisions; August 2012[22].

International Telecommunication Union, Recommendation ITU-R BT.1306, Error correction, data framing, modulation and emission methods for digital terrestrial television Broadcasting[23].

International Telecommunication Union, Recommendation ITU-R BT.1877, Error-correction, data framing, modulation and emission methods for second generation of digital terrestrial television Broadcasting systems[24].

International Telecommunication Union, Recommendation ITU-R BT.1368, Planning criteria for digital terrestrial television services in the VHF/UHF bands[25].

International Telecommunication Union, Final Report on ITU R Question 11-2/2: Examination of terrestrial digital sound and television broadcasting technologies and systems, including cost/benefit analyses, interoperability of digital terrestrial systems with existing analogue networks, and methods of migration from analogue terrestrial techniques to digital technique.

International Telecommunication Union, REPORT ITU-R BT.2140-4 Transition from analogue to digital terrestrial broadcasting www.itu.int/pub/R-REP-BT.2140-4-2011[26].

International Telecommunication Union, Recommendation ITU--R BT,417-5 Minimum field strengths for which protection may be sought in planning an analogue terrestrial television service[27].

International Telecommunication Union, 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[28].

22 www.itu.int/ITU-D/tech/digital_broadcasting/Reports/DigitalDividend.pdf

23 www.itu.int/rec/R-REC-BT.1306-6-201112-I/en

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

25 www.itu.int/rec/R-REC-BT.1368-9-201112-I/en

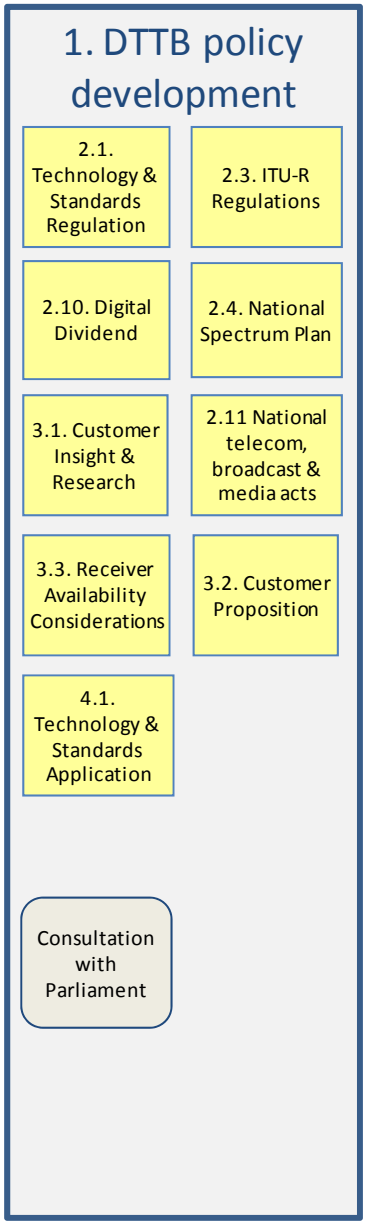
26 www.itu.int/dms_pub/itu-r/opb/rep/R-REP-BT.2140-4-2011-PDF-E.pdf

27 www.itu.int/dms_pubrec/itu-r/rec/bt/R-REC-BT.417-5-200210-I!!PDF-E.pdf

28 www.itu.int/rec/R-REC-P.1546-4-200910-I/en
www.itu.int/dms_pubrec/itu-r/rec/p/R-REC-P.1546-4-200910-I!!PDF-E.pdf

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

DTTB policy development



Phase 1 of the roadmap is described in Section 3.4.2 of this report.

This Annex gives an overview in of the status of each of the selected functional blocks in Phase 1 using the following codes:

A	Decisions on key topic and choices that are already taken
B	Decisions on key topic and choices that are partly taken
C	Activities for which choices that have not yet been decided
D	Activities where earlier choices need revision
NA	Not applicable

The selected functional block number refers to the corresponding chapter in the ITU Guidelines. Refer to the ITU Guidelines for additional information.

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)?	C	Options could include allocation of a specific bit rate capacity within a common multiplex and allowing the broadcaster to determine if this is to be used for HDTV or multiple SD programmes; defining a specific minimum bit rate (hence minimal quality for SD services) defining the services as SD only with HD to be considered at a later date perhaps on a separate multiplex.
2.1.2 Transmission standard: for DTTB platforms. Has the standard setting been decided?	C	At this point, no standard has been determined; however, all of the existing broadcasters and industry stakeholders in Papua New Guinea seem to agree that DVB-T family of standards would be the appropriate choice for Papua New Guinea and align with other countries in the region including their major trade partners. If the DVB-T family of standards is adopted then DVB-T2 would be an appropriate choice because it will allow sufficient capacity on each multiplex to meet the various needs of FTA and subscription broadcasters. For more detailed considerations see Section 4.1 in this report.
2.1.3 Compression technology: for DTTB platforms MPEG2 or MPEG4. Has the standard setting been decided?	C	Not yet determined however, there is a strong consensus amongst existing broadcasters that given Papua New Guinea is just starting out on DTV, it should take advantage of the benefits of MPEG 4 as it will provide a better match to the potential capacity need for both FTA and future subscription television requirements. Currently in the retail market there continues to be a small difference for a simple MPEG4 set-top-box (no hard disk and CAS) over an MPEG2 box, but most boxes are now being supplied as MPEG 2 and advertised FOB factory prices are now in the range USD 15-30 for MPEG 4 DVB-T2 boxes. Price should therefore no longer be a primary consideration. Consideration also needs to be given as to the need to provide CA protection to the satellite distribution/DTH service.
2.1.4 Conditional access (CA) system and digital rights management (DRM): interoperability between deployed systems for DTTB. Has the standard setting been decided?	C	CA could be regulated. Also dependent on the selected licensing model (A/B). However, if the model of a FTA multiples and separate subscription multiplexes is followed CA could be left to the subscription broadcasters to determine whether they agree on a common standard or opt for individual solutions. Regulation or agreement on CA may be necessary if DTH and subscription services are to share a common platform to reduce cost to consumers and facilitate CA management. For more detailed considerations see Section 4.1 and 4.8 in this report.
2.1.5 Application programming interface (API) for additional and interactive services: for DTTB platforms e.g. MHP.	C	Not decided yet. For more details see the ITU Guidelines Section 2.1.2.

Main activities	Observation/Advice
1. Carry out market research/surveys for identifying industry and consumer needs for standardization.	To be included in the market research as suggested in this phase (see subsection 3.4.2). Given the migration to digital is not specifically driven by consumer demand, the need for consumer research might be limited to progressive assessment of consumer take-up of digital television post commencement of DTTB services, as a guide to the preparedness for ASO>
2. Determine minimum set of receiver standards for the DTTB market, based on the market developments.	See subsection 3.4.2 of this report
3. Assess impact on industry and end consumers.	As part of the analysis of the market research results (as indicated in Subsection 3.4.2).
4. Determine receiver requirements and include in frequency licence terms and conditions and/or media permits and authorizations.	See subsection 3.4.2 of this report
5. Determine communication messages, planning, standardization/testing bodies and methods (including logos and labelling).	The selected functionality and specs are important input for the communication plan (see second phase of the roadmap) and the ASO planning (e.g. the work stream 'Financial and installation support can include the logistics of the labelling of the STB as to support the viewer). For more details see Section 4.7 in this report.

2.3 ITU-R Regulations

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

Key topics and choices	Status	Decision
2.3.1 The international context of the ITU-R regulations: Are the different entries in the GE06 plan considered (allotment/assignment)?	NA	A plan like the GE06 plan is not available for Region 3.
2.3.2 Applicability and implications of ITU-RR: (a) what frequencies or allotments will be assigned for what type of service (b) In what combinations these frequencies or allotments will be assigned (c) When these frequencies or allotments will be licensed or can be taken into operation? For answering these questions process steps are defined in this section.	C	All three sub-choices (a-c) still to be decided. Available spectrum and spectrum requirements for DTTB has been assessed at a preliminary level in the draft television spectrum plan for Papua New Guinea.

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.	A clear and shared understanding of the available spectrum will enable the NRT to develop a soundly based DTTB policy document (see Subsection 3.4.2 of this report.
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) licences for operational analogue TV services.	A preliminary examination of the draft television spectrum plan suggests that it should be possible to avoid disruption to existing analogue services during the transition.
4.	Determine notification to the ITU.	As discussed in Subsection 3.4.6 these procedures need not to be part of the critical path.
5.	Possibly determine necessary budget for any network retuning activities.	Not expected to be required in Papua New Guinea.

2.4 National Spectrum Plan

Brief description	The National Spectrum Plan reflects the long, medium and short-term planning of the available national spectrum resources for DTTB and MTV services in a particular country. It may also include the stipulated assignment procedures for the various services and a national frequency register, including all the assigned licences and licensees.
Objective	With a national spectrum plan the NICTA 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	A revised draft television spectrum plan is in the early stages of development by NICTA.
2.4.2	Planning current and future DTTB and spectrum use: Has the national spectrum plan/strategic planning process started/completed? (For process, see this section).	C	See comments against 2.4.1 above.
2.4.3	National Spectrum Plan publication and DTTB introduction dates.	C	Not yet determined.
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	Yet to determine whether existing arrangements should be modified for broadcasting.

Main activities		Observation/Advice
1.	Make an inventory of current spectrum use in the broadcast bands (bands III, IV and V).	Completed.
2.	Register use and provide rules for registration.	NICTA has responsibility for this.
3.	Carry out market analyses and consultations and forecast future spectrum needs.	Can be part of the market research to be carried out in Phase 1 of the roadmap (see also Functional Block 2.10).
4.	Determine re-farming needs and assess impact on existing and future users.	To be carried out in this phase of the roadmap. Would normally be further detailed in Phase 2. Unlikely to be an issue in Papua New Guinea.
5.	Determine publication content, dates and formats for the National Spectrum Plan.	To be determined according to established practice.
6.	Determine budget for spectrum management and administrative fees.	Licence and spectrum are managed by NICTA. An appropriate fee regime will need to be established to support DTTB implementation decisions and ASO transition.

2.10 Digital dividend

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

Key topics and choices		Status	Decision
2.10.1	Determining the size of the digital dividend: has the size been determined?	B	The immediate spectrum requirements for Mobile services have been identified by NICTA.
2.10.2	Digital dividend options: have the allocations to the different service been determined? (Broadcasting or non-broadcasting).	B	For non-broadcasting services (e.g. LTE/4G) it is above channel 48. This is subject to current planning activity in Papua New Guinea.

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, but will most likely be determined ahead of the DTTB policy formulation.
2.	Assess current and future market needs for DTTB services, possibly based on formulated legislation and policies.	To be carried out as part of Phase 1 of the roadmap.
3.	Assess available spectrum after ASO, based on ASO plans, National Spectrum Plan and ITU-R Regulations.	To be carried out as part of Phase 1 of the roadmap.
4.	Map spectrum needs on available spectrum and determine priorities and assign spectrum to broadcasting.	To be carried out at a high level in this phase of the roadmap. Later to be detailed in Phase 2 and finalized in Phase 3 (see respectively subsection 3.4.3 and 3.4.4).

Main activities		Observation/Advice
5.	Possibly draft spectrum re-farming plans and compensation schemes (for network and receiver re-tuning activities), reserve budgets.	No requirement in Papua New Guinea. Such changes are not likely to be required, and legislation makes clear no compensation is payable in these circumstances.
6.	Update National Spectrum Plan and align licence terms and conditions for DTTB services.	A check of current licence terms and conditions for both broadcast and frequency licences will be necessary. 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 compliance with the intended policy decisions and with the existing and relevant regulatory framework. Very often this regulatory framework comprises national telecommunication, broadcast and media legislation. For Papua New Guinea the relevant regulatory framework is given in Table 2.2 of this report.
Objective	To be compliant with existing regulations, which might also include regulations on cross and foreign ownership and state aid.

Key topics and choices		Status	Decision
2.11.1	Checking compliancy with existing national, telecommunications, broadcast and media legislation: is the formulated DTTB/MTV policy in line with the legislation?	D	Current legislation does not appear to present any obstacle to DTTB implementation. New arrangements will have to be drafted to establish the framework and licensing requirements for shared multiplex/network arrangements.
2.11.2	Checking compliancy with other legislation, especially related to cross and foreign ownership and State aid: is the formulated DTTB policy in line with legislation?	D	(See subsection 3.4.4). This does not seem to be an issue for Papua New Guinea.

Main activities		Observation/Advice
1.	Make inventory of current legislation.	Table 2.2 in this report covers the current situation and 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 DTTB services will depend on many consumer related factors
Objective	The NRT will have to carry out some form of market research for identifying these demand drivers, and service uptake projections.

Key topics and choices	Status	Decision
3.1.1 Overview of the DTTB markets: market definition, key service and market characteristics.	B	• The broadcasters have great knowledge of the Papua New Guinea market. This knowledge should be utilized. • Options to pay for STB or to assist in STB acquisition should be investigated. • Tax exemption on STBs and transmission equipment may be one option to reduce the cost to broadcasters and consumers and improve take-up rates. • Interest in subscription television delivered by DTTB needs further investigation.
3.1.2 Market research methods: basic market research approaches and embedding market research in the DTTB business planning process.	C	Apply low cost methods to research the Papua New Guinea market, particularly in the transition stage where consumer take-up will need to be monitored to adjust communications strategy and possible incentives to allow the ASO timetable to be achieved.

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.
4. Design and develop preliminary DTTB service propositions.	As part of the 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 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 subsection 3.4.3. (ASO planning) in this report.

3.2 Customer proposition

Brief description	This section focuses on determining the customer proposition for DTTB.
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 (during the first visit). For more detailed considerations see Section 4.2 in this report. Attributes still to be decided/defined (e.g. coverage and number of channels).

Main activities	Observation/Advice
1. Analyse earlier DTTB service launches and compare with customer research results/local market conditions.	Also service launches in other countries could be considered. For example in the neighbouring countries.
2. Define DTTB service propositions and check feasibility in terms of network planning and business case.	Part of the Phase 2.

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). And establishment of a transport stream specification against which receiver compatibility can be established for conformance labelling purposes.	C	For ASO budget limitations and the low ability to pay in the market, the functionality will be to provide the basic set of functions (to include, zapping, EPG, software updates and standard compliancy). Please note that including (embedded) CAS will increase the price and should perhaps be left to subscription service offerings only rather than burden all FTA users with the additional cost of CAS even if a common standard can be agreed. Subscription receivers should be set up to receive FTA as well as subscription to ensure simple consumer operation

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 Papua New Guinea specific issues as included in subsection 3.4.2 (i.e. independent and warranted supplies and affordable and sufficient 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).	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 Papua New Guinea and whether the government will assist consumer take up and broadcaster transition by reducing/removing taxes on basic transmission and reception equipment
6. Decide key receivers and their attributes, draft receiver/service roadmap.	Labelling and the inclusion of IDTV information in the ASO Communication plan are strongly advised.

4.1 Technology and standards application

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

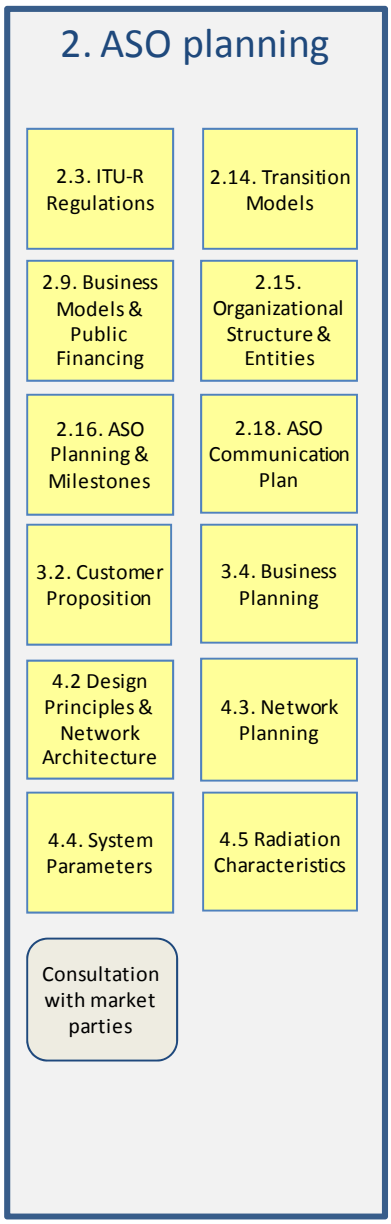
Key topics and choices	Status	Decision
4.1.1 Technical tests to evaluate system performance	C	Technical tests may be needed to assess the proper power levels for different types of markets to achieve analogue equivalence, taking into account the use of external receiving antennas
4.1.2 SDTV and HDTV specifications	C	SDTV and one sound channel. Bit rate for services still to be decided. Picture ratio 16:9 is already standard.
4.1.3 Selection of DTTB transmission standard	C	As previously mentioned, there is a strong view amongst all stakeholders that the correct system choice for Papua New Guinea is to adopt the DVB-T family of standards. The NRT should consider this topic early and obtain the necessary approval for adoption of the selected standards.

Key topics and choices	Status	Decision
4.1.4 Compression system	C	MPEG 4 would appear to be the best choice for Papua New Guinea given the timing of its DTTB implementation and the additional service capacity it provides over MPEG 2
4.1.5 Encryption system	C	Only applicable if pay-tv was decided to be included in the service proposition.
4.1.6 Additional services	C	There are no teletext services in Papua New Guinea. The NRT will need to determine if there is to be any specified requirement for teletext and or closed captions on the digital platform. Irrespective of immediate needs, provision for these should be included in the specification because these features can be used for a number of special services such as emergency warnings (cyclone etc.). Access services have not currently been specified in Papua New Guinea. Provisions for system software updates (SSU) should be included in the Papua New Guinea specification because it allows receiver manufacturers to update receiver software over the air at no cost to the consumer when changes/improvements are necessary. (Note not all STBs support over-the-air download. This is particularly true of low cost boxes so in-order to ensure lowest price availability of STBs, the requirement should be provided for but not mandated).

Main activities	Observation/Advice
1. Estimate required bit rate of SDTV services (including sound channels)	The bit rate of the multiplex is trade-off between picture quality and multiplex capacity. Final estimation can only be made after Design principles and network architecture (see Functional Block 4.2 in Phase 2) and network planning (see Functional Block 4.3 in Phase 2) have been considered. First estimate could be: SD Video bit rate: 2-3 Mbit/s (MPEG4), depending on the kind of programme, because good picture quality is an objective. Audio bit rate: 192 Kbit/s (MPEG1 layer 2) for a stereo channel and 96 Kbit/s for a mono channel.
2. Evaluation of conditional access (CA) systems. The choice for a CA system is a trade-off between costs of the system and security.	This is a concern for subscription TV service providers. In order to save costs and convenience for viewers, the same system should be used by all service providers; however, this is a commercially sensitive issue that needs detailed discussion with potential subscription television providers.
3. Estimation of required bit rate for SI and need for SSU Service information (SI) is needed for constructing the EPG in the receiver. System software updates (SSU) is likely required to be able to upload new software to the receivers.	The service information required for the EPG may take about 0.5 Mbit/s. It is recommended to undertake testing of SSU beforehand to avoid risk of problems during live data transmission.

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

ASO planning



Phase 2 of the roadmap is described in Section 3.4.3 of this report.

This Annex gives an overview in of the status of each of the selected functional blocks in Phase 1 using the following codes:

A	Decisions on key topic and choices that are already taken
B	Decisions on key topic and choices that are partly taken
C	Activities for which choices that have not yet been decided
D	Activities where earlier choices need revision
NA	Not applicable

The selected functional block number refers to the corresponding chapter in the ITU Guidelines. Refer to the ITU Guidelines for additional information.

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 include the Radio Regulations (RR) and in particular the table of frequency allocations (Region 3) and the relevant provisions of the World Radiocommunication Conference 2007 (WRC-07).
Objective	In this phase, is to determine the most suitable ASO model given the insights of the first phase.

Key topics and choices		Status	Decision
2.3.3	The international context of the ITU-R regulations: Are the different entries in the GE06 plan considered (allotment/assignment)?	NA	There is no equivalent to the GE06 plan applicable to Region 3.
2.3.4	Applicability and implications of initial inventory (see Phase 1): what are the possible ASO models given the available spectrum and initial spectrum requirements.	C	As part of the ASO planning process. Please note that simulcasting is a requirement, although the exact model is not decided yet.

Main activities		Observation/Advice
1.	Map the preferred transition models on the available spectrum for DTTB services. Select on the basis of this analysis the most optimal transition model.	To be carried out as part of Phase 2. See also functional build block 2.14 and the details provided in Section 4.5 on transition model selection.
2.	Determine necessary changes to *planned* licensing procedures, terms and conditions for DTTB services and ASO plans.	As input for Phase 3.

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 4.4 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) Financing the simulcast period (d) 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 (TVK) channels on digital platform still to be determined; (c) still to be considered; (d) NA.

Main activities		Observation/Advice
1.	Consult broadcasters and government on possible subsidy of consumer equipment.	
2.	Define or complete required service offering on DTTB.	NRT will need to recommend to government when submitting the ASO plan for approval.

Main activities		Observation/Advice
3.	Align defined service offering with other DTTB licence terms and conditions and media permits, and their planning.	Can be minimized by use of existing transmission towers and sites.
4.	Determine and establish budget for ASO plan.	The ASO plan should be approved by government and hence should contain a well-developed analysis and funding proposal.

2.14 Transition models

Brief description	This section deals with the task that analogue television broadcasts have to cease and the existing analogue services migrated to a DTTB platform in one coordinated effort, led by the national government (i.e. the ASO process). This section deals with what ASO or transition model will be applied where in Papua New Guinea.
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)?	C	Partly because NRT would like to see additional services on DTTB. See also 'DSO objectives' in Section 2.3 in this report. Still the exact number of additional services to be decided. Also what type of service coverage the NRT would like to see (this could include Universal coverage).
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	When considering the current analogue viewing situation. See also Subsection 4.4.1 of this report.
2.14.3	ASO transition models: Which models is envisioned (a) ASO with simulcast period, with two sub-categories (i) phased approach to analogue switch-off (ii) national approach to analogue switch-off (b) ASO without simulcast period.	C	Although the NRT may decide on a simulcast model, it should still define the exact model. For more considerations 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.	To be carried out in the previous phase of the roadmap (DTTB policy). See Subsection 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.	

Main activities	Observation/Advice
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).	To be included in this phase of the roadmap.

2.15 Organizational Structure and Entities

Brief description	The ASO process is a complex and time consuming operation and a special purpose entity (e.g. Task Force, Committee or separate company) may coordinate the overall process and planning. The arrangements for managing this process will need to be considered by the NRT and NICTA.
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 Papua New Guinea NRT is established but has not yet been given a formal mandate. Its mandate has to be developed. Broad membership of the NRT has been generally determined but may need to be modified over time (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	Detail inventory necessary as part of the process of balancing DTTB service planning, customer proposition and financing (see subsection 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 subsection 3.4.3 and 4.4.1 of this report.
2. Establish clear mandate (which is politically approved).	
3. Establish budget and communication means (air-time, website, etc.).	

2.16 ASO planning and milestones

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

Key topics and choices	Status	Decision
2.16.1 Outlining the ASO planning: when and where to begin the process and how long the entire operation should last.	C	The switch off date has yet to be determined. A realistic objective would appear to lie between 2016-2017 (potentially earlier if there were a strong desire).

Key topics and choices	Status	Decision
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.	C	

Main activities	Observation/Advice
1. Draft comprehensive ASO planning (milestones and activities) and assign tasks and responsibilities (including core project management team).	All to be included as part of this phase. An Example ASO 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 focuses on communication to the viewers and other stakeholders in the DTTB value chain.
Objective	To help viewers prepare adequately, the whole broadcast community needs to address all viewers relying on the analogue terrestrial platform using targeted communication tools that can reach out to diverse population segments.

Key topics and choices	Status	Decision
2.18.1 Communication strategy: including communication messages (related to the communication stage) and target group (see phased model).	C	The establishment of a 'trusted brand' for labelling certified/approved receivers will be necessary.
2.18.2 Communication tools: the various communications means to reach the listed target groups.	C	The main tools are likely to be (a) radio and television (b) printed media (c) SMS coverage checker (d) social Papua New Guinea 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 subsection 3.4.3 and section 4.7 of this report.
2. Continuous alignment with ASO planning.	
3. Determine and establish compensation schemes and systems, to include in the communication plan.	

3.2 Customer proposition

Brief description	This section focuses on determining the competitive advantage and what the related service attributes might be. This phase 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.

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 Subsection 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 passing government.

Key topics and choices	Status	Decision
3.4.1 Business models for DTTB services: which model or combination of models is considered (may vary per multiplex).	C	All business models are under consideration for DTTB services: (a) FTA only, (b) pay-tv only and (c) any combinations.
3.4.2 What does the business case look like for the ASO plan?	C	The business case = ASO plan budget. Still to be drafted and decided.

Main activities	Observation/Advice
1. Assess market up-take and project revenue streams, based on customer research and proposition.	All to be carried out as part of this phase. For more considerations see subsection 3.4.3 and Section 4.4 and 4.8 of this report.
2. Assess and calculate associated costs for different ASO plans.	
3. Carry out sensitivity analysis, draft business case /ASO plan for scenarios. For example yes/no simulcast; indoor/outdoor (i.e. different quality levels) or yes/no pay-tv services.	

Main activities		Observation/Advice
4.	Quantify total investments and their associated risks, assess financing and public funding possibilities, consider co-operation, joint venture, vendor financing, and or revenue sharing.	
5.	Prepare approval of ASO budget by government (as part of the ASO plan).	

4.2 Design principles and network architecture

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

Main topics and choices		Status	Decision
4.2.1	Trade-off between network rollout speed, network costs and service quality,	C	
4.2.2	Main reception mode and defining receiving installations	C	In principle the objective is to plan DTTB services for rooftop reception. Indoor reception will be possible closer to the transmitter; see example in Annex 6.
4.2.3	Services for national, regional, or local coverage	C	Insertion of regional programs at a site requires a bit-stream inserter re-multiplexer at that site. Alternatively the regional programs could be transported to a central multiplex centre and the transport stream distributed to each site, where the appropriate Transport Stream will be selected and broadcasted (see also Section 4.2.3 of the ITU Guidelines). The use of a bit-stream processor is the more flexible way of providing this within a network.
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 limited terrestrial infrastructure for distribution and the fact that no other alternative are available to access many of the isolated transmitters, the only practical distribution means at this stage is satellite.

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. There also needs to be work on capacity building and review and overhaul as necessary to bring teaching syllabus of university and technical colleges up to date so that they can provide graduates with the essential basic skills.

<table>
<tr><th>Main activities</th><th>Observation/Advice</th></tr>
<tr><td>2. Determine rollout scheme for head-ends, transmitting stations and distribution links</td><td>Installation of head-ends, distributions links and transmitting stations should be in conformity with ASO planning (see Functional building block 2.16).</td></tr>
<tr><td>3. Define receiving installation for estimating coverage</td><td>At this point the receiving assumptions have not been specified. Observation suggests that consumers only use external antennas if indoor reception is not possible. Further many of the external antennas appear to be in a poor state of repair. It would be better to plan for external antennas, but some testing may be appropriate because the widespread use of metal roofing makes indoor reception problematic. Planning for indoor reception would impose a significant cost burden on broadcasters. Consumers will still have the option of using indoor antennas in high signal strength areas but where they currently have marginal reception an external antenna will be needed (giving substantial improvement in picture quality, particularly for digital services)
Unless specific data regarding noise figure, receiving antenna gain and receiving antenna height are required in the Papua New Guinea situation, the receiving installation as defined in Recommendation ITU-R BT.1368 , Annex 2, Section 5 could be adopted with regard to DVB-T; these characteristics are:
<table>
<tr><th>Characteristic</th><th>Band III</th><th>Band IV/V</th></tr>
<tr><td>Noise figure</td><td>5 dB</td><td>7 dB</td></tr>
<tr><td>Antenna gain minus feeder loss</td><td>2 dB</td><td>7dB</td></tr>
</table></td></tr>
<tr><td>4. Evaluation of network topology</td><td>Existing sites could be used as far as possible, also depending on the choice of licensing Model A or B. Preferably, on a site the digital channels should be close to the analogsue channels in order to be able to use the same transmitting and receiving antennas.
For use of existing antennas see also Functional Block 4.5.</td></tr>
<tr><td>5. Drafting multiplex composition plan</td><td>The bit rate of the multiplex should be lower than the bit rate of the DTTB variant set at the transmitters in order to avoid overflow.
Final estimation of the multiplex composition can only be made after Network planning has been considered (see Functional Block 4.3).
The initial multiplex composition for the head-end, should take into account the bit rate requirements established in Functional Block 4.1.
The use of statistical multiplexing is in principle advised, when more than two services of different kind of content are carried in the multiplex. However, implementing statistical multiplexing may impose some technical constraints - for example it would probably be necessary for the MPEG encoders and the multiplexer to be physically close to each other and controlled by the same computer.
In case of DVB-T, a network ID (one per country and operator) should be obtained at the DVB project office.</td></tr>
</table>

Main activities	Observation/Advice
6. Evaluation of the required operational availability time of transmission equipment	The operational equipment availability time is a trade-off between costs and acceptable off-air time due to failures. Broadcasters in Papua New Guinea will have their own experience with operation of transmission equipment under the environmental conditions of Papua New Guinea and will have specified the reserve conditions of the existing transmitter stations based on this experience. Solid state transmitters have a built-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. Evaluation of type of distribution network	Distribution by via a fixed satellite service or optical fibre is possible. The type of digital distribution link must be supported by the DTTB standard.
8. 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. Station layout may need review to accommodate additional transmitters. The number of transmitters per site will depend on the choice for licensing Model A or B. The power supply facilities and electrical features of the antenna need to be checked and if necessary adapted.

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 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	C	There is no apparent need for SFNs in DTTB planning in Papua New Guinea.
4.3.3 In-fill transmitters	C	Some additional in-fill transmitters may be needed to improve coverage in future.

Key topics and choices	Status	Decision
4.3.4 Feed back to business plan and service proposition	C	

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.
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: • The DVB-T standard (if so required); • Accurate terrain and clutter data; • Transmitter database of operational and planned stations (analogue and digital) including stations in neighbouring countries if there are potential transborder interference possibilities.
3. Gap-filler planning	Gap-fillers, also called in-fill 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 1, is likely to show areas where coverage can be improved by means of gap-fillers. In Papua New Guinea, off-air inputs have generally been eliminated by feeding all transmitters with microwave or satellite inputs. This is a better solution for a number of reasons and should be continued for the few additional transmitters that may be needed for DTTB.
4. 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. The multiplex capacity depends on the choice of licensing Model A or B. With regard to the radiation characteristics see also the considerations given in Section 4.9.3. 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

Key topics and choices	Status	Decision
4.4.1 FFT size	A	DTTB reception at high speed is not a requirement; therefore the 2k option in DVB-T/T2 does not need to be considered. Consequently the FTT size is 8k in case of DVB-T.
4.4.2 Carrier modulation and code rate Radiation characteristics, multiplex capacity coverage quality are interrelated.	B	The choice will mainly depend on the required multiplex capacity resulting from the adoption of licensing Model A or B (see also the considerations in Annex 6. Initially QPSK 1/2 and 64QAM 2/3 could be chosen in case of licensing Model A or B respectively.
4.4.3 Guard interval	A	As MFNs are envisaged, the lowest possible interval is sufficient: With DVB-T a guard interval of 28µs.

Main activities	Observation/Advice
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. Lower order modulation and lower code rates provide a more robust coverage at the cost of a restricted multiplex capacity. Coverage analysis and evaluating the net bit rate of the multiplex through the "service trade off" should verify the initial choice of QPSK 1/2 and 64QAM 2/3 in case of licensing Model A or B respectively.

4.5 Radiation characteristics

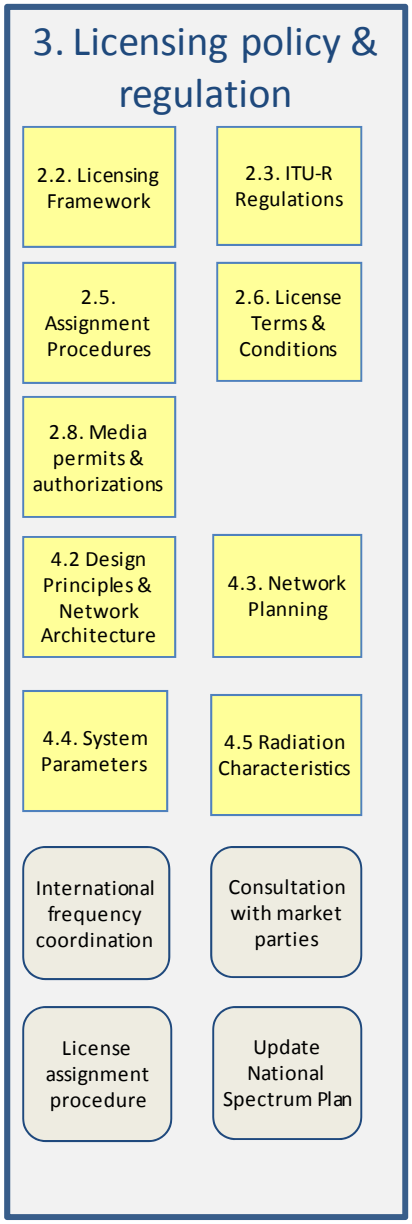
Brief description	Determination of transmitter power and transmitting antenna gain in order to achieve the required or allowed effective radiated power and configuration of the optimum antenna diagram and polarization.
Objective	Specification of transmitter power, antenna gain and antenna diagram as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

Key topics and choices	Status	Decision
4.5.1 Transmitter power and transmitting antenna gain	C	
4.5.2 Polarization	A	In order to minimize costs for the viewer as much as possible existing receiving antennas should be used.
4.5.3 Use of existing antennas or need for new antennas.	B	In order to achieve low cost operations as much as possible existing transmitting antennas should be used (subject to the DTTB frequency assignments and electrical features of the antenna). Site-by-site analysis will be needed to determine whether the existing (generally single channel antennas) can be replaced with wide-band types. This will impact on tower loadings and other factors that can only be decided after a full RF and structural assessment.

Main activities	Observation/Advice
1. Evaluation of transmitter power and antenna gain	The ERP of a transmitting station is determined by applying the "service trade-off". The initial choice of ERP could be guided by the values indicated in Section 4.9.3.The transmitter power is given by subtracting feeder and combiner losses from the ERP value. If the assigned digital frequency is not close to the frequencies in use, the antenna gain and the antenna pattern is probably not optimal. A new antenna could then be considered.
2. Calculation of antenna power budget	In case more than one transmitter has be to fed into the same antenna (see Functional Block 4.2 Design principles and network architecture), an antenna combiner is needed and the antenna power budget has to be calculated to ensure that allowed mean power and peak voltage of the antenna is not exceeded.

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

Licensing policy and regulation



Phase 3 of the roadmap is described in Section 3.4.4 of this report.

This Annex gives an overview in of the status of each of the selected functional blocks in Phase 1 using the following codes:

A	Decisions on key topic and choices that are already taken
B	Decisions on key topic and choices that are partly taken
C	Activities for which choices that have not yet been decided
D	Activities where earlier choices need revision
NA	Not applicable

The selected functional block number refers to the corresponding chapter in the ITU Guidelines. Refer to the ITU Guidelines for additional information.

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 Papua New Guinea the licensing framework concentrates on the selection of the appropriate model; either model A or B.
Objective	The objective of the licensing framework should be to actually implement the defined policy objectives for the introduction of DTTB, including the Analogue Switch-Off (ASO).

Key topics and choices	Status	Decision
2.2.1 A licensing framework for any television services comprises the assignment of three sets of rights (a) spectrum (b) broadcast and (c) local/building rights. For DTTB services has the model been decided?	C	
2.2.2 For the extra function of the multiplex operator in the value chain, two basic licensing models can be distinguished for DTTB; Model A or B. Has the basic model been decided?	C	For more considerations see Section 4.3 in this report.
2.2.3 Has the PBS services and spectrum rights been defined yet (and where) for the DTTB services?	C	Not decided yet. See also considerations in Functional Block 2.9.

Main activities	Observation/Advice
1. Make inventory of current spectrum and broadcast rights of licensed broadcasters.	To be carried out on the basis of the results of the Functional 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 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 4.3 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 licence assignment, framework changes and update National Spectrum Plan (and possibly legislation).	

2.3 ITU/R regulations

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

Key topics and choices	Status	Decision
2.3.1 The international context of the ITU-R regulations: Are the different entries in the GE06 plan considered (allotment/assignment)?	NA	A plan like the GE06 plan is not available for Region 3.

Key topics and choices	Status	Decision
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 Subsection 3.4.4 of this report).

Main activities	Observation/Advice
1. Carry out a detailed DTTB service planning.	For more details see Subsection 3.4.4 in this report.
2. Determine necessary terms and conditions for *planned* DTTB services and ASO plans.	For more details see Subsection 3.4.4 in this report.
3. Possibly redefine necessary changes to *assigned* frequency (and possibly content) licences for operational DTTB and Analogue TV services.	Whether this will be necessary depends on the results of this Functional Block in Phase 2 of the roadmap and the detailed DTTB service planning.

2.5 Assignment procedures

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

Key topics and choices	Status	Decision
2.5.1 Basic assigned instruments and procedures: What is the preferred assignment instrument (FCFS, auction or public tender) for broadcasting?	C	No legislation present arranging assignment instruments for spectrum and/or broadcast rights. The current situation is that all licences to the Papua New Guinea broadcasters and service providers were assigned on the basis of FCFS.
2.5.2 Assignment procedures for DTTB services: What is the selected assignment instrument (FCFS, auction or public tender) for DTTB services?	C	The NRT should make a difference between assigning licences to broadcasters (Model A) and multiplex/network operator (Model A). In case of Model A the NRT could apply a different instrument (for example public tender). In case of Model A, the NRT should be aware of the risk that introducing another assignment instrument (other than FCFS) may lead to claims of unfair competition. Mitigation may be needed.

Main activities		Observation/Advice
1.	Consult market (current broadcasters and potential bidders/applicants) on assignment methods and licence Terms and Conditions.	All to be carried out as part of this phase. Drafting of the licensing procedure and passing government should be aligned with the ASO planning. Licensing procedure should be 'future proof' in the sense that after ASO additional licences might be assigned.
2.	Evaluate results and select assignment method and procedures.	
3.	Draft detailed plans and planning for DTTB assignment procedure (for detailed steps see ITU Guidelines Appendix 2.5B).	
4.	Prepare approval of assignment procedures by government.	
5.	Publish assignment planning and procedures and update National Spectrum Plan (and possibly legislation).	

2.6 License terms and conditions

Brief description	The licence terms and conditions of the DTTB frequency or spectrum licences.
Objective	Assigning DTTB/MTV frequency rights is carried out in conjunction with assigning the other two types of rights as well. The objective is to have all rights covered, in the right balance, between the various licence types.

Key topics and choices		Status	Decision
2.6.1	Licensing and fair competition rules: Are the licence terms and conditions in line with the competition rules (transparent and non-discriminatory)?	NA (yet)	Competition Law for telecom/broadcast market still in development. Compliancy to be checked later/when appropriate.
2.6.2	Frequency licence terms and conditions: have all licence terms and conditions been determined and is the list of conditions complete (see list in this section)?	C	Depends on Model A or B. In case of Model A the licence conditions are likely to cover other terms and conditions (next to the spectrum usage rights). 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 licence terms and conditions check the ITU Guidelines. Depending on the licensing model selected, 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, NICTA 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	Dependent on Model A and B. If Model A is selected, NRT may continue with current system (although to avoid having different STBs has to be resolved).
2.8.2	Broadcast licensing requirements: have all licence terms and conditions been determined and is the list of conditions complete (see list in this paragraph)?	C	The NRT should considering the exiting digital broadcast rights in the market.

Main activities		Observation/Advice
1.	Check existing media legislation, DTTB policy and licensing framework (Model A/B).	All to be carried out as part of this phase of the roadmap. For more details check Subsection 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.	
4.	Publish policies for media permits and authorizations (may include waivers).	

4.2 Design principles and network architecture

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

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

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

- the initial frequency plan;
- 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 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	Prepare a 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 Block 4.2 in Phase 3).
4.3.2 SFN or MFN	C	
4.3.3 Fill-in transmitters	C	
4.3.4 Feed back to business plan and service proposition	C	

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

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

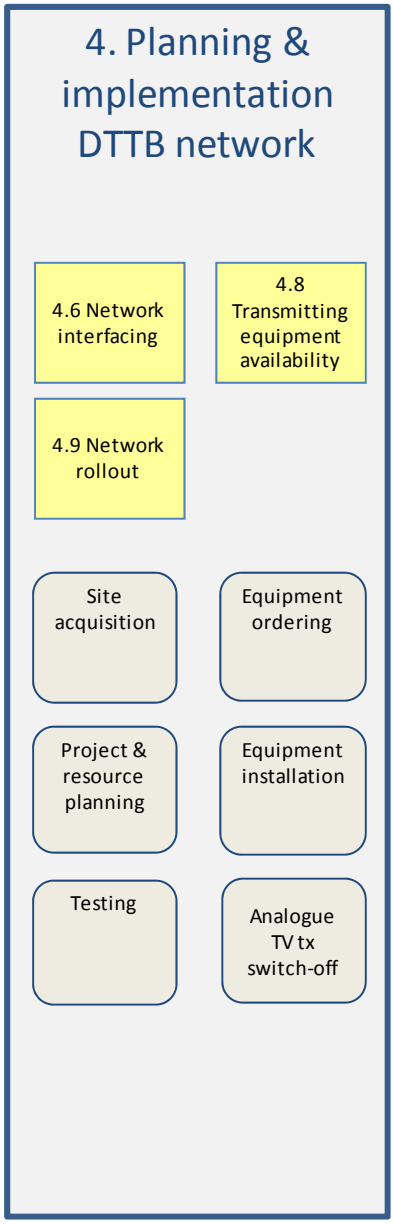
4.5 Radiation characteristics

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 Block 4.2 in Phase 3).
4.5.2 Polarization	C	
4.5.3 Use of existing antennas or need for new antennas	C	

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

DTTB implementation



Phase 4 of the roadmap is described in Section 3.4.5 of this report.

This Annex gives an overview in of the status of each of the selected functional blocks in Phase 1 using the following codes:

A	Decisions on key topic and choices that are already taken
B	Decisions on key topic and choices that are partly taken
C	Activities for which choices that have not yet been decided
D	Activities where earlier choices need revision
NA	Not applicable

The selected functional block number refers to the corresponding chapter in the ITU Guidelines. Refer to the ITU Guidelines for additional information.

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 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 Block 4.2 in Phase 3. The radio interface is best described using reception probability. This 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	
4.8.2 Technical specifications	B	

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

4.9 Network rollout and planning

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

Key topics and choices	Status	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 rollout plan are given by the ASO plan. The rollout 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: Information on DTTB standards

General

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

1. Recommendation ITU-R BT.1306, Error correction, data framing, modulation and emission methods for digital terrestrial television broadcasting[29];
2. Recommendation ITU-R BT.1877, Error-correction, data framing, modulation and emission methods for second generation of digital terrestrial television Broadcasting systems[30];
3. Recommendation ITU-R BT.1368, Planning criteria for digital terrestrial television services in the VHF/UHF bands[31].
4. Final Report on ITU R Question 11-2/2: Examination of terrestrial digital sound and television broadcasting technologies and systems, including cost/benefit analyses, interoperability of digital terrestrial systems with existing analogue networks, and methods of migration from analogue terrestrial techniques to digital techniques.

These Recommendations can be downloaded freely from the ITU website by using the indicated hyperlinks.[32]

These publications provide comprehensive information on each of the available standards for DTTB. Given the strong preference being expressed amongst Papua New Guinea broadcasters for adoption of the DVB-T standards some additional information on the DVB-T2 variant may be of further assistance.

DVB-T2 standard

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

The specification of the DVB-T2 standard can be downloaded freely[33]. More high-level information on DVB-T2 can be found in the DVB-T2 factsheets[34]. Compared to DVB-T, DVB-T2 can offer:

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

[29] See www.itu.int/rec/R-REC-BT.1306-6-201112-I/en

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

[31] See www.itu.int/rec/R-REC-BT.1368-9-201112-I/en

[32] See www.itu.int/dms_pub/itu-d/opb/stg/D-STG-SG02.11.2-2010-PDF-E.pdf

[33] See www.etsi.org/deliver/etsi_en/302700_302799/302755/01.01.01_60/en_302755v010101p.pdf

[34] See www.dvb.org/technology/fact_sheets/DVB-T2_Factsheet.pdf

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

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

Information on protection ratios of the DVB-T2 standard is included in the latest edition of Recommendation ITU-R BT.1368. Additional, detailed information on frequency and network planning is given in EBU Tech 3348 Frequency and Network Planning Aspects of DVB-T2, Geneva May 2011[35].

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

Annex 6: Coverage considerations

This Annex provides several examples of the coverage achieved by analogue and digital transmitting stations and indicates the ratio of the effective radiated power (ERP) of an analogue and digital transmitting station covering the same area. The examples shown are for much higher power levels than that needed in Papua New Guinea where the highest power transmitter is 2kW and the required coverage limits accordingly much shorter. Given the existing analogue coverage is well known, the digital power levels can be simply scaled back from the analogue power. In all probability, the minimum digital power levels will end up being higher than the nominal figure suggested by the analogue power, simply because the typical minimum digital transmitter power will result in some available overhead. This could assist with improving indoor reception and reception in marginal coverage areas because the digital signal will not be a susceptible to multipath interference.

These representative calculations are provided particularly as a general guide to the difficult question of indoor v outdoor antenna reception in planning. Examples are shown with rooftop reception, followed by considerations regarding indoor reception.

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[36]. 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	G-PAL	DVB-T: 64QAM, 16QAM, QPSK with code rate 2/3

In the example of analogue TV the minimum field strength values are taken from Recommendation ITU BT.417[37] and Annex 1 of that Recommendation with regard to the reception limit[38].

[36] 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).

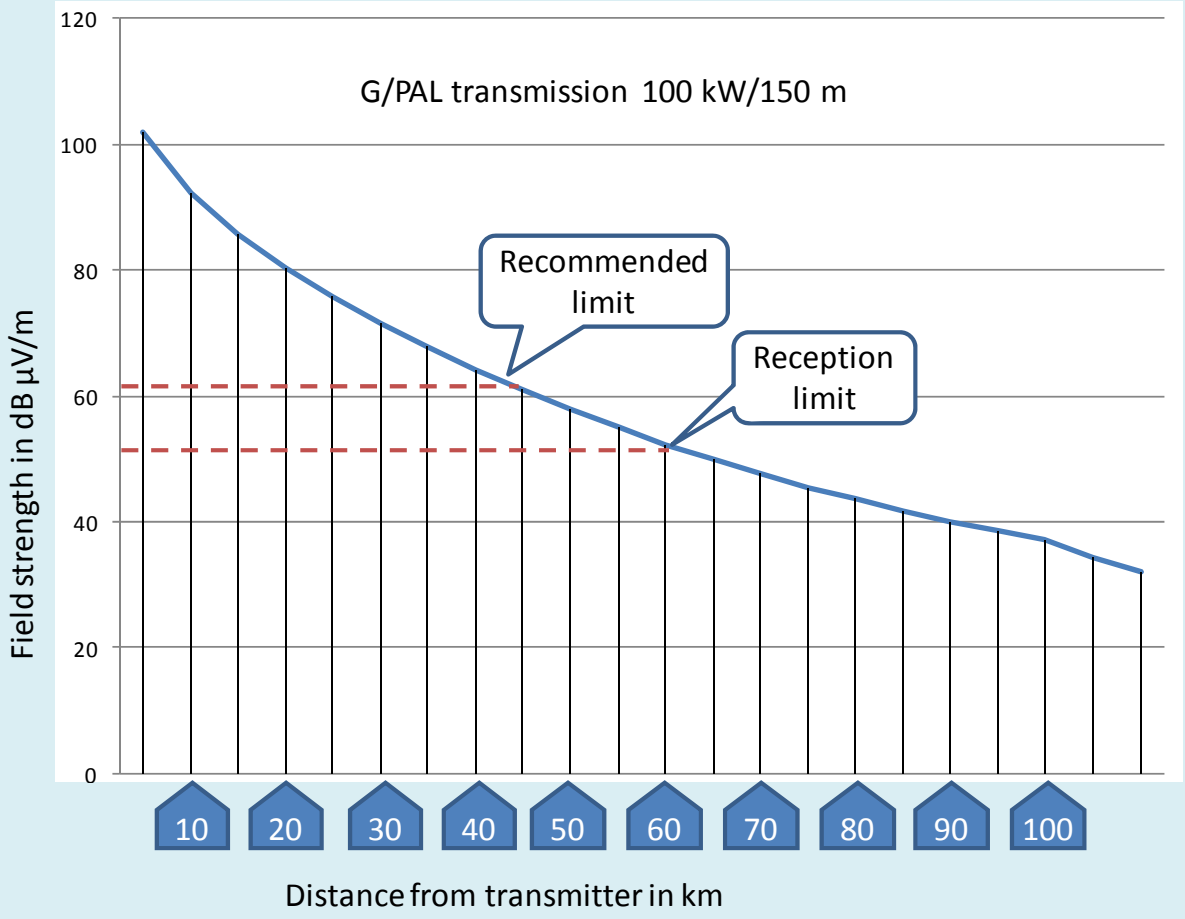
[37] See Recommendation ITU-R BT.417-5 Minimum field strengths for which protection may be sought in planning an analogue terrestrial television service.

[38] 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.

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):

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

Figure A6-1: Example of analogue TV coverage area



Source: ITU

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 DVB-T standard this choice can be made by selecting one out of three carrier modulations (64QAM, 16QAM and QPSK) and for each carrier modulation one out five code rates.

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

Because of the high required location probability and the fact that field strength predictions are normally made with a location probability of 50 per cent, the term "median minimum field strength" (Emed) is used for planning DTTB. Emed is the field strength value necessary to achieve the minimum field strength (Emin) at the required percentage of locations (normally 95 per cent). In Recommendation ITU-R BT.1368[39] the Emed values are not given, but can be derived from the minimum field strength values using the formulas given in Appendix 1 to Annex 2 of this recommendation. The Emed values for three selected system variants (carrier modulation and code rate) in Band IV are given in Table A6-2.

Table A6-2: Emed values in Band IV

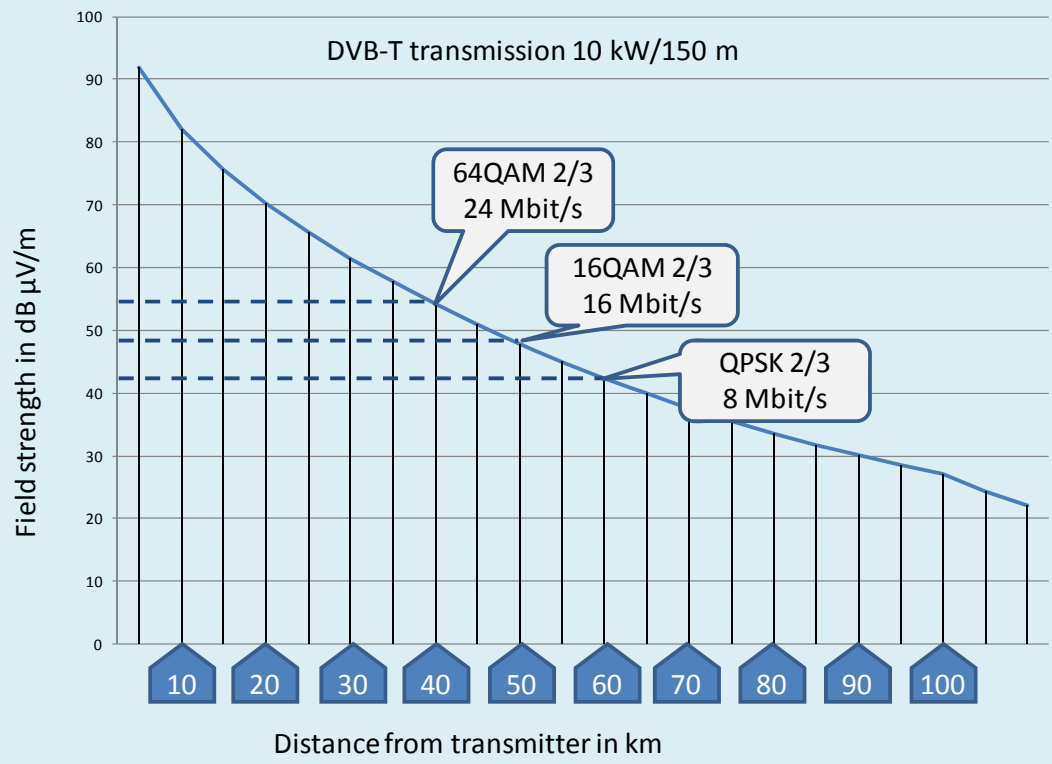
Factor for determining Emed for rooftop reception (DVB-T standard)	Carrier modulation and code rate		
	64QAM 2/3	16QAM 2/3	QPSK 2/3
Emin at 550 MHz	45 dBµV/m	39 dBµV/m	33 dBµV/m
Location correction factor (µ x c), for 95% location probability and a standard deviation of 5.5 dB: 1.64 x 5.5	9 dB	9dB	9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

In the digital TV example the multiplex capacity and coverage range (distance from the transmitter), in the absence of interference other than noise, is (see Figure A6-2):

1. 24 Mbit/s and about 40 km with 64QAM 2/3, according to recommended median minimum field strength (54 dBµV/m);
2. 16 Mbit/s and about 50 km with 16QAM 2/3, according to recommended median minimum field strength (48 dBµV/m);
3. 8 Mbit/s and about 60 km with QPSK 2/3, according to recommended median minimum field strength (42 dBµV/m).

[39] Recommendation ITU-R BT.1368-8 Planning criteria for digital terrestrial television services in the VHF/UHF bands. Annex 2 this recommendation deals with DVB-T.

Figure A6-2: Example of digital TV coverage area



Source: ITU

The power requirements of a digital transmitter compared to an analogue transmitter covering the same area, in the absence of interference other than noise, can be obtained by comparing the Emed values for digital TV and the Emin value for analogue TV. Table A6-3 shows this ratio for the three DVB-T variants used in the example above.

Table A6-3: ERP ratio of digital TV transmitting stations to replace an analogue coverage area

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

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

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

1. an analogue TV transmitter with combined video and audio amplification has been equipped with the required 7 or 8 MHz bandwidth filter and can easily be adjusted to digital transmission;

2. 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;
3. analogue TV transmitters with klystrons are not suitable for digital transmissions because of the non-linear characteristics of the klystron;
4. the mean power of a digital transmission from a converted analogue TV transmitter is about 1/5 to 1/3 of the analogue peak envelop power.

From a frequency planning point of view it is possible to convert an analogue transmission to digital without inverse impact on the compatibility situation if the ERP of the digital transmission is five times less than the analogue ERP[40].

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:

1. the lower receiving height;
2. the lower receiving antenna gain;
3. 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.

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

Portable outdoor reception is a balanced compromise for the type of receiving installation normally used in the Papua New Guinea situation, because:

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

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

As for rooftop reception, the median minimum field strength values (Emed) can be derived from Recommendation ITU-R BT.1368 by using the formulas given in Appendix 1 to Annex 2 of that recommendation. The Emed values for three selected system variants (carrier modulation and code rate) in Band IV are given in Table A6-4.

Table A6-4: Emed values for outdoor reception in Band IV

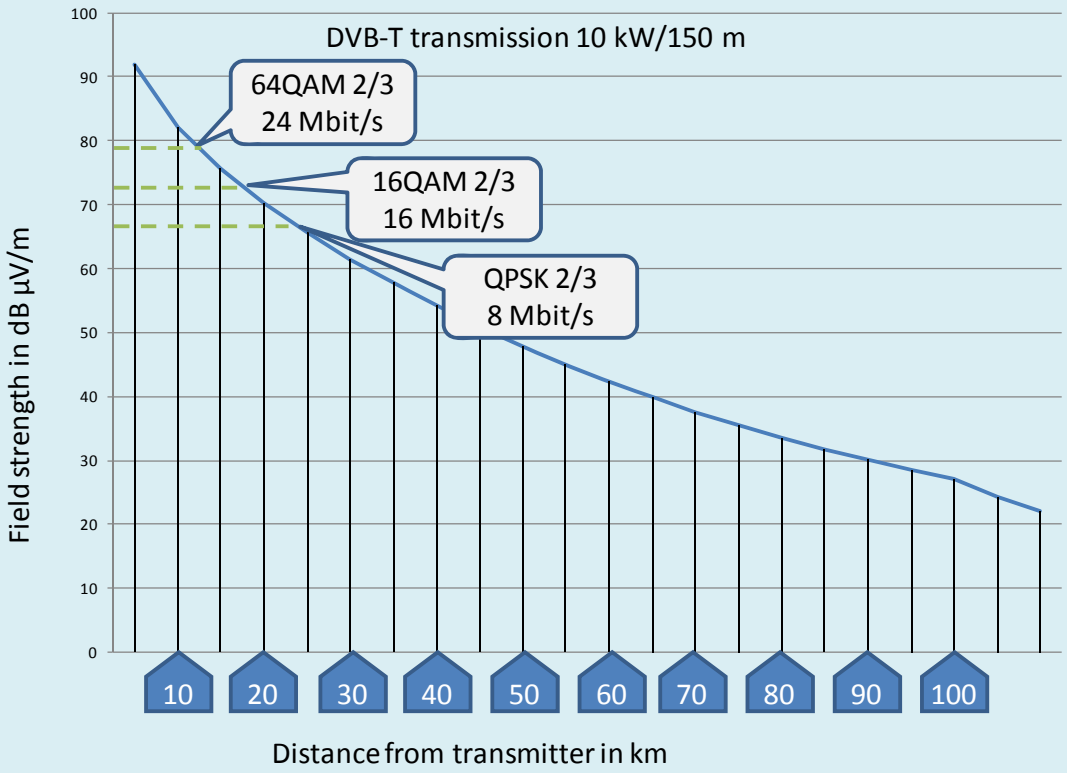
Factors for determining Emed for outdoor reception (DVB-T standard)	Carrier modulation and code rate		
	64QAM 2/3	16QAM 2/3	QPSK 2/3
Emin at 550 MHz	45 dBµV/m	39 dBµV/m	33 dBµV/m
Correction of Emin for reception in presence of multipath "Rayleigh channel", taken from Chapter 3 to Annex 2 of the GE06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

The multiplex capacity and coverage range (distance from the transmitter), in the absence of interference other than noise, of the digital transmitter example given in Table A6-1 is shown in Figure A6-3):

1. 24 Mbit/s and about 13 km with 64QAM 2/3, according to recommended median minimum field strength (77 dBµV/m);
2. 16 Mbit/s and about 18 km with 16QAM 2/3, according to recommended median minimum field strength (71 dBµV/m);
3. 8 Mbit/s and about 24 km with QPSK 2/3, according to recommended median minimum field strength (65 dBµV/m).

Reception areas using indoor antennas are much smaller than with rooftop reception.

Figure A6-3: Example of digital TV coverage area with portable reception



Source: ITU

Glossary of abbreviations

16-QAM	16-state Quadrature Amplitude Modulation
64-QAM	64-state Quadrature Amplitude Modulation
API	Application Programming Interface
APT	Asia-Pacific Telecommunity
ASEAN	Association of Southeast Asian Nations
ASO	Analogue switch-off
ATSC	Advanced Television Systems Committee
C/N	Carrier to Noise ratio
CA	Conditional Access
CAS	Conditional Access System
dB	decibel
DRM	Digital Rights Management
DSO	Digital switch over
DTH	Direct-to-home
DTMB	Digital Terrestrial Multimedia Broadcast
DTTB	Digital Terrestrial Television Broadcasting
DTV	Satellite TV provider in Papua New Guinea
DVB	Digital Video Broadcasting
DVB-T	Digital Video Broadcasting-Terrestrial
DVB-T2	Digital Video Broadcasting – Terrestrial 2nd generation
DVR	Digital Video Recorder
Emed	Median field strength
Emin	Minimum field strength
EM TV	Commercial Television Broadcaster in Papua New Guinea
EPG	Electronic Program Guide
ERP	Effective Radiated Power
FCFS	First come, first served
FFT	Fast Fourier Transform
FTA	Free-To-Air
GDP	Gross Domestic Product
GE06	Geneva Agreement 2006
HDTV	High Definition Television
ID	Identification
IDTV	Integrated Digital Television set
IMT	International Mobile Telecommunications
IP	Internet Protocol
IPTV	Internet Protocol Television
ISDB-T	Integrated Services Digital Broadcasting – Terrestrial

ITU-D	International Telecommunication Union – Development Sector
ITU-R	International Telecommunication Union – Radiocommunication Sector
LTE	Long Term Evolution, often marketed as 4G
MFN	Multi Frequency Network
MHP	Multimedia Home Platform
MIFR	Master International Frequency Register
MMDS	Multichannel Multipoint Distribution System
MCI	Ministry of Communications and Information in Papua New Guinea
MPEG	Moving Picture expert Group
MTV	Mobile Television
NA	Not applicable
NBC	National Broadcasting Corporation of Papua New Guinea (Government owned)
NICTA	National Information Communications and Technology Authority of Papua New Guinea
NRT	National roadmap Team
NSP	National Spectrum Plan
ONP	Open Network Provisioning
PAL	Phase Alternating Line; analogue colour TV system
PMO	Project Management Office
PSB	Public Service Broadcasting
QPSK	Quadrature Phase Shift Keying
RR	Radio Regulations
SDTV	Standard Definition Television
SFN	Single Frequency Network
SMS	Short Message Service
SSU	System Software Updates
STB	Set-Top-Box
T-DAB	Terrestrial – Digital Audio Broadcasting
T-DMB	Terrestrial – Digital Multimedia Broadcasting
TVHH	Television households
UHF	Ultra High Frequencies (frequency range between 300 and 3000 MHz)
UPS	Uninterruptable Power Supply
VHF	Very High Frequencies (frequency range between 30 and 300 MHz)
WRC-07	World Radiocommunication Conference 2007
WRC-12	World Radiocommunication Conference 2012
WTDC -10	World Telecommunication Development Conference 2010

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