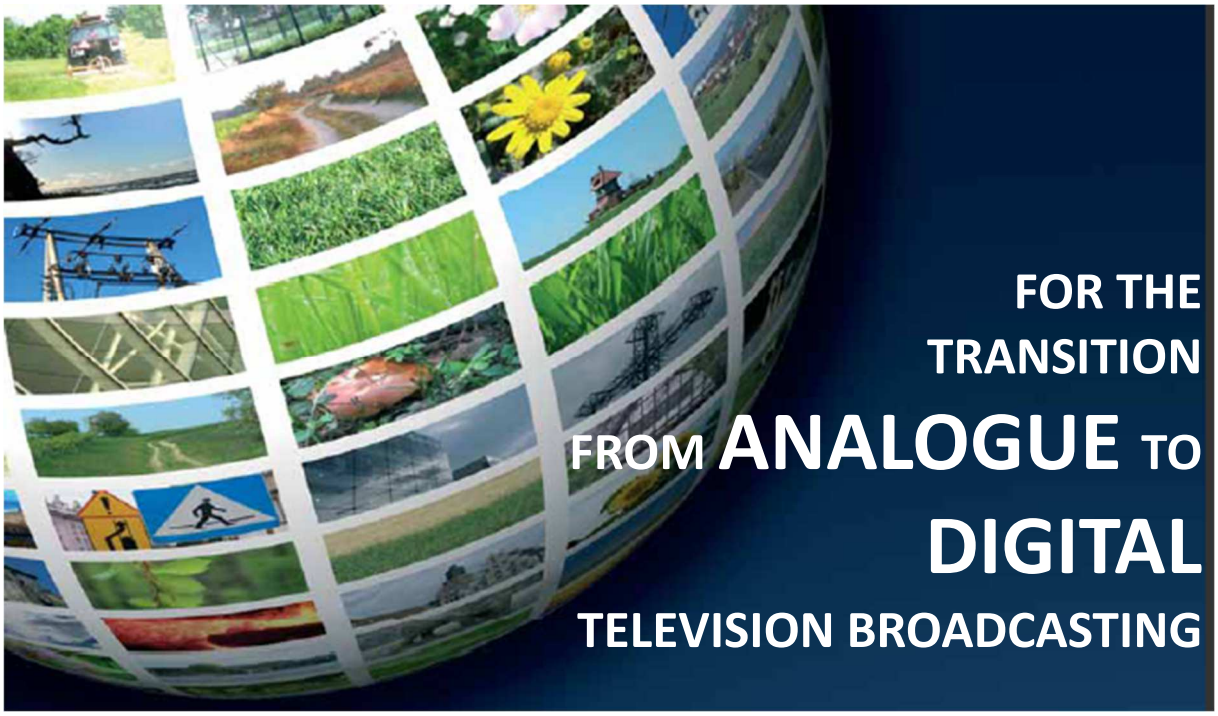
Jamaica Roadmap Report



June 2015

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This report has been prepared by International Telecommunication Union (ITU) expert Peter Walop. The report covers the results of a country visit in March 2015 to Jamaica. An analysis of the collected data was carried out in the period March to April 2015. After the first draft of the report comments were collected in May to June 2015. These comments have been incorporated in this final report.

ITU would like to express its gratitude for receiving support from the Development Bank of Latin America (Corporación Andina de Fomento- CAF) which made this Jamaica mission possible.

ITU would also like to express its appreciation for the contributions and support from the Office of the Prime Minister, Ministry of Information, Digital Switch-Over committee members, Broadcasting Commission, Spectrum Management Authority, members of the Association of Cable Providers, CVM and TVJ.

Content

1. Introduction

ITU has published Guidelines for the transition from analogue to digital broadcasting[1]. These Guidelines provide assistance to member countries to smoothly migrate from analogue to digital broadcasting.

In an effort to help countries to switch over to digital broadcasting, and with support of the Development Bank of Latin America (Corporación Andina de Fomento- CAF), ITU has selected Jamaica for further assistance in migrating to digital broadcasting.

This Roadmap report aims to provide this further support for the transition from analogue to digital terrestrial television broadcasting (DTTB) in Jamaica. It has been jointly developed by a team comprising Istvan Bozsoki (ITU-D, Geneva Office), Peter Walop (ITU expert), DSO committee members, Broadcasting Commission (BC), Spectrum Management Authority (SMA), Association of Cable Providers members, CVM and TVJ.

From 23rd to 27th of March 2015, Istvan Bozsoki and Peter Walop visited Jamaica for conducting a workshop on the digital migration, collecting data, exchanging ideas and proposing migration steps. In the month April 2015 this Roadmap report was drafted, with support from ITU-D and ITU-R.

This report is structured as follows:

1. This Introduction;
2. Current TV market and objectives;
3. National roadmap;
4. Top-6 most critical topics;
5. Recommendations;
6. Glossary of Abbreviations.

The report has the following Annexes:

1. Annex 1: Checklist;
2. Annex 2: Service trade-off and network planning;
3. Annex 3: More details on Reference Offers;
4. Annex 4: DTTB network cost drivers;
5. Annex 5: Example tracker board.

[1] See www.itu.int, latest edition of January 2014 : http://www.itu.int/en/ITU-D/Spectrum-Broadcasting/Documents/Guidelines%20final.pdf

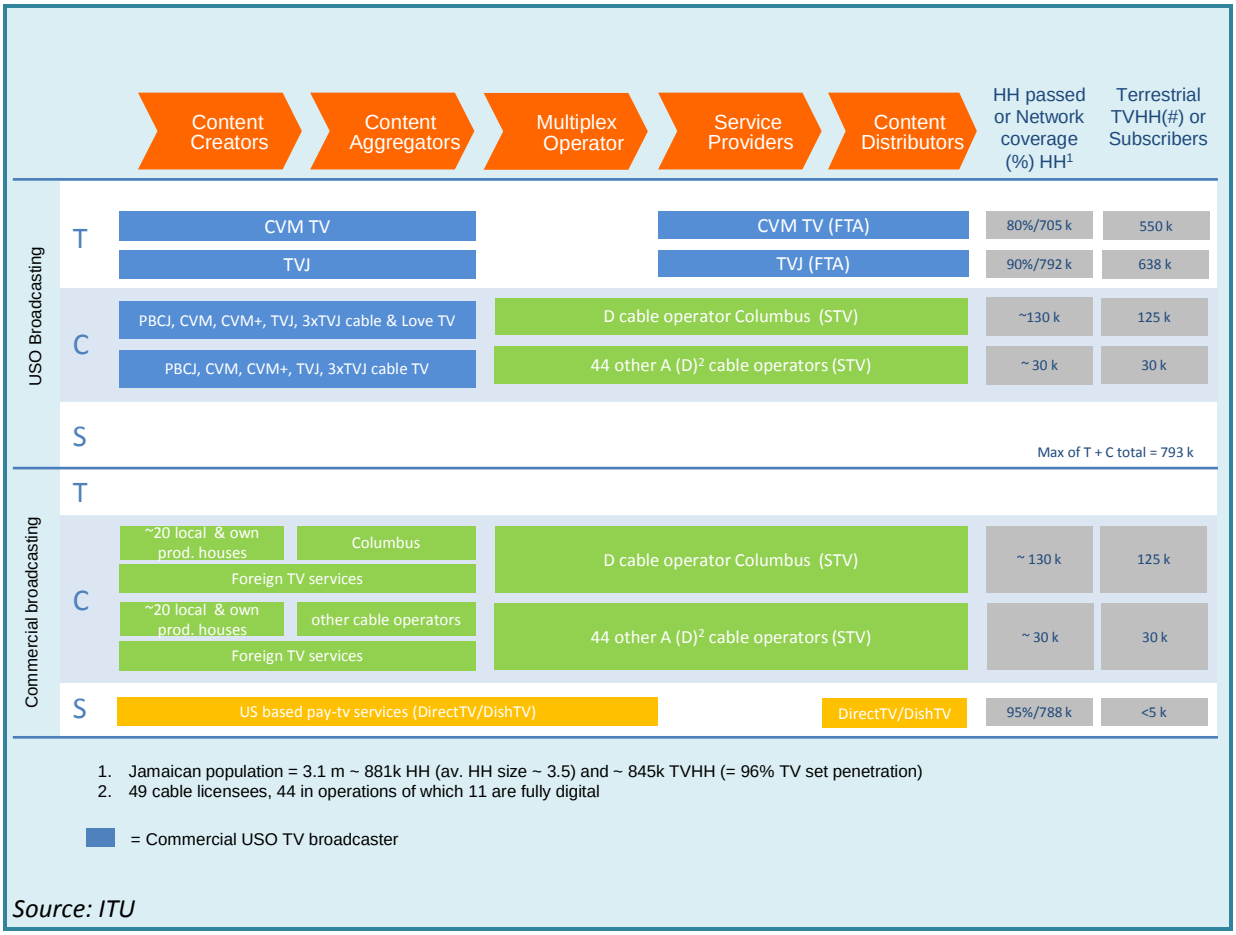
2. Current TV market and objectives

A profound understanding of the current Jamaican television market and the policy objectives are needed for the development of an effective Roadmap for the migration to Digital Terrestrial Television Broadcasting (DTTB). This Chapter covers an analysis of the current TV market structure, analogue TV networks and regulatory framework, described in Section 2.1 to Section 2.3 respectively.

The Digital Switch-Over (DSO) and Analogue Switch-Off (ASO) policy objectives, are described in Section 2.4.

2.1 Market structure

The market structure of the television market in Jamaica is depicted in Figure 1[2].



Source: ITU

FIGURE 1: MARKET STRUCTURE OF THE TELEVISION MARKET IN JAMAICA

From Figure 1 the following can be observed:

1. The Jamaican television market comprises 881k households (HH) and with a TV set penetration of 96% the number of television households (TVHH) amounts to approximately

[2] The market structure is based on the value chain as described in the ITU Guidelines, January 2014, see pp5-6.

845k[3]. This is a relatively small television market when compared to the DSO/ASO costs (see also Section 4.4.1);

2. The analogue terrestrial television (ATV) platform is by far the largest platform for Jamaicans to watch television. As there are two independently operating ATV providers their reach is assessed to be respectively 550k and 638k TVHHs (for CVM and TVJ)[4]. This compares to the second largest platform, being cable, serving 155k TVHHs[5];
3. Pay-tv Direct-to-Home (DTH), i.e. over satellite, is offered in the Jamaican market. However as can be seen from Figure 1, these DTH offerings are from US based providers (Direct TV and Dish Network) which are not intended for the Jamaican market. Consequently there is no service provisioning (e.g. retail outlets and customer support) for these services in Jamaica[6]. Also these pay-tv revenues (and taxes) are not contributing to Jamaican economic growth. They are considered to be illegal as they do not hold any license. As there are no official figures available their market share was assessed and found to be small (below 5k TVHHs);
4. The pay-tv cable services are offered by a large group of cable service providers of approximately 45 providers. Of the in total 155k cable subscribers, 125k are subscribed to the Flow services of Columbus Communications (in Figure 1 separately depicted)[7]. Consequently the remaining 44 cable providers have to split a remaining market of 30k TVHHs, resulting in an average customer base of below 1000 subscribers. The remaining market of 30k may be underestimated as the total number of TVHHs is approximately 845k and the total number of cable and ATV-served TVHHs is 793k. Even assuming that the difference of 52k TVHHs (845k-793k) would all be served by these smaller cable operators, the average customer base would be just above 1800 subscribers, still small[8];
5. On the ATV platform two incumbent broadcasters (CVM and TVJ) are currently broadcasting each a single television service (on a 24/7 basis). Both broadcasters span the whole value chain, i.e. they are vertically integrated and carry out the service provisioning (content

[3] The Media Association of Jamaica commented that recent market research showed that the average number of television sets per TVHH is 1.7 sets. Given the total of 845k TVHHs, this results in a total number of television sets of 1,437k in Jamaica. The average of 1.7 set per TVHH is important to consider when offering financial aid per affected TVHH (see also Section 2.4).

[4] It is recommended that the network coverage of these two ATV networks are calculated with planning software as to have an accurate understanding of the coverage areas and the TVHHs served (see also Section 2.2).

[5] See "An analysis of the Jamaican STV sector", October 2014, revised November 2014, p11.

[6] Also the coverage/footprint of these foreign based DTH providers is not guaranteed to be available in Jamaica. For reducing their content right and license fee payments, these foreign based DTH providers may adjust or reduce their coverage (to be limited to the USA only).

[7] Columbus Communications operates a digital cable network and hence it is assumed that the registration of subscribers is accurate (due to the application of a Conditional Access System in combination with a Subscriber Management System).

[8] The average number of subscribers per cable company may be larger if the ATV coverage assessments are too optimistic and hence the number of ATV viewers smaller. However no more accurate figures are available, see footnote 4.

production) and network provisioning (content distribution). A third broadcaster (Love TV) holds a license for the ATV platform but stopped operating (its two to three ATV sites which were shared with TVJ);

6. The two broadcasters CVM and TVJ also produce services for cable-only distribution:
    a. CVM+ (sports and entertainment) on the basis of 24/7;
    b. TVJ Sports, RE (entertainment) and JNN (news), all on the basis of 24/7;
7. Next to CVM and TVJ, two other Jamaican broadcasters are distributing their television services over cable; Love TV and Public Broadcasting Cooperation Jamaica (PBCJ). The reason that PBCJ is distributing over cable only is that the initial Public Broadcast Service (PBS) was sold to the market (to RJR Communications Group, owner of TVJ). At a later date PBCJ was established and a must-carry and free-carriage obligation was applicable for the cable operators in Jamaica;
8. The television services as produced by CVM, TVJ, Love TV and PBCJ (in total eight services) are considered Universal Services (see the blue colour in Figure 1). CVM, TVJ and Love TV are operating as a commercial broadcaster with a Universal Service Obligation (USO)[9]. Such services are considered as 'must-have' services for the Jamaican television viewers (see also Section 2.4);
9. Cable operators produce their own television services by sourcing content from the approximately 20 Jamaican production houses and rebroadcasting foreign television services. These cable-company produced and rebroadcasted television services are not considered as Universal Services.

As indicated above approximately 550k TVHHs watch two television services by means of analogue terrestrial television broadcasting. Assuming that the smallest network coverage (of CVM) falls completely with the coverage area of the largest network (of TVJ), there are 88k TVHHs (= 638k - 550k) with only one television service (which is more than 10% of the total market, 845k TVHHs).

The largest cable operator (Columbus Communications) offers several digital packages in SD and HD quality. The basic package ("Flow Watch Starter") comprises of 66 (radio & SD TV) services, including the eight incumbent TV services (as listed above under item 8), and costs approximately 1,100 JMD (~ 10 USD). The basic HD package, including approximately 75 (radio and TV) services, of which 7 TV services are in HD quality, retails at approximately 1,575 JMD (~ 13.5 USD). Installation fees apply and are charged as a one-time fee of 2,325 JMD (~ 20 USD).

As included in Figure 1, of the 44 smaller cable companies the majority (44 – 11) operates analogue cable systems. Analogue cable systems do not necessarily require a STB, unless premium service are offered with a converter box, and hence installation fees or STB costs can be avoided. However the analogue monthly charges do not seem to be lower than Flow's basic packages[10]. Therefore the Flow

[9] See also ITU Guidelines, January 2014, section 2.9.1. In addition more details on this USO concept can be found in the ICT Regulations Toolkit from infoDev and ITU, see www.ictregulationtoolkit.org

[10] For example Telstar Cable Limited charges 3,145 JMD/month and Combined Communications offers a package for 1,800 JMD for the first month.

basic offering is considered as the minimum price for a cable package in the Jamaican television market.

The foreign DTH packages are priced significantly higher. For example DirectTV offers their cheapest package for 30 USD/month for the first 12 months (on 2-years contract basis) and with a regular price of 50 USD/month. This minimum package comprises 130+ (radio and TV) services with over 60 HD television services. It should be noted that these foreign DTH packages do not include the eight incumbent television services (as listed above under item 8). The absence of these incumbent services, their high price and the lack of service provisioning on Jamaica explains the low DTH subscriber numbers.

2.2 Analogue TV networks

Currently CVM and TVJ operate two analogue TV networks (for two television services) in VHF Band I and III using the NTSC system in a 6 MHz frequency raster. The CVM network consists of 18 sites whereas the TVJ network comprises 14 sites. Table 1 shows an overview of the applied Effective Radiated Powers (ERP) in both networks[11].

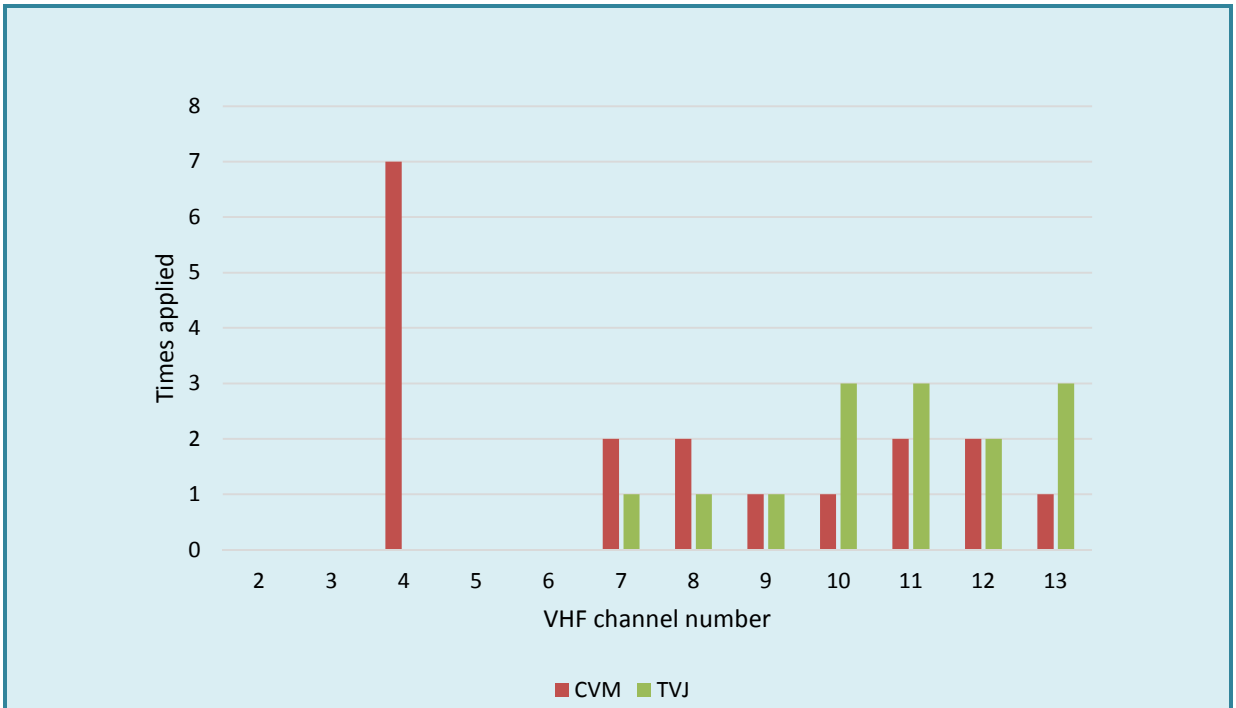
Network operator	<100 W	>100 - 500 W	>500-1000 W	>1-2 kW	>2-5 kW	>5-10 kW	>10 kW	Total network ERP
CVM	1	5		6	2	1	3	63 kW
TVJ			6	1	3	1	3	91 kW

TABLE 1: APPLIED ERPS IN CVM AND TVJ NETWORKS

As can be observed from Table 1, the TVJ network incorporates higher ERPs and the total network ERP is higher than the ERPs applied in the CVM network. At most stations directional transmitting antennas are used and they are mainly fed by microwave links, in both networks. Figure 2 shows the VHF frequency use of both networks. It shows the number of times a television channel number (i.e. frequency) is used. It should be noted that television channel numbers 2 to 6 are frequencies in the VHF Band I (running from 54 to 88 MHz), whereas channel numbers 7 to 13 are frequencies in the VHF Band III (running from 174 MHz to 216 MHz)[12].

[11] Source: Spectrum Management Authority of Jamaica.

[12] The Jamaican Table of Frequency Allocation has in VHF Band I the frequency ranges 54 to 72 MHz and 76 to 88 MHz allocated to BROADCASTING and in Band III the range 174 to 216 MHz is allocated to BROADCASTING.



Source: SMA

FIGURE 2: FREQUENCY USE OF CVM AND TVJ NETWORKS

Figure 2 shows that CVM is using VHF Band I frequencies (seven times channel number 4)[13]. The wavelength difference between Band I and III is so large, that different sized receiving antennas are used for Band I and III reception. In practice this implies that TVHHs in the coverage areas of the Band I transmitter sites will have to use two type of antennas if they would also like to receive the TVJ service in Band III.

It was understood that many TVHH's do not use rooftop antennas and use either 'rabbit ears' (an indoor antenna mounted on top of the TV set) or self-made antennas (referred to as 'coat hanger' antennas). Under such receiving conditions it is actually difficult to predict what the actual coverage areas are of both networks and how many services (one or two) are receivable in each area[14].

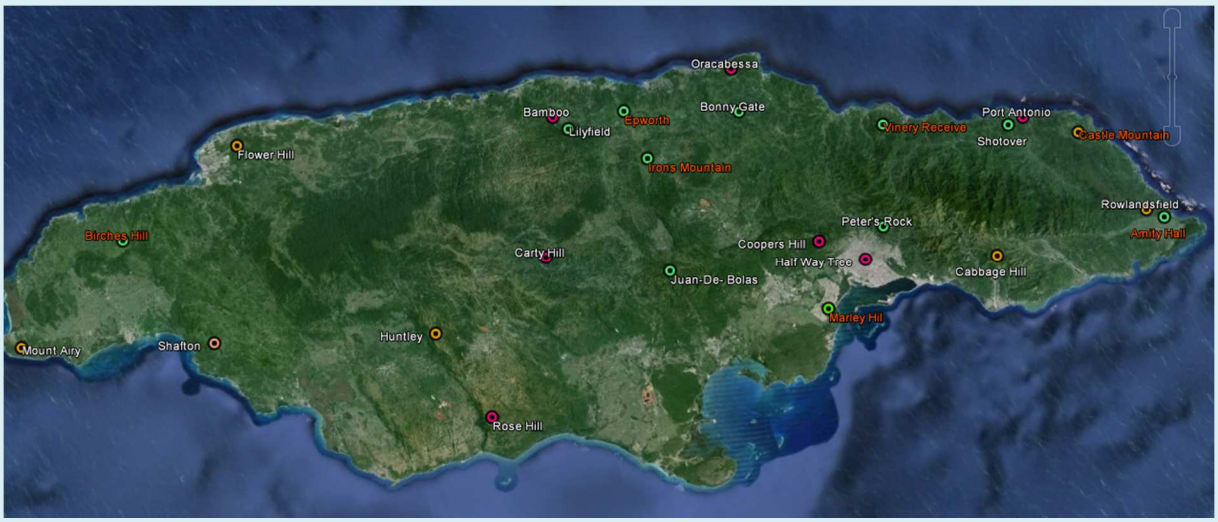
Figure 3 shows a map of Jamaica and the location of the transmitter stations. The following notations are used:

1. Red markers: CVM transmitter location;
2. Green markers: TVJ transmitter location;

[13] These seven transmitters sites have lower powers 30 W (one), 500 W (five), except for one (Marley Hill) 6 kW, see also Table 1. However Band I frequencies propagate better and hence larger coverage areas.

[14] In network planning software the receiving conditions are usually modelled according to ITU recommendations and a single standard antenna is assumed with a defined antenna gain and front to back ratio. In Jamaica a mix is applied of standard receiving antennas, rabbit ears and self-made antennas.

3. Orange marker: CVM and TVJ shared transmitter location[15];
4. Marker label in red: (CVM) transmission in Band I (channel 4);
5. Marker label in white: transmission in Band III (channels 7 to 13).



Source: SMA, Google Earth

FIGURE 3: LOCATION OF ATV SITES IN JAMAICA

From Figure 3 the following can be observed and concluded:

1. Seven locations are shared between CVM and TVJ. Consequently CVM and TVJ broadcast from respectively 11 and 7 unique locations. Without frequency planning work it is difficult to assess if their network coverages are similar, especially considering that CVM's Band I transmitters are deployed across the country;
2. The coverage areas of the Birches Hill location (CVM, channel 4) may have overlapping coverage from the shared locations Mount Airy, Shafton and Flower Hill. This could result in areas where the CVM service can be received twice (in Band I and III), as well as the TVJ service in Band III. This may happen in other coverage areas as well. Reversely without the overlap (from other stations) in the coverage areas of the Birches Hill transmitter, CVM's network would have a different coverage area and only one service can be received in these Birches Hill coverage areas (and hence CVM and TVJ coverage areas may not overlap greatly);
3. One transmitter location (Castle Mountain), shared between CVM and TVJ, facilitates CVM broadcasts in Band I and TVJ broadcasts in Band III. Assuming that these broadcasts intend to cover the same areas, the TVHHs in these areas would ideally use different rooftop antennas

[15] A shared location does not necessarily mean that tower (and antenna) facilities are shared. It was understood that towers are not shared. However at the given coordinates it was difficult to identify two towers in most locations (using Google Earth). Also some locations appear to be in the middle of fields or valleys without any access road, tower structure or urban clutter. The given coordinates may be first estimates.

for receiving both services. The same receiving conditions could apply in other areas of the country as well (e.g. areas around Marley Hill and Epworth).

Network planning work is required to get a better understanding of the different reception conditions and areas in the country[16]. Such a network planning exercise will help in:

1. Setting the DTTB coverage target as a simulcasting requirement (see also Section 2.4) would require that the DTTB coverage matches the ATV coverage areas;
2. Identifying the different television offers in the market as the ATV offering is not uniform (i.e. 2 services in the same VHF Band) across the market. Consequently this would help defining the competitive edge of the DTTB platform more accurately;
3. Informing people about the benefits of DTTB and why they should migrate to digital (as part of the DSO/ASO communications);
4. Instructing (also as part of the DSO/ASO communications) TVHHs what to do as it provides insight into which TVHHs are affected when switching off transmitter sites and in what way (which services they are going to stop receiving).

2.3 Regulatory framework

As described in the ITU Guidelines a licensing framework for any television service comprises the assignment of three sets of rights (and obligations). These three types of rights apply to analogue and digital television services. However the distribution of those rights over the various market players might be different for digital platforms. The following types of rights can be distinguished:

1. Spectrum rights: the right to have access and use a defined part of the radio spectrum in a designated geographical area for a specified time period;
2. Broadcast rights: the right or permission to broadcast television services on a defined broadcast platform in a designated geographical area and for a specified time period, very often both at a programme level (for specific programs or services – often referred to as media/broadcast permit or authorization) and a platform level (i.e. for a bouquet of channels and services – often referred to as a broadcast licence);
3. Operating rights: the right to install and operate a broadcasting infrastructure in a defined geographical area for a specified time period, including regulations as to safeguard technical, environmental and health conditions.

As Figure 1 shows, two type of providers are legally operating on the Jamaican television market:

1. Cable providers (49 are licensed of which 44 are in operations), and;
2. ATV providers (3 are licensed and 2 are in operations).

[16] This network planning exercise should incorporate interference from (a) analogue to analogue (i.e. CVM and TVJ operate the same ATV channels, see Figure 2, and this could cause unacceptable interference and hence reduce the coverage) and (b) foreign stations (either analogue or digital). For more details see Section 4.5.

The cable providers are licensed by the Broadcasting Commission of Jamaica (BC). The Broadcasting and Radio Re-Diffusion Act defines for commercial television broadcasting two license types island-wide and limited area. The Jamaican cable operators are mostly assigned a limited area license.

The television broadcast license holds *operating* and *broadcasting* rights. The *operating* rights (and obligations) are defined in the Television and Sound Broadcasting Regulations (1996) which include:

1. With reference to the Radio and Telegraph Control Act, aspects such as apparatus approval and avoidance of harmful interference;
2. Aspects such as financial viability, proper accounting and financial reporting requirements;
3. Aspects such as operating the technical facilities with proper qualified personnel, reporting and (cable) equipment installation regulations;
4. With reference to the Second Schedule of the Regulations, aspects such as the technical standards to be applied (e.g. NTSC, 6.0 MHz per channel, visual carrier frequency, minimum signal levels, interference levels, etc.).

The *broadcasting* rights are also defined in the Television and Sound Broadcasting Regulations (1996) which include aspects such as duties in relationship to type, minutes of advertising, political and national emergency broadcasts. In addition the BC has also published programming Directives and Codes, including;

1. Children's Code of Programming;
2. Directive on the Transmission of Sexually Explicit Content;
3. Directive on Transmission of Soca/Calypso Content;
4. Directive on Transmission of Violent Content.

Next to the Broadcast license (as assigned by BC) ATV providers will need to acquire a license for the use of spectrum. As stipulated in the Telecommunications Act (2012), the Spectrum Management Authority (SMA), on behalf of the Minister, assigns this "Spectrum License" (Section 23) and recommends the Minister on the assignment procedure[17]. In addition the SMA recommends the Minister on the preparation of a national plan for the allocation of the spectrum (Section 22) – i.e. the Jamaica Table of Frequency Allocation (see also footnote 12).

The above described regulatory framework seems to suffice for the current situation. It is advised however to review the regulatory framework for its adequacy for assigning the broadcast, operating and spectrum rights for the DTTB services. For example, the technical requirements as included in Television and Sound Broadcasting Regulations (1996), Second Schedule, only cover NTSC (an analogue standard). Also the regulations on the avoidance of harmful interference, as included in the Radio and Telegraph Control Act, seems to be outdated.

[17] It should be noted that the spectrum rights in the Spectrum License cannot be transferred to other individuals or organisations without the approval of the Minister with the responsibility for Telecommunications.

2.4 DSO and ASO objectives

The Digital Switch-Over (DSO) and Analogue Switch-Off (ASO) objectives were defined during the country visit with members of the DSO committee, representatives of BC, SMA, CVM, TVJ and the Association of Cable Providers. Table 2 shows an overview of these objectives, with the third column spanning the period before ASO and the fourth column the period after ASO.

No	Objective	2018 - 2019	> 2019
1	Smooth transition from analogue to digital	• All analogue TV services areas (2 terrestrial incumbents) covered with DTTB FX first (=14 sites) • Simulcasting in all areas of 12 months • DTTB in the UHF Band • At start of 2018 first DTTB transmitters on air for covering 3 urban areas (Phase 1)[18], rest of the country completed before end of 2018 (Phase 2)	
2	End of analogue transmission	• Phased switch-off (2 Phases) • A set ASO date at start and end of 2019 (Phase 1 and 2), unless digital receiver uptake is below 80% (of TVHH)[19]	
3	New entrants/services	• 2 MUX carrying approx. 25 SD services[20] of which (4+4) are 'must carry' FTA services (i.e. 2 terrestrial services + Love TV + PBCJ + 4 incumbent cable services) • The remaining capacity (~17 services) is for pay-tv services, offered by a single SP	• For the next 3 MUX, capacity will be reserved for (4+4) services to migrate to HD service • Rest of capacity is for the incumbent pay-tv SP • 1 MUX for MTV (in either VHF or UHF) • Capacity reserve needed for introduction of 2nd gen. ATSC (3.0) standard • Migration to HD may depend on intro of ATSC 3.0
4	Extended population coverage	• Matching current analogue coverage areas (see also objective 1)	• Near national coverage, being 95% and 90% pop coverage in resp. urban and rural areas
5	Better picture quality	• Picture ratio (4:3) • SD services	• Picture ratio (16:9) • HD services

[18] Urban areas are the Kingston metropolitan area (including St. Andrew and parts of St. Catherine), Montego Bay and Mandeville areas.

[19] Includes IDTVs and STBs.

[20] Based on ITU-R BT.1306-6, ATCS in 6 MHz raster, highest capacity 19.39 Mbit/s and required capacity per SD service ~ 2 Mbit/s (=video 1.75 + 0.096 audio + 0.15 Mbit/s) and applying statistical multiplexing, ~ 12 service can be carried in a single multiplex.

No	Objective	2018 - 2019	> 2019
6	Compensation for viewers	• Minimize viewer migration costs by financial aid for STB & RX antenna – financed from pay-tv revenues and public resources • For terrestrial dependent and eligible TVHHs[21] only	
7	Compensation for analogue broadcasters	• Incumbents terrestrial broadcasters (2) will not be compensated for its ATV OPEX during simulcast	
8	Digital Dividend	• No decisions (yet) – as for now follow ITU-RR	

TABLE 2: DSO AND ASO OBJECTIVES

The following explanation can be provided for the defined DSO and ASO objectives as included in Table 2:

1. As a relatively large proportion (~75%) of the Jamaican TVHHs are dependent on the ATV network (634k out of the 845k, see Figure 1), a simulcast period of at least 12 months is provided in all ATV service areas. During simulcast the same ATV services (CVM and TVJ) are also broadcasted on the DTTB network. In this way each ATV dependent TVHH has 12 months to migrate to DTTB;
2. As it is assumed (for the time being as network planning is need – see Section 2.2) that the CVM network coverage falls completely within the TVJ coverage, the number of DTTB sites could be limited to 14 locations (see Section Annex 2: Service trade-off and network planning)[22]. Without a complete overlap and assuming that also TVHHs with only one ATV service needs to be provided with simulcasting, the number of required DTTB sites is likely to be higher;
3. DTTB will be launched in the UHF band, although the current ATV network is operated in the VHF Band (I and) III. This decision is based on two key considerations (a) the limited number of VHF Band III rooftop receiving antennas that are installed and hence no or limited re-use of these antennas for DTTB and (b) the number of SD/HD services required in the long term, which cannot be facilitated in the relatively short VHF Band III (see also Section 4.5.1);
4. A two-phased ASO model has been selected as to limit the required operational capacity and ASO execution risks. The first DTTB transmitters are planned to be on air at the start of 2018, for covering three urban areas (Phase 1). The rest of the country (Phase 2) is planned to be completed before the end of 2018. Applying the simulcast period of 12 months would result in ASO date at the start (Phase 1) and end of 2019 (Phase 2);

[21] Eligible TVHHs defined as beneficiaries of the PATH program, TVHHs with predominantly elderly people and TVHHs headed by a person of 75 and over.

[22] This does not necessarily mean that only TVJ tower facilities are used. Not considering any business, industry political and operational aspects, network planning could indicate what the best locations and towers are.

5. The ASO date is a set date with the condition that the digital receiver uptake is at least 80% under the ATV dependent TVHHs. This digital receiver uptake includes any IDTV or STB. This will provide more comfort (as compared to an unconditioned ASO date, as adopted in many countries) for the incumbent ATV broadcasters that after ASO they will continue to reach a similar audience (as their reach is driving their advertising revenues[23]). It should be noted that this condition cannot be set at 100% as experience has shown that the majority of people will leave the purchasing of the digital receiver for the last two weeks and more so, after ASO. This conditioned ASO date does not imply that viewers not having switched to DTTB before the set ASO date will be denied access and not migrate to DTTB at all. Practice has shown that after ASO the remaining analogue TVHHs will switch over to DTTB quickly (by utilize their DTTB receiver voucher) or seek an alternative to DTTB. Setting such a condition will mean that the DTTB uptake should be monitored closely by carrying out surveys periodically. An example monitoring framework can be found in Annex 5: Example tracker board;
6. As financial means are limited in Jamaica, a model is pursued whereby industry and Government are working together to execute and finance the DSO/ASO process. In such a public-private partnership a bouquet of services is offered on the DTTB platform including eight FTA and ~ 17 pay-tv services. The revenues generated from the pay-tv services can help in financing the DTTB network and receiver subsidies. Building on this premises, a minimum number of FTA and pay-tv services should be offered to be competitive on the Jamaican market (see Section 2.1). Such a bouquet should be balanced against the investments needed (i.e. the number of sites and multiplexes). It was assessed that ~24/25 SD services will suffice for the launch proposition. Having adopted the ATSC standard (see Annex 1: Checklist) such a bouquet of services can be carried in two multiplexes (MUX);
7. These pay-tv DTTB services should be grouped together and offered by a single service provider (SP). An alternative scenario of having multiple SPs would result in duplication of costs (in running multiple subscriber management systems - SMS - and conditional access systems - CAS) as well as additional regulations and coordination efforts (to assure the same CAS in the market and sharing of service information to feed a common electronic programming guide – EPG);
8. In a next deployment stage (after 2019), the number of multiplexes can be extended with three, increasing the available DTTB capacity. Of this additional capacity, first capacity will be reserved for the eight incumbent services to convert from SD to HD[24]. The remaining capacity will be reserved for the single incumbent DTTB SP, providing an incentive (in the form of exclusivity) for this SP to enter the DTTB market;

[23] In this context, it should be noted that for their advertisers the reach is measured across all platforms, including cable distribution (and internet – Over-the-Top distribution).

[24] It should be noted that HD receivers normally can display HD services on an (old) SD television set (e.g. a CRT set). The HD receiver downgrades the HD service to the SD resolution and format. This requirement is important as the HD service doesn't have to be simulcasted with the incumbent SD service. Hence this receiver requirement should be stipulated in the receiver specifications.

9. The migration of SD services to HD may depend on the introduction and availability of ATSC 3.0 receivers[25]. Currently it is not known when the ATSC 3.0 standard will be finalized and receivers commercially available. This availability will depend on the adoption of this new standard in the USA and South Korea. The adoption of the ATSC 3.0 standard will require the replacement of any installed base of ATSC 1.0 receivers. In case ATSC 3.0 receivers would be commercially available by 2020 (i.e. > 2019), an HD offering (and an extended number of services) on the DTTB platform would provide an incentive for TVHHs to replace their ATSC 1.0 receiver for an ATSC 3.0 receiver. Under such a scenario it would be advisable to combine the changeover to HD and ATSC 3.0 in one process. It should be noted that the migration to ATSC 3.0 is likely to require a 'simulcast' of the ATSC 1.0 services, as ATSC 1.0 receivers will not be phased out overnight[26];
10. The capacity of one multiplex for Mobile Television (MTV) services is reserved for after 2019. MTV services are television services intended for reception on handheld devices and are delivered by a digital broadcast network[27]. Depending on the MTV standard, these systems can operate in the VHF Band III or UHF Band (or both). A decision on the frequency band and MTV standard should be made at that time (> 2019). At that time these decisions will depend, amongst other factors, on the available spectrum, demand for MTV and DTTB services, MTV receiver availability and availability of alternative distribution technologies. It should be noted that the reservation of MTV capacity equivalent to one multiplex does not necessarily exclude the option of having an in-band system[28];
11. An extension of the DTTB coverage area beyond the current ATV coverage area, is foreseen after ASO (i.e. > 2019). For the final stage of the network deployment the target is a near nationwide coverage, defined as being 95% of the population covered in the urban areas and 90% coverage in the rural areas;

[25] The ATSC 3.0 transmission standard is a next generation transmission standard which is currently under development. It is designed to provide a higher net transport capacity and work with the latest compression technologies, notably H.265/HEVC.

[26] It is noted that the Media Association of Jamaica has argued the case that the introduction of DTTB should be delayed until ATSC 3.0 receivers will be available. As low receiver costs are critical it should be assumed that this introduction date will then be dependent on when relatively cheap ATSC 3.0 receivers will be commercially available. This date is unknown and may not happen if volumes remain low. Not opting for ATSC 1.0 but for ATSC 3.0 is actually a revision of the selected transmission standard. If such a revision would be considered the arguments for opting for ATSC should be reviewed and other transmission standards (readily available) should be included in the scope. It was understood that ATSC was selected as Jamaicans buy ATSC standardised IDTVs in the USA. However this is only a very small share of the market as most TVHHs will reuse their exiting ATV set (and any STB will do).

[27] Recommendation ITU-R BT.1833-3 (02/2014) covers eight standards for MTV service delivered by digital broadcast networks of which two are satellite systems and six are based on terrestrial networks.

[28] Some of the MTV systems have this in-band capability, including ISDB-T/OneSeg, DVB-T2 Lite and ATSC-M/H. The ATSC-M/H service is implemented as part of a network architecture delivering the main service (i.e. the DTTB services) and is carried in the same multiplex (i.e. transmitter). For a complete overview of the ATSC-M/H standard, please refer to: ATSC-Mobile DTV Standard, Part 1 – ATSC Mobile Digital Television System, Document A/153 Part 1:2011, 1 June 2011.

12. Viewer's financial compensation is deemed necessary for purchasing one DTTB Set-Top-Box (STB) and receiving antenna[29]. Integrated Digital Television Sets (IDTV) are explicitly excluded as these households are deemed to be financially able to pay for a digital television set[30]. The amount of STB subsidy is still to be decided and is dependent on public resources and the business case. The number of eligible TVHHs are limited to:
    a. TVHH's dependent on the ATV network for receiving television services, and;
    b. Which are beneficiaries of the PATH program, or;
    c. Which have predominantly elderly people, or;
    d. Which are headed by a person of 75 and over;
13. The incumbent terrestrial television network operators (CVM and TVJ) will not get operational expenditure (OPEX) compensated from public resources for continuing to operate their ATV networks during the simulcast period. Under the previously mentioned public-private partnership, CVM and TVJ are envisioned to be licensed as (common) multiplex operator and service provider by priority (i.e. exclusively). As a licensed multiplex operator and service provider they will be provided with an opportunity to generate new revenue streams. Hence it was deemed not necessary to provide compensation;
14. The Digital Dividend is not a directly relevant issue for Jamaica as spectrum for both broadcasting and mobile services is available in the UHF band. Hence no decision will be taken as part of this Roadmap (see also Section 4.5).

[29] It should be noted that the average number of television sets per TVHH is reported to be 1.7 sets. Please refer also to footnote 3.

[30] IDTVs are commonly available and have no extra charge for having a digital receiver integrated. Moreover television sets without a digital receiver are in some markets (e.g. in Europe and US) no longer commonly available.

3. National roadmap

After having determined the aim of the Roadmap, as described in Section 2.4, this Chapter describes the Roadmap itself and starts with an introduction on the concept of a Roadmap, followed by the description of the construction of the Roadmap in Section 3.2. In Section 3.3 the selected functional building blocks of the Jamaican Roadmap are shown. Section 3.4 describes each of the Phases of the Roadmap for Jamaica.

3.1 Roadmap concept

A *Roadmap* is a management forecasting tool and is directed to the implementation of a 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 for the transition to DTTB has three major uses:

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

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

3.2 Roadmap construction

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

The basis for constructing the roadmap is a functional framework consisting of five layers as shown in Figure 4.

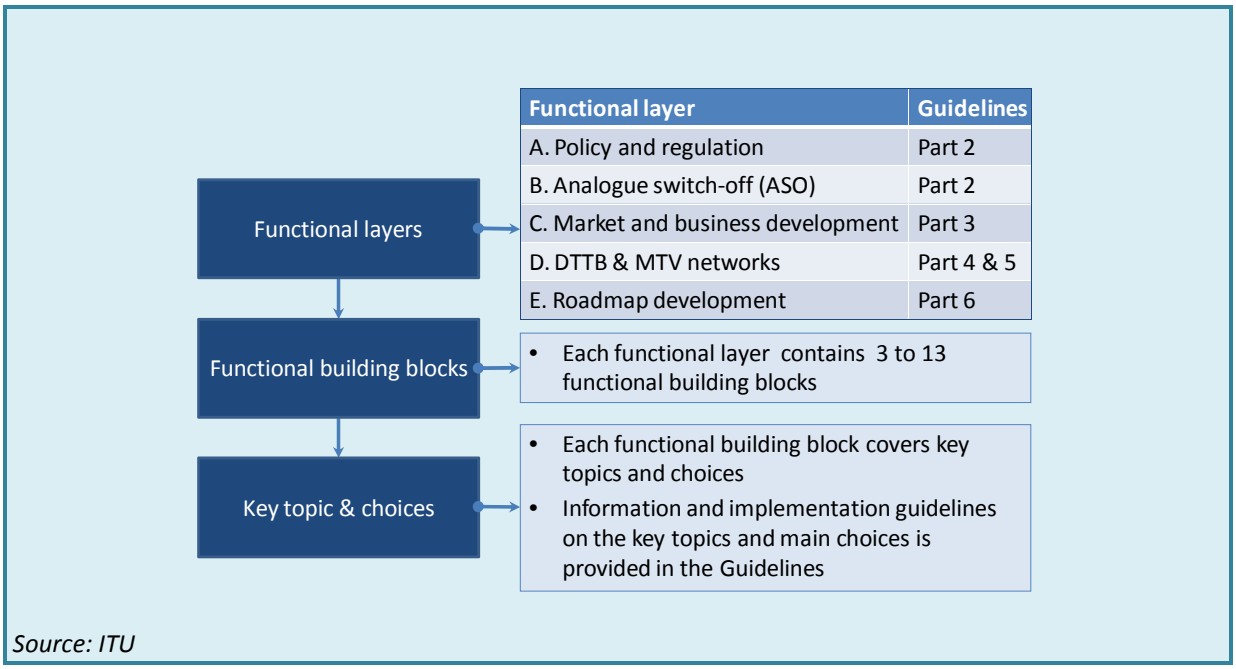


FIGURE 4: FUNCTIONAL FRAMEWORK

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

The Roadmap is constructed by defining the phases and by placing the relevant functional blocks in each phase in a logical order and in a time frame. For each of the functional building blocks the decisions already taken and not yet decided on key topics and choices are identified, as well as the activities to be carried out. Figure 5 illustrates the construction process.

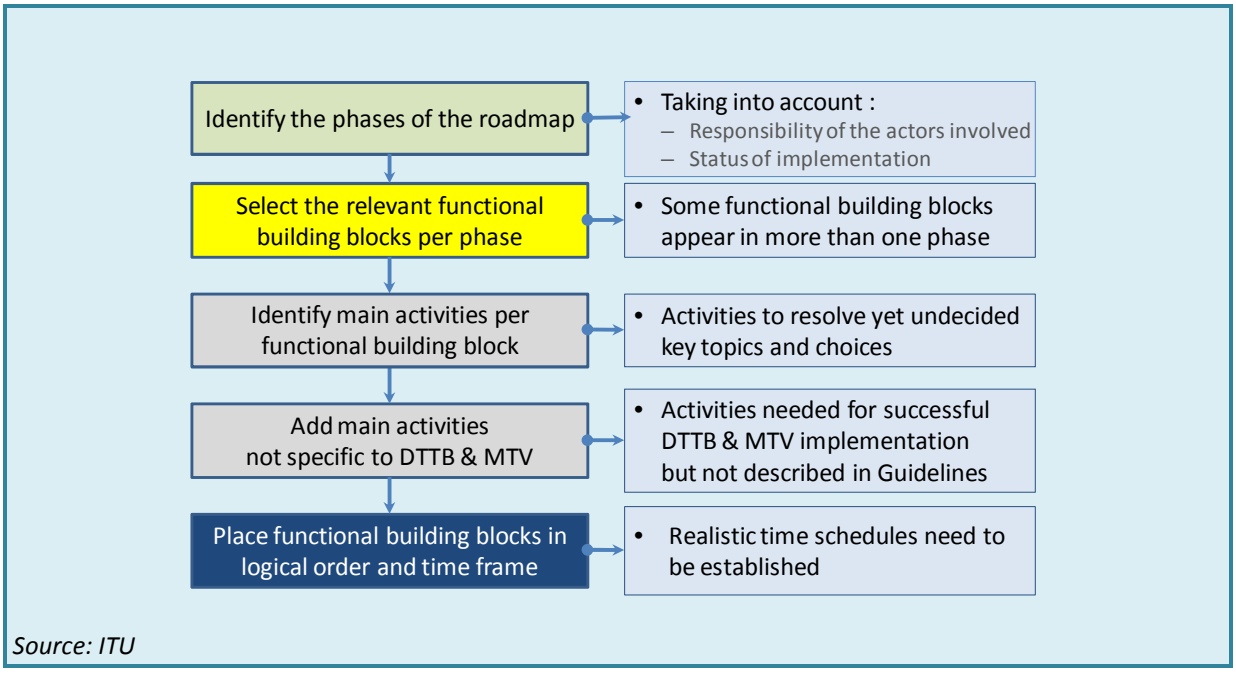
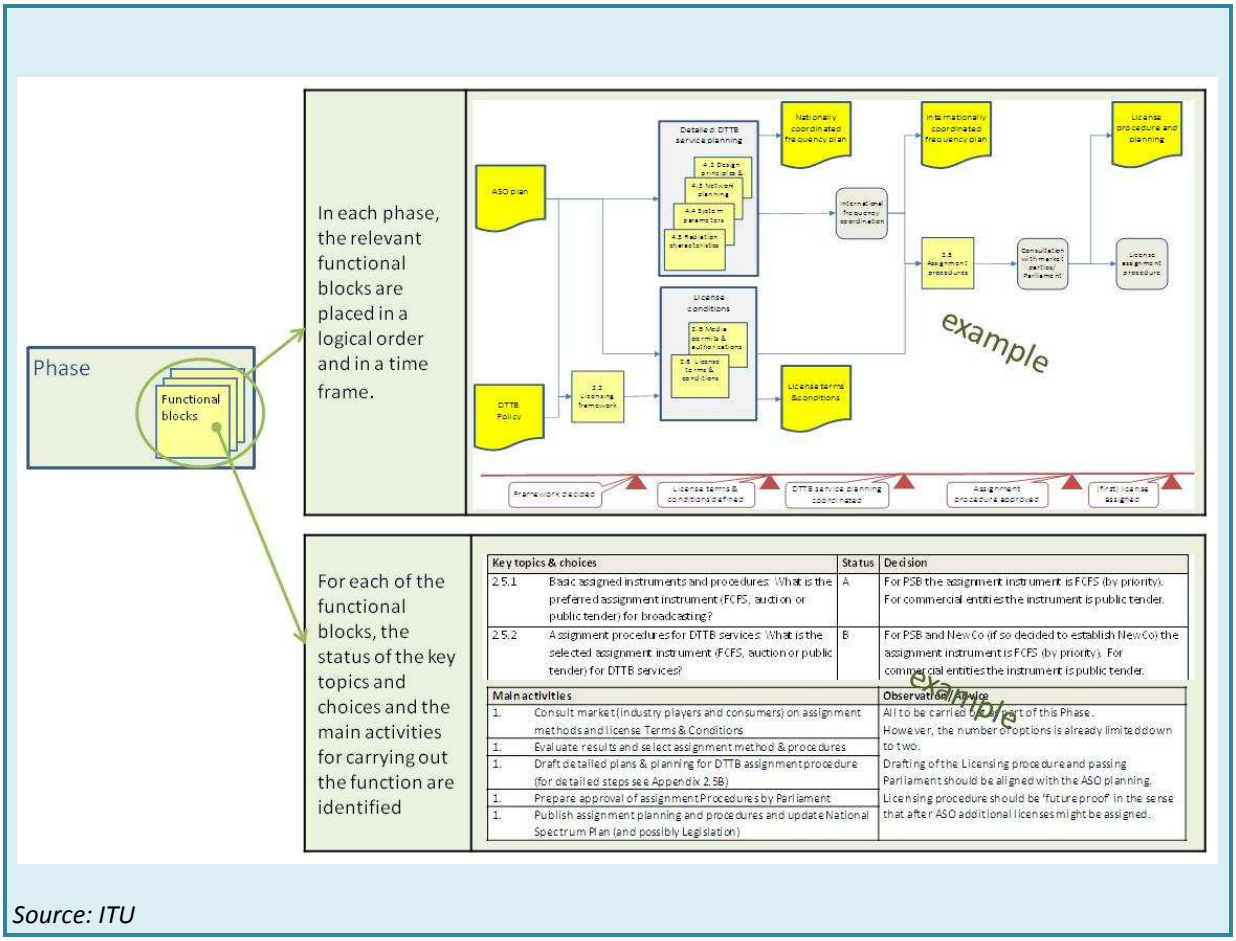


FIGURE 5: ROADMAP CONSTRUCTION

The result is a Roadmap consisting of three levels:

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

The Roadmap structure is illustrated in Figure 6.



Source: ITU

FIGURE 6: ROADMAP STRUCTURE

The selected relevant functional building blocks are shown in Figure 7 in Section 3.3. Key topics and choices related to the selected functional building blocks of functional layers A (Policy & Regulation), B (ASO), C (Market & Business Development) and D (Networks) have been considered and it has been identified which decisions have (partly) been taken and which still need to be taken.

An overview of the status of the selected functional building blocks is given in Annex 1: Checklist.

3.3 Relevant functional building blocks for Jamaica

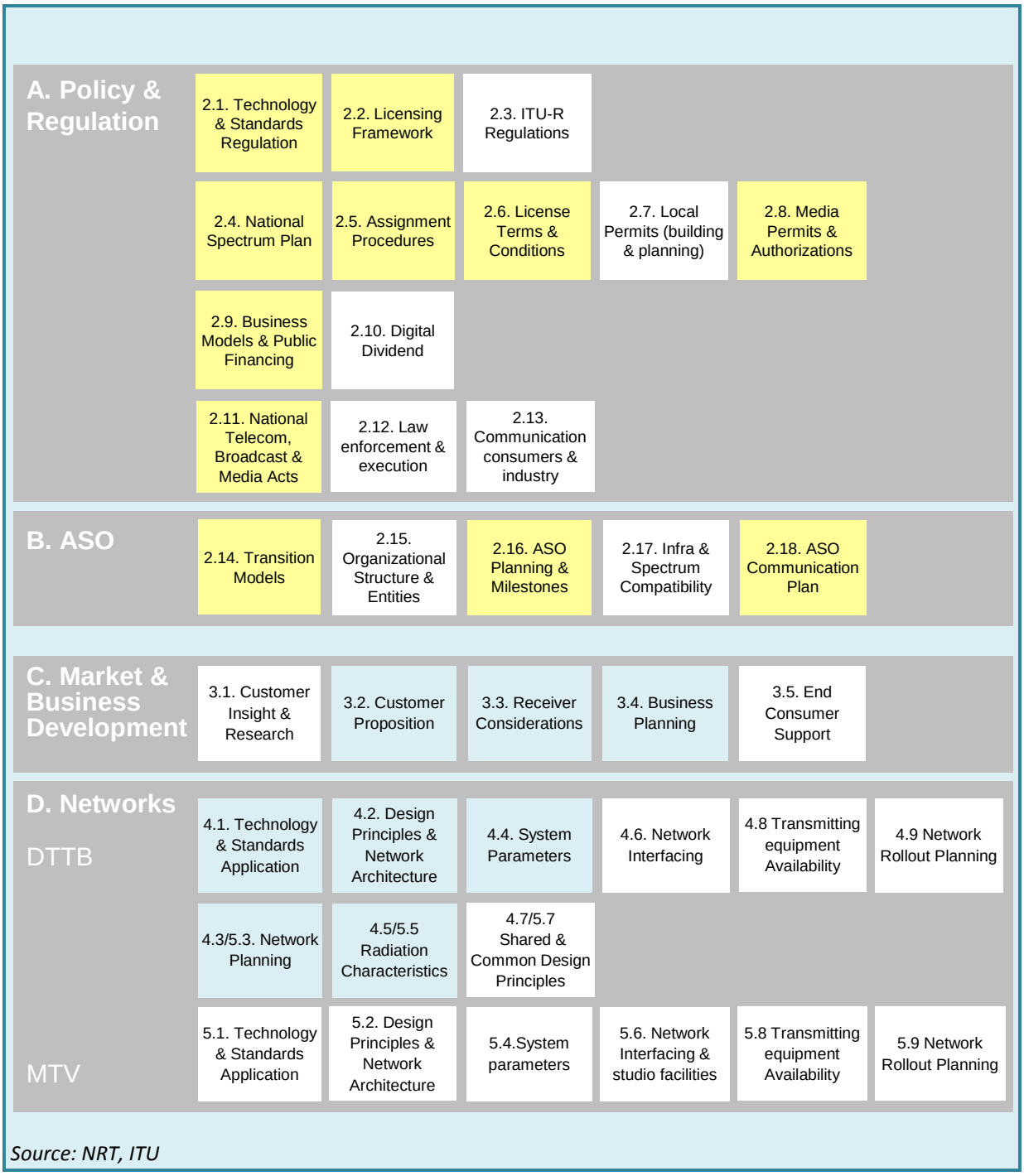
Out of the five functional layers as described in the ITU Guidelines, layer E is "Roadmap development" and hence covered by this report. The other functional layers A (Policy & Regulation), B (ASO), C (Market & Business Development) and D (Networks) contain in total 38 functional building blocks (see Figure 7). Out of the 38 functional building blocks, 19 blocks were selected to construct the Roadmap for transition to DTTB in Jamaica.

Figure 7 shows three types of functional building blocks (FBB):

1. Non-shaded/white blocks:
   These blocks were not selected to be included in the Roadmap for the transition to DTTB in Jamaica (see Table 3 below);
2. Yellow shaded blocks:
   These blocks are included in the Roadmap for the transition to DTTB in Jamaica and will be led by the Government representatives (including BC, SMA, Office of the Prime Minister and Ministry of Information) in the NRT[31];
3. Blue shaded blocks:
   These blocks are included in the Roadmap for the transition to DTTB in Jamaica and will be led by the industry representatives (including CVM, TVJ and Association of Cable Providers) in the NRT[32].

[31] This will mean in practice that these parties will report in the NRT meetings on progress and results of the activities included in the scope of these functional building blocks.

[32] See footnote 31.



Source: NRT, ITU

FIGURE 7: SELECTED FBB

The considerations for not including the white functional building blocks (as included in Figure 7) are provided in Table 3.

No	Functional building block	Consideration
2.3	ITU-R regulations	There is no ITU DTTB Frequency Plan for Region 2. The frequency use should comply with the ITU Radio Regulations, but it is not considered as a main topic to be controlled by the NRT. However

No	Functional building block	Consideration
		FBB 2.4 National Spectrum Plan is included as to ensure that enough spectrum is (made) available for the DSO/ASO objectives (see also Section 4.5).
2.7	Local permits (building & planning)	Limited or no (specific) regulations in place which could result in a critical path in the Roadmap planning.
2.10	Digital dividend	No decisions have been taken on the allocation of IMT in the 700 MHz band. It is not expected that broadcasting and mobile spectrum requirements are conflicting[33].
2.12	Law enforcement & execution	Is not considered essential or a task to be undertaken in the DSO/ASO process.
2.13	Communication consumer & industry	As the policy and regulation activities will be carried out as part of the ASO process, the decisions and activities related to FBB 2.13 will be included in FBB 2.18 (ASO communication plan).
2.15	Organisational structures & entities	In Jamaica a DSO committee, headed by the Minister of Information, has been formally established. All relevant market parties participate in this committee.
2.17	Infra & spectrum compatibility	Infra-structure incompatibility is not considered as a major issue in Jamaica. Spectrum incompatibilities are not expected as ATV and DTTB will use different frequency bands. VHF Band III (see Section 2.2) and UHF Band IV (see Section 4.5.1) respectively. Hence spectrum compatibility is not an issue.
3.1	Customer insight & research	As financial resources are limited, a practical approach is adopted for collected or assessing missing market data and information.
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).
4.6	Network interfacing	The decisions and activities of this FBB are considered to be a task to be carried out by the multiplex/network operator without direct involvement of the NRT. The design of the network

[33] It should be noted that the 700 MHz band (i.e. 698 – 806 MHz in Region 2) is currently allocated for IMT (too) in Jamaica and that frequencies in that band have been assigned. See also footnote 5.317A in the Jamaican Table of Frequency Allocation.

No	Functional building block	Consideration
		interfaces takes place during the detailed planning phase of the DTTB network deployment.
4.7	Shared & common design principles	The introduction of MTV services is considered at a later date and is out of scope of the current Roadmap (see also Section 2.4).
4.8	Transmission equipment availability	See FBB 4.6
4.9	Network roll-out planning	See FBB 4.6
5.1 to 5.9	MTV networks (all FBB)	See FBB 4.7

TABLE 3: FBBS NOT INCLUDED IN THE NATIONAL ROADMAP

3.4 Description of the Jamaican Roadmap

In this section first and overview is provided of the overall Roadmap. In line with the ITU Guidelines the Roadmap comprises four phases. Following this top-view of the Roadmap a more detailed description per Roadmap phase is included in the subsequent sections.

3.4.1 Overall Roadmap

As described in Section 2.4, the objective is to complete the ASO by end of 2019. This would result in an overall Roadmap duration of approximately 4 years. A key decision impacting the Roadmap greatly, is the decision on the licensing model. The ITU Guidelines have outlined two basic models; model A and B[34]. The NRT has not formally decided on the licensing model (see Annex 1: Checklist).

However during the country visit a public-private partnership was proposed as a way forward in financing the DSO/ASO process. This was reflected in the DSO and ASO objectives (as included in Table 2). Assuming that this partnership model can be agreed and that the most efficient DTTB network deployment is pursued, licensing model B is the better fit. Under licensing model B a common multiplex operator can carry both the eight FTA services and the pay-tv bouquet. DTTB transmission services can be (most) transparently offered and charged. Also the network deployment and coordination costs can be minimized (i.e. better than under a model A scenario). The arguments for model B are further detailed in Section 4.2.

Hence the presented Roadmap in this Chapter assumes that model B is selected. This implies that the multiplex and network operations will be carried out by a single entity, serving both the eight incumbent FTA services and the single pay-tv SP (see Section 2.4).

Also as the DSO/ASO process will be prepared, implemented and financed in this public-private partnership, the planning of the network and services will be carried out as part of the NRT tasks and responsibilities. The actual detailed planning, design and implementation can be carried out by the newly established common multiplex operator.

[34] See ITU Guidelines, January 2014, pp24-25.

Figure 8 shows a top overview of the Jamaican Roadmap, including the five Roadmap phases.

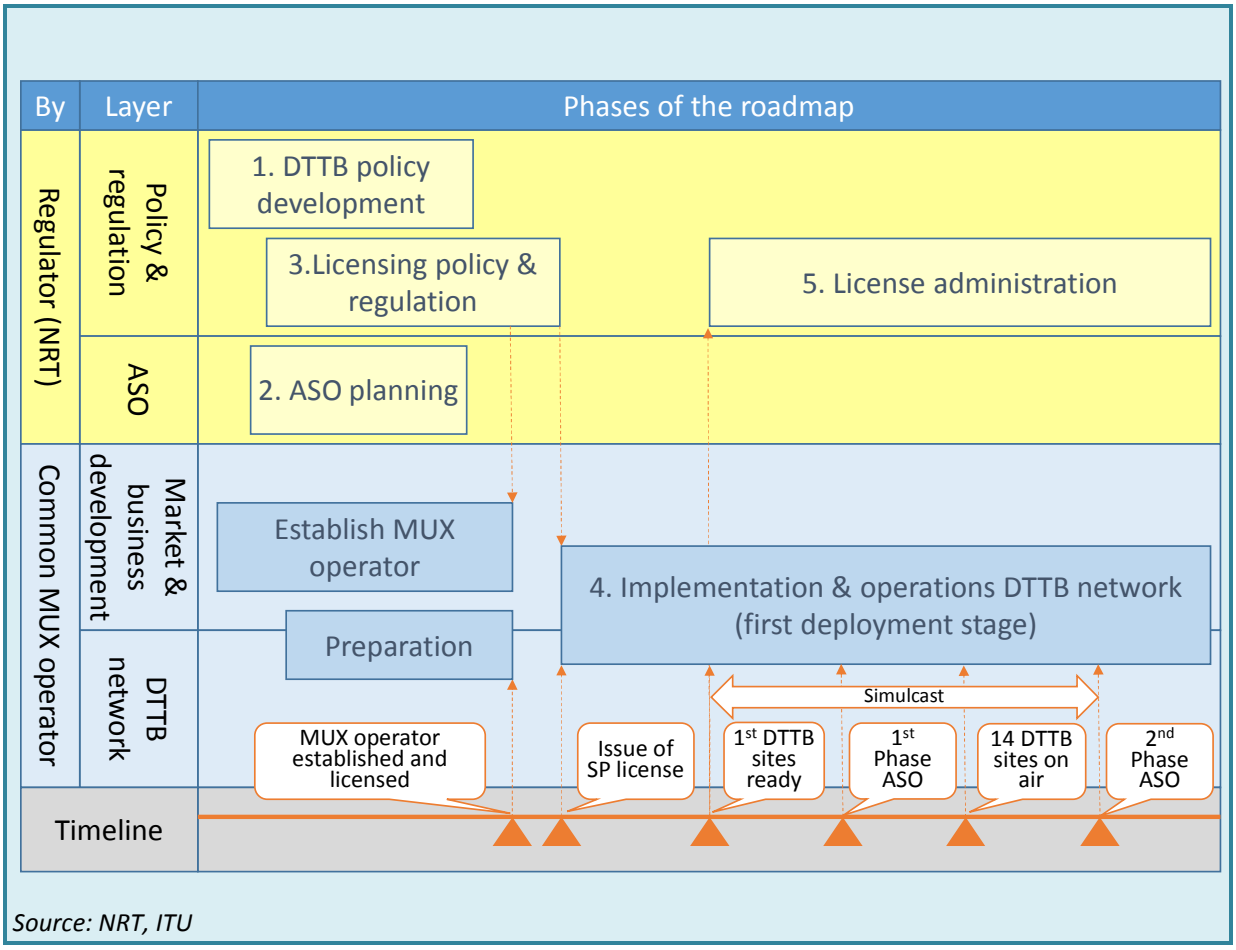


FIGURE 8: OVERALL ROADMAP

Figure 8 shows the following:

1. The Roadmap Phases 1 to 3 are carried out in parallel as many decisions in these Phases are interdependent;
2. Prior to the implementation of the DTTB network, the multiplex operator has to be established. The two incumbent terrestrial broadcasters (CVM and TVJ) would be well positioned to participate in these multiplex operations as they own most of the tower infrastructure. Third parties (like the Association of cable providers) could participate in the ownership of this new entity (what is still to be determined and dependent on negotiations). CVM and TVJ agreeing to joint network operations would automatically result in the establishment of a separated legal entity;
3. The preparations for splitting off (part of) the network activities from CVM/TVJ and establishing a new company (NewCo) are indicated in blue as it is assumed that these activities will be carried out under the direct responsibility of CVM and TVJ's management. This will require a formal decision. The NRT will have to get progress reports on the establishment of NewCo and ultimately management of NewCo will have to participate in the NRT;

4. Alternatively if the network operations are not separated from CVM and TVJ[35], they should reorganise their operations in such a way that it can serve third party clients in a transparent way for network distribution services. Accounting separation is part of such a reorganisation (see also Section 4.1);
5. After having taken the first DTTB transmitter sites into operations for the Phase 1 coverage areas, the simulcast period starts. The number of required DTTB sites (and their exact characteristics) for this first (and second) Phase should be determined by carrying out network planning. After completing the minimum simulcast period in these Phase 1 coverage areas[36], the corresponding ATV sites can be taken off-air (ASO Phase 1). For the time being it was assessed that 14 sites are required for covering all ATV coverage areas (based on the assumption that the CVM coverage areas fall completely with in the TVJ ATV coverage areas). After having all 14 sites on-air and completing the minimum simulcast period, the remaining ATV sites can be switched-off (ASO Phase 2);
6. License administration (Phase 5) entails the administrative process of transmitter station approval and registration. Before a DTTB transmitter station is taken into operations SMA as the national spectrum manager should approve the station's characteristics and proper installation. It will register this new station in their register of spectrum usage and will then notify the ITU. In turn the ITU will register this station in their global register (i.e. Master International Frequency Register - MIFR).

The NRT will resume responsibility for the proper deployment of the DTTB network by designing and assigning the network/multiplex license. It will also determine and endorse which DTTB services will be launched onto the Jamaican television market. In addition, the NRT will determine the network roll-out and the associated planning by including network roll-out obligations in the network license. Hence the Roadmap will also include functional building blocks of the Market and Business Development and DTTB Network layer:

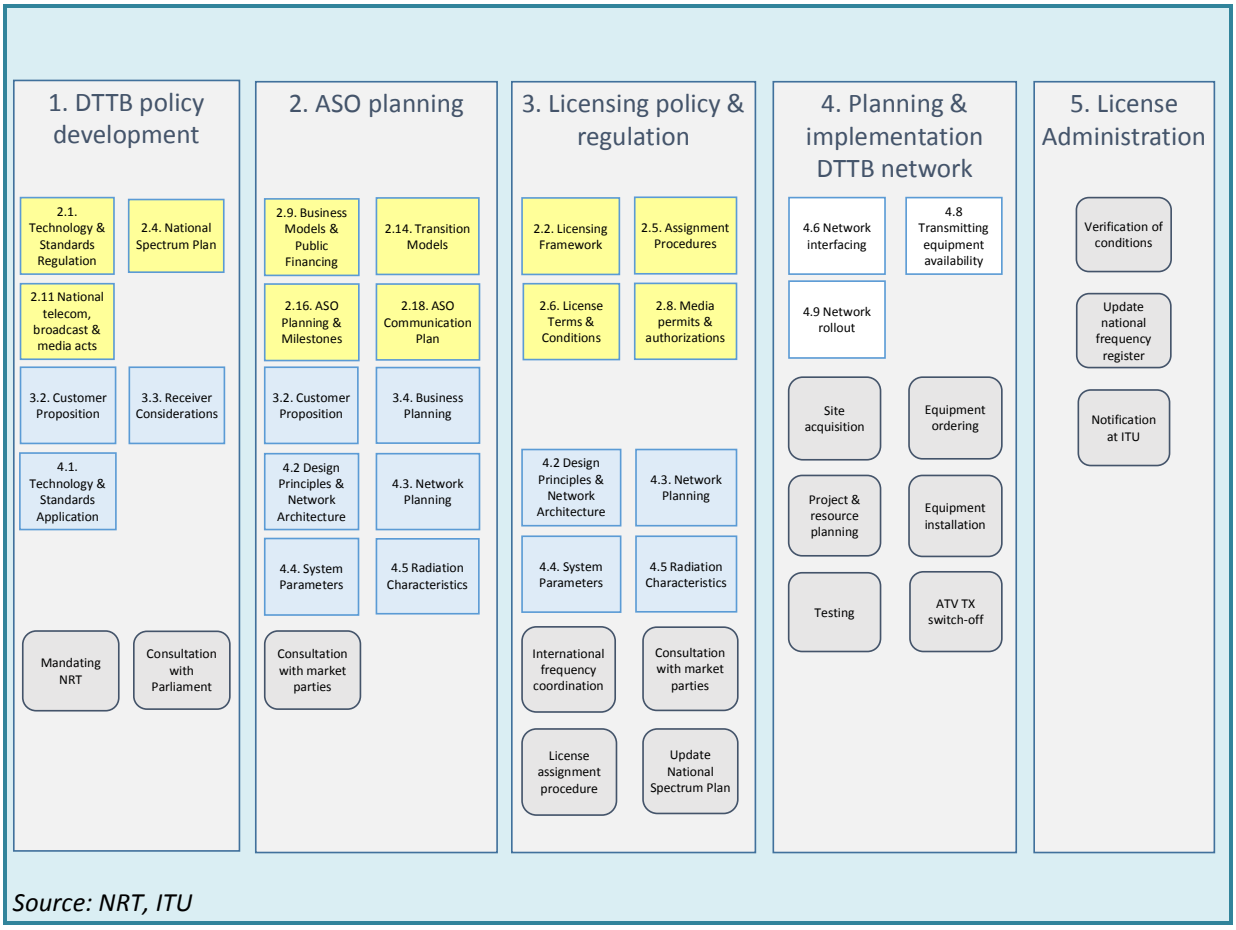
1. Market and Business Development layer:
    a. Customer Proposition (functional building block 3.2): the NRT will have to determine the most compelling attributes of the DTTB services, such as coverage areas, number of services, picture quality, reception mode/quality and price tables for the various services (including multiplex capacity reservations);
    b. Business Planning (functional building block 3.4): the NRT will also have to resume responsibility for an economically viable DTTB offering for the network provider, broadcasters and other market parties. Hence the NRT will have to assess the future cash flows of the network providers and broadcasters. And what type of public financing is required;
2. DTTB Network layer:

[35] As defined under the DSO/ASO objectives (see Table 2), this would imply that CVM and TVJ would each deploy and operate one multiplex. However such a scenario is not recommended as explained in Section 4.1.

[36] And assuming that the condition is met that 80% of the TVHHs in the Phase 1 (and Phase 2) areas have acquired a digital receiver.

a. Technology & Standard Application (functional building block 4.1) to Radiation Characteristics (functional building block 4.5): all these five technical functional building blocks have to be included as to determine what the required DTTB network(s) will look like. This includes aspects such as the design of the key network elements (i.e. the head-end/multiplex centre, the distribution links and the transmitter sites), the various system parameters (i.e. transmission mode, guard interval[37], etc.) and the applied frequencies per site (i.e. ERP, antenna height and diagram).

With reference to the selected functional building blocks in Section 3.3, Figure 9 shows the blocks to be included in each Phase of the Jamaican Roadmap. Please note that the yellow and blue shaded blocks are described in the Chapters of the ITU Guidelines with corresponding numbering. The grey shaded blocks are not described in the ITU Guidelines. These blocks represent activities that are not specific to the introduction of digital terrestrial television services.



Source: NRT, ITU

FIGURE 9: FFBS PER ROADMAP PHASE

[37] Please note that the guard interval is relevant for deploying Single Frequency Networks (SFN), the ATSC 1.0 standard as a single carrier system does not allow for deploying SFNs. See ITU Guidelines, Table 4.1.4.

In the following Sections the subsequent Phases of the Jamaican Roadmap are described in more detail.

3.4.2 Phase I DTTB policy development

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

Inputs

The inputs for this Phase are international agreements (if any), existing regulatory framework (see Section 2.3) and policy objectives (see Table 2). It should be noted that the DSO/ASO policy objectives as included in Table 2 still have to be confirmed and politically endorsed.

Outputs

The key output of the DTTB policy development Phase is a politically endorsed DTTB Policy document to be published to the general public (in an official state publication, i.e. the 'Official Gazette'). Such a DTTB Policy document typically includes the following items[38]:

- Policy justification. This includes the benefits and necessities of introducing DTTB services in Jamaica. The customer benefits/competitive edge of DTTB for the key markets (e.g. terrestrial served and non-served) should be clearly outlined;
- The legal framework: This entails the legal basis (and any necessary changes) for the DTTB service introduction and the ASO;
- Technical framework. Detailing the current spectrum in use by existing broadcasters and the available spectrum for the DTTB services. Also the spectrum available for non-broadcasting services (i.e. the digital dividend) could be clarified;
- Starting (i.e. the introduction of the first DTTB broadcasts) and ending date of the ASO process (i.e. switching of the last analogue broadcasts and lifting any restrictions on the DTTB broadcasts). These dates have to be exact as to inform the general public and the industry accurately;
- The principle ASO model. It was decided in the NRT that this model was to include simulcasting and a two-phased ASO. The policy document should also include the justification for this model;
- DTTB services. Describing which incumbent television services and additional content/services will be distributed on the DTTB platform and at which districts/areas these services will be made available. In the NRT it was decided that these DTTB services include FTA and pay-tv services;
- DTTB standards: what standards (ATSC and MPEG4 for respectively the transmission and compression standard) will be mandatory and its justification. In Jamaica also a decision on the CAS regulation should be made as it was decided to include pay-tv services;

[38] It may be published in several subsequent parts, depending on the political decision making process.

- Funding principles. In Jamaica it was decided to fund the DSO/ASO process in a public-private partnership. The policy paper should include this model and indicate what items are dependent on negotiations and what are possible fall back scenarios;
- Communication and Plan of Action. Outline of how viewers (and other stakeholders) will be informed about the ASO process and Plan of Action with major regulatory and operational milestones (e.g. the establishment of the multiplex operator, the start of the simulcast period, the end date of the ASO, etc.).

For an example of a DTTB Policy document please refer to "Strategy for Switchover from Analogue to Digital Broadcasting of Radio and Television Programs in the Republic of Serbia" as published in the Official Gazette of the Republic of Serbia, No. 55/05, 71/05 – correction 101/07, the Government of the Republic of Serbia on July 2nd 2009[39].

Roadmap

The Roadmap of the DTTB policy development Phase and the associated functional building blocks is shown in the Figure 10. The decisions taken, partly taken and not yet taken on the key topics and choices per functional build block are indicated in Annex 1: Checklist.

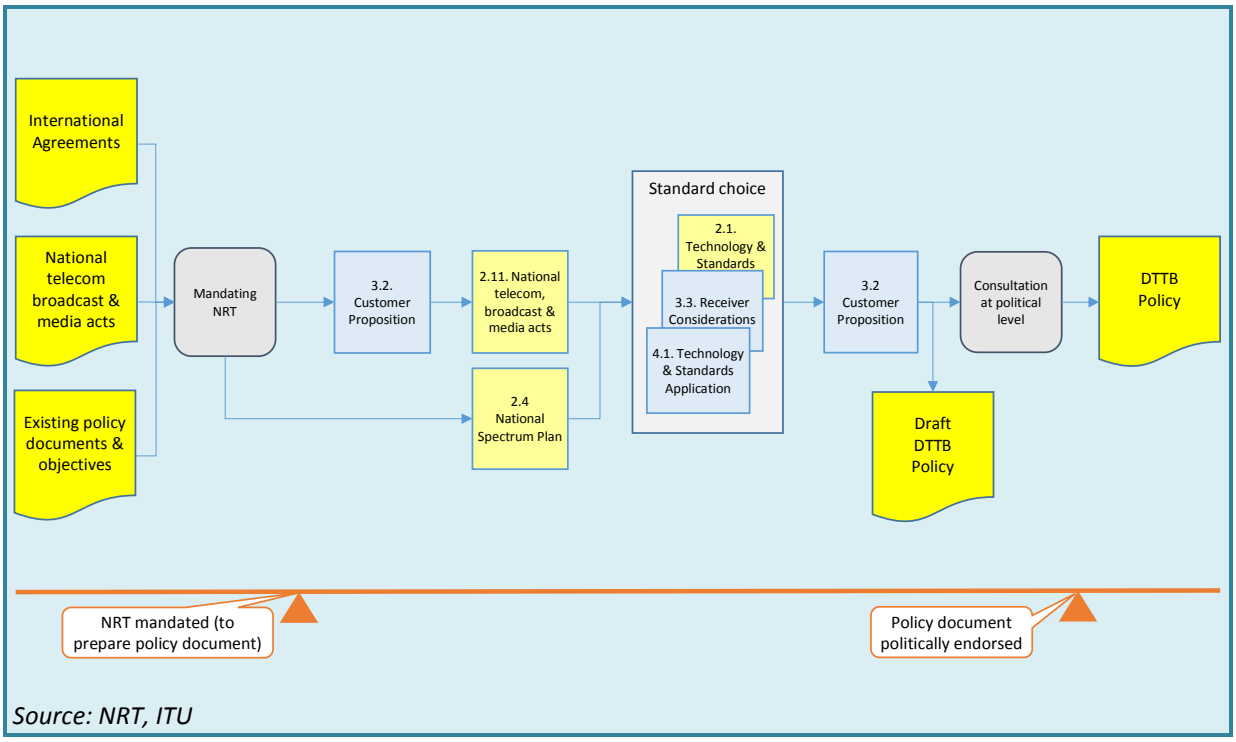


FIGURE 10: DTTB POLICY DEVELOPMENT (PHASE 1)

As can be derived from Figure 10, the following steps (i.e. functional building blocks and non-DTTB specific activities) are included in the first Phase of the Roadmap:

1. Mandating the NRT. Although the NRT has been formally established, its mandate should be checked. In order to deliver the aforementioned DTTB Policy document it should have at

[39] Also available on the ITU website.

least a clear mandate to do so. After this policy document has acquired political approval, the NRT's mandate can be extended to prepare, plan and execute the Roadmap. In this Phase of the Roadmap this NRT can have a limited membership. At the second Phase of the Roadmap (i.e. ASO planning) the NRT membership can be extended to include all stakeholders in the DTTB value chain (and structured in line with the implementation guidelines of functional building block 2.15). Alternatively the NRT can be mandated at once for the whole DSO/ASO process;

2. Determining the Customer Proposition (functional building blocks 3.2). Conducting market research of the current television and future DTTB market in Jamaica was excluded from the Roadmap because (a) resources are limited and (b) NRT members are well aware of the possibilities in the Jamaican television market. Consequently this step includes only the functional building 3.2. At this Phase of the Roadmap the NRT should provide support/justification for the proposed DTTB customer proposition. Section 2.1 can serve as an initial basis for collecting and completing the market data. Market data will have to cover the following elements:
    a. *Current* television market in Jamaica. A profound and *agreed* understanding of the current television market provides a sound basis for any policy document. This part of the data will include the following:
        i. Current market players (to include broadcasters, content creators, network operators, service providers etc) and their television services. Figure 1 as included in this report, provides an initial overview of services on the Jamaican market;
        ii. Television viewing 'demographics'. This entails the common market parameters like number of television sets deployed, the number of television households , the number of viewing hours (per channels), the number of subscriptions, etc;
        iii. Size and growth of the total pay-tv (subscription) and television advertising markets in Jamaica[40]. Also the impact of the ASO and DTTB introduction on this advertising market should be assessed;
        iv. Current reception situation and conditions. This entails having insight in what the different viewing groups (to include individual viewers, household size, group viewing, hotels, multi-dwelling units, etc) look like, their numbers and under what conditions current analogue television is received (e.g. the antenna installation and type of television sets). This part should also include the reception from other platforms (cable and satellite)[41];
        v. Current analogue service coverage. Given the current reception conditions, it should be clarified where what service can be received. This might entail an ATV network planning exercise (see Section 2.2);

[40] This information is collected by the BC, see for example "An analysis of the Jamaican STV sector", October 2014 (revised November 2014).

[41] See also Section 4.3.

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

b. *DTTB* market for Jamaica. The DTTB Policy document should illustrate that there is a need for DTTB[42]. This part of the market description should provide an insight into what the Jamaican viewers and industry players expect, including:
   i. Content. To include the number and the type of programs/channels and other service to be broadcasted (for example the EPG, subtitling, theme channels). Also the willingness to pay for the STB and the television services is an important aspect to include. Knowing this willingness can help to determine any necessary financial support for the Jamaican viewers[43];
   ii. Supplies. Jamaican distributors might show an interest in distributing and provisioning DTTB receivers;
   iii. Content creators. Jamaican content creators (most notably the approximately 20 Jamaican production companies, see Figure 1) might be interested in provided dedicated content for the DTTB platform;

3. National Spectrum Planning (functional building blocks 2.4). The *current* available spectrum for DTTB should be identified, as well as the *future* available spectrum for digital terrestrial television services should be clarified and agreed (see also Section 4.5), taking into account:
   a. Spectrum already assigned (not necessarily in use)[44] for analogue and/or digital television services (as indicated/to be incorporated in the National Spectrum Plan and Register);
   b. Neighbouring spectrum usage. Spectrum may not be readily available in Jamaica as the same spectrum is in use in neighbouring countries[45]. Coordinating this spectrum is in the interest of all involved countries and may require bilateral/multilateral coordination;
   c. Spectrum required for future digital radio and mobile television services (as indicated/to be incorporated in the National Spectrum Plan and Register);

[42] Supporting evidence can be found in the report "A feasibility study of the introduction of digital terrestrial television in Jamaica", dated July 2012, by College of Business & Management, University of Technology, Jamaica.

[43] With the DTTB platform carrying a pay-tv bouquet (with a similar number of television services as the Jamaican cable providers), the willingness to pay can be derived from digital cable offerings in Jamaica.

[44] It was understood that Love TV does hold spectrum rights for ATV but that their ATV service is not on-air anymore.

[45] As Jamaica is an island it should consider that foreign interfering signals can travel far as radio waves propagate well over sea. Depending on the climate and frequency radio waves can propagate for several hundreds of kilometres.

   d. Spectrum requirements for non-broadcasting services, for example spectrum for LTE services[46] (as indicated/to be incorporated in the National Spectrum Plan and Register);

4. Checking compliancy with current legislation and identifying required changes (functional building block 2.11). A first assessment should be carried out of what parts of the current legislation will be impacted by the introduction of DTTB services (see Section 2.3). At this first Phase of the Roadmap, the assessment is focused on identifying the areas that might be impacted, how required changes can be achieved (e.g. legal and parliamentary procedures) and how long this will take. This assessment will then provide input for the Plan of Action (as part of the DTTB Policy document). During the third Phase of the Roadmap (i.e. determining the DTTB regulations) specific DTTB regulations are defined (e.g. the licensing framework and procedures), a further detailed assessment of the changes needed may be necessary;
5. Selecting system standards. As the above figure shows the process for deciding standards is an iterative process between the functional building blocks 4.1 Technology standards application (i.e. addressing the technical performance), 2.1 Technology standards regulation (i.e. considering regulatory aspects) and 3.3 Receiver availability considerations (i.e. dealing with functionality, price and delivery of receivers). For Jamaica this iterative process will focus on setting the standard for the Conditional Access System (CAS) as the standards for the transmission (ATSC) and compression (MPEG 4) are already decided (see Annex 1: Checklist). As for the selected ATSC transmission standard it should be noted that although the ATSC standard has been adopted and deployed in various countries (most notably in the USA and South Korea), most implementations are without CAS as the DTTB platform is used for FTA broadcasts. To keep receiver costs low, set-top-boxes (STB) have the CAS embedded in the chipset and consequently the receiver becomes a proprietary device. Therefore the availability of the receivers will depend on the selected CAS. Furthermore the NRT will also have to consider:
   a. Long term supplies of ATSC 1.0 receivers. As mentioned in Section 2.4, ATSC 3.0 is under development and once introduced this 2nd generation standard will replace the ATSC 1.0 (like DVB-T2 replacing DVB-T). Such a replacement cycle may take several years during which ATSC 1.0 receivers continue to be produced. However manufacturers may be reluctant to continue producing proprietary ATSC 1.0/CAS receivers. The NRT should check with manufacturers what their product roadmaps look like as to secure long term supplies of ATSC 1.0 receivers;
   b. Absence of rooftop antennas. As discussed in Section 2.2, many TVHHs in Jamaica use indoor 'rabbit ear' or 'homemade' outdoor antennas. This may lead to a decision to design the DTTB network (partly) for indoor reception. Indoor reception can be made easier by having a so-called active receiving antenna (see also Section 4.5). Active antennas require a 5V powering of the RF input connector (i.e. connector for the receiving antenna). This requirement is not uncommon, but should be checked with the ATSC receiver manufacturers ;

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

c. Installed base of SD television sets. In Jamaica most installed television sets are SD sets (e.g. CRT sets). Modern (ATSC) digital receivers are all HD receivers, capable of receiving SD/HD services and providing SD/HD signals to a connected HD screen (by means of an HDMI connector). In the case of a connected SD television set, any received HD service should be downgraded to an SD signal. Again, although not uncommon, the receiver specifications should include this requirement (as it will also require different connectors – mostly composite connectors) and receiver availability checked.

6. Determining the first Customer Proposition. After checking the available spectrum and compliancy with existing regulations, a shared definition of the Customer Proposition will have to be agreed. This proposition should be as concrete as possible in terms of six dimensions as explained in the ITU Guidelines[47]. It should be consistent as it will have a knock-on effect on other decisions of the NRT in other Phases of the Roadmap. An evident example is that if picture quality (from SD to HD) or reception quality (to a more robust signal) is changed, that the number of DTTB services carried in a single multiplex will be reduced and hence the number of required frequencies higher;
7. Consultation at political level. In this step a draft DTTB Policy document is offered to politicians to approve. This might include several consultation sessions, extensive lobbying and several revisions. Sufficient time should be planned for these activities. It should be noted that in this set-up of the Roadmap, the DTTB Policy document should leave room for the NRT to further detail the Customer Proposition, Frequency Plan (including the service planning process) and ASO Plan (including the organizational structure, budget and planning). After any simplification/adjustments, the approved DTTB Policy document (including the Customer Proposition) can then be published in the Official Gazette as a first communication to the general public and television industry.

3.4.3 Phase 2 ASO planning

The second Phase of the Jamaican Roadmap is aimed at providing a detailed insight into the roles and responsibilities of the various involved parties, the process of transitioning from analogue to digital terrestrial television Broadcasting, the milestone planning and the communication/support process. The ASO planning Phase also serves the purpose of getting support from various involved market parties and politicians.

Inputs

The key input for this Phase is the (passed) DTTB Policy document.

Outputs

The main outputs for the ASO planning Phase are an Initial Frequency Plan (based on an initial DTTB service planning) and ASO Plan. For drafting the ASO Plan the functional building blocks included in this second Phase of the Roadmap will help the NRT in detailing their ASO Plan.

In general terms, an initial Frequency Plan describes how the available spectrum will be utilized in a deployed network and which service (including the number of frequencies and reception mode) will

[47] See the ITU Guidelines, section 3.2.1.

be provided in what areas and with what quality levels (including picture quality and coverage probability). In more specific terms, the Frequency Plan details all the decisions and trade-offs as included in the functional building blocks 4.2 to 4.5.

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

- The applied ASO model (see functional building block 2.14). The applied model might be different from area to area. To start with, ATV-served areas in Jamaica differ as some areas receive one of the incumbent terrestrial services in VHF Band I whereas in other areas both ATV services are received in the VHF Band III. In addition some areas may only receive one ATV service. In this Phase further decisions are needed on the simulcast model (phasing and duration) for the various served areas;
- The Customer Proposition (see functional building block 3.2). Including the details about which services can be received under what conditions (i.e. the reception conditions – rooftop/indoor reception) in what areas;
- The ASO planning (see functional building block 2.16). This planning describes when what Customer Proposition will be made available and how this proposition will be provided. As indicated in the Guidelines this planning comprises several work streams or result paths, including:
    - Regulation & political approval;
    - Frequency Plan;
    - Licensing (further detailed in Phase 3 of the Roadmap)
    - Content/service production and delivery;
    - Network roll-out (includes service delivery details);
    - STB (and other receivers) delivery;
    - Communications (further detailed in functional building block 2.18);
    - Financial & installation support;
    - Consumer & Market monitoring;
- The Business Planning and Public Financing (see functional building block 3.4 and 2.9). A business case should detail what the DSO/ASO process will cost (under various scenarios) and what financial resources should be made available. The initial Frequency Plan will provide the basis for a first estimate of the network costs. Please note that, as Table 2.15.2 in the Guidelines illustrates, the network costs are just one item of the overall budget.

Roadmap

The Roadmap of the ASO Planning Phase and the associated functional building blocks is shown in Figure 11. The decisions taken, partly taken and not yet taken on the key topics and choices per functional building block are indicated in Annex 1: Checklist.

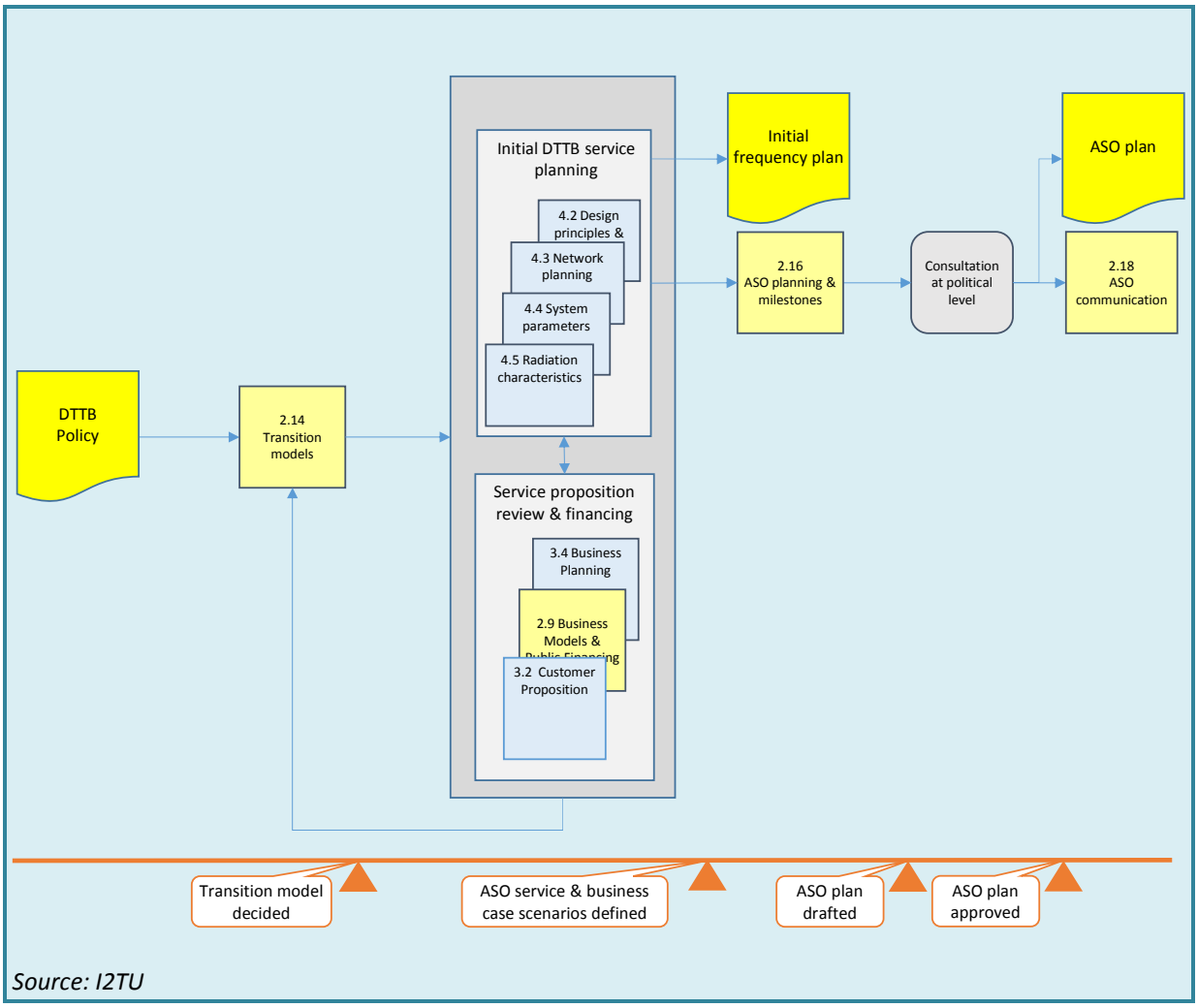


FIGURE 11: ASO PLANNING (PHASE 2)

As can be observed from Figure 11, the following steps (i.e. functional building blocks and non-DTTB specific activities) are included in the second Phase of the Roadmap:

1. Determining an initial transition model (see functional building block 2.14). In the first Phase of the Roadmap a first understanding of the available spectrum was established. In this Phase of the Roadmap, the NRT should assess what the ASO model would compose of and if any changes of DSO/ASO objectives are needed. The ASO model could incorporate the differences between ATV served and non-served areas. During the country visit the ASO model was decided to include a two-phased switch-off with two respective ASO dates;
2. Balancing the Service Proposition (functional building blocks 4.2 to 4.5, 3.2, 2.9 and 3.4). This step entails an iterative process where three elements (i.e. Service Proposition, Network Planning and Business Case) are balanced against each other as illustrated in figure 3.1.1 in the ITU Guidelines. Although in the Guidelines this process is explained for a commercial DTTB service provider, the process is in essence no different for the NRT. As discussed before, within the NRT the public-private partnership should be detailed and this part of the Roadmap will be at the heart of these partnership negotiations. As Figure 11 illustrates, this iterative process consists of two parts:

a. Initial DTTB service planning (which in turn is an iterative process of four functional building blocks 4.2 – 4.5);
b. Service proposition review and financing (which are also in turn an iterative process of three functional building blocks 2.9, 3.2. and 3.4);

Figure 12 below provides a flow chart of the two feedback loops that are incorporated in the balancing of these three elements[48]. For example, the network planning work may show that the coverage target can be best met with three multiplexes to fit in the number of services (as a more robust transmission mode was needed). This would be in contradiction with the originally planned network architecture of having two multiplexes. Consequently the business case should be checked as more transmitters are needed per site. This may result in a re-definition of the service proposition (see the second iteration loop in Figure 12);

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

[48] Please note that the chapter numbers in the figure refer to chapter numbers of the ITU Guidelines.

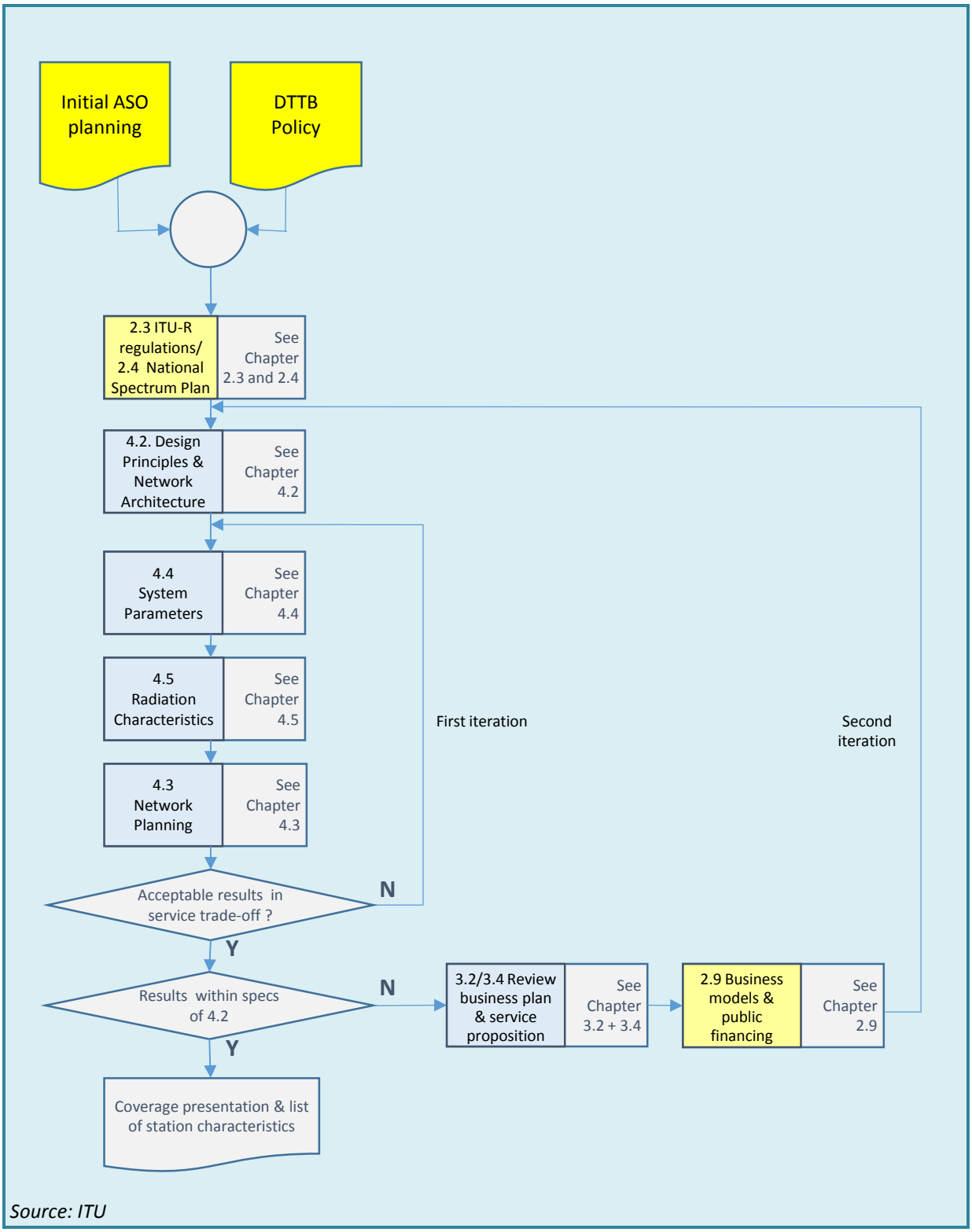


FIGURE 12: FREQUENCY AND BUSINESS PLANNING ITERATIONS

In Figure 12, the first iteration is the so-called service trade-off. In this trade-off transmission costs (given by the number of transmitters and the radiation characteristics), service quality (given by the multiplex capacity) and coverage quality (given by the coverage area which depends on its turn on receiving installation and location probability) are balanced. The optimum solution should be found

within the limits given by the decisions taken in the functional building blocks 4.1 (Technology & standards application) and 4.2 (Design principles & network architecture).

The second iteration is a further balancing of the service trade-off optimum against the financial possibilities. If no satisfactory solutions can be found in the service trade-off, the service proposition and business plan may need to be reviewed, resulting in a possible review of functional building blocks 4.1 (Technology & standards application)[49] and 4.2 (Design principles & network architecture).

Further details on the service trade-off and network planning can be found in Annex 2: Service trade-off and network planning.

3.4.4 Phase 3 Licensing policy and regulation

The objective of this third Phase of the Jamaican Roadmap is to have the required DTTB licenses defined and the associated licensing procedure and planning published. In this way, clarity is provided to market parties operating on the Jamaican television market, as well as television viewers. It also serves the purpose of ensuring uninterrupted broadcasts, free of any interference from any other spectrum users.

Inputs

The input data for this phase are the DTTB Policy document resulting from the first Phase of the Roadmap and the ASO Plan resulting from the second Phase. As indicated in Figure 8 in this report, the third Phase may start in parallel to the execution of Phase 1 and 2. For example, the NRT could start working on the activities in this Phase before the DTTB Policy document and ASO Plan have been endorsed. Such an approach might entail some later changes/revisions of the resulting documents.

Outputs

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

- A nationally coordinated frequency plan defining which DTTB frequencies will be used when and in which geographical areas. This plan will have to be in line with the National Spectrum Plan or reversely made part of this National Spectrum Plan (please refer to functional building block 2.4 of the Guidelines);
- An internationally coordinated frequency plan. As indicated previously this may require bilateral/multilateral coordination. However these administrative procedures may not have to be part of the critical path of the ASO planning;
- The DTTB license conditions & terms and assignment procedures:
    - *The spectrum and operating rights*. The spectrum rights will have to be assigned to the common multiplex/network operator. To ensure spectrum efficiency and compatibility the spectrum license will have to specify detailed frequency use. Assignment of the spectrum rights can be on the basis of a public tender (or auction) or by priority (as part of the public-private partnership agreement). An assignment by priority has to be supported and motivated by sound policy considerations;

[49] This may include the selection of 2nd generation transmission standard.

- The broadcast rights (i.e. the content approval for a part/slot of the DTTB capacity) will be assigned to service providers (including the 8 incumbent FTA broadcasters and a single pay-tv SP). However, the NRT still has to decide which entity can decide the number of pay-tv services and the change over time of these pay-tv services. For example this can be the single SP (see Section 2.4) after approval of the *content* by BC (for example per service). Also the assignment procedure for the broadcast rights has to be decided. The multiplex capacity for the pay-tv services can be assigned to a bidder (i.e. service provider) in a public tender[50]. Alternatively the assignment of these broadcast rights is part of the public-private partnership agreement and the rights are assigned by priority. Such an assignment has to be supported by sound policy considerations. In both cases the NRT will have to arrange for Open Network Provisioning (OPN) rules (including capacity access, reservation, pricing and publication rules) for the common multiplex/network operator[51];

Roadmap

The Roadmap of the Licensing policy & regulation Phase and the associated functional building blocks is shown in Figure 13. The decisions taken, partly taken and not yet taken on the key topics and choices per functional building block are indicated in Annex 1: Checklist.

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

[51] Access to and fair pricing of 'essential facilities', i.e. infrastructure that cannot be duplicated under normal market conditions or infrastructure which operations is uniquely licensed to a single market party. The ONP rules stipulate under what conditions access to this infrastructure should be made available and against what costs/prices. See also the ITU Guidelines section 2.6.1.

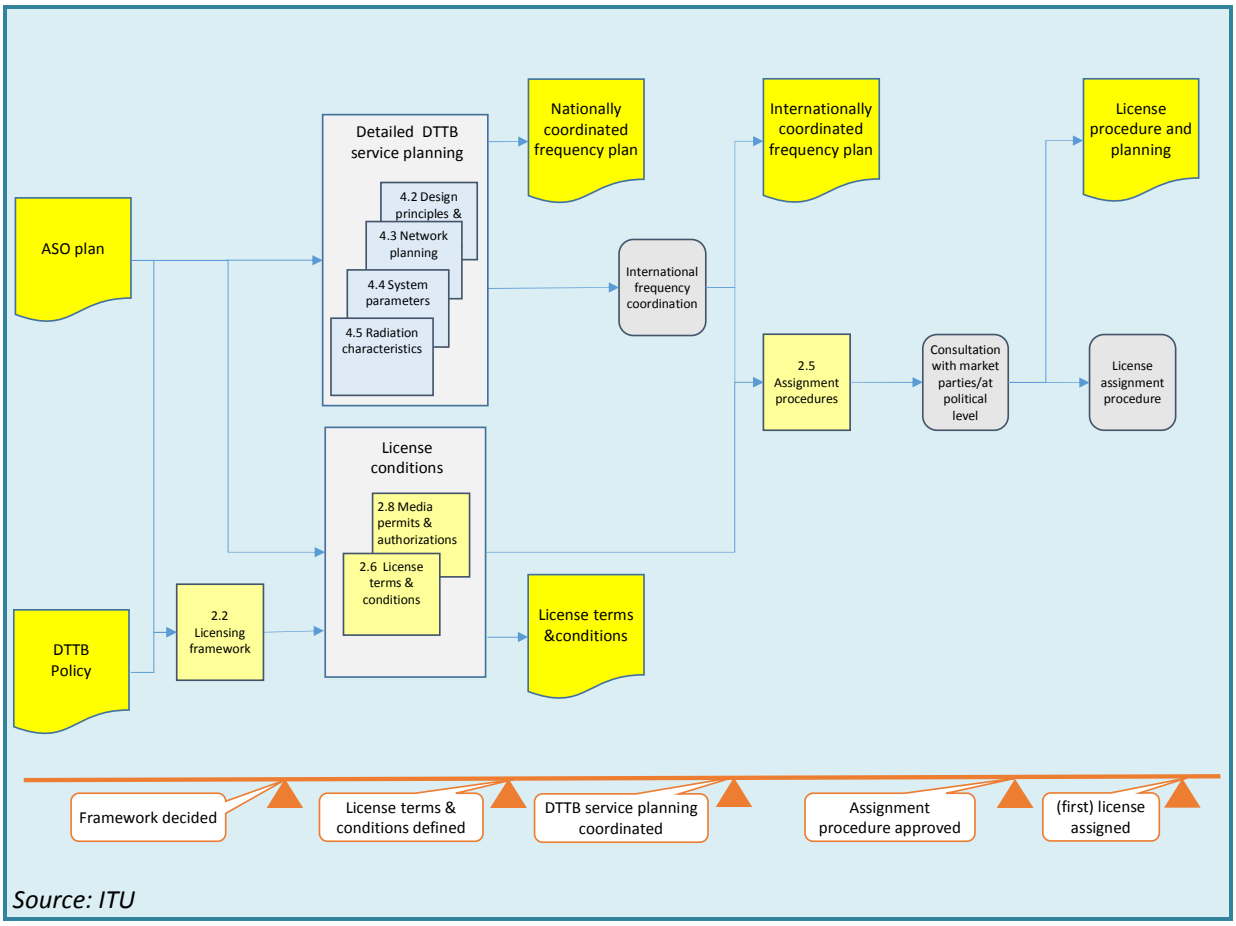


FIGURE 13: LICENSING POLICY AND REGULATION (PHASE 3)

As can be observed from Figure 13, the following steps (i.e. functional building blocks and non-DTTB specific activities) are included in the third Phase of the Roadmap:

1. Detailing DTTB service planning (see functional building blocks 4.2 – 4.5). After having agreed the ASO Plan (including the initial DTTB service planning) a detailed service plan can now be drafted. This detailed plan is different from the initial plan as on the basis of this plan:
    a. License conditions are defined. Hence it will have to consider all characteristics that determine the coverage that should be achieved and the interference potential that should not be exceeded;
    b. Viewers are informed what to do. It will have to provide the details for the communication plan so that viewers know exactly what services they will receive where and what they have to do (e.g. instructions for (re)directing their existing rooftop antenna or acquiring a new one);
    c. Network roll-out will be organized. The detailed planning is a working document. During the roll-out changes will take place and the detailed planning will have to be updated. Consequently the ordering of equipment (a rolling forecast system is advised here) will have to be updated and the resources to have transmitter sites equipped re-planned;
2. Coordinating the required spectrum with national and international users. Based on the detailed planning, stipulating the exact spectrum use, the DTTB frequencies can be

coordinated with other spectrum users. Coordination should take place at an international and a national level. International frequency coordination will be needed to have at each required site 5 (+ 1 for MTV) UHF channels protected from cross-border interference (for more details see Section 4.5). At a national level this is carried out by matching the detailed DTTB spectrum plan with the National Spectrum Plan or reversely the NSP should be aligned with this detailed spectrum plan. For example, this might entail changing frequencies in the detailed planning and/or changing existing (digital) spectrum rights;

3. Determining the licensing framework (see the functional building block 2.2). Assuming that Jamaica would opt for model B as their principle licensing model, remaining key decisions still to be made include:
    a. Capacity management/service portfolio;
    b. Open Network Provisioning (ONP) and Reference Offer (RO);
    c. Accounting separation;
4. License conditions and procedures (see functional building blocks 2.6, 2.8 and 2.5). After having the above key remaining decisions clear, the license conditions and procedures can be defined. License terms and conditions will have to be stipulated for the spectrum/operating rights for the common multiplex operator and the content rights for the pay-tv/commercial SP;
5. Consultation with market parties and political endorsement. Before deciding the licensing regime (to include licensing framework, conditions and procedures), the NRT can organize a market consultation to check the validity and market support for its plans. Given the number of directly involved market parties on the Jamaican television market (see also Figure 1 in this report) this might be organized in a closed set-up with invited parties only. After market consultation, the NRT can support its proposal to the politicians with the feedback acquired in this consultation. Finally, the licensing regime can be officially published after the regime has been endorsed. Sufficient time should be incorporated in the DSO/ASO planning for this endorsement;
6. Assignment of licenses. These assignment procedures entail:
    a. Assignment of the spectrum and operating rights to the common multiplex operator (by priority or public tender), and;
    b. Assignment of the broadcast rights to the pay-tv SP (by priority or public tender).

3.4.5 Phase 4 Planning and implementation DTTB network

This Roadmap Phase can only commence when the common multiplex operator has been established and regulations are in place to arrange for the service levels and pricing of the DTTB transmission services (including a Reference Offer and OPN rules).

The aim of the DTTB implementation Phase is to have the DTTB networks deployed and in operation and the ATV networks switched-off in accordance with the ASO Plan (including the planning and the budget). In this implementation Phase the (inter)nationally coordinated frequency plan is translated into a network rollout or implementation planning. As mentioned in the second Roadmap Phase (ASO planning), the ASO planning comprises a ‘Network Plan & Roll-out’ work stream or result path. The network implementation planning feeds into this work stream.

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

Inputs

The input data for this Phase are the License procedure and planning (including the license terms and conditions) and the (inter)national coordinated frequency plan from Phase 3.

Outputs

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

- DTTB implementation plan. Other than the actual DTTB network rollout planning, this plan also includes the project management structure and resources (including tasks, responsibilities and escalation procedures), detailed and broken down project budget and operational/financial progress reporting;
- Detailed coverage presentations. As the network deployment progresses the coverage predictions become definite (i.e. when the sites have been equipped and no changes can occur anymore). These detailed coverage predictions or presentations will feed into work stream Communication of the ASO plan. See also Section 4.6.3;
- Notifications to SMA that DTTB stations have been installed. SMA as the national spectrum manager should be notified by the common multiplex/network operator that stations are ready to be taken into operation. In the ASO planning a timely reporting of these Notifications to SMA should be taken into account as to avoid that this activity will be part of the critical path;
- Notifications to SMA that an analogue TV transmitter has been switched off by the ATV broadcasters (CVM and TVJ). For the purpose of updating its National Frequency Register SMA also has to be notified when an analogue transmitter is taken out of operation;
- Order to take a DTTB transmitter into operation. After checking compliancy with the DSO/ASO planning the NRT issues an order to the common multiplex/network operator to bring the site into operation.

Roadmap

The Roadmap of the fourth Phase and the associated functional building blocks are shown in Figure 14. The figure also shows the relationship with the other work streams, which should be coordinated with the planning and implementation of the DTTB network (see the grey blocks in the top half of the figure). Although it was decided to have functional building blocks 4.6, 4.8 and 4.9 outside the scope of the Roadmap (see Section 3.3), the common multiplex operator should report to the NRT on these activities. Hence a short description on these blocks is included in this Section. The decisions taken, partly taken and not yet taken on the key topic and choices per functional build block are indicated in Annex 1: Checklist.

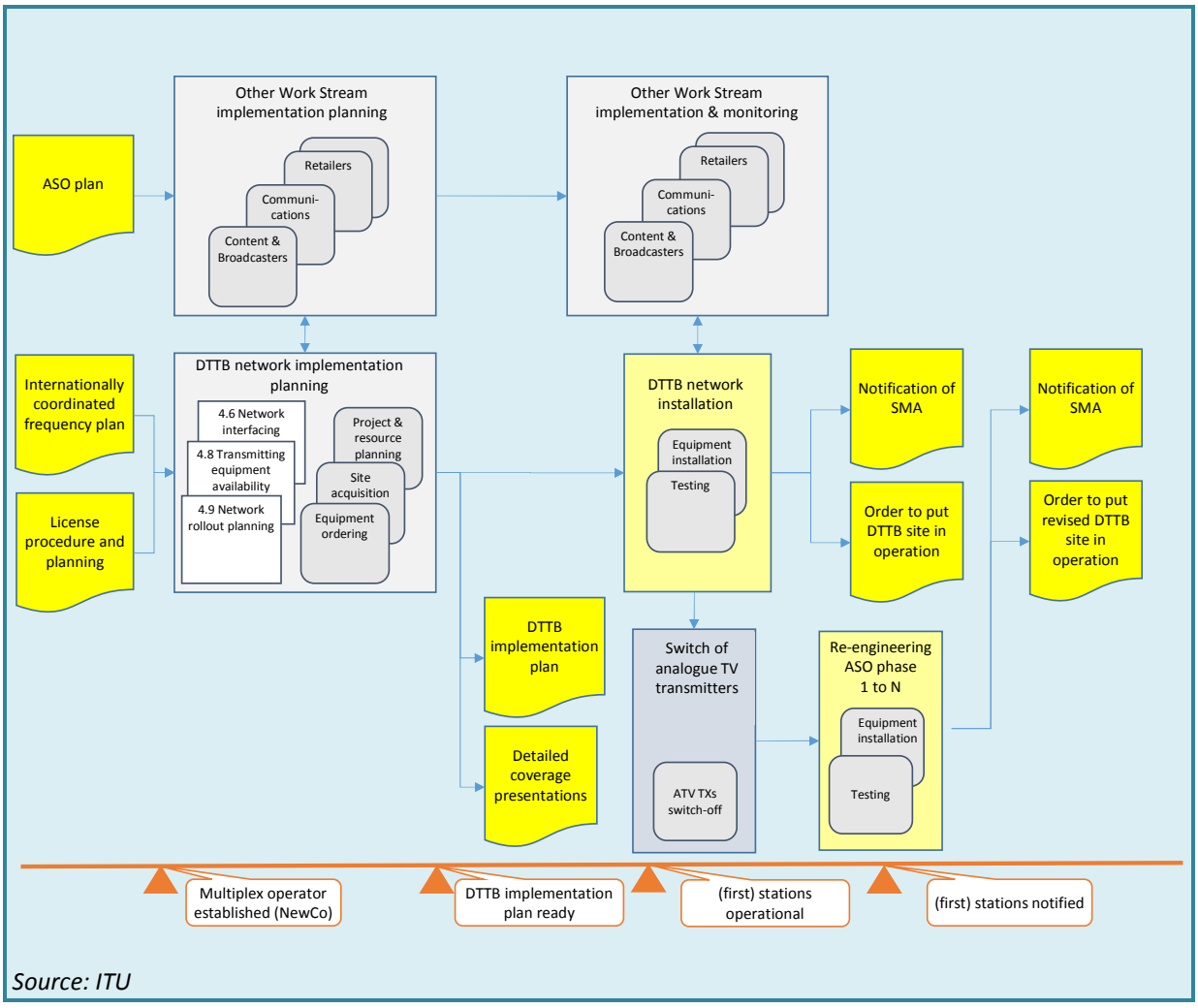


FIGURE 14: PLANNING AND IMPLEMENTATION DTTB NETWORK (PHASE 4)

As Figure 14 shows, the following steps (i.e. functional building blocks and non-DTTB specific activities) are included in the fourth Phase of the Roadmap:

1. Developing and executing the DTTB network implementation planning (see functional building blocks 4.6, 4.8 and 4.9). Developing the network implementation planning entails a large amount of work and the functional building blocks of the Guidelines cover an important part of this work but not all. The Guidelines blocks cover the actual design and implementation of the network infrastructure ranging from the head-end(s), distribution network, transmitter sites, monitoring system and all interfaces of this infrastructure (see also Annex 4: DTTB network cost drivers). For developing and executing a DTTB network implementation planning other critical activities will have to be incorporated in the planning, including:
    a. Project management. This includes the project structure and resources, budget management and reporting and progress reporting (not only to the multiplex operator's project team members but also to the NRT);
    b. Site acquisition. Although an important part of the transmitter sites are already present (the first 14 sites), new sites may have to be acquired for completing the

network (for near nationwide coverage – see Table 2). This may include long preparations (e.g. meeting/negotiations with local councils, land owners, public hearings, etc.);

c. Equipment ordering. Network equipment ordering is not an off-the-shelve ordering process. Manufacturers tend not to keep transmitters in stock. Production times are long (i.e. 3-6 months and beyond). Also the testing and acceptance procedures can take several stages (for example, in-factory testing, on-site testing and end-to-end testing);

2. DTTB network equipment installation. An important part of the installation process is managing the available resources. In case the installation process is outsourced to the supplier/manufacturer, this capacity planning will be part of the equipment ordering process. It should also be considered that the multiplex operator (function) will be just established and people and processes might not be fully in place. Hence capacity might initially be limited;
3. Switching off stations (by CVM and TVJ). As the DTTB network implementation planning is part of the ASO Plan, analogue transmitters will be switched-off too. It is important that this will not only be reported to the SMA (so that they can update their National Frequency Register) but also coordinated and agreed with the NRT. These reports will feed into the work stream 'Consumer & Market monitoring' too. In this work stream this information will be used to monitor the progress of the ASO process and improve the logistics and communications;
4. Re-engineering DTTB network sites. Cross border spectrum restrictions might change during the network roll-out. This could entail frequency changes to sites that are already taken into operations. Re-engineering of these sites might be necessary. Special care should be taken for avoiding service interruptions. For this reason solutions with temporary frequencies and carousel like planning methods are not uncommon in the network implementation planning. The approval procedures for these re-engineered sites are no different to the approval procedure for new sites, as explained above.

3.4.6 Phase 5 License administration

The objective of the License administration Phase is to check compliancy with the issued license (to the multiplex operator), to update the National Frequency Register and to notify the ITU of any new DTTB station put into operation, as well as ATV stations taken off-air.

The same procedure also applies for changing the station characteristics (e.g. when restrictions on the digital transmissions have been lifted or temporary frequencies are replaced) and when taking stations out of operations. In the latter situation no approval will be issued by SMA. However, as indicated before, the NRT will have to approve of the switch-off of the ATV transmitters.

Inputs

The input data for this Phase are the notifications of the common multiplex operator to SMA.

Outputs

The Phase will have two outputs:

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

Roadmap

The Roadmap of the License administration Phase and the associated activities is shown in Figure 15.

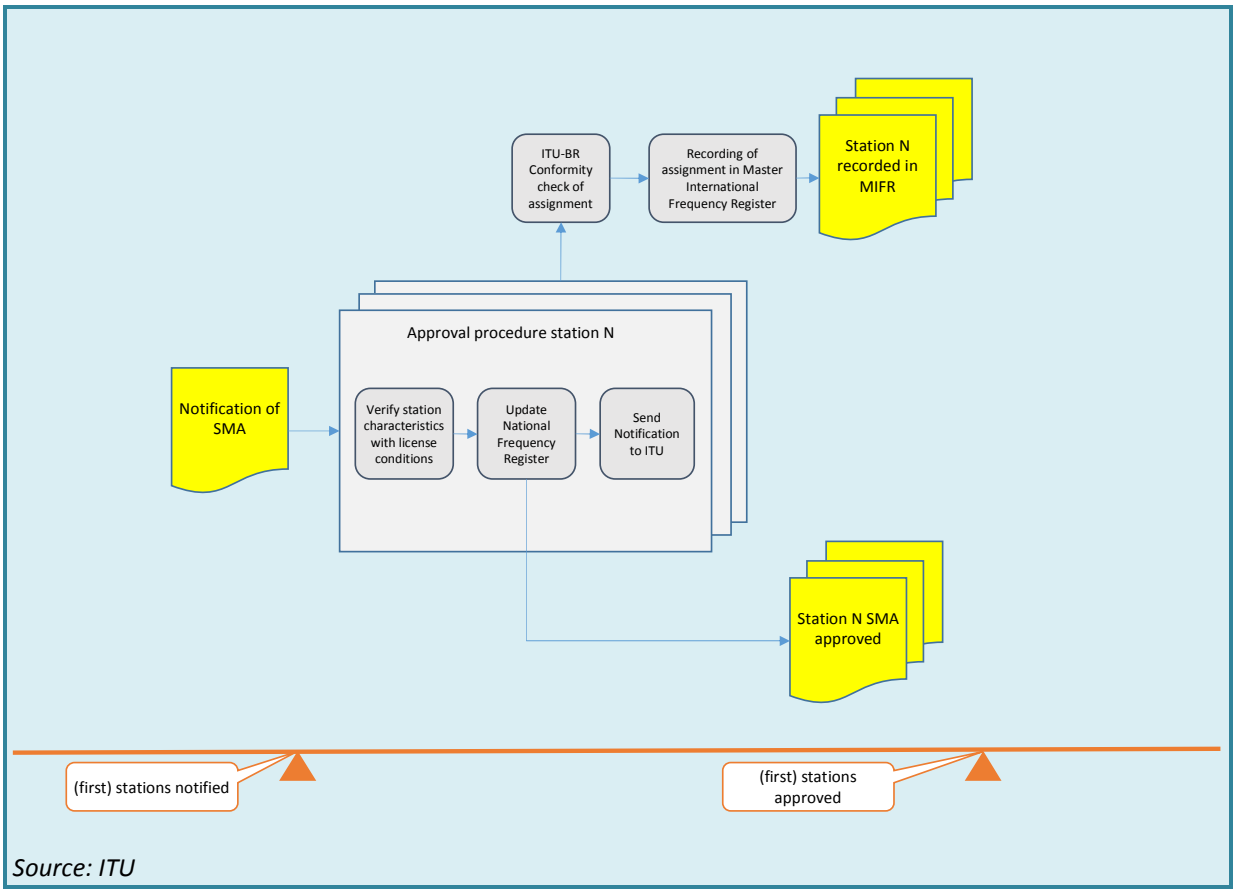


FIGURE 15: LICENSE ADMINISTRATION (PHASE 5)

As Figure 15 shows, the following activities are included in the fifth Phase of the Roadmap:

1. Approving the subsequent DTTB stations. After having checked respectively the spectrum license compliancy SMA will issue an approval to the multiplex operator. SMA will then update its National Frequency Register and will notify the ITU-BR of the new DTTB station;
2. Recording of the assignment in the MIFR. The recording of a frequency assignment in the Master Register is preceded by various checks, including:
    a. Conformity with the Table of Frequency Allocations and the other provisions of the Radio Regulations (regulatory examination); this examination consists in

checking that the assignment (frequency, class of station, notified bandwidth) does indeed correspond to an allocation in the Table of Frequency Allocations in Article 5;

b. Conformity with the procedures relating to coordination with other administrations applicable to the radiocommunication service and the frequency band concerned;
c. Conformity with regional allotment or assignment plan and the associated provisions.

4. Top-6 most critical topics

During the country visit eight functional building blocks were selected as most important. In this Chapter these selected blocks are grouped together in a top-6 most critical key topics and discussed in more detail. The order of addressing the topics in this section does not express their level of priority or importance. The planning of these topics is indicated in the Roadmap (see Section 3.4).

Please note that the top-6 not necessarily correspond to the full scope as addressed in the functional building blocks of the ITU Guidelines. Also parts of two additional functional building blocks (3.2 and 4.3) were added to complete the composition of the top-6.

Table 4 provides an overview of the top-6 most critical key topics.

No	Topic	(Part of) FBB
1	Technology standards	2.1
2	Licensing framework	2.2 and 2.5
3	Service proposition	3.2
4	Business model and financing	2.9 and 3.4
5	Frequency plan	2.4. and 4.3
6	ASO Plan	2.16 and 2.18

TABLE 4: TOP-6 MOST CRITICAL TOPICS AND CHOICES

4.1 Technology standards

This Section covers first an overview of the current developments in the ATSC and compression standards. This overview is followed by future technology choices to be made when migrating to HD services.

4.1.1 Transmission and compression standard

In Jamaica the ATSC standard has been proposed to be formally adopted as the digital television transmission standard (see also Annex 1: Checklist). The ATSC transmission standard is adopted by industry and published by the ATSC under document A/53: “ATSC Digital Television Standard, Parts 1-6, 2007. ATSC A/53 is also referred to as ATSC 1.0. In this standard the compression technology for video is MPEG-2. In an addition to the A/53 standard, document A/72 (Parts 1- 3, 2014) describes how H.264/MEPG-4 video signals (also referred to as AVC) can be carried over an ATSC system. In Jamaica MPEG-4 was also selected as the compression standard.

It is important to note that the successor of the ATSC 1.0 standard, ATSC 3.0, is still under development within the ATSC and should not be confused with the following ATSC standards adopted or under development:

1. ATSC MH or Mobile DTV standard (A/153, Parts 1-10, various dates): this standard defines the technical specifications necessary for broadcasters to provide new services to mobile and handheld devices using their ATSC transmissions (i.e. an in-band system);
2. ASTC 2.0 or interactive service standard (candidate standard, A/105, April 2014): This standard allows the broadcaster to connect broadcast programming with additional services related to that programming. It is backward compatible with ATSC 1.0 so that digital receivers don't need to be replaced.

Whereas the ATSC 1.0 system is a single carrier system, the ATSC 3.0 system is a multi-carrier system/OFDM system[52]. Such a multi-carrier system is fundamentally different from the single carrier system so that ATSC 3.0 is not backward compatible with ATSC 1.0 or ATSC 2.0. Hence the adoption of an ATSC 3.0 standard can only be justified if a significant performance improvement is achieved.

The development of the ATSC 3 standard is divided into different parts and the core part the 'Physical Layer' is in the phase of call for proposals and one of the proposals claims a data throughput increase of 30% and improved multipath performance for fixed and portable TV reception, as compared to the ATSC 1.0 standard[53].

In addition, the ATSC 3.0 is currently tested in combination with the new encoding standard H.265/HEVC[54] for the transmission of Ultra HDTV (UHDTV or 4k) services. This compression standard will need only half the bit rate of its predecessor, H.264. Currently the H.265 is already deployed (notably in the Internet domain) and is expected to be phased-in in high-end digital television receivers. In the case of ATSC receivers it is very likely that only with the introduction of ATSC 3.0 H.265 will be introduced. Although theoretically H.265 encoded services can be carried over ATSC 1.0 it is unlikely to happen as this will also require a new receiver, i.e. a replacement of the installed base of ATSC 1.0/H.264 receivers.

At this moment it is difficult to assess when the ATSC 3.0 will be standardised and ready to be incorporated in mass produced receivers. In ATSC the standard is still under developed and has not been proposed yet as a candidate standard (like ATSC 2.0)[55]. The original planning for ATSC 3.0 to be adopted by the ATSC as an industry standard was 2016. It is unclear if this deadline will be met. Only after ATSC adoption it can be proposed to the ITU-T to be set as a global ITU standard.

[52] See also ITU-R BT.1306-6.

[53] It should be noted that this throughput or payload capacity increase is an average number and in practice it will dependent on the selected system variant, applied frequency and type of content carried.

[54] Also other 2nd generation transmission standards, i.e. DVB-T2, are currently testing the H.265 compression technology (for the transmission of 4k/UHDTV services). For the H.265 standard please refer to ITU-T REC H.265 (10/2014).

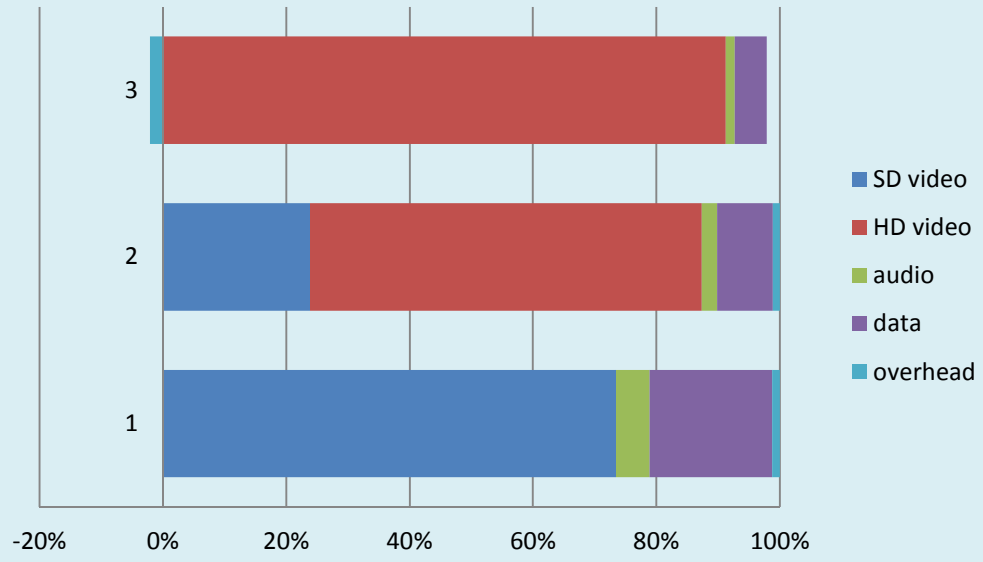
[55] As the ATSC 3.0 standard will incorporate a large part of the ATSC 2.0 functionality (and also the ATSC MH functionality), it may frog leap the ATSC 2.0 standard in the sense that manufacturers will not (continue to) invest in production lines for ATSC 2.0 receivers.

4.1.2 Future technology choices

As included in Table 2 (DSO/ASO objectives) it was stated that the migration from SD to HD services *may* dependent on the introduction of the more transport efficient ATSC 3.0 standard. This choice is dependent on the required minimum number of HD services and the level of investment the business case can carry at that time (after 2019).

With the current choice for ATSC 1.0/H.264 it can be assessed how many SD and HD service can be carried in a single multiplex[56]. Figure 16 shows the number of services in a single multiplex under the following loading scenarios:

1. 11 SD services only;
2. 2 HD and 3 SD services;
3. 3 HD services only.



Source: ITU

FIGURE 16: MAXIMUM LOAD SCENARIOS FOR A SINGLE ATSC 1.0/H.264 MULTIPLEX

Under the assumption that the maximum payload of 19.39 Mbit/s is available (and this will dependent on the required signal robustness) and statistical multiplexing can be applied, Figure 16 shows that these are the maximum load scenarios for an ATSC multiplex as little or no overhead remains. Considering the DSO/ASO objectives (see Table 2), the following can then be concluded:

[56] See for more details Annex 2: Service trade-off and network planning.

1. The launch proposition of 25 SD services cannot be completely facilitated in two multiplexes (2 times 11 services). However reducing the picture quality a little bit can make 25 SD services fit;
2. The five multiplexes that would be made available after ASO (after 2019) can either fit:
    a. 8 HD services and 23 SD services (4 multiplexes with 2 HD + 3 SD and 1 multiplex with 11 SD services), or;
    b. 10 HD services and 15 SD services (5 multiplexes with 2 HD + 3 SD), or;
    c. 15 HD services only (5 multiplexes with 3 HD services).

The loading scenarios under 2b and 2c would imply that the pay-tv provider will have to reduce its number of television services (of ~17 of the initial package). This is assumed to be unacceptable as a way forward after 2019. Hence only scenario 2a remains feasible but will imply that the pay-tv operator can't migrate its services to HD. A requirement to have HD services also in the pay-tv bouquet will imply either:

1. The adoption of a second generation standard (ATSC 3.0), which comes with H.265 (and hence with a 30% payload and 50% encoder gain), or;
2. Increase the number of multiplexes beyond the five planned.

As said, it is currently unclear if mass produced ATSC 3.0/H.265 receivers will be available (and at competitive price point) by 2019. The uncertainty around this introduction date works both ways. The ATSC 3.0 introduction may be late and hence the installed base of ATSC 1.0 larger. Or the introduction is early and the installed base smaller. This installed base of ATSC 1.0 receivers has to be phased out gradually. Hence a 'simulcast' is required of the ATSC 1.0 services onto the ATSC 3.0 multiplexes. This simulcast will require a capacity reserve as the same service is broadcasted twice.

4.2 Licensing framework

In Jamaica a decision on the licensing framework (model A or B) has not been made yet. In Chapter 3 model B was assumed for drafting the national Roadmap. In this Section, first the pros and cons of each model are discussed on the basis of policy objectives a National Regulatory Authority (NRA) may have. Secondly further key decisions and aspects are presented if model B would be formally adopted. It should be noted that only the choice between the basic models is presented here. In practice many variants can be made on the basis of these two basic models.

4.2.1 Model A and B

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

1. *"Spectrum management objectives*: In order to increase spectrum efficiency the NRA would like to avoid content duplication". In both models this can be accomplished if:
    a. In (a variant of) model A: the spectrum rights are awarded in combination with an obligation to provide a defined bouquet of channels, for example as proposed in the bid book, to broadcasters. This bouquet should make use of all available capacity (so no capacity is left unused) and between broadcasters services should not be

duplicated. It may also be necessary to stipulate the quality of services as to avoid unwanted content or many repeats. Also the spectrum license conditions should be specified on the basis of a detailed service or network planning (see Annex 2: Service trade-off and network planning) stipulating exactly the spectrum use (including site location, antenna height, ERP, and antenna diagram). It seems doubtful if the broadcasters can provide a viable business plan for filling their multiplex capacity with a complete bouquet as content production/purchase costs are high[57]. As Jamaica has opted for SD services and ATSC 1.0/H.264, each multiplex should be loaded with 12-13 services;

b. In (a variant of) model B: the spectrum rights are award to one (or two) common multiplex/network operator. This operator rolls-out the network on the basis of a detailed service planning. In addition the NRA grants capacity to individual broadcasters (in a transparent and non-discriminatory way) and does not assign capacity twice for the same service in the same area;

2. *"Competition rules and objectives*: the NRA would like to see the introduction of a new competing platform next to a dominant (e.g. satellite or cable) platform". The relevancy of this consideration in Jamaica seems limited. The satellite platform (DTH) has a very small market share of below 1% (5k out of 845k TVHHs). For the cable platform only in the areas where there is no terrestrial platform a dominant market position may be present. This situation can only apply up to a maximum of 10% of the Jamaican territory (as TVJ's network is assessed to cover 90% of the island). However, in both models this objective of introducing a competing DTTB platform can be met by the NRA exercising control over the assignment of broadcast rights:

   a. In model A: the broadcast rights (together with the spectrum and operating rights) are assigned to the broadcasters which are NRA approved;

   b. In model B: the broadcast rights (i.e. capacity slots on the multiplex) are assigned to the individual broadcasters, also NTA approved;

3. *"Market structure and environmental objectives*: in order to avoid duplication of infrastructure". Given the situation in Jamaica:

   a. In model A: by assigning the broadcast and spectrum rights *directly* to the broadcasters (and no further stipulations), the broadcasters will each of them roll-out their own network. It is doubtful whether these broadcasters can draw a viable business case for such digital operations. This disadvantage of infrastructure duplication can be somewhat reduced if the NRA enforces operating rules. In other words, the NRA imposes site and, possibly, antenna sharing obligations between broadcasters. Such an arrangement only 'loosely' avoids infrastructure duplication;

[57] Please note that in the USA spectrum rights were assigned to broadcasters (i.e. 'networks') at the time of ATSC 1.0 and MPEG 2. In addition, the broadcasters who picked-up a license had to provide HD services. A single multiplex could carry one (or at best two) HD services. Under these circumstances multiplexes were fully loaded.

b. In model B: by assigning only one license for the spectrum (and operating) right to a common multiplex/network operator, the NRA ensures that only one network will be deployed. It is not recommended to have two network operators each deploying a multiplex. For more details on this see Section 4.2.2);

4. *"Media rules and objectives*: "the NRA would like to see the analogue television services continued onto the digital platform(s)". Assuring this objective can be facilitated in both models:

   a. In model A: including a '*must carry*' rule in the broadcast license. The broadcasters have the obligation to have at least one service in the multiplex that is the same as their current analogue service. In addition it should stipulate that the digital service should cover at least the same area as the analogue service. In Jamaica the must carry rule has been formulated wider, not only to include the current analogue terrestrial services but also six cable provided services. This requirement makes model A not a viable option as CVM and TVJ would be required to carry third parties' services. Consequently model B would have to be adopted;

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

As the above considerations show, model A will lead to considerable spectrum inefficiency (as broadcasters cannot finance the content production costs and multiplexes will not be fully utilized) and seems only possible if major concessions are made to the DSO objectives (i.e. no 25 services and no 'must carry' of eight incumbent services).

4.2.2 Model B considerations

Assuming model B will be adopted, a multiplex/network operator will have to be formed by separating the network activities from CVM and TVJ. This can be accomplished by establishing a new legal entity (NewCo) or by creating a network department within CVM and TVJ (in combination with accounting separation). These important decisions should be further detailed in its consequences for the DTTB licensing policy and regulation.

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

1. *Spectrum and operating rights*: as indicated in Section 3.4.4 licenses should be assigned to one or two multiplex operator(s):
   a. First the NRT should decide if one or two multiplex operators should be established. As financial resources are limited in Jamaica, the most efficient DTTB deployment should be pursued. Although tower and antenna sharing rules can be established, large inefficiencies and deployment challenges remain[58]:

[58] Only by very stringent regulations these inefficiencies and deployment challenges can be reduced, resulting in practice in an operating model as if the infrastructure was run by one operating entity.

i. Redundant active equipment (e.g. redundant transmitters, multiplexers, network management systems, etc.) will be deployed twice as both network operators will have to guarantee service levels;
ii. Loading of multiplexes will have to be regulated as to avoid that service providers (i.e. the clients of the network operators) will favour one operator above the other and capacity will be left over and clients not served. This will also include a decision on the split of the must-carry services between the network operators;
iii. Deployment capacity and planning of both network operators will have to be actively managed by the NRT as to ensure service availability of the whole bouquet at each deployment stage;
iv. Detailed network design (for example the distribution technology for delivering the transport stream to the transmitter sites could differ) should be monitored closely as to avoid different network performances;
v. Procedures should be stablished and incorporated in the license terms and conditions for the exchange of Service Information (SI) for loading the Electronic Programming Guide (EPG) and System Software Updates (SSU);

b. In case of assigning these spectrum rights directly (by priority) to a multiplex operator, a legal basis should be found for assigning these rights in this way. Next to this legislative aspect, the NRT should define:
   i. Duration of the rights. For what period and also when spectrum can be revoked or extended;
   ii. Roll-out obligation which stipulates the speed in which sites and services will be deployed. Once the public-private partnership is agreed, it is advised that the pay-tv operator participates in the NRT and that the network roll-out is jointly planned and managed;
   iii. Must carry regulations. The multiplex operator should first reserve capacity for the eight 'must-carry' services. Only remaining capacity can be offered for other (pay-tv) services. In the first stage of the DTTB deployment, with only two multiplexes, this reservation is clear (see Table 2). The second stage (after 2019) the order of reservations for the following should still be agreed and endorsed formally:
      - Eight incumbent services from SD to HD[59];
      - Increase of the number of SD pay-tv services (this implies access to the market of new television services);
      - Incumbent pay-tv services from SD to HD (reversely this implies limited access);
      - MTV capacity;

[59] Please note that this reservation should also stipulate whether the eight incumbent services should be continued to be broadcasted in SD for a certain period, as HD services will require HD receivers (including 16:9). Modern digital receivers will be able to handle both services. However older IDTVs may not. It should be checked at that time how many of these older IDTVs are still deployed (likely to be very low).

iv. License fees to be paid. The multiplex operator might be exempt from paying any license fees. However, this will require a legal justification as to avoid anti-competition claims. Especially considering that Jamaican cable operators are not license fees exempt;
v. Other license conditions. Please refer to the Guidelines section 2.6 'License terms and conditions';

2. *Broadcast rights*: (a group of) private parties may offer the pay-tv service package. The NRT should have the objective to have a joined roll-out between the FTA services and the pay-tv services. In this way a comprehensive and single DTTB offer can be launched into the market. Hence the license procedure, terms and conditions should include:
    a. Aggregation rules stipulating the number of capacity slots and multiplexes a single SP can acquire (in subsequent tender procedures – if this assignment instrument would be adopted and not by priority). The basic aggregation rules are already included in Table 2;
    b. CAS requirement stipulating which services can be encrypted. It was decided in the NRT that the eight incumbent services would be broadcasted FTA and that the remaining services could be broadcasted as pay-tv services. However this does not necessarily imply that FTA services are not encrypted. It could be that smartcards can be obtain free of charge and that no charges apply for receiving the FTA services decrypted. This model is commonly applied for satellite television services, including also FTA services. For satellite distribution this is however applied to limit the content rights to be paid (as the footprint spans often more than one country/one region). For terrestrial services this situation does not usually apply. Although such a system can increase the uptake of pay-tv services as potential DTTB viewers should first contact the DTTB SP for such a free smartcard (and hence provide a sales opportunity);
    c. Obligation to promote and communicate the DTTB bouquet together with the other FTA services. It is advised that the pay-tv SP participates in the NRT and will help drafting the Communication Plan;
3. *Open Network Provisioning rules (ONP):* when having a multiplex operator it is good practice to formulate some basic ONP rules, including[60]:
    a. Grounds for refusing requests for carriage (i.e. to be distributed);
    b. Rules for capacity reservation;
    c. Maximum and/or minimum capacity to be allocated to one single service;
    d. Fair and transparent pricing of carriage and the associated service levels(i.e. the DTTB distribution fees to be paid)[61];
    e. Publication of access and pricing rules.

    Service levels and pricing of the DTTB distribution fees can be regulated by having the multiplex operator preparing a Reference Offer (RO). A reference offer is a binding offer from the multiplex operator in which the distribution service is defined, as well as the service

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

[61] For example SD and HD services can charged differently.

levels and pricing. DTTB broadcasters can only distribute their television services by contracting the multiplex operator. Consequently this DTTB network provider has an exclusive position. In the case of CVM/TVJ having a network department or both of them having a significant shareholding in the multiplex operator, CVM/TVJ would simultaneously carry out network and service provisioning in the same television market. Hence to ensure a level playing field between service providers, it is critical that the BC requests the multiplex operator to publish, in sufficient detail, a RO for these network services. The RO subsequently has to be approved by BC. More details are provided in Annex 3: More details on Reference Offers;

4. *Scope of activities and assets of the multiplex operator*: The NRT will have to decide the service portfolio of the multiplex operator. This will be determined to a large extend by what assets and activities (people) will be transferred from CVM/TVJ. Based on experience in other countries, it is common practice to split off all distribution services to include infrastructure and people for television and radio services (including head-end equipment and the distribution network to the transmitter sites). It is also advised to transfer all the current analogue transmitter (sites) and associated activities to the multiplex operator and not only the antennas and towers. In this way the separation is clear and resources will be shared as little as possible. In addition the business planning for the common multiplex operator will be easier. The operator should be sufficiently financed to cover all network related ASO costs, including CAPEX for rolling out multiplexes and OPEX for running the analogue (simulcasting) and the digital networks;
5. *Accounting separation*: in the case of a wider service portfolio (radio and television) and in order to provide fair and transparent pricing a sound financial administrative set-up will be required (for both the CVM/TVJ network departments as for a separated multiplex operator). This administrative system should allow for accounting separation (i.e. the direct and common costs can be allocated in a transparent way to the individual services or cost 'carriers'). It should be noted here that allocating costs to the different services may not stop at the level of the multiplex. It may be required that clients of the multiplex operator will request a capacity slot in a limited coverage area. Consequently the price per so called 'point of service' (i.e. per site for a specific frequency) should be made available (see also Annex 3: More details on Reference Offers);
6. *Special duties*: the multiplex operator may have assigned special duties of national interest. For example resolving interference issues or providing national disaster services. The first one may cover carrying out investigation and proposing solutions when interference on equipment and other spectrum users occur.

4.2.3 License terms and conditions

Under the model of the public-private partnership, the spectrum and operating rights have to be assigned to the multiplex operator and the broadcast rights to the single pay-tv provider. The corresponding license terms and conditions should cover obligations, rights and incentives. Table 5 provides an initial overview of possibilities.

License	Obligations	Rights	Incentives
Spectrum and operating license for MUX operator	• Coverage targets, service levels and pricing as included in the approved RO	• Exclusive spectrum and operating rights	• A guaranteed (long) period of exclusivity • License fee and/or tax exemptions • Capacity reservations for offering own (additional) television services
Broadcast license for pay-tv SP	• Providing an approved service line-up in agreed quality (SD/HD) and with a minimum number of broadcast hours • Providing viewers with assistance for acquiring STBs, DSO/ASO information and installation aid	• Exclusive broadcast rights	• A guaranteed (long) period of exclusivity • License fee and/or tax exemptions • Capacity reservations for extending the pay-tv service offering

TABLE 5: LICENSING OPTIONS

Table 5 provides an initial overview and any obligations, rights and incentives should be balanced against the DSO/ASO cost/financing contributions. Such balancing will take place in the negotiations on the public-private partnership. As the network costs are a key cost element in the DSO/ASO process (see Section 4.4.1) a cost model should be developed that can cater for different scenarios (see also Table 7).

4.3 Service proposition

The competitive advantage of the DTTB offering will be of crucial importance to the public-private partnership agreement (see Section 2.4 and 3.4.3) as this partnership is proposed to finance the DSO/ASO process.

Table 6 below provides an overview of the service coverage areas of the main television platforms in Jamaica, expressed in household (HH, which equals to 880k in Jamaica) and percentages (i.e. the potential market)[62]. It also includes an estimate of service uptake per platform, expressed in the actual number of viewers/subscribers and as percentage of total number of television households (845k).

Platform	Service coverage area		Service uptake	
	% HH	HH (k)	Subs or TVHH (k)	% TVHH
Satellite – pay-tv services (Ku-band)	~95%	810	5	<1%
Cable – pay-tv services	18%	160	155	18%
ATV – FTA services (TVJ)	90%	792	638	75%

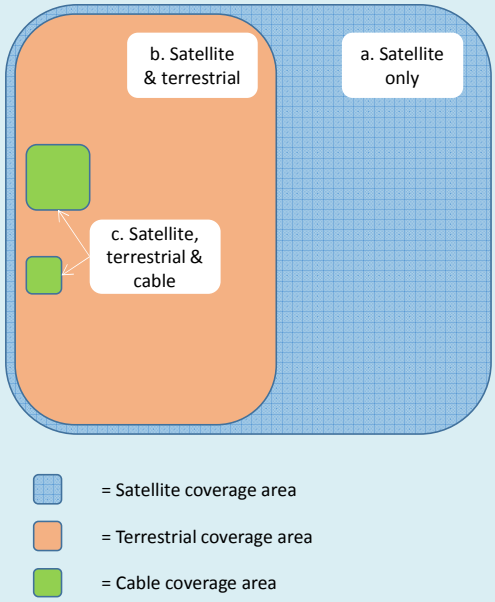
[62] Data taken from Figure 1.

TABLE 6: MAIN TV PLATFORMS AND MARKET SHARES IN JAMAICA

From Table 6 the following can be concluded that:

1. The satellite offering has a footprint not covering the whole of Jamaica. As noted before this offering is not officially intended for Jamaica and the footprint may change as content rights owners may require the satellite operator (Direct TV/Dish Network) to change/limit the satellite's footprint. Also the offering is not supported in Jamaica (i.e. there is no service provisioning in Jamaica– see also Figure 1). Hence service availability is not guaranteed to these viewers;
2. The cable offering has an uptake of (18%) of the TVHH and the average price is approximately 10 USD/month for a service package of 50 SD services, which is apparently well within the range of the willingness to pay;
3. The analogue terrestrial network coverage is assessed to be reaching 75% of the TVHHs. As discussed in Section 2.2 it may that not all of these TVHHs have two services (CVM and TVJ). Here it assumed they do;
4. There are three principle reception situations for households in Jamaica (illustrated in the Figure 17)[63]:
    a. Areas with just satellite reception (with a relative large number of services). Given an assumed network coverage of the analogue terrestrial network of 90% and the cable networks only being present in urban areas, these satellite areas are theoretically 10% at the most (i.e. 100% - 90%, assuming a complete overlap between terrestrial and cable networks);
    b. Areas with satellite and terrestrial reception (approximately 90%). The number of terrestrial services is two (CVM and TVJ) in all ATV coverage areas. There are no regional ATV services or regional broadcast windows;
    c. Areas with satellite, terrestrial and cable reception. These areas are actually limited to the urban areas.

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



Source: ITU

FIGURE 17: DIFFERENT RECEPTION SITUATIONS IN JAMAICA

It is assumed that in the areas with only satellite (situation a in Figure 17) the number of TVHHs is very low (as the penetration of satellite subscribers is very low and the ATV covers 90% of the island). Consequently the DTTB service offering has to initially compete on two basic markets:

1. Non-cabled areas (situation b in Figure 17). In these areas analogue terrestrial viewers will compare its current analogue offering (including 2 services) with the costs of switching to satellite or DTTB (next to comparing the channel line-up). This is comparing the purchasing costs for a DTTB STB and antenna (including any subsidies/vouchers) to the satellite STB and dish. For ATV viewers with also satellite this trade off will be different (they may decide not to switch to DTTB);
2. Cabled areas (situation c in Figure 17). In these areas people will have to decide between the DTTB, satellite and the (digital) cable offering.

In the following Sections these two basic markets are further analysed.

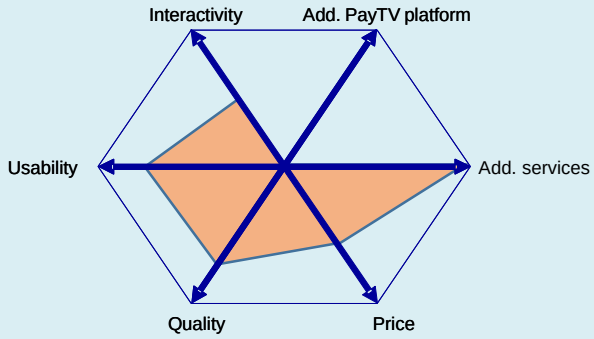
4.3.1 Non-cabled areas

The Guidelines (see Section 3.2.1) identifies six competitive advantage categories. Applying these categories on the Jamaican non-cabled areas (where satellite is the only alternative after switching off ATV services) result in the following considerations:

1. *Interactivity/enhanced television services*: the DTTB platform could offer interactive service as a competitive edge. However without any return path, these interactive services are limited to services like the Electronic Program Guide (EPG), additional program information and enhanced teletext. These services are also offered on the satellite platform and hence little competitive edge can be expected in this category;

2. *Additional pay-tv platform/conditional access and billing facilities*: as DTTB platforms can easily be equipped with conditional access and billing facilities, it could provide service providers/broadcasters a platform to launch pay-tv services, such as tiered television packages, pay-per-view offerings and pre-paid facilities. It should be noted that in the case of a combined pay-tv/FTA offering the possibilities of offering tiered television packages is relatively limited on a DTTB platform (even with 5 multiplexes), let alone the cost consequences for content production/sourcing. On satellite the possibilities to create packages and tiers are almost endless. For ATV viewers billing is not an advantage in itself;
3. *Additional services/multi-service offering*: in Jamaica the ATV platform offers only 2 services. The introduction of a multi-service DTTB offering could be a key demand driver. As the DSO/ASO objectives states (see Section 2.4) Jamaica intends to launch two multiplex carrying 25 SD services. This advantage should be handled with care as satellite offers a multi-service line-up too (pay-tv satellite). Compared to satellite the DTTB platform is faced with a lower distribution capacity. However the satellite service providers operate in a higher price range (i.e. receiver installation and subscription prices). Hence the DTTB platform does not necessarily have to compete directly with satellite;
4. *Lower costs (one-off and recurring)*: The DTTB platform in Jamaica has the advantage of having lower receiver costs as compared to satellite. Especially the one-off costs form a major barrier for consumers to adopt digital television. DTTB STB retail prices are in the range of USD 20 and don't require any installation (and consequently an installation fee to be paid). The recurring costs (i.e. the pay-tv services in the DTTB service line-up) can be lower as the number of services is significantly lower than on satellite. It should be noted however, as the DTTB launch is part of an ASO process (a government led operation), low purchasing costs (including subsidies/vouchers) for the Jamaican people is really a prerequisite rather than a competitive edge;
5. *Picture and reception quality*: The introduction of DTTB could entail for many Jamaican viewers a significantly better picture quality. Most terrestrial viewers have an indoor reception installation (the so called 'rabbit ears') or a 'coat hanger' in an ATV network that was basically designed for rooftop reception. Viewers will have distorted reception and picture quality due to multipath propagation under indoor reception conditions. This does apply less to viewers with rooftop antennas. However, the number of rooftop antennas is limited in Jamaica. Hence this could provide a competitive edge for DTTB and will help ATV viewers to migrate to DTTB;
6. *Usability/Portability*: DTTB services are wireless and can be received on compact receivers. Hence DTTB services have the competitive advantage of portability, especially when the receiver comes with a small (active) antenna. In Jamaica DTTB can deliver better coverage and in more places of the home, depending on the selected DTTB system parameters and frequency plan. Accompanied with proper communications, this portability can provide a competitive advantaged, especially compared to satellite reception.

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



Source: ITU

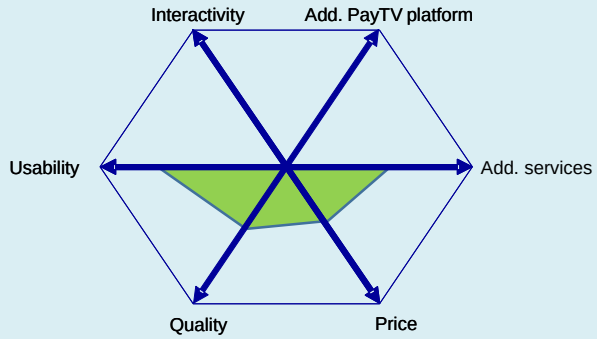
FIGURE 18: DTTB'S COMPETITIVE PROFILE IN NON-CABLED AREAS IN JAMAICA

4.3.2 Cabled areas

When applying the six competitive advantage categories on the Jamaican cabled areas results in different considerations. The following category can be assessed *differently*:

1. *Additional services/multi-channel offering*: As said the introduction of a multi-channel DTTB offering could be the key demand driver. For people in the cabled areas this argument seems to be less strong. The cable networks can offer service bouquets over 50 services. In areas where the cable offering have been in the market for some years the window of opportunity may be gone as people have already switched from analogue terrestrial television to cable. Consequently additional services may be a less stronger competitive edge for DTTB;
2. *Lower costs (one-off and recurring)*: a large portion of cable networks in Jamaica are analogue networks and a STB is not necessary (except for premium packages). Considering this aspect the DTTB offering is not offering an advantage. However the Jamaica cable industry is migrating to digital too. The cable STB is also a 'plug & play' device like the DTTB STB. For satellite providers the tuning of the dish remains a competitive disadvantage as many consumers find this dish tuning too difficult and will call in help;
3. *Picture and reception quality*: For cable subscribers their reference point for picture quality is most likely to be the picture quality of digital cable. DTTB cannot provide a competitive advantage here as cable will always be able to match the DTTB picture quality (as cable networks have far more bandwidth available than the DTTB platform). Hence the argument of having a better picture quality should be handled with care as competition can outperform the DTTB platform on this aspect;
4. *Interactivity/enhanced television services*: Digital cable has the ability to offer a return channel. Integrated interactive services are well developed for cable offerings (including the API on the STB) and hence digital cable has a clear advantage over the DTTB platform. Moreover as most digital cable offerings come very often with so-called 'multi-play' packages (e.g. television, fixed phone, mobile and Internet).

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



Source: ITU

FIGURE 19: DTTB'S COMPETITIVE PROFILE IN CABLED AREAS IN JAMAICA

The above analysis can help in:

1. Positioning and defining the DTTB offering (including pricing), which in turn can contribute to the business modelling and public-private partnership negotiations;
2. Designing the DSO/ASO communications as it shows the different reception situations and what should motivate viewers to migrate to DTTB;
3. Designing the network as it shows what the DTTB offering should be in terms of network coverage, number of services and type of reception.

4.4 Business model and financing

In the NRT financing the DSO/ASO process was identified as one of the key challenges because:

1. Government's financial resources are limited;
2. Television Industry earning capacity is limited as the advertising and pay-tv markets are relatively small[64];
3. Spectrum scarcity is relatively low and hence spectrum auctions will generate low proceeds.

Hence it was proposed to engage in a public-private partnership whereby the cable industry, CVM, TVJ and Government would work together in financing the DSO/ASO process. These partnership negotiations will have to consider:

1. DSO and ASO costs;
2. Public and private revenue sources.

In the following Sections these considerations are addressed in more detail.

[64] A recent industry review by the BC shows that many providers on the broadcasting market are struggling to financially break-even. See "An analysis of the broadcast radio and TV sectors in Jamaica", November 2014 and "An analysis of the Jamaican STV sector", October 2014 (revised November 2014).

4.4.1 DSO and ASO costs

The Guidelines provide in Table 2.15.2 an overview of DSO/ASO cost categories. Table 7 shows the DSO/ASO cost categories for Jamaica.

No	ASO Activity	ASO organisation function	Considerations for Jamaica	Relative costs
1	Migrating viewers to digital	Logistic function for administrating and handing-out vouchers Logistic function for RX antenna retuning and installation Contact centre function for (technical) assistance Customer support function Consumer communication function Media and Public Affairs function	Size of the operations depends on the actual number of ATV dependent TVHHs. Assuming that 483 k (= 638-155 k) TVHHs are dependent the size is considerable (see also Table 6 and Figure 17). Financial impact can be further limited if financial compensations is minimized (see brackets in next column): 1. Selection of cheap set-top-boxes only (no IDTVs); 2. Partly financial compensation (not the whole purchase costs) or loan system (please note this will include interest/finance charge for the Government); 3. Roll-out indoor coverage network, as to avoid roof-top antenna purchase costs (see also Annex 2: Service trade-off and network planning).	++(+)
2	Transmitter network migration efforts	Network planning function	Depends on the actual/final coverage of the DTTB network. The first deployment stage would entail 14 existing sites to be converted to DTTB. The top-3 cost drivers are (a) the number of sites (b) number of multiplexes and (c) the ERP per site. A cost model can help running different cost scenarios: 1. For the first deployment stage the number of sites is 14 (and in further stages more additional sites); 2. The number of multiplexes ranges from one up to five in the final stage;	++(++)

No	ASO Activity	ASO organisation function	Considerations for Jamaica	Relative costs
			3. The DTTB ERPs needed to match ATV can be derived from a formula as included in Annex 2: Service trade-off and network planning. The ERPs needed for the other sites will result from detailed planning work (to be carried out). Detailed network planning (with advanced software) can reduce costs as the transmitter site characteristics can be optimised (whilst still complying with the business plan and service requirements).	
3	Re-farming of spectrum and compensations	Network planning function	According to the current information provided (but should be double checked) there are no existing spectrum users to be migrated. Also the consequences of ASO on the distribution to cable head-ends should be assessed. This may result in compensation claims.	0
4	Simulcast period for analogue terrestrial services	Broadcast network roll-out monitoring function	Simulcasting costs are the operational expenditure of the ATV network during the simulcast period. As Jamaica has opted for a phased ASO this costs can be limited by: 1. Deploying the DTTB sites quicker (it is assumed that as soon as a site is DTTB ready it will be brought into operations and the simulcast period will start) as the last DTTB site will determine the end date of the simulcast period; 2. Reducing the simulcast period for the latest DTTB sites.	+
5	Managing the ASO process	Broadcast network roll-out monitoring function	Assuming all functions (see left column) will be included in the NRT responsibilities and NRT members will absorb their own costs the managing efforts and costs can be relatively low.	+

No	ASO Activity	ASO organisation function	Considerations for Jamaica	Relative costs
		Market monitoring and research function Consumer communication function Industry communication functions	Given the low penetration rate of Internet access and use in Jamaica[65], communication costs might be relatively high (e.g. printed materials, mobile and more radio and TV broadcasts) DTTB uptake should be monitored closely by carrying out survey periodically. An example monitoring framework can be found in Annex 5: Example tracker board.	
6	Setting mandatory certification and labelling	Industry liaisons function	These costs could be minimized by: 1. Have suppliers guarantee compliancy and label STBs (before they receive an import license); 2. Stipulating a widely accepted and proven transmission standard (which ATSC is) and CAS system; 3. Implementing a voucher system for a single standard receiver (i.e. set-top-box).	+
7	Cost for resolving any DTTB interference	Contact centre function Customer support function	Interference to cable could occur in Jamaica, given the presence of cable networks and home installations. If interference do take place, costs can be minimized if cable operators are willing to use spectrum not in use by DTTB (in the cable network coverage area)[66]. That will imply that network operators will have to change their so-called network raster and subscribers have to retune their television sets.	0

TABLE 7: DSO AND ASO COST CATEGORIES

[65] See ITU report "Measuring the Information Society", 2014. In Jamaica the percentage of households with Internet access is reported to be 21.3%. Percentage of inhabitants using the internet is reported to be 37.8%.

[66] It should be noted that this would be based on the spectrum capacity and availability as per the (revised) National Spectrum Plan.

From Table 7, it can be concluded that the main cost element for the Jamaica is likely to be the subsidising of receivers and DTTB network costs. More details on the cost drivers of the DTTB network are included in Annex 4: DTTB network cost drivers.

4.4.2 Public and private revenue sources

A first inventory of possible financial sources have been made by the NRT. A systematic inventory should be made of the possible sources for financing the DSO/ASO costs as included in Table 7. This also serves the purpose of providing evidence that the proposed public-private partnership is the best way forward. The Guidelines provides guidance on sources for funding. Table 8 provides some first considerations on the various sources for Jamaica.

No	Source	Considerations for Jamaica
1	General Taxes	When financing the ASO from general taxes the following should be taken into account: 1. Given the first DTTB coverage target (to match ATV coverage) as stated in the DSO/ASO objectives, a portion (TVHHs with cable and/or satellite or without TV) of the population will pay towards the DSO/ASO but will not directly benefit from DTTB. This may constitute a political barrier; 2. This is a form of indirect financing of activities (i.e. not through a purpose/specific tax). The DSO/ASO costs and benefits have to be balanced against other national priorities (e.g. building schools or roads). This political process might be long and the DSO/ASO planning should take this into account when deciding to include this source in its financial planning.
2	TV license fees[67]	Introducing the TV license fee can be an option to finance the DSO/ASO process. However in Jamaica such a system is currently absent. Experiences in the past have shown that such fees are heavily debated and people tend to resist such an introduction. This may cause significant political debate. Although law enforcement has shown to be very difficult in the past (as people hide television sets and regular checks are necessary) with a CAS system in place, non-payment can be easily resolved (i.e. non-payers are cut-off). In this system only DTTB viewers would contribute.
3	Spectrum usage/industry levies	The number of licensed spectrum users is relatively low in Jamaica. Hence there seems to be no basis for (additional) spectrum usage levies. Special industry levies for equipment suppliers will be problematic for (inter)national competition rules and policies. Moreover this may work adversely as equipment prices will go up.

[67] This is a system whereby the ownership of a television (or radio) set is taxed (and not the actual usage).

No	Source	Considerations for Jamaica
4	Spectrum auctions or tenders	Spectrum auctions and tenders procedure with substantial upfront payments are rare (although recently Thailand successfully auctioned off broadcast spectrum). However, considering the relatively small television market such an auction would generate little proceeds. Alternatively one could auction off the 'Digital Dividend' spectrum (for example for LTE services). However in the short term spectrum is not scarce in Jamaica, including for mobile/LTE services. Also it should be noted that the revenues/proceeds of this type of auction will become available after ASO. Hence DSO/ASO costs have to be advanced.
5	International organizations/loans (CAF, World bank, other countries, etc.)	No information available. In the case of international loans (accompanying equipment and service supplies) the ability to pay back should be seriously considered.
6	Public-private partnership (pay-tv service revenues with Government contributions)	The NRT already assessed this as a candidate to be detailed and negotiated further. It should be noted that this model is different from auctioning (which also includes private contributions) as mentioned under item 4. The risk profile is much lower. Costs are incurred in steps and can be actively managed during the deployment. Also the options to share costs can be formulated in a flexible way and/or (re)negotiated during deployment.

TABLE 8: SOURCES FOR FINANCING THE DSO/ASO PROCESS

As Table 8 shows several options are available with their own pros and cons. The NRT should review them systematically. Currently option 6 was assessed to be the most promising. This will require negotiations where costs, financial contributions and licence terms and conditions (see Table 5) are balanced against each other.

4.5 Frequency plan

The aim of a frequency plan is to:

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

For broadcasting services normally a so-called a-priori plan is made. In such a plan all known and expected (long term) requirements are planned at once. The plan contains only stations that are compatible. In order to cope with unforeseen developments, changes of the plan should be possible, but without significantly affecting the coverage areas. The a-priori plan gives certainty for a long period to the regulator, the network operator(s) and broadcasters that good quality reception levels are maintained in the coverage areas, defined at the moment of licensing.

This section addresses:

1. The frequency band to be used for DTTB;
2. The frequency plan related to the transition from analogue TV to DTTB, and;
3. Some attention points for establishing the frequency plan.

4.5.1 Frequency band to be used for DTTB

According to the national spectrum plan (Table of Frequency Allocation, March 2015), in Jamaica the following bands are available for broadcasting:

1. VHF Band I (54 to 72 MHz and 76 to 88 MHz);
2. VHF Band III (174 to 216 MHz), and;
3. UHF Band IV (512 to 608 MHz)[68].

In Band I and III analogue TV is in operation with the NTSC system in 6MHz channels (see also Figure 2). Band IV is not used. It is recommended to apply a 6 MHz bandwidth in Band IV, because this is the most commonly used channel bandwidths in UHF in countries that adopted the ATSC standard (including the USA and South Korea).

The ITU Guidelines for transition to digital broadcasting give guidance on selection of the VHF or UHF band for DTTB[69]. The selection table has been reproduced below.

Condition	Band choice	Reason
A. Fixed reception and • **8 MHz channel raster in Band III** • **Installed base of Band III receiving antennas**	Band III, where available [a])	• Less power needed compared to Band IV/V
B. Fixed reception and • **7 MHz channel raster in Band III** • **Installed base of Band III receiving antennas** • **12.5 per cent reduced multiplex capacity acceptable compared to 8 MHz Band IV/V channels** • **Band III channels available at all sites fed by the data stream [b])**	Band III [a])	• Less power needed compared to Band IV/V
C. Fixed reception and • **6 MHz channel raster in Band III** • **Installed base of Band III receiving antennas**	Band III	• Less power needed compared to Band IV/V

[68] According to footnote 5.297 (ITU RR) this band is *also* allocated on a primary basis to FIXED and MOBILE. See also footnote 72.

[69] See Section 4.2.4 of Guidelines for the transition from analogue to digital broadcasting, edition January 2014

Condition	Band choice	Reason
D. Fixed reception in other cases	Band IV/V	• Limited Band III capacity (in case 7 MHz channel raster) • No need to install Band III receiving antennas • Less interference probability due to abnormal propagation conditions (fading)
E. Portable reception	Band III	• Less power needed compared to Band IV/V • Less propagation losses owing to diffraction effect in urban areas • Higher man-made noise levels compared to Band IV/V • Combined Band III/IV/V portable receiving antenna shows relative poor performance in Band III
F. Portable reception	Band IV/V	• Lower man-made noise levels compared to Band III • Easier installation of fill-in transmitters with smaller transmission antennas
[a]) taking into account protection of analogue TV services and T-DAB and T-DMB requirements [b]) in principle it possible to feed transmitters with 7 MHz and 8 MHz channels by one data stream, however care must be taken that the net bitrate of the system variant used in the transmitters 7 MHz and 8 MHz channels is higher than the data stream bitrate; inefficient spectrum use in the transmitters with 8 MHz channels may occur due to unused capacity.		

TABLE 9: DTTB BAND SELECTION

Row D fits best the DSO objectives in Jamaica, because with regard to fixed reception:

1. Condition A is not applicable in Jamaica, because the bandwidth in Band III is 6 MHz;
2. Condition B and C do not apply because in Jamaica there is no (large) installed base of Band III rooftop antennas;
3. Condition D applies and has the advantage that:
    a. In the long term five multiplexes are required which cannot all be accommodated in Band III. By using UHF only, installation of both VHF and UHF antennas (transmitting and receiving) is avoided;
    b. The UHF band is not used, hence no compatibility problems will occur during the transition from analogue to digital television.

With regard to portable reception, in addition to the reason given for fixed reception, condition F applies better than condition E because:

1. The propagation disadvantages of the UHF band are less prominent because in the valleys in many cases the propagation path is short and in line of sight due to the high site heights and relative small coverage areas (to be checked by carrying out network planning work);
2. Combined band VHF and UHF receiving antennas are avoided by using UHF only.

Taken into account the above mentioned considerations, it is recommended to plan DTTB in UHF only.

4.5.2 Frequency plan related to the transition from ATV to DTTB

A frequency plan related to the transition from analogue to digital television plans deals with three stages in the VHF and UHF broadcasting bands[70]:

1. The existing situation with the analogue TV (ATV) plan;
2. The transition period with the ATV plan and DTTB plan and the condition that analogue TV services should be protected by DTTB transmissions;
3. After analogue TV switch-off (ASO) when only digital TV exits (i.e. the all-digital situation).

During the transition period the analogue TV needs to be protected. This means that the analogue coverage areas should not be unacceptably reduced due to interference from digital TV transmissions. Depending on the frequency bands used for ATV and DTTB and the number of analogue TV stations in operation, this requirement limits the number of channels that can be used for digital TV and may also limit the radiated powers of digital transmissions. However, if ATV is operated in VHF only and DTTB is planned in UHF only, analogue TV will not be affected by DTTB and DTTB will not be limited by analogue TV.

Table 10 gives an overview of the planning situations in Jamaica, taking into account the recommendation to plan DTTB in UHF only.

Stages	Band I and III	Band IV/V
Existing	• 54 to 72 MHz: ATV • 174 – 230 MHz: ATV	• < 512 MHz: Fixed[71] • 512 – 608 MHz: no TV assignments[72] • > 608 MHz: Radio Astronomy, Fixed
During transition	• 54 to 72 MHz: ATV • 174 – 230 MHz: ATV	• < 512 MHz: Fixed • 512 – 608 MHz: DTTB replacing ATV and additional DTTB • > 608 MHz: Radio Astronomy, fixed
After ASO	• 174 – 230 MHz: Digital Radio and or MTV?	• < 512 MHz: Fixed • 512 – 608 MHz: DTTB replacing ATV and additional DTTB • > 608 MHz: reallocation to DTTB (698-824 MHz)?

TABLE 10: NATIONAL TV SPECTRUM SITUATION

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

[70] See also Section 4.2.4 of Guidelines for the transition from analogue to digital broadcasting, edition January 2014

[71] See footnote 5.293 ITU RR.

[72] It was reported that channel 21 (in the UHF Band) was in use by a media company. It was not clear for what application. See also Annex 1: Checklist,

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

1) Existing situation (before DTTB introduction)

The analogue TV plan in Jamaica contains assignments in VHF (Band I and III) related to operational TV stations. Further information on the analogue TV plan is also given in Section 2.2.

Attention points regarding the existing analogue TV plan are:

1. Verification of transmitter data. In order to calculate the current analogue TV coverage areas, accurate transmitter station data are needed. The analogue TV station data should be verified and be more detailed (including frequency off-set);
2. Assessment of the current analogue TV coverage areas. According to the DSO objectives the analogue TV coverage should be matched by DTTB. It is therefore necessary to determine the current analogue TV coverage areas in a similar way as for DTTB and taking into account interference from other analogue TV stations.

2) During transition

During the transition period the currently operational analogue TV stations in Band I and III remain as they are and *no new* analogue TV stations will be licensed. According to the DSO objectives two DTTB multiplex should be in operation. It is recommended to plan at once also the three additional multiplexes required after analogue TV switch-off and to establish a channel assignment scheme. By means of such a channel assignment scheme, regular channel assignments to sites will be made which facilitates planning.

It also provides the possibility to group channels in several parts of the band. This would make it possible to use transmitting and receiving antennas more efficiently, as the efficiency of an antenna is wave length dependent and better coverage could be achieved. However, the application of a regular channel scheme may be limited due to international coordination.

The frequency plan for all five multiplexes makes it possible from the start to take account of future frequency assignments in specifying transmission equipment. Also it may avoid future frequency changes.

As according to the recommendation in Section 4.5.1, DTTB is planned in UHF only; compatibility between analogue TV and DTTB is no issue and is not described in this report.

3) After ASO

After analogue TV switch-off, all analogue TV stations should be deleted from the plan. The spectrum used by analogue TV becomes available for new broadcasting services or for other services, for example Digital Terrestrial Audio Broadcasting (DTAB) or mobile TV (MTV).

4.5.3 Attention points for establishing the frequency plan

A number of attention points for establishing the plan are described in this section:

1. Spectrum capacity;
2. Planning and system parameters;
3. Planning process;
4. Compatibility with other services;

5. International coordination;
6. Verification of transmitter data.

1) Spectrum capacity

In the national spectrum plan broadcasting is allocated in the frequency range 512 to 608 MHz. In a 6 MHz raster that is 16 (= (608-512)/6) channels (not considering guard bands).

The European Broadcasting Union (EBU) estimated that in general 6 to 8 channels are needed to plan a national DTTB coverage in UHF[73]. Further studies in the EBU[74] concluded that by applying large SFNs with the DVB-T2 standard the number of channels could be reduced to four to five per national coverage taking into account that interference from one country into another should be avoided. Although the ATSC 3.0 standard has not be formally adopted, it is known that it will facilitate for SFN planning and hence it assumed that this system will perform similarly to the DVB-T2 standard in this respect[75].

In Jamaica the number of channels needed to plan one DTTB multiplex maybe less due to terrain shielding. The required number of channels may be reduced further (from the EBU estimates of four to five) to three to four. However frequency planning work should show how many channels are really needed. At this stage it can already be concluded that:

1. The current spectrum allocation is tight, and;
2. Under the assumption of applying ATSC 1.0, the five multiplexes cannot be deployed (as SFN are not possible and the capacity load is limited) without an additional frequency allocation to DTTB (see Table 10, the row 'after ASO').

The current broadcasting allocation of 512 to 608 MHz is certainly sufficient to plan the two ATSC 1.0 multiplexes that are required in the period from 2015 to 2019. However for the period after ASO (after 2019), it seems that the best option to go forward is with ATSC 3.0 only (and not ATSC 1.0) because:

1. As was concluded in Section 4.1.2, ATSC 3.0 is needed to increase the multiplex load so that the pay-tv package can also include HD services, and;
2. ATSC 3.0 is needed to reduce the required number of frequencies (due to possibility of planning for SFN and higher multiplex load), and;
3. An additional frequency allocation to DTTB (as suggested above) goes against the global trend, especially in the USA where more and more UHF spectrum is allocated to mobile services[76].

[73] See EBU Technical Report 015 Defining Spectrum Requirements of Broadcasting in the UHF Band, dated July 2012.

[74] See EBU Technical Report 029 DVB-T2 Single Frequency Networks and spectrum Efficiency, dated October 2014.

[75] Please note that the ATSC 1.0 does not allow for SFN planning, see also 4.1.1.

[76] See also ITU WRC-2015 preparatory plans and FCC's incentive auctions.

2) Planning and system parameters

In order to establish the frequency plan that fulfils the DSO objectives and complies with the customer proposition, appropriate planning and system parameters should be adopted. Following what was concluded in the previous paragraph, the planning parameters should be selected for the ATSC 1.0 and 3.0 standards. It should be checked if a set of well-tested planning parameters are available for the ATSC 3.0 standard[77]. An initial approach towards a set of planning and system parameters is described in Annex 2: Service trade-off and network planning.

3) Planning process

Before the DTTB planning starts the planning principles and the planning method needs to be described and endorsed by all parties concerned.

With regard to reception of DTTB it should be reminded that, contrary to analogue TV, there is no smooth degradation from good to poor picture quality when the signal to noise ratio or signal to interference ration is decreased below the required value. DTTB should therefore be carefully planned using advanced planning software and detailed terrain and clutter data[78].

4) Compatibility of DTTB assignments with other services

In the national spectrum plan the frequency range below 512 MHz is allocated to fixed services. As fixed services are in operation or planned in that frequency range, compatibility between DTTB and fixed services on adjacent channels needs to be taken into account.

If in the future the channels above 48 are allocated to IMT, compatibility between DTTB and IMT needs be investigated taking into account the latest ITU-R recommendations. In case of incompatibilities, it has be decided who is responsible for eliminating the harmful interference.

Interference from DTTB to cable systems may occur if in the cable system the same channels are used as for DTTB broadcasting. Experience in Europe learned that this kind of interference is mainly caused by poor domestic cable installations. Interference was resolved in many cases by applying good quality coax-cable and good quality connectors in the homes. Moreover, sometimes cable operators avoided this kind of interference by not using the channels that are broadcasted in the area served by the cable system.

5) International coordination

An important principle of international coordination of frequencies is that all countries have equitable access to the spectrum. Coordination agreements with neighbouring should be made considering the use of frequencies in border areas. As Jamaica is an island in a warm climate special consideration should be given to sea path propagation[79]. Also transmitter data (in ITU format) should be exchanged which makes it possible to take interference from foreign transmitters into account.

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[77] Network planning software suppliers (like ATDI, LS Telcom and Progira) can help out here.

[78] Clutter data describes in different categories what the land use is. For example buildings, houses, water, forest, etc.

[79] See also footnote 45.

It is important to finalize the international coordination before the licensing procedures start and to incorporate the results in the frequency plan. Otherwise there will be uncertainties about the assignments as changes to licensed DTTB stations may be required once the international coordination is completed.

ITU-BR should be informed about the coordination results (see Article 6.7 of the Radio Regulations) and when a station is brought into operation it should be notified to ITU-BR in accordance to the provision of Article 11 of the Radio Regulations.

6) Verification of transmitter data

In order to calculate the DTTB coverage areas and to perform compatibility calculations, accurate transmitter station data is needed. The data should include:

1. Site name;
2. Geographical coordinates of the site;
3. Altitude of the site above sea level;
4. Height of the transmitting antenna above ground level;
5. Antenna pattern if a given antenna should be used.

The planning process will result in specification of the channel, ERP and antenna pattern (if not prescribed).

4.6 ASO Plan

The section covers the ASO planning and the ASO communications plan.

4.6.1 ASO planning

A key element for the ASO planning is that it is well coordinated and facilitates cooperation throughout the value chain. The table below provides an overview of possible work streams (or result paths) of the ASO planning and the key tasks associated to them. The work streams correspond to work streams as indicated in Section 3.4.3 and also illustrated in Figure 14.

Next to the different works streams (in Table 11 below nine result paths are suggested), the ASO planning should specify the key milestones on each result path and the interdependencies between them. In Table 11 example milestones are provided for each work stream. In this way Table 11 can form the basis of an initial ASO planning.

No	Result path	Key tasks	Example milestones	Considerations for Jamaica
1	Regulation & Political Approval	• Mandating the NRT • Approving (at political level) the DTTB policy document • Endorsing (at political level) the ASO planning and DTTB licensing regime • Approving (at political level any necessary regulatory changes	• DTTB policy document approved (see Phase 1) • ASO planning approved (see Phase 2) • DTTB license terms and conditions agreed (see Phase 3) • Regulatory framework changed (see Phase 1)	• Staged approach, in which first a DTTB Policy document is agreed (see Section 3.4.2 in this report) and later the ASO Plan
2	Frequency planning & coordination	• The NRT should manage and have a frequency planning carried out • Also the coordination efforts to free-up (if decided necessary) spectrum and to ensure interference free broadcasts should be included.	• Initial DTTB service plan agreed (see Phase 2) • Detailed DTTB service plan agreed (see Phase 3)	• Likely to be a task of the NRT. Especially considering that it is important input for the network costs (and hence part of the public-private partnership negotiations).
3	Licensing & contracting	• SMA has to stop licensing analogue terrestrial licenses or any other license in the target band for DTTB • SMA needs to assign the required DTTB frequency licenses to the multiplex operator • BC needs to assign broadcast licenses • Network operator distribution contracts signed with service providers/broadcasters • Regulator(s) might need to take away any obstacles in the	• DTTB licenses assigned to multiplex operator (see Phase 3) • Broadcast license assigned to pay-tv provider • Network Operator contracts signed	• Evidently tasks to be overseen by the NRT

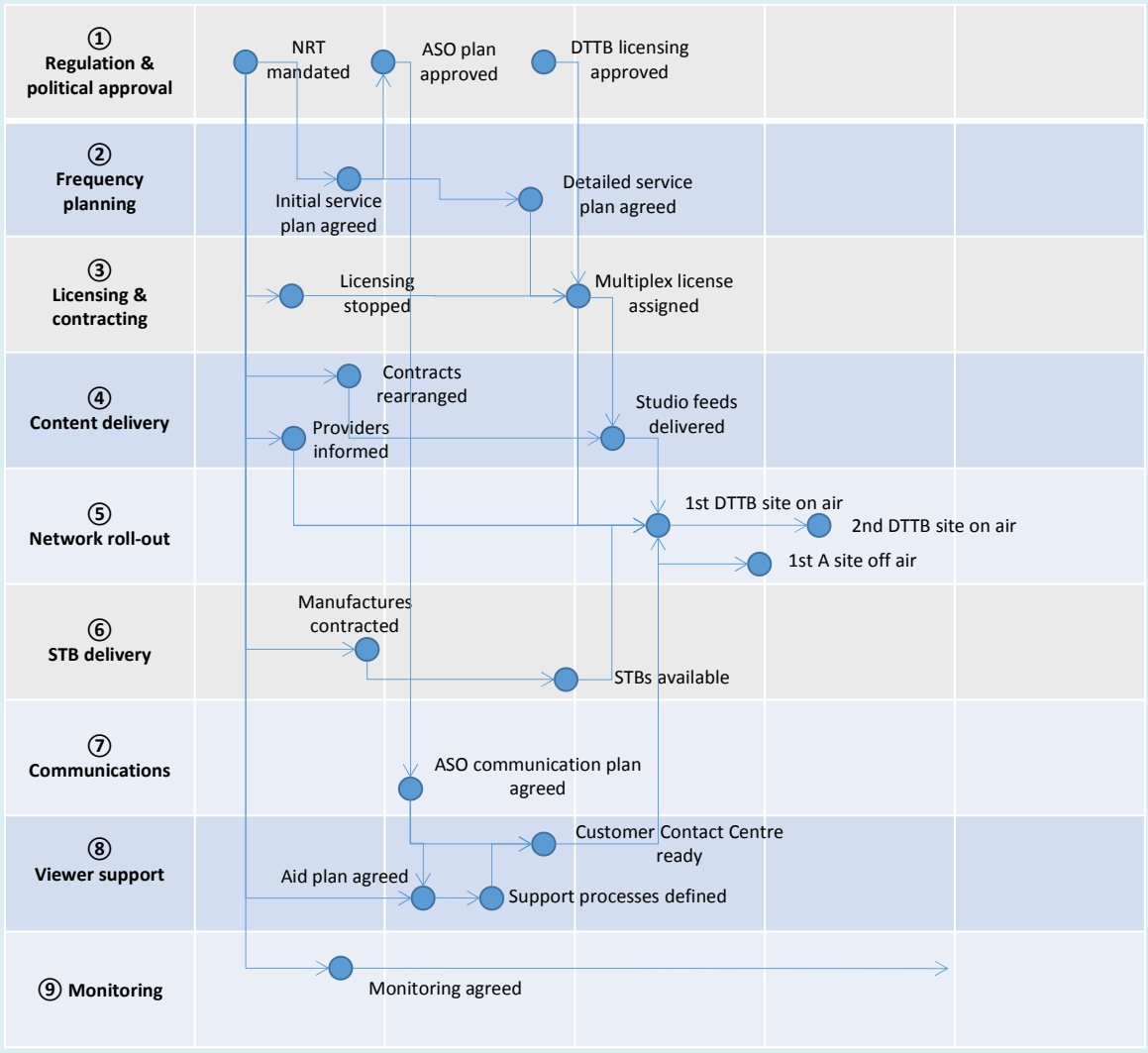
		acquisition of building permits (in case new sites or temporarily transmitter sites have to be erected quickly) or any other permits		
4	Content delivery	• Broadcasters need to be informed about the ASO planning and the impact on their production chain • The eight incumbent television services and the pay-tv service provider need to deliver their studio feeds to the common multiplex/network operator site • Broadcasters need to communicate to their viewers about the DSO/ASO (by incorporating items in their own programming)	• Studios updated and compliant to DTTB broadcast requirements (including aspects such as SI/EPG) • All studio feeds delivered at multiplex centre (see Phase 4)	• Broadcasters may have to deliver different studio feeds • Broadcasters distribution network to the transmitter sites may change (also including cable network head-ends) • Content rights may be impacted. Purchased content may only be distributed in a certain area of Jamaica and/or only in analogue format
5	Network roll-out	• Network operator needs to detail the network planning and the associated service roll-out planning • Network operator needs to carry out the DTTB network & service roll-out • Broadcasters have to switch off analogue transmission at the right time in the right area(s)	• Network & service roll-out planning drafted and agreed (see Phase 4) • DTTB transmitter site in first region taken in operations (see Phase 4) • First analogue transmitter in first region switched off (see Phase 4)	• The ASO planning should allow for a 'learning curve' as network provisioning to third parties is a new activity in Jamaica
6	STB delivery	• Manufacturers need to supply sufficient quantities of DTTB receivers • In case of pay-tv, CAS suppliers need to supply smartcards	• Contract agreed for certifying and labelling STBs • First batch of STB available in selected retail	• This will include the retail chains as well. • STB manufactures are not likely to participate in the NRT, but a good 'liaison officer' will be needed

		• Manufactures may be required to certify compliancy with a set of receiver specifications and to provide proper or specific labelling	shops in first region	• Representatives of logistic chain providers (shops, post offices) are likely to be included in the NRT • Labelling/certification will require a trusted organization to do so. Given the limited means for communications this should ideally be an organization already know to the Jamaican public. Such an organisation is likely to participate in the NRT
7	Communications (Viewers and other target groups)	• Setting acceptable timetables and understanding local issues • Formulate adequate messages and executing communications through various means/tools • Making sure that the marketing around analogue switch-off does not favour the digital terrestrial platform only. Viewers should be informed about opportunities for television reception across all platforms • Information of their offerings should be exchanged and coordinated in the NRT	• ASO communication plan agreed (see Phase 2) • Information exchange with other providers agreed • Website published • Customer/viewer contact centre operational	• Representatives of the various viewer groups are likely to be consulted in the NRT
8	Financial & installation support	• Define and agree financial aid and eligible groups • Define the support processes • Select and contract (installation) suppliers	• Aid program approved • Installation suppliers contracted • Support processes tested	• Political approval will be required. Defining the eligible groups is very often politically sensitive

		• Implement and test processes (not only in the customer contact centre)		
9	Consumer & Market monitoring	• Define and agree monitoring report and agree how to process the results (for an example see Annex 5: Example tracker board) • Especially the first switch off region will serve as a test case. The monitoring results should be used for the second region	• Monitoring report and procedure agreed • First monitoring report delivered at NRT	• NRT can use these reports to manage the ASO process and also to inform the public and politics • Different versions may be required. Information may be published on the website too (see Communications work stream)

TABLE 11: ASO PLANNING AND MILESTONES

Figure 20 provides and impression of what an ASO planning could look like.



Source: ITU

FIGURE 20: ILLUSTRATION OF AN ASO MILESTONE PLANNING

4.6.2 ASO communications

An ASO communication strategy focuses on effective and impartial communications with the general public, broadcasting and retail industry about the introduction of the DTTB services and switching off the analogue television services. In Jamaica the NRT has an important coordinating task as two incumbent broadcasters are likely to be involved in the deployment of the DTTB networks (2 multiplexes) and switching off two ATV networks. The communication efforts of the different parties should be consistent and well planned.

The ASO communication phases follow the same basic marketing phases as for any other service or product introduction. In Figure 21 the subsequent communication phases are depicted.

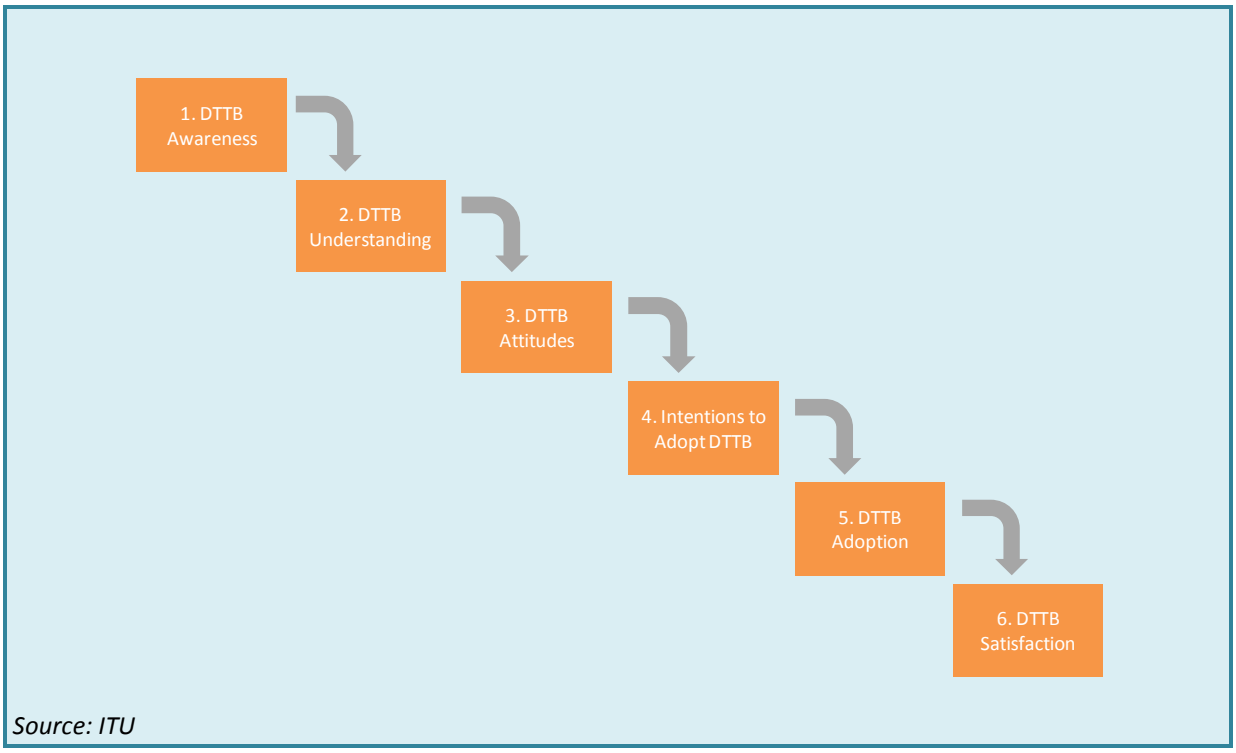


FIGURE 21: ASO COMMUNICATION PHASES

Although Figure 21 shows a sequential order of the different phases, in practice the phases overlap. However the different phases cannot be skipped. For example, explaining what people have to do for receiving DTTB services whilst people are unaware of DTTB will not be effective. These communications phases correspond to the phases as included in the proposed monitoring framework (see Annex 5: Example tracker board). For more details on the consecutive phases please refer to the ITU Guidelines.

4.6.3 ASO communication tools

A wide range of communication tools can be applied, including the analogue television broadcasts. Two tools are presented in more detail; the website and smartphone application. These tools have proven to be:

1. Effective in informing people, especially in situations that the network deployment, television service and receiver delivery changes over time;
2. Useful in optimising the network costs, as people can be accurately informed how to best receive the DTTB services and when to get a better receiving antenna (in the fringes of the coverage area) and hence extending the network reach (without increasing network investments).

These two tools are showcases of what is possible with modern communication technology nowadays. In early DSO/ASO countries, like in Europe, the widespread availability of broadband internet and smartphones were not present and the tools were more limited.

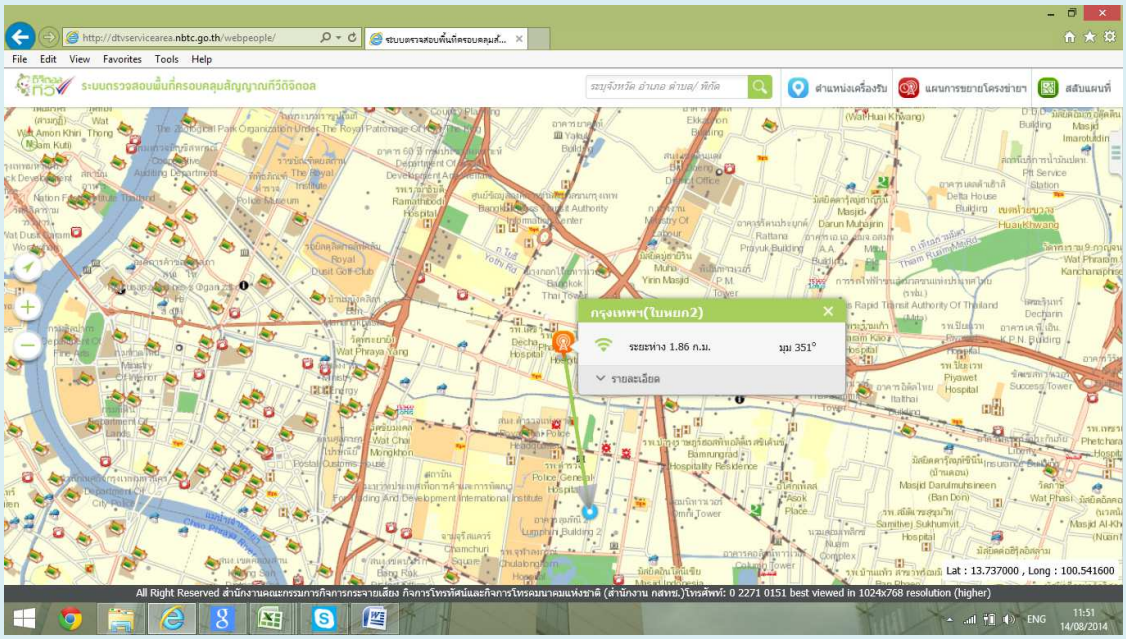
Figure 22 shows the graphical user interface of one of the web pages of the coverage checker in Thailand[80]. It shows the common information found on any other typical coverage checker websites[81], including:

1. A text box to enter the position of the reception location;
2. The location of the nearest or best transmitter site (indicated on the map with a tower symbol);
3. An indication of the signal strength and quality (indicated with a signal strength symbol, typically found on mobile telephone hand-sets);
4. The number of multiplexes available on this transmitter site (and click through pages to the available services on each multiplex);
5. Indication of the antenna direction angle (azimuth angle) towards the nearest or best transmitter site (indicated on the map with a green line)[82].

[80] This checker was made available for tablets and smartphones using Android or iOs.

[81] See ITU Guidelines on the Transition from Analogue to Digital Broadcasting, January 2014, pp 169-170. Also the following example website could be consulted; http://transition.fcc.gov/mb/engineering/dtvmaps/ or http://www.csa.fr/csatvnumerique/television_couverture

[82] This angle is based on what is called the 'best server' information. A modern frequency planning tool can calculate which transmitter site provides the best signal quality/strength at any given reception location. With the coordinates of this best server transmission site and the reception location the azimuth angle can be calculated.



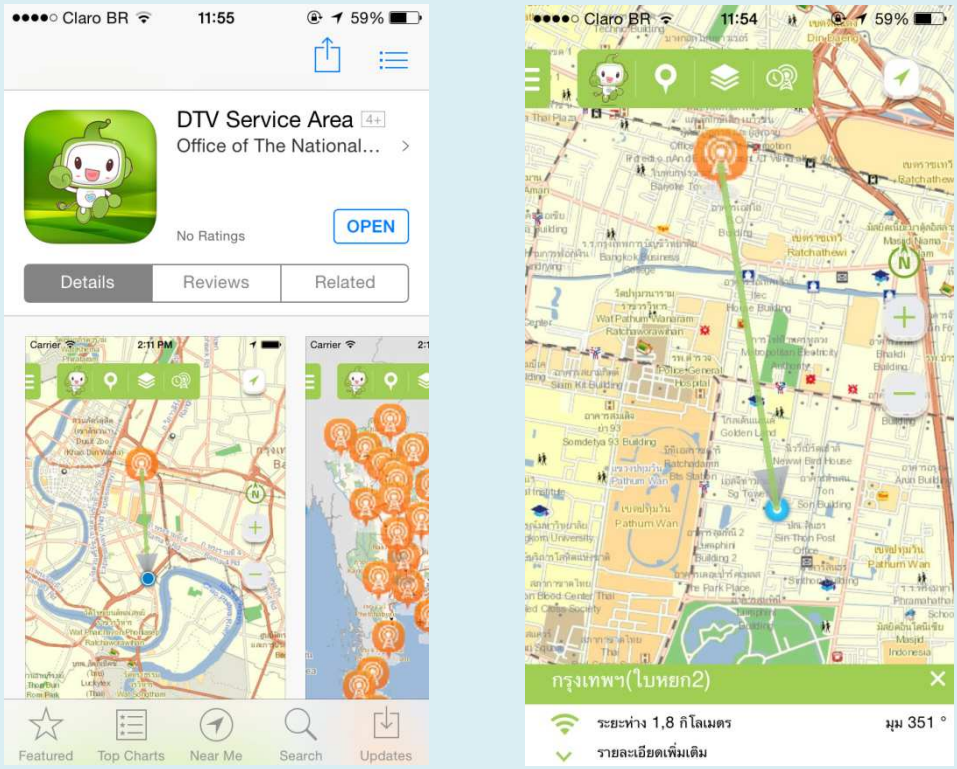
Source: NBTC, ESRI

FIGURE 22: GRAPHICAL USER INTERFACE OF COVERAGE CHECKER

Modern smartphones have GPS, Wi-Fi and compass functionality and these technologies are used to locate the exact position of the smartphone. Location based services, like Google Maps, use this positioning information. Similarly the coverage checker on the smartphone can be designed as a location based service.

A smartphone at any reception location can automatically use the positioning information to let the coverage checker software[83] know where the reception location is. In addition, using the compass functionality the smartphone can be directed to the best server transmission site. This is particularly helpful for people having difficulties in reading maps and figuring out the azimuth angle (for directing their receiving antenna). Figure 23 shows the smartphone user interface for this functionality.

[83] In turn this web based software pulls the DTTB coverage information from the frequency planning tool.



Source: NBTC, ESRI

FIGURE 23: SMARTPHONE USER INTERFACE

Another local based application the NRA developed was entering network measurement data. This is an application for regulator's network monitoring task and is not intended for the general public. Engineers measuring signal strength and other system parameters across the network coverage can enter this data and automatically the exact position of these measurements can be uploaded to a central database.

5. Recommendations

Given the information collected/provided during the Jamaica country visits and the analyses carried out by the ITU, the NRT is recommended to carry out the following steps for a smooth transition to digital television broadcasting and switching off the analogue services:

1. Get the Roadmap report endorsed at either ministerial level and/or political level;
2. After endorsement, acquire a mandate to plan and manage the DSO/ASO process in accordance to the Phases of the Roadmap. As indicated in this Roadmap report, this mandate may come in stages;
3. After being mandated, prepare and take the following decisions first as these decisions are needed to determine the scope and duration of the Roadmap planning:
    a. Finalize and agree on the DSO/ASO objectives (see Table 2);
    b. Carry-out network planning for calculating the ATV coverage areas and the DTTB coverage (as important input for network costs and ASO planning);
    c. Develop a cost model for running different DSO/ASO deployment scenarios;
    d. Define and get agreement on the DSO/ASO costs in scope;
    e. Negotiate the public-private partnership on the basis of balancing cost/financing contributions and license terms & conditions (including obligations, rights and incentives);
4. Select and finalize the licensing model, to include:
    a. Decide how to separate the network activities (either by establishing a new common multiplex operator or by separating the network activities within the two incumbent terrestrial broadcasters);
    b. Assignment of the spectrum and operating rights to the multiplex operator. This includes
        i. The drafting of the request for a Reference Offer (RO);
        ii. The answering of the request for a RO (and this will take detailed frequency and network planning);
        iii. The approval of the RO;
    c. Assignment of the broadcast rights to the single pay-tv SP;
5. Form a project management office (PMO) and start drafting an initial detailed DSO/ASO planning (on the basis of this Roadmap report) and determine the progress reporting procedures and structures;
6. Start preparations for separating the network provisioning activities/assets from CVM/TVJ and arranging for accounting separation.

Glossary of Abbreviations

API	Application Programming Interface
ASO	Analogue Switch-Off
ATSC	Advanced Television Systems Committee
ATV	Analogue Television
BC	Broadcasting Commission (of Jamaica)
CA	Conditional Access
CAPEX	Capital Expenditure
CAS	Conditional Access System
CRT	Cathode Ray Tube (television set)
DSO	Digital Switch-Over
DTAB	Digital Terrestrial Audio Broadcasting
DTH	Direct To Home
DTTB	Digital Terrestrial Television Broadcasting
DVB-T2	Digital Video Broadcasting-Terrestrial (second generation)
EPG	Electronic Program Guide
FFB	Functional Building Block
FTA	Free To Air
FX	Fixed (rooftop) reception
HH	Household
IDTV	Integrated Digital Television set
LRIC	Long Run Incremental Costs
MFN	Multi Frequency Network
MIFR	Master International Frequency Register
MPEG	Moving Picture Experts Group
MTV	Mobile Television (service over broadcasting systems)
MUX	Multiplex or Multiplexer
NO	Network Operator
NRA	National Regulatory Authority
NRT	National Roadmap Team
OFDM	Orthogonal frequency-division multiplexing
OPEX	Operational Expenditure
PBS	Public Broadcasting Service
PI	Portable Indoor reception
PoS	Point of Service
RF	Radio Frequency
RO	Reference Offer
SFN	Single Frequency Network
SI	Service Information

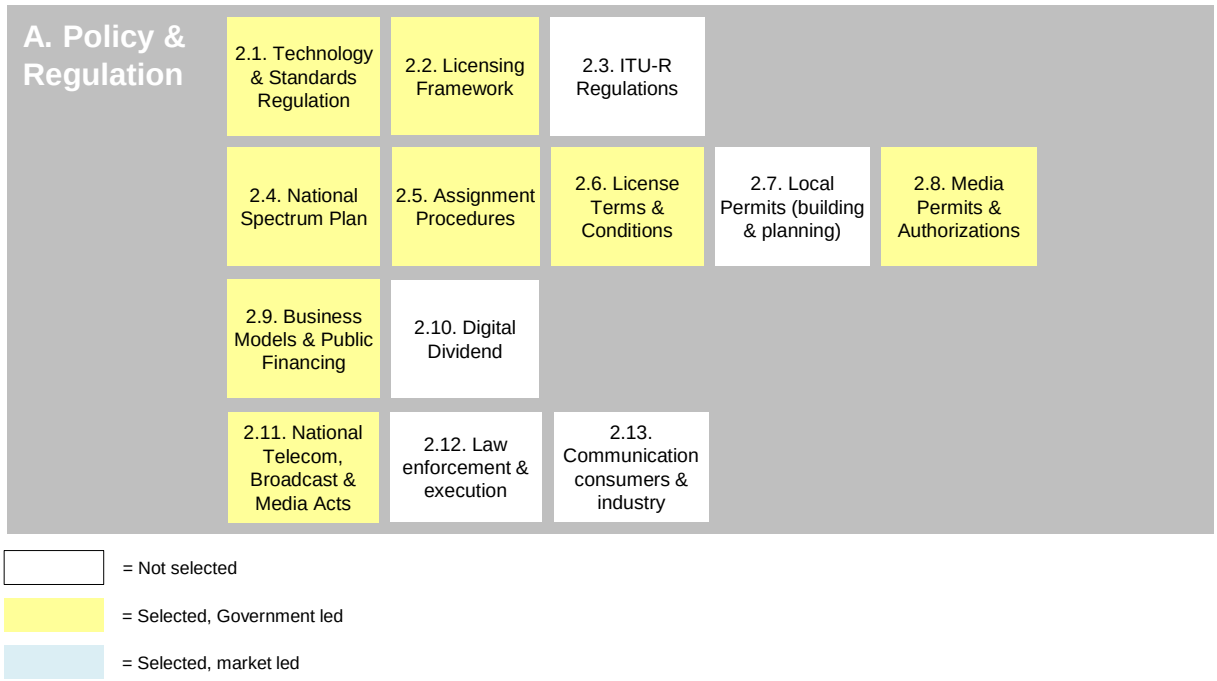
SMA	Spectrum Management Authority (of Jamaica)
SMS	Subscriber Management System
SP	Service Provider
SSU	System Software Update
STB	Set-Top-Box
TS	Transport Stream
TVHH	Television Household
TVJ	Television Jamaica
WACC	Weighted Average Cost of Capital

Annex 1: Checklist

In this Annex an inventory is given of the decisions already taken and those still to be considered for the functional building blocks in scope of the Jamaican Roadmap (see Section 3.3). This checklist is structured according to the four layers of the functional framework:

1. Policy and Regulation
2. Analogue Switch-Off (ASO);
3. Market and Business development;
4. DTTB Networks.

A. Policy and Regulation



Description	This part of the guidelines will provide an overview of the key issues and choices the Regulator faces when either formulating Digital Terrestrial Television Broadcasting (DTTB), Mobile Television (MTV) or Analogue switch-off (ASO) policy objectives.
Objectives	In striving for a rapid service up-take and development of the DTTB and MTV markets, the Regulator will implement such policies by issuing information, funds, rights, licenses and permits to (qualified) market parties in compliance with the relevant Legislation.
Building blocks	2.1 Technology & Standards Regulation 2.2 Licensing Framework 2.4 National Spectrum Plan 2.5 Assignment Procedures

	2.6 Licensing Terms & Conditions 2.8 Media Permits & Authorizations 2.9 Business Models & Public Financing 2.11 National Telecom, Broadcast & Media Acts

2.1 Technology & Standards Regulation

Key topics & choices	Status	Decision
2.1.1 Television presentation formats: for DTTB platforms either Standard Definition Television (SDTV) and/or High Definition Television (HDTV) and for MTV platforms a minimum bit rate per service. Has the standard setting been decided?	a	SD for DTTB After 2019 HD services (see DSO/ASO objectives) For MTV only capacity is reserved in the future (after 2019), see DSO/ASO objectives
2.1.2 Transmission standard: for DTTB platforms e.g. DVB-T2 or ATSC and for MTV platforms ISDB-Tmm or T-DMB. Has the standard setting been decided?	a	ATSC 1.0
2.1.3 Compression technology: for DTTB platforms MPEG2 or MPEG4 and for MTV platforms e.g. H265 or MPEG-4 AVC or open. Has the standard setting been decided?	a	MPEG4
2.1.4 Conditional Access (CA) system and Digital Rights Management (DRM): interoperability between deployed systems for respectively DTTB and MTV platforms. Has the standard setting been decided?	c	Dependent on the number of pay-tv SP in the market Initially it was agreed that one single SP would be best
2.1.5 Application Programming Interface (API) for additional and interactive services: for DTTB platforms e.g. MHP or proprietary and for MTV platforms specific technical requirements to support integration between broadcast TV and 3/4G mobile TV networks. Has the standard setting been decided?	a	Will not be regulated, as long as there will be no additional services requiring an API

a. Already decided
b. Partly decided
c. Not decided yet

d. Revision needed

2.2 Licensing Framework

Key topics & choices	Status	Decision
2.2.1 A licensing framework for any television services comprises the assignment of three sets of rights (a) spectrum (b) broadcast and (c) operating rights. For DTTB and MTV services has the model been decided?	a	All three rights are assigned and embedded in the current regulatory framework
2.2.2 For the extra function of the multiplex operator in the value chain, two basic licensing models can be distinguished for DTTB and MTV services: model A and model B. Has the basic model been decided?	c	Model A or B
2.2.3 Public Service Broadcasting (PSB) refers to broadcasting intended for the public benefit rather than for purely commercial objectives. In most cases the broadcast content and spectrum rights are specified in a media or broadcast Act. Has the PBS services and spectrum rights been defined yet (and where) for the DTTB and MTV platform?	a	8 SD slots on the 2 MUX (2 terrestrial incumbents + Love TV + PBCJ + 4 cable services). After 2019 additional slots will be preserved for 8 services to migrate to HD The four cable services are pay-tv services. The four others services are FTA.

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

2.4 National Spectrum Plan

Key topics & choices	Status	Decision
2.4.1 The context of the national spectrum plan: Is the national spectrum plan, covering the broadcast spectrum, available and is it complete?	A	Yes available.
2.4.2 Planning current and future DTTB and MTV spectrum use: Has the national spectrum plan/strategic planning process	a for present b for future requirements	Yes, UHF band (512-608 MHz = 96 MHz = 16 channels) is allocated for BROADCASTING and this is the band DTTB is planned in. This

Key topics & choices	Status	Decision
started/completed? (for process see this paragraph)		spectrum is enough (to be checked for 2 MUX. For the 5 MUX it should be investigated too. Note: ch21 is in use by media company.
2.4.3 National Spectrum Plan publication and DTTB/MTV introduction: NONE		
2.4.4 General approaches for pricing spectrum usage: (a) One off pricing and/or recurring pricing? (b) Cost based or market based pricing?	b	Review and change needed for broadcast spectrum usages.

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

2.5 Assignment Procedures

Key topics & choices	Status	Decision
2.5.1 Basic assigned instruments and procedures: What is the preferred assignment instrument (FCFS, auction or public tender) for broadcasting?	a	If demand > supply = auction for spectrum rights (included in the spectrum policy). For broadcast spectrum other instruments are available
2.5.2 Assignment procedures for DTTB and MTV services: What is the selected assignment instrument (FCFS, auction or public tender) for DTTB and MTV?	c	For DTTB still to be decided

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

2.6 License Terms & Conditions

Key topics & choices	Status	Decision
2.6.1 Licensing and fair competition rules: Are the license terms and conditions in line with the competition rules (transparent and non-discriminatory)?	c	
2.6.2 Frequency license terms & conditions: have all license terms and conditions been determined and is the list of	c	See above

Key topics & choices	Status	Decision
conditions complete (see list in this paragraph)?		

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

2.8 Media Permits & Authorizations

Key topics & choices	Status	Decision
2.8.1 Broadcast licensing framework: the different levels of granting broadcast rights, program or platform level?	c	
2.8.2 Broadcast licensing requirements: have all license terms and conditions been determined and is the list of conditions complete (see list in this paragraph)?	c	

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

2.9 Business models & public financing

Key topics & choices	Status	Decision
2.9.1 General PSB financing models and sourcing: basic forms already decided, including (a) PSB entity is established by Government, with defined PSB services, fully funded by public sources (either through licensing fees and/or general taxes) (b) A PSB entity is established by Government, with defined PSB services, funded by public sources and (later) partly by commercial income (mostly advertising based) (c) A commercial/private broadcaster was established, fully funded by commercial income (either advertising based and/or subscription based) and has a PSB obligation assigned. (d) Have the	b	

Key topics & choices	Status	Decision
different sources for DSO/ASO been selected and is the budget fully financed?		
2.9.2 DTTB specific financing issues: (a) Financing of digital receivers (b) Financing the impact of free-to-air stipulations(c) In case the PSB service is encrypted content rights can be lowered (d) Financing the simulcast period (e) TV licensing fee system might need revision.	c	

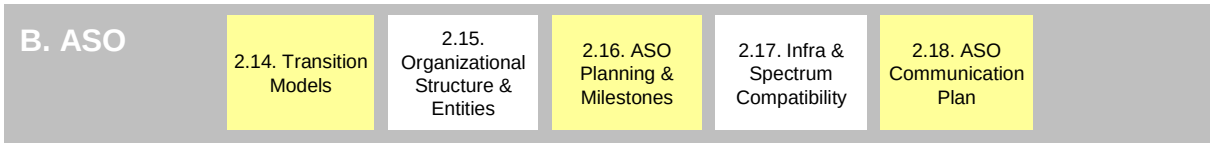
a. Already decided
b. Partly decided
c. Not decided yet
d. Revision needed

2.11 National telecom, broadcast & media act

Key topics & choices	Status	Decision
2.11.1 Checking compliancy with existing national, Telecommunications, Broadcast and Media Acts: is the formulated DTTB/MTV policy in line with the Acts?	c	
2.11.2 Checking compliancy with other legislation, especially related to cross and foreign ownership and State aid: is the formulated DTTB/MTV policy in line with the Acts?	c	Broadcast Act says 51% should be Caribbean nationals No cross-ownership rules State Aid should be checked explicitly

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

Analogue Switch-Off (ASO)



= Not selected

= Selected, Government led

= Selected, market led

Description	Analogue switch-off (ASO) is the process of turning off the analogue terrestrial television signal and replacing it with a digital signal. It will basically require changing existing television broadcast networks and changing end-consumer television receiver equipment (either connecting a digital converter to the existing television set/recorder or replacing the existing television set for and integrated digital television set and/or digital recorder).
Objectives	The ASO is a government initiated policy, aiming at gaining spectrum efficiency which will bring consumer benefits (more choice in television channels and services) and industry benefits (new revenue streams and business models). The key objective in the ASO process is reducing the risks of disenfranchising viewers.
Building blocks	2.14 Transition Models 2.16 ASO Planning & Milestones 2.18 ASO Communication Plan

2.14 Transition Models

Key topics & 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)	a	See DSO/ASO table
2.14.2 ASO factors: What type of ASO process is envisioned, consider the following factors: (a) Required PSB services; (b) The number of analogue terrestrial television viewers; (c) Availability of spectrum; (d) DTTB service uptake.	b	(c) and (d) still to be addressed

Key topics & choices	Status	Decision
2.14.3 ASO Transition models: Which models is envisioned (a) ASO with simulcast period, with two sub-categories (i) Phased approach to analogue switch-off (ii) National approach to analogue switch-off (b) ASO without simulcast period.	a	2 Phases + 12 months simulcast for each Phase

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

2.16 ASO Planning & Milestones

Key topics & 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	a	2 years
2.16.2 Overall ASO planning set-up: including the overall program structure and the key result paths in an ASO plan	c	
2.16.3 ASO planning phases (in a phased approach): the three phases and their key milestones	c	

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

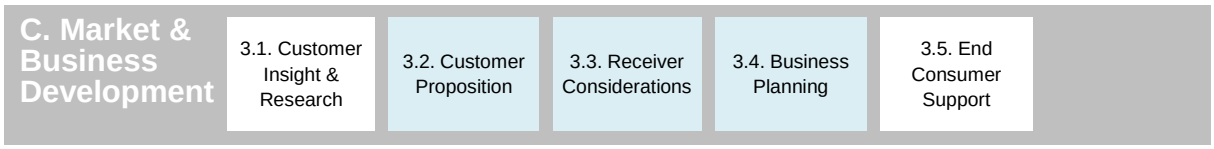
2.18 ASO Communication Plan

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

a. Already decided
b. Partly decided

c. Not decided yet
d. Revision needed

Market and Business development



= Not selected

= Selected, Government led

= Selected, market led

Description	Layer C deals with key business issues and choices that Service Providers/Broadcasters face when planning the commercial launch of DTTB and MTV services. It includes a set of business activities and tools for defining the DTTB/MTV service proposition and associated business case and plan, taking into account identified demand drivers, service barriers, financial feasibility and more specifically receiver availability and customer support issues.
Objectives	Commercial parties will seek a DTTB or MTV Service Proposition which fulfil a consumer demand, generating sufficient revenues (either advertising or subscription based). In contrast, Public Service Broadcasters (PSB) normally fulfil objectives of public interest in the field of information and culture. That is why they are interested in viewing ratings, high population coverage and mainly prefer unencrypted broadcasting. Market and business development work differently as they have to fulfil primarily these 'information and culture' objectives. However, PSBs can also have advertised based income and some of the topics addressed in this section might also be relevant for PSBs.
Building blocks	3.2 Customer Proposition 3.3 Receiver Availability & Considerations 3.4 Business Planning

3.2 Customer Proposition

Key topics & choices	Status	Decision
3.2.1 DTTB competitive advantage and related Service Proposition attributes	b	e.g. price and service line up still to be figured out
3.2.2 MTV competitive advantage and related Service Proposition attributes	NA	

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

3.3 Receiver Availability & Considerations

Brief description	The consideration of the many different DTTB and MTV receiver types that are 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 & choices	Status	Decision
3.3.1 DTTB functional receiver requirements and availability (see receiver model)	c	Receiver specifications still to be defined and decided
3.3.2 MTV functional receiver requirements and availability	NA	

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

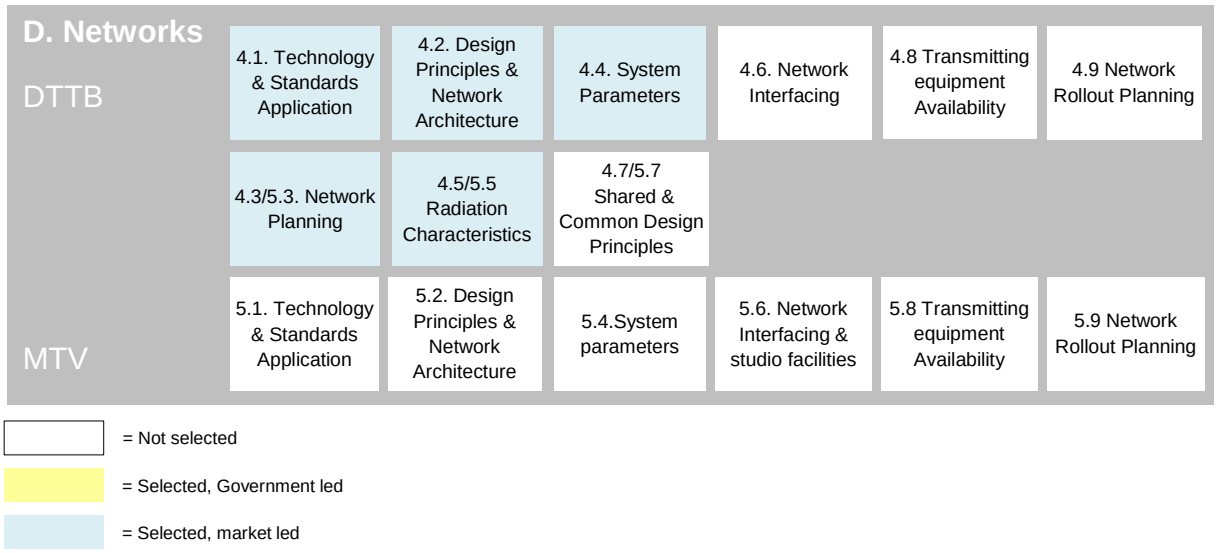
3.4 Business Planning

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

Key topics & choices	Status	Decision
3.4.1 Business models for DTTB services: which model or combination of models is considered (may vary per multiplex)	c	
3.4.2 Business models for MTV services.	NA	
3.4.3 Business case examples: what does the first estimated look like for the DTTB and MTV services?	c	

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

DTTB Networks



Description	DTTB networks cover functional building blocks 4.1 to 4.9 (see Figure above). The checklist contains key topics and choices operators face when planning transmitter networks for broadcasting DTTB services. Choices in network architecture, frequency planning, network planning, roll out planning and network operation should be made in such a way that the license conditions are fulfilled and that the business objectives are met. In doing so, optimum solutions should be found between often conflicting requirements regarding picture and sound quality, coverage quality and transmission costs.
Objectives	Developing DTTB networks in conformity with regulatory framework and formulated business objectives.
Building blocks	4.1 Technology & standards application 4.2 Design principles & network architecture 4.3 Network planning 4.4 System parameters 5.5 Radiation characteristics

4.1 Technology & standards application

Key topics & choices	Status	Decision
4.1.1 Technical tests to evaluate system performance	b	No test to evaluate system performance, testing for demo/to get familiar with the technology still to be decided.
4.1.2 SDTV and HDTV specifications	c	

Key topics & choices	Status	Decision
4.1.3 Selection of DTTB transmission standard	b	ATSC 1.0 and 2.0
4.1.4 Compression system	a	MPEG4
4.1.5 Encryption system	c	
4.1.6 Additional services	a	No additional service for the launch proposition, may be later

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

4.2 Design principles & network architecture

Main topics & choices	Status	Decision
4.2.1 Trade-off between network roll-out speed, network costs and service quality	c	
4.2.2 Main reception mode and defining receiving installations	c	
4.2.3 Services for national, regional, or local coverage	c	
4.2.4 Frequency plan and network topology	c	
4.2.5 Head- end configuration	c	
4.2.6 Equipment reserve configurations	c	
4.2.7 Type of distribution network	c	

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

4.3 Network planning

Key topics & choices	Status	Decision
4.3.1 Service trade-off	c	
4.3.2 SFN or MFN	c	
4.3.3 Fill-in transmitters	c	

Key topics & choices	Status	Decision
4.3.4 GE06 compliance of planned stations, if applicable (Region I only)	NA	
4.3.5 Feed back to business plan and service proposition	c	

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

4.4 System parameters

Key topics & choices	Status	Decision
4.4.1 FFT size	c	
4.4.2 Carrier modulation and code rate	c	
4.4.3 Guard interval	c	

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

4.5 Radiation characteristics

Key topics & choices	Status	Decision
4.5.1 Transmitter power and transmitting antenna gain	c	
4.5.2 Polarization	c	
4.5.3 Use of existing antennas or need for new antennas	c	

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

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Annex 2: Service trade-off and network planning

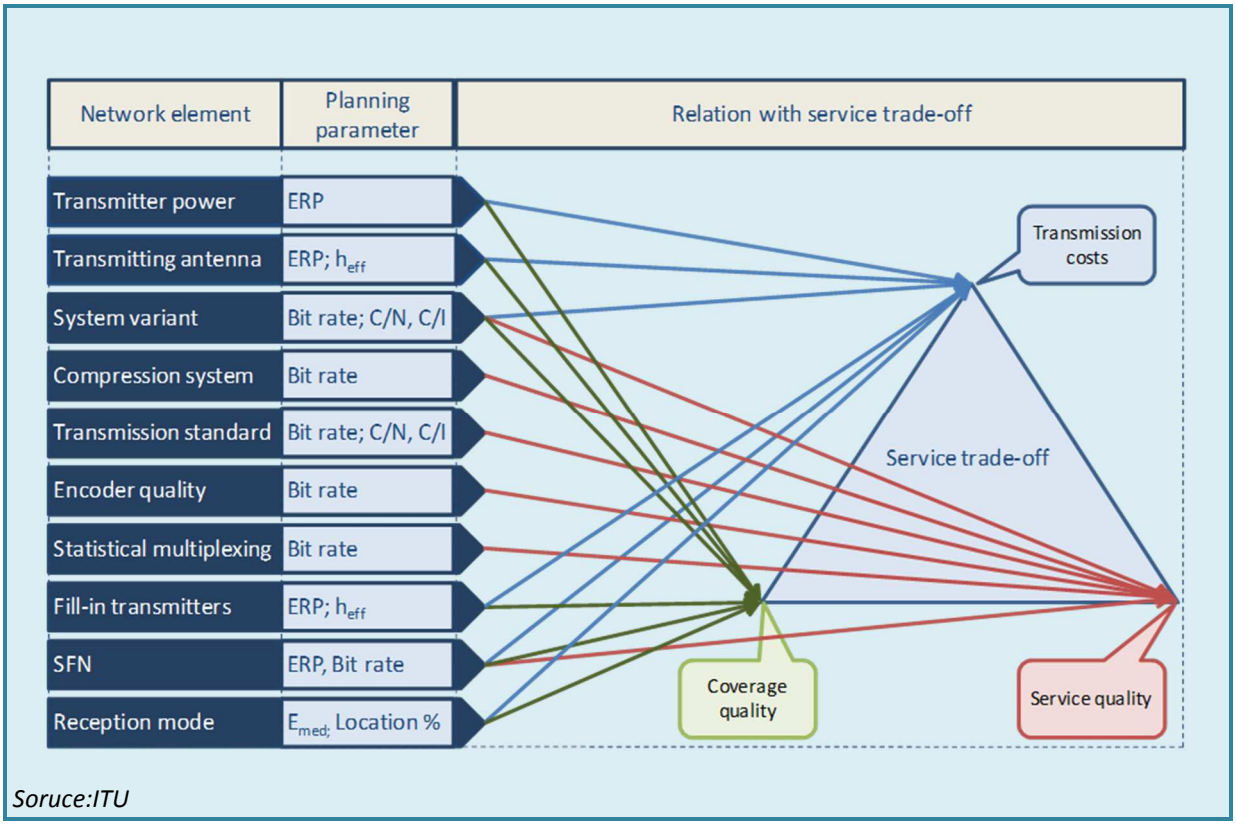
This Annex includes the following sections:

1. Introduction;
2. Technology standards and applications;
3. Design principles and network architecture;
4. Network planning;
5. Radiation characteristics.

Introduction

In this Annex an initial approach is given for the specification of a number of system and planning parameters, which comply with the DSO objectives. In the frequency planning process in Phase 2/3 of the Roadmap the parameters should be verified against the resulting coverage and spectrum use and adjusted where necessary.

The selection of DTTB system and planning parameters is a trade-off between the potential numbers of viewers (coverage quality), payload of the multiplex (service quality) and transmission costs (number of sites and radiated power)[84]. This so-called service trade-off is illustrated in Figure 24.



Soruce:ITU

FIGURE 24: SERVICE TRADE-OFF IN PLANNING DTTB STATIONS

[84] See Section 4.3 of ITU report "Guidelines for transition from analogue to digital broadcasting", edition January 2014.

In the initial approach it is assumed that the existing 14 analogue TV sites and the DTTB coverage matches the analogue TV coverage of these analogue TV sites. With this assumption the size of the coverage area has been defined. The following sections deal with system and planning parameter needed to define radiated power and transmission capacity. The system and planning parameters relate to the following functional buildings blocks (see Section 3.3 of the Roadmap report):

- 4.1 Technology standards and applications;
- 4.2 Design principles and network architecture;
- 4.3 Network planning;
- 4.4 System parameters;
- 4.5 Radiation characteristics.

Technology standards and applications[85]

In Jamaica it has been decided to use the ATSC 1.0 transmission standard with MPEG-4 compression. The system specification assumed for the initial approach is given in Table 12. Also the video and audio bitrates are indicated that are needed for good quality presentation of SDTV and HDTV using state of the art MPEG4 encoders.

Topic	Specification
Transmission standard	ATSC 1.0 or A/53
Video compression system	MPEG-4 AVC
Audio compression	MPEG-4 HE AACv2
Video presentation format	SD; after 2019 also HD
Audio	One stereo channel per service
Data services	Service Information (SI); no other data services
SDTV video bit rate	1.75 Mbit/s per service
HDTV video bit rate	7 Mbit/s per service
Audio bit rate	96 kbit/s for two-channel stereo
Service information (SI)	0.15 Mbit/s per service

TABLE 12: VIDEO, AUDIO AND DATA SYSTEM SPECIFICATIONS

[85] See also Section 4.1 of ITU report "Guidelines for transition from analogue to digital broadcasting", edition January 2014.

Design principles and network architecture[86]

This section addresses the planning parameters related to reception mode and head-end configuration.

Reception mode

For analogue TV, planning criteria are specified for fixed (rooftop) reception only (in ITU-R recommendations). However, in practise a large proportion of the TVHHs in Jamaica receive analogue TV with simple antennas and due to the features of analogue TV, reception quality is poor because of impairments by noise and ghost images.

DTTB offers the possibility of good quality reception with rooftop antennas (fixed reception), but also with simple antennas at indoor or outdoor locations. The latter receiving conditions are called "portable reception". In order to enable viewers to use low cost and easily to install DTTB antenna installations, portable reception is an attractive DTTB feature, but at a given ERP the size of the coverage is smaller compared to fixed reception. It may not be possible for practical and network cost reasons to provide portable coverage everywhere in the defined coverage areas. The aim could be to provide portable indoor coverage as far as practically and economically feasible in urban areas.

The parameters for determining the minimum median field strength (Emed) for fixed (FX), portable outdoor (PO) and portable indoor (PI) reception are summarised in Table 13. Determining the values for the parameters as listed in Table 13 one can refer to Recommendation ITU-R BT.1368-10. Some parameters could be adapted to cater for the situation in Jamaica, for example:

1. The building penetration loss can be adjusted for the build-up areas In Jamaica (as they are different from dense urban cities) and can be taken from Recommendation ITU-R BT.2033, Section 2.2 of Annex 3, which relates to:
    a. Suburban residential building without metallised glass windows;
    b. Room with a window on the exterior wall in an apartment in an urban environment;
2. The height loss can be adjusted as houses don't have receiving possibilities at 10 meters above ground level. Height loss can be calculated using the method given in Recommendation ITU-R P.1546, Section 9 of Annex 5, which relates to rural areas.

#	Parameter
1	Noise figure (dB)
2	C/N (dB)
3	Antenna gain minus cable loss (dB)
4	Building penetration loss - mean value (dB)

[86] See also Section 4.2 of ITU report "Guidelines for transition from analogue to digital broadcasting", edition January 2014.

#	Parameter
5	Man-made noise allowance (dB)
6	Field strength standard deviation (dB)
7	Height loss - 10/1.5 m (dB)
8	(the total of 1 to 8) results in an Emed for DTTB (in dBµV/m at 500 MHz) for: • Fixed reception at 10 meters • Other reception modes at 1.5 meters

TABLE 13: SUMMARY OF PARAMETER FOR DETERMINING THE MINIMUM MEDIAN FIELD STRENGTH (EMED)

Emed specified in item 8 of Table 13 should be used in coverage calculations with "path specific" propagation prediction methods using detailed terrain and clutter data.

It should be noted that for PI and PO reception the Emed, and hence the associated Effective Radiated Powers (ERP), are generally significantly higher than for FX reception. For example for PO the ERP in noise limited conditions can be 20 dB (factor 100) higher than with fixed reception (FX) and with portable indoor reception (PI) 30 dB (factor 1000) higher than with fixed reception. Consequently with a given ERP the PI and PO coverage is much smaller than the FX coverage. However, with high transmitting site heights and relative small coverage areas, portable reception may be possible for viewers in urban areas at reasonable ERPs. In houses where (indoor) reception is not possible reception could be improved by:

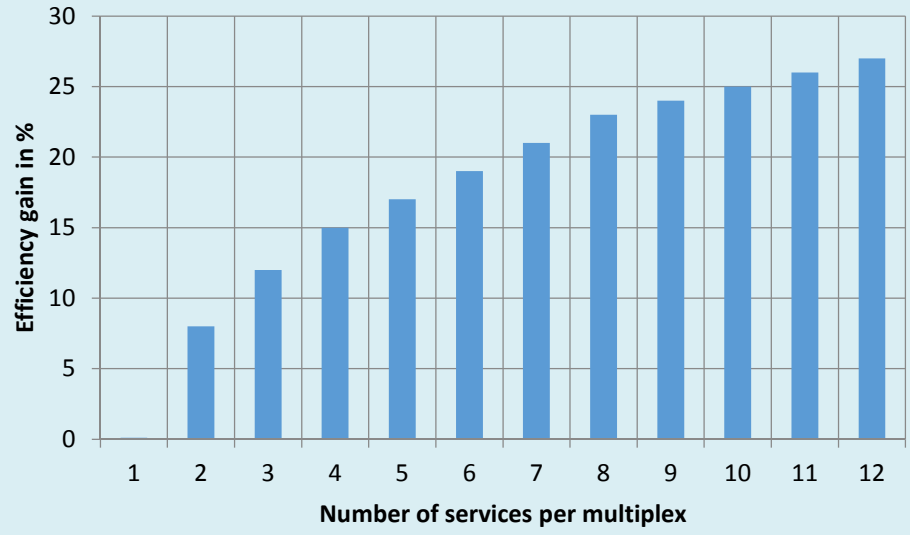
1. Applying an indoor antenna with an integrated low noise amplifier (so-called active indoor antenna);
2. Mounting of a simple antenna outdoors, the higher the better;
3. Applying a small active outdoor antenna;
4. Mounting a directional rooftop antenna;
5. Applying a low noise amplifier at the rooftop antenna.

In an initial approach it could be assumed that planning is based on fixed reception and that a considerable number of household are situated fairly close to the transmitter site and have good indoor or outdoor reception.

Head-end configuration

Multiplexing takes place in the head-end. Statistical multiplexing (statmux) is widely used. In a statistical multiplexer the bitrate is dynamically allocated to different services depending on the programme content. Compared to a constant bitrate per service, it can provide on average higher picture quality of each service, or instead a higher number of services can be accommodated.

In the initial approach it is assumed that in the head-end statistical multiplexing is applied and that an efficiency gain of up to 27% can be reached depending on the number of services in the multiplex (see Figure 25).



Source: Ofcom

FIGURE 25: EFFICIENCY GAIN OF STATISTICAL MULTIPLEXING

Network planning[87]

This section addresses the planning parameters related to the network configuration (SFN or MFN).

As with analogue TV, digital TV transmitters can be planned and operated as Multi Frequency Networks (MFN). In addition multi-carrier transmission standards such as ATSC 3.0 have the advantage that signals from several transmitters arriving at a receiving antenna may contribute constructively to the total wanted signal. This feature makes it possible to operate transmitters in a single frequency network (SFN). As indicated in the ITU Guidelines for transition to DTTB, in practice, SFNs are mainly used in one or more of the following circumstances:

1. High field strength values are needed over large areas, e.g. for mobile, portable or handheld reception;
2. Fill-in transmitters;
3. No frequencies are available for high and medium power stations or fill-in transmitters in MFN configuration;
4. The related GE06 Plan entry is an allotment.

[87] See also Section 4.3 of ITU report "Guidelines for transition from analogue to digital broadcasting", edition January 2014.

Conditions 1) and 4) do not apply to Jamaica. A number of low power DTTB transmitters might be operated as fill-in transmitter with off-air reception. With the formulated DSO/ASO objectives (see Section 2.4) spectrum availability is a pressing issue in the UHF band in Jamaica. As was concluded in Section 4.5.3, the application of ATSC 3.0 and SFNs are likely to be a requirement.

Radiation characteristics[88]

This section addresses the planning parameters related to transmitting antenna pattern, radiated power (ERP) and polarisation.

Transmitting antenna pattern

In the initial approach it is assumed that the DTTB sites have non-directional horizontal radiation patterns. In the detailed planning in Phase 3 of the Roadmap the antenna pattern should be verified and where appropriate to be adjusted with the aim to:

1. Avoid spill-over across the border and to direct the radiation to the required areas by applying directional antennas;
2. Provide portable indoor coverage in urban areas with an appropriate directional horizontal radiation pattern; noting that directional antennas have higher gain and hence result in a lower transmitter power with a given ERP.

ERP

The required ERP depends on the size of the coverage area (see Introduction of this Annex), the reception mode (see Section Reception mode) and the ATSC system parameters. In the initial approach the DTTB ERP is determined to match the analogue TV coverage of the *same site* (or location) with fixed reception.

The ERP of a DTTB station needed to match analogue TV with fixed reception can be calculated with the following formula:

$$ERP_D = ERP_A + (Emed_D - Emin_A) + C_f \qquad (1)$$

Where:

ERP_D	is the ERP of the DTTB station needed to match analogue TV at the same site with fixed reception in dBW;
ERP_A	is the EPR of the analogue station in dBW;
$Emed_D$	is the minimum median field strength for DTTB in dBµV/m with the selected system parameters at a representative channel in the UHF band;

[88] See also Section 4.5 of ITU report "Guidelines for transition from analogue to digital broadcasting", edition January 2014.

$Emin_A$ is the minimum field strength for analogue TV derived from Recommendation ITU-R BT.417 (Emin in the absence of interference other than noise);

C_f is a correction factor in dB for difference in propagation loss between UHF and VHF.

A precise match is not feasible because:

1. $Emed_D$ and $Emin_A$ increase by increasing frequency because of the frequency dependent "effective antenna aperture". In the initial approach a mid-channel can be taken.
2. The factor Cf depends on the propagation path. In the situation in Jamaica, with high transmitting antenna site heights, the difference in propagation in Band III and Band IV could be negligible in case of line sight. But in the shadow zones behind mountains the losses in Band IV are higher than in Band III.

In an initial approach the DTTB ERP can be determined by applying the formula, as presented above. In the detailed planning in Phase 3 of the Roadmap, ERP should be verified and where appropriate to be adjusted with the aim to:

1. To match to analogue TV coverage with fixed reception;
2. To provide portable indoor coverage in urban areas by increasing the ERP to economically acceptable values, taking into account the antenna diagram adjustments.

Polarisation

As in indicated in the ITU Guidelines for transition to digital broadcasting, the choice of polarisation is guided by the polarisation of existing transmitting and receiving antennas. Table 14 summarizes the considerations of the polarisation choice, where H is horizontal polarisation and V is vertical polarisation.

#	Transmissions, all combined into one antenna	Use of existing transmitting antenna [a)]	Use of new transmitting antenna	
			Rooftop antennas in use [a)]	Almost no rooftop antennas in use
1	DTTB multiplexes intended for fixed reception	H	H	H
2	DTTB multiplexes also intended for portable or mobile reception	H	H	V
3	Combination of DTTB multiplexes intended for fixed reception and MTV multiplex	H	H [b)]	V
4	Combination of DTTB multiplexes intended for portable or mobile reception and MTV multiplex	H	H [b)]	V
	a) assuming that existing antennas are horizontally polarised, if existing antennas are vertically polarised the choice is vertical polarisation for all indicated transmissions; b) or a double polarised antenna (available for Band III) with MTV transmission in vertical polarisation.			

TABLE 14: POLARISATION CHOICE

Taking into account that portable reception is important and that there are no existing UHF transmitting antennas and no UHF rooftop antennas, the recommended polarisation is vertical (see blue shaded field in Table 14). Vertically polarised transmitting antennas have also the advantage that for low power transmissions, low cost non-directional dipole antennas can be used.

In an initial approach it can be assumed that the transmitting antennas are vertically polarised.

Annex 3: More details on Reference Offers

This Annex provides some more details on the system of requiring reference offers (RO) from DTTB multiplex/network operators.

This Annex is structured as follows:

1. Scope of RO;
2. Pricing of RO.

Scope of RO

A NRA stipulates that the network provider has to offer a *minimum service*. The following could be included in the minimum service:

1. Encoding and multiplexing of service feeds, and;
2. The distribution of a ATSC compliant national[89] SD or HD service in calculated coverage areas and covering a minimum population as included in the Network Deployment Plan (i.e. in compliancy with their network roll-out obligation);
3. Not exceeding the maximum permissible powers (and hence interference levels) as included in the Frequency Plan (see also Section 4.5).

A licensed network provider could also provide auxiliary services, such as the supply of studio or service feeds to the national head-end system or to a satellite uplink station. Figure 26 shows an overview of the reference offer' scope, technical interfaces and Point of Service (PoS).

[89] This excludes the requirement for provisioning of regionalised services. A separate reference offer for regionalised services should be drafted.

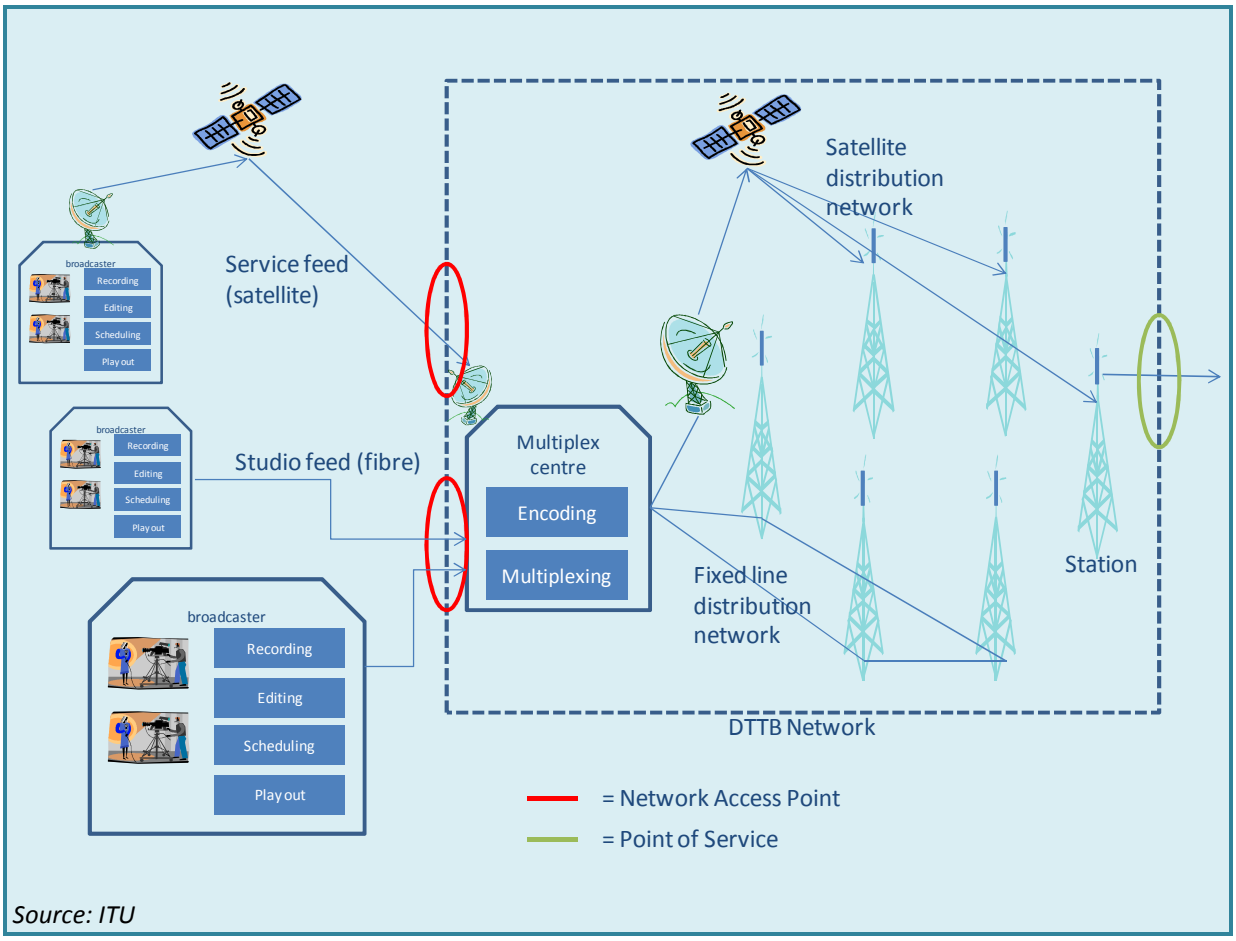


FIGURE 26: SCOPE OF THE RO FOR DTTB NETWORK SERVICES

The network operator has a roll-out obligation to deploy their network in defined stages. In the final stage their network could be near nationwide coverage (see Table 2). The reference offer has to consider this staged deployment. Hence, for the DTTB service delivered at each site the network operator should to include the following:

1. Calculated rooftop (and indoor) coverage per site (or SFN, if applied), plotted on maps, and in sufficient detail to assess the quality of the coverage areas[90];
2. Calculated rooftop (and indoor) coverage per site (or SFN, if applied), expressed in number/percentage of households/population;
3. Monthly charge per site per service (Point of Service) allowing for charging distribution fees proportional to the deployment stage.

In the case of two or more network operators some special requirements are necessary in the reference offers as to ensure a coordinated deployment between the multiple network operators. The design, deployment and operations of the sites should be coordinated between the network

[90] The NRA can request the in- and output files from the network operator's planning software tool. It is also noted that the wanted coverage areas are not defined in the case of population target for network coverage. For example only the required population coverage of a whole network is defined (e.g. 90%). Consequently there can be coverage gaps.

operators in such a way that the viewer needs to direct its antenna in one direction while receiving all available services with optimal signal strength.

Also the network operator should provide details on System Software Updates (SSU) it may wish to carry out. SSU should be tested before they are carried out. These SSU procedures have to be described and included in the description of the operational and maintenance procedures of the reference offer. Similarly, the provisioning of service information (i.e. PSI/SI) should be detailed.

Pricing of RO

The pricing structure and pricing model should be defined by the NRA. The costing methodology for calculating the cost of the *minimum service* is commonly based on long run incremental cost (LRIC)[91]. The increment is defined as a DTTB service. The principle of the LRIC model can be defined as the difference between the company cost level with and without the minimum service. Figure 27 illustrates this in the form of a simple formula.

$$LRIC\ of\ the\ minimum\ service = \frac{(\text{Cost of providing the minimum service} - \text{Cost without the minimum service})}{\text{Total number of services in the network/multiplex}}$$

FIGURE 27: LRIC MODEL

The cost of the *minimum service* comprised the following cost elements:

1. Capital expenditure (CAPEX): investment costs in the DTTB network which are directly relevant to the provision of *minimum service* such as encoder, multiplexer, transmitter etc;
2. WACC: reasonable return on capital invested in the DTTB network calculated based on weighted average cost of capital (WACC[92]);
3. Operating expenditure (OPEX): expenses which are directly relevant to the provision of *minimum service* such as operation and maintenance cost;
4. Common cost: costs which are relevant to the business operation but cannot be directly or indirectly allocated to *minimum service* such as general and administration costs, regulatory costs etc.[93]

Table 15 includes the assets lives and cost trends that could applied for the various asset categories.

[91] For more details on the application of LRIC models see ITU Regulations Toolkit on www.ictregulationtoolkit.org

[92] For non-public financed entities the WACC is different (higher) from publicly financed entities. Please note that also bank loan interest rates and the risk profiles of the business (and country) drive WACC percentages.

[93] The distribution of common cost to access the minimum service can be based on equal proportional mark up (EPMU) method.

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

TABLE 15: ASSET LIVES AND COST TRENDS

Example reference offers can be found on the Ofcom website (i.e. the NRA of the UK), under reference offers (see www.ofcom.org.uk).

Annex 4: DTTB network cost drivers

A DTTB network consists of one or more head-ends, the distribution links and the transmitter sites.

This section describes items having an impact on transmission costs and efficient use of frequencies and gives an example of a network lay-out that complies with the DSO objectives and the decisions taken or advised on key topics and choices of the selected functional building blocks.

5.1.1 Items having an impact on transmission costs and efficient use of frequencies

It is up to the network provider to consider the various options of the network architecture and to decide on cost effective and technically sound solutions that comply with the license conditions and the requirements of the service providers. However, in developing the license conditions it should be taken into account that the following items have an impact on transmission costs, efficient use of frequencies and reliability and quality of the service delivery:

1. Local and regional services;
2. Network configuration (SFN or MFN);
3. Statistical multiplexing;
4. Distribution links;
5. Equipment redundancy

1) Local and regional services

Requirements for regional and local services are important design criteria in the network architecture and have an impact on transmission costs. The DSO objectives do not indicate the need for regional of local services, consequently all 25 services are exactly the same at all sites at any time. Under these conditions one head-end at a central location is sufficient where all services are multiplexed and from where the data stream (Transport Stream - TS) is distributed to the transmitter sites.

However, if at a later stage regional services at one or more sites are required, the services intended for these sites should be re-multiplexed by taking out one or more of the national services and inserting one or more regional services. In principle three basic network lay-outs could be considered in that case:

1. One main head-end only
   All national and regional services are transported to the main head- end and from there distributed to all transmitter sites;
2. Regional head-end in each region
   National services and regional services are multiplexed at regional head-ends and distributed to the transmitter sites that are part of the regional coverage area;
3. Combination of 1 and 2
   Some regional services are multiplexed at the main head-end and together with the national services distributed to all transmitter sites. Other regional services are coded and (re)multiplexed with national services at regional head-ends.

As the DSO objectives indicate national services only, layout 1 (one main head-end) is shown in Section 5.1.2.

2) Network configuration (SFN or MFN)

As ATSC 1.0 does not allow for SFNs it is assumed that DTTB planning is based on MFNs for the first stage. However, if at a later stage (after 2019) it is decided to apply ATSC 3.0 and operate one or more transmitters in SFN (e.g. to cover a town by two sites in order to improve portable indoor reception) it should be taken into account that transmitters belonging to an SFN:

1. Must have the same content at any time;
2. Must be connected to the same network adapter/gateway, generating the synchronization information to the transmitters in the SFN.

3) Statistical multiplexing

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

4) Distribution links

In the ITU guidelines[94] several physical means and technologies for distributing signals from the head-end to the transmitters are described including:

1. Satellite links, microwave links, and optical fibre using PHD, SDH, ATM and IP technologies;
2. DVB-S2 satellite broadcasting transmissions;
3. Off-air reception.

As for analogue television, distribution of the DTTB signals to the transmitters could be provided by microwave links. The transmitters should be fed with a TS as defined in the ATSC standard.

Off-air reception offers the lowest installation costs[95]. In particular in MFN networks some sites could be fed off-air provided that the received input signal level is sufficiently high. In SFNs the ERP of off-air fed transmitters is restricted in order to avoid oscillation and depends on the isolation between input and output. The quality and availability of the transmitting signal depends on the quality and availability of the received signal. Application of many off-air fed sites and cascaded off-air fed sites reduces the services availability levels and may not be acceptable for operational reasons.

5) Equipment redundancy

In order to avoid long service interruptions in case of maintenance or equipment failure, critical parts of the transmission chain, including ancillary equipment such as power supply and cooling, should

[94] See Section 4.2.7 of Guidelines for the transition from analogue to digital broadcasting, edition January 2014

[95] See also Section 4.3.3 of Guidelines for the transition from analogue to digital broadcasting, edition January 2014

have a certain redundancy[96]. The redundancy could range from use of parallel units in operational equipment to a complete back-up system.

Monitoring the operational status of the transmission chain is essential to make the operator aware of an operational problem and to take actions to resolve the problem.

The ITU Guidelines give the following guidance with regard to redundancy:

1. If several transmitters are used at a site, an n+1 redundancy configuration is often used.
2. If a site accommodates one or two transmitters, it may be appropriate to install a double driver unit. The RF power amplifier consists in general of several units, thus providing a built-in redundancy;
3. In the multiplex centre encoders and multiplexers have often full or n+1 back-up configurations;
4. Monitoring equipment and links should have full redundancy.

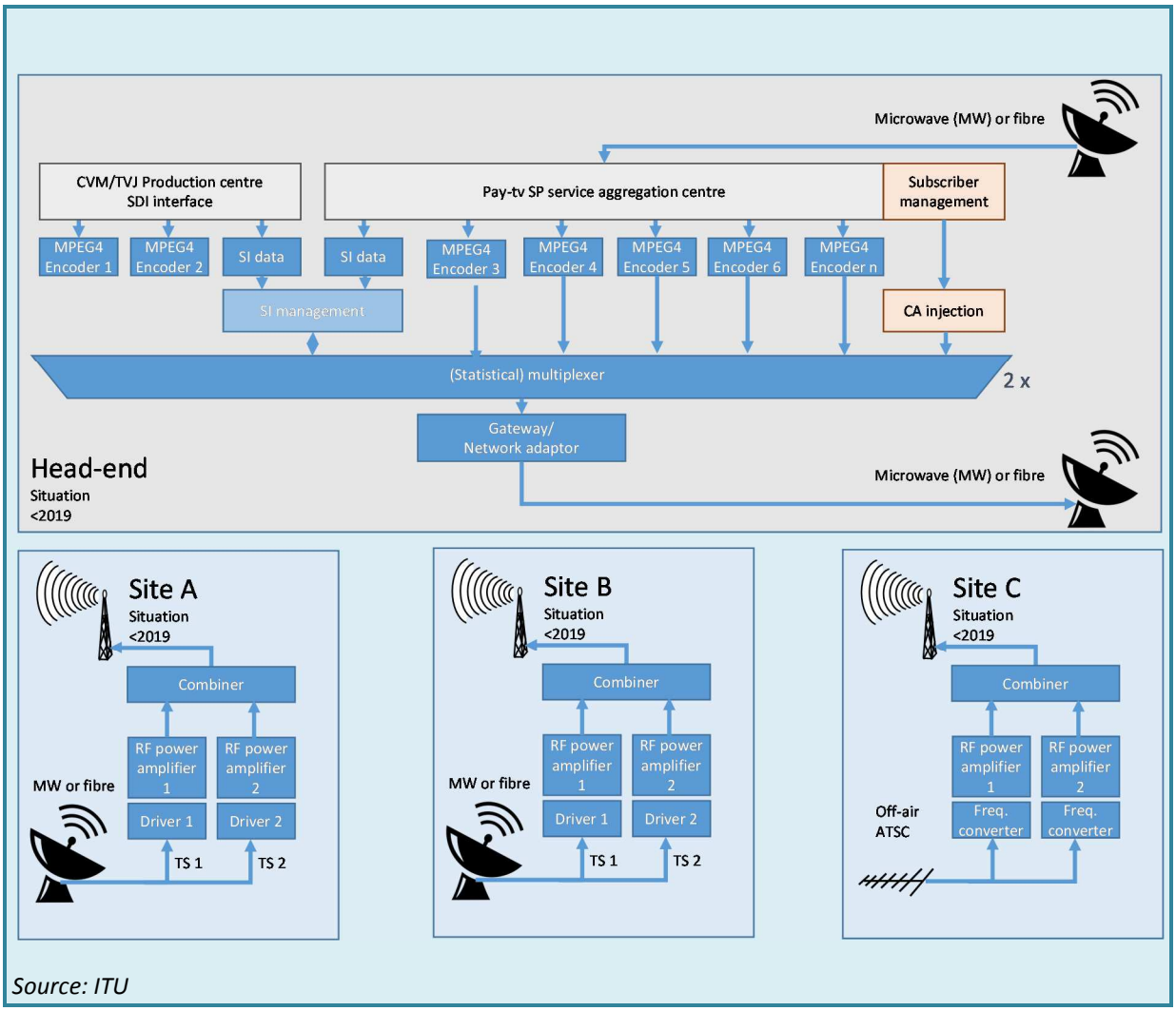
The available budget may make it necessary to compromise on back-up facilities; priority may be given to:

1. Parts in the transmission chain that are sensitive to failure based on the experience of the operation of the analogue TV networks;
2. Central parts in the network, such as the head-end;
3. Transmitting stations covering relative large parts of the population.

5.1.2 Example network architecture

The block diagram in Figure 28 shows an example of a network architecture In order to simplify the figure only three transmitting sites are indicated.

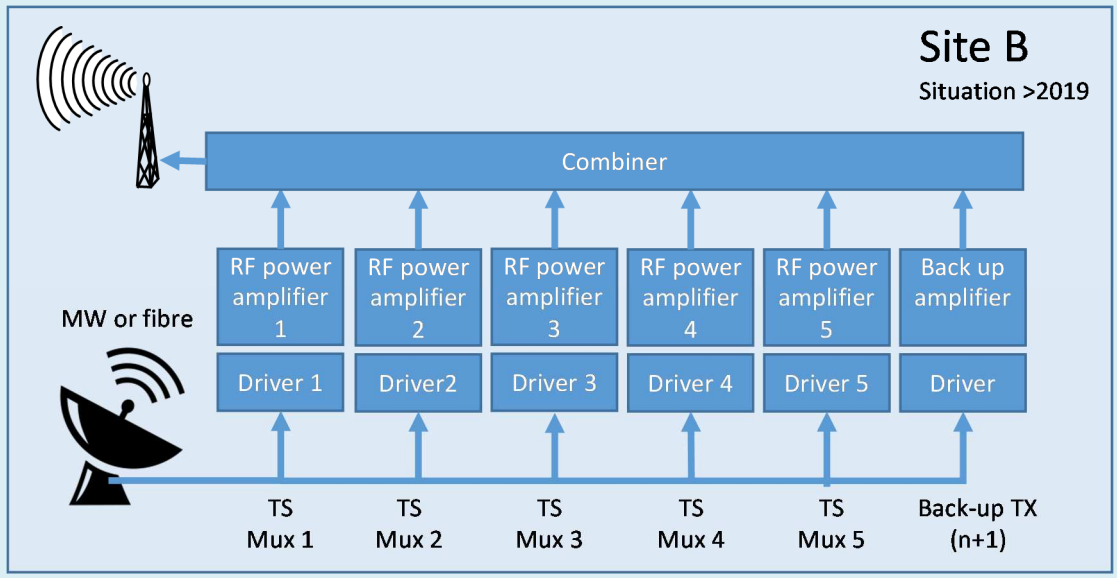
[96] See also Section 4.2.6 of Guidelines for the transition from analogue to digital broadcasting, edition January 2014



Source: ITU

FIGURE 28: EXAMPLE NETWORK ARCHITECTURE

Figure 28 shows the situation before 2019 with two multiplexers and two transmitters per site (no back-up transmitter). After 2019, five multiplexes are expected. The head-end should then be extended with encoders for each of the future SD or HD services and with three additional multiplexers. The transmitting sites will contain five active transmitters (one for each multiplex) and the transmitter output will be combined into the antenna. In Figure 29 shows the lay-out of one of the transmitting stations (Site B) after 2019 with five operational transmitters (and one back-up transmitter).



Source: ITU

FIGURE 29: LAY-OUT OF SITE B AFTER 2019

The three different parts of the DTTB network are described in the following sections.

1) Head-end

At the head-end the programme streams are delivered by CVM, TVJ, Love-TV, PBCJ and the pay-tv service provider (SP) and are then compressed in the MPEG 4 encoders and multiplexed into a data stream (TS) which is distributed to the transmitting stations. Statistical multiplexing is recommended (see Annex 2: Service trade-off and network planning).

The output of production centres is often Digital Serial Interface (SDI), which allows transporting uncompressed video from the studio centre to the encoders in high quality. SDI links are designed for short distances; therefore the encoders should be located at or close to the production centres. Hence depending on the location of the broadcasters and the pay-tv SP the encoding could alternatively take place at their premises. Hence the studio feeds are delivered at the head-end in compressed format.

Because of the interaction between encoders and the statistical multiplexer, normally encoders and multiplexer need to be located close to each other and controlled by the same computer. Some manufactures offer encoders and multiplexers that can be located at different locations. To simplify operations and reduce costs (to be checked) it is assumed that in Jamaica encoders and multiplexer are placed in the same location.

The pay-tv SP may offer a package of services received by DVB-S(2) satellite. As the multiplex bandwidth and modulation of the satellite services is different than the ATSC bandwidth and modulation, the services need to be re-multiplexed. For the same reason as above, it is assumed that the decoders and encoders are placed in the central head-end. The service package offered by the cable operators will be delivered as pay-tv. Therefore the signals need to be scrambled and

Conditional Access (CA) data be inserted. Furthermore a Subscriber Management System is required for managing the billing process and providing authorisations.

At the head-end also the programme related data (SI) for establishing the electronic programme guide (EPG) should be inserted in the data stream.

2) Distribution links

In the example it is assumed that most sites are fed by microwave links (Site A and Site B in Figure 28) and that some low power sites are fed off-air (Site C in Figure 28).

3) Transmitting station

At the sites fed by microwave, receiving installation (dish) is installed which gives the TS data stream as output. The TS data stream is fed to the transmitter input. The ATSC system parameters are selected at the transmitter.

At sites fed off-air, an UHF receiving antenna and receiver are installed. In the transmitter the received signal is down converted to the intermediate frequency stage (IF) and up-converted to the required transmission frequency.

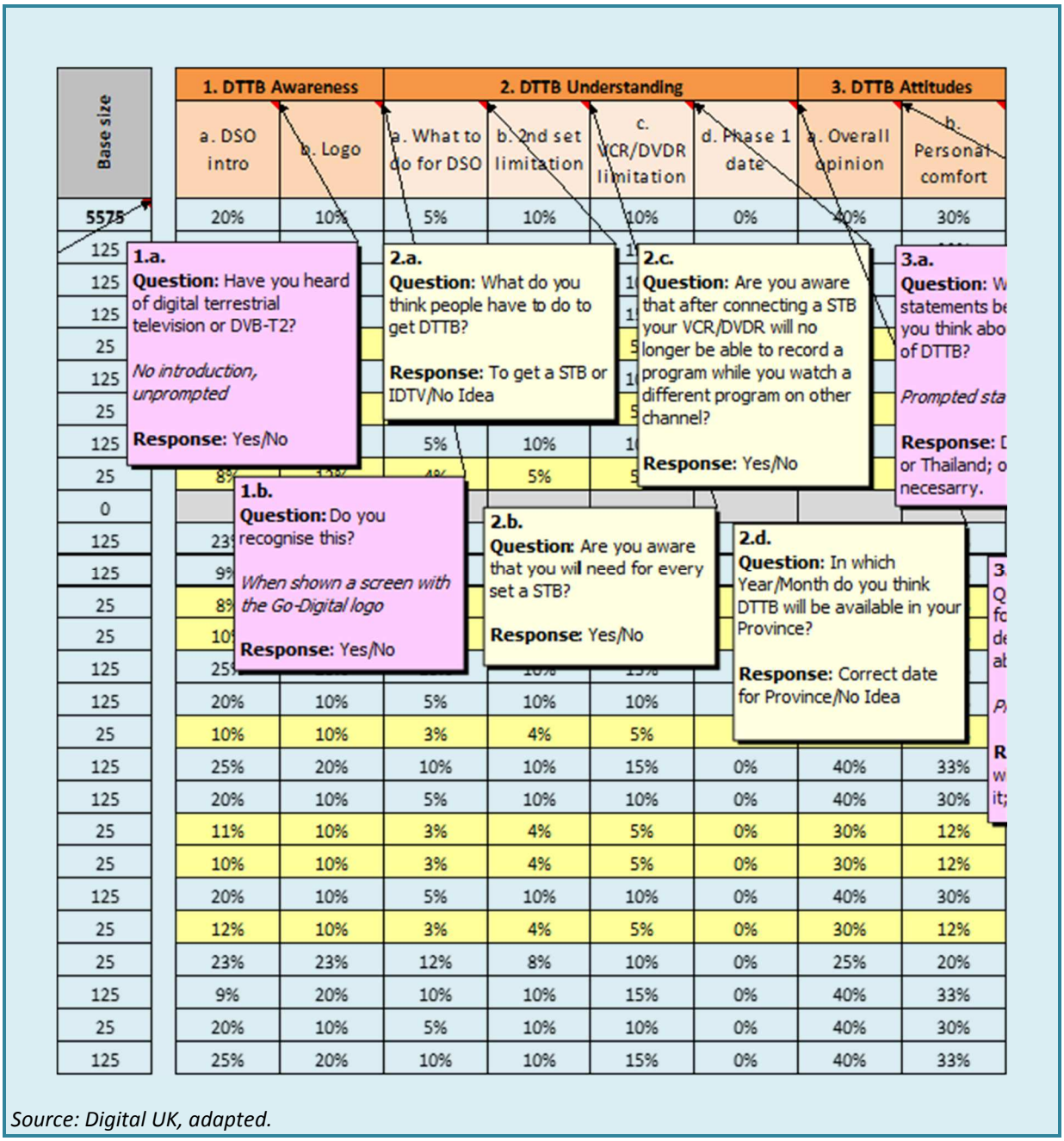
In Jamaica DTTB will start with two ATSC 1.0 multiplexes (two transmitters per site). After 2019 five multiplexes are expected, hence five transmitters per site. It is assumed that in the latter situation a back-up transmitter in n+1 configuration will be installed. It should be noted here that the first two transmitter are ATSC 1.0 and the additional three transmitters are likely to be ATSC 3.0. After migrating all services to ATSC 3.0 the ATSC 1.0 transmitters may be replace with ATSC 3.0 transmitters. The reuse of the ATSC 1.0 RF power amplifier should be checked and taken into account when ordering the ATSC 1.0 transmitters (the driver cannot be reused).

Annex 5: Example tracker board

DSO tracker board is a management tool for planning and monitoring the DSO progress. It can also be used for determining the ASO date. Systematically collected DSO data and regularly communicated DSO tracker boards provide a solid base for determining a national ASO date. Depending on the demographics and the target group details registered in DSO surveys, the tracker board scores can be displayed per administrative area or per target group.

The included example is based on the tracker board as was used by Digital UK for managing the DSO/ASO process in the UK. The DSO tracker board is designed around the six communications phases (as included in the ITU Guidelines in section 2.18.1).

Figure 30 to Figure 32 show an overview of the tracker broad.



Base size	1. DTTB Awareness		2. DTTB Understanding				3. DTTB Attitudes	
	a. DSO intro	b. Logo	a. What to do for DSO	b. 2nd set limitation	c. VCR/DVDR limitation	d. Phase 1 date	a. Overall opinion	b. Personal comfort
5575	20%	10%	5%	10%	10%	0%	40%	30%
125								
125								
125								
25								
125								
25								
125			5%	10%	1(			
25	8%		4%	5%	5			
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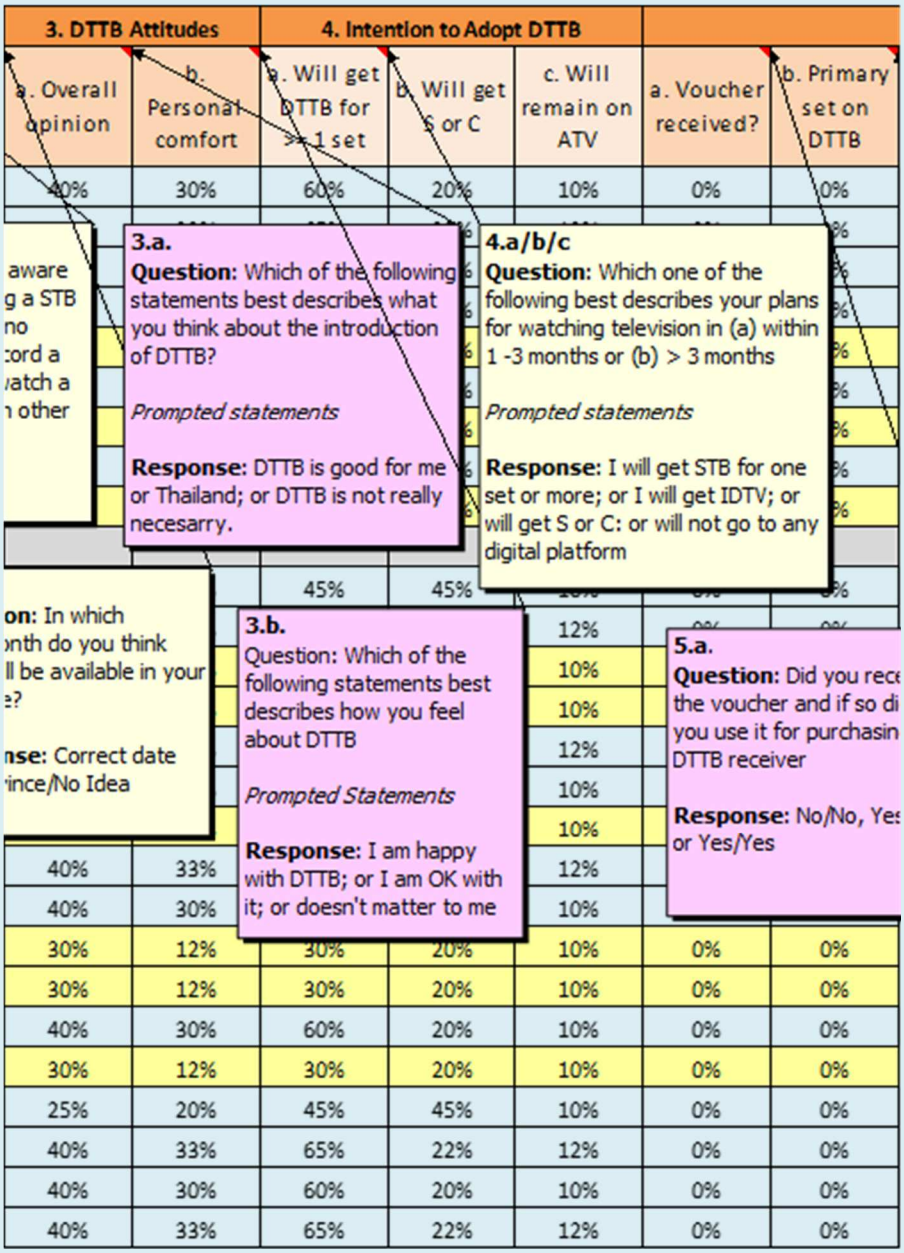
125	23							
125	9%							
25	8%							
25	10							
125	25				10%	15%		
125	20%	10%	5%	10%	10%			
25	10%	10%	3%	4%	5%			
125	25%	20%	10%	10%	15%	0%	40%	33%
125	20%	10%	5%	10%	10%	0%	40%	30%
25	11%	10%	3%	4%	5%	0%	30%	12%
25	10%	10%	3%	4%	5%	0%	30%	12%
125	20%	10%	5%	10%	10%	0%	40%	30%
25	12%	10%	3%	4%	5%	0%	30%	12%
25	23%	23%	12%	8%	10%	0%	25%	20%
125	9%	20%	10%	10%	15%	0%	40%	33%
25	20%	10%	5%	10%	10%	0%	40%	30%
125	25%	20%	10%	10%	15%	0%	40%	33%

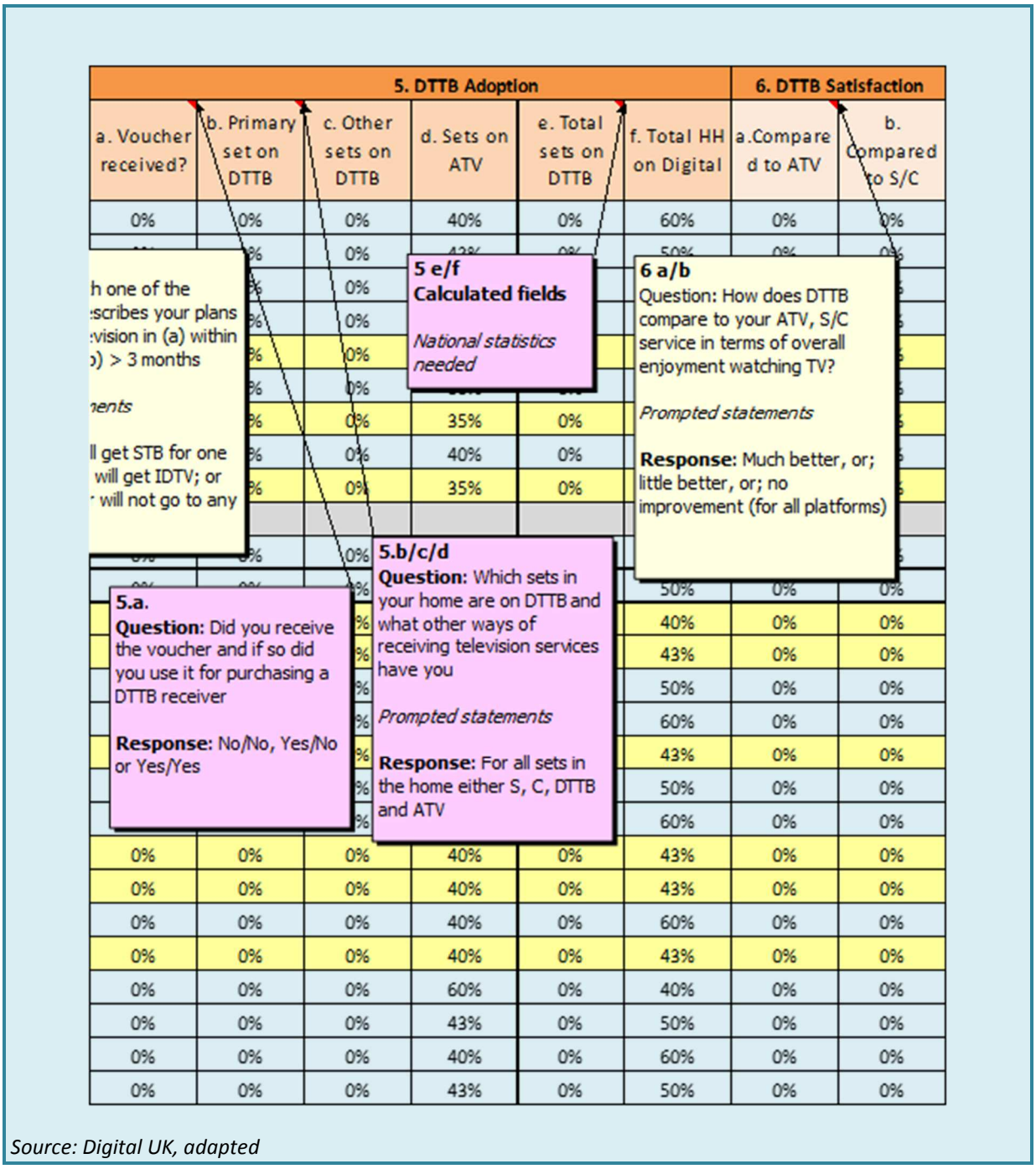
Source: Digital UK, adapted.

FIGURE 30: PHASE AWARENESS AND UNDERSTANDING



Source: Digital UK, adapted.

FIGURE 31: PHASE ATTITUDES AND INTENTIONS



Source: Digital UK, adapted

FIGURE 32: PHASE ADOPTION AND SATISFACTION