



# **Implementation Plan for the Free-to-Air Television Digital Switchover in Trinidad and Tobago**

## Maintenance History

Date	Change Details	Version
15 <sup>th</sup> December 2023	First draft developed by the Digital Terrestrial Television (DTT) Working Group and approved by the DTT Steering Committee	0.1
17 <sup>th</sup> January 2024	Approved version	1.0

## Table of Contents

Maintenance History .....	i
List of Tables .....	iii
List of Figures .....	iv
Abbreviations .....	iv
1 Introduction.....	1
1.1 Background .....	1
1.2 Purpose.....	1
1.3 Objectives.....	2
1.4 Other Relevant Documents .....	2
1.5 Review Cycle .....	2
2 Project Definition.....	3
2.1 Scope .....	3
2.2 Critical Success Factors .....	4
2.3 Assumptions.....	6
3 Strategy for the Implementation .....	7
3.1 Key Stakeholders.....	7
3.2 Implementation Approach.....	10
4 Regulatory Framework .....	12
4.1 Authorisation Requirements.....	12
4.1.1 Shared Signal Distributors .....	12
4.1.2 FTA TV Broadcasters and Individual Signal Distributors .....	12
4.1.3 FTA TV Broadcasters Only .....	13
4.2 ATSC 3.0 Advanced Feature Content.....	13
4.3 DTT Transmission Specifications .....	14
4.4 Technical Regulations .....	17
4.4.1 Coverage Obligations.....	18
4.4.2 Technical Limits .....	18
4.4.3 QoS Parameters for Reception Quality.....	19
5 Spectrum Allocation and Management.....	21
5.1 Frequency Planning.....	21

5.2	Channel Assignment .....	22
5.3	Interference Management.....	23
6	Authorisation and Regulation of the Shared Signal Distributor .....	24
6.1	Authorisation Approach .....	24
6.2	Regulation of the Shared Signal Distributor .....	24
7	Receiver Specification and Proliferation .....	26
7.1	Minimum Receiver Specification.....	26
7.1.1	Minimum Viable Product .....	26
7.2	Receiver Proliferation Incentives and Strategies .....	27
8	Stakeholder Awareness and Engagement .....	28
9	Digital Switchover Schedule.....	29
9.1	Digital Switch-On .....	29
9.2	Phased Analogue Switch-Off.....	30
9.3	Stakeholder Awareness .....	30
9.4	Receiver Proliferation .....	31
10	Monitoring and Evaluation (M&E) .....	32
10.1	Service Rollout.....	32
10.2	Awareness .....	33
10.3	Uptake .....	33
	Appendix I – Required C/N and Field Strength for ModCod Combinations .....	34
	Appendix II – Detailed Digital Switch-over Schedule .....	36
	Appendix III – Summary of CTA’s Recommended Practice for ATSC 3.0 TV Sets .....	37

## List of Tables

Table 1.	Critical success factors of the DSO project .....	4
Table 2.	Roles and responsibilities of the key stakeholders .....	7
Table 3.	DTT transmission specifications .....	14
Table 4.	Reception quality parameters for DTT .....	20
Table 5.	QoS metrics for DTT .....	20
Table 6.	Frequency channels available for DTT.....	22
Table 7.	Threshold levels at which interference is considered to occur .....	23

Table 8. Required C/N (dB) for BER = $10^{-6}$ after LDPC and BCH decoding under AWGN channel .....	34
Table 9. Required receive field strength (dB $\mu$ V/m) for BER = $10^{-6}$ after LDPC and BCH decoding under AWGN channel.....	35
Table 10 CTA Required and Optional ATSC 3.0 Features and Functionality (O depicts optional, R depicts recommended, and CR depicts conditional conditionally recommended) .....	37

## List of Figures

Figure 1. DTT implementation structure .....	11
Figure 2. Adjacent channel emission mask.....	19
Figure 3. TV UHF broadcasting band.....	21
Figure 4: NEXTGENTV logo.....	26
Figure 5: DSO project timeline.....	29

## Abbreviations

AAC	Advanced Audio Coding
AC-4	Audio Codec 4
ALP	ATSC Link-Layer Protocol
ATSC	Advanced Television Systems Committee
ATSC 3.0	Advanced Television Systems Committee standard version 3.0 (ATSC 3.0)
BER	bit error rate
BWA	broadband wireless access
C/N	carrier to noise ratio
DSO	digital switchover
DTT	digital terrestrial television
EPG	electronic programme guide
ERP	effective radiated power
ESG	electronic service guide
FEC	forward error correction
FER	frame error rate
FTA	free-to-air
HDR	high dynamic range
HEVC	high efficiency video coding
ITU-R	ITU Radiocommunications Bureau
LDPC	low-density parity check
MDT	Ministry of Digital Transformation
NTSC	National Television Standards Committee

MER	modulation error ratio
MHz	megahertz
PLP	physical layer pipe
RFP	request for proposals
SD	standard definition
SFN	single frequency network
STB	set-top-box
QAM	quadrature amplitude modulation
QoS	quality of service
QPSK	quadrature phase shift keying
TTPBA	Trinidad & Tobago Publishers & Broadcasters Association
TV	television
UHF	ultra-high frequency
WGC	wide colour gamut

# 1 Introduction

## 1.1 Background

The Telecommunications Authority of Trinidad and Tobago (the Authority) is facilitating the evolution of the free-to-air (FTA) television sector in its transition from analogue to digital terrestrial television (DTT), also known as the digital switchover (DSO). FTA television is currently transmitted and received in an analogue format, based on the National Television Standards Committee (NTSC) standard. In January 2023, the Authority adopted the Advanced Television Systems Committee standard version 3.0 (ATSC 3.0) as the DTT standard for Trinidad and Tobago.

The DSO, using ATSC 3.0, is expected to ensure the sustainability and longevity of the FTA television broadcasting sector based on the following three main benefits of DTT:

1. Improved quality – both audio and video quality are improved. Multichannel and immersive audio are possible with DTT. Video resolution up to ultrahigh definition (UHD) and modern features like high dynamic range, wide colour gamut and variable frame rate up to 120 Hz are also available.
2. Additional services – many enhanced services are available, such as advanced emergency alert, interactive viewing, hybrid viewing, personalisation and datacasting.
3. Increased spectral efficiency – one RF channel (6 MHz in Trinidad and Tobago), which carried one standard definition analogue FTA television channel, can carry multiple high-definition (HD) digital FTA channels.

The DSO is a national project involving many stakeholders and therefore, the implementation should adopt a multi-stakeholder approach and should be guided by the *Framework for Digital Terrestrial Television Broadcasting in Trinidad and Tobago*.

## 1.2 Purpose

The purpose of this *Implementation Plan for the Free-to-Air Television Digital Switch-Over in Trinidad and Tobago* (Implementation Plan) is to detail the technical and regulatory provisions and requirements to be adopted by broadcasters, consumers and other stakeholders during the transition of the FTA television broadcasting sector from analogue to DTT in Trinidad and Tobago using the ATSC 3.0 standard.

## 1.3 Objectives

This Implementation Plan:

1. details the regulatory framework for the authorisation of the signal distributor(s) and the FTA television broadcasters, the DTT transmission standard, and other technical regulatory requirements.
2. establishes the spectrum management approaches for DTT, including spectrum allocation, assignment and interference management.
3. defines the specifications of receivers and identifies the strategies for the proliferation of ATSC 3.0 receivers.
4. outlines the strategy for stakeholder engagement to ensure stakeholders receive relevant and timely communication on the transition.
5. establishes the DSO schedule, including timelines and targets.
6. identifies monitoring and evaluation mechanisms for assessing the impact and effectiveness of the DTT deployment, including awareness, take-up and signal rollout.

## 1.4 Other Relevant Documents

The following documents, in effect, are to be read along with this Implementation Plan:

1. *Framework for Digital Terrestrial Television Broadcasting in Trinidad and Tobago (DTT Framework)*
2. *Authorisation Framework for the Telecommunications and Broadcasting Sectors of Trinidad and Tobago (ver. 0.5, 2005)*

## 1.5 Review Cycle

As the DSO project implementation progresses, the need may arise to revise and update this Implementation Plan and as such, this document will be modified as the Authority deems appropriate. The document's maintenance history will be modified accordingly.



## 2 Project Definition

### 2.1 Scope

This project aims to facilitate the transition of the FTA television broadcasting sector from analogue to DTT in Trinidad and Tobago using the ATSC 3.0 standard.

Upon completion, one or more ATSC 3.0 networks will be deployed by a shared signal distributor and/or individual broadcasters, all the FTA television broadcasting service providers' content will be broadcast in a digital format using the ATSC 3.0 standard, and all analogue transmissions will be switched off.

The main activities within the scope will be as follows:

1. Authorisation of signal distributors
  - a) the development and issuance of an RFP for the shared signal distributor
  - b) issuing authorisations to shared and individual signal distributors
2. Stakeholder awareness and engagement
  - a) the development and execution of a stakeholder awareness plan
  - b) handling the overall stakeholder engagement
3. Adoption of strategies for ATSC 3.0 receiver availability and affordability
  - a) recommendation of strategies for the availability and affordability of receivers
  - b) implementation of the approved strategies
4. Project monitoring and evaluation
  - a) review the progress of the implementation to determine whether deployments are in accordance with the applications submitted and if critical success factors have been achieved

## 2.2 Critical Success Factors

The critical success factors of the DSO project are listed in Table 1.

Table 1. Critical success factors of the DSO project

<b>Objectives</b>	<b>Critical Success Factors</b>	<b>KPIs</b>
Authorisation of the shared signal distributor	<p>Entities interested in applying for authorisation to operate the shared signal distributor DTT network</p> <p>The awarding of relevant concession and licence(s) to the shared signal distributor</p>	<p>Timely issuance of an RFP inviting applications for the operation of the shared signal distributor DTT network</p> <p>Receipt of applications in response to the RFP</p> <p>Minimal requests for clarifications</p> <p>Timely evaluation of applications</p> <p>Timely approval of the concession and the granting of licence(s)</p>
Authorisation of digital FTA TV broadcasting service providers	<p>Entities' interest in applying for the authorisation to provide FTA broadcasting services or to operate individual signal distributor networks</p> <p>The awarding of relevant the concession to FTA TV broadcasting service providers</p>	<p>Receipt of concession applications to provide FTA television broadcasting services or to operate individual signal distributor networks</p> <p>Timely processing of concession applications</p> <p>Timely approval of the concession</p>
Rollout of digital FTA television services using ATSC 3.0 networks	Partial or full deployment of ATSC 3.0 network(s) before the digital switch-on date	At least two transmitter sites deployed for each DTT network – one in Trinidad and

Objectives	Critical Success Factors	KPIs
	<p>Launch of FTA TV services by the digital switch-on date</p>	<p>one in Tobago – before the digital switch-on date</p> <p>Receipt of signed standard access offers from FTA television broadcasters intending to use the shared signal distributor’s DTT network before the digital switch-on date</p> <p>Connections required for the delivery of content from the FTA television broadcasters to the shared signal distributor’s DTT network are commissioned before the digital switch-on date.</p> <p>Successful testing of digital signals with services on-air before the digital switch-on date</p>
<p>Effective stakeholder engagement</p>	<p>Stakeholders provided with relevant and timely information on the DSO</p>	<p>The public is informed of the DSO.</p> <p>Viewers of FTA TV are informed about the DSO and the requirements to continue receiving FTA television services after the analogue switch-off.</p> <p>Importers, distributors and retailers of television sets are informed about the DSO and the receivers that are required</p>

Objectives	Critical Success Factors	KPIs
		to view ATSC 3.0 television content.

**2.3 Assumptions**

The successful implementation of this project will depend on the Authority gaining full cooperation from the relevant stakeholders. The following are some assumptions, upon which the success of this project depends:

1. Commitment from existing FTA television broadcasting service providers in transitioning to DTT
2. Support from the Ministry of Digital Transformation (MDT) and other ministries with the implementation of DTT
3. The availability of foreign exchange for the purchase of headend and transmission equipment for the deployment of DTT network infrastructure. Some of the existing infrastructure at broadcasting transmission facilities can be reused, including towers and the building housing the transmission equipment.
4. The availability of ATSC 3.0 equipment and receivers for purchase for network deployments and sale to consumers, respectively

### 3 Strategy for the Implementation

#### 3.1 Key Stakeholders

The engagement of key stakeholders will be critical to the success of the DTT transition. The key stakeholders identified for this initiative are the Authority, the FTA TV broadcasters, the Trinidad & Tobago Publishers & Broadcasters Association (TTPBA), importers and retailers of televisions, the Ministry of Digital Transformation, the Ministry of Finance and the Consumer Affairs Division of the Ministry of Trade and Industry.

The identification of stakeholder roles and responsibilities, along with the purpose of their involvement and expected contribution, will also be critical to the successful completion of the project. These roles and responsibilities are identified in Table 2.

Table 2. Roles and responsibilities of the key stakeholders

Stakeholder	Role	Responsibility
Telecommunications Authority of Trinidad and Tobago	DTT implementation coordinator	<ul style="list-style-type: none"> <li>i. Finalise the DTT Framework</li> <li>ii. Develop the implementation plan</li> <li>iii. Prepare and issue the RFP for the shared signal distributor</li> <li>iv. Authorise the shared signal distributor and DTT FTA TV broadcasters</li> <li>v. Recommend fiscal and other incentives to MDT to aid with the availability and affordability of the receivers</li> <li>vi. Develop and execute the stakeholder communication plan and campaign</li> <li>vii. Settle disputes between the shared</li> </ul>

Stakeholder	Role	Responsibility
		signal distributor and FTA TV broadcasters viii. Monitor and evaluate the implementation of the transition to DTT
FTA TV broadcasters	DTT implementation support  DTT FTA TV broadcasting service providers  DTT FTA TV broadcasting network operators (individual signal distributors)	i. Contribute to the work of the DTT Steering Committee and working groups ii. Provide FTA TV broadcasting services iii. Deploy ATSC 3.0 DTT single frequency networks (SFNs) (individual signal distributors), if desired and in accordance with the timelines outlined in the implementation plan
DTT shared signal distributor	DTT FTA TV broadcasting network operator	i. Deploy ATSC 3.0 DTT SFN by the timelines outlined in the implementation plan  ii. Onboard FTA TV broadcasters, based on the approved standard access offer and in accordance with the timelines outlined in the implementation plan
Trinidad & Tobago Publishers & Broadcasters Association	DTT implementation support	i. Contribute to the work of the DTT steering committee and working groups

Stakeholder	Role	Responsibility
Importers and retailers of receivers	Importation and sale of ATSC 3.0 TV sets and set-top boxes (STBs)	<ul style="list-style-type: none"> <li>i. Source and import certified ATSC 3.0 TV sets and STBs, having regards for the timelines for implementation</li> <li>ii. Support the availability and affordability of ATSC 3.0 receivers by promoting DTT transition and the implementation of fiscal and other incentives provided by the Ministry of Finance and the Economy</li> </ul>
Ministry of Digital Transformation	DTT implementation support	<ul style="list-style-type: none"> <li>i. Facilitate the engagement of other government ministries, in support of the implementation</li> <li>ii. Grant of concessions in accordance with the Act.</li> </ul>
Ministry of Finance	DTT implementation support	<ul style="list-style-type: none"> <li>i. Provide fiscal and other incentives, as recommended by the Authority, to support the implementation, and, in particular, for the availability and affordability of receivers</li> </ul>
Consumer Affairs Division of the Ministry of Trade and Industry	DTT implementation support	<ul style="list-style-type: none"> <li>i. Support consumer with issues related to</li> </ul>

Stakeholder	Role	Responsibility
		receivers purchased from local retailers
Customs and Excise	DTT implementation support	i. Support with the importation of receivers and the implementation of fiscal incentives, where applicable

**3.2 Implementation Approach**

The Authority intends to achieve the transition to DTT in collaboration with the key stakeholders. The Authority has established a DTT Steering Committee with oversight of three working groups: the public relations, technical, and finance working groups. The working groups comprise representatives from the Authority and each of the existing FTA TV broadcasters and TTPBA.

Figure 1 illustrates the implementation structure. As shown in Figure 1, the DTT Technical Working Group was responsible for and instrumental in developing this Implementation Plan.



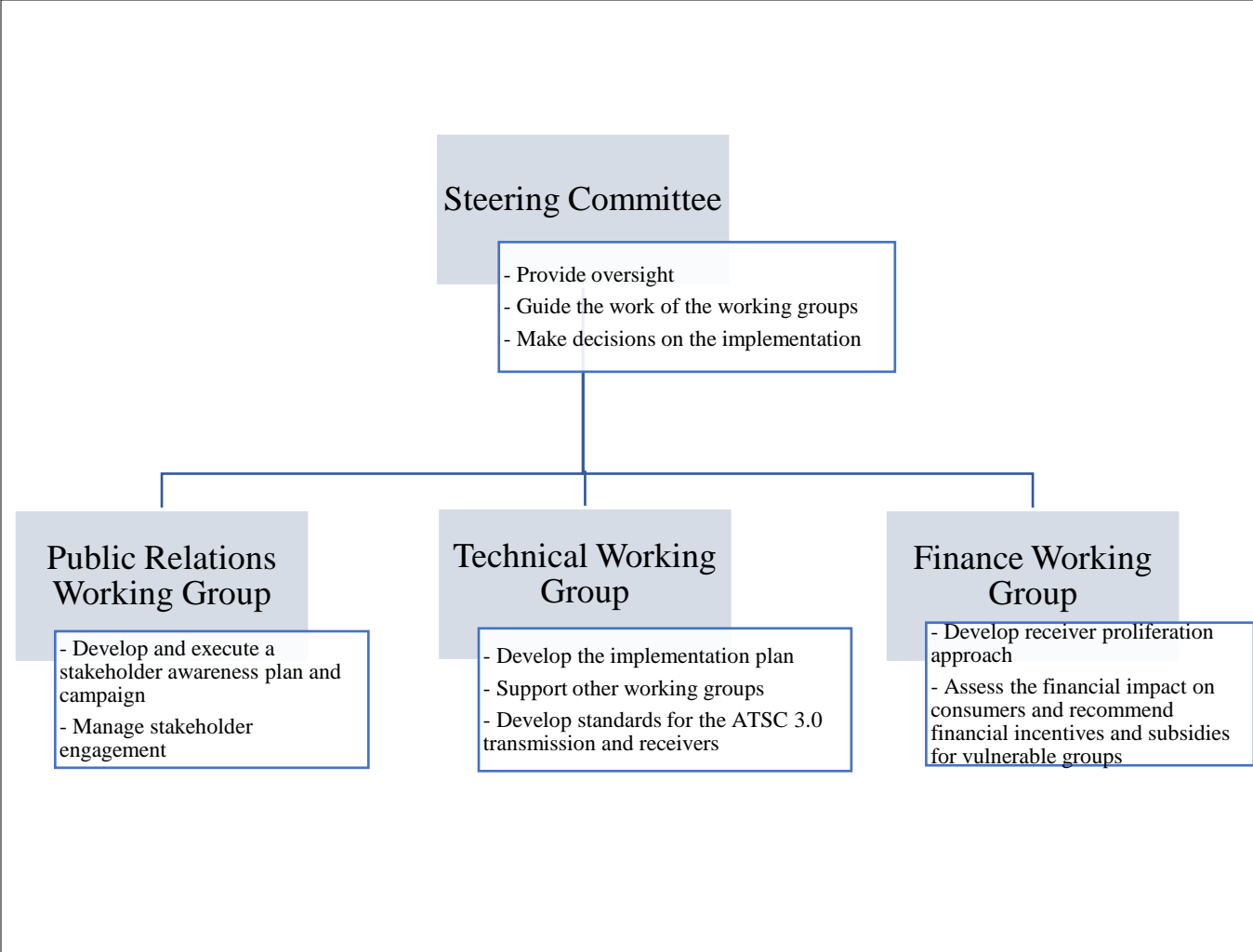


Figure 1. DTT implementation structure

## **4 Regulatory Framework**

### **4.1 Authorisation Requirements**

The Authority has adopted a flexible approach to signal distribution for DTT. Two approaches are accommodated, i.e., a shared signal distribution approach and an individual signal distribution approach. Both approaches require the entities to be authorised with the appropriate concessions and licences. The entities will fall into the following three categories:

1. Shared signal distributors
2. FTA TV broadcasters and individual signal distributors
3. FTA TV broadcasters only

#### **4.1.1 Shared Signal Distributors**

The shared signal distributor will be issued the following authorisations:

1. A National Type 1 concession for the operation of a public domestic fixed telecommunications network
2. A television broadcasting station licence for transmitter stations, comprising the DTT network using spectrum assigned in the UHF band
3. Any other licences required for the operation of the network referred to above (e.g., licences for microwave backhaul or other associated services)

Details of the authorisation and regulation of the shared signal distributor is provided in section 6.

#### **4.1.2 FTA TV Broadcasters and Individual Signal Distributors**

An FTA TV broadcaster and individual signal distributor will be issued the following authorisations:

1. A National Type 5 concession for the provision of a broadcasting service
2. A National Type 1 concession for the operation of a public domestic fixed telecommunications network

3. A television broadcasting station licence for transmitter stations comprising the DTT network using spectrum assigned in the UHF band
4. Any other licences required for the operation of the network referred to above

Authorised FTA TV broadcasters will be invited to apply for National Type 1 concessions to operate ATSC 3.0 networks as individual signal distributors. The timeframes for the invitations and application deadline will align with the process for the authorisation of the shared signal distributor.

#### **4.1.3 FTA TV Broadcasters Only**

An FTA TV broadcaster only, who provides a broadcasting service using an authorised public domestic fixed telecommunications network, will be issued a National Type 5 concession for the provision of broadcasting services.

## **4.2 ATSC 3.0 Advanced Feature Content**

Advanced-feature content is a means for FTA TV broadcasters to provide advanced features of ATSC 3.0 that may not be used in the provision of FTA service, such as UHD video, immersive audio, and interactive applications like gaming. FTA broadcasting service providers will be able to provide one advanced-feature content channel that leverages ATSC 3.0 advanced features such as interactivity using Digital Rights Management (DRM), under the following conditions:

1. The provision of advanced-feature content shall be restricted to only authorised FTA TV broadcasting service providers. Entities that are not FTA broadcasting service providers, wishing to leverage the advanced features of ATSC 3.0 will provide services only via authorised FTA broadcasting service providers.
2. The provision of advanced-feature content shall be provided by a FTA broadcasting service provider, only after it has completed the switch-off of its analogue service.
3. FTA TV broadcasters shall provide only one advanced-feature content channel and shall maintain at least one standard FTA content channel.

4. The FTA TV broadcaster offering advanced-feature content will provide the appropriate means to access the service and features. Such means may include an ATSC 3.0 broadcast application.
5. A common standard for the delivery and access of advanced-feature content may be agreed upon among the FTA TV broadcasters and approved by the Authority before its provision.
6. The providers of advanced-feature content shall comply with all consumer rights and obligations guidelines and regulations including for billing, customer care, information, pricing notifications and intellectual property rights.

Advanced-feature content does not include emergency message content delivery. These terms and conditions will be included in the respective concessions for broadcasting service providers.

### 4.3 DTT Transmission Specifications

All DTT transmissions shall adhere to the specifications listed in Table 3.

Table 3. DTT transmission specifications

	<b>Specification</b>	<b>Details</b>	<b>Notes</b>
1	DTT Standard	ATSC 3.0	All deployments must comply with the ATSC 3.0 suite of standards. The standards approved and published by ATSC can be accessed via the following URL <a href="https://www.atsc.org/atsc-documents/type/3-0-standards/">https://www.atsc.org/atsc-documents/type/3-0-standards/</a>
2	Network Type	Single-frequency network (SFN)	-
3	Frequency Band	UHF (470-518 MHz)	-
4	Channel Bandwidth	6 MHz	-
5	Maximum Physical Layer Pipes (PLPs)	Four	For an RF channel carrying one or more services, each service can use up to four PLPs.

	<b>Specification</b>	<b>Details</b>	<b>Notes</b>
6	Modulation and Forward Error Correction (FEC) Code Rate (ModCod) Combinations, Long LDPC code (64800 bits)	QPSK - 2/15, 3/15, 4/15, 5/15, 6/15, 7/15, 8/15, 9/15 and 11/15  16QAM - 4/15, 5/15, 7/15, 8/15, 9/15 and 11/15  64QAM - 3/15, 4/15, 5/15, 6/15, 7/15, 8/15, 9/15, 10/15 and 11/15  256QAM - 4/15, 5/15, 7/15, 8/15, 9/15, 10/15, 11/15, 12/15 and 13/15	Only the listed ModCod combinations shall be used in the physical layer configuration where long LDPC codes are utilised.
7	Modulation and Forward Error Correction (FEC) Code Rate (ModCod) Combinations, Short LDPC code (16200 bits)	QPSK - 2/15, 3/15, 4/15, 5/15, 6/15, 7/15, 8/15 and 9/15  16QAM - 5/15, 6/15, 7/15, 8/15 and 11/15  64QAM - 5/15, 6/15, 7/15, 8/15, 9/15, 10/15 and 11/15  256QAM - 5/15, 7/15, 8/15, 9/15, 10/15, 11/15, 12/15 and 13/15	Only the listed ModCod combinations shall be used in the physical layer configuration where short LDPC codes are utilised.
8	Frame Length	≤ 250ms	-
9	ATSC Link-Layer Protocol (ALP)	ALP encapsulation of Internet protocol (IP) packets and other link layer signalling	Encapsulation of MPEG-2 transport stream packets is not a requirement.
10	Electronic Programme/Service Guide	Service announcements via on-screen service guide with content offering and properties, such as the presence or absence of captioning, interactive enhancements, video and audio format, content rating and genre	EPG/ESG support is mandatory for the shared signal distributor.  In the case where there are multiple signal distributors, a common format for the EPG/ESG shall be developed.
11	Closed Caption and Subtitles	The delivery of closed caption and subtitle tracks to receivers	Support for the delivery of closed captioning and subtitle tracks is mandatory for the shared signal distributor.

	Specification	Details	Notes
			Captioning must be IMSC-1 protocol. Current encoding models converts EIA-608 or EIA-708 captions to IMSC-1.
12	Advanced Emergency Information	The delivery of advanced emergency information, such as basic and critical emergency information, emergency preparation guidance, and post-event information. Additional features include the ability to wake up receivers, the use of rich media for things such as animated weather maps and escape routes, and localisation filtering to target those most affected. Audio emergency information is also a feature and can also be included as an audio component.	Support for the delivery of advanced emergency information is mandatory. An encoding system that is upgradable with software licensing in the future to insert EAS text crawl and audio is preferred.
13	Video Compression Standard	High Efficiency Video Coding (HEVC)	-
14	Video Format	720 x 1280 progressive with high dynamic range (HDR) and wide colour gamut (WGC) and a picture rate of 24/1.001, 24, 30/1.001, 30, 60/1.001, 60, 120/1.001 and 120 Hz  1080 x 1920 progressive with HDR and WGC a picture rate of 24/1.001, 24, 30/1.001, 30, 60/1.001, 60, 120/1.001 and 120 Hz  2160 x 3840 progressive with a picture rate of 24/1.001, 24, 30/1.001, 30, 60/1.001 and 60 Hz	720p only allowed by the shared signal distributor for the primary FTA signals for a period during the simulcast if all the assigned RF channels are not available. Standard definition (SD) can be allowed, to accommodate additional channels or PLPs to utilise the available bandwidth.
15	Audio System	Audio Codec 4 (AC-4) and Advance Audio Coding (AAC)	-
16	Interactivity and Personalisation	Delivery of alternative or auxiliary content to viewers via the broadcasting or broadband segment of the ATSC 3.0 signal, such as alternate video components and audio feeds and secondary content	Support for the delivery of alternative and auxiliary content is mandatory for the shared signal distributor.

	<b>Specification</b>	<b>Details</b>	<b>Notes</b>
17	Targeted Advertising and Analytics	<p>Delivery of advertisements based on user desires and trends or geographically within the primary or secondary content via interactive applications</p> <p>Analytics including advertising delivery and effectiveness and user-viewing telemetry like viewing time and programme choice collected via a broadband return path</p>	Support for targeted advertising and analytics is optional.
18	Accessibility	Use of features to provide enhancements to content to support the accessibility needs of individuals, including audio descriptions, closed signing, dialogue enhancements and closed captioning	Support for the delivery of accessibility features is mandatory for the shared signal distributor.
19	Security	Mechanisms to protect service and content such as digital certificates and encryption.	Support for security mechanisms is mandatory for the shared signal distributor and should not inhibit FTA viewing with receivers that are not connected to the internet. The shared signal distributor should support A3SA signal signing, A3SA one-way DRM and A3SA individualised licenses.

**4.4 Technical Regulations**

This section defines the coverage obligations, technical limits and quality of service (QoS) indicators that will guide the transmission of FTA TV broadcasters using the ATSC 3.0 digital standard.

#### **4.4.1 Coverage Obligations**

The coverage obligations are defined percentages of populated area coverage requirements, based on field-strength reception. The coverage obligations for FTA TV broadcasters using ATSC 3.0 shall be no less than 90% of the populated area of Trinidad and no less than 90% of the populated area of Tobago.

#### **4.4.2 Technical Limits**

The technical limits proposed in this section are subject to verification through testing and analysis with the FTA television broadcasting sector.

##### **4.4.2.1 Maximum Effective Radiated Power (ERP)**

An FTA TV transmitter station shall not exceed the maximum ERP of 20 kW.

##### **4.4.2.2 Adjacent Channel Mask**

The power level of emissions on frequencies outside the authorised channel of operation must be attenuated by no less than the following values below the average transmitted power within the authorised channel<sup>1</sup>:

1. In the first 500 kHz from the authorised channel edge, transmitter emissions must be attenuated by no less than 47 dB below the average transmitted power.
2. More than 6 MHz from the channel edge, emissions must be attenuated by no less than 110 dB below the average transmitted power.
3. At any frequency between 0.5 and 6 MHz from the channel edge, emissions must be attenuated by no less than the value determined by the following formula:

$$\text{Attenuation (dB)} = -11.5(\text{delta (f)} + 3.6)$$

where delta (f) is the frequency difference in MHz from the edge of the channel.

---

<sup>1</sup> The attenuation values were taken from FCC CFR 47 Part 73.622h.



Figure 2 illustrates the adjacent channel mask.

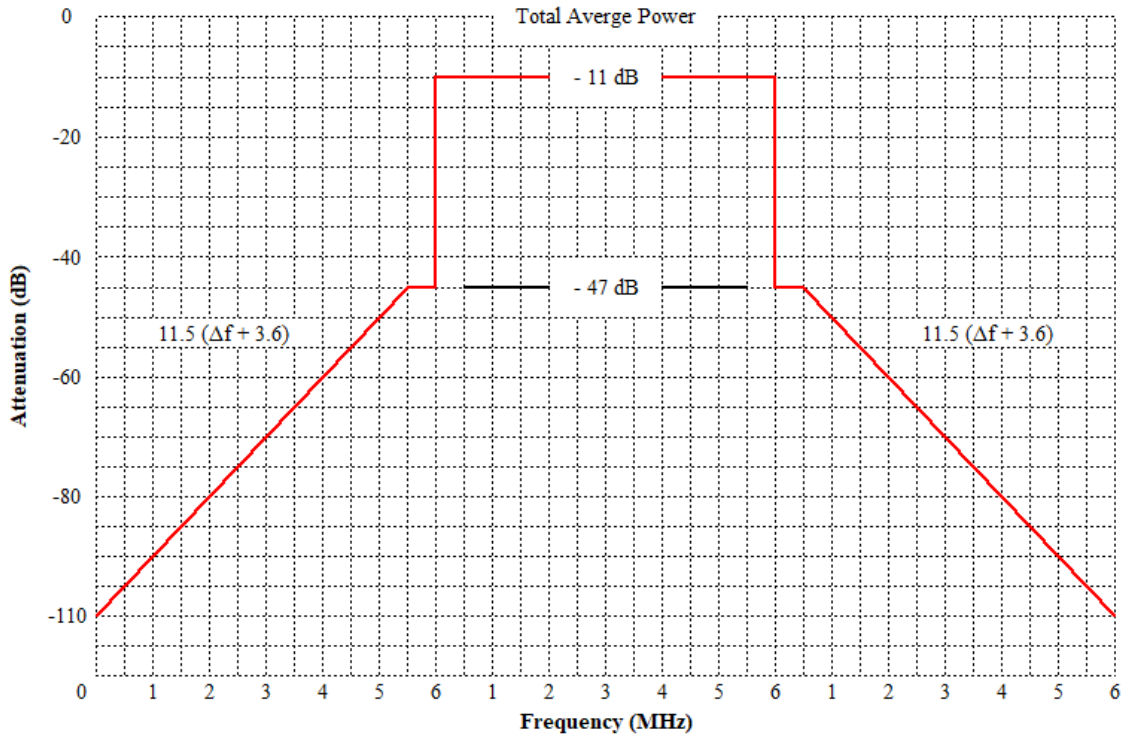


Figure 2. Adjacent channel emission mask

#### 4.4.3 QoS Parameters for Reception Quality

The QoS parameters for reception quality are indicators for the conditions under which an ATSC 3.0 signal is received and decoded. The parameters are:

- Received signal level
- Carrier-to-noise ratio (C/N)
- Bit error rate (BER) post-FEC
- Frame error rate (FER)
- Modulation error ratio (MER)

The key performance indicators for the reception quality parameters are given in Table 4.

Table 4. Reception quality parameters for DTT

Parameter	Requirement	Measurement Methodology
Received signal level ( $E_{req}$ )	See Appendix I Table 9	See A/326-04 Field Test Plan <sup>2</sup> , section 6.2.1 and section 6.2.2 for fixed outdoor reception and fixed indoor reception, respectively.
Carrier-to-noise ratio (C/N)	See Appendix I Table 8	
Bit error rate (BER) post-FEC	$\leq 10^{-6}$	
Frame error rate (FER)	$\leq 10^{-4}$	
Modulation error ratio (MER)	> 20 dB (fixed outdoor reception) > 15 dB (fixed indoor reception)	

The reception quality shall be graded from Q1 (lowest) to Q3 based on Table 5. Q1 is considered no reception, Q2 is considered inadequate quality reception, and Q3 is considered adequate quality reception.

Table 5. QoS metrics for DTT

BER post-FEC \ Field Strength	$BER > 10^{-3}$	$10^{-6} < BER \leq 10^{-3}$	$BER \leq 10^{-6}$
$E < E_{req}$	Q1	Q2	Q2
$E \geq E_{req}$	Q1	Q2	Q3

<sup>2</sup> <https://www.atsc.org/wp-content/uploads/2023/04/A326-2023-04-Field-Test-Plan.pdf>

## 5 Spectrum Allocation and Management

### 5.1 Frequency Planning

In accordance with the Framework, DTT will be deployed in the TV UHF band. Currently, the spectrum available in the ITU-R Region 2 TV UHF band for FTA TV broadcasting in Trinidad and Tobago is 470–608 MHz (ch14–ch36). There are seven channels in this frequency range currently assigned to the existing FTA TV broadcasters, illustrated in Figure 3.

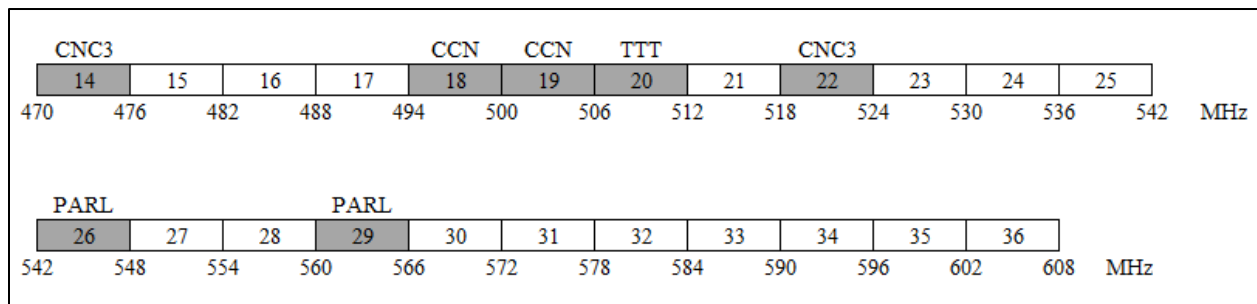


Figure 3. TV UHF broadcasting band

In determining the channels for DTT, the following factors were considered:

1. UHF channels occupied by existing analogue FTA television broadcasters
2. The requirement for channel separation to mitigate possible interference between broadband wireless access (BWA) and DTT and analogue FTA and DTT operators
3. The simulcast period

To avoid having signal distributors shift frequencies after the simulcast, the same channels will be assigned for use during and after the simulcast. The eight channels in Table 6 will be available for DTT. Given that analogue FTA TV broadcasting is co-channel and adjacent channel to some of the DTT channels, several DTT channels will not be available at the digital switch-on. The phased analogue switch-off will allow for a coordinated analogue channel switch-off, to facilitate the smooth rollout of the DTT network(s).

Table 6. Frequency channels available for DTT

<b>UHF Channel</b>	<b>Frequency Range/MHz</b>
<b>14</b>	470–476
<b>15</b>	476–482
<b>16</b>	482–488
<b>17</b>	488–494
<b>18</b>	494–500
<b>19</b>	500–506
<b>20</b>	506–512
<b>21</b>	512–518

## **5.2 Channel Assignment**

Each individual signal distributor will be assigned a maximum of one channel to provide FTA TV broadcasting services. The channel shall be in the range of ch17–ch21.

The shared signal distributor will be assigned:

1. up to three channels to operate the SFN
2. a minimum of two channels for its network
3. channels in the range of ch14 – ch16.

Consideration will be given to the assignment of additional channels to the shared signal distributor after the analogue switch-off, once it is demonstrated that additional capacity is required.

### 5.3 Interference Management

All interference shall be assessed using the rejection thresholds in Table 7.

Table 7. Threshold levels at which interference is considered to occur

<b>Interference Type</b>	<b>Desired/Undesired Ratio</b>
Co-channel	30 dB
1 <sup>st</sup> adjacent channel	-26 dB

All channels assigned for DTT shall be exclusive assignments, i.e., shall only be used by the DTT licensee and will not be reassigned for any other services while the television broadcasting station licence remains valid. Before assignment, the Authority shall monitor all channels to ensure suitability for use, i.e., the channel is free from any emissions that may cause harmful interference.

All broadcasters are required to implement the appropriate mechanism to limit out-of-band emissions and ensure operations are in accordance with the spectral mask in section 4.3.

## **6 Authorisation and Regulation of the Shared Signal Distributor**

### **6.1 Authorisation Approach**

As indicated in section 4.1, the shared signal distributor will be authorised by the Authority via the issuance of a concession, a TV broadcasting station licence and other relevant licences. The concession and licence will be issued via a request for proposals (RFP) process, where interested applicants will be invited to apply for the award. The Authority will develop and issue the RFP.

### **6.2 Regulation of the Shared Signal Distributor**

The shared signal distributor will operate in accordance with the following regulatory terms and conditions:

1. The shared signal distributor shall treat all authorised FTA TV broadcasting service providers seeking access to its resources for the provision of an FTA service in a non-discriminatory manner.
2. The shared signal distributor may only reject a request for access to its resources by a bona fide broadcasting service concessionaire on the grounds of system capacity.
3. The shared signal distributor shall be obliged to prepare a standard access offer for the provision of its channel resources and make such an offer available to all parties seeking access.
4. The Authority may regulate the terms and conditions of the standard access offer to ensure that bona fide broadcasting service providers have fair and equitable access.
5. Where there is only one shared signal distributor, or where there is evidence of anti-competitive conduct by a dominant shared signal distributor, or where there is no agreement, the Authority may set terms and conditions including the prices for access to the shared signal distributor's resources, in accordance with the Authority's *Financial Viability Model for ATSC 3.0 Free-to-Air Digital Terrestrial Television (DTT) to Assess the Impact on Broadcasters' Costs*, which determines the annual revenue contribution necessary to recoup the distributor's capital costs and annual operational expenses over the period of the term of the concession earning a suitable rate of return to be determined by the Authority.

6. An entity that is authorised solely as the shared signal distributor shall not be subject to the provisions of the concession relating to the Broadcast Code and shall not be liable to any penalty for the breach of the Code undertaken by an FTA broadcasting provider who leases its resources. An FTA broadcasting service provider that is also authorised as the shared signal distributor will be subject to the terms and conditions of its concession as it relates to the Broadcast Code, based on its type 5 concession.
7. The shared signal distributor must make available the connection requirements to the FTA broadcasting service providers for the delivery of content to its head end<sup>3</sup>.

These terms and conditions will be included in the respective concessions.

---

<sup>3</sup>For IP delivery bitrate, and acceptable codec for video and audio must be specified. A direct connection or SDI handoff is acceptable, but terms must be worked out for this type of connection. Internet connection of 20Mbit MPEG 4 4:2:0 Video with AC4 and AAC audio delivered via single or redundant SRT, RIST or ARQ method would be a suggestion.

## 7 Receiver Specification and Proliferation

### 7.1 Minimum Receiver Specification

All ATSC 3.0 receivers imported into Trinidad and Tobago must be NEXTGEN TV certified, listed on the website <https://www.watchnextgentv.com>, and carry the NEXTGEN TV logo shown in Figure 4, on the receiver or the packaging.



Figure 4: NEXTGENTV logo

The logo is an indication that the receiver was certified by Resillion<sup>4</sup> (formerly Eurofins Digital Testing) for conformance with the ATSC 3.0 standard, i.e., they are designed to properly receive and display NEXTGEN TV/ATSC 3.0 content.

#### 7.1.1 Minimum Viable Product

All ATSC 3.0 receivers imported and sold in Trinidad and Tobago should meet the minimum requirements set out below:

- i. Video – SD, 720p HDR, 1080p HDR
- ii. Audio – AC-4 or AAC
- iii. Connectivity – Wi-Fi (802.11a/b/g/n/ac) 2.4/5 GHz
- iv. Ports – HDMI, antenna RF in (F-type)

---

<sup>4</sup> Resillion was selected by the Consumer Technology Association (CTA) to develop ATSC 3.0 conformance test material and conduct testing for the NEXTGEN TV logo programme. A summary of CTA's recommended practice for ATSC 3.0 TV sets is given in Appendix V.



- v. Security – Widevine DRM capable and supports A3SA signal signing, A3SA one-way digital rights management (DRM) and A3SA individualised licenses.
- vi. Single ATSC 3.0 tuner
- vii. Software update OTA or via the internet
- viii. Support basic ATSC 3.0 (see CTA-CEB-32-A)
- ix. Support A/344<sup>5</sup> basic applications
- x. Support ESG/EPG

## **7.2 Receiver Proliferation Incentives and Strategies**

The Authority will recommend fiscal incentives to ensure that there are available and affordable ATSC 3.0 capable receivers in Trinidad and Tobago in advance of the DSO. The recommendations will be developed by the DTT Finance Working Group.

Section 9.4 provides details of the schedule for developing and implementing the receiver proliferation recommendations.

---

<sup>5</sup> A/344 – ATSC 3.0 Interactive Content. This document describes the interactive content environment provided by an ATSC 3.0 receiver. This environment is comprised of a standard W3C User Agent with known characteristics, a WebSocket interface for obtaining information from the receiver and controlling various receiver functionality, and an HTTP interface for accessing files delivered over broadcast. This document also specifies the life cycle of the interactive content when delivered over broadband or broadcast or both.

## **8 Stakeholder Awareness and Engagement**

As part of the implementation, stakeholders will be engaged with relevant information. *The Stakeholder Awareness Plan* will be developed by the DTT Public Relations Working Group to identify the stakeholder groups to be targeted, the types of activities to be undertaken for these groups, and outlines elements of an appropriate awareness-building campaign.

Section 9.3 provides details of the schedule of stakeholder engagement activities.

## 9 Digital Switchover Schedule

Figure 5 illustrates a high-level timeline of the DSO project.

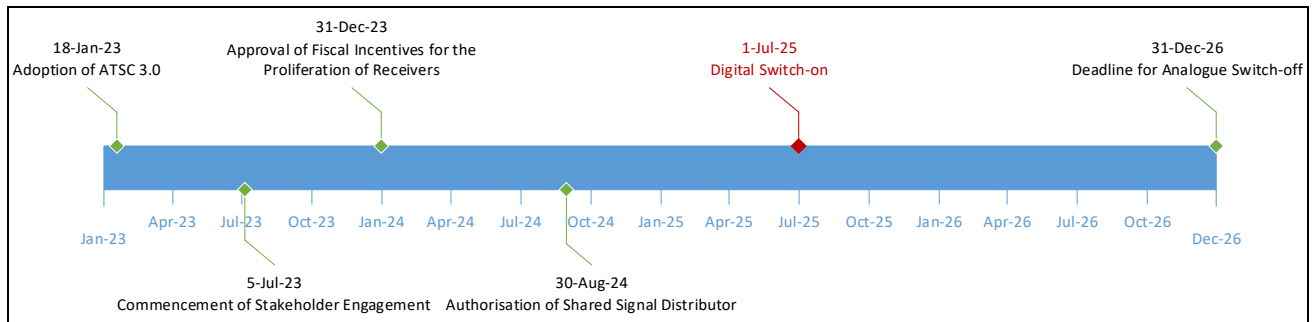


Figure 5: DSO project timeline

The detailed schedule for the DSO is provided in Appendix IV and includes the key tasks, milestones and time frames.

### 9.1 Digital Switch-On

The digital switch-on is scheduled for 1<sup>st</sup> July 2025. The key tasks that must be completed before the switch-on is the awarding of the shared signal distributor and individual concessions and licences. The RFP for the shared signal distributor will be issued by January 2024, with 29<sup>th</sup> March 2024 as the deadline for the submission of applications, and for individual FTA TV broadcasting concession and licence applications.

Additionally, all current FTA TV broadcasters must be ready to provide service at switch-on. To ensure this, the following milestones should be reached before the switch-on:

1. Standard access offers must be signed and submitted to the Authority at least eight weeks before the switch-on.
2. Content delivery connection links to the shared signal distributor must be commissioned and tested at least four weeks before the switch-on.
3. Digital signals must be tested at least four weeks before the switch-on.

Other tasks that will be initiated before the switch-on but will be completed after it are:

1. **Construction of DTT networks.** While some sites and the headend (where required) will be commissioned before the switch-on, the full network rollout will be completed up to a year after it. The full rollout will be impacted by the phased analogue switch-off, as some channels used for analogue service will only become available for digital after analogue service is switched off. At digital switch-on, at least one transmission site should be deployed in Trinidad and at least one in Tobago and a minimum of 65% coverage of the populated areas should be achieved.
2. **Stakeholder engagement.** All phases of the stakeholder engagement campaign will begin before the switch-on. However, engagement with first and second movers' groups and the public will continue after the switch-on.
3. **Implementation of fiscal and other incentives.** Approved fiscal and other measures, to reduce the cost of ATSC 3.0 receivers and increase their availability, will be implemented before the digital switch-on and will continue for a defined period after it.

## 9.2 Phased Analogue Switch-Off

The phased analogue switch-off will occur during a simulcast period of eighteen months. The simulcast period will end with the switch-off of the final analogue channel(s) and should occur by 31<sup>st</sup> December 2026. An analogue channel may be switched off after the populated area covered by the associated analogue transmitter is also covered by a digital transmitter. The Authority intends to have each of the existing broadcasters switch off at least one analogue channel within six months of Digital Switch-On, and that existing broadcast licences will only be renewed in early 2026 with one or two of the current analogue channels for a period of not exceeding one year.

## 9.3 Stakeholder Awareness

As mentioned in 9.1, under “2. Stakeholder engagement”, the stakeholder awareness and education campaign will begin before the digital switch-on and continue until the analogue switch-off is completed. The campaign will begin with the first movers in September 2023, followed by the second movers, including the public in January 2024. Both will continue until the end of the analogue switch-off.

The Authority will measure the effectiveness of stakeholder engagement activities and other metrics of the implementation, using methods such as surveys, within six months of digital switch-on.

## **9.4 Receiver Proliferation**

Recommendations on strategies and measures to increase the affordability and availability of ATSC 3.0 capable receivers are scheduled to be finalised by January 2024. The approved strategies and measures will be implemented from their approval until the end of the analogue switch-off.

## **10 Monitoring and Evaluation (M&E)**

Throughout the DSO process, key aspects of the transition will be monitored, and the results will be fed back to the implementation team to evaluate and determine the effectiveness of the transition and if intervention is required, and to inform the stakeholders engagement campaign. The areas that will be monitored are as follows:

1. Service rollout
2. Awareness
3. Uptake

### **10.1 Service Rollout**

The aspects of service rollout that will be monitored are deployment, coverage and signal quality.

The deployment of DTT transmitter stations and FTA services will be monitored to ensure the digital switch-on and analogue switch-off targets are met. As mentioned in section 9.1, under “1. Construction of DTT networks”, at digital switch-on at least one transmission site should be deployed in Trinidad and at least one in Tobago. Also, as digital transmitter stations are deployed, the analogue switch-off will progress. As indicated previously, an analogue channel will be switched off only after the populated area covered by the associated analogue transmitter is also covered by a digital transmitter for a period not shorter than three months. The timely deployment of digital stations will ensure the simulcast period will be maintained at the targeted period of 18 months.

Coverage will be monitored to ensure DTT networks are meeting the obligations that will be established in the concessions issued (see section 4.3.1) and the coverage requirement for the phased analogue switch-off (see section 9.2).

Reception quality will be monitored using measurements of received field strength and BER-post FEC, to ensure that the areas that are covered are receiving the required signal quality. This information will be fed to the shared signal distributors and other network operators, though the shared signal distributor is also required to perform their own monitoring to ensure acceptable levels of quality.

## **10.2 Awareness**

The effectiveness of stakeholder engagement will be monitored, using methods that may include:

1. A survey of the public: this survey will be used to collect data on public awareness of the DSO, i.e., assess awareness of DTT, the transition and its impact on viewers.
2. Social media interactions: social media will be widely used to share information on the DSO. Social media interactions on the posts, such as likes and comments, will be monitored.

## **10.3 Uptake**

The number of receivers imported and sold will be monitored throughout the DSO process. Reported numbers will be used as the indicators for take-up. Importers and retailers will be required to submit importation and sales numbers to the Authority.

## Appendix I – Required C/N and Field Strength for ModCod Combinations

The values in Table 8 are based on field test measurements of C/N for a BER (post-FEC) of  $10^{-6}$  taken from Table A.3.2 of A/327, ATSC Recommended Practice: Guidelines for the Physical Layer Protocol.

Table 8. Required C/N (dB) for BER =  $10^{-6}$  after LDPC and BCH decoding under AWGN channel

Modulation	LDPC Code Length	LDPC Code Rates											
		2/15	3/15	4/15	5/15	6/5	7/15	8/15	9/15	10/15	11/15	12/15	13/15
QPSK	Long	-3.9	2.9	-1.9	-0.7	0.7	1.1	2.2	2.9				
	Short	-4.1	-2.7	-1.5	-0.5	0.9	1.6	2.3	2.9		4.5		
16QAM	Long				3.7	5.7	6.1	7.3			10.5		
	Short			2.9	3.9		6.5	7.6	8.6		10.5		
64QAM	Long				6.9	9.2	9.6	11.4	12.8	13.9	15.2		
	Short		3.7	5.5	7.1	9.3	10.6	11.9	12.9	14.2	15.5		
265QAM	Long				9.3		12.9	15	16.8	18.5	19.9	21.6	23.4
	Short			8.1	9.8		14.1	15.6	16.8	18.5	19.9	21.7	23.4

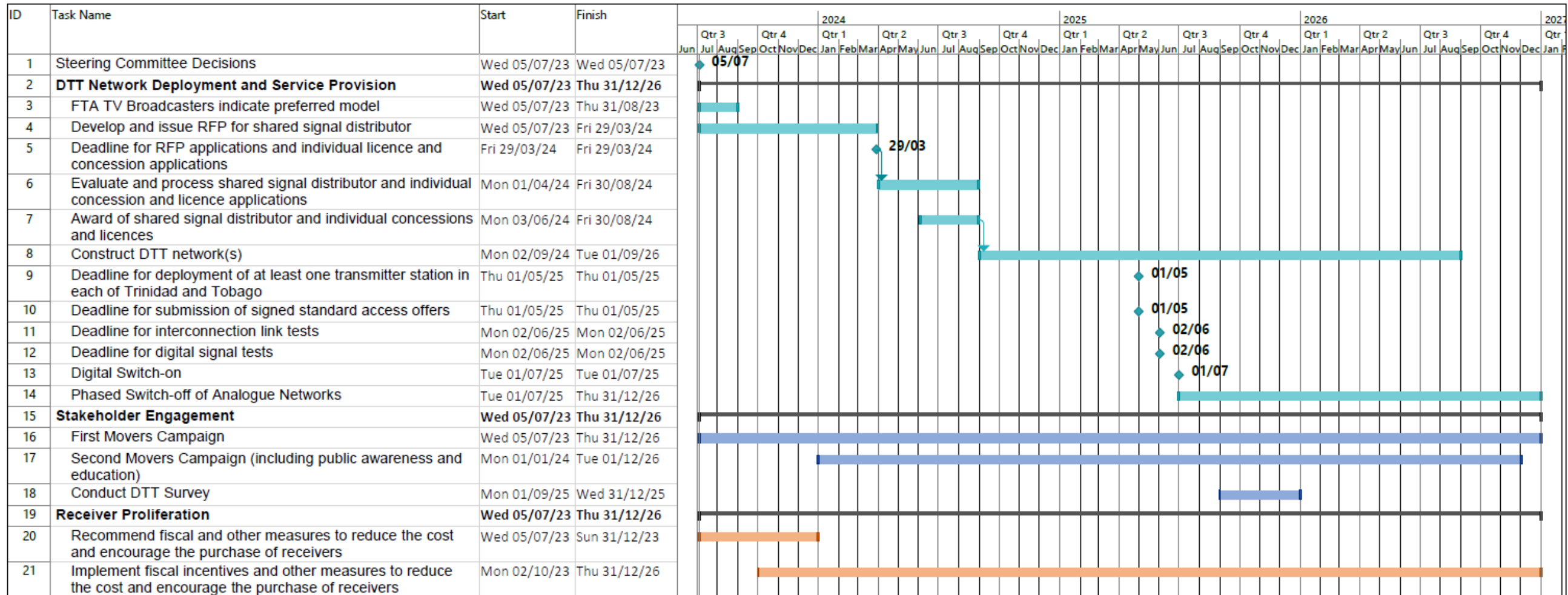


The values in Table 9 are based on the C/N values in Table 8 and a measured noise floor in the TV UHF band of -100 dBm.

Table 9. Required receive field strength (dB $\mu$ V/m) for BER = 10<sup>-6</sup> after LDPC and BCH decoding under AWGN channel

Modulation	LDPC Code Length	LDPC Code Rates											
		2/15	3/15	4/15	5/15	6/5	7/15	8/15	9/15	10/15	11/15	12/15	13/15
QPSK	Long	29.1	35.9	31.1	32.3	33.7	34.1	35.2	35.9				
	Short	28.9	30.3	31.5	32.5	33.9	34.6	35.3	35.9		37.5		
16QAM	Long				36.7	38.7	39.1	40.3			43.5		
	Short			35.9	36.9		39.5	40.6	41.6		43.5		
64QAM	Long				39.9	42.2	42.6	44.4	45.8	46.9	48.2		
	Short		36.7	38.5	40.1	42.3	43.6	44.9	45.9	47.2	48.5		
265QAM	Long				42.3		45.9	48	49.8	51.5	52.9	54.6	56.4
	Short			41.1	42.8		47.1	48.6	49.8	51.5	52.9	54.7	56.4

## Appendix II – Detailed Digital Switch-over Schedule



Project: Project Schedule Date: Tue 28/11/23	Task	Project Summary	Manual Task	Start-only	Deadline
	Split	Inactive Task	Duration-only	Finish-only	Progress
	Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
	Summary	Inactive Summary	Manual Summary	External Milestone	

## Appendix III – Summary of CTA’s Recommended Practice for ATSC 3.0 TV Sets

The Consumer Technology Association (CTA) has released recommendations for the functionality and features of ATSC 3.0 TV sets for the multiple subsystems of ATSC 3.0. The recommendations are documented in the following nine standard documents<sup>6</sup>:

- i. CTA CEB32.1, *Recommended Practice for ATSC 3.0 Television Sets, System Issues*
- ii. CTA CEB32.2-A, *Recommended Practice for ATSC 3.0 Television Sets, Physical Layer*
- iii. CTA CEB32.3-B, *Recommended Practice for ATSC 3.0 Television Sets, Logical Layer*
- iv. CTA CEB32.4-B, *Recommended Practice for ATSC 3.0 Television Sets, Video*
- v. CTA CEB32.5-B, *Recommended Practice for ATSC 3.0 Television Sets, Audio*
- vi. CTA CEB32.6-A, *Recommended Practice for ATSC 3.0 Television Sets, Advanced Emergency Information*
- vii. CTA CEB32.8-A, *Recommended Practice for ATSC 3.0 Television Sets, Application Run-time Environment*
- viii. CTA CEB32.9, *Recommended Practice for ATSC 3.0 Television Sets, Security and Protected Services*,

Televisions sold in the US market, i.e., those with the NEXTGEN TV certification would meet the minimum specifications recommended by the CTA and summarised in Table 10.

**Table 10 CTA Required and Optional ATSC 3.0 Features and Functionality<sup>7</sup> (O depicts optional, R depicts recommended, and CR depicts conditional conditionally recommended)**

Feature	Reference
<b>System Integration, CEB32.1</b>	
Full-service scan suggestion	R
Fast or full services scan on regular intervals during sleep periods	R
Sufficient buffer space and buffering capability to be able to successfully receive, decode, and display streams	R
Support the channel bonding methods described in A/331	O
<b>Physical Layer, CEB32.2</b>	
Modulation: QPSK, 16 QAM, 64 QAM and 256 QAM	R
Modulation: 1024 QAM and 4096 QAM	O
Decode at least 4 PLPs	R
Broadband capabilities	O
<b>Logical Layer, CEB32.3</b>	
Staggercast support	O
AL-FEC data recovery capabilities	O
Two or more concurrent video streams	R
Electronic Service Guide	O
Processing of ATSC 3.0 Link Layer Protocol packets	R
Processing of MPEG-2 TS Packet Encapsulation	O
Closed Captions (IMSC1 Text Profile)	R
Parse Region Rating Tables	R
Content Advisory Ratings	R
ROUTE and MMTP	R
Concurrent ROUTE and MMT processing for OTA	O
One audio Elementary Stream	R
Synchronize audio, video, and captions	R
Ignore reserved, unused, and unexpected fields	R
<b>Video, CEB32.4</b>	
HEVC Scalable Main 10, Main Tier, Level 5.1	R
HEVC Scalable Main 10, Main Tier, Level 5.2	O
Resolutions and framerates SD: 704x480, 720x576, 704x480 and 720x576 up to 60 Hz	R
Resolutions and framerates HD interlaced: 1920x1080 at 50 Hz, 59.94 Hz and 60 Hz.	R
Resolutions and framerates HD progressive: 1280x720, 1920x1080 and 3840x2160 up to 120 Hz 50 Hz	R
SHVC	R
SDR, HDR (PQ & HLG)	R
3D	O
HFR: Compatible (show the content, possibly at standard frame rate)	R
HFR: Display at a high frame rate	O
Active Format Description and Bar Data	R
<b>Audio, CEB32.5</b>	
Process audio based on the region(s) for which designed	R
Convert(render) to appropriate TV set outputs	R

<sup>6</sup> CTA recommended practice documents for ATSC 3.0 can be downloaded from this web page <https://shop.cta.tech/collections/standards/audio-and-video>

<sup>7</sup> Source: CTA-CEB32-A

	<b>Feature</b>	<b>Reference</b>
	48 kHz audio sampling rate	R
	Synchronization (see CEB32.3-A Section 5.14)	R
	Decode and present any available Audio Presentation from the broadcast stream, including language and accessibility (Dialog Enhancement, Emergency Information, Descriptive Video Service)*	R
	Support for additional audio Elementary Streams	O
	Support for automatic selection of Audio Presentation and match to user preferences (preferred language, Video Descriptive Service, Dynamic Range Control)	R
	Support for decoding Audio Program Components delivered over a broadband connection	O
	Binaural Headphone output	O
	Set and save audio system preferences*	R
	User Interface, support for setting and enabling the user options of Audio Presentations including language, accessibility (Video Descriptive Services, Emergency Information, Dialog Enhancement)*	R
	Seamless Processing to handle stream transitions	R
	Loudness Control. Set audio decoder output reference levels	R
	Audio Outputs HDMI or S/PDIF requirements	CR
	<b><u>AC-4 Recommendations:</u></b>	
	Decoder with compatibility level 3 or greater	R
	Compatibility level 3 decoder with full decoding defined in ETSI TS 103 190-2, Section 4.7.2	O
	Decode all audio frame rates corresponding with video frame rates in CEB32.2-A	R
	Decode audio frame rates of 100, 120/1.001, and 120 fps, if receiver video system supports those rates	R
	Dialog Normalization at audio outputs	R
	Loudness Management and DRC metadata*	R
	Dialog Enhancement*	R
	Presentation Selection default (1 <sup>st</sup> in TOC)*	R
	Downmix mode (Lo/Ro, Lt/Rt)*	R
	<b><u>MPEG H Recommendations:</u></b>	
	Support for MPEG-H Audio LC Profile Level 1, 2, 3	R
	100mS fade-in on tune-in	R
	Detect configuration changes	R
	Adaptive switch between DASH Segments	R
	Loudness and DRC*	R
	Audio Presentation Selection*	R
	Multi-stream Consideration support (main + 2 auxiliary MHAS streams)	CR
	Selection of alternate Audio Elements (e.g. VDS, Emergency Info, Alt dialog)*	R
	User Interactivity*	O
	<b>Advanced Emergency Information, CEB32.6</b>	
	Audience filtering	CR
	Relevance filtering (location, priority)	O
	AEAText	CR
	NRT Media	O
	Live media selection	O
	Accessibility/language support	O
	Dismiss/Recall	CR
	Monitor Wake Up Field	O
	Onscreen Message Notification	O
	Video watermark monitor	O
	<b>Application Run-time Environment, CEB32.8</b>	
	HELD signal processing	CR
	W3C User Agent	CR
	WebSocket Server	CR
	HTTP Protocol interface	CR
	Media Source Extensions (MSE)	CR
	WebSocket Server RPC	CR
	WebSocket Server APIs	CR
	Distributed Window Descriptor (DWD)	O
	Media Player Control (AMP/RMP)	CR
	<b>Security and Protective Services, CEB32.9</b>	

	<b>Feature</b>	<b>Reference</b>
	TLS 1.2 and 1.3	R
	Time-based verification	R
	App validation	R
	Signed message validation	R
	Secure storage of certificates	R
	MPEG Common encryption	R
	EME	R

\* Denotes element that is recommended to be included in the User Interface