MCMC SRSP BS (DTT) 470
5 January 2023

Standard Radio System Plan

REQUIREMENTS FOR

DIGITAL TERRESTRIAL TELEVISION (DTT) SERVICE

OPERATING IN THE FREQUENCY BAND OF

470 MHz TO 694 MHz

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1 FOREWORD

1.0 This Standard Radio System Plan ("**SRSP**") is prepared by the Malaysian Communications and Multimedia Commission ("**MCMC**") pursuant to the Communications and Multimedia Act 1998 ("**Act**") and the Spectrum Plan ("**Spectrum Plan**") to provide information on the minimum technical and regulatory requirements for the efficient use of the **470 MHz to 694 MHz** frequency band.

1.1 This SRSP does not attempt to establish any detailed equipment standards.

1.2 In the event there are any inconsistencies between this SRSP and the Act or any subsidiary legislation made under the Act, the Act or the subsidiary legislation shall prevail.

2 ABBREVIATIONS

AA	Apparatus Assignment
ACLR	Adjacent Channel Leakage Ratio
ACS	Adjacent Channel Selectivity
ASP	Applications Service Provider
AWGN	Additive White Gaussian Noise
BS	Base Station
CASP	Content Applications Service Providers
CA	Class Assignment
CIIP	Common Integrated Infrastructure Provider
DTT	Digital Terrestrial Television
DVB-T2	Digital Video Broadcasting — Second Generation Terrestrial
eMBMS	Evolved Multimedia Broadcast Multicast Services
FACSMAB	Frequency Assignment Committee of Singapore, Malaysia and Brunei Darussalam
FEC	Forward Error Correction code
FFT	Fast Fourier Transform
FS	Fixed Service
FTA	Free-to-Air
HDTV	High-Definition Television
HEVC	High Efficiency Video Coding
ITU	International Telecommunications Union
ITU-R	ITU Radiocommunication Sector
JCC	Joint Committee on Communications between the Republic of Indonesia and Malaysia
JTC	Joint Technical Committee on Coordination and Assignment of Frequencies along Malaysia-Thailand Common Border

LTE	Long-Term Evolution
MCMC	Malaysian Communications and Multimedia Commission
MFN	Multiple Frequency Network
MISO	Multiple-input and single-output
MPEG	Moving Picture Experts Group
MS	Mobile Service
MUX	Multiplexer
NFP	Network Facility Provider
NFP(I)	Network Facilities Provider Individual
NSP	Network Service Provider
NSP(I)	Network Service Provider Individual
PR	Protection Ratio
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Key
RCT	Return Channel Terrestrial
RF	Radio Frequency
RN	Reference Networks
SDTV	Standard Definition Television
SFN	Single Frequency Network
SISO	Single-Input, Single-Output
SRSP	Standard Radio System Plan
Trilateral	Trilateral Coordination Meeting between the Republic of Indonesia, Malaysia and Singapore
UE	User equipment

3 INTENT

3.1 This SRSP provides the minimum requirements for utilisation of the frequency band of **470 MHz to 694 MHz** ("**said band**") for **DTT** in Malaysia as described in the Spectrum Plan, and the information on technical characteristics of radio systems, channelling of frequencies and coordination initiatives, in order to maximise the utilisation, minimise interference and optimise the usage of the said band.

3.2 DTT deploys digital technology instead of the conventional analogue technology for the delivery of terrestrial **FTA** or subscription television services. The intended services of DTT in Malaysia may include the followings:

3.2.1 HDTV;

3.2.2 Three Dimensional Television (3D or Stereoscopic TV);

3.2.3 SDTV;

3.2.4 Small screen digital format for handheld devices;

3.2.5 Broadband high-speed data and multimedia services;

3.2.6 Stationary, portable or mobile reception including handheld devices;

3.2.7 Interactive information via RCT or other alternative return channels; and

3.2.8 Sound Broadcasting services.

4 GENERAL

4.1 Technical characteristics of the DTT equipment used in DTT system shall conform to all applicable Malaysian standards, related recommendations of ITU and its radio regulations as agreed and adopted by Malaysia.

4.2 All DTT equipment installations shall comply with safety rules and other requirements as specified in the applicable standards.

4.3 The DTT equipment used shall be certified under the Communications and Multimedia (Technical Standards) Regulations 2000.

4.4 The allocation and assignment of the said band and the information in this SRSP are subject to further review by MCMC from time to time to reflect new developments in the communications and multimedia industry.

Concept on DTT service implementation in Malaysia

4.5 The concept of DTT service implementation is described in **Figure 1**. Considering the economies of scale in the Malaysian market, a CIIP approach has been adopted to maximise operational efficiency, such as infrastructure sharing, bandwidth sharing, and the use of a common platform for customer management. The CIIP shall be responsible in providing the end-to-end network and service availability for DTT service in Malaysia.

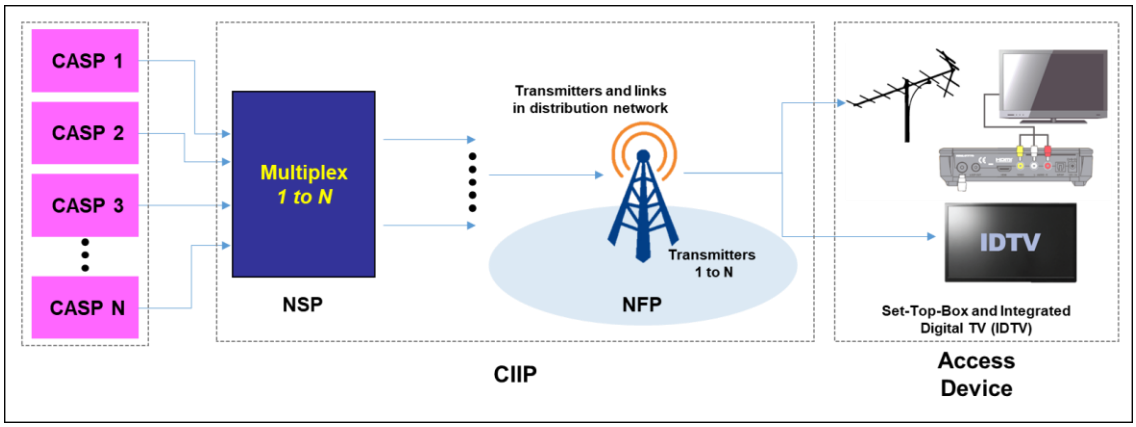

Figure 1: Concept of DTT Service Implementation in Malaysia

4.6 The CIIP shall hold the necessary individual licences under the Act for the deployment and implementation of the DTT service in Malaysia. The NFP(I) licence is required to own or provide the DTT transmitters (TX) and links. On the other hand, the NSP(I) licence is required to own or provide the MUX and manage the bandwidth for CASP and ASP which may introduce supplementary data services such as messaging service and traffic update etc. For interactivity, the return channel may be used via broadband network or other technologies that may be available in the future.

4.7 DTT service rollout in Malaysia is based on the DVB-T2 standard, which is an extension of the DVB-T standard with the adoption of the MPEG-4 standard for video compression. However, newer technology such as eMBMS and HEVC may be considered in the future.

4.8 The DTT service can be deployed in various network configurations as follows:

4.8.1 Continuous operation for nation-wide coverage (SFN nation-wide);

4.8.2 Multiple Frequency Network for nation-wide coverage (MFN nation-wide);

4.8.3 Regional Single Frequency Network (Regional-SFN);

4.8.4 Localised Single Frequency Network (Local-SFN);

4.8.5 Adjacent channels to existing services; and

4.8.6 Transmissions in conjunction with bordering countries.

4.9 The DTT network can be designed based on the reception modes. The reception modes options are as follows:

4.9.1 Fixed reception – fixed roof top antenna reception (i.e. at 10-meters antenna height above ground level); and

4.9.2 Portable (outdoor or indoor) or mobile receptions – handheld and portable receivers (i.e. at 1.5-meters antenna height above ground level).

4.10 The DTT network configurations are referred to the MUXs that have been designed for DVB-T2 fixed reception.

4.11 The DTT service described in this SRSP is referred to in the relevant ITU-R Recommendations and Reports relating to broadcasting service, namely as the ITU-R Television Broadcasting (BT) series, which is designated specifically for use of the said band.

4.12 For reference, protection criteria for DTT service (DVB-T2) is described in **Appendix A** of this SRSP.

5 CHANNEL ARRANGEMENT

5.1 The allocation of spectrum and services within the said band is described in the **Spectrum Plan**.

5.2 The said band is divided into RF channels as shown in **Appendix B** of this SRSP.

6 REQUIREMENTS FOR USAGE OF SPECTRUM

6.1 This SRSP covers the minimum key characteristics considered necessary in order to make the best use of the available said band.

6.2 Sharing between broadcasting service and other services is subject to the relevant provisions of the ITU Radio Regulations.

6.3 The PR for the compatibility analysis of other primary services with broadcasting service shall be used during the coordination process in respect of the new or varied assignments/allotments. PR for the cases where DVB-T2 is interfered by other primary services and by DTT service can be referred to in **Appendix A**.

6.4 DTT transmitters shall radiate only as much power as necessary to ensure a satisfactory service within the targeted service area as reflected in the AA.

6.5 The number of MUXs depends on the spectrum availability within the said band.

6.6 A DTT system conforming to the requirements of this SRSP may require modifications if major interference is caused to other radiocommunication stations or systems.

6.7 For the avoidance of doubt, MCMC shall not be responsible for any costs incurred as a result of the system modification. The cost of modification shall be fully borne by the assignment holder.

7 PRINCIPLES OF ASSIGNMENT

7.1 Authorisation to use the said band for the DTT broadcasting transmitter station and receiver device shall be subject to the followings:

7.1.1 by way of AA for DTT broadcasting transmitter station; and

7.1.2 by way of CA for receiver device and is required to comply with the most recent provisions of the CA issued by MCMC pursuant to section 169 of the Act.

7.2 The appointed CIIP shall hold NFP(I) and NSP(I) licences.

7.3 Subject to paragraphs 7.2 and 7.3, the appointed CIIP is required to:

i) submit AA application for the DTT broadcasting transmitter station using the prescribed AA form in accordance with the Act, relevant subsidiary legislations including the Communications and Multimedia (Spectrum) Regulations 2000 ("**Spectrum Regulations**") and any relevant instrument issued by MCMC from time to time; and

ii) submit any other documents and/or information that may be requested by MCMC.

7.4 The application for an AA shall be based on the committed roll out plan as specified in the latest detailed business plan submitted and approved by MCMC.

7.5 The assignment shall be subject to all conditions as specified in regulations 9, 10 and 22 of the **Spectrum Regulations**, and any additional conditions as may be imposed by MCMC from time to time.

7.6 Issuance of an AA within the said band shall be subject to successful coordination with Malaysia's neighbouring countries for stations that are to be located along the common border areas.

8 COORDINATION REQUIREMENTS

8.1 It should be noted that the FS and MS are also allocated on a primary basis in the said band. Currently, priority usage of the said band is accorded to broadcasting service. As such, any FS and/or MS systems shall not cause major interference to DTT service at all times.

8.2 Common Border Area Coordination

8.2.1 The use of the said band for broadcast transmitter apparatus shall require coordination at the common border areas with the neighbouring countries within coordination zones. The coordination zones are based on agreements reached at border coordination committees, namely FACSMAB, JTC, JCC and Trilateral. Agreement on the use of the frequency band may differ from one neighbouring

country to another, subject to the requirements of the respective country.

8.2.2 In the event there is no agreement on coordination zone, a zone within 50 km from the border of the neighbouring countries will be used.

8.2.3 It shall be noted that the coordination distance and other coordination parameters between Malaysia and the neighbouring countries may be reviewed and updated from time to time.

8.3 Any costs incurred as a result of the coordination process shall be fully borne by the assignment holder.

8.4 In the event of any interference, MCMC will be guided by the interference resolution process as shown in **Appendix C** of this SRSP.

9 EFFECTIVE DATE

9.1 This SRSP shall be effective on the date of issuance of this document.

10 REVOCATION

10.1 MCMC SRSP-521 DTT dated 25 September 2007 is hereby revoked.

11 REFERENCES

(i) **Spectrum Plan**

(ii) **ITU Radio Regulations**

(iii) **Final Act of Regional Radiocommunication Conference 2006 (RRC 06)**

(iv) **Recommendation ITU-R BT.1306** - Error correction, data framing, modulation and emission methods for digital terrestrial television broadcasting

(v) **Recommendation ITU-R BT.2033** - Planning criteria, including protection ratios, for second generation of digital terrestrial television broadcasting systems in the VHF/UHF bands

(vi) **Report ITU-R BT.2254** - Frequency and network planning aspects of DVB-T2

(vii) **Report ITU-R BT.2383** - Typical frequency sharing characteristics for digital terrestrial television broadcasting systems in the frequency band 470-862 MHz

(viii) **Recommendation ITU-R P.2109** - Prediction of building entry loss

(ix) **Broadcast Planning Software** by LS Telcom (ChirplusBC)

APPENDIX A
PROTECTION CRITERIA FOR DTT SYSTEMS (DVB-T2)

SECTION 1

Protection ratios for DVB-T2 wanted digital terrestrial television signals

The possible PR for terrestrial broadcast systems is summarised in the tables in **Section 1** of this appendix, based on those developed in Recommendation ITU-R BT.2033-2.

1. Wanted signal configuration

It is proposed that PR measurements for DVB-T2 systems should be made with the following mode shown in Table 1. PR values for the different required operational modes can be calculated from the given measured values. All data in this **Appendix A** corresponds to this mode unless stated otherwise.

Table 1

Preferable DVB-T2 mode type for measurements on protection ratios

Overall	Parameter Value
FFTSIZE	32 K
Guard Interval	1/128
Data symbols	59
SISO/MISO	SISO
PAPR	None
Frames per superframe	2
Bandwidth	8 MHz
Extended bandwidth mode	Yes
Pilot pattern	PP7
L1 Modulation	64-QAM
PLP #0	
Type	1
Modulation	256-QAM
Rate	2/3
FEC Type	64 800
Rotated QAM	Yes
FEC blocks per interleaving frame	202
TI blocks per frame (N_TI)	3
T2 frames per interleaving frame (P_I)	1
Frame interval (I_JUMP)	1
Type of time-interleaving	0
Time interleaving length	3
C/N (AWGN Channel) dB	19.7
Data rate Mbit/s	40.2

2. Protection of a DVB-T2 digital terrestrial television signal interfered with by a DVB-T2 digital terrestrial television signal

The values in Table 2 are theoretical values calculated for the mode in Table 1 using the method described in Report ITU-R BT.2254.

Table 2

Co-channel protection ratios (dB) for a DVB-T2 signal (defined in Table 1) interfered with by a DVB-T2 signal of similar mode

Modulation	Code rate	Gaussian channel	Ricean channel Note 8	Rayleigh channel (static) Note 8
QPSK	1/2	2.4	2.6	3.4
QPSK	3/5	3.6	3.8	4.9
QPSK	2/3	4.5	4.8	6.3
QPSK	3/4	5.5	5.8	7.6
QPSK	4/5	6.1	6.5	8.5
QPSK	5/6	6.6	7.0	9.3
16-QAM	1/2	7.6	7.8	9.1
16-QAM	3/5	9.0	9.2	10.7
16-QAM	2/3	10.3	10.5	12.2
16-QAM	3/4	11.4	11.8	13.9
16-QAM	4/5	12.2	12.6	15.1
16-QAM	5/6	12.7	13.1	15.9
64-QAM	1/2	11.9	12.2	14.0
64-QAM	3/5	13.8	14.1	15.8
64-QAM	2/3	15.1	15.4	17.2
64-QAM	3/4	16.6	16.9	19.3
64-QAM	4/5	17.6	18.1	20.9
64-QAM	5/6	18.2	18.7	21.8
256-QAM	1/2	15.9	16.3	18.3
256-QAM	3/5	18.2	18.4	20.5
256-QAM	2/3	19.7	20.0	22.1
256-QAM	3/4	21.7	22.0	24.6
256-QAM	4/5	23.1	23.6	26.6
256-QAM	5/6	23.9	24.4	28.0

PR in Table 3 are given for three types of propagation channels (i.e. Gaussian, Ricean and Rayleigh). For fixed and portable reception, the values relevant to the Ricean and Rayleigh channels, respectively, should be adopted.

The same PR corrections in Table 3 should be applied for DVB-T2 systems with 6, 7 and 8 MHz bandwidth.

Table 3

Protection ratios (dB) and overload threshold (dBm) for a DVB-T2 signal (defined in Table 1) interfered with by a DVB-T2 signal (defined in Table 1) in adjacent channels for silicon tuners

Channel offset N (8 MHz channels)	Centre frequency offset (MHz)	Number of receivers tested	PR (dB)		O_{th} (dBm)	
			Percentile		Percentile	
			50th	90th	10th	50th
–9	72	11	–54	–50	–14	0
–4	–32	11	–50	–44	–14	–2
–3	–24	11	–48	–44	–14	–2
–2	–16	11	–47	–43	–15	–6
–1	–8	11	–35	–33	–15	–6
Co-channel	0	11	19.0	19.0	–	–
1	8	11	–32	–30	–15	–6
2	16	11	–46	–43	–15	–5
3	24	11	–47	–43	–14	–2
4	32	11	–50	–44	–13	1
9	72	11	–54	–49	–13	1

The values given apply to the case where wanted and unwanted DVB-T2 signals have the same channel width. Other combinations of channel width need further studies.

The interfering signal had the same mode parameters as the wanted signal but was uncorrelated to it.

The PR is given in dB and applies to both continuous and tropospheric interference.

3. Protection of a DVB-T2 digital terrestrial television signal interfered with by a LTE BS signal

The following tables show PR and overload thresholds for three different traffic loadings on the LTE BS.

Table 4

Measured protection ratios (dB) for a DVB-T2 signal (defined in Table 1) interfered with by an LTE BS signal in adjacent channels for silicon tuners

Channel Offset N (8 MHz channels)	Centre frequency offset (MHz)	Number of receivers tested	0% BS traffic loading PR (dB)		50% BS traffic loading PR (dB)		100% BS traffic loading PR (dB)	
			Percentile		Percentile		Percentile	
			50th	90th	50th	90th	50th	90th
Co-channel AWGN	0	11	19	19	19	19	19	19
Co-channel LTE	0	11	10	11	18	18	19	19
1	10	11	–44	–24	–40	–38	–38	–36
2	18	11	–50	–32	–48	–44	–47	–43
3	26	11	–51	–35	–49	–45	–48	–44
4	34	11	–52	–39	–51	–46	–50	–45
5	42	11	–53	–41	–51	–47	–51	–46
6	50	11	–55	–46	–54	–48	–52	–47
7	58	11	–56	–46	–54	–49	–54	–48
8	66	11	–57	–45	–54	–50	–53	–49
9	74	11	–58	–45	–55	–50	–53	–49

Table 5

Measured overload thresholds (dBm) for a DVB-T2 signal (defined in Table 1) interfered with by an LTE BS signal in adjacent channels for silicon tuners

Channel offset N (8 MHz channels)	Centre frequency offset (MHz)	Number of receivers tested	0% BS traffic loading O_{th} (dBm)		50% BS traffic loading O_{th} (dBm)		100% BS traffic loading O_{th} (dBm)	
			Percentile		Percentile		Percentile	
			10th	50th	10th	50th	10th	50th
1	10	11	–18	–6	–15	–6	–13	–8
2	18	11	–14	1	–12	–2	–13	–3
3	26	11	–12	3	–13	0	–12	–1
4	34	11	–11	5	–12	2	–12	0
5	42	11	–10	6	–12	3	–12	2
6	50	11	–10	4	–12	2	–12	2
7	58	11	–10	4	–11	2	–12	1
8	66	11	–10	4	–12	2	–12	1
9	74	11	–10	5	–12	3	–12	1

4. Protection of a DVB-T2 digital terrestrial television signal interfered with by a LTE user equipment (UE) signal

The following Tables show PR and O_{th} for three different UE traffic loadings:
Table 6 – Uncorrected UE PR results
Table 7 – Estimated UE ACLR based on 3GPP TS 36.101[1] and ETSI[2] masks
Table 8 – UE PR results corrected for UE out-of-band noise degradation
Table 9 – UE overload threshold results.

[1] 3GPP TS 36.101: Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception
[2] ETSI: European Telecommunications Standards Institute

Table 6

Un-corrected protection ratios (dB) for a DVB-T2 signal (defined in Table 1) interfered with by an LTE UE signal in adjacent channels for silicon tuners

Channel offset N 8 MHz channels/ (centre frequency offset)	No. of Rx. tested	1 Mbit/s UE traffic loading Signal generator ACLR = 100 dB all offsets		10 Mbit/s UE traffic loading Signal generator ACLR = 100 dB all offsets		20 Mbit/s UE traffic loading Signal generator ACLR = 67.8 dB (N+1) 80.4 dB (N+2) 100 dB (N+3 to N+9)	
		PR Percentile (dB)		PR Percentile (dB)		PR Percentile (dB)	
		50th	90th	50th	90th	50th	90th
Co-channel AWGN (0)	11	19	19	19	19	19	19
Co-channel LTE (0)	11	10	11	18	18	19	19
1/(10)	11	–36	–19	–41	–39	–41	–39
2 (18)	11	–41	–24	–47	–45	–47	–43
3 (26)	11	–44	–26	–48	–45	–50	–44
4 (34)	11	–46	–36	–48	–45	–52	–45
5 (42)	11	–47	–37	–48	–44	–54	–46
6 (50)	11	–50	–38	–49	–43	–52	–45
7 (58)	11	–50	–41	–49	–44	–53	–44
8 (66)	11	–50	–41	–49	–42	–54	–45
9 (74)	11	–50	–43	–49	–43	–54	–47

The UE PR are corrected for the estimated UE ACLR in 8 MHz adjacent and non-adjacent channels to take account of the degradation in PR caused by UE out-of band noise. The ACLR estimates based on the mask in Table 6.6.2.1.1 of 3GPP TS 36.101 and the ETSI 301-908-13[3] requirement for –65 dBm out-of-band noise in the band 470-790 MHz. These are shown in Table 7.

[3] ETSI 301-908-13: IMT cellular networks; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU; Part 13: Evolved Universal Terrestrial Radio Access (E-UTRA) User Equipment (UE)

Table 7

Assumed UE ACLRs for corrected UE PR values

Channel offset N (8 MHz channels)	Centre frequency offset (MHz)	ACLR (dB)
1	10	25.2
2	18	32.2
Other offsets (corresponding to 65 dBm/8 MHz)	26-74	88.0

The co-channel PR_0 values used in the correction calculation were the AWGN figures in Table 8. The ACLR correction method is described below.

The final PR is found in two stages; firstly, for a frequency offset Δf the ACS of the receiver is calculated from the measured PR at the offset ($PR(\Delta f)$), the co-channel PR, PR_0 and the ACLR of the interference signal generator:

$$ACS(\Delta f) = -10\log(10^{-\frac{PR_0 - PR(\Delta f)}{10}} - 10^{-\frac{ACLR}{10}})$$

Secondly, the derived value of the DTT *ACS* is used to determine the appropriate adjacent channel PR for interfering terminal that may have different ACLR characteristics.

The final PR, $PR'(\Delta f)$, is a function of the *ACS* and the ACLR of the LTE device at (Δf), *ACLR′*:

$$PR'(\Delta f) = PR_0 + 10\log(10^{\frac{-ACS}{10}} + 10^{\frac{-ACLR'}{10}})$$

This method can also be used to reverse the corrected PRs back to the uncorrected *PR*s to allow the effect of different UE ACLR assumptions to be calculated.

Note that the ACLR and ACLR′ in the equations above are based on power measurements using the channel bandwidth of the LTE interferer (e.g. 10 MHz) and the channel bandwidth of the wanted DVB-T2 signal (e.g. 8 MHz) at the appropriate frequency offsets of the interferer.

Table 8

Corrected protection ratios (dB) for a DVB-T2 signal (defined in Table 1) interfered with by an LTE UE signal in adjacent channels for silicon tuners

Channel offset N 8 MHz channels/ (centre frequency offset)	No. of Rx. tested	1 Mbit/s UE traffic loading Signal generator ACLR = 100 dB all offsets		10 Mbit/s UE traffic loading Signal generator ACLR = 100 dB all offsets		20 Mbit/s UE traffic loading Signal generator ACLR = 67.8 dB (N+1) 80.4 dB (N+2) 100 dB (N+3 to N+9)	
		PR Percentile (dB)		PR Percentile (dB)		PR Percentile (dB)	
		50th	90th	50th	90th	50th	90th
Co-channel AWGN (0)	11	19	19	19	19	19	19
Co-channel LTE (0)	11	10	11	18	18	19	19
1/(10)	11	–6	–6	–6	–6	–6	–6
2 (18)	11	–13	–13	–13	–13	–13	–13
3 (26)	11	–44	–26	–48	–45	–50	–44
4 (34)	11	–46	–36	–48	–45	–52	–45
5 (42)	11	–47	–37	–48	–44	–54	–46
6 (50)	11	–50	–38	–49	–43	–52	–45
7 (58)	11	–50	–41	–49	–44	–53	–44
8 (66)	11	–50	–41	–49	–42	–54	–45
9 (74)	11	–50	–43	–49	–43	–54	–47

Table 9

Measured overload thresholds (dBm) for a DVB-T2 signal (defined in Table 1) interfered with by an LTE UE signal in adjacent channels for silicon tuners

Channel offset N (8 MHz channels)	Centre frequency offset (MHz)	Number of receivers tested	1 Mbit/s UE traffic loading		10 Mbit/s UE traffic loading		20 Mbit/s UE traffic loading	
			O_{th} (dBm)		O_{th} (dBm)		O_{th} (dBm)	
			10^{th}	50^{th}	10^{th}	50^{th}	10^{th}	50^{th}
1	10	11	–37	–6	–15	–5	–12	–5
2	18	11	–12	5	–11	0	–11	0
3	26	11	–10	6	–11	2	–11	0
4	34	11	–24	5	–11	2	–11	1
5	42	11	–10	6	–11	2	–11	1
6	50	11	–10	6	–11	2	–11	2
7	58	11	–10	5	–11	2	–11	2
8	66	11	–10	5	–11	2	–11	2
9	74	11	–11	6	–11	2	–11	2

5. Correction factors for different wanted DVB-T2 system variants and different reception conditions

Selection of PR and O_{th} for sharing studies

Table 10 illustrates recommended values for PR and O_{th} to be used in sharing studies. By applying these values 90 percent of receivers (among all 14 tuners measured), would be protected across all traffic loadings. For the UE, the corrected PR 90^{th} percentiles were used based on the UE ACLR assumptions in Table 7.

Table 10

Recommended sharing study values of PR and Oth for a DVB-T2 signal (defined in Table 1) in a clear channel, interfered with by an LTE BS or UE signal in adjacent channels for 3 can and 11 silicon tuners combined

Channel offset N (8 MHz channels)	Centre frequency offset (MHz)	LTE BS		LTE UE	
		PR (dB)	O_{th} (dBm)	Corrected PR (dB)	O_{th} (dBm)
Co-channel (AWGN)	0	19	–	19	–
Co-channel (LTE)	0	19	–	19	–
1	10	–25	–16	–6	–30
2	18	–33	–12	–13	–11
3	26	–36	–11	–28	–10
4	34	–40	–13	–37	–20
5	42	–43	–11	–38	–10
6	50	–46	–11	–40	–9
7	58	–47	–11	–42	–9
8	66	–46	–11	–43	–10
9	74	–46	–10	–44	–10

SECTION 2

For the different reception modes, the field strengths required to provide the desired location probability for reception of the wanted signal can best be compared by using a reference receiving antenna height, location probability and percentage time, as follows:

- Receiving antenna height: 10 m above ground level
- Location probability: 50%
- Percentage time: 50%

The field strengths corresponding to these conditions are termed the “minimum median field strengths”, referred to as E_{med}. These field strengths correspond to the minimum signal levels needed to overcome natural and man-made noise (in the absence of interference from other transmitters) known also as the “minimum usable field strengths”.

Section 2 of this **Appendix A** shows formula for calculation of minimum median field strengths and example value for calculation at 650 MHz frequency.

1. Calculation of minimum field strength and minimum median equivalent field strength

The minimum field strength and minimum median equivalent field strength values calculated using the following equations:

$$P_n = F + 10 \log (k\, T_0\, B)$$

$$P_{s\,min} = C/N + P_n$$

$$A_a = G + 10 \log (1.64\lambda^2/4\,\pi)$$

$$\varphi_{min} = P_{s\,min} - A_a + L_f$$

$$E_{min} = \varphi_{min} + 120 + 10 \log (120\,\pi)$$

$$= \varphi_{min} + 145.8$$

$$E_{med} = E_{min} + P_{mmn} + C_l \quad \text{for roof top level fixed reception}$$

$$E_{med} = E_{min} + P_{mmn} + C_l + L_h \quad \text{for portable outdoor and mobile reception}$$

$$E_{med} = E_{min} + P_{mmn} + C_l + L_h + L_b \quad \text{for portable indoor and mobile hand held reception}$$

$$C_l = \mu \cdot \sigma_t$$

$$\sigma_t = \sqrt{\sigma_b^2 + \sigma_m^2}$$

where:

P_n : receiver noise input power (dBW)

F : receiver noise figure (dB)

k : Boltzmann's constant ($k = 1.38 \times 10^{-23}$ (J/K))

T_0 : absolute temperature ($T_0 = 290$ (K))

B : receiver noise bandwidth ($B = 7.61 \times 10^6$ (Hz))

$P_{s\,min}$: minimum receiver input power (dBW)

C/N : RF S/N at the receiver input required by the system (dB)

A_a : effective antenna aperture (dBm^2)

G : antenna gain related to half dipole (dBd)

λ : wavelength of the signal (m)

φ_{min} : minimum pfd at receiving place (dB(W/m^2))

L_f : feeder loss (dB)

E_{min} : equivalent minimum field strength at receiving place (dB(μV/m))

E_{med} : minimum median equivalent field strength, planning value (dB(μV/m))

P_{mmn} : allowance for man-made noise (dB)

L_h : height loss (reception point at 1.5 m above ground level) (dB)

L_b : building or vehicle entry loss (dB)

C_l : location correction factor (dB)

σ_t : total standard deviation (dB)

σ_m : standard deviation macro-scale ($\sigma_m = 5.5$ (dB))

σ_b : standard deviation building entry loss (dB)

μ : distribution factor being 0.52 for 70%, 1.28 for 90%, 1.64 for 95% and 2.33 for 99%.

The minimum median field-strength values shall be calculated using the following formulas:

$$P_n = F + 10 \log (k\, T_0\, B)$$

$$P_{s\,min} = C/N + P_n$$

$$A_a = G + 10 \log (1.64\lambda^2/4\,\pi)$$

$$\varphi_{min} = P_{s\,min} - A_a + L_f$$

$$E_{min} = \varphi_{min} + 120 + 10 \log (120\,\pi)$$

$$= \varphi_{min} + 145.8$$

$$E_{med} = E_{min} + P_{mmn} + C_l \quad \text{for fixed reception}$$

$$E_{med} = E_{min} + P_{mmn} + C_l + L_h \quad \text{for portable outdoor and mobile reception}$$

$$E_{med} = E_{min} + P_{mmn} + C_l + L_h + L_b \quad \text{for portable indoor reception}$$

$$C_l = \mu \cdot \sigma_t$$

$$\sigma_t = \sqrt{\sigma_b^2 + \sigma_m^2}$$

where:

P_n : receiver noise input power (dBW)

F : receiver noise figure (dB)

k : Boltzmann's constant (k = 1.38 × 10^{-23} (J/K))

T_0 : absolute temperature (T_0 = 290 (K))

B : receiver noise bandwidth
(6.66 × 106 Hz for a 7 MHz DVB-T channel,
7.61 × 106 Hz for a 8 MHz DVB-T channel and
1.54 × 106 Hz for a T-DAB frequency block)

$P_{s\,min}$: minimum receiver input power (dBW)

C/N : RF signal-to-noise ratio at the receiver input required by the system (dB)

A_a : effective antenna aperture (dBm^2)

G : antenna gain related to half dipole (dBd)

λ : wavelength of the signal (m)

φ_{min} : minimum pfd at receiving place (dB(W/m^2))

L_f : feeder loss (dB)

E_{min} : minimum field strength at the location of the receiving antenna (dB(μV/m))

E_{med} : minimum median field strength (dB(μV/m))

P_{mmn} : allowance for man-made noise (dB)

L_h : height loss correction factor (location of the receiving antenna at 1.5 m above ground level) (dB)

L_b : mean building entry loss (dB)

C_l : location correction factor (dB)

σ_c : combined standard deviation (dB)

σ_m : standard deviation macro-scale (dB) (σ_m = 5.5 dB)

σ_b : standard deviation building entry loss (dB)

μ : distribution factor being 0.52 for 70%, 1.28 for 90%, 1.64 for 95% and 2.33 for 99%.

2. Minimum field strengths for DVB-T2 terrestrial digital television

The formula for calculating minimum field strength is given in item 1 above (as in Recommendation ITU-R BT.2033). For other reception modes (mobile rural, handheld portable outdoor and handheld mobile with integrated antenna) field strength calculations are available in Report ITU-R BT.2254 – Frequency and network planning aspects of DVB-T2.

Table 11

Calculation of minimum field strength DVB-T2 8 MHz system at 650 MHz

DVB-T2 in Band IV/V			**Fixed**	**Portable outdoor/urban**	**Portable indoor/urban**
Frequency	Freq	MHz	650	650	650
Minimum *C*/*N* required by system	*C*/*N*	dB	20.0	17.9	18.3
System variant (example)			256-QAM FEC 2/3, 32k, PP7 Extended	64-QAM FEC 2/3, 32k, PP4 Extended	64-QAM FEC 2/3, 16k, PP1 Extended
Bit rate (indicative values)		Mbit/s	35-40	26-29	23-28
Receiver noise figure	*F*	dB	6	6	6
Equivalent noise bandwidth	*B*	MHz	7.77	7.77	7.77
Receiver noise input power	P_n	dBW	–128.0	–128.3	–127.9
Min. receiver signal input power	$P_{s\,min}$	dBW	–109.1	–111.2	–110.8
Min. equivalent receiver input voltage, 75Ω	U_{min}	dBµV	29.7	27.6	28.0
Feeder loss	L_f	dB	4	0	0
Antenna gain relative to half dipole	G_d	dB	11	0	0
Effective antenna aperture	A_a	dBm^2	–4.6	–15.6	–15.6
Min power flux-density at receiving location	Φ_{min}	$dB(W)/m^2$	–100.5	–95.6	–94.2
Min equivalent field strength at receiving location	E_{min}	dBµV/m	45.3	50.2	50.6
Allowance for man-made noise	P_{mmn}	dB	0	1	1
Penetration loss (building or vehicle)	L_b, L_h	dB	0	0	11
Standard deviation of the penetration loss		dB	0	0	6
Diversity gain	*Div*	dB	0	0	0
Location probability		%	70	70	70
Distribution factor			0.5244	0.5244	0.5244
Standard deviation			5.5	5.5	8.1
Location correction factor	C_l	dB	2.8842	2.8842	4.24764

Minimum median power flux-density at reception height(1); 50% time and 50% locations	Φ_{med}	dB(W)/m^2	–97.6	–91.7	–79.0
Minimum median equivalent field strength at reception height(1); 50% time and 50% locations	E_{med}	dBµV/m	48.2	54.1	66.8
Location probability		%	95	95	95
Distribution factor			1.6449	1.6449	1.6449
Standard deviation			5.5	5.5	8.1
Location correction factor	C_l	dB	9.04695	9.04695	13.32369
Minimum median power flux-density at reception height(1); 50% time and 50% locations	Φ_{med}	dB(W)/m^2	–91.5	–85.6	–72.3
Minimum median equivalent field strength at reception height(1); 50% time and 50% locations	E_{med}	dBµV/m	54.3	60.2	75.9

APPENDIX B
CHANNELLING PLAN IN BAND IV & V FOR DIGITAL TERRESTRIAL TV

Channel number	Channel boundaries		Assigned frequency (MHz)
Band IV			
21	470	478	474
22	478	486	482
23	486	494	490
24	494	502	498
25	502	510	506
26	510	518	514
27	518	526	522
28	526	534	530
29	534	542	538
30	542	550	546
31	550	558	554
32	558	566	562
33	566	574	570
34	574	582	578
Band V			
35	582	590	586
36	590	598	594
37	598	606	602
38	606	614	610
39	614	622	618
40	622	630	626
41	630	638	634
42	638	646	642
43	646	654	650
44	654	662	658
45	662	670	666
46	670	678	674
47	678	686	682
48	686	694	690

APPENDIX C
INTERFERENCE RESOLUTION PROCESS

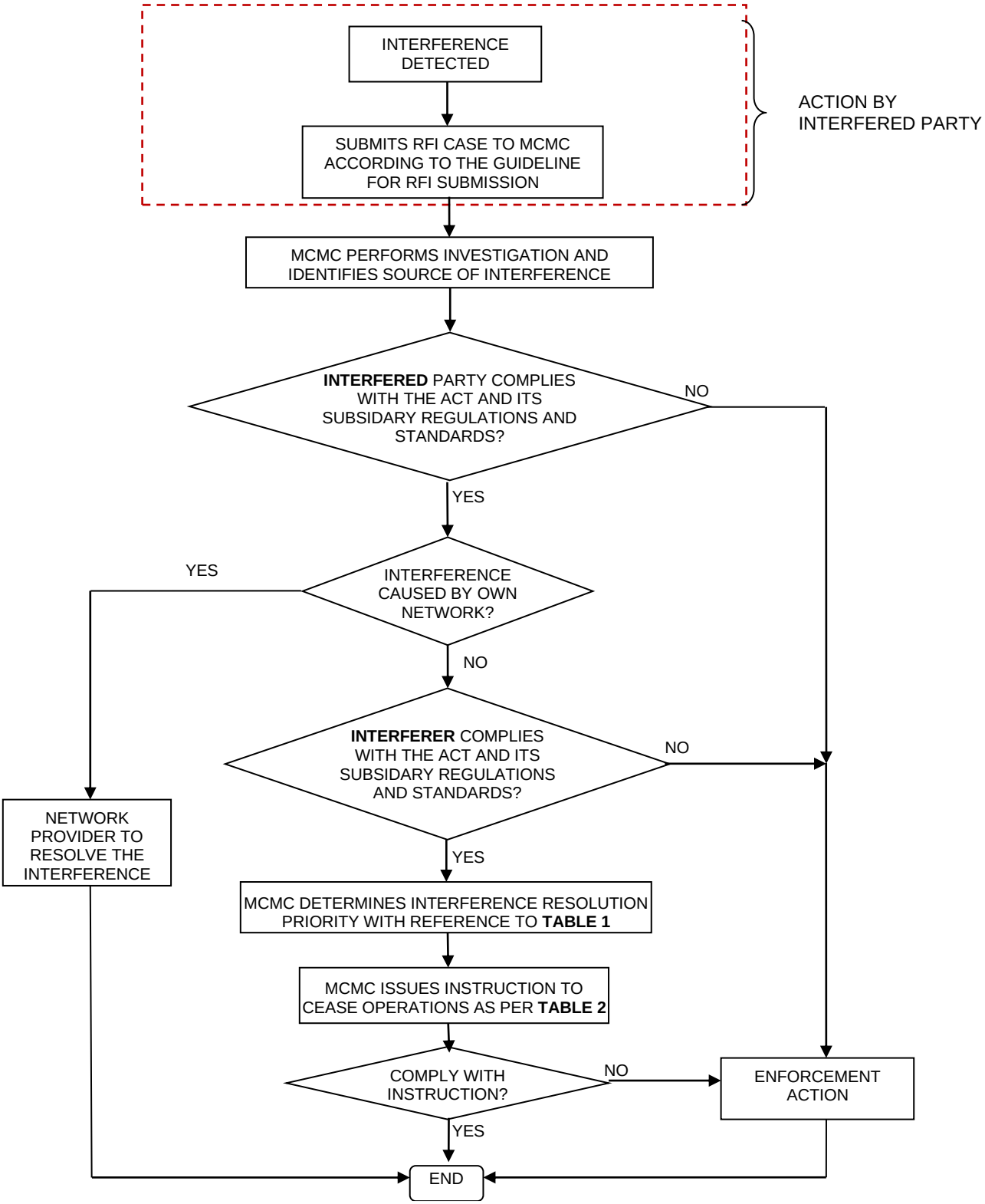

TABLE 1: INTERFERENCE RESOLUTION PRIORITY

No.	Types of Priority	Description
1	Service Priority	Primary services have priority over secondary services. Among co-primary or co-secondary services, the stated priority is accorded as provided in the Spectrum Plan.
2	Assignment Type Priority	SA and AA have equal priority but are of higher priority than CA.
3	Service Type Priority	In the event where service priority and assignment type priority are equal for affected parties, the following list will determine the priority level for the interference case (the earlier in the list is given higher priority): i. Safety or radionavigation service; and ii. Based on the date of AA - Priority is given to the earliest/first installation

TABLE 2: INTERFERENCE RESOLUTION TIMELINE TO PARTIES

No.	Types of Interference	Description	Resolution Timeline
1.	Harmful	Interference which endangers or seriously degrades, obstructs or repeatedly interrupts the functioning of a radionavigation service or one or more safety services operating in accordance with the Spectrum Regulations.	To cease* operation immediately within 24 hours or earlier as specified in the notice issued by MCMC.
2.	Major	Electromagnetic interference – (a) rendering any apparatus or services unsuitable for its intended purpose; or (b) which degrades or obstructs, or repeatedly interrupts, a radiocommunications service operating in accordance with the Spectrum Regulations.	To cease* operation within 3 days or earlier as specified in the notice issued by MCMC if interference cannot be resolved.
3.	Minor	Electromagnetic interference which does not affect the overall operation of any radiocommunications transmission.	To cease* operation within 7 days or earlier as specified in the notice issued by MCMC if interference cannot be resolved.

*Note:
Resumption of operation of the apparatus is not allowed unless the assignment holder submit interference resolution or mitigation plan and has completed the implementation of the mitigation plan to the satisfaction of MCMC to remove/avoid the interference.