



Spectrum Plan for the Accommodation of Public Mobile Telecommunications Services

Maintenance History		
Date	Change Details	Version
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September 30, 2008	Revised version — Plan updated: Based on conclusion of the competitive licensing process for the introduction of new public mobile telecommunications service concessionaires, which concluded in June 2005.	2.0
November 6, 2012	Consultative document, including the 700 MHz frequency allocation for cellular mobile radiocommunications service	2.1
February 6, 2013	Revised consultative document based on comments received from first round of consultation	2.2
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June 26, 2013	Revised Version – Plan updated based on consultation to include 700 MHz spectrum for the provision of public mobile telecommunications services	3.0
July 17, 2015	Consultative document include the 1.7 GHz and 2.1 GHz frequency allocations for cellular mobile radiocommunications service	3.1
July 28, 2017	Revised consultative document based on comments received from first round of consultation	3.2
November 29, 2017	Final approved version – Plan updated, based on consultation, to include AWS Band and to change from the US 700 MHz Band Plan to the APT 700 MHz Band Plan for the provision of public mobile telecommunications services	4.0

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Executive Summary

Telecommunications infrastructure is the foundation for Information and Communications Technology (ICT). Continual upgrade and expansion of this infrastructure are imperative for national development. Mobility and broadband connectivity, in particular, are the cornerstones of a connected society and economic progress, so prudent spectrum planning for optimum provision of public mobile telecommunications services is of critical importance.

The first version of this spectrum plan was published in 2004. The *Recommendations for Spectrum Management Policy* (TATT 2005) was then developed, which laid out the framework for the granting of access to spectrum for the provision of telecommunications services and established optimal frequency assignment plans. The plan was then revised in 2008 to be consistent with those recommendations, and further revised in 2013 and 2017 to include additional bands.

The *National Spectrum Plan* (TATT 2008) is a collection of all spectrum planning documents developed by the Authority, incorporating this and other spectrum plans. This document, *Spectrum Plan for the Accommodation of Public Mobile Telecommunications Services* (the Plan), is one element of the *National Spectrum Plan* (NSP). For this Plan, the Telecommunications Authority of Trinidad and Tobago (the Authority) identified the optimal frequency bands of operation as deployed globally and, in particular, by ITU-R Region 2 countries. Contemporary cellular mobile technologies were also considered, and the current spectrum occupancy for the associated frequency bands in Trinidad and Tobago was assessed. On the basis of these findings, the Authority determined frequency assignment plans for the provision of public mobile telecommunications services and the appropriate licensing process for the assignment of spectrum to cellular mobile operators.

Table 1 summarises the frequency assignment plans and the respective licensing approach for the provision of public mobile telecommunications services.

Table 1: Operating Frequency Ranges for Cellular Mobile Technologies and the Respective Licensing Approaches

Frequency Range of Operation	Available Cellular Mobile Technologies	Licensing Approach
<p>The 700 MHz Band: 698 – 806 MHz (i.e., 703 – 748 MHz and 758 – 803 MHz)</p>	<p>LTE</p>	<p>The licensing approach shall consist of a competitive licensing process, as determined by the Authority from time to time, for new spectrum users, or where there is preference for specified spectrum blocks.</p> <p>An assignment process will be applied to existing and eligible concessionaires, as prescribed by the Authority, provided there is no preference for specified spectrum blocks.</p> <p>The spectrum cap for the 700 MHz Band shall be 20 MHz (i.e., 2 x 10 MHz).</p> <p>An allotment of 20 MHz (i.e., 2 x 10 MHz) has been made for public protection and disaster relief (PPDR).</p> <p>10 MHz (i.e., 2 x 5 MHz) has also been allocated for future use.</p> <p>Up to 90 MHz of spectrum can be made available in the 700 MHz Band for public mobile telecommunications service, save and except for the allotment to PPDR.</p>

Frequency Range of Operation	Available Cellular Mobile Technologies	Licensing Approach
<p>The 850 MHz Band: 824 – 896 MHz (i.e., 824 – 849 MHz and 869 – 894 MHz)</p>	<p>GSM, CDMA, GPRS, EDGE CDMA 2000 EvDO, UMTS, HSPA(+), LTE</p>	<p>The licensing approach shall consist of a competitive licensing process, as determined by the Authority from time to time, for new spectrum users, or where there is preference for specified spectrum blocks.</p> <p>An assignment process will be applied to existing and eligible concessionaires, as prescribed by the Authority, provided there is no preference for specified spectrum blocks.</p> <p>The minimum assignment shall be 10 MHz, i.e., 2 x 5 MHz. Additionally each assignment shall be accompanied by a quantum of spectrum for guard bands.</p> <p>The spectrum cap for the 850 MHz Band shall be 10 MHz, i.e., 2 x 5 MHz. Each 2 x 5 MHz assignment shall be accompanied by a quantum of spectrum for guard bands, which shall be no less than 2 x 1 MHz and shall not exceed 2 x 2.5 MHz.</p> <p>10 MHz (i.e., 2 x 5 MHz) has been allocated for future use.</p> <p>Currently, 12 MHz is available for the provision of public mobile telecommunications services.</p>

Frequency Range of Operation	Available Cellular Mobile Technologies	Licensing Approach
<p>The 1900 MHz Band: 1880 – 1990 MHz (i.e., 1850 – 1910 MHz and 1930 – 1990 MHz)</p>	<p>GSM, CDMA, GPRS, EDGE CDMA 2000 EvDO, UMTS, HSPA(+), LTE</p>	<p>The licensing approach shall consist of a competitive licensing process, as determined by the Authority from time to time, for new spectrum users, or where there is preference for specified spectrum blocks.</p> <p>An assignment process will be applied to existing and eligible concessionaires, as prescribed by the Authority, provided there is no preference for specified spectrum blocks.</p> <p>The minimum assignment shall be 10 MHz (i.e., 2 x 5 MHz).</p> <p>The spectrum cap for the 1900 MHz Band shall be 40 MHz for the available spectrum.</p> <p>Currently, 40 MHz is available for provision of public mobile telecommunications services.</p>

Frequency Range of Operation	Available Cellular Mobile Technologies	Licensing Approach
<p>The 1.7/ 2.1 GHz Band: (i.e., 1710 – 1755 MHz and 2110 – 2155 MHz)</p>	<p>UMTS, HSPA(+), DC-HSPA(+), CDMA, 2000 EvDO, LTE</p>	<p>The licensing approach shall consist of a competitive licensing process, as determined by the Authority from time to time, for new spectrum users, or where there is preference for specified spectrum blocks.</p> <p>An assignment process will be applied to existing and eligible concessionaires, as prescribed by the Authority, provided there is no preference for specified spectrum blocks.</p> <p>The minimum assignment shall be 10 MHz (i.e. 2 x 5 MHz).</p> <p>The spectrum cap for the 1.7 GHz Band will be 30 MHz (i.e. 2 x 15 MHz) per spectrum licensee.</p> <p>Currently, 90 MHz is available for provision of public mobile telecommunications services.</p>

List of Abbreviations

1G	First generation
2G	Second generation
3G	Third generation
3GPP	3rd Generation Partnership Project
4G	Fourth generation
5G	Fifth generation
APT	Asia-Pacific Telecommunity
AWS	Advanced Wireless Services
BWA	Broadband wireless access
CDMA	Code Division Multiple Access
CEPT	European Conference of Postal and Telecommunications Administrations
DoRs	Decisions on Recommendations
EDGE	Enhanced Data Rates for GSM Evolution
EIRP	Equivalent isotropic radiated power
ERP	Effective radiated power
FDD	Frequency Division Duplexing
GHz	Gigahertz
GSM	Global System for Mobile communications
GPRS	General Packet Radio Service
HSPA	High Speed Packet Access
HSPA+	Evolved High Speed Packet Access
IMT	International Mobile Telecommunications
IS-95	Interim Standard 95
ITU	International Telecommunication Union
kHz	Kilohertz
LTE	Long Term Evolution
MHz	Megahertz
PCS	Personal communications services
PMTS	Public mobile telecommunications services
PPDR	Public protection and disaster relief
SPTWG	Spectrum Planning Technical Working Group
TATT	Telecommunications Authority of Trinidad and Tobago
TDD	Time Division Duplexing
UMTS	Universal Mobile Telecommunications Service
WCDMA	Wideband Code Division Multiple Access
WRC-07	World Radio Conference 2007
WRC-15	World Radio Conference 2015

1. Introduction

1.1 Rationale

The Telecommunications Authority of Trinidad and Tobago (the Authority) is mandated by the Telecommunications Act Chap. 47:31 to:

Regulate the use of the spectrum in order to promote the economic and orderly utilisation of frequencies for the operation of all means of telecommunications and to recover the cost incurred in the management of the spectrum.

The Authority executes this mandate through the development and implementation of a *National Spectrum Plan (ver. 1)* (TATT 2008). The NSP is a collection of spectrum planning instruments that articulate the rules, procedures, terms and conditions to effectively and efficiently manage spectrum.

The Authority will actively seek to facilitate the upgrade and expansion of telecommunications infrastructure, recognising that such infrastructure is the foundation for Information and Communications Technology (ICT) development and, by extension, economic competitiveness and social connectivity. Judicious spectrum management, of which spectrum planning is a critical component, accelerates ICT penetration, which is needed to create a knowledge-based society and digital economy.

1.2 Purpose

This Plan:

- i. identifies the optimal frequency bands for cellular mobile networks, as allocated globally and in particular by Region 2 countries¹, taking account of contemporary technologies.

¹ The International Telecommunication Union, Radiocommunications Bureau (ITU-R) Region 2 countries are the Americas and the Caribbean countries.

- ii. determines the appropriate frequency band plans for the provision of public mobile telecommunications services (PMTS), based on item (1.2 i).
- iii. specifies the appropriate licensing process for the assignment of spectrum to users.

The Plan is a subset of the *National Spectrum Plan* (NSP) and should be considered as part of the entire NSP. The NSP provides a framework for the regulation of spectrum, in an orderly, efficient manner, in accordance with the Authority's mandate.

1.3 Background

Under its *Recommendations for Spectrum Management Policy* (TATT 2005), the Authority is obligated:

To make available radio frequency spectrum for fostering the delivery of emerging radiocommunications services within an enabling spectrum licensing framework.

To facilitate the introduction of cellular mobile operators for the provision of public domestic mobile telecommunications networks and services, the Authority identified appropriate frequency bands, 850 MHz and 1900 MHz, based on prevailing cellular mobile technologies at that time. A license was required for spectrum use and a concession, granted by the Minister, was required to operate a public domestic mobile telecommunications network and to provide public telecommunications services.

The Authority conducted a competitive authorisation process from September 2004 to June 2005 to introduce two new entrants into the public mobile telecommunications market. Out of this process, Digicel (Trinidad and Tobago) Limited and LaqTel Limited were authorised to provide public mobile telecommunications services, in addition to the incumbent — the Telecommunications Services of Trinidad and Tobago (TSTT). As Laqtel was unable to launch service within the specified timeframe, the spectrum was reclaimed and its concession revoked. This reclaimed spectrum is available for licensing to a potential third operator via the Authority's authorisation process.

The Authority initiated a second competitive authorisation process in 2008, with a view to introducing a third mobile operator into the market. However, there were no successful applicants and, consequently, there were no spectrum assignments. This authorisation process was conducted for a third time between 2013 and 2014, attempting to assign the 850 MHz paired with 1900 MHz spectrum set aside for a third mobile operator. Also included in this authorisation process was provision for 700 MHz spectrum. In September 2014, a recommendation was made by the Authority to the Minister for the grant of a concession to a

third mobile operator and the award of spectrum, including assignments in the 700 MHz Band. The outcome of this authorisation process is still pending.

To date, the mobile sector comprises two cellular mobile operators — TSTT and Digicel (Trinidad and Tobago) Limited. The cellular mobile technologies employed have been Global System for Mobile communications (GSM), GSM Packet Radio Service (GPRS), Enhanced Data Rates for GSM Evolution (EDGE), Wideband Code Division Multiple Access (WCDMA), High Speed Packet Access (HSPA+) and Long Term Evolution (LTE).

TSTT's migration of its cellular mobile operations from the 1800 MHz to 1900 MHz Band has prompted planning for the 1.7/ 2.1 GHz Band, more commonly known as the Advanced Wireless Services (AWS) Band.

Pursuant to the Authority's commitment to consider additional IMT bands, for example, the AWS Band, a Spectrum Planning Technical Working Group (SPTWG) was formed consisting of relevant stakeholders, namely, cellular mobile operators and broadband wireless access (BWA) operators. The Working Group fulfilled its terms of reference in March 2014, with the submission of its internal report with recommendations for consideration by the Authority.

The Authority has agreed with the recommendation to make spectrum in the 1.7/ 2.1 GHz Band available for PMTS subsequent to the approval of this Plan and any other necessary approvals.

The Authority also notes the ongoing work to finalise a standard for fifth generation (5G) wireless systems (5G) by the 3rd Generation Partnership Project (3GPP) group. Given the Authority's technology neutral position, the spectrum identified in this Plan can be used for 5G.

1.4 Objectives

The Plan:

- i. identifies the frequency ranges that will be allocated for the provision of public mobile telecommunications services, in accordance with market and sector interests.
- ii. indicates the licensing process for the assignment of frequency ranges, including any specific licensing conditions.
- iii. specifies the technical operating conditions and specifications to be imposed on the licensed radiocommunications systems in the allocated frequency ranges.

1.5 Relevant Legislation

The sections of the Telecommunications Act Chap. 47:31 that inform this Plan are:

Section (18)(1)(i):

Subject to the provisions of this Act, the Authority may exercise such functions and powers as are imposed on it by this Act and in particular –

Plan, supervise, regulate and manage the use of the radio frequency spectrum, including –

- 1. the licensing and registration of radio frequencies and call signs to be used by all stations operating in Trinidad and Tobago or on any ship, aircraft, or other vessel or satellite registered in Trinidad and Tobago;*
- 2. the allocation, assignment and reallocation or reassignment of frequency bands where necessary.*

Section 21(1):

No person shall operate a public telecommunications network, provide a public telecommunications service or broadcasting service, without a concession granted by the Minister.

Section 36(1):

No person shall –

- 1. establish, operate or use a radio-communication service;*
- 2. install, operate or use any radio transmitting equipment; or*
- 3. establish, operate or use any radio-communication service on board any ship, aircraft, or other vessel in the territorial waters or territorial airspace of Trinidad and Tobago, other than a ship of war or a military aircraft or satellite registered in Trinidad and Tobago without a licence granted by the Authority.*

Section 41(1):

The Authority shall regulate the use of the spectrum in order to promote the economic and orderly utilisation of frequencies for the operation of all means of telecommunications and to recover the cost incurred in the management of the spectrum.

Section 41(2):

The Authority shall develop a spectrum plan in order to regulate the use of the spectrum.

Section 41(3):

The National Spectrum Plan shall be made available to the public in the manner prescribed by the Authority.

Section 41(4):

The National Spectrum Plan shall state how the spectrum shall be used and the procedures for licensing frequency bands.

1.6 Review Cycle

This Plan will be revised periodically to meet changing needs, taking account of technological advancements. The Authority will review the document as necessary, and in consultation with stakeholders, to ensure the Plan is guided by relevant policy guidelines and objectives.

Questions or concerns regarding the maintenance of this Plan may be directed to the Authority via e-mail to info@tatt.org.tt.

1.7 Consultation Process

In keeping with the commitment made in version 3.0 of this Plan, the Authority established a Spectrum Planning Technical Working Group (SPTWG), comprising key stakeholders including the cellular mobile operators, to consider additional IMT bands for inclusion in this Plan. This SPTWG recommended additional spectrum for the provision of public mobile telecommunications services.

The Authority reviewed the recommendation and, consequently, revised the plan to include the 1.7/ 2.1 GHz Band for the provision of public mobile telecommunications services.

The Authority sought, in accordance with its [Procedures for Consultation in the Telecommunications Sector of Trinidad and Tobago](#) (ver. 2.0) (TATT 2010), the views of the general public and industry stakeholders on the first draft of this document, which was published on July 17, 2015, with a closing date of August 14, 2015.

This consultation process was suspended in order to review comments concerning the 700 MHz Band. Although this band was not under consideration at that time, it was prudent to examine the comments and recommendations made therein, and any impact on the assignment of 700 MHz spectrum.

The comments and recommendations received from that first round of consultation and the Authority's decisions on these comments and recommendations were compiled in the Decisions on Recommendations (DORs) in Annex I.

The Authority sought, in accordance with its [*Procedures for Consultation in the Telecommunications Sector of Trinidad and Tobago*](#) (ver. 2.0) (TATT 2010), the views of the general public and industry stakeholders on the second draft of this document, which was published on July 28, 2017, with a closing date of September 4, 2017.

The comments and recommendations received from the second round of consultation and the Authority's decisions on these comments and recommendations were compiled in the Decisions on Recommendations (DoRs) in Annex II.

There were no further material revisions made to the content of the second consultative document, based on comments and recommendations from the second round of consultation.

The Authority has aligned this document to its current format and style.

1.8 Other Relevant Documents

Other relevant policies, plans and regulations to be read along with the *Spectrum Plan for the Accommodation of Public Mobile Services* include:

- i. [*Authorisation Framework for the Telecommunications and Broadcasting Sectors of Trinidad and Tobago*](#) (ver. 0.5, 2005)
- ii. [*Recommendations for Spectrum Management Policy*](#) (ver. 0.5, 2005)
- iii. [*National Spectrum Plan*](#) (ver. 1, 2008)
- iv. [*Trinidad and Tobago Frequency Allocation Table*](#) (9 kHz – 1000 GHz) (ver. 2, 2010)

1.9 Definitions

Equivalent isotropic radiated power (EIRP): the product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna (absolute or isotropic gain) (ITU-R 2016)

Effective radiated power (ERP) (in a given direction): the product of the power supplied to the antenna and its gain relative to a half-wave dipole in a given direction (ITU-R 2016)

Harmful interference: interference that endangers the functioning of telecommunications so as to impede, degrade, obstruct or interrupt a telecommunications service (The Telecommunications Act Chap. 47:31)

Primary service: a radiocommunications service for which stations can claim protection from harmful interference from stations of a secondary service (ITU-R 2016)

Public telecommunications network: a telecommunications network used to provide a public telecommunications service (The Telecommunications Act Chap. 47:31)

Public telecommunications service: a telecommunications service, including a public telephone service, offered to members of the general public, whereby one user can communicate with any other user in real time, regardless of the technology used to provide such service (The Telecommunications Act Chap. 47:31)

Secondary service: a radiocommunications service for which stations shall cause harmful interference to stations of primary services and cannot claim protection from interference from stations of primary services (ITU-R 2016)

Station: one or more transmitters or receivers or a combination of transmitters and receivers, including the accessory equipment, necessary at one location for carrying on a radiocommunications service or radio astronomy service (ITU-R 2016)

2. Considerations for the Accommodation of Public Mobile Telecommunications Services

2.1 Global Environment

Cellular mobile technologies have evolved considerably with new generations of technologies being released approximately every decade. The technological evolution is shadowed by a simultaneous evolution in spectrum use. The evolution of cellular mobile technologies and the frequencies and channel bandwidth used by these technologies are illustrated in Figure 1.

The fourth generation (4G) is the latest cellular mobile technology available to date. In markets where 4G networks are deployed, 4G technologies operate in parallel with earlier generation technologies — in many cases with both second generation (2G) and third generation (3G). Therefore, planning must consider spectrum allocation for all generations of technologies in deployment.

The ITU has defined spectrum for International Mobile Telecommunications (IMT) for the provision of public mobile telecommunications networks and services (such as traditional mobile telephony), and more recently mobile data services, including mobile broadband (ITU 2017). IMT refers to the entire family of technology specifications. IMT-2000 refers to the family of 3G technology specifications and IMT-advanced refers to 4G technology specifications. Table 2 lists the various frequency bands identified for IMT.

Work is also ongoing to finalise the standard for fifth generation wireless systems (5G). As of February 2017, the ITU-R released draft minimum requirements for IMT-2020 radio interface(s) (ITU-R 2017), which are expected to be approved by Study Group 5 at its next meeting in November 2017. The 3rd Generation Partnership Project (3GPP) has two open releases — Releases 14 and 15 — and committed, in March 2017 at a plenary RAN #75 meeting, to a work plan proposal containing accelerated timeframes for the finalisation of specific key 5G features. The freeze date of Release 15, defining the 3GPP 5G standard, is scheduled for September 2018.

Figure 1 and Table 3 summarise the spectrum allocations for 2G, 3G and 4G networks deployed in the ITU-R Region 2 territories.

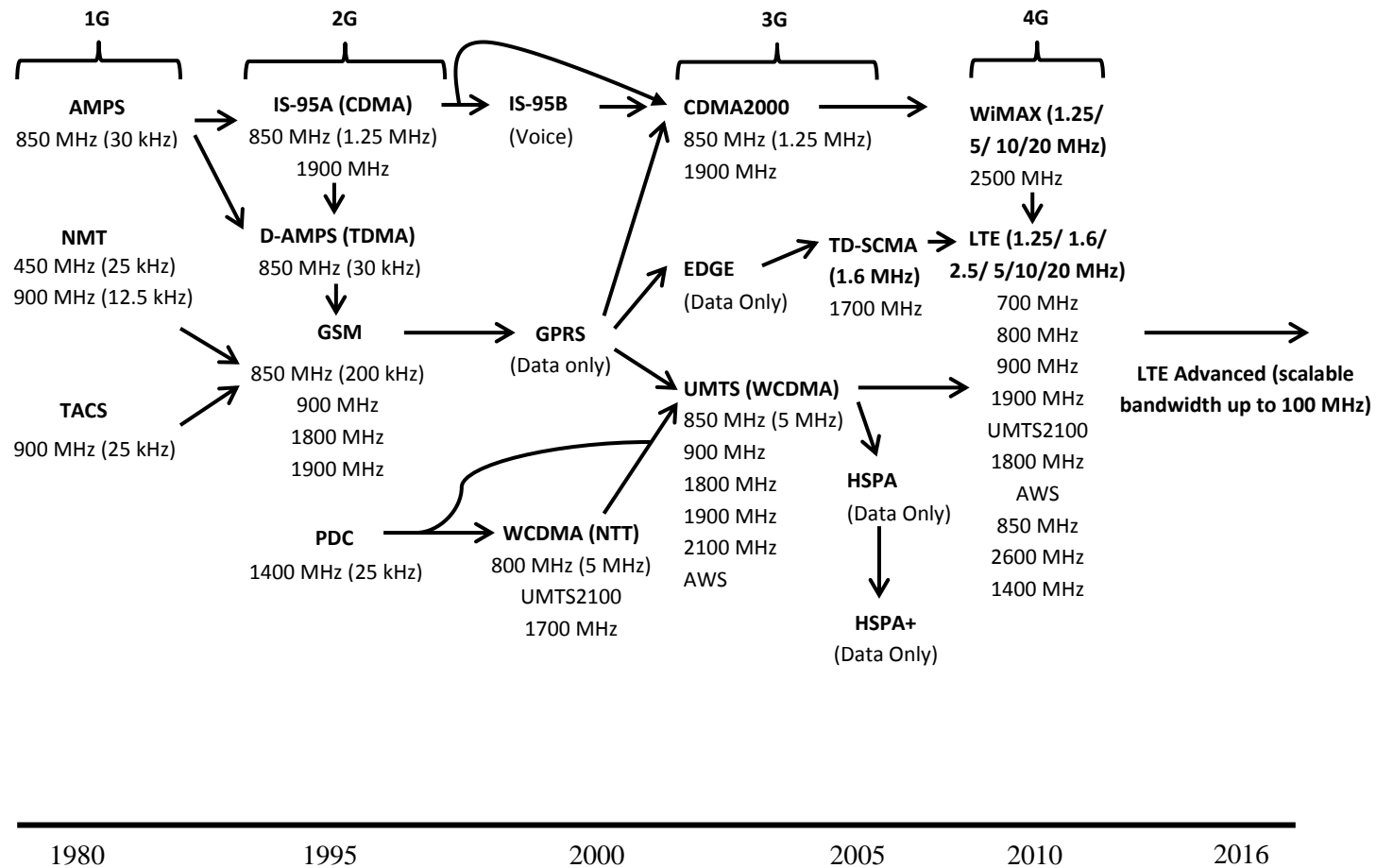


Figure 1: Frequency Allocations for 2G, 3G and 4G Cellular Mobile Networks

Table 2: Frequency Bands Identified for IMT (Source: ITU-R Radio Regulations Resolutions and Recommendations Edition of 2016)

Band (MHz)	Footnotes identifying the band for IMT
450 – 470	5.286AA
470 – 698	5.295,5.296A,5.308A
698 – 960	5.313A,5.317A
1427 – 1518	5.341A, 5.341B, 5.341C, 5.346, 5.346A
1710 – 2025	5.384A, 5.388
2110 – 2200	5.388
2300 – 2400	5.384A
2500 – 2690	5.384A
3300 – 3400	5.429B, 5.429D, 5.429F
3400 – 3600	5.430A, 5.431B, 5.432A, 5.432B, 5.433A
3600 – 3700	5.434
4800 – 4990	5.441A, 5.441B

Table 3: Frequency Allocations for 2G, 3G and 4G Cellular Mobile Networks Deployed in ITU-R Region 2 Territories

Generation	Available Technologies	Frequency	Remarks
2G	<ul style="list-style-type: none"> • Global System for Mobile communications (GSM) • General Packet Radio Service (GPRS) • Enhanced Data Rates for GSM Evolution (EDGE) 	<ul style="list-style-type: none"> • 850 MHz (824 – 849/869 – 894 MHz) • 1900 MHz (1850 – 1910/1930 – 1990 MHz) 	<p>GSM networks are actively used for voice services throughout the region. They are deployed in conjunction with data enhancements, GPRS and EDGE, as well as other more recent generations of data services.</p>
	<p>Code Division Multiple Access (CDMA) or Interim Standard 95 (IS-95)</p>	<ul style="list-style-type: none"> • 850 MHz (824 – 849/869 – 894 MHz) • 1900 MHz (1850 – 1910/1930 – 1990 MHz) 	<p>IS-95 networks are being decommissioned. They offer limited data services, as no data enhancements were released for this generation of CDMA networks. These networks are rapidly being upgraded to LTE networks.</p>
3G (IMT-2000)	<ul style="list-style-type: none"> • Universal Mobile Telecommunications Service (UMTS) • High Speed Packet Access (HSPA) 	<ul style="list-style-type: none"> • 850 MHz (824 – 849/869 – 894 MHz) • 1900 MHz (1850 – 1910/1930 – 1990 MHz) • 1710 – 1755 MHz /2110 – 2155 MHz 	<p>UMTS networks are currently deployed throughout the region for voice and data services. These networks were given a significant boost in data service when the HSPA data enhancement upgrades were released.</p>

Generation	Available Technologies	Frequency	Remarks
	CDMA2000 1xRTT 1xEV-DO	<ul style="list-style-type: none"> • 850 MHz (824 – 849/869 – 894 MHz) 	<p>CDMA2000 networks are deployed throughout Region 2, offering voice and data services. The 1xRTT air interface is used for the voice services and the EV-DO for mobile and wireless broadband data services. These networks are rapidly being upgraded to LTE networks.</p>
	CDMA 1xRTT 1xEV-DO	<ul style="list-style-type: none"> • 1900 MHz (1850 – 1910/1930 – 1990 MHz) 	<p>The 1xRTT air interface is used for the voice services and the EV-DO for mobile and wireless broadband data services. These networks are rapidly being upgraded to LTE networks.</p>
4G (IMT-Advanced)	Long Term Evolution (LTE)	<ul style="list-style-type: none"> • 700 MHz (698 – 746 MHz/746 – 806 MHz) • 850 MHz (824 – 849/869 – 894 MHz) • 1900 MHz (1850 – 1910/1930 – 1990 MHz) • 2500 – 2690 MHz • 1710 – 1755/2110 – 2155 MHz 	<p>LTE networks are being rapidly deployed worldwide. At this time, there are no global harmonised frequencies.</p> <p>Networks based on 700 MHz improve economies of scale as infrastructure costs are reduced. Infrastructure savings arise because fewer base stations are needed since signals have better propagation properties in this band. Reports on the LTE ecosystem show that 308 devices support 700 MHz Bands 12 or 17 (GSMA 2014). The AWS Band is being utilised to complement the 700MHz Band in LTE deployment.</p> <p>The ITU established requirements for the technical performance for IMT-Advanced radio interface(s), specifying the standard for 4G networks. From Release 10 onwards, the 3GPP has worked to meet these requirements by specifying the LTE-Advanced standard.</p>

Generation	Available Technologies	Frequency	Remarks
	Worldwide Interoperability for Microwave Access (WiMAX)	<ul style="list-style-type: none"> • 2500 – 2690 MHz 	The deployment of WiMAX cellular technology has been limited. WiMAX has been deployed largely for broadband wireless access (BWA) services.
	Evolved High Speed Packet Access (HSPA+)	<ul style="list-style-type: none"> • 817 – 824/862 – 869 MHz • 1900 MHz • 2500 – 2690 MHz • 1710 – 1755/2110 – 2155 MHz 	<p>HSPA+ is a mainstream mobile technology, implemented via a software update to existing HSPA networks. Penetration of this technology is boosted by a rapidly growing device ecosystem.</p> <p>Because of the ease of deployment (software upgrade), many operators opt to use this technology for their entry level 4G service while deploying their LTE network.</p>

Considering the better propagation characteristics of the 700 MHz Band and the development of the ecosystem of end-user devices and network equipment, the 700 MHz Band will be the preferred band for the provision of mobile broadband services. This will complement the 850 MHz and 1900 MHz Bands, currently deployed for the provision of public mobile telecommunications services. In addition to the above-mentioned bands, the 1.7/ 2.1 GHz Band can be paired with the 700 MHz Band, to add additional capacity for LTE network deployment.

2.2 Further Considerations

To optimally allocate and adequately plan the use of the 700 MHz, 850 MHz, 1900 MHz and 1.7/ 2.1 GHz frequency Bands for the accommodation of PMTS, the Authority considered:

- i. the frequency bands allocated to mobile service, in accordance with ITU-R Region 2 Table of Frequency Allocations and the Trinidad and Tobago Frequency Allocation Table (TTFAT).
- ii. the spectrum used by licensed PMTS in Trinidad and Tobago.
- iii. the availability of spectrum in Trinidad and Tobago to accommodate public mobile telecommunications services.
- iv. the appropriate licensing method for the assignment of spectrum to users.
- v. the assignment of spectrum to facilitate telecommunications infrastructure growth.
- vi. recommendations made by the Spectrum Planning Technical Working Group (SPTWG) for IMT bands.

These considerations have been summarised in Table 4.

Table 4: Frequency Allocations for 2G, 3G and 4G Cellular Mobile Networks

ITU-R Recommended Frequency Range of Operation	Trinidad and Tobago Frequency Allocation Table (TTFAT)	Current Spectrum Availability
<p>The 700 MHz Band: (698 – 806 MHz)</p>	<p>The frequency range 698 – 806 MHz is allocated in the TTFAT to mobile and broadcasting services as co-primary services and to fixed services as the secondary service.</p>	<p>Currently, 43 MHz of spectrum in the 700 MHz Band is available for the provision of public mobile telecommunications services.</p> <p>However, 48 MHz of spectrum in the 700 MHz Band is currently allocated to BWA services. This quantum of spectrum is being re-classified for the provision of public mobile telecommunications services by the re-assignment of the existing spectrum user to spectrum below the 700 MHz Band. This will increase the spectrum availability to a total of 90 MHz.</p> <p>The increase in available spectrum allows the following allotments:</p> <ul style="list-style-type: none"> i. 60 MHz of spectrum for the provision of PMTS ii. 20 MHz of spectrum for the provision of public protection and disaster relief (PPDR) services, formerly termed Public Health and Safety (PHS) services iii. 10 MHz of spectrum allotted for future use

ITU-R Recommended Frequency Range of Operation	Trinidad and Tobago Frequency Allocation Table (TTFAT)	Current Spectrum Availability
The 850 MHz Band: (824 – 849/869 – 894 MHz)	The frequency ranges 824 – 849/869 – 894 MHz spans two frequency allocations in the TTFAT: 806 – 890 MHz and 890 – 902 MHz Mobile service is the primary service in both ranges.	The 850 MHz Band is currently allocated to public mobile telecommunications services, with the two existing operators assigned spectrum in this band. Currently, 12 MHz is available in this band for the provision of public mobile telecommunications services. 10 MHz is allotted for future use.
The 1900 MHz Band: (1850 – 1910/1930 – 1990 MHz)	The frequency ranges 1850 – 1910/1930 – 1990 MHz spans four frequency allocations in the TTFAT: 1710 – 1930 MHz, 1930 – 1970 MHz, 1970 – 1980 MHz and 1980 – 2010 MHz. Mobile service is primary service in all the ranges.	The 1900 MHz Band is currently allocated to public mobile services, with the two existing operators currently assigned spectrum in this band. Currently, 40 MHz is available in this band for the provision of PMTS.
The 1.7/ 2.1 GHz Band: (1710 – 1755/2110 – 2155 MHz)	The frequency ranges 1710 – 1755 MHz and 2110 – 2155 MHz spans three frequency allocations in the TTFAT: 1 710 – 1 930 MHz, 2110 – 2120 MHz and 2 120 – 2 160 MHz. Mobile service is primary service in all the ranges.	There are currently no spectrum assignments in this band. Currently, 90 MHz is available in this band for the provision of public mobile telecommunications services, subject to a spectrum audit to verify available spectrum.

Based on work undertaken by the Authority to migrate an existing licensee within the 700 MHz Band to spectrum below 700 MHz, the entire 700 MHz Band (i.e., 90 MHz of spectrum) will be made available for allocation and assignment to public mobile telecommunications services, as indicated in Table 4, save and except for the allotment to PPDR.

The Authority conducted a monitoring exercise to verify that the 700 MHz Band was free of unwanted signals that might cause harmful interference. However, in light of the change from the US 700 MHz Band Plan to the APT 700 Band Plan, the Authority will be conducting new monitoring exercises to verify that spectrum in both the 700 MHz and 1.7/ 2.1 GHz Bands are

free from harmful interference. Furthermore, the Authority is aware of the possibility of harmful interference with neighbouring countries. The *ITU-R Radio Regulations* articulates the procedures by which countries can conduct frequency notification, coordination and treatment of harmful interference across borders. The Authority will be guided by these procedures should the need arise. As part of the implementation process, the Authority will issue the necessary notification to the ITU-R, should any coordination process be necessary with neighbouring countries.

In its continuing effort to make additional spectrum available for public mobile telecommunications services, and recognising the value of feedback from the industry, the Authority will establish an SPTWG comprising relevant stakeholders to assess any future candidate bands for public mobile telecommunications services and to make such recommendations to the Authority.

It is also the Authority's intention that the other candidate IMT bands shall be considered for the provision of public mobile telecommunications services as demand and/or changes in the sector emerge.

3. Frequency Assignment Principles

The following principles undergird the frequency assignment plans for the accommodation of public mobile telecommunications services in Trinidad and Tobago:

- i. The adopted frequency assignment plan for a specified band shall follow the relevant ITU-R recommendation, if applicable, and take into consideration the predominant frequency assignment plan utilised by mobile services in the particular frequency band.
- ii. The frequency assignment plan shall allow the allotment of sufficient spectrum for up to three cellular mobile operators.
- iii. All frequency assignment plans shall have a reference channel bandwidth that serves as the minimum channel bandwidth assignment. Frequency channels that require larger bandwidths can be achieved by concatenating multiple non-contiguous frequency channels of the reference channel bandwidth, which would equate to contiguous spectrum.
- iv. The frequency assignment plans are limited to Frequency Division Duplexing (FDD) mode of operation only. Consequently, Time Division Duplexing (TDD) mode of operation is not supported.
- v. Frequency assignments shall be made in accordance with the selected licensing process, as established by the Authority.
- vi. The frequency spectrum blocks or frequency channels in a frequency assignment plan incorporates any necessary guard bands. Any necessary guard bands for entities authorised to use adjacent blocks or channels will be determined at such time that the licensees and the respective technologies to be deployed have been determined.
- vii. A spectrum cap shall be instituted in each band to limit the quantum of spectrum assigned to an individual spectrum user. The spectrum cap is the maximum quantum of spectrum that can be assigned to an individual licensee in a specified frequency band.
- viii. A licensee shall utilise the spectrum to which it is assigned in a manner that does not cause harmful interference to any licensee with an adjacent spectrum assignment. The licensee shall employ in-band guard bands to mitigate harmful interference from adjacent channel licensees.

- ix. The maximum RF output power limits may vary between different frequency bands, as radio frequency propagation characteristics are different across the frequency bands.

4. Frequency Assignment Plans for Public Mobile Telecommunications Services

The various frequency bands allocated for public mobile telecommunications services can be further sub-divided into frequency channel assignments, predicated on the type(s) of technologies that can be employed. These frequency assignment plans aim at maximising the efficient use of the allocated spectrum.

The following sub-sections outline the various frequency ranges under consideration: the frequency assignment plan, including rationale; the recommended licensing process and conditions; and the technical operating conditions and specifications for the radiocommunications systems operating in the stated frequency band.

The actual availability of frequency channels for public mobile telecommunications services will be determined subject to a spectrum audit to verify the availability of spectrum prior to the implementation of the respective licensing process for the designated frequency band.

4.1 The 700 MHz Band (703-748/758-803 MHz)

4.1.1 Selection of Frequency Assignment Plan

In light of the development of new cellular mobile technologies, such as LTE, and the identification of frequency bands for IMT by the ITU-R, there are new opportunities for cellular mobile operators to deploy 3G and 4G networks and monetise the added services such as broadband that can be offered.

The propagation characteristics of the spectrum in the 700 MHz Band and the allowable power limits make it conducive to serving consumers over a large area.

As part of the IMT family of specifications for 4G mobile technologies, the only cellular mobile technology deployed to date in the 700 MHz Band is LTE. Globally, the use of the 700 MHz Band for LTE has taken three main forms, by way of three competing frequency assignment (channel) plans. Figure 2 identifies the plans employed by the European Conference of Postal and Telecommunications Administrations (CEPT) in its 800 MHz Band; the Asia-Pacific Telecommunity (APT) in the 700 MHz Band; and the US in the 700 MHz Band.

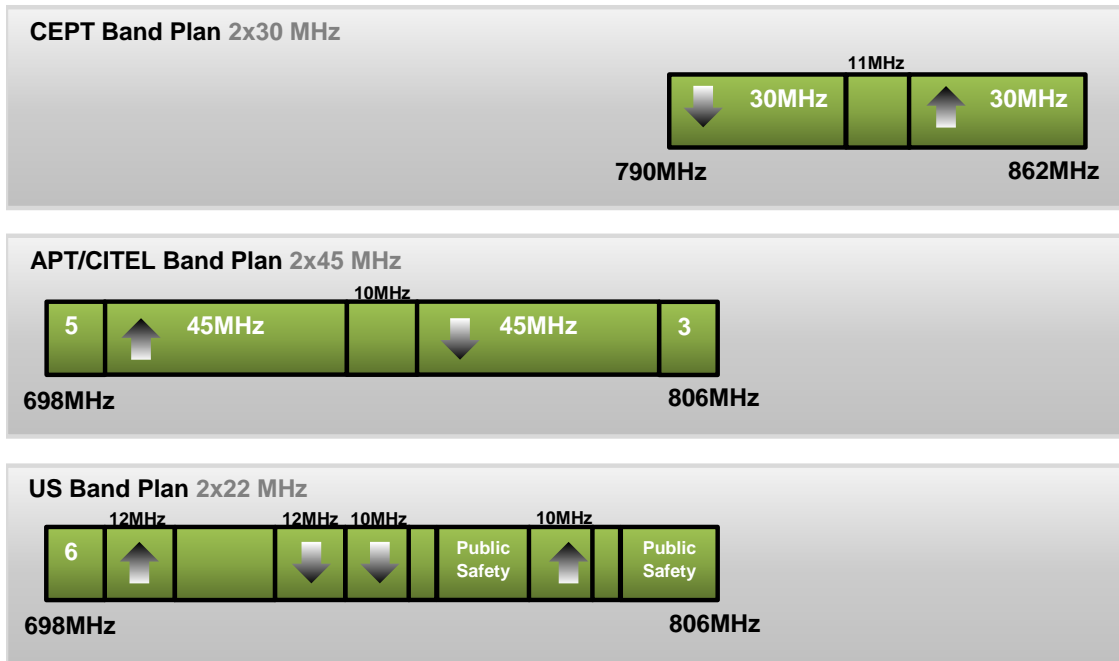


Figure 2: 700/800 MHz Band Plans

The CEPT Band Plan was not considered as it overlaps with the 850 MHz Band currently employed by the Authority. This left the APT and US 700 MHz Band Plans open to consideration.

The Authority adopted the US 700 MHz Band Plan, namely, the 3GPP Bands 13 and 17 (3GPP 2014), in version 3.0 of this *Spectrum Plan for the Accommodation of Public Telecommunications Services*. The chronology and reasons for this previous adoption are outlined in Annex II — The Adoption of the US 700 MHz Band Plan.

The Authority later considered the expansion of the US Band Plan to allow up to three operators and an allotment for PPDR. This is captured in Annex II.

However, the Authority acknowledges that blocks A, D, E and A' (of the US Band Plan) are currently allocated to BWA services and assigned to an existing spectrum user. The incumbent spectrum user is being re-assigned to spectrum below the 700 MHz Band, allowing for these blocks to be re-classified for the provision of public mobile telecommunications services. This allows sufficient spectrum for up to three cellular mobile operators and a PPDR allotment.

Although the US 700 MHz (expanded) Band Plan had been considered by the Authority, the global outlook now favours the APT 700 MHz Band Plan. Several CITELE countries have adopted the APT 700 MHz Band Plan, including Mexico, Brazil and Venezuela (GSMA 2014). Fourteen (14) LTE networks that employ the APT 700 MHz Band Plan have been launched as of August 2015, including three operators in Panama (GSMA 2016). The number of networks is expected to increase significantly in Latin America, with countries such as Chile moving to auction 700 MHz spectrum. The handset ecosystem for the APT 700 MHz Band Plan has grown to 639 devices, inclusive of high-end and low-end devices (GSA 2017). The handset ecosystem has evolved to include both band plans, making roaming seamless across countries that have adopted either band plan.

Most significantly, ITU-R Region 1 jurisdictions — the UK, Europe, Africa and Russia — adopted the APT 700 MHz Band Plan at the ITU-R World Radio Conference, 2015 (ITU-R 2016). Therefore, the APT 700 MHz Band Plan is now harmonised across ITU-R Regions 1 and 3 and Latin America in Region 2, while North America and the English-speaking Caribbean have maintained the US 700 MHz Band Plan. Operators and manufacturers in the USA and Canada continue to facilitate growth in network equipment and handsets.

It is noteworthy that the APT 700 MHz Band Plan can accommodate four equal allotments of 2 x 10 MHz, whereas the allotments in the US 700 MHz Band Plan are not equal.

In view of the aforementioned, the APT 700 MHz Band Plan will now be utilised for the 700 MHz Band, i.e., 3GPP Band 28 (3GPP 2014), for the provision of public domestic mobile telecommunications networks and services.

The adoption of the APT 700 MHz Band Plan requires an allotment for PPDR. The ITU-R, at the World Radio Conference 2015 (WRC-15) (ITU-R 2016), modified Resolution 646: Public Protection and Disaster Relief (first approved in 2007 at WRC-07) and resolved to encourage administrations to:

- i. use harmonised frequency ranges for PPDR to the maximum extent possible, taking into account the national and regional requirements, and also allowing for consultation and cooperation with other concerned countries.
- ii. consider parts of the frequency range 694 – 894 MHz, as described in the most recent version of ITU-R Recommendation M.2015, when undertaking their national planning for PPDR applications, in particular, broadband, to achieve harmonisation.

It is within this context that consideration should be given to the allocation of spectrum for PPDR within the frequency range 694 – 894 MHz, which is a designated range for IMT. Further

to this, careful planning of the 700 MHz band (i.e., 698 – 806 MHz) is needed in ITU-R Region 2 countries (the Americas and the Caribbean), given the available mobile broadband technologies and the quantum of spectrum for allocation.

The US 700 MHz Band Plan is the only 700 MHz Band Plan that has a designated spectrum allocation for PPDR, i.e., the frequency ranges 788 – 798 MHz paired with 758 – 768 MHz, also known as 3GPP Band 14. This band plan has been adopted by the USA, Canada, Bolivia, Nicaragua and some English-speaking Caribbean countries. However, the APT 700 MHz Band Plan does not have a designated spectrum allocation for PPDR. Hence, Region 2 countries that have adopted this plan, and wish to comply with the ITU resolution, require PPDR designations in the planning of the 700 MHz Band.

The identification of 3GPP Bands 14 and 28 for PPDR also enables harmonisation, so that equipment may be used across borders, in particular, to support disaster relief efforts. Therefore, it is advisable that an allotment to PPDR conforms to either Band 14 or 28.

For national security reasons, the Authority will maintain an exclusive allotment of 700 MHz spectrum for PPDR. This is consistent with the quantum of spectrum allotted in the US 700 MHz Band Plan, i.e., 2 x 10 MHz. Therefore, to satisfy the PPDR requirement for the 700 MHz Band, the Authority shall identify an allotment of 2 x 10 MHz.

4.1.2 Frequency Assignment Plan

The channel assignment plan outlined in Table 5 shall be adopted. This plan permits equitable allotment of spectrum for up to three cellular mobile operators, allots spectrum for PPDR and sets aside spectrum for future use.

Block A (i.e., 2 x 5 MHz) shall be allocated for future use. Block B (i.e., 2 x 10 MHz) shall be allotted for the provision of PPDR. This allows Blocks C, D and E (i.e., 2 x 10 MHz each) for assignment to up to three cellular mobile operators.

This frequency assignment plan does not require the establishment of guard bands, as guard bands are established within the allotted spectrum blocks.

Table 5: Frequency Assignment Plan for 700 MHz Band

Band	Frequency Range/MHz		
	Mobile Station Transmit	Base Station Transmit	Block Name
700 MHz	703 – 708	758 – 763	A
	708 – 718	763 – 773	B
	718 – 728	773 – 783	C
	728 – 738	783 – 793	D
	738 – 748	793 – 803	E

4.1.3 Licensing Process and Conditions

The rules for licensing are as follows:

- i. A concession for the provision of a public domestic mobile telecommunications network and public telecommunications services is a prerequisite for the assignment of spectrum in the 700 MHz Band.
- ii. The licensing of spectrum in the 700 MHz Band shall be for the provision of public mobile telecommunications services on a national basis, save and except for an allotment to PPDR.
- iii. A cellular mobile spectrum licence shall be granted by the Authority in order to assign spectrum in the 700 MHz Band.
- iv. The allocated spectrum in the 700 MHz Band shall be licensed in accordance with the frequency assignment plan (Table 5).
- v. The spectrum cap for the 700 MHz Band shall be 20 MHz (i.e., 2 x 10 MHz) of spectrum, which allows for up to three cellular mobile operators.
- vi. The assignment of spectrum, to new spectrum users or where there is preference for specified spectrum blocks, shall be via a competitive licensing process, as determined by the Authority.
- vii. The assignment of spectrum to existing and eligible concessionaires, where there is no preference for specified spectrum blocks, shall be via an assignment process determined by the Authority.

4.1.4 Technical Operating Conditions and Specifications

To operate public mobile telecommunications services in the 700 MHz Band, no spectrum users shall exceed the maximum technical operating conditions and specifications identified in Table 6.

Table 6: Maximum Technical Operating Specifications for the 700 MHz Band²

Parameter	Constraint/Maximum Value	Comments
Maximum effective radiated power (ERP)	Base Station: 30 dBW Mobile Station: 4.77 dBW	Total power of all channels
Modulation scheme	Digital	Any digital modulation technique, e.g., BPSK, QPSK
Out-of-Band Emissions Limits	-43 dBW	Attenuation (α) on max power (P) of emissions calculated using: $\alpha = 43 + 10 \log(P)$
Standardisation	N/A	FCC, Industry Canada, ETSI

Notwithstanding the parameters identified in Table 6, amended or additional technical operating conditions may be instituted and identified in the respective schedule of the licence document for the specific radiocommunications technology deployed.

² These specifications were developed in accordance with the *Code of Federal Regulations*, Title 47, Part 27 (i.e., FCC Rules).

4.2 The 850 MHz Band (824-849/869-894 MHz)

4.2.1 Selection of Frequency Assignment Plan

Two predominant band plans exist globally for IMT — those of North America and of the European Union. Administrations worldwide develop band plans that either adhere completely to one of these plans or use a blend of both designations. North America has operated mobile telecommunications systems in the 800 MHz (824 – 849/869 – 894 MHz) and 1900 MHz (1850 – 1910/1930 – 1990 MHz) frequency bands, whereas counterpart systems in Europe operate in the 900 MHz (880 – 915/925 – 960 MHz) and 1800 MHz (1710 – 1785/1805 – 1880 MHz) Bands.

It is challenging to blend the band plans from Europe and North America. Radio equipment designed for one market cannot inherently coexist in the same environment as those designed for another market, without threatening quality degradation and harmful interference. Consequently, a blend of band plans requires extraordinary steps to engineer adjacent systems generally resulting in inefficient use of spectrum. Therefore, the use of a single band plan is preferred.

Trinidad and Tobago belongs to ITU-R Region 2 and imports a significant portion of equipment from North America. It is generally advisable that Trinidad and Tobago adopt band plans that conform to North American markets to ensure equipment availability and, in particular, handset availability. Additional factors requiring consideration include: compatibility of international and regional cross-border systems, such as mobile-satellite communications systems; and coexistence with widely available radiocommunications systems, such as industrial, scientific and medical (ISM) applications, which operate in the band 902 – 928 MHz. The North American band plan is also employed throughout Latin America, except for Brazil and Venezuela.

In Region 2 countries, other radiocommunications systems operate in the 900 MHz Band used by Region 1 cellular mobile networks. These include studio-to-transmitter links (STLs) for broadcasting auxiliary services, and for paging systems, low-powered tele-metering systems and ISM applications and systems. In Trinidad and Tobago, making spectrum available in this band would be difficult as there are numerous radiocommunications systems operating in the 900 MHz Band.

The predominant second generation mobile telecommunications technologies are CDMA, GSM, GPRS and EDGE. Third generation systems have generally been based upon Wideband CDMA (WCDMA), such as Universal Mobile Telecommunications Service (UMTS) and its data variants of High Speed Packet Access (HSPA).

The Authority recognises that spectrum in the North America plan for IMT can be used for 4G cellular mobile technologies such as LTE, as it has been designated as an operating band (i.e.,

Band 5) in the 3GPP Evolved Universal Terrestrial Radio Access (E-UTRA) technical specifications document (3GPP 2014). It is also noteworthy that LTE is band plan neutral, as its specification permits operation in all current band plans.

4.2.2 Frequency Assignment Plan

The Authority’s assignment plan for the 850 MHz Band shall be based on the North American band plan, allowing for various technologies, for the provision of public mobile telecommunications services as shown in Table 7.

Block B (i.e., 2 x 5 MHz) shall be allocated for future use. This allows the remaining blocks to be assigned to up to three cellular mobile operators, inclusive of guard bands.

Table 7: Frequency Assignment Plan for 850 MHz Band

Band	Frequency Range/MHz		
	Mobile Station Transmit	Base Station Transmit	Block Name
850 MHz	824 – 825	869 – 870	A’
	825 – 830	870 – 875	A ₁
	830 – 835	875 – 880	A _u
	835 – 840	880 – 885	B
	840 – 845	885 – 890	B’’
	845 – 846.5	890 – 891.5	A’’
	846.5 – 849	891.5 – 894	B’

4.2.3 Licensing Process and Conditions

The rules for licensing are as follows:

- i. A concession for the provision of a public domestic mobile telecommunications network and public telecommunications services is a prerequisite for the assignment of spectrum in the 850 MHz Band.
- ii. The licensing of spectrum in the 850 MHz Band shall be for the provision of public mobile telecommunications services, on a national basis.
- iii. A cellular mobile spectrum licence shall be granted in order to assign spectrum in the 850 MHz Band.

- iv. The allocated spectrum in the 850 MHz Band shall be licensed in accordance with the frequency assignment plan as shown in Table 7. The minimum assignment shall be 10 MHz, i.e., 2 x 5 MHz.
- v. The spectrum cap for the 850 MHz Band shall be 10 MHz, i.e. 2 x 5 MHz, which allows for up to three cellular mobile operators.
- vi. Each minimum assignment shall be accompanied by a quantum of spectrum for guard bands (not to exceed 2 x 2.5 MHz). Blocks A', A'' and B' are used for guard bands and range from 2 x 1 MHz to 2 x 2.5 MHz. In the event that a licensee has remaining spectrum after the establishment of guard bands, said spectrum may be utilised for the provision of public mobile telecommunications services.
- vii. The assignment of spectrum, to new spectrum users or where there is preference for specified spectrum blocks, shall be via a competitive licensing process, as determined by the Authority.
- viii. The assignment of spectrum to existing and eligible concessionaires, where there is no preference for specified spectrum blocks, shall be via an assignment process prescribed by the Authority.

4.2.4 Technical Operating Conditions and Specifications

To operate public mobile telecommunications services in the 850 MHz Band, no spectrum users shall exceed the maximum technical operating conditions and specifications identified in Table 8.

Table 8: Maximum Technical Operating Specifications for the 850 MHz Band³

Parameter	Constraint/Maximum Value	Comments
Maximum effective radiated power (ERP)	Base Station: 27 dBW Mobile Station: 8.45 dBW	Total power of all channels
Modulation scheme	Digital	Any digital modulation technique e.g. BPSK, QPSK
Out-of-Band Emissions Limits	-43 dBW	Attenuation (α) on max power (P) of emissions calculated using: $\alpha = 43 + 10 \log(P)$
Standardisation	N/A	FCC, Industry Canada, ETSI

Notwithstanding the parameters identified in Table 8, amended or additional technical operating conditions may be instituted. Such revisions shall be identified in the respective schedule of the licence document for the specific radiocommunications technology deployed.

³ These specifications were developed in accordance with the *Code of Federal Regulations*, Title 47, Part 22 (i.e., FCC Rules).

4.3 The 1900 MHz Band (1850-1910/1930-1990 MHz)

4.3.1 Selection of Frequency Assignment Plan

The 1900 MHz Band, called the personal communications services (PCS) block in North America, is used throughout the region for the provision of mobile voice and data services. The North American allocation comprises two sub-bands, the lower sub-band and the upper sub-band. The sub-bands are divided into six paired blocks, three 15 MHz blocks and three 5 MHz blocks.

Two predominant band plans exist globally for IMT — those of North America and of the European Union. Administrations worldwide develop band plans that either adhere completely to one of these plans or use a blend of both designations. North America has operated mobile telecommunications systems in the 800 MHz (824 – 849/869 – 894 MHz) and 1900 MHz (1850 – 1910/1930 – 1990 MHz) frequency bands, whereas counterpart systems in Europe operate in the 900 MHz (880 – 915/925 – 960 MHz) and 1800 MHz (1710 – 1785/1805 – 1880 MHz) bands.

It is challenging to blend the band plans from Europe and North America. Radio equipment designed for one market cannot inherently coexist in the same environment as those designed for another market, without threatening quality degradation and harmful interference. Consequently, a blend of band plans requires extraordinary steps to engineer adjacent systems generally resulting in inefficient use of spectrum. Therefore, the use of a single band plan is preferred.

Trinidad and Tobago belongs to ITU-R Region 2 and imports a significant portion of equipment from North America. It is generally advisable that Trinidad and Tobago adopts band plans that conform to North American markets to ensure equipment availability and, in particular, handset availability. Additional considerations include compatibility of international and regional cross-border systems such as mobile-satellite communications systems and the consideration of spectrum for AWS in the 1.7/ 2.1 GHz Band.

The predominant second generation mobile telecommunications technologies are CDMA, GSM, GPRS and EDGE. Third generation systems have generally been based upon WCDMA, such as UMTS and its data variants of HSPA.

The Authority also notes that this spectrum may be used in the future for 4G cellular mobile technologies such as LTE, as it has been designated as an operating band (i.e. Band 2) in the 3GPP Evolved Universal Terrestrial Radio Access (E-UTRA) technical specifications document (3GPP 2014). It is also noteworthy that LTE is band plan neutral, as its specification permits operation in all current band plans.

4.3.2 Frequency Assignment Plan

The Authority’s assignment plan for the 1900 MHz Band will be based on the North American PCS Band Plan, for the provision of public mobile telecommunications services as shown in Table 9.

This frequency assignment plan does not require the establishment of guard bands, as guard bands are established, if required, within the allotted spectrum blocks.

Table 9: Frequency Assignment Plan for 1900 MHz Band

Band	Frequency Range/MHz		
	Mobile Station Transmit	Base Station Transmit	Block Name
1900 MHz	1850 – 1865	1930 – 1945	A
	1865 – 1870	1945 – 1950	D
	1870 – 1875	1950 – 1955	B1
	1875 – 1880	1955 – 1960	B2
	1880 – 1885	1960 – 1965	B3
	1885 – 1890	1965 – 1970	E
	1890 – 1895	1970 – 1975	F
	1895 – 1910	1975 – 1990	C

4.3.3 Licensing Process and Conditions

The rules for licensing are as follows:

- i. A concession for the provision of a public domestic mobile telecommunications network and public telecommunications services is a prerequisite for the assignment of spectrum in the 1900 MHz band.
- ii. The licensing of spectrum in the 1900 MHz Band shall be for the provision of public mobile telecommunications services, on a national basis.
- iii. A cellular mobile spectrum licence shall be granted in order to assign spectrum in the 1900 MHz Band.

- iv. The allocated spectrum in the 1900 MHz Band shall be licensed in accordance with the frequency assignment plan shown in Table 9. The minimum assignment shall be 10 MHz (i.e., 2 x 5 MHz).
- v. The spectrum cap for the 1900 MHz band shall be 40 MHz (i.e. 2 x 20 MHz), which allows for up to three cellular mobile operators.
- vi. The assignment of spectrum, to new spectrum users or where there is a preference for specified spectrum blocks, shall be via a competitive licensing process, as determined by the Authority.
- vii. The assignment of spectrum to existing and eligible concessionaires, where there is no preference for specified spectrum blocks, shall be via an assignment process determined by the Authority.

4.3.4 Technical Operating Conditions and Specifications

To operate public mobile telecommunications services in the 1900 MHz band, spectrum users shall not exceed the maximum technical operating conditions and specifications identified in Table 10.

Table 10: Maximum Technical Operating Specifications for the 1900 MHz Band⁴

Parameter	Constraint/Maximum Value	Comments
Maximum effective radiated power (ERP)	Base Station: 27 dBW Mobile Station: 3 dBW	Total power of all channels
Modulation scheme	Digital	Any digital modulation technique e.g., BPSK, QPSK
Out-of-Band Emissions Limits	-43 dBW	Attenuation (α) on max power (P) of emissions calculated using: $\alpha = 43 + 10 \log (P)$
Standardisation	N/A	FCC, Industry Canada, ETSI

⁴ These specifications were developed in accordance with the *Code of Federal Regulations*, Title 47, Part 24 (i.e., FCC Rules).

Notwithstanding the parameters identified in Table 10, amended or additional technical operating conditions may be instituted. Revisions shall be identified in the respective schedule of the licence document for the specific radiocommunications technology deployed.

4.4 The 1.7/ 2.1 GHz Band (1710-1755/ 2110-2155 MHz)

4.4.1 Selection of Frequency Assignment Plan

Trinidad and Tobago complies with the ITU-R Region 2 frequency allocations and has elected to use the 850 MHz and 1900 MHz bands for the provision of public mobile telecommunications services. Consequently, the 1.7/ 2.1 GHz Band is available for consideration for public mobile telecommunications services.

The comparable European 1.9/2.1 GHz Band (i.e., 1920 – 1980 MHz and 2110 – 2170 MHz) is not compatible as the lower band overlaps with the 1900 MHz Band currently used by cellular mobile operators in Trinidad and Tobago.

The 1.7/ 2.1 GHz Band supports the implementation of different technologies, primarily UMTS (band 4, otherwise known as UMTS1700) and may also be used in the future for 4G cellular mobile technologies such as LTE. Band 4 has been designated as an operating band in the 3GPP Evolved Universal Terrestrial Radio Access (E-UTRA) technical specifications document (Release 12) (3GPP 2014).

The 1.7/ 2.1 GHz Band, i.e., the AWS band, is used throughout ITU-R Region 2 countries for the provision of mobile broadband services. The North American allocation is divided into six paired spectrum blocks, with each pair consisting of a lower and upper block, as shown in Figure 3.

The Report and Order issued by the FCC (2003) establishes rules to license the AWS Band in North America in the 1710 – 1755 and 2110 – 2155 MHz frequency range. This is in keeping with band 4 allocations of the 3GPP frequency allocations in Europe, Africa and Asia and the 1.9/2.1 GHz band, i.e., Band 1 of the 3GPP.

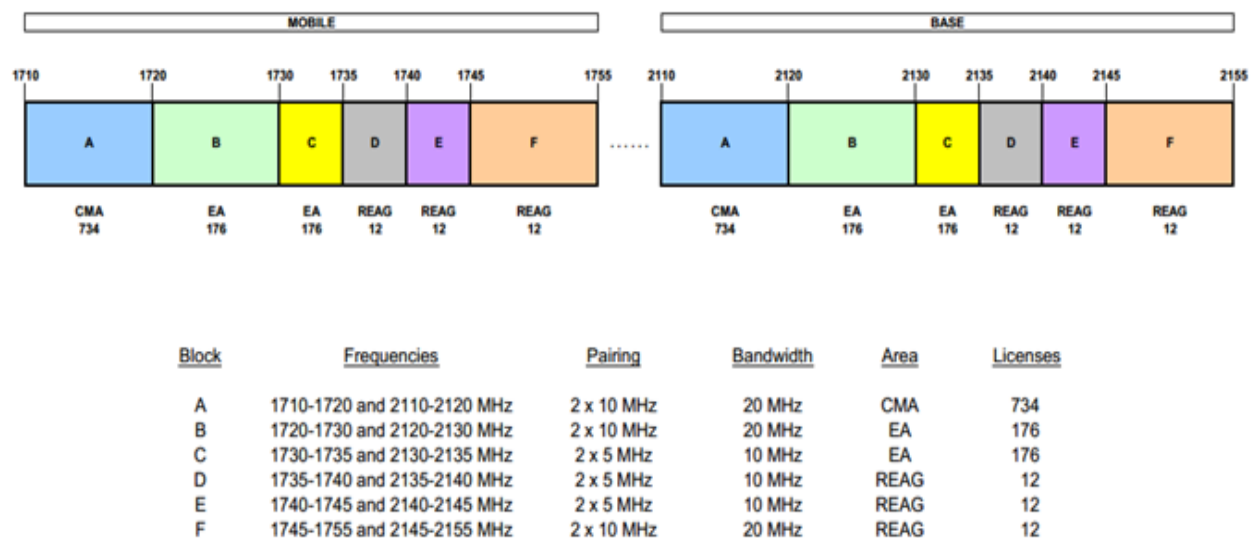


Figure 3: US AWS Assignment Plan (FCC 2009)

Trinidad and Tobago imports a significant portion of equipment from North America. This further supports the adoption of the frequency assignment plan that conforms to North American markets to ensure equipment availability and, in particular, handset availability. It should also be noted that many Latin American and some Caribbean countries have also adopted the AWS band.

The Authority considered the AWS band, within the IMT bands 1710 – 2025 MHz and 2110 – 2200 MHz, for allocation to PMTS for the following reasons:

- i. Available spectrum based on existing allocation of the 1900 MHz band in this spectrum plan
- ii. Conformance to the ITU-R Region 2 table of frequency allocation
- iii. Suitable spectrum for the deployment of LTE technology
- iv. Growing ecosystem of mobile handsets
- v. Preferred band for pairing with either the US 700 MHz or APT 700 MHz Band Plan

4.4.2 Frequency Assignment Plan

Nine paired 5 MHz spectrum blocks will be available for assignment. The frequency assignment plan in Table 11 is an adaptation of the AWS band plan, taking into consideration the assignment of spectrum to up to three cellular mobile operators.

This frequency assignment plan does not require the establishment of guard bands, as guard bands are established, if required, within the allotted spectrum blocks.

Table 11: Frequency Assignment Plan for the AWS Band

Band	Frequency Range/ MHz		
	Mobile Station Transmit	Base Station Transmit	Block Name
1.7/ 2.1 GHz	1710 – 1715	2110 – 2115	A
	1715 – 1720	2115 – 2120	B
	1720 – 1725	2120 – 2125	C
	1725 – 1730	2125 – 2130	D
	1730 – 1735	2130 – 2135	E
	1735 – 1740	2135 – 2140	F
	1740 – 1745	2140 – 2145	G
	1745 – 1750	2145 – 2150	H
	1750 – 1755	2150 – 2155	I

The Extended AWS Band (3GPP band 10), i.e. 1755 – 1770 MHz and 2155 – 2170 MHz will not be considered at this time. This band can be considered in the future when the network equipment and handset ecosystem become viable.

4.4.3 Licensing Process and Conditions

The rules for licensing are as follows:

- i. A concession for the provision of a public domestic mobile telecommunications network and public telecommunications services is a prerequisite for the assignment of spectrum in the 1.7/ 2.1 GHz Band.
- ii. The licensing of spectrum in the 1.7/ 2.1 GHz Band shall be for the provision of public mobile telecommunications services, on a national basis.

- iii. A cellular mobile spectrum licence shall be granted in order to assign spectrum in the 1.7/ 2.1 GHz Band.
- iv. The allocated spectrum in the 1.7/ 2.1 GHz Band shall be licensed in accordance with the frequency assignment plan shown in Table 11.
- v. The spectrum cap for the 1.7/ 2.1 GHz Band will be 30 MHz (i.e. 2 x 15 MHz) per cellular mobile operator, which allows for up to three cellular mobile operators.
- vi. Assignments to a maximum of three operators shall be made in this band as follows:
 - a. All spectrum blocks shall be made available for assignment.
 - b. All assignments to an operator shall be contiguous.
 - c. In the event that the assignment of spectrum to an operator is less than the spectrum cap, said operator shall have first preference to the remaining contiguous spectrum blocks, up to the spectrum cap.
 - d. In the event that spectrum remains unassigned pursuant to 4.4.14 (iii), such spectrum may be allocated for future use or assigned to another operator, as determined by the Authority.
- viii. The assignment of spectrum, to new spectrum users or where there is preference for specified spectrum blocks, shall be via a competitive licensing process, as determined by the Authority.
- ix. The assignment of spectrum to existing and eligible concessionaires, where there is no preference for specified spectrum blocks, shall be via an assignment process determined by the Authority.

4.4.4 Technical Operating Conditions and Specifications

To operate public mobile telecommunications services in the AWS Band, spectrum users shall not exceed the maximum technical operating conditions and specifications identified in Table 12.

Table 12: Maximum Technical Operating Specifications for the AWS Band⁵

Parameter	Constraint/Maximum Value	Comments
Base Station Maximum EIRP	32 dBW	
Mobile Station Maximum EIRP	0 dBW	
Out-of-Band Emission Limits	-43 dB for (P=1640 W or 32.148438 dBW)	The power of any emission outside the licensee's frequency block shall be attenuated below the transmitter power (P) by at least $43+10\log(P)$. Attenuation (α) on max power (P) of emissions calculated using: $\alpha = 43+10\log(P)$
Standardisation	N/A	FCC, Industry Canada

Notwithstanding the parameters identified in Table 12, amended or additional technical operating conditions may be instituted. Such revisions shall be identified in the respective schedule of the licence document for the specific radiocommunications technology deployed.

⁵ These specifications were developed in accordance with the *Code of Federal Regulations*, Title 47, Part 22 (i.e., FCC Rules).

References

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Annex I – Decisions on Recommendations Matrix for First Consultation Round

(...Matrix is attached separately...)

Annex II – Decisions on Recommendations Matrix for Second Consultation Round

(...Matrix is attached separately...)

Annex III — Adoption of the US 700 MHz Band Plan

In 2012, the Authority considered the US 700 MHz Band Plan for implementation in Trinidad and Tobago. Version 3.0 of this *Spectrum Plan for the Accommodation of Public Telecommunications Services* adopted the US Band Plan, namely, the 3GPP bands 13 and 17 (3GPP 2014). It should be noted, however, for the reasons outlined in Section 4.2.1 of this Spectrum Plan, that the APT 700 MHz Band Plan will now be utilised for the 700 MHz band, i.e., 3GPP Band 28 (3GPP 2014), for the provision of public domestic mobile telecommunications networks and services.

The reasons for the consideration of the US Band Plan at that time are outlined below:

- i. Overall, a vibrant North American market utilising the US 700 MHz Band Plan
- ii. Network equipment readily available for the US band plan based on the mature North American market
- iii. A growing handset ecosystem with over 138 devices (GSA 2012)
- iv. Lack of availability of devices at that time for the competing Asian-Pacific Territories (APT) 700 MHz Band Plan
- v. No network deployments at that time that used 700 MHz spectrum in accordance with the APT 700 MHz Band Plan
- vi. Adoption of the US 700 MHz Band Plan allowing for LTE data roaming with North America
- vii. Discussions amongst other Caribbean countries for the adoption of the US 700 MHz Band Plan

Additionally, the US 700 MHz Band Plan was expanded to allow up to three operators and a PPDR allotment, based on:

- i. the FCC's Order 11-188 (FCC 2011), which awarded Blocks D and E to AT&T.
- ii. the FCC's Order 13-136 (FCC 2013), which mandates lower 700 MHz interoperability, the 698 – 704 MHz (Block A), Blocks 716 – 722 MHz (Block D), 722 – 728 MHz (Block E) and 728 – 734 MHz (Block A').

- iii. developments in the network and handset ecosystem to support the above blocks.

Block A can be paired with Block A' to allow 2 x 6 MHz for LTE network deployment, but Blocks D and E are unpaired. Through LTE carrier aggregation, Blocks D and E can be paired with AWS spectrum, i.e., the 1.7/ 2.1 GHz Band, to increase its downlink capacity.