Refarming Plan for Broadband Wireless Access Services in the 2.3 GHz, 2.5 GHz and 3.5 GHz Bands

Maintenance History		
Date	**Change Details**	**Version**
12-02-08	First Draft	0.1
17-04-08	Consultative Document for public consultation	0.2
19-08-08	Final Draft: Modifications made as a result of comments and recommendations made during the consultation stage.	0.3
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1 Introduction

Background

The National Information and Communications Technology (NICT) Strategy (***fastforward*** strategy) of the Government of Republic of Trinidad and Tobago (GoRTT) is founded on the concept that information is critical to knowledge which in turn is crucial to the growth and development of the country. This Strategy provides the blueprint for a self-sustaining, knowledge-based society and will be a major contributor in the country's drive for a prominent position in the global information society, and providing Trinidad and Tobago with a giant stride towards developed country status.

The ***fastforward*** strategy describes many 'pathfinder' projects which will allow Trinidad and Tobago to realize this NICT vision. One such project is the development of a Broadband Strategy which will aid in achieving the national connectivity agenda, and accomplish the following:

- Provide all citizens with affordable Internet access;
- Focus on the development of skills for adults and children to ensure a sustainable solution and a vibrant future;
- Promote citizen trust, access, and interaction through good governance; and
- Maximize the potential within all citizens, and accelerate innovation, to develop a knowledge-based society.

GoRTT has also outlined the broad objective of its Broadband Strategy as the creation of a business environment that is conducive to the proliferation of market-led initiatives that are enabled through a robust regulatory regime, as well as by Government's direct or indirect participation, if required, to provide the necessary impetus for the roll out of broadband services in the country.

There are three (3) broad elements to GoRTT's proposed strategy:

1) Stimulating the provision of high speed access to the general public. This aspect of the proposed strategy aims at bringing about broadband connectivity throughout the country by a variety of means. GoRTT believes that the successful execution of this strategy demands a review of two (2) characteristics that currently limit a wider dispersion:
    a. the technical implementation of broadband to the home/customer premises; and
    b. the cost of provision, and associated retail rates.

2) Stimulating the provision of high speed connectivity and access by the public service. GoRTT is of the view that, in order to realize the goal of using e-government tools to increase performance and efficiency, Government and the Public Service need the foundation of connected high speed ICT infrastructure. Therefore, this element of the GoRTT's proposed strategy seeks to put this infrastructure in place.

3) Stimulating the provision of high speed connectivity and access to support the development/evolution of the local ICT sector. GoRTT is convinced that the ICT sector can become a pillar of the domestic economy. Indeed, in countries throughout the world, developed ICT sectors have formed essential elements in establishing and maintaining those countries' economic foundations. GoRTT believes that if Trinidad and Tobago were to duplicate this outcome, the necessary high speed, cost-effective connectivity must be provided. This element of the proposed strategy seeks to provide such connectivity.

In keeping with the ***fastforward*** initiatives and vision, the Telecommunications Authority of Trinidad and Tobago (hereafter called the Authority) has embarked on the liberalization of the telecommunications sector which will serve to facilitate

telecommunications infrastructure growth essential for accessing information and the provision of communications services.

In the spirit of the broadband strategy of GoRTT and facilitating telecommunications infrastructure growth, the Authority published a Spectrum Plan for the Accommodation of Broadband Wireless Access (BWA) Services (hereafter called, "the Spectrum Plan") in January 2007. This Spectrum Plan contained the bands which interest was expressed for the provision of BWA services. Pursuant to this Spectrum Plan, an authorisation process was initiated to licence spectrum in the bands that were readily available for licensing (i.e. the Lower 700 MHz, 2.4 GHz, 5 GHz, 12 GHz and 28 GHz bands). BWA radiocommunication equipment in the 2.4 GHz and 5 GHz bands were class licensed under the Authority's Class Licence Regime. Spectrum in the Lower 700 MHz, 12 GHz and 28 GHz were licensed via a competitive process that comprised a pre-qualification stage followed by an auction.

Pursuant to the Spectrum Plan as well, the 2.3 GHz band (i.e. 2300 MHz – 2360 MHz), 2.5 GHz band (i.e. 2500 MHz – 2690 MHz) and 3.5 GHz band (i.e. 3400 MHz – 3800 MHz) were placed under moratorium for licensing to new spectrum users for 12 months, in order to investigate the availability of spectrum for new spectrum users, which will also include the rationalization of the current spectrum usage by existing spectrum users, in accordance with the goals and objectives of the Spectrum Plan. This investigation was conducted via a process that included the following steps:

1. Interview existing spectrum users with respect to the use of spectrum in the respective bands under moratorium;
2. Research the optimum use of the spectrum in the bands under moratorium, in particular, the typical quantum of spectrum that is assigned to a spectrum user;
3. Make a preliminary determination based on an assessment of the information gathered;
4. Consult with the existing spectrum users on the preliminary determination.
5. Make a final determination on the investigation of the availability of spectrum for new spectrum users.

This reframing plan includes the result of the investigation that was conducted on the availability of spectrum for new spectrum users in the 2.3 GHz, 2.5 GHz and 3.5 GHz bands for the provision of BWA services. Also, this reframing plan assesses the current uses of these bands by existing spectrum users with the intention of aligning the current uses to the goal and objectives of the Spectrum Plan and ultimately the broadband strategy outlined by GoRTT. The recommendations made in this reframing plan will address the following:

1. The terms and conditions for the use of this spectrum by existing spectrum users; and
2. The availability of spectrum for new spectrum users and the authorisation process for licensing and the provision of public BWA services.

Objectives

The objectives of this reframing plan are to:

1. Make a determination on the availability of spectrum for new spectrum users in the 2.3 GHz, 2.5 GHz and 3.5 GHz bands;
2. Identify the terms and conditions which will govern the use of the 2.3 GHz, 2.5 GHz and 3.5 GHz bands for the provision of BWA services; and
3. Indicate the authorization process to be implemented for spectrum that can be licensed to new spectrum users.

Regulatory Framework

The reframing plan is guided by the following sections of the Telecommunications Act 2001, as amended in 2004:

1. Section 3 (f): promoting the telecommunications industry in Trinidad and Tobago by encouraging investment in, and the use of, infrastructure to provide telecommunications services;

2. Section 3 (c) (i) : promoting and protecting the interests of the public by promoting access to telecommunications services;
3. Section 40 (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;

Other Relevant Documents

The following documents previously published by the Authority are of relevance with respect to the context of this document:

1. Spectrum Plan for the Accommodation of Broadband Wireless Access Services.
2. Final Draft of the Spectrum Management Policy.

The Consultation Process

In April 2008, the Authority sought the views and opinions of the general public and key stakeholders regarding the proposals made in the first draft of this document in accordance with the Authority's *Procedures for Consultations in the Telecommunications Sector of Trinidad and Tobago*. The consultation took place over a period of four (4) weeks.

A Decisions on Recommendations (DOR) matrix (Annex A) was developed which summarizes the Authority's response to all of the comments and recommendations received from the consultation. This final document takes into consideration the feedback received from this consultation.

2 Assessment of BWA Technologies in 2.3 GHz, 2.5 GHz and 3.5 GHz bands

The Spectrum Plan for the Accommodation of BWA Services identified BWA technologies that have been deployed in the 2.3 GHz, 2.5 GHz and 3.5 GHz bands, such as Multipoint Multi-channel Distribution Service (MMDS) in the 2.5 GHz band Wireless DSL technology in the 2.3 GHz, 2.5 GHz and 3.5 GHz bands and other pre-WiMAX technology in the 2.3 GHz and 3.5 GHz bands. Today, with the fixed WiMAX[1] standard (IEEE 802.16d standard) established and the further amendment to Mobile WiMAX (IEEE 802.16e standard established in December 2005), WiMAX technology is advertised as the technology of choice for the provision of BWA services in the 2.3 GHz, 2.5 GHz and 3.5 GHz bands. In the first quarter of 2007, WiMAX deployment was evident in 36 countries[2] by 103 Operators.

Some key technical parameters of the WiMAX standard (i.e. IEEE 802.16, as amended by IEEE 802.16e), have been collated in the Table 1[3] below:

Table 1: Key Technical Parameters of the WiMAX Standard

Frequency Range of Operation	Below 6 GHz.
Nominal RF Channel Bandwidth	Flexible from 1.25 MHz up to 28 MHz. Typical bandwidths are: 3.5, 7 MHz (IEEE 802.16d); 5, 8.75, 10 and 20 MHz (IEEE 802.16e)
Peak Channel Transmission Rate per 5 MHz Channel Bandwidth	Up to 17.5 Mbit/s with Single Input Single Output (SISO). Up to 35 Mbit/s with (2 × 2) Multiple Input Multiple Output (MIMO). Up to 70 Mbit/s with (4 × 4) MIMO.
Spectral Efficiency	Up to 3.5 bits/s/Hz in SISO configuration
Frequency Re-use Factor	1
Duplex Method	Frequency Division Duplexing (FDD) [Fixed WiMAX] Time Division Duplexing (TDD) [Fixed and Mobile WiMAX]

[1] WiMAX, which is the acronym for Wireless Interoperability of Microwave Access, was coined to describe interoperable technologies that conform to the IEEE 802.16 standard.
[2] MARAVEDIS, WiMAX Counts Quarterly Newsletter, WiMAX Operator Tracking and Analysis Service, June 2007, Issue 1.
[3] The information source for this Table was: International Telecommunications Union – Radiocommunication Bureau, ITU-R Recommendation M.1801;

Multiple Access Method	Time Division Multiple Access (TDMA) Orthogonal Frequency Division Multiple Access (OFDMA) Scalable OFDMA (SOFDMA)
Mobility Capabilities (Fixed/Nomadic/Mobile)	Fixed, Nomadic (IEEE 802.16d, IEEE 802.16e) Mobile (IEEE 802.16e)
Range	Up to 30 km (Line-of-Sight) (IEEE 802.16d) Up to 10 km (Non Line-of-Sight) (IEEE 802.16e)

The more prominent public telecommunications service offered in a WiMAX deployment is broadband Internet Access. However, with the identification of Mobile WiMAX as a specification under the IMT family of air interface specifications in September 2007, WiMAX may be poised to compete against 3G technologies such as Code Division Multiple Access 2000 (CDMA 2000) and Universal Mobile Telecommunications Services (UMTS) in the cellular mobile (telephony) market.

Countries around the world are making spectrum available in the 2.3 GHz, 2.5 GHz and 3.5 GHz bands for the allocation and auction of spectrum for the provision of BWA services via WiMAX applications. The favoured duplex mode of operation is TDD, which is standard in the 2.3 GHz and 2.5 GHz bands. Both FDD and TDD duplex modes of operation exist in the 3.5 GHz band, with the FDD duplex mode being more prominent as the frequency assignment plans in the 3.5 GHz band has evolved from FDD fixed wireless access systems.

Auctions have taken place in some countries and are being planned in others, in order to licence spectrum users who are interested in utilizing WiMAX as an alternative last mile solution (i.e. namely, for BWA services) or even as competitors to cellular mobile operators in the mobile Internet access market segment. The Table 2[4] below summarizes a sample of countries around the world that have licensed, or will be licensing, spectrum users in the 2.3 GHz, 2.5 GHz and 3.5 GHz bands for the provision of BWA services via WiMAX applications.

[4] Sources for this Table came from the following:
- Public Utilities Commission of Anguilla, WiMAX Review and Report
- www.wimaxday.net

Table 2: Sample Countries that have licensed or will be licensing spectrum users to provide BWA Services via WiMAX Technologies

Country	Spectrum Users Licensed for WiMAX applications?	Frequency Band / GHz	Minimum Spectrum Block Size MHz	Maximum Quantum of Spectrum per Licensee
Antigua and Barbuda	Yes	3.5	25	50 MHz (TDD); 2 x 25 MHz (FDD)
ECTEL Countries	Yes	2.5; 3.5	5	50 MHz (TDD); 2 x 25 MHz (FDD)
Jamaica	Yes	3.5	5	2 x 25 MHz (FDD)
United States of America	Yes	2.5	5.5	Unlimited
Canada	Yes	2.3; 3.5	25	Unlimited
United Kingdom	Yes	2.5	5	Unlimited
Sweden	Yes	3.5	5	40 MHz (TDD); 2 x 20 MHz (FDD)
Switzerland	Yes	3.5	2 x 7	2 x 7 MHz (FDD)
New Zealand	Yes	2.3; 2.5; 3.5	5	40 MHz
Uganda	Yes	3.5	3.5	28 MHz (TDD); 14 MHz (FDD)
Hong Kong	Yes	3.5	28	28 MHz (TDD)
	Q4 2008	2.3	5	30 MHz (TDD)
Taiwan	Yes	2.5	30	30 MHz (TDD)
Bahrain	Yes	3.5	2 x 45	2 x 45 MHz (FDD)

In summary, the spectrum planning and subsequent frequency allocation for the 2.3 GHz, 2.5 GHz and 3.5 GHz bands are based on the prominent BWA technology, WiMAX. The minimum spectrum block size compares with the typical WiMAX channel bandwidth of 5 MHz. Also, the maximum quantum of spectrum per Licensee typically ranges between 30 – 50 MHz.

3 Assessment of Current Spectrum Usage in the 2.3 GHz, 2.5 GHz and 3.5 GHz Bands in Trinidad and Tobago

In order to ascertain the current spectrum usage in the 2.3 GHz, 2.5 GHz and 3.5 GHz bands, the existing spectrum users were interviewed. The intention of the interview was to gather the following information:

1. Verification of frequency band(s) of operation and the quantum of radio frequency spectrum assigned and in use.
2. Explanation of the nature of current business operations with regard to the use of this spectrum.
3. Explanation of the technical details of the radiocommunications system deployed using this spectrum, inclusive of technologies employed and coverage area.
4. Explanation of future plans for the use of this spectrum.

A summary of results based on the interviews held was tabulated in Table 3 in order to assess the general use of these frequency bands.

Table 3: Summary of Results for Current Spectrum Usage on the 2.3 GHz, 2.5 GHz and 3.5 GHz Bands

Frequency Band	BWA Technologies Employed	No. of Spectrum Users in Frequency Band	Total Spectrum Used by Existing Users	Total Spectrum Currently Available	Telecommunications Services Provided	Remarks
2.3 GHz (i.e. 2300 – 2360 MHz)	Pre-WiMAX, MMDS	2	34 MHz	26 MHz	WAN / VPN[5] services; private WAN / VPN; and Corporate Internet Access.	The spectrum is use mainly to provide services to business consumers or for the purpose of establishing private WAN / VPN connectivity.
2.5 GHz (i.e. 2500 – 2690 MHz)	Pre-WiMAX, MMDS	3	190 MHz	No spectrum available	WAN / VPN services; private WAN / VPN; and Corporate Internet Access.	The spectrum is use mainly to provide services to business consumers or for the purpose of establishing private WAN / VPN connectivity.
3.5 GHz (i.e. 3400 – 3600 MHz and 3600 – 3800 MHz)	Pre-WiMAX, WiMAX	4 (i.e. 2 users in the 3400 – 3600 MHz and 2 users in the 3600 – 3800 MHz)	341 MHz (i.e. 200 MHz in the 3400 – 3600 MHz and 141 MHz in the 3600 – 3800 MHz)	69 MHz* (12 MHz Effective) (only in the 3600 – 3800 MHz.)	WAN / VPN services; private WAN / VPN; and Corporate Internet Access; and Residential Internet Access	The spectrum is use mainly to provide services to business consumers or for the purpose of establishing private WAN / VPN connectivity. However, there is some limited service provisioning to residential consumers. * Note that 57 MHz will not be available for public BWA services and the primary use for this spectrum is Fixed Satellite Services

Total quantum of spectrum allocated in the 2.3 GHz band – 60 MHz

Total quantum of spectrum allocated in the 2.5 GHz band – 190 MHz

Total quantum of spectrum allocated in the 3.5 GHz band – 400 MHz

[5] WAN is the acronym for Wide Area Network and VPN is the acronym for Virtual Private Network

In general, the Table above suggests that the 2.3 GHz, 2.5 GHz and 3.5 GHz bands are primarily used for the provision of services to Business customers by way of closed-user group services such as WAN / VPN connectivity, including the offering of public telecommunications services such as wireless Internet access services, or private WAN / VPN connectivity for the spectrum user itself. The incumbent BWA technology employed is based on pre-WiMAX specifications, with the frequency assignments were made based on the following specifications:

- 6 MHz channel bandwidth;
- 1 – 4 Mbps Capacity per 6 MHz channel;
- FDD duplex mode; and
- 100 MHz Tx / Rx (duplex) spacing.

There are also some existing spectrum users with network deployments that use WiMAX technology. The existing spectrum users in these bands possess frequency assignments ranging from as little as 12 MHz of spectrum (i.e. 2 x 6 MHz) to as much as 100 MHz (i.e. 2 x 50 MHz).

In addition to the tabulated information, the coverage area information supplied by the existing spectrum users, on average, was localized in Trinidad and Tobago where the business consumer market segments were located.

4 Decisions of Refarming Plan

Based on the assessment of the BWA technologies operating in the 2.3 GHz, 2.5 GHz and 3.5 GHz bands, WiMAX is the prominent technology deployed in these bands and the frequency planning conducted for the assignment to spectrum users favour WiMAX applications. Also, the typical range to the quantum of spectrum assigned to an individual spectrum user is 30 – 50 MHz, based on the sample countries assessed in Table 2.

Based on the assessment of current spectrum usage in the 2.3 GHz, 2.5 GHz and 3.5 GHz bands in Trinidad and Tobago, there is insufficient spectrum that can be assigned to new spectrum users for the provision of BWA services. Considering the quantum of spectrum utilized by the existing spectrum users in Trinidad and Tobago and the number of existing spectrum users per band, spectrum can be made available to new spectrum users by placing a limit to the quantum of spectrum assigned to an individual spectrum user, similar to the limit employed by other countries.

The following decisions seek to further the GoRTT broadband strategy and also realize the availability of spectrum for assignment to new spectrum users in the 2.3 GHz, 2.5 GHz and 3.5 GHz bands:

1. Consistent with the Spectrum Plan, these bands shall be used for the provision of public BWA services. The provision of public BWA services will require a public domestic fixed network and public telecommunications services concession, and the relevant spectrum licence.

2. An existing spectrum user shall apply within six (6) weeks after the approval of this reframing plan for the appropriate concession and related BWA spectrum licence to provide public BWA services.

3. In consideration of the business model presently employed by the existing spectrum users in these bands, permission shall also be granted for the provision of closed user group or private BWA services additionally, provided that Decision 4 is satisfied.

4. In the interest of furthering the deployment of telecommunications infrastructure for the provision of public BWA services, in particular broadband Internet access, and to maximize the coverage of and access to public BWA services the Authority and each existing spectrum user shall meet with the Authority to finalize a network rollout plan to achieve coverage of **85%** of the populated area of each of Trinidad and Tobago in **three (3) years**. This network rollout obligation shall be submitted along with the concession application and this obligation will be approved in accordance with the procedures outlined in Appendix I.

5. In accordance with the frequency assignment principles of the Spectrum Plan, the frequency assignment plan for these bands shall be based on the prominent assignment plan utilized for BWA services in the particular frequency band.

6. All existing spectrum users shall adhere to the frequency assignments plans and the technical operating conditions and specification attached in Appendix II of the Refarming Plan.

7. The Spectrum Plan shall be revised to include the frequency assignment plans and the technical operating conditions and specifications attached in Appendix II of the Refarming Plan and also identify the spectrum that will be available for authorization to new spectrum users.

8. Both existing and new spectrum users in these bands shall conform to the terms and conditions for the use of these bands as defined in Appendix III.

9. A Spectrum Cap shall be instituted in each band in order to limit the quantum of spectrum assigned to an individual spectrum user. Considering that these three (3)

bands are being planned to accommodate WiMAX, there shall also be a Spectrum Cap on the quantum of spectrum an individual spectrum user can have across all three (3) bands. These Spectrum Caps are defined in Appendix III.

10. An existing spectrum user who is currently assigned more than the Spectrum Cap in these bands will be required to:
    (i) Identify the frequency assignment it wishes to maintain, in accordance with the Frequency Assignment Plan, subject to the approval of the Authority; and
    (ii) Surrender any spectrum in excess of the Spectrum Cap to the Authority within a period as determined by the Authority in consultation with the respective existing BWA spectrum user; such period being no greater than one (1) year subsequent to the grant of the necessary licence for the approved frequency assignment.

11. Spectrum that is made available via reclamation, in addition to the spectrum currently available, shall be authorised via a competitive licensing process to both new spectrum users and existing spectrum users who have not exceeded the Spectrum Caps.

12. The spectrum usage (i.e. per MHz pair) fee deduced from the competitive licensing process for the 2.3 GHz, 2.5 GHz and 3.5 GHz bands shall supersede the spectrum usage fee identified for the provision of BWA services in the present Telecommunications (Fee) Regulations, 2006 (i.e. TT $4,000.00 per MHz pair). Hence, all existing spectrum users will be required to pay a new annual licence fee consistent with the new spectrum usage fee deduced from the competitive licensing process.

Appendix I – Outlined Procedures for the Determination of Network Rollout Plan

The following steps outline the procedure for the determination of a network rollout plan to achieve coverage of **85%** of the populated area of each of Trinidad and Tobago over three (3) years:

1. The existing spectrum user shall include in its concession application the following:
    a. A topographical map illustrating its present coverage area; and
    b. A proposed rollout plan and topographical map(s) illustrating coverage of 85% of the populated area of Trinidad and 90% of the populated area of Tobago at the end of three (3) years, including the progressive increase in the present coverage area annually, over the three (3) year rollout period.

2. The Authority shall review all present and proposed coverage maps and rollout plans submitted by all existing spectrum users before the grant of concession and associated licences, with the intention of maximizing the coverage of and access to public BWA services.

3. Before the grant of concession and associated licences, the Authority shall invite each existing spectrum user to a meeting in order to discuss and finalize its proposed rollout plan and coverage map(s) submitted as per Step 1(b), inclusive of any adjustments proposed by the Authority.

4. The Authority shall include the finalized rollout plan and coverage map of each existing spectrum user as an obligation under its concession.

Appendix II – Frequency Assignment Plans

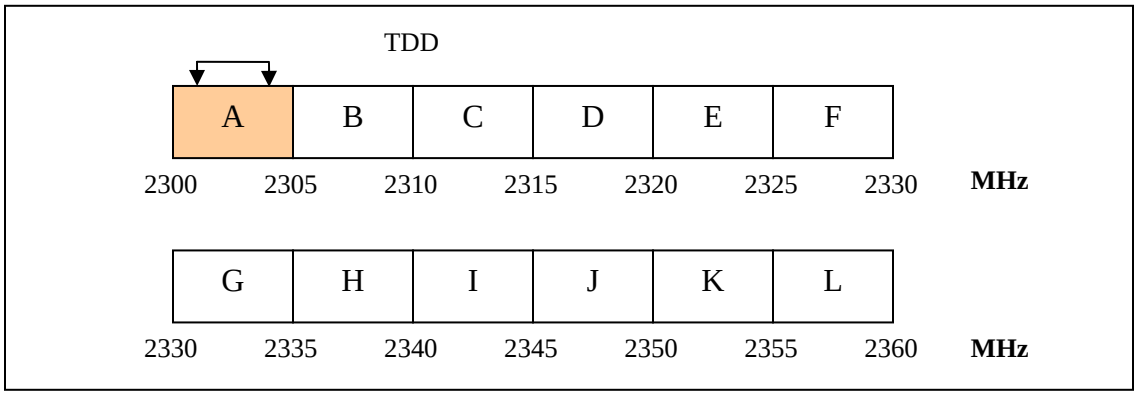
2.3 GHz Band: 2300 MHz – 2360 MHz

Frequency Assignment Plan

7.3.1 In accordance with the frequency assignment principles of the Spectrum Plan, the frequency assignment plan for these bands shall be based on the prominent assignment plan utilized for BWA services in these bands.

7.3.2 The frequency assignment plan that shall be adopted for BWA radiocommunications systems in the 2.3 GHz band is illustrated in Figure 1 below.

Figure 1: Frequency Assignment Plan for BWA Radiocommunication Systems in the 2.3 GHz Band



7.3.3 The frequency range is divided into twelve (12) spectrum blocks of 5 MHz each. Considering that the total quantum of spectrum in this band is 60 MHz, there is not sufficient Tx/Rx (duplex) spacing to accommodate FDD duplex mode of operation. Also, the typical allocation of spectrum for WiMAX in this band is in TDD duplex mode. Therefore, the duplex mode of operation of WiMAX in the 2.3 GHz band shall be limited to TDD.

7.3.4 The Spectrum Cap for the 2.3 GHz band shall be 30 MHz (i.e. six (6) spectrum blocks).

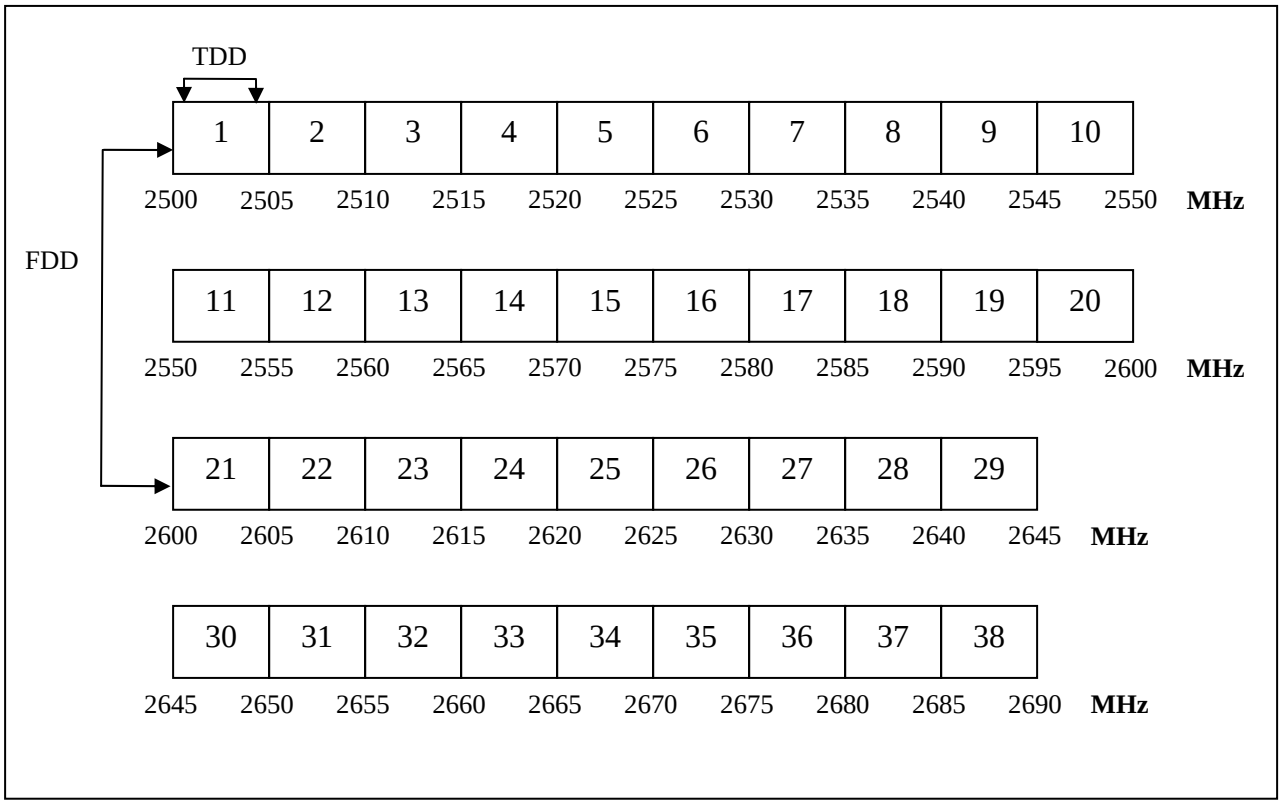
2.5 GHz Band: 2500 MHz – 2690 MHz

Frequency Assignment Plan

7.4.1 In accordance with the frequency assignment principles of the Spectrum Plan, the frequency assignment plan for these bands shall be based on the prominent assignment plan utilized for BWA services in these bands.

7.4.2 The frequency assignment plan that shall be adopted for BWA radiocommunications systems in the 2.5 GHz band is illustrated in Figure 2 below.

Figure 2: Frequency Assignment Plan for BWA Radiocommunications Systems in the 2.5 GHz Band



7.4.3 The frequency range is divided in thirty-eight (38) spectrum blocks of 5 MHz each (i.e. blocks 1, 2, 3 to 38).

7.4.4 This assignment plan allows the assignment of blocks to facilitate both FDD and TDD duplex mode of operation within this band. The accommodation of a FDD duplex mode will facilitate the incumbent spectrum users as the standard duplex mode of operation for the prominent BWA technologies in this band is TDD. It is anticipated that the incumbent spectrum users in this band will also upgrade to BWA systems that employ a TDD duplex mode of operation.

7.4.5 FDD operation will maintain a duplex spacing (i.e. Tx/Rx spacing) of 100 MHz (e.g. Block 1 paired with Block 21).

7.4.6 Considering that the minimum spectrum block is 5 MHz, a guard band of one (1) spectrum block (i.e. 5 MHz) shall be established by the Authority between adjacent spectrum blocks, which duplex modes of operation are FDD-to-TDD or TDD-to-FDD. This guard band shall be identified before the licence of spectrum in this band to a spectrum user wishing to employ a TDD duplex mode.

7.4.7 The Authority shall not establish a guard band between adjacent spectrum blocks, which duplex modes of operation are FDD to FDD or TDD to TDD. The licensees of such spectrum blocks will be required to operate in a manner that does not cause harmful interference to adjacent spectrum users.

7.4.8 The Spectrum Cap for the 2.5 GHz band shall be 50 MHz (i.e. equivalent to ten (10) spectrum blocks or five (5) paired spectrum blocks of 5 MHz each).

3.5 GHz Band: 3400 MHz – 3800 MHz

Frequency Assignment Plan

7.5.1 In accordance with the frequency assignment principles of the Spectrum Plan, the frequency assignment plan for these bands shall be based on the prominent assignment plan utilized for BWA services in these bands.

7.5.2 The frequency range 3300 – 3400 MHz is allocated on a primary basis to the Radiolocation Service and on a secondary basis to the Amateur Service, in accordance with the Trinidad and Tobago Frequency Allocation Table. Further to this, the ITU-R Region 2 Table of Frequency Allocation allocates this frequency range to Fixed Service on a secondary basis as well. BWA radiocommunication equipment is categorized under Fixed Service. Consequently the provision of BWA services shall not claim protection from harmful interference from radiocommunication equipment in the Radiolocation Service. Considering this, the frequency range 3300 – 3400 MHz will not be considered for the provision of BWA services.

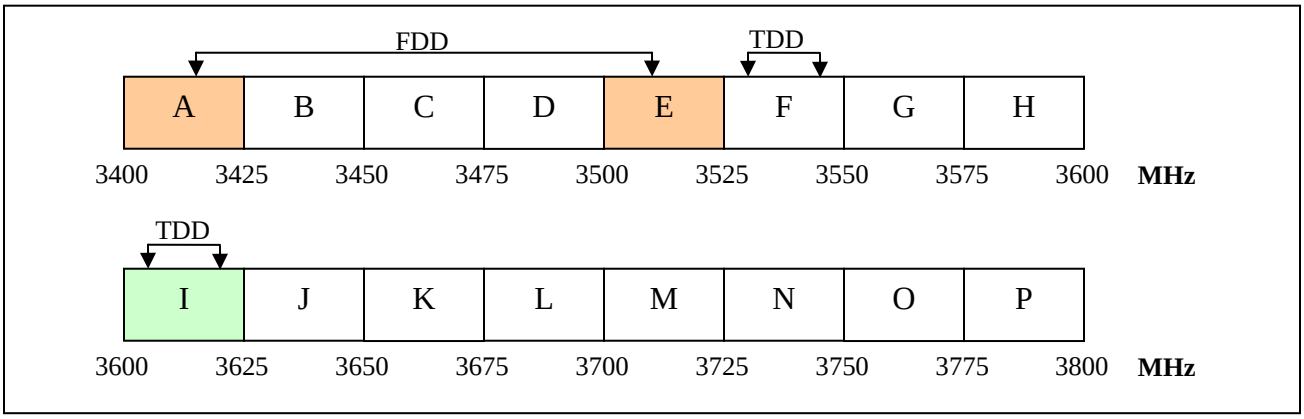
7.5.3 Consideration shall be given to Fixed Satellite Service which currently exist on a co-primary basis with Fixed Service in the frequency range 3400 – 3800 MHz, in accordance with the Trinidad and Tobago Frequency Allocation Table, as follows:

a) 3400 – 3700 MHz – The Fixed Service shall remain as primary but the Fixed Satellite Service shall operate on a secondary basis. This implies that BWA services shall be protected from harmful interference from radiocommunications equipment in the Fixed Satellite Service.

b) 3700 – 3800 MHz – The Fixed Satellite Service shall remain as primary but the Fixed Service shall operate on a secondary basis. This implies that BWA services shall not be protected from harmful interference caused by radiocommunication equipment in the Fixed Satellite Service.

7.5.4 The frequency assignment plan that shall be adopted for BWA radiocommunications systems in the 3.5 GHz band is illustrated in Figure 3 below.

Figure 3: Frequency Assignment Plan for BWA Radiocommunication Systems in the 3.5 GHz Band



7.5.5 The frequency range 3400 – 3600 MHz is divided in eight (8) spectrum blocks of 25 MHz each. This spectrum block size was chosen in order to accommodate the typical channel bandwidths in this band, namely 3.5 MHz, 5 MHz of 7 MHz. This arrangement allows the assignment of blocks to facilitate both TDD and FDD duplex mode of operation within this band.

7.5.6 FDD operation in the frequency range 3400 – 3600 MHz shall maintain a duplex spacing (i.e. Tx/Rx spacing) of 100 MHz (e.g. – Block A paired with Block E).

7.5.7 Considering that the minimum spectrum block is 25 MHz, the Authority shall not establish a guard band between adjacent spectrum blocks, which duplex modes of operation are FDD-to-FDD, TDD-to-TDD, FDD-to-TDD or TDD-to-FDD. The licensees of such spectrum blocks will be required to operate in a manner that does not cause harmful interference to adjacent spectrum users, via the establishment of any necessary in-band guard bands or adjacent spectrum user coordination.

7.5.8 The frequency range 3600 – 3800 MHz is divided in eight (8) spectrum blocks of 25 MHz each. Considering part 7.5.3 (b), the provision of public BWA services shall be restricted to the frequency range 3600 – 3700 MHz.

7.5.9 New and existing spectrum users shall be encouraged to operate in a TDD or FDD duplex mode for the provision of public BWA services, within the frequency range 3600 – 3700 MHz. FDD operation in this frequency range shall maintain a duplex spacing (i.e. Tx/Rx spacing) of less or equal to 50 MHz (e.g. – Block I paired with Block K).

7.5.10 Consideration shall be given to existing spectrum users who currently operate in a FDD duplex mode in the frequency range 3600 – 3800 MHz, subject to the conditions in part 7.5.3.

7.5.11 The Spectrum Cap for the 3.5 GHz band shall be 50 MHz (i.e. equivalent to two (2) paired spectrum blocks of 25 MHz each)

Appendix III – Terms and Conditions

The terms and conditions for the use of the 2.3 GHz, 2.5 GHz and 3.5 GHz bands for the provision of public BWA services are as follows:

(i) These bands shall be used for the provision of public BWA services, on a national basis.

(ii) The Licensee shall achieve coverage of **85%** of the populated area of each of Trinidad and Tobago in **three (3) years** subsequent to the grant of necessary concession. This coverage shall include underserved areas as determined by the Authority.

(iii) The Licensee shall adhere to the following Spectrum Caps which have been identified for these bands in the Spectrum Plan for the Accommodation of Broadband Wireless Access Services, as revised by the Authority:

- 2.3 GHz band – 30 MHz (i.e. 6 x 5 MHz);
- 2.5 GHz band – 50 MHz (i.e. 10 x 5 MHz); and
- 3.5 GHz band – 50 MHz (i.e. 2 x 25 MHz).

(iv) The Licensee who is assigned spectrum blocks in two (2) or more of these bands shall not exceed a total Spectrum Cap of 50 MHz.

Annex I – Decision on Recommendations Matrix

The following summarises the comments and recommendations received from stakeholders on the first consultative version of this document (dated April 2008), and the decisions made by TATT as incorporated in this revised document (dated August 2008).

Document Sub-Section	Submission Made By: Stakeholder Category[6]	Comments Received	Recommendations Made	TATT's Decisions
Section 1				
Background	Digicel (Trinidad and Tobago) Limited	The word 'and' appears inappropriately after "promote citizen trust, access and interaction though good governance; and"	Delete 'and' at the end of that point.	(Editorial Committee to respond)
Section 2				
	Digicel (Trinidad and Tobago) Limited	Digicel would like to state that there is a greater allocation of spectrum for FDD use when compared to TDD. TDD duplex mode may be preferred for a nationwide domestic offering which predominantly requires asymmetric transmission. FDD favours a corporate consumer offering. TDD supports fixed and mobile WiMax while FDD supports fixed WiMax. In keeping with the point made on Page 5 of this BWA consultation document, one important focus of the government is to ensure "…the technical implementation of broadband to the home/customer premises…"	Notwithstanding the explanations within the document, Digicel would like the Authority to reconsider its allocation of spectrum between FDD and TDD modes and increase the allocation of TDD primarily in the 2.5GHz band. This will enable greater flexibility in deploying a future domestic offering.	Comments and recommendations are noted. Only FDD mode was allowed in the 2.5 GHz band based on operation of existing BWA spectrum users. However, in order to maintain a technology neutral approach to licensing, both FDD and TDD modes will be accommodated for WiMAX and other BWA technologies in the 2.5 GHz band.

[6] Regional regulatory or Governmental agencies, Existing service and/ or network provider and affiliates, Potential service and/ or network providers and affiliates, Service/ Network Provider Associations/ Clubs/ Groups, General Public

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		Digicel believes that TDD is more suited for Broadband applications to home/customer premises.		
Section 3				
	Digicel (Trinidad and Tobago) Limited	The following section of text contained within the document is not necessarily accurate: "*In general, the Table above suggests that the 2.3 GHz, 2.5 GHz and 3.5 GHz bands are primarily used for the provision of services to Business customers by way of closed-user group services such as WAN / VPN connectivity, including the offering of public telecommunications services such as wireless Internet access services, or private WAN / VPN connectivity for the spectrum user itself.*" Digicel is of the view that a more accurate statement would be "…2.3 and 2.5 GHz bands are mainly used for the provision of Consumer customers as this band is to be used for Mobile WiMAX. 3.5 GHz WiMAX deployments are predominantly based on fixed outdoor antennas. As such, this band is more suited for business / corporate customers."	Digicel would like the Authority to review this section of the document and make the relevant changes.	Please note that this Section is accurate. It summarizes the current use of the spectrum in T&T and not the common or prospective use of these bands in other countries.
Section 4				
No. 5 *In accordance with the frequency*	TSTT	It is noted that Frequency Assignment Principles in Section 6 of TATT's "Spectrum Plan for the Accommodation of Broadband Wireless Access Services" state that "*Although*	It is respectfully submitted that in keeping with the stated Frequency Assignment Principles and in the best	It is not the intention of this statement to prohibit the use of other BWA technologies in these bands but to state that the

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assignment principles of the Spectrum Plan, the frequency assignment plan for these bands shall be based on the prominent BWA technology deployed in these bands, namely WiMAX.		*the spectrum plan may identify the prominent BWA technology deployed in a particular band, BWA technologies not identified in this plan may be deployed subject to the conformance to the frequency assignment plan and technical conditions and specifications."* This principle therefore contemplates the possible use of technology other that the prominent BWA technology. However, Decision No. 5 of this Consultative Document indicates that the frequency assignment plan for the 2.3GHz, 2.5GHz and 3.5GHz spectrum bands "***shall*** *be based on the prominent BWA technology deployed in these bands, namely WiMAX."* It is noted that in the assignment of spectrum by TATT would be required to be cognizant of the stated objectives of the Government of Trinidad and Tobago and in particular to promote the provision of high speed access to general public. It is unclear how therefore any limitation of the technology to be utilized in these spectrum bands would be in keeping with this and we shall therefore be grateful if TATT can elaborate on same.	interest of all stakeholders that licensees of spectrum in these bands should be permitted to utilize whatever technology it considers most appropriate for the delivery of its services. As such, it is suggested that this Decision be appropriately amended to remove any limitation on the technology to e employed and essentially seek to ensure that the service is delivered (regardless of the technology used).	frequency assignment and technical operating specifications will favour the prominent technology in these bands. This statement has been re-worded to reflect this intention and not to conflict with the frequency assignment principle in the Spectrum Plan for the Accommodation of BWA Services.
No. 9 *A Spectrum Cap shall be instituted in each band in order to limit the quantum*	Digicel (Trinidad and Tobago) Limited	Point 9 of this document states that a Spectrum Cap shall be instituted in each band. Deciding on an appropriate spectrum cap may have included relying upon Table 2 (page 11) within the document which lists several sample	Digicel understands the importance of managing the available spectrum however we recommend that the Authority review its decision	The determination of the spectrum cap considered both Caribbean and non-Caribbean countries. The Caribbean benchmarks chosen came from

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of spectrum assigned to an individual spectrum user. Considering that these three (3) bands are being planned to accommodate WiMAX, there shall also be a Spectrum Cap on the quantum of spectrum an individual spectrum user can have across all three (3) bands. These Spectrum Caps are defined in Appendix III.		countries that have licensed or will be licensing spectrum users to provide BWA. Digicel believes that Caribbean benchmarks are appropriate but disagrees with the Caribbean countries selected to populate the list. Antigua and Barbuda and ECTEL member countries are all smaller in comparison to Trinidad and Tobago and cannot possibly be used as a comparator country in deciding a spectrum cap. Jamaica currently uses FDD in the 3.5GHz which is primarily focused on Corporate use and they are currently awaiting spectrum auction in the 2.5GHz band, therefore Jamaica is not suitable as a comparator country.	on the respective Spectrum caps and reconsider those that may be too restrictive.	data available at the time. Benchmarks from other jurisdictions were used as well in order to compare with the Caribbean data.
No. 10 *An existing spectrum user who is currently assigned more than the Spectrum Cap in these bands will be required to: Identify the frequency assignment it wishes to maintain, in accordance with the Frequency Assignment Plan, subject to the*	Digicel (Trinidad and Tobago) Limited	Point 10 (i) indicates that existing spectrum users will be able to identify the spectrum frequencies it wishes to maintain, subject to the approval of the Authority. The Authority has published in Appendix 2 the frequency assignment plan for the various bands. Considering Point 10, this frequency assignment plan would not be a true indicator of all available frequencies since some spectrum users would already have cornered certain blocks through incumbency. The method by which the Authority intends to approve spectrum for existing users is not clear	The Authority should amend Point 10 and explain in greater detail how it intends to make the decisions and give necessary approvals for existing spectrum users to retain certain frequencies.	The Spectrum Plan is intended to identify the spectrum that is made available for the service and not how much spectrum is made available to new entrants. The process for authorizing new entrants will identify the spectrum available to new entrants. This refarming plan will be the instrument the Authority will use to regularize the incumbents in these bands.

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approval of the Authority		in the document. It is important that all existing and potential users are able to see the actual decision making guidelines regarding this important allocation of spectrum. Further, even though the allocation of available spectrum is subject to competitive bidding, due to the restrictive supply, the Authority needs to ensure that the distribution is equitable.		Comment noted.
No. 11 *Spectrum that is made available via reclamation, in addition to the spectrum currently available, shall be authorised via a competitive licensing process to both new spectrum users and existing spectrum users who have not exceeded the Spectrum Caps*	Digicel (Trinidad and Tobago) Limited	Point 11 states "spectrum that is made available via reclamation in addition to spectrum currently made available shall be authorized via a competitive licensing process to both new and existing users that have not exceeded the spectrum cap." This statement is largely unclear. Firstly, it does not discuss specific timeframe i.e. when this competitive licensing process will take place. Second, Point 11 makes reference to "spectrum that his made available via reclamation". There is uncertainty in this statement since the spectrum that is made available via reclamation depends heavily on incumbent preferences and decision making of the Authority – a point Digicel has raised above.	This statement should be changed to inform new and potential users of the timeframes in relation to reclamation exercise.	The timeframe for reclamation is identified in the Decisions of Reframing Plan. The Authority is currently preparing the authorization process and we expect recommendations to be made to the Minister by September 2008. Subsequent to this the timeframes for authorizing new entrants will be published by the Authority.
No. 12 *The spectrum usage fee deduced from the competitive licensing process for the 2.3*	Digicel (Trinidad and Tobago) Limited	Point 12 of the consultation document indicates that the spectrum usage fee that is derived from the competitive bidding process will replace the current fees for spectrum usage as provided for in the Telecoms Fees regulations 2006.		See previous TATT decision.

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GHz, 2.5 GHz and 3.5 GHz bands shall supersede the spectrum usage fee identified for the provision of BWA services in the present Telecommunications (Fee) Regulations, 2006 (i.e. TT $4,000.00 per MHz pair). Hence, all existing spectrum users will be required to pay a new annual licence fee consistent with the new spectrum usage fee set by the competitive licensing process		We would like to inquire about the timeframe i.e. when will this competitive take place?		
Appendix I				
Appendix I – *Outlined Procedures for the Determination of Network Rollout Plan*	Digicel (Trinidad and Tobago) Limited	With regards the following statement: "*The following steps outline the procedure for the determination of a network rollout plan to achieve coverage of **85%** of the populated area of Trinidad and Tobago over three (3) years*" Digicel is not clear on what the Authority considers as a 'populated area'. Given that the Authority will require us to commit to 85%	Digicel would like the Authority to clarify what it means by populated area and describe how it will measure population coverage especially since this term appears several times in this document and can be interpreted in various ways.	Populated area is defined in the Concession. The concessionaire shall provide evidence of achieving the population area coverage for verification by the Authority.

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		coverage over 3 years we would like to know the method by which the Authority intends to verify population coverage.		
Appendix II				
Appendix II – Frequency Assignment Plans	Digicel (Trinidad and Tobago) Limited	7.3.4 Indicates that the Spectrum Cap for 2.3 GHz band shall be 30MHz. In addition to our comments above on Point 9 in Section 4, Digicel believes that a spectrum cap of 30 MHz is inadequate to deploy a domestic network in Trinidad and Tobago. With regards same Point 7.4.3 it is stated in the document that "this arrangement allows the assignment of blocks to facilitate FDD duplex mode of operation in order to maintain the current duplex mode of operation." Subject to clarification, Digicel interprets the above statement as the intention to move the 2.5 GHz range to FDD. This is divergent with what is happening elsewhere in the world as this band is being used for TDD.	Digicel recommends that a minimum allocation of 60MHz be considered in order to avoid interference. Digicel recommends that TDD should be used in the 2.3 & 2.5 GHz bands. One possible option is looking within the 2.5GHz at 4 Spectrum blocks of 25MHz (FDD) and 1 Spectrum block of 80 MHz (TDD). For FDD, 4 x 25 MHz blocks in the following ranges can be considered: 2500-2525, 2525-2550, 2635-2660 and 2660-2685. For TDD, 80 MHz is available (less a guard band between FDD/TDD) from 2555 – 2635.	The Authority disagrees as this would only allow spectrum for one operator, and this quantum is over the spectrum cap. The Authority will consider accommodation of FDD and TDD duplex modes of operation in this band.
Appendix II – Frequency Assignment Plans	Digicel (Trinidad and Tobago)	Within the Plan for 2.5 GHz band there is a mistake in Point 7.4.3 where the document states "*the frequency range is divided in **three***	Digicel is of the view that the document should read "*the frequency range is divided in*	Noted. Typograpical error will be corrected.

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	Limited	***(6)*** *spectrum blocks of 25 MHz each…"*	***six (6)*** *spectrum blocks of 25 MHz each…"*	
Appendix II – Frequency Assignment Plans	Digicel (Trinidad and Tobago) Limited	Point 7.5.6 states "t*he frequency range 3600 – 3800 MHz is divided in eight (8) spectrum blocks of 25 MHz each. Considering part 7.5.3 (b), new and existing spectrum users shall be encouraged to operate in a TDD duplex mode for the provision of public BWA services, within the frequency range 3600 – 3700 MHz only."* Digicel disagrees with using the TDD mode in this band for the provision of public BWA services. Our investigations in terms of the RF environment has shown that indoor penetration for devices will be difficult at such a high band where there are houses with concrete walls. Second is the lack of TDD equipment from WiMAX manufacturers in this band coupled with the lack of deployment / support by the WiMAX forum for TDD in this band you will be heading in to a technology cul-de-sac with a service that would not work for consumer customers and would still only be suitable for Business / Corporate fixed outdoor antenna installations.		Notwithstanding the availability of TDD equipment issue, 7.5.6(b) was stated based in the statement made in 7.5.3 (b). Protection of BWA services from FSS will only be afforded from 3600 – 3700 MHz, as FSS is allocated on a primary basis in that band. TDD is encouraged only because FDD systems would not have the Tx/Rx duplex spacing less than 100 MHz. Notwithstanding this, this statement has been re-worded to also include the facilitation of FDD systems with Tx/Rx duplex spacing of less than of equal to 50 MHz.
Appendix III				
	Green Dot Limited	The minimum spectrum block size should be 5Mhz in all bands.	There will be different requirements for each operator on how their network will be deployed and hence an operator may only	TATT agrees with the recommendation. The nominal spectrum block size would now reflect the minimum typical channel bandwidth in the

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			require 10MHz of spectrum. Likewise, if a bidder requires 30MHz for their project, they can make this up as opposed to having to take 2 blocks and taking 50MHz of spectrum when only 30MHz in needed. Additionally, with 25MHz blocks, the cost of the spectrum may be prohibitive for the operator to launch or spectrum will be wasted thus limiting the number of operators in the market. Either way, there is no harm in having a minimum of 5MHz and let the operators decide what they want to apply for once they can show TATT that they can meet the concession obligations with the spectrum applied for.	respective bands.
	Green Dot Limited	The document states that the typical RF channel bandwidth for WIMAX is 20MHz maximum. Why is then for the 2.5 and 3.5 band, the spectrum divided into 25MHz blocks.	Clarification needed.	The block sizes were determined based on the Spectrum Cap stated. However, TATT has revised the nominal block size to the minimum typical channel bandwidth of 5 MHz