Policy

Spectrum Policy and Planning

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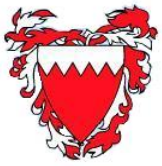
A Joint Policy Issued by the Telecommunications Regulatory Authority (TRA) and the Ministry of Transportation (MoT) of the Kingdom of Bahrain

27 June 2006

Purpose: Consultation on the implementation of the frequency allocation policy

MINISTRY OF TRANSPORTATION
KINGDOM OF BAHRAIN



وزارة المواصـــلات
مملكـــة البحريـــن

TRA
البحرين
BAHRAIN

هيئة تنظيم الإتصالات
Telecommunications Regulatory Authority

Spectrum Policy and Planning

1 Executive summary

1.1 Introduction

The developments in the telecommunications sector and the demand for spectrum by licensees and prospective licensees, so as to offer new or more cost-effective services, necessitated a review of the availability and usage of spectrum in the Kingdom of Bahrain.

To meet these demands in the short term, but also to plan for their long-term implications in a way that best meets the needs of the Kingdom and its citizens, the Telecommunications Regulatory Authority together with the Ministry of Transportation of the Kingdom of Bahrain have launched a public review of spectrum usage in Bahrain. The publication of this document is the last step of this consultation and evaluation process conducted by the Telecommunications Regulatory Authority (TRA) and the Ministry of Transportation (MoT) of Bahrain. The TRA and MoT recognise that developing a long-term spectrum allocation strategy is critical for the future expansion of telecommunications in Bahrain. This document sets forth the TRA and MoT's Spectrum Allocation and Policy Plan for Bahrain, and has taken into account all the input received on this matter.

1.2 Document approval and issue

This document is issued pursuant to Sections 3 (c) and 12 (f) of the Telecommunications Law. It is publicly available via the TRA website.

1.3 Structure of the spectrum allocation and policy plan

The spectrum allocation and policy plan defines the overall principles of the spectrum management policy in Bahrain. Based on all the responses to the consultation from stakeholders in Bahrain, the TRA and MoT outline in this document the decisions on the allocation and assignment of spectrum in each frequency band and for the main telecommunications applications.

The executive summary highlights the key decisions taken by the TRA and MoT, while the background, details, principles and technology discussions are set out in the main body of the report.

1.4 Way forward

Following the publication of this Plan, public announcements will be issued making known that applications will be accepted for specific types of licences, as well as providing details of the relevant deadlines and how interested parties can apply for the licences. No relevant licence applications will be accepted at any

stage prior to such announcements, and those received will be rejected as being premature.

1.5 Overall principles

a) Spectrum allocation and assignment

The TRA and MoT have different roles with regard to the allocation and assignment of spectrum:

- The MoT allocates frequency bands for telecommunications use (if possible) upon request from the TRA.
- The MoT will continue have the Master Frequency Registry with All the details.
- Frequencies are assigned by the TRA in an open, transparent and non-discriminatory manner.

The overall use of national spectrum is defined by the country's National Frequency Plan, which is derived primarily from the ITU-R Allocation Table for the region (Region I for Bahrain). Within this general allocation, individual frequencies are assigned to specific users for use in specific geographical locations. Future assignments will be based on international best practice and the best interests of consumers, the industry and the Kingdom of Bahrain as a whole.

b) Licensing mechanisms

The method of selecting particular licensees differs for different services. In certain cases, subject to Board of Directors approval, auctions may be used[1], particularly where the nature of the spectrum available indicates that the demand for licences is likely to exceed supply. The TRA and MoT believe auctions to be the most efficient way to assign spectrum and optimise its use. However, the TRA and MoT recognise that it is important to make decisions on a case-by-case basis rather than subscribe to a purely one-size-fits-all approach. For example, for some FWA licences, particularly when the demand for licences is unlikely to exceed supply, the TRA could use a First Come First Served (FCFS) mechanism as the more appropriate method of allocating spectrum. In addition, FCFS will be implemented for private use of fixed wireless links.

[1] In all cases where reference is made to assignment by auction, the final decision rests with the Board of Directors of the TRA and will be made on a case-by-case basis.

A light licensing regime will be introduced in certain frequency bands specified in this document. Short-term licences will be introduced for technology-testing purposes as well as programme-making and special event (PMSE) purposes.

c) Spectrum pricing

The TRA charges license fees and the MoT charges spectrum fees for spectrum licensees. The fees will cover:

1) the administrative and spectrum management costs of the MoT

2) the administrative costs of the TRA

In specific cases, spectrum fees will be determined by a spectrum pricing formula (as opposed to an administrative cost formula). This spectrum pricing mechanism is designed to encourage the most efficient use of spectrum and will only apply where there is congestion and where an auction has not been the licensing mechanism used. Bulk discounts will not be applied generally, as this might encourage inefficient use of spectrum, but discounts will apply in specific cases where microwave and VSAT frequencies are reused by the licensee.

1.6 Changes made in specific bandwidths

a) 0 - 200 MHz

- No changes will be made to the current allocation in this bandwidth.

b) 200 - 450 MHz

- The 200 – 450 MHz band is predominantly allocated to fixed and mobile applications, and licensed primarily to government and private users. Most public mobile radio (PMR) and public access radio technologies (PAMR) fall within this bandwidth.
- The allocation to analogue PMR will remain unchanged, and spectrum will be awarded on an FCFS basis. Spectrum fees (Ministry fees) and TRA fees (license fees) will apply.
- Spectrum in the 350 MHz band will be allocated to 'walkie-talkies', and will be subject to a light licensing regime in Bahrain. As the 446 band (used for 'walkie-talkies' internationally) is not available in Bahrain due to current usage of the spectrum. Therefore, it will not be possible to allocate the spectrum in the 446 band at this time, but the TRA and the MoT will start to review with the current users if it would be feasible in the long term to migrate out of these bands
- No respondent to the consultation expressed an interest in deploying commercial TETRA in Bahrain at present. However, the TRA and MoT

understand that interest in the technology could develop at a later stage, and consequently the MoT will allocate spectrum for commercial TETRA upon a request from the TRA. However, the TRA and MoT does not plan any assignment for the time being.

- Frequencies will not be allocated to SRBiz short-range radio, TETRAPOL, or DISCUS.

c) 450 – 1900 MHz

- Current public mobile spectrum assignments follow the standard GSM 900 and GSM 1800 frequency allocation. Both the standard GSM 900 and extended GSM 900 frequency bands have been allocated to public mobile in Bahrain.
- The TRA will delay decisions concerning the award of a potential new public mobile licence until after the completion of a public consultation process devoted to the matter. It is however envisaged that any assignment would be technology-neutral.
- The 450MHz band of spectrum will be opened up on a technology-neutral basis, potentially for Flash OFDM, and one licence will be awarded through an auction mechanism.
- There are frequency supply conflicts in Bahrain for all the recommended iDEN bands. Consequently, the TRA and MoT will not allocate spectrum for iDEN deployment in Bahrain.

d) 1.9 – 2.2 GHz

- To date, only MTC-Vodafone has been assigned 3G frequency spectrum (as part of the award of the 2nd mobile licence). In addition, 3G spectrum in the TDD and FDD bands has been reserved for Batelco. Given the responses received from the public consultation, the TRA and MoT will not allocate further spectrum in the 1900 MHz band for future public mobile services at the present time, apart from existing 3G allocations. Instead, the assignment of spectrum that falls within these frequencies will be discussed by the upcoming consultation on the possibility of granting additional mobile licences in Bahrain.
- The current allocations for UMTS-TDD will remain and are designated technology-neutral. No spectrum in the 1900 MHz bands will be allocated for fixed wireless access.

e) 2.2 – 3.5 GHz

- Governmental applications are currently in conflict with an assignment of spectrum at 2.3 GHz to wireless applications (such as WiBro or WiMAX) and

as such the TRA and MoT will discuss with the current users of this spectrum whether any alternative arrangement can be reached.

- In line with international practices, the TRA and MoT distinguish between two separate bands within the 2.4 to 2.7 MHz frequencies - the 2.4 GHz band and the 2.5 to 2.7 GHz band.
- In line with international technical standards, the 2.4 GHz band will be reserved for WiFi applications. This will be carried out using a light licensing scheme. The current governmental usage of this band will gradually be phased out.
- Due to current usage of the spectrum it will not be possible to allocate the spectrum in the 2.5GHz to 2.7GHz band at this time, but the TRA and the MoT will start to review with the users if it would be feasible in the long term to migrate out of these bands. .

f) 3.5 – 10 GHz

- The TRA aims to licence two fixed wireless operators in the 3.5 GHz band. These licences will be awarded on a technology-neutral basis and via an auction mechanism.
- A light licensing regime will be applied in the 5.150 to 5.350 and 5.725 to 5.850 GHz bands.
- The band 5.470 GHz to 5.725 GHz band is assigned exclusively to the government.

g) 10 – 20 GHz

- The MoT allocated and the TRA will assign 2 x 40 MHz of spectrum in the 10 GHz band to one FWA operator, awarded through an auction mechanism.
- Current frequency allocations for VSAT will remain in the Ku-Band.

h) 20 – 50 GHz

- The MoT plans to allocate spectrum for two licences, one in the 26GHz band and one in the 28GHz band. The MoT will allocate 2 x 100 MHz of spectrum for FWA in the 28 GHz frequencies, and the TRA proposes to award licences in these frequencies by auction. A further 2 x 100 MHz of spectrum will be allocated for future use by a public operator in the 26 GHz band.
- The MoT will allocate the 40.5-43.5 GHz spectrum for future FWA operator licences.

2 Introduction

2.1 Process for developing Bahrain's spectrum allocation strategy

The development of Bahrain's spectrum allocation strategy has been based on an extensive two-step review and consultation process, including an initial review process and a public consultation.

2.2 The initial review process

The initial review process consisted of the following steps:

(1) An international benchmarking of the best practices in terms of spectrum allocation strategy

(2) A review of the existing spectrum allocation and assignment in Bahrain

2.3 The public consultation

The public consultation was built on the initial review process, with two main aims:

(1) To suggest possible options for each frequency band under review

(2) To gather input from various stakeholders, including public and private users of spectrum, on the future allocation and assignment of spectrum in Bahrain

2.3.1 Options for each frequency band

The first purpose of the consultation was to define the overall principles of the spectrum management policy in Bahrain. These principles are reviewed in sections 3 and 4 which address the topics of spectrum award mechanisms (auctions, "beauty contests", First-Come-First-Served), spectrum pricing (administrative charging, administered incentive pricing) and the introduction of new technologies in Bahrain.

For each of the relevant spectrum bands, the TRA and MoT described the potential technologies which could be deployed in these frequencies, reviewed the current situation in Bahrain, and detailed some options for future spectrum allocation and assignment. At the end of each relevant sub-section, the TRA and MoT formulated a consultation question to gather the views of current and future spectrum users on the options outlined in the consultation document.

2.3.2 Input from various stakeholders

The underlying goal of the consultation was to set the foundation for the optimal allocation of spectrum in Bahrain. Spectrum is a scarce resource and the TRA

and MoT foresee potential conflicts between spectrum users for the allocation and assignment of frequencies. On the basis of the responses received from 15 parties, the TRA and MoT are proposing a National Frequency Plan, which they believe maximises the benefits of spectrum to users and the citizens of Bahrain.

2.4 Structure of the spectrum allocation and policy plan

The rest of this document will first cover the overall principles for spectrum policy, including frequency management, award mechanism and spectrum pricing. Two sections will also focus on the specific topics of light licensing and short-term licensing. The second part of this document will outline and explain the rationale of the decisions taken for each band of the spectrum in Bahrain.

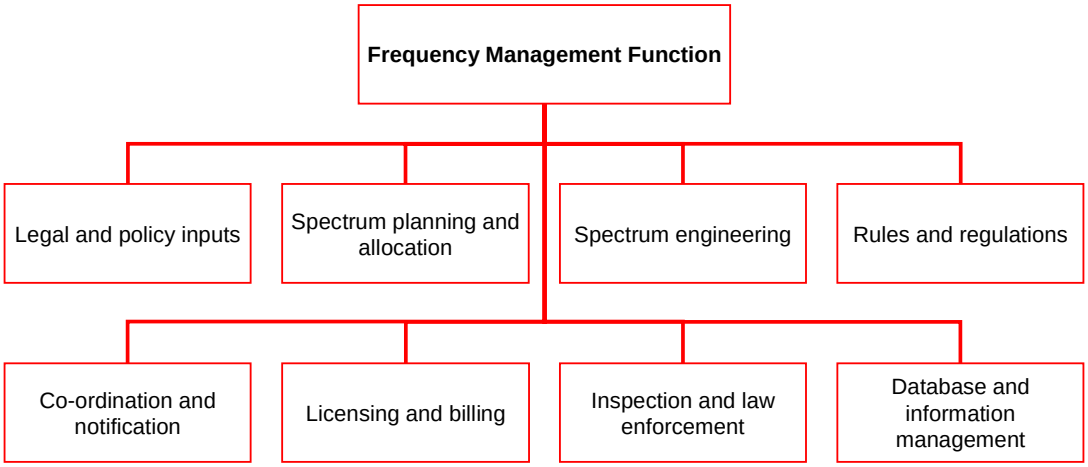
3 General guidelines on spectrum policy: frequency management, award mechanisms and spectrum pricing

3.1 Background on frequency management

Spectrum management is the combination of administrative, scientific and technical procedures necessary to ensure the efficient operation of radio communication equipment and services without interference. The goal of spectrum management is to maximise spectrum efficiency and minimise interference.

There are a number of processes that constitute frequency management. These are shown generically in Exhibit 1. Unlike the rest of the consultation, the TRA and MoT expressed views on the processes that they need to implement so as to properly perform these functions without fully consulting stakeholders.

Exhibit 1: Functions within frequency management



3.1.1 Spectrum planning and allocation

The use of national spectrum is defined by the country's National Frequency Plan, which is derived primarily from the ITU-R Allocation Table for the region (Region I for Bahrain). Going forward, the TRA and MoT will aim to review and revise the National Frequency Plan as and when is necessary in order to reflect changes in governmental policy/strategy, technological developments, and the likely needs of the country.

3.1.2 Spectrum assignment

Spectrum assignment refers to the assignment of specific frequencies to specific users for use in specific geographical locations. Frequency in Bahrain is assigned using an open, transparent and non-discriminatory method.

The TRA will adopt different methods of selecting licensees for different services – for example, auctions for the provision of public telecommunications services, as detailed in Exhibit 3.

The TRA and MoT will work together to ensure that harmful interference will not be caused by new licensees to other licensed spectrum users, and that a satisfactory service will be obtained by the licensee.

3.1.3 Introduction of new technologies and services

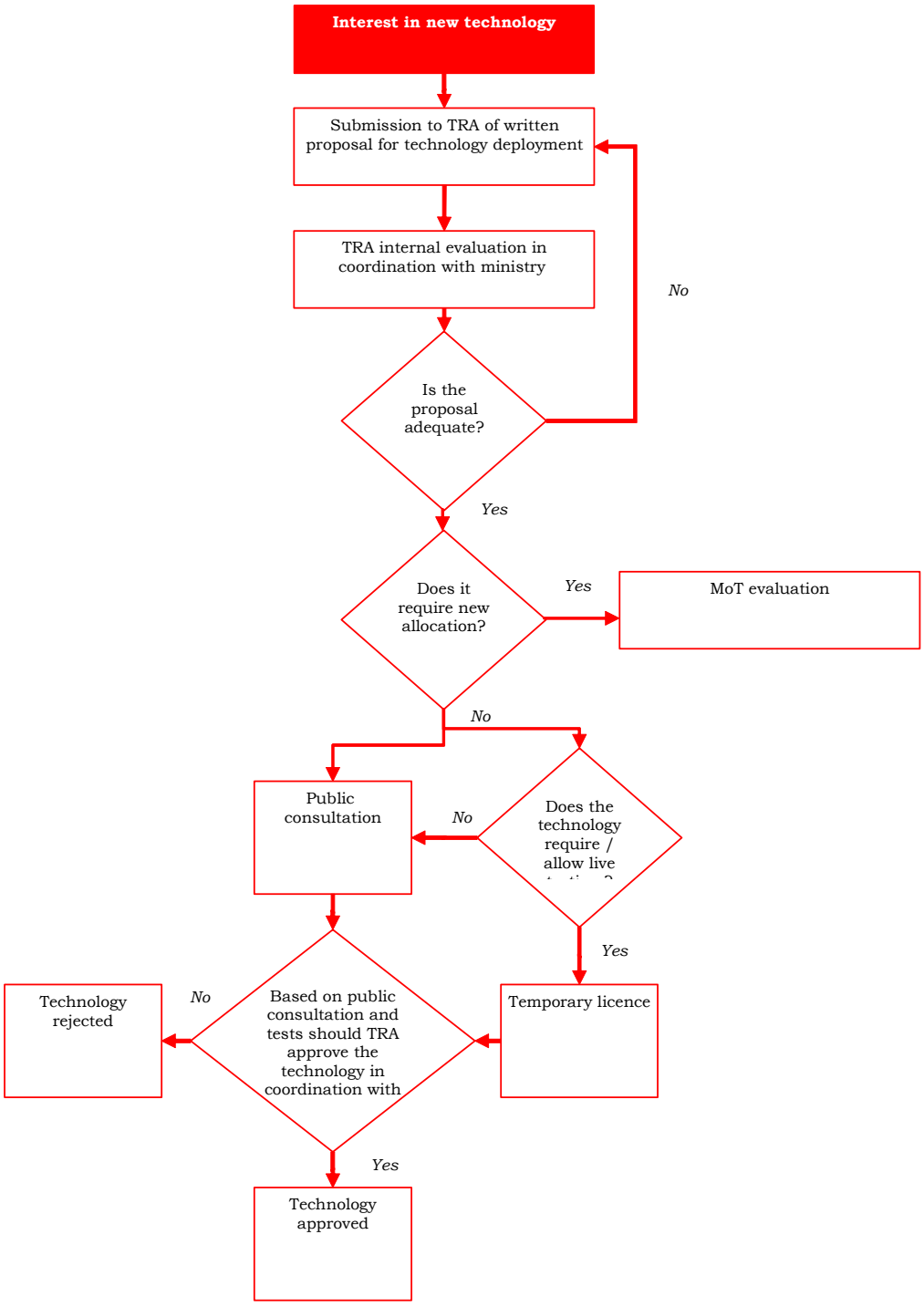
The public consultation process revealed strong support within Bahrain for the introduction of new technologies and services. The TRA and MoT will therefore implement an evaluation and approvals process designed to stimulate and speed up the introduction of new technologies. This approval process will be the following (also see exhibit 2):

- Proposals for new technologies and/or standards will be acceptable from any source
- The proposer will be required to submit written evidence as to how the new technology can be introduced without detriment to other spectrum users, and on the benefits to be gained. This evidence may be in any form, but evidence of actual operation elsewhere, co-existence studies by recognised standards bodies, and assignments by other Administrations will be considered as strong evidence
- The TRA and MoT will evaluate the evidence submitted to TRA and publish both the original proposal and its own evaluation, and invite comments from the public
- Should the evidence provided be determined to be inadequate, the proposer will be given the opportunity to prove compatibility by means of tests, measurements and demonstrations
- Should the introduction of the technology require a new or modified spectrum allocation, the TRA will refer the issue to the MoT for assessment
- Again, the TRA and MoT will evaluate the evidence, publish its response, and invite further comments from the public. If appropriate, the TRA may decide

to award a limited number of temporary licences to allow live testing of the technology

- Finally, in the light of all the evidence and comments received, the TRA will decide whether or not the new technology is to be approved, and will make its decision public. Where relevant, the TRA and the MoT may need to consider issues arising from the need to coordinate use of the new technology with neighbouring countries.

Exhibit 2: Processes for new technology approval



The TRA and MoT will ensure that this process is run as efficiently as possible, in order to minimize the time to market for technologies which are deemed viable options for Bahrain.

The MoT will allocate and the TRA will assign such blocks to new technologies and services using the same process. The TRA and MoT will continue to streamline the approvals process for new technologies.

3.1.4 Co-ordination and Notification

Co-ordination is required whenever assignments have the potential to cause or be subject to interference from other licensed users across national borders. Co-ordination can also be required between different users within a country where there is co-channel use in adjacent regions or adjacent channel operation in a common region. Co-ordination can be achieved through agreement between neighbouring administrations and through regional bodies.

3.1.5 Certification

Equipment needs to meet certain technical parameters to ensure that it will operate properly within the designated frequencies and not cause harmful interference to themselves and to other legal users (or suffer harmful interference from other legal users). Parameters can include transmit power, frequency band, antenna gain, etc. Requiring that the equipment meet appropriate type approval tests is the conventional means to achieve this.

Certification of equipment can be a burdensome process, and a number of administrations now delegate the responsibility to manufacturers and certified test houses for certain types of equipment. For a small country it is best to accept equipment which meets other well-established national or international standards (e.g. GSM, CEPT, FCC).

The TRA will use two methods to certify equipment. On a case-by-case basis, the TRA can carry out or delegate the technical certification of wireless equipment for telecommunications usage. However, in most cases, the TRA accepts the international or national certification, including self-assessment to nationally or internationally accepted standards.

3.2 Award mechanisms

The consultation document outlined the relative merits and limitations of different approaches to allocating spectrum licences. Three spectrum assignment mechanisms have been considered by the TRA:

1. Auction

2. Beauty Contest
3. First-Come-First-Served (FCFS)

The TRA will use auctions as the preferred mechanism for awarding licences, particularly where the nature of the spectrum available indicates that the demand for licences is likely to exceed supply. In any such case, and subject to a case-by-case Board of Directors approval, the process for licence award will be an auction rather than a beauty contest or FCFS procedure. When awarding licences via an auction mechanism, the TRA will be careful to protect commercial and consumer interests, and to prevent the unreasonable exacerbation of any positions of market dominance.

However, while as a general rule auctions will be the default option, it is important to make decisions on a case-by-case basis rather than subscribe to a purely one-size-fits-all approach. For example, in the case of FWA spectrum, particularly when the demand for licences is unlikely to exceed supply, the TRA could decide to revert to the FCFS method of assignment. In addition, for non-public uses, such as private, individual and local assignment of spectrum for fixed links, auctions are irrelevant and FCFS should be the preferred method.

The TRA could set up simplified auction processes and logistics in order to achieve faster and more efficient assignment of spectrum. For example, the TRA will assess the possibility of introducing remote internet-based bidding for certain licence types. All in all, rather than relying on generic formats, the focus should be on bespoke auctions which are specifically tailored to the particular type of spectrum that is being allocated, in order to ensure an optimal solution for the market. The auctions will not be set up in such a way as to maximise revenue for the TRA but to ensure a proper selection mechanism for the licence.

3.3 Light licensing

Licence-exempt spectrum is not permitted in Bahrain under the current Telecommunications Law. However, the TRA and MoT have received very positive feedback to their proposal, outlined in the public consultation document, to implement a light licensing regime in Bahrain.

The TRA and MoT therefore intends to develop a light licensing regime along the following lines:

- All users, including service providers, retailers and end users, will have to get a “light” licence
- This licence will be purchased at a low cost (or potentially no cost, depending on the service)

- This licence will be easy to obtain and the TRA will promote concepts such as online registration
- All users will be governed by type approval of equipment
- Limits will be placed, depending on the type of technology, on the maximum power of the equipment
- In some cases, the light licensing regime will place a limit on the use of the technology to a specific application (e.g. 350MHz use for Walkie-Talkie)

It is important to note that the allocation of spectrum under a light licensing regime does not imply that there will be no restrictions on the equipment that can be used or on the emissions that may be radiated. As a minimum, there will be limits on the power that may be radiated both within the band and in the adjacent band. However, as such bands are intended to be shared by multiple users without coordination, it is often appropriate to additionally require that equipment meet certain standards which optimise the use that users can make of the spectrum in this environment.

Spectrum bands in which a light licensing regime will apply are designated in the following chapters of this document. In these bands, all users of spectrum, including service providers, retailers and end users, will have to obtain a 'light' licence.

3.4 Short-term licensing

The TRA and MoT received very enthusiastic responses to their proposal to introduce program making and special event licences. These will not be awarded where interference is caused to existing users of spectrum. The TRA and MoT will not set a specific duration for these licences, but will instead set licence durations on a case-by-case basis. Short-term licences for program making and special event licences (e.g. the Formula 1 Grand Prix) will be awarded on a first-come-first-served basis. Users will have to apply for a short-term licence.

The process for short-term licensing for program making and special events will be the following:

- Applicants will be required to identify the characteristics of the radio emissions and type of application (video links, wireless micro, etc.), the amount of spectrum required and the preferred frequencies, the area over which transmissions will be made, the duration of the event, and the precautions that will be taken to ensure that interference is not caused to other users of the spectrum

- The TRA and MoT will determine whether the preferred frequencies are free, and if they are not could propose alternative frequencies, using a specific database
- a short-term licence will then be issued. The cost of the licence will be based on the spectrum fees (for MoT) and TRA fees (licence fees) charged for a permanent licence, pro-rata the duration of the temporary licence. It will be for a fixed and limited period, will confer no rights on the licensee beyond those specified in the licence, and will not commit the TRA and MoT to any further licensing, allocation or assignment of spectrum

The proposal to introduce new temporary test licences was also endorsed by the vast majority of respondents to the public consultation. As set out in the consultation document, the mechanism for awarding these licences will be straightforward and involve minimal cost to applicants. The conditions under which technology tests may be carried out will be specified on a case-by-case basis for individual licences.

The process for short-term licensing for temporary test licences will be the following:

- Applicants will be required to identify the system they wish to test, the characteristics of the radio emissions, the amount of spectrum required and the preferred frequencies, the area over which test transmissions will be made, the duration of the tests, and the precautions that will be taken to ensure that interference is not caused to other users of the spectrum
- The TRA and MoT will evaluate the proposal. The evaluation will be primarily concerned with ensuring that the tests can be conducted without detriment to other legitimate users, but will also be dependent on the availability of suitable spectrum
- When a proposal is approved, a test licence will be issued. The cost of the licence will be based on the spectrum fees (for MoT) and TRA fees (licence fees) charged for a permanent licence, pro-rata the duration of the temporary licence. The licence will specify the conditions under which tests may be carried out. It will be for a fixed and limited period, will confer no rights on the licensee beyond those specified in the licence, and will not commit the TRA to any further licensing, allocation or assignment of spectrum

3.5 Overall pricing strategy for Bahrain

The TRA and MoT have decided on the following pricing mechanisms for each of the technologies and frequency bands discussed in this consultation:

Exhibit 3: **Spectrum pricing**

Technology		Proposed pricing
Public Mobile		Auction + Spectrum Fees for MoT
PMR and PAMR	Analogue	Spectrum Fees for MoT + TRA fees
	TETRA emergency	Spectrum Fees for MoT + TRA fees
	TETRA commercial	Auction + Spectrum Fees for MoT
Fixed Wireless Access		Auction (or FCFS) + Spectrum Fees for MoT
Short Range/ WiFi		Spectrum Fees for MoT + TRA fees
VSAT		Spectrum Fees for MoT + TRA fees

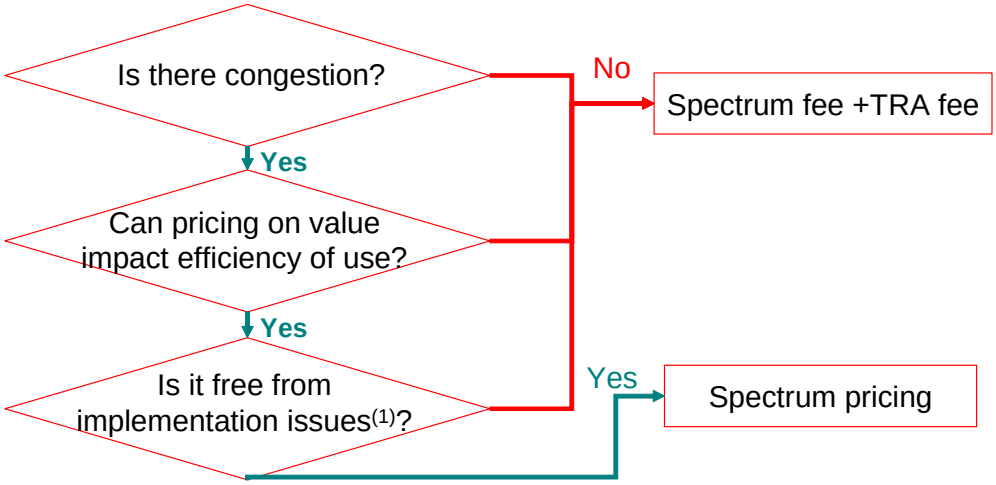
The MoT will apply spectrum fees to spectrum licensees through the TRA licence. The licence and spectrum fees (for MoT) will also cover:

- the administrative and spectrum management costs of the MoT
- the administrative costs of the TRA

In specific cases, spectrum fees will be determined by a spectrum pricing formula (as opposed to an administrative cost). This spectrum pricing mechanism is set to encourage the most efficient use of spectrum and will only apply where there is congestion and where an auction has not been the licensing mechanism used.

The following flowchart depicts the methodology used to determine which applications are conducive to the adoption of spectrum pricing.

Exhibit 4: Methodology used to evaluate which applications are conducive to spectrum pricing



Note: (1) For example complexity of the pricing formula, degree of change needed, government control etc.

Possible applications that could merit the use of spectrum pricing are fixed wireless access operators (where not auctioned), fixed links in congested bands (e.g. 3.5 GHz, 5.8 GHz), and public mobile applications (where not auctioned).

Spectrum fees will be charged as follows:

Exhibit 5: Spectrum fees (Annual)

List of annual fees for wireless equipment and frequencies	Fees (BD)[2]	Previous fees (BD)
Frequency with bandwidth < 12.5 KHz	50	No change
Frequency with bandwidth < 50 KHz	100	No change
Frequency with bandwidth < 75 KHz	300	No change
Frequency with bandwidth < 100 KHz	400	No change
Frequency with bandwidth < 200 KHz	800	No change
Frequency with bandwidth < 300 KHz	1200	No change
Frequency with bandwidth < 400 KHz	1600	No change
Frequency with bandwidth < 500 KHz	2000	No change
Spectrum usage fees	20 x no. of devices	No change
Issue or renew a marine ship station licence for radio navigation (pleasure) –(issue or renew call sign)	10	No change

[2] Fees will differ for frequency bands governed by a light licensing regime

Issue or renew a marine/aeronautical ship station licence for radio navigation (commercial) –(issue or renew call sign)	100	50
Issue/renew a call sign for Amateur radio	10	No change
Spectrum usage for the coast station	40 x no. of used radios	20
Frequency with bandwidth < 12.5 KHz	50	No change

Frequency Temporary Assignment Fees

Assignment band capacity (KHz)	Fees (BD)
≤12.5	3
>12.5 and ≤50	5
> 50 and ≤75	15
>75 and ≤100	20
>100 and ≤200	40
> 200 and ≤300	60
> 300 and ≤400	80
> 400 and ≤500	100
Data Control	10
Wireless Camera	11
On-Board Camera UL/DL	14

Spectrum fees = fees1+fees2+fees3+.....

Example of calculating the fees outlined above:

Fees1 = (no. of frequency (≤12.5) × BD 3 × ((no. of days)/(minimum no. of days of assignment))

The minimum number for assignment of frequencies for special programs and events is two days.

The number of days of the event is divided by the minimum number for assignment of frequencies for special programs and events (i.e, two days), and the result should either be a whole number or it should be rounded up.

Example: 5/2 = 2.5 = 3

Overtime fees:

Overtime fees depend on the type of event and the number of staff to whom the event is attributed by the Directorate. If the event is a simple one, such as GP2, the number of staff is usually 2. One of the exceptions is the Formula 1 Grand Prix.

Overtime fees = number of staff × number of overtime hours in a day × hourly rate × number of days.

Number of overtime hours = 8 hours.

Hourly rate = BD 5.

The cost of using monitoring equipment during an event organized by the Bahrain International Circuit or any other body is outlined in the following equation:

BD 140 + (BD 20 × (number of days required - 2)) =

Example:

Application for use of frequency for two days: BD 140 + (BD 20 × (2 - 2)) = BD 140

On the basis of the above, the total amount to be collected is as follows:

Total amount = fees for using frequency spectrum + administrative fees.

Administrative fees = overtime fees + cost of using monitoring equipment.

3.6 Discounts for bulk use

The issue of charging discount rates to bulk users of spectrum was addressed by the public consultation. The MoT is not averse in principle to giving discounts to bulk users, but a number of respondents pointed out that such a move may lead to the inefficient use of spectrum. The MoT will not offer bulk discounts for all types of spectrum usage, but acknowledges that bulk discounting could apply to microwave frequencies and VSAT services. The rationale behind awarding a bulk discount for use of microwave and VSAT is that the management of the spectrum planning is left to the operator using the allocated frequency. Therefore, the MoT is willing to consider some savings in terms of overhead costs. The proposed structure bases discounts on the reuse of spectrum (see exhibit below).

Exhibit 6: Reuse discounting for microwave frequencies services

Reuse of band (Microwave)	Discount	Cost for use of single frequency (BD)	Total cost
Frequency has not been reused	No discount	BD 2000	BD 2000
Frequency has been reused once	5%	BD 1900	BD 3900 (2000 + 1900)
Frequency has been reused two or more times	10%	BD 1800	BD 5700 (2000 + 1900 + 1800)

Reuse discounting for VSAT services

Earth Stations (VSAT)Reuse of VSAT earth station	Discount	Cost for use of single frequency / earth station (BD)	Total cost (BD)
Earth Station Frequency has not been reused	No discount	BD 2000	BD 2000
Earth Station Frequency has been reused once	40%	BD 1200	BD 3200 2000) + (1200+
Earth Station Frequency has been reused two or more times	65%	BD 700	BD 3900 2000) + 1200+ + (700+

This is a revision of the previous charging structure, which priced reused microwave frequencies at the same level as new frequencies.

The above fees shall apply with effect from 1/6/2006

The rest of this document is organised into chapters dealing with specific frequency bandwidths. In this way we seek to outline in a clear and linear fashion the changes to spectrum allocations made as a result of the consultation process, and briefly summarise the rationale behind these decisions. The frequencies marking the boundaries of the scope of each chapter have been chosen so that discussion of particular technologies or applications falls mainly within a single chapter. Please note that this document examines only the telecommunications spectrum dealt with in the public consultation, and not the use of spectrum as a whole in Bahrain.

4 Frequencies up to 200 MHz

4.1 Previous allocation

Radio spectrum in the 0 – 200 MHz band is primarily allocated to non-general public and governmental uses. There are some private fixed and mobile services (e.g. ISM band 40.66 – 40.70 MHz) and a small amount of spectrum is used by the Government for medium wave broadcasting, including TV channel 4 on 47-68 MHz. In addition, there is a small amount of spectrum allocated to amateur public use (e.g. 10,100 - 10,150 KHz). In general, however, the spectrum in this band is not allocated to public telecommunications usage, and consequently is not examined in detail by this report.

4.2 Changes made to allocation as a result of the consultation

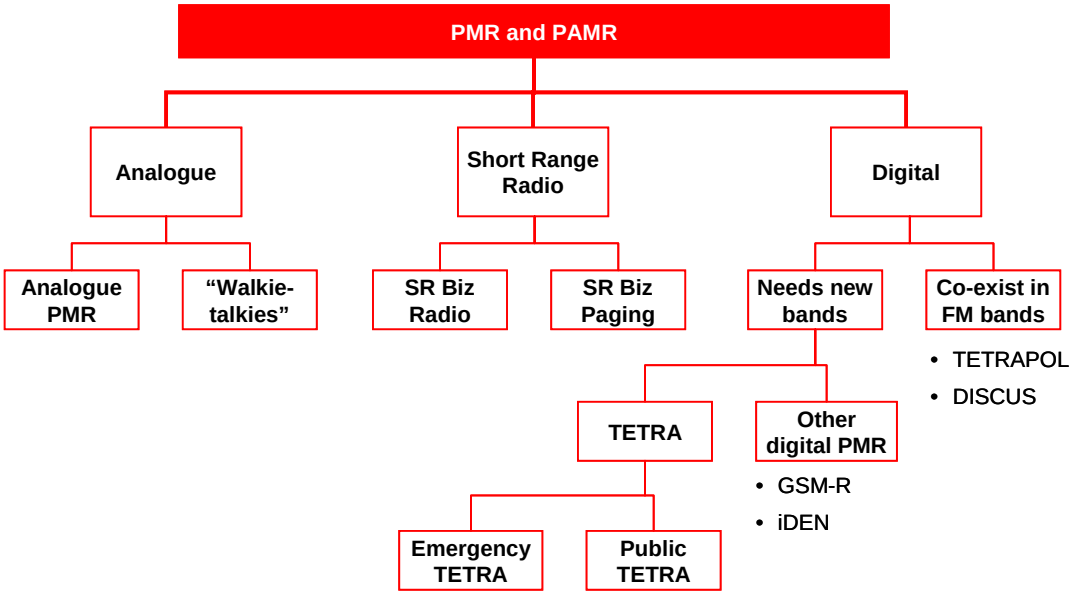
No responses addressing this part of the spectrum were generated by the consultation. The current allocation is in line with international benchmarking, and the TRA and MoT believe that this part of the spectrum has been allocated adequately in its capacity as primarily non-general public usage. As a result, the TRA and MoT do not believe that there is any significant reason to change the current spectrum allocation within this bandwidth.

5 Frequencies between 200 and 450 MHz

5.1 Previous allocation

The 200 – 450 MHz band is predominantly allocated to fixed and mobile applications, and licensed primarily to government and private users. Most public mobile radio (PMR) and public access mobile radio (PAMR) technologies fall within this bandwidth. There is also a small amount of aeronautical radionavigation usage.

Exhibit 7: **Technologies under the PMR umbrella**



No commercial TETRA network is currently deployed in Bahrain. The international PMR-446 allocation for 'walkie-talkie' private radios falls at 446 – 446.1 MHz, but this spectrum is currently in use by an operator with whom discussions will take place to see whether it would be feasible in the long term to migrate out of these bands.. The use of 'walkie-talkie' private radios is, however, common in Bahrain.

5.2 Changes made to allocation as a result of the consultation

5.2.1 Analogue

a) Analogue PMR

The use of Analogue PMR is likely to remain important in Bahrain. Therefore, these bands should continue to be available in the next few years. Given the percentage of spectrum availability in the Analogue potential PMR bands, there is also scope for additional growth. However, users should be encouraged to move from analogue to digital.

There will be no change for analogue PMR: usage of these bands will continue to be available. The TRA will coordination with MoT to award future spectrum through a First-Come-First-Served mechanism unless spectrum demand exceeds supply (in which case the TRA will revert to an auctions mechanism: note that spectrum fees and TRA fees (license fees) for Analogue PMR have traditionally been set on the basis of administrative cost recovery). The importation of equipment for Analogue PMR will be governed by accepted international standards.

Although Administered Incentive Pricing has been used for Analogue PMR, the TRA and MoT propose to retain the spectrum fee mechanism based on administrative cost recovery, unless significant additional interest is expressed.

b) 'Walkie-Talkies'

The 446 band (used for 'walkie-talkies' internationally) is not available in Bahrain. PAMR 446 traditionally occupies 8 channels of 12.5 kHz each between 446 MHz and 446.1 MHz. One option would be to allocate spectrum in the 350 MHz band to such applications (a similar application in this band is currently in use in Japan). In parallel, the TRA and MoT will enter into negotiations with the current user of the spectrum in the 446MHz band in order to assess the possibility of moving this user out of the band in the long term. Any use of 'walkie-talkies' in Bahrain outside of these frequencies can cause major interference and is prohibited (through the type approval regulation).

The PMR 'walkie-talkie' band is licence-exempt in most countries and will be subject to a **light licensing regime** in Bahrain, according to the principles outlined in section 3.3 of the document. Licences will be required in order to import the equipment, so as to ensure compliance with the relevant technical specifications.

c) Short-Range Radio - SRBiz

SRBR is complemented by a similar paging service known as Short-Range Business Paging (SRBP) operating in the 450 - 470 MHz band. This is an unprotected, albeit licensed, service for which no licence fee is payable in some countries, such as the UK. However, the service has now been withdrawn in the UK, and is in terminal decline in all other markets. The TRA and MoT believe that SRBR and SRBP will have a very limited interest for users in Bahrain, and will **not allocate** frequencies for these services.

5.2.2 Digital

a) Commercial TETRA

Commercial TETRA networks offer the opportunity to "upgrade" existing analogue PMR users to digital. Internationally in Region I, commercial TETRA is typically in the 410 – 430 MHz band. However, in Bahrain there are some actual and potential conflicts in this band:

- Current occupation of the 410 – 438 MHz band
- Possible interference from deployment in neighbouring countries, although this would be addressed by coordination at a GCC level

At the same time, neither is the 450 – 470 MHz band well suited for roll-out, as the proper handsets and equipment for these frequencies are more expensive and difficult to obtain in Bahrain.

The consultation process did not generate any expression of interest in deploying commercial TETRA in Bahrain at present. However, the TRA and MoT believe it is important to ensure that a possible future interest in commercial TETRA is covered by the National Frequency Plan, and the MoT will therefore **allocate spectrum to commercial TETRA** by opening up parts of the 410 – 430 MHz band to commercial TETRA. This would likely be done on the basis of one public licence and a band of spectrum allocated to private users:

- 2 x 4 MHz for public commercial TETRA
- 1 x 1 MHz for private users

The TRA and MoT are proposing to discuss a migration plan with the current users of this band. The preferred award mechanism for these frequencies would be auctions**.** Equipment for commercial TETRA – both stations (Fixed & Mobile) and handsets – would need type approval as specified by accepted international standards.

b) TETRAPOL and DISCUS

The MoT will **not allocate frequencies** to co-existent technologies such as TETRAPOL and DISCUS. Given the demographic and geographical characteristics of Bahrain, the TRA and MoT expect growth in these technologies to be small. In addition, both TETRAPOL and DISCUS can be deployed using existing frequencies allocated to Analogue PMR.

c) GSM-R

The TRA and MoT will take no immediate action with regard to the GCC railway, but will continue to monitor developments in the situation.

6 Frequencies between 450 and 1900 MHz

6.1 Previous allocation

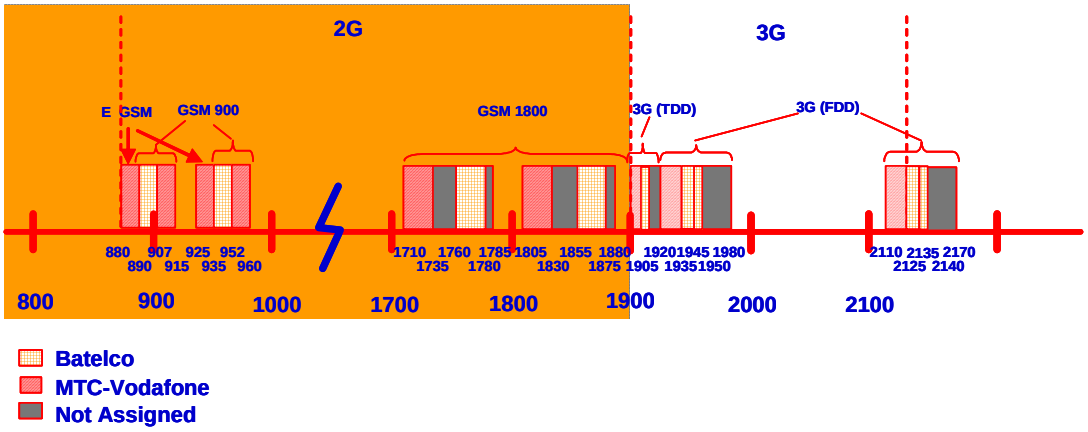
a) Public mobile networks (2G GSM/CDMA: 1710 to 1880 MHz)

GSM is the incumbent mobile communications technology in Bahrain. Both mobile companies in Bahrain (MTC-Vodafone and Batelco) run GSM networks.

While in principle the GSM system can be implemented in any frequency band, there are far fewer bands where GSM handsets are available. There are five frequency bands used by GSM: GSM 900, GSM 1800, GSM 850, GSM 1900 and GSM 400. Of these, GSM 900 and GSM 1800 are used in most parts of the world, with GSM 850 and GSM 1900 limited mainly to the Americas. GSM 400 has experienced very little deployment so far.

The current allocation of the spectrum for GSM follows the standard GSM 900 and GSM 1800 frequencies allocation (see Exhibit 7 below). Both the standard GSM 900 and extended GSM 900 frequency bands have been allocated to public mobile in Bahrain. Public mobile spectrum is currently split between Batelco and MTC-Vodafone. The Extended GSM spectrum has only been assigned to MTC-Vodafone.

Exhibit 8: Public Mobile spectrum assignments in Bahrain (<1900 MHz highlighted)



6.2 Changes made to allocation as a result of the consultation

a) Public mobile assignment

The TRA will **publish a consultation on the possibility of awarding new public mobile licences**. This assignment will be technology-neutral, allowing for both GSM and CDMA. In line with the principles outlined by the TRA and MoT, **the award mechanism for the potential licence** is an issue subject to the public consultation.

Four options for future public mobile (GSM or CDMA) allocation and assignment will be reviewed as part of the public consultation on the third mobile licence:

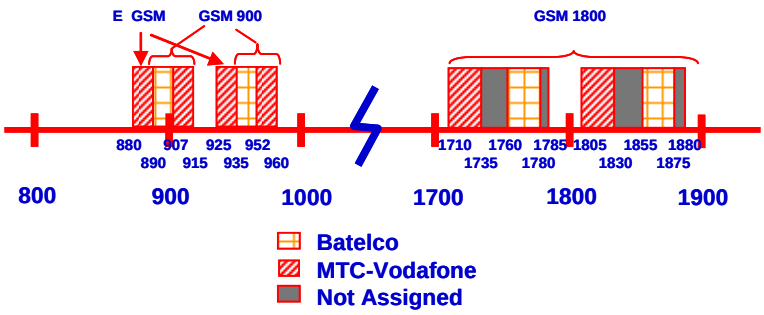
- Option 1: Status quo, no allocation of further spectrum for public mobile
- Option 2: allocate (and assign) spectrum in the 400 MHz band (2x7.2 MHz)
- Option 3: allocate (and assign) spectrum in the 850 MHz band (2x10MHz)
- Option 4: allocate (and assign) spectrum in the 1800 MHz band (2x(25+5) MHz)

These four options are illustrated in further detail below.

i) Status Quo

As part of the public consultation process, the TRA will assess the need and potential for a third mobile licence. A potential outcome is retention of the status quo where no further spectrum will be assigned for public mobile licences.

Exhibit 9: Options for future public mobile – option one (Status Quo)

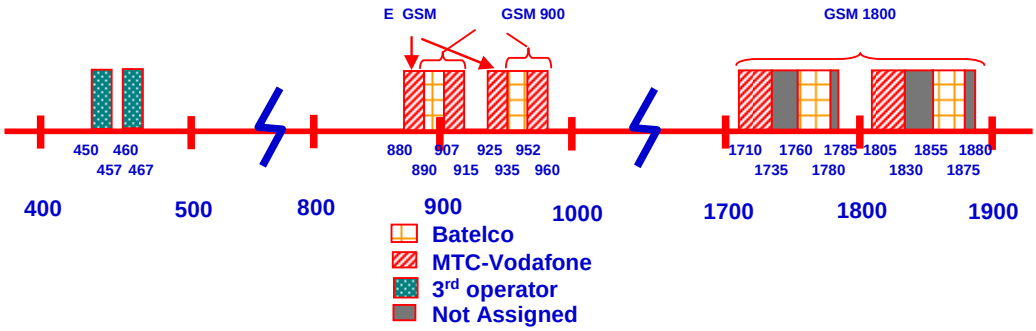


ii) 400 MHz band spectrum assignment

The TRA will assess whether a third mobile licence could be usefully allocated in the 450 – 470 MHz band. The amount of spectrum potentially available is limited to 2 x 7.2 MHz, and this is approximately the minimum amount of

spectrum required for a practical network. Operators would also need to consider the short supply of GSM and CDMA equipment in the 400-450 MHz bands, as the technology has not been widely deployed.

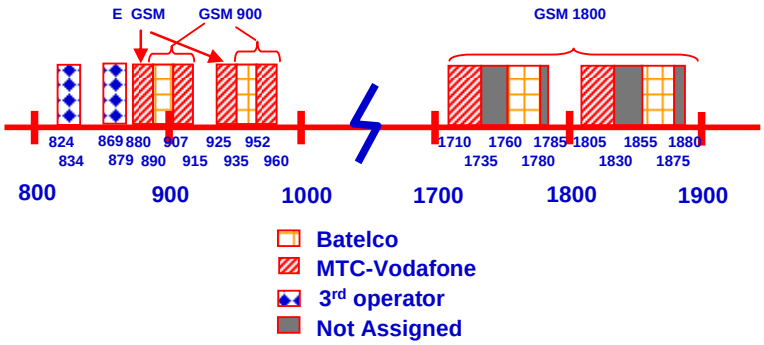
Exhibit 10: Options for future public mobile – option two (400 MHz)



iii) 850 MHz band spectrum assignment

The TRA regards assignment in the 850 MHz band as another potential option. There is 2 x 10 MHz of bandwidth in the 850 MHz band which could potentially be used for either GSM or CDMA networks, significantly less than that available in the 1800 MHz band.

Exhibit 11: Options for future public mobile – option three (850 MHz)

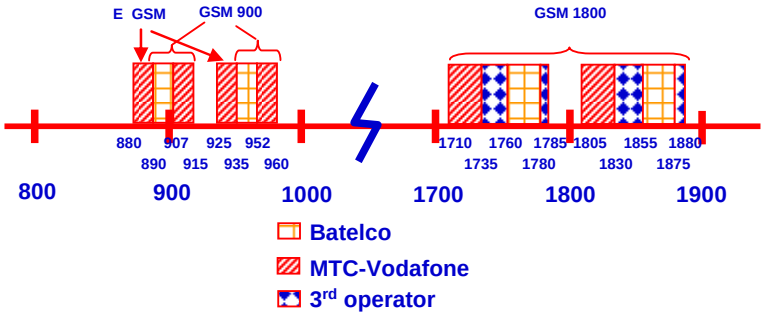


iv) 1800 MHz band spectrum assignment

The fourth option is an assignment in the 1800 MHz band. There is enough spare spectrum (although non-contiguous) within this band (one block of 2 x 25 MHz plus one of 2 x 5 MHz). Although CDMA equipment availability will be

limited in the 1800 MHz band, the TRA would propose that any award of a licence in this band be made on a technology-neutral basis (GSM or CDMA).

Exhibit 12: Options for future public mobile – option four (1800 MHz)



b) GPRS/EDGE

Neither GPRS nor EDGE inherently require additional spectrum. However, the provision of higher data throughputs occupies network capacity and, depending upon the amount of GPRS/EDGE traffic carried, can lead to a requirement for additional spectrum.

The TRA and MoT believe it would be premature to include additional capacity needs for the deployment of GPRS or EDGE services. These may be rendered obsolete by the deployment of 3G services. Therefore, the TRA and MoT will **not allocate spectrum** for these technologies.

c) Flash OFDM

Given the amount of interest generated by Flash OFDM, the TRA with coordination with MoT has decided to allocate spectrum to this technology. Flash OFDM will be deployed at **450 MHz**, rather than in the 2.1 – 2.3 GHz band where spectrum is scarce.

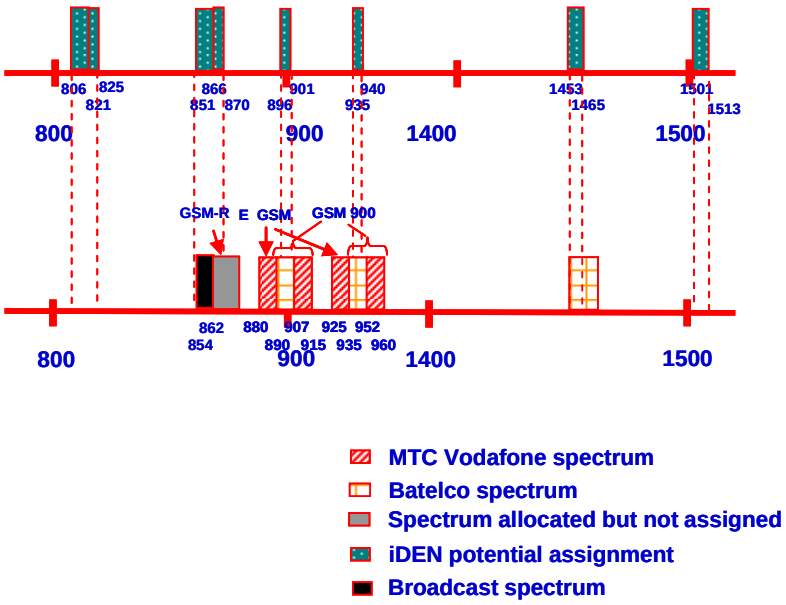
To remain in line with a technologically neutral view, the TRA and MoT will open up this spectrum on a technology-neutral basis. Both GSM and CDMA networks could be deployed in this band, and therefore an assignment here would favour neither technology. Given the amount of spectrum available in the 450 MHz band and the amount of bandwidth for such a technology, the TRA will award **one licence** through **auctions**.

d) iDEN

There has been some interest in iDEN technology in Bahrain. The TRA and MoT's policy is technology-neutral and, provided there are available frequencies,

sufficient demand and guarantees of no interference in other bands, the TRA and MoT assume that iDEN could bring viable competition to the market. Unfortunately, there are frequency supply conflicts in Bahrain for all the recommended iDEN bands (see Exhibit 13 below). The TRA and MoT have considered all views expressed but remain convinced that, given supply constraints, they could not allocate spectrum to iDEN in Bahrain nor would it be feasible to seek to migrate current users.

Exhibit 13: Spectrum conflicts for iDEN



7 Frequencies between 1.9 and 2.2 GHz

7.1 Previous allocation

3G bands between 1900 MHz and 2170 MHz have been allocated to public operator use for mobile services. Specifically, the following bands have been allocated:

- FDD: 1920 MHz – 1980 MHz paired with 2110 MHz – 2170 MHz
- TDD: 1900 MHz – 1920 MHz

These allocations can be seen in Exhibit 14 below.

7.1.1 Spectrum assignment

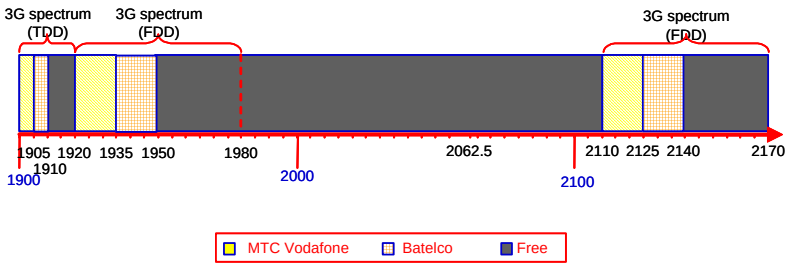
MTC-Vodafone has been assigned 3G frequency spectrum (as part of the award of the 2nd mobile licence). It was assigned 1 x 5 MHz within the 1900 – 1920 MHz TDD band, and 2 x 15 MHz within the 1920 – 1980 MHz / 2110 – 2170 MHz FDD band. This 3G spectrum was granted to MTC-Vodafone in 2003 as part of a "beauty contest" process.

In addition, Batelco has the right to part of the 3G spectrum. 1x5MHz in the TDD band and 2x15MHz in the FDD band have been reserved for Batelco.

It should be noted that spectrum between 1427 MHz and 2700 MHz is used in parts by the government, potentially conflicting with 3G users. However, the government has been consulted on this matter, and it has been concluded that expected government usage of the 3G spectrum will not be at a level which would impede future 3G assignment.

There is an additional 52.5 MHz of free spectrum in this band (10 MHz + 22.5 MHz + 20 MHz), as shown in Exhibit 13.

Exhibit 14: Current use of spectrum in the 1900 MHz – 2170 MHz band



7.2 Changes made to allocation as a result of the consultation

a) Public mobile services (3G)

Although one organisation has argued that further allocation of spectrum for 3G use could be beneficial for Bahrain, the majority of respondents have agreed with the view that no further allocation should be made for 3G services. The TRA and MoT will therefore **not allocate or assign (pending the consultation) further spectrum** in the 1900 MHz band for future public mobile services, apart from existing 3G allocations. The existing 3G allocations include the spectrum currently in use by MTC-Vodafone, the spectrum reserved for Batelco and the remaining unassigned spectrum (i.e. 50% of the total spectrum allocated to 3G).

The proposed assignment and award mechanism for 3G bands in Bahrain will be **discussed as part of the upcoming consultation on the possibility of granting additional mobile licences**. Future assignment of 3G spectrum will involve the potential deployment (on a technology-neutral basis) of technologies such as TD SCDMA in the TDD band. All respondents who commented on the issue of the assignment of frequencies in the UMTS-TDD band agree that there should not be specific allocation for TD SCDMA, and that the current allocation for the UMTS-TDD frequencies should remain unchanged. Finally, future technology upgrades such as HSUPA / HSDPA will be left to the market to decide.

At the present time, the TRA and MoT believe that the current 3G spectrum allocation will be sufficient to accommodate the need for further 3G roll-out. This allocation is compliant with international standards, and will not be changed.

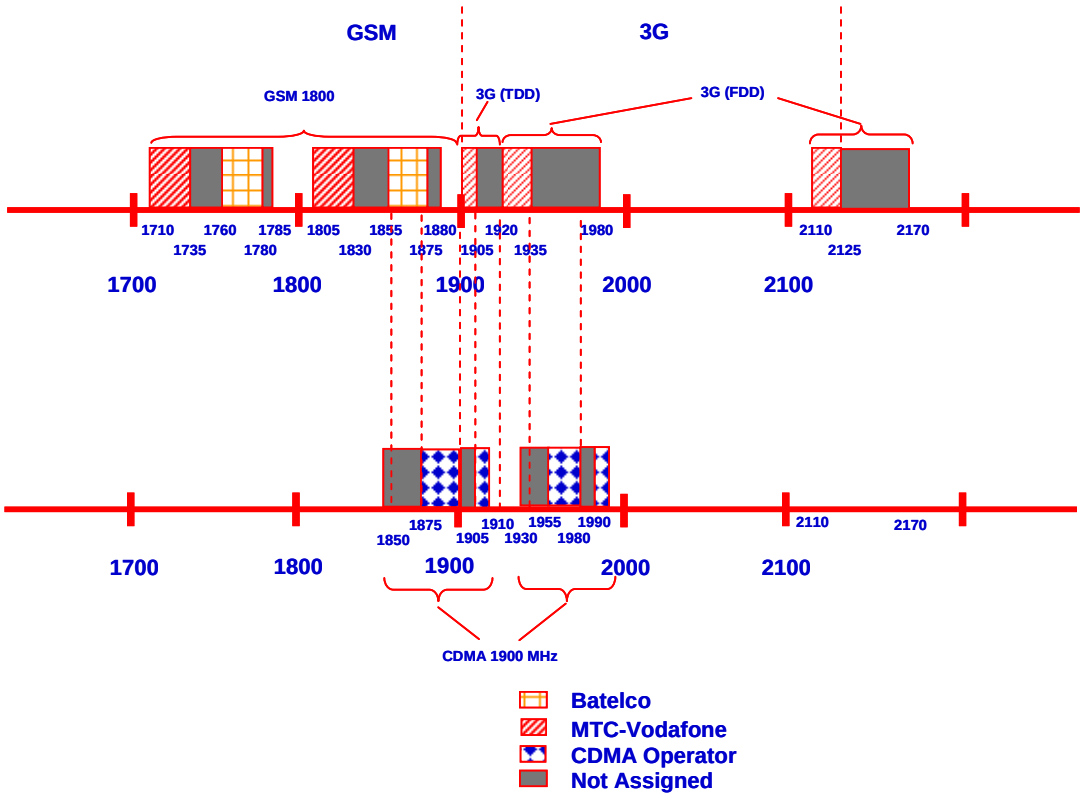
b) CDMA 1900 MHz

Many CDMA networks have been deployed in the 1900 MHz band, and equipment is readily available. However, the position of the 1900 MHz and 1800 MHz bands means that they overlap. Given the assignments already made at 1800 MHz (and to MTC-Vodafone in the 3G band), the amount of spectrum that could be made available for mobile operator licences would be limited to 2 x 25 MHz (1875 – 1900 MHz paired with 1955 – 1980 MHz) plus 2 x 5 MHz (1905 – 1910 MHz paired with 1990 – 1995 MHz).

This is illustrated in Exhibit 15, which also demonstrates how such an assignment would prevent the assignment of 2 x 5 MHz within the 1800 MHz band (1780 – 1785 MHz paired with 1875 – 1880 MHz) and also limit future assignments in the 3G band to one block of 2 x 20 MHz (1935 – 1955 MHz paired with 2125 – 2145 MHz) plus one block of 1 x 5 MHz in the 1910 – 1920 MHz

band. Such an assignment would also preclude the deployment of other systems (e.g., DECT systems in the 1880 to 1900 MHz band).

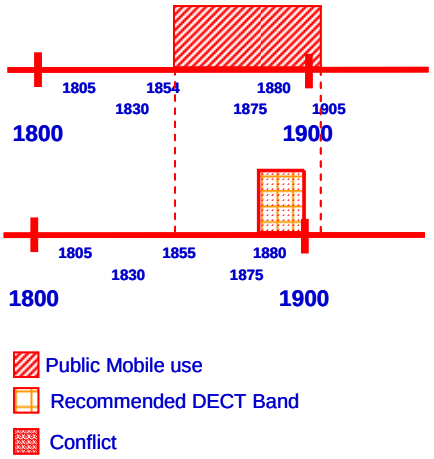
Exhibit 15: Assignment within the 1900 MHz band



c) Fixed Wireless Access

Assigning spectrum from the 1900 MHz bands to FWA applications (e.g. DECT) has a number of disadvantages with regard to the future deployment of public mobile networks. In particular, it restricts further assignments to GSM 1800 spectrum and also limits future assignments within the 3G band. In the case of DECT technology, which can be deployed as part of a high power/public network, the frequencies required are clearly in conflict with existing public mobile networks, as shown in Exhibit 16 below. It is therefore considered inappropriate to use this spectrum for fixed wireless access.

Exhibit 16: **The overlap of DECT spectrum with spectrum already assigned to other uses in Bahrain**



8 Frequencies between 2.3 and 3.4 GHz

8.1 Previous allocation

In line with international benchmarks, the TRA and MoT distinguish between two separate bands within the 2.4 to 2.7 GHz frequencies. As illustrated below, these are the 2.4 GHz band and the 2.5 to 2.7 GHz band.

a) 2.4 GHz

At present there is a conflict of use in the 2.4 to 2.5 GHz part of the spectrum – a situation the TRA and MoT are keen to resolve.

In line with international standards, the 2.4 GHz band (2.4000 – 2.4835 GHz) in Bahrain has been allocated to ISM use.

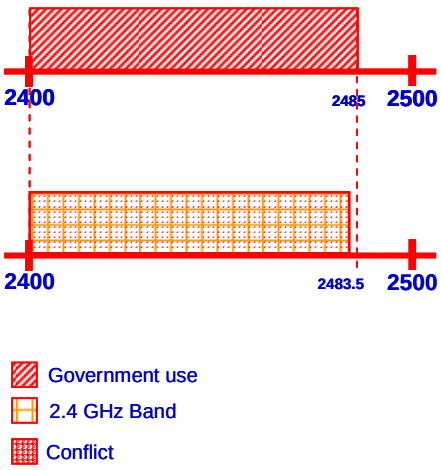
However, an MMDS licence has also been assigned in this frequency band, and most of the spectrum in this band is currently being used by the government.

Many low-power communication devices, such as WiFi and Bluetooth, operate at these frequencies. In most regions, WiFi spectrum allocation has been harmonised in the 2.4 GHz band (although WiFi allocation in the 5 GHz band is still dealt with on an individual country basis).

Temporary WiFi licences have been granted in Bahrain since September 2005. The licences contain specific restrictions and conditions on the power of the WiFi units.

There is currently no specific allocation in this band to other FWA technologies, such as WIMAX or WiBro, in Bahrain. Internationally, these applications are typically allocated in the 2.3 – 3.4 GHz spectrum range.

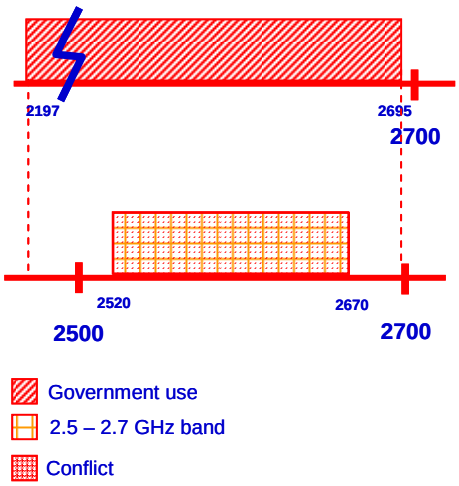
Exhibit 17: **Current assignments in Bahrain within the 2400 to 2483.5 MHz band**



b) 2.5 to 2.7 GHz

At the present time, the 2.5 to 2.7 GHz band is mainly in use for governmental applications.

Exhibit 18: **Current assignments in Bahrain within the 2520 to 2670 MHz band**



8.2 Changes made to allocation as a result of the consultation

a) 2.4 GHz band

The TRA and MoT believe that the 2.4 GHz band should be reserved for WiFi applications, and that current governmental usage of this band should be phased out.

Most laptops currently come equipped with WiFi cards installed for this frequency band, and it is the TRA and MoT's view that they should encourage the development of a technology which has been very popular in most other markets.[3]

Any licensed fixed wireless user would have to share the frequencies with multiple other users, and would be unable to receive the quality of service normally associated with telecommunications services. Therefore, the TRA does not believe that it would be appropriate to license exclusive frequencies from this band to fixed wireless access licensees.

Like all ISM bands (including 2.4 GHz and 5.8 GHz), the 2.4 GHz band is likely to become crowded with many users of spectrum running different types of application, both civilian and other. In the short term, all users in this band should be able to co-exist, using the dynamic frequency selection and the transmission power control features of WiFi and WiMAX technologies to prevent harmful interference amongst users. In the long term, all users with stringent quality of service requirements are advised to migrate to other parts of the spectrum.

The TRA will reserve spectrum in the 2.4 GHz band and issue licences using a **light licensing scheme** along the lines established in section 3.3. All users in this band will have output power limitation.

All users will have to be licensed, in accordance with the light licensing regime described in section 3.3.

b) 2.5 – 2.7 GHz

Due to current usage of the spectrum, it will not be possible to allocate the spectrum in the 2.5GHz to 2.7GHz band at this time, but the TRA and MoT will start to review with the users if it would be feasible in the long term to migrate out of these bands. .

[3] WiFi is also deployed on an international basis in the 5.725 – 5.850 GHz ISM band.

c) 2.3 GHz

In addition to the separation of the 2.4 GHz band and the 2.5 to 2.7 GHz band, the TRA and MoT would theoretically wish to allocate further spectrum at 2.3 GHz, with the intention of opening the band up to WiBro and WiMAX applications on a technology-neutral basis. WiBro is a particular configuration of WiMAX wireless technology, and a flexible channelling and duplexing allowance would permit the application of both these and related technologies in this band. Governmental applications are currently in conflict with an assignment of spectrum at 2.3 GHz to wireless applications, and therefore the TRA and MoT will discuss with the current users of this spectrum whether any alternative arrangement can be reached.

9 Frequencies between 3.4 and 10 GHz

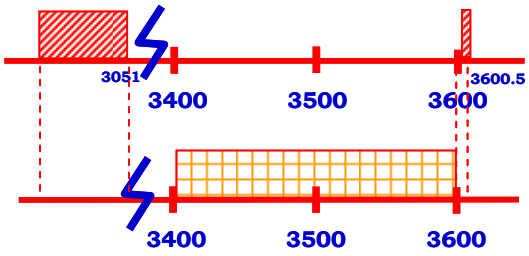
9.1 Previous allocation

a) 3.4 to 4.2 GHz band

The 3.4 to 4.2 GHz band is allocated on a co-primary basis to fixed services in all three ITU-R regions, and the potential for a global market has made it popular with vendors of fixed wireless access (FWA) equipment. The 3.4-3.6 GHz band has been recommended as a preferred band throughout ECC/CEPT countries for FWA systems, and several countries have licensed 'exclusive use' spectrum to operators.

In Bahrain there are no commercial assignments to fixed wireless access at 3.5 GHz. Radar services are allocated close to this band and have stringent protection requirements.

Exhibit 19: Current assignments in Bahrain within the 3400 to 3600 MHz band



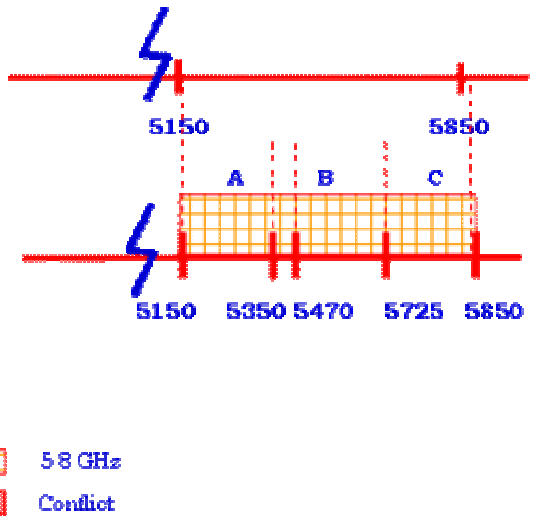
b) 5 GHz band

It should be noted that this document refers to 5150 to 5350 MHz (Band A) and 5725 to 5850 MHz (Band C).This band has been targeted by the ECC/CEPT for WLAN and BFWA services.

At present, no FWA licences have been granted in the 5 GHz band.

The spectrum between 5470 and 5725 MHz (Band B) is currently assigned to government use..

Exhibit 20: Current assignments in Bahrain within the 5 GHz band



c) VSAT

Internationally, some VSAT services have been assigned in frequency bands between 3.4 and 10 GHz (the C Band and Extended C Band). However, in Bahrain, only the Ku-Band (14 to 14.5 GHz) is currently assigned. A more detailed discussion on VSAT can be found in the next chapter.

9.2 Changes made to allocation as a result of the consultation

a) 3.5 GHz band

The amount of spectrum available in the 3.5 GHz band would permit the licensing of two operators, in this band. The number of operators to be licensed is limited by the need to prevent interference among current users of the band as well as ensuring that the spectrum is adequate for commercial use. From the responses received and the spectrum constraints, it appears that 2 licences will be the optimum number to award in this band.

The allocated spectrum which will be assigned will be 2x45 MHz per licence:

- One licence in the frequencies 3.410-3.455 GHz paired with 3.500-3.545 GHz
- One licence in the frequencies 3.455-3.500 GHz paired with 3.545-3.590 GHz

These licences will prohibit the provision of mobile but not nomadic services. Nomadic services are defined as applications of wireless access in which the location of the end-user termination may be in different places but it must be stationary while in use. In practical terms and as opposed to wireless services, no handover between cellular coverage is allowed in nomadic environments.

These licences will also be technology-neutral, but any licensee will be required by the TRA and MoT to demonstrate that the technology chosen would not cause interference to other users of the spectrum.

The most appropriate method of awarding this spectrum to potential operators is by auction.

b) 5 GHz band

The TRA and MoT are, in favour of a light licensing regime for fixed wireless access services in these bands. Given the shared use of spectrum, licensed fixed wireless operators in these bands may be unable to offer the quality of service normally associated with telecommunications services. Therefore, it would not be appropriate to license exclusive frequencies from these bands to fixed wireless access operators. The light licensing regime will follow the guidelines established in section 3.3.

The band 5.470 GHz to 5.725 GHz band is assigned exclusively to the government.

Like all ISM bands (including 2.4 GHz and 5.8 GHz), the 5.8 GHz band is likely to become crowded with many users of the spectrum running different types of application, both civilian and non-civilian. In the short term, all users in this band should be able to coexist, using the dynamic frequency selection and the transmission power control features of the relevant technologies to prevent harmful interference amongst users. In the long term, all users with stringent quality of service requirements should be advised to migrate to other parts of the spectrum.

c) VSAT

The frequency bands currently allocated in Bahrain for VSAT services (14 GHz to 14.5 GHz band) are in line with international standards and, at present, there is **no need to allocate additional capacity** with the C Band or Extended C Band.

d) The case of Ultra Wide Band (UWB)

UWB operates in two bands of the spectrum, 3.2-4.8 GHz and 6-10 GHz.

The main issue with UWB comes from potential interference with other users, particularly if UWB becomes widely popular and a large number of UWB units get deployed. Currently, the US and Europe are trialling the technology and assessing the potential impact of UWB on other spectrum users.

The TRA and MoT believe that it is currently premature to allocate spectrum for UWB in Bahrain. It is also untimely to allow the deployment of UWB equipment until trials in other countries can assess the impact of UWB on other spectrum users. The TRA and MoT will therefore delay the frequency allocation, assignment and equipment type approval for UWB in Bahrain until the testing of the technology in other countries has proven successful.

10 Frequencies between 10 and 20 GHz

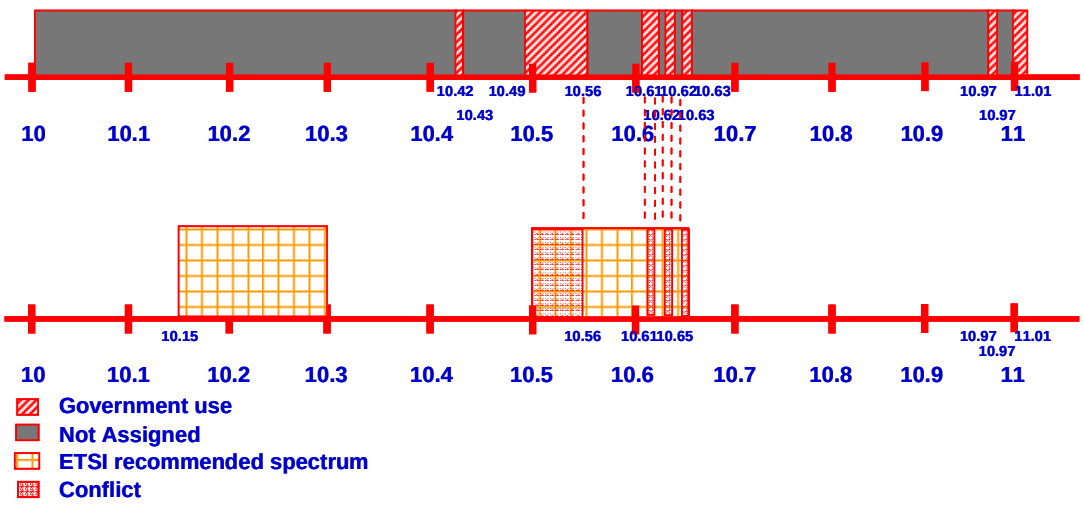
10.1 Previous allocation

a) 10 GHz

The 10 GHz band is also identified by ECC/CEPT as a preferred band for FWA. However, as in many other countries, there are conflicts in Bahrain between the currently assigned spectrum in the 10 GHz band and the proposed CEPT spectrum allocation (particularly in the 10.50 – 10.56 GHz and 10.61 – 10.65 GHz bands, which are in use by the government).

Consequently, there is currently no assignment for FWA in Bahrain in these bands.

Exhibit 21: Current frequency allocation 10 GHz Bahrain



b) VSAT

Internationally, VSAT services are allocated in one of three bands: C Band, Extended C Band and Ku Band. In Bahrain, only the Ku Band (14 to 14.50 GHz uplink; 10.95 to 11.70 GHz downlink) is used.

VSAT licences in Bahrain have been assigned on a First-Come-First-Served basis. VSAT and commercial licences (IFL) are subject to an initial fee and a recurring charge of 1% of gross annual turnover attributable to licensed activity. Current VSAT pricing is proportional to the amount of activity generated by the VSAT and IFL (VSAT-based solutions) licence.

10.2 Changes made to allocation as a result of the consultation

a) 10 GHz

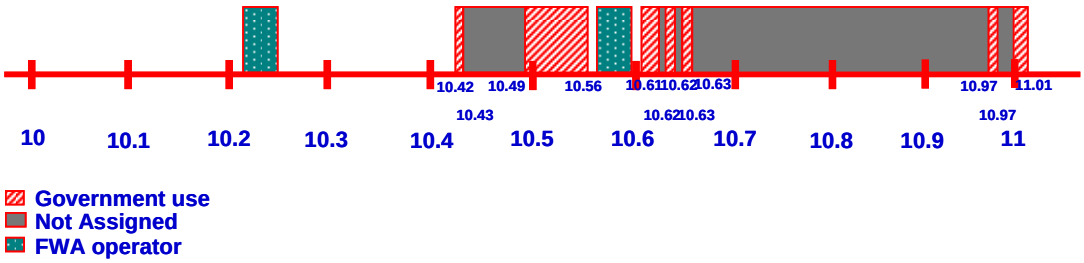
The TRA and MoT will allocate and assign spectrum for FWA in the 10.21-10.25 GHz band, paired with the 10.56 – 10.60 GHz band, enough for a sole FWA operator. This will give the potential FWA operator 2 x 40 MHz worth of spectrum.

Given the demographics of Bahrain and the potential to allocate FWA licences in other parts of the spectrum, the TRA and MoT believe that **one FWA licence in the 10 GHz band** should be sufficient for the needs of the Kingdom.

This will be awarded through an **auction mechanism** and revert to FCFS if insufficient interest is expressed.

The TRA and MoT do not believe at this point that they should enter into discussions with the government to free additional spectrum in the 10 GHz band for FWA use.

Exhibit 22: **Allocation / assignment for FWA spectrum in the 10 GHz band**



b) VSAT and other

As stated in the previous section, the current frequency allocations for VSAT will continue in the Ku-Band (14.00 to 14.50 GHz) and the TRA will continue to award individual licences on a First-Come-First-Served basis. On pricing, going forward, there will be a licence fee and a spectrum fee for private and public users.

Other fixed satellite services

Fixed satellite services include a range of services mostly out of the range of the TRA's direct jurisdiction (broadcast and international communications). However, some fixed satellite services need to be addressed by the TRA, particularly the

use of fixed satellite to provide services to ships and planes. As is the case with all other users of spectrum in Bahrain, planes and ships will need to obtain a licence from the TRA in order to use fixed satellite services while within the territory of the Kingdom of Bahrain. Non-civilian vessels and planes will be exempt from this requirement.

Mobile-Satellite Services

Mobile-satellite services refer to the delivery of mobile services to end users using satellite communications (e.g. Thuraya). No provision for mobile-satellite services will be made at the current time, as no interest has been expressed.

11 Frequencies between 20 and 50 GHz

11.1 Previous allocation

a) 26 and 28 GHz bands

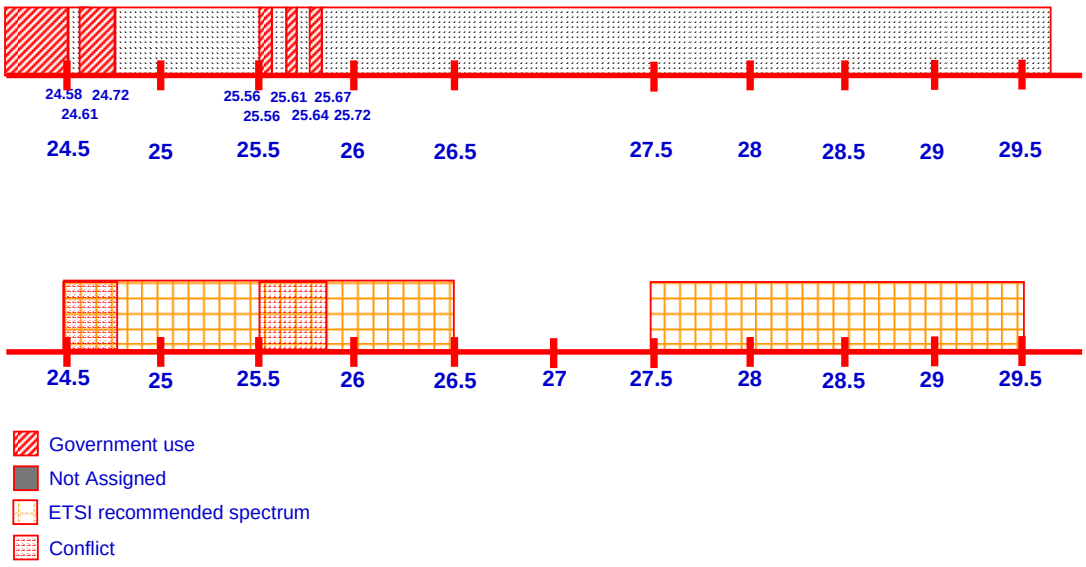
These bands (24.5 to 26.5 GHz and 27.5 to 29.5 GHz) are allocated to FWA by ECC/CEPT. In some cases these applications are shared with fixed point-to-point links and satellite services. The larger bandwidth available makes these allocations useful for high-capacity connections with large business premises.

The two bands have very different current assignment profiles:

- The 26 GHz band (24.5 GHz to 26.5 GHz) is currently partly used by the government (see Exhibit 23).
- The 28 GHz band (27.5 GHz to 29.5 GHz) is currently free of any assignment and could be used for FWA. The band is shared on a co-primary basis between Fixed Services, Fixed Satellite Services and Mobile Services.

There is currently no assignment for FWA in Bahrain in either the 26 GHz or 28 GHz bands.

Exhibit 23: Current frequency allocation 26/ 28 GHz Bahrain



b) 40 GHz band

This band was designated for "Multimedia Wireless Systems" (MWS) by ECC/CEPT. MWS refers to terrestrial multipoint systems that provide fixed wireless services with very high bandwidth (sufficient for a host of broadcast services as well as high-speed two-way telecommunications, such as VoD, gaming, etc.). This band is potentially a key resource for developing the next generation of broadband services.

The band is currently allocated to a range of services. The 40.5 - 42.5 GHz band is allocated on a co-primary basis to broadcasting, broadcasting-satellite, fixed and fixed satellite. The 42.5 - 43.5 GHz band is allocated to fixed, fixed satellite and radio astronomy services. There is currently no assignment for any service in this band in Bahrain.

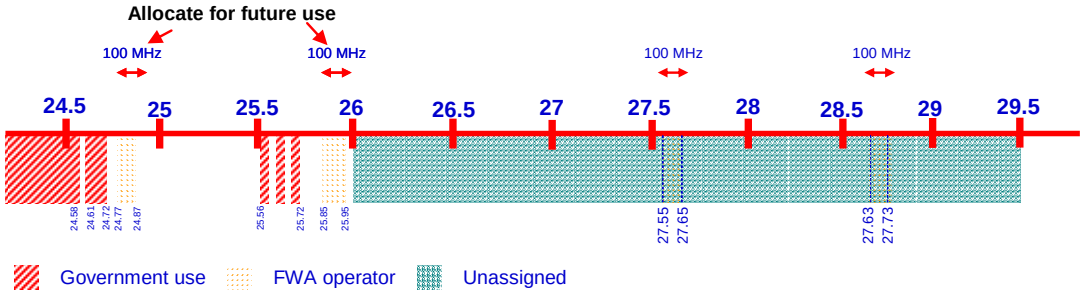
11.2 Changes made to allocation as a result of the consultation

a) 26 and 28 GHz bands

The TRA and MoT will allocate and assign 2 x 100 MHz of spectrum (paired) for **one FWA licence** between 27.55 - 27.65 GHz and 27.63 - 27.73 GHz in the 28 GHz frequencies, as no significant requirements for other applications were expressed for spectrum in this band. **Licences will be awarded by auction**, unless insufficient interest is expressed, in which case assignment will revert to a FCFS basis. 2 x 100 MHz of spectrum (paired) will also be reserved for future FWA use between 24.77 and 24.87 GHz and between 25.85 and 25.95 GHz.

The two bands (26 GHz and 28 GHz) represent a significant amount of spectrum, which could be assigned for civil use and public operators. However, experience in other countries shows that the commercial roll-out of FWA services can be challenging. Given the size of Bahrain, the TRA and MoT believe that only a limited number of licences awarded to public FWA operators will eventually be commercially viable, and therefore the TRA and MoT will carefully take into account all requirements for spectrum by different types of users.

Exhibit 24: Revised spectrum allocation in the 26 / 28 GHz bands



b) 40 GHz

Although the band holds interesting future prospects, it seems premature for the TRA and MoT to allocate and assign any spectrum in the 40 GHz frequency. The TRA and MoT will wait for the results of the assignment in the 26 / 28 GHz bands before acting on the 40GHz. The TRA and MoT are also in favour of waiting for the initial feedback on the award of pioneer licences in this band in Europe. For the time being and in line with responses to the public consultation, the MoT will allocate the 40.5 - 43.5 GHz spectrum for future FWA operator licences, but the TRA will not assign any spectrum at this point.

12 Other "non-spectrum" technologies

12.1 FSO

Free-Space Optics is an alternative technology to traditional fibre optics, using laser beams between buildings with line of sight. Since the technology uses light and not spectrum, FSO will not have a direct impact on frequency allocation. However, FSO equipment is subject to type approval (please refer to the FSO type approval guidance on the TRA's website). Users may be charged an administrative fee for the corresponding FSO equipment type approval (for private or public users).

13 Glossary

2G: second generation mobile telephony systems - digital

2.5G: term used to describe the enhancements to 2G systems enabling higher and/or more efficient data throughput. These include GPRS and EDGE

3G: third generation mobile telephony systems, currently being deployed, offering higher data rates than previous generations

3.5G: term used to describe the enhancements to 3G systems. These are technologies under development to allow even higher data rates over a 3G air interface

4G: term used to describe the concepts behind the next generation of mobile telephony systems. Although the term is currently used, it does not refer to a specific existing technology

AIP: Administrative Incentive Pricing. A fee charged to users of the spectrum to encourage them to make economically efficient use of it

Allocation: the process of identifying specific ranges for specific applications; or a frequency band entered in a table of frequency allocations, for use by a particular category of service

Analogue: as opposed to digital. The traditional method of modulating signals so that they can carry information

Assignment: authorisation given by a licensing authority for an entity or individual to use a specific band of spectrum under specified conditions

Band: a defined range of frequencies that may be allocated for a particular service (telecom or broadcast) or shared between services

CDMA: Code Division Multiple Access, a radio access method where individual traffic transmissions use the same frequency, but where users' traffic is separated by means of different codes.

cdma2000: 3G mobile phone standard built on the CDMA technology. Belongs to the IMT-2000 family of standards.

cdma450, cdma1800, cdma1900: terms used to describe CDMA technologies deployed in these specific bands (450 MHz, 1800 MHz, 1900 MHz)

cdmaOne: commercial name of the 2G mobile phone systems based on CDMA

CEPT: Conference of European Postal and Telecommunications administrations, comprising over 40 European administrations

Co-ordination: refers to the process under which a new user seeks the agreement of existing users to share access to a particular range of frequencies while avoiding harmful interference

DECT: Digital Enhanced Cordless Telecommunications: an access technology used in private cordless telephone equipment

Digital PAMR: a fully digital implementation of PAMR

DSL: Digital Subscriber Line: a technology allowing data transmission over existing copper telephone cables that increases the data capacity above that of traditional dial-up rates

E-GSM: Extended GSM. Extension of the GSM band to cover a larger frequency range

EDGE: Enhanced Data Rates for Global Evolution: an access technology that delivers data to mobile devices at data rates higher than those possible with GSM/GPRS

EIRP: Equivalent Isotropically Radiated Power: theoretical measure of the power radiated by a transmitter/ antenna – defined as the product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna

ETSI: European Telecommunications Standards Institute. A European industry group that produces standards for telecommunications systems and equipment

FDD: Frequency Division Duplex. A transmission method where the downlink/downstream and the uplink/upstream paths are separated by frequency

Fixed Links: communications links between fixed points. Such links may be uni-directional or bi-directional

FS: Fixed Services. Radio service where all ground-based transmissions are to and from fixed, non-mobile, stations

FSO: Free-Space Optics. Alternative technology to traditional fibre optics using laser beams between buildings with line of sight

FSS: Fixed Satellite Services. A satellite system, where the ground or earth station is fixed during transmission and/or reception

FWA: Fixed Wireless Access. Radio link to the home or the office from a base station giving access to telecommunications services

Guard band: frequency band deliberately kept vacant between assignments to give a level of protection to users on either side from mutual interference

GHz: Gigahertz. A unit of frequency equal to one billion Hz or cycles per second

GPRS: General Packet Radio Service: a method of implementing packet data services over GSM 2G networks allowing services such as internet browsing and emails

GSM: Global System for Mobile communications or "Groupe Spéciale Mobile". A 2G mobile technology behind the vast majority of 2G mobile phones used across the world. GSM is the dominant digital mobile standard.

GSM 400, GSM 900, GSM 1800, GSM 1900: terms used to describe GSM technology deployed in these frequency bands (400, 900, 1800 and 1900 MHz)

GSM-R: variant of the GSM standard developed specifically for use by the railways

HSDPA/HSUPA: High-Speed Downlink/ Uplink Packet Access: an add-on access component used to enhance the data speed to the end user on 3G/UMTS networks

IEEE: Institute of Electrical and Electronics Engineers. US-based standardisation organisation that produces equipment standards for, amongst other things, radio access systems

IMT-2000: International Mobile Telephony 2000. A family of global standards for mobile phone networks proposed by the ITU. Also referred to as 3G

Interference: the effect of unwanted signals on the reception of a wanted signal in a radio system, resulting in the degradation of performance and misinterpretation or loss of information compared with that which would have been received in the absence of the unwanted signal

ITU: International Telecommunication Union: international organisation within the United Nations system where governments and the private sector coordinate, discuss and agree the logistics of global telecom networks and services

KHz: kilohertz. A unit of frequency equal to 1000 Hz or cycles per second

Licence exemption: allowing anyone to use the spectrum for any application under certain specified restrictions but typically with maximum power levels. Licence exemption is not allowed by law in Bahrain

MHz: megahertz. A unit of frequency equal to 1 million Hz or cycles per second

Mobile satellite: a service between mobile earth stations and one or more space stations

MoT: Ministry of Transportation

MWS: Multimedia Wireless Systems. Term created within the CEPT project teams to describe a converged wireless platform that would supply two data services, video-on-demand and broadcasting

OB: outside broadcast. The use of radio in the production of film or television programming

Ofcom: Office of Communications. UK regulator

PAMR: Public Access Mobile Radio. A mobile radio service where a number of different organisations have access to a common radio system

PDC: 2G mobile phone system used in Japan

Point-to-Multipoint: Fixed radio system that transmits from a central point to multiple users and/or multiple sites

Point-to-Point: Fixed radio system that transmits between two users

PMR: Private Mobile Radio. A private radio service installed and operated by businesses and public sector organisations to provide mobile communications for their own workforce

PMSE: Programme Making and Special Events: a collective term used to describe the provision of news, film, television, stage, concert and sports programming through the use of radio

Primary: term used to indicate that a frequency allocation for a particular service has priority over other services in the same band. Services can also be "co-primary" (e.g. fixed and mobile), i.e. have equal priority

Primary assignment: initial allocation of spectrum by a regulator

Radio spectrum: a section of frequencies of electromagnetic radiation in the range of approximately 10 kHz to 3000 GHz

Secondary: term applied to services which can be assigned spectrum with a lower level of priority. Stations of a secondary service should not cause harmful interference to primary services or claim protection from harmful interference from primary services

Spectrum trading: process through which spectrum licence holders are able to transfer some or all of their rights to a third party

TDD: Time Division Duplex. A transmission method where the downlink/downstream path and the uplink/upstream path are separated by time

Terrestrial radio service: any radio service other than a space service or radio astronomy

TETRA: Terrestrial Trunked Radio. An ETSI standard for digital mobile radio utilised by fleets of vehicles such as emergency services, courier companies, etc.

TRA: Telecommunications Regulatory Authority

UHF: Ultra High Frequency. Term used to describe frequencies in the range 300 MHz to 3 GHz

UMTS: Universal Mobile Telecommunications System. A 3G mobile phone standard built on W-CDMA technology. One of the IMT-2000 family of standards. This is the standard being deployed by the vast majority of European mobile phone operators to offer 3G services

UWB: Ultra Wide Band. A technology that spreads a low-power signal over a wide range of frequencies

VHF: Very High Frequency. Term used to describe frequencies in the range 30 to 300 MHz

W-CDMA: Wideband-CDMA. A version of CDMA that has a bandwidth wider than that defined in the original CDMA consideration. W-CDMA is considered the 3G upgrade path from GSM networks

WiFi: Wireless Fidelity short range wireless broadband technology that allows internet access on a nomadic basis (e.g. in hotspots such as hotels, airports, coffee shops, etc.). WiFi is built on the IEEE802.11 series of standards.

WiMAX: Worldwide Interoperability for Microwave Access, fixed broadband wireless access technologies based on the IEEE802.16 and ETSI HiperMAN series of standards.

WRC: World Radiocommunications Conference