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TELECOMMUNICATIONS REGULATORY AUTHORITY

United Arab Emirates

UAE Spectrum Outlook (2020–2025)

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Table of Contents

1. INTRODUCTION AND OBJECTIVES 3

2. INNOVATIVE APPROACHES TO SPECTRUM PLANNING 5

3. REVIEW OF WIRELESS SYSTEMS DEVELOPMENTS 7

3.1 International mobile telecommunications 7

3.2 Fixed radio systems 9

3.3 Satellite 9

3.4 Broadcasting 10

3.5 Programme making and special events 11

3.6 Private mobile radio 12

3.7 Ultra-wide band and short-range devices 13

3.8 Intelligent transport systems 14

3.9 Aeronautical radio systems 15

3.10 Maritime radio systems 16

3.11 Unmanned aircraft systems 16

3.12 Amateur radio 17

4. INDICATIVE SPECTRUM RE-PLANNING ROADMAP 18

5. IMPACT OF THE UAE SPECTRUM OUTLOOK 36

ANNEX A–LIST OF ACRONYMS AND ABBREVIATIONS 37

1. Introduction and objectives

Radio spectrum is the cornerstone of wireless connectivity, but is a scarce resource that all wireless systems depend on for their operation. The way spectrum is managed and the way its concurrent and different users access it will enable industries to digitalise and thrive or may alternatively impede the development of entire parts of the economy. This is therefore a prime area for the TRA to focus on given its increasing economic and social value.

Connectivity, supported by information and communications technologies more broadly, is the fundamental prerequisite for all the platforms that form part of the developing 'digital lifestyle', powered by smart devices, smart systems and smart services. Wireless connectivity in all sectors will become a basic human need, as wireless connectivity will bring flexibility and ubiquity to the digital lifestyle.

The "UAE Strategy for the Future" encourages all government entities to focus on future topics that include amongst others:

- the future of technology and smart systems
- the future of the infrastructure and transportation
- the future of economy and economic and commercial security
- the future of the government and governmental services
- the future of positive and happy life environment.

In its endeavour to contribute towards the "Digital UAE", the TRA has prepared a Spectrum Outlook for the period 2020–2025 based on meeting future wireless connectivity needs, accounting for the evolution of wireless technologies, market demands, changing lifestyles, smart and connected living. The "UAE Spectrum Outlook" is the output of a comprehensive future-looking exercise to reflect the aspirations for the UAE's wireless sector over the coming years. This includes proposed changes to the way that spectrum is used to address the major wireless sectors and their growing demands for wireless connectivity.

As part of the development exercise to prepare the UAE Spectrum Outlook, the TRA has taken account of a broad range of considerations:

- abiding to the key principles governing all the TRA's activities, as listed in the Radiocommunication Policy
- achieving the TRA's objectives for frequency spectrum management as presented in the Radiocommunications Policy
- assessing local and global, demand and technology trends as well as understanding the main future challenges which could affect spectrum management in the UAE
- studying the international experience in preparing future-looking spectrum strategies, and in particular other spectrum outlook documents developed in leading countries such as Australia, Canada, Ireland, New Zealand and the UK

- collaborating with the industry and incorporating feedback from industry stakeholders, with a public consultation held in October/November 2019.

The paramount objective of developing the "UAE Spectrum Outlook" is to give the industry the confidence that frequencies will be available to meet future demand, and also to give existing spectrum users confidence that spectrum will continue to be available to meet their needs. This will allow spectrum users to make informed long-term decisions and allow technological advancements to develop and mature in the UAE market.

The TRA has set a five-year horizon for the "UAE Spectrum Outlook", because the TRA believes that this period is sufficient to give a reasonable level of predictability to the industry, while considering the rapid pace of change in wireless technology and shifting demands of various spectrum users. Furthermore, this period is in line with international practice and the industry has expressed its satisfaction at this time horizon. Notwithstanding the above, the TRA may revisit from time to time some aspects of the plan within the 2020–2025 period.

In order to highlight the main issues that should be covered in the UAE Spectrum Outlook (2020–2025), the TRA has explored different aspects that affect spectrum needs and usage in the UAE and developed the outlook document in the following way:

- In Section 2, considers the challenges of spectrum management and the alternative spectrum management approaches that are emerging internationally in terms of assignment, change of use and sharing. The TRA will have to consider whether changes are needed to the UAE spectrum management framework.
- In Section 3, the outlook then reviews key wireless developments such as the demand for services and technology trends affecting the main categories of radio system and service, which are subject to TRA national regulation. Based on this review, the TRA highlighted a number of issues in relation to the potential changes in needs and demand for spectrum in the next five years.
- Section 4 of the UAE Spectrum Outlook (2020–2025) identifies the main actions for the TRA in the next five years, mostly on the basis of the analysis in Sections 4 and 5, also taking into account international developments such as decisions taken internationally at the recent World Radiocommunication Conference in Sharm el-Sheikh (WRC-19), and future studies that will be conducted in accordance with the agenda for the next WRC, in 2023, as well as the provisional agenda for WRC-27. Actions for the TRA to take to reflect these developments include the consideration for a change of use of spectrum, sharing frameworks, new allocation and assignments. The TRA will then undertake spectrum re-planning activities, technical and sharing studies, prepare UAE positions for regional and international study groups on radio and spectrum matters, follow international developments and update the national frequency plan and spectrum regulations accordingly.
- Section 5 finally provides a high-level assessment of the impact of the UAE Spectrum Outlook, highlighting the expected benefits for the UAE from the outlook.

2. Innovative approaches to spectrum planning

Regulators worldwide are exploring new spectrum planning approaches to maximise spectrum efficiency, enable new uses and, where relevant, allow for more dynamic and adaptive spectrum assignment and use, including shared use of spectrum enabled through databases or spectrum access systems (SAS). Dynamic spectrum access techniques have been reviewed internationally in ITU-R Report SM.2405, "Spectrum management principles, challenges and issues related to dynamic access to frequency bands by means of radio systems employing cognitive capabilities"[1]. The ITU-R report notes the need for regulators to weigh up a range of considerations – including cross-border frequency co-ordination with neighbouring countries, efficient use of spectrum and complexity of implementation (e.g. of SAS databases) – before taking a decision on implementing an innovative future spectrum management approach.

As per current regulations, the TRA aims to ensure spectrum is allocated, assigned and used efficiently in the UAE. The TRA recognised that the rapid development of new technologies requires an increasingly dynamic and flexible approach to spectrum planning, while taking into account the needs of the UAE market.

The TRA has noted from responses to the public consultation on the draft Spectrum Outlook published on 30 September 2019, that a number of stakeholders are interested in seeing greater use of spectrum-sharing approaches in some spectrum bands in the UAE.

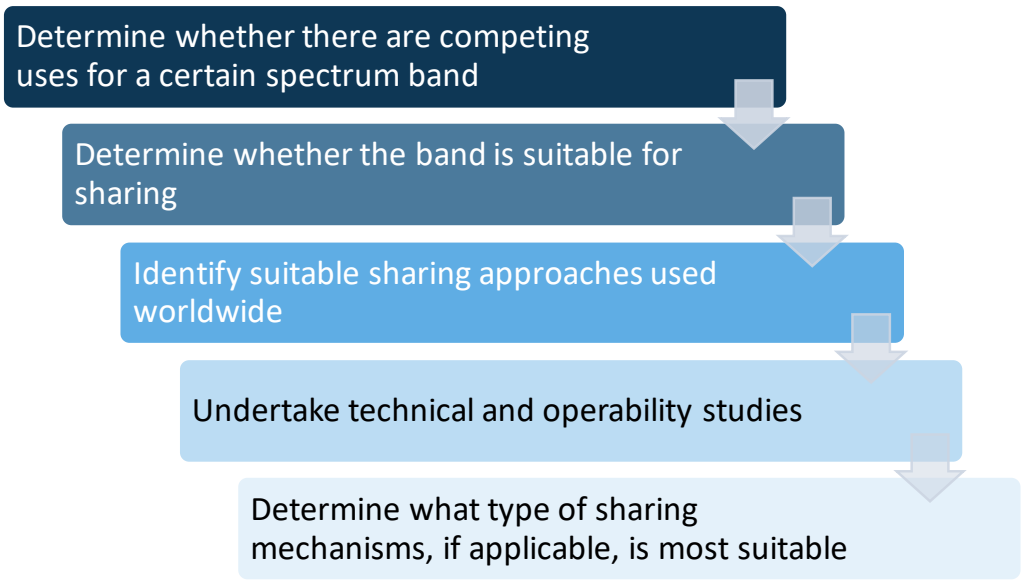
Within the next five years, the TRA will study the feasibility of applying approaches identified as relevant in the UAE. In light of these studies and within the UAE's legal, technical and regulatory framework, the TRA will consider whether changes are needed to UAE spectrum planning to allow for greater flexibility, use of novel spectrum sharing approaches and/or other emerging spectrum planning approaches. In the event that the TRA identifies that future spectrum planning approaches require changes to the UAE's legal and regulatory framework for use of spectrum, the TRA will identify the revisions needed, to enable the identified actions.

One consideration that the TRA will reflect in its future studies on future planning approaches in the UAE is that spectrum planning approaches tend to be market specific, taking account of incumbent uses and emerging local market needs. For example, several spectrum-sharing approaches have been applied in certain markets such as the Citizens Broadband Radio Services (CBRS) approach being applied in the 3.5GHz band in the USA or 'licensed shared access' methods being considered in the 2.3–2.4GHz band in some markets in Europe. However, these initiatives have been market specific with limited scope for regional and/or international harmonisation on approaches to occur.

[1] https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-SM.2405-2017-PDF-E.pdf

Whilst the TRA can learn from developments in other countries, further work is needed in the UAE market to identify relevant new planning approaches, and also, where pertinent, suitable bands for shared use.

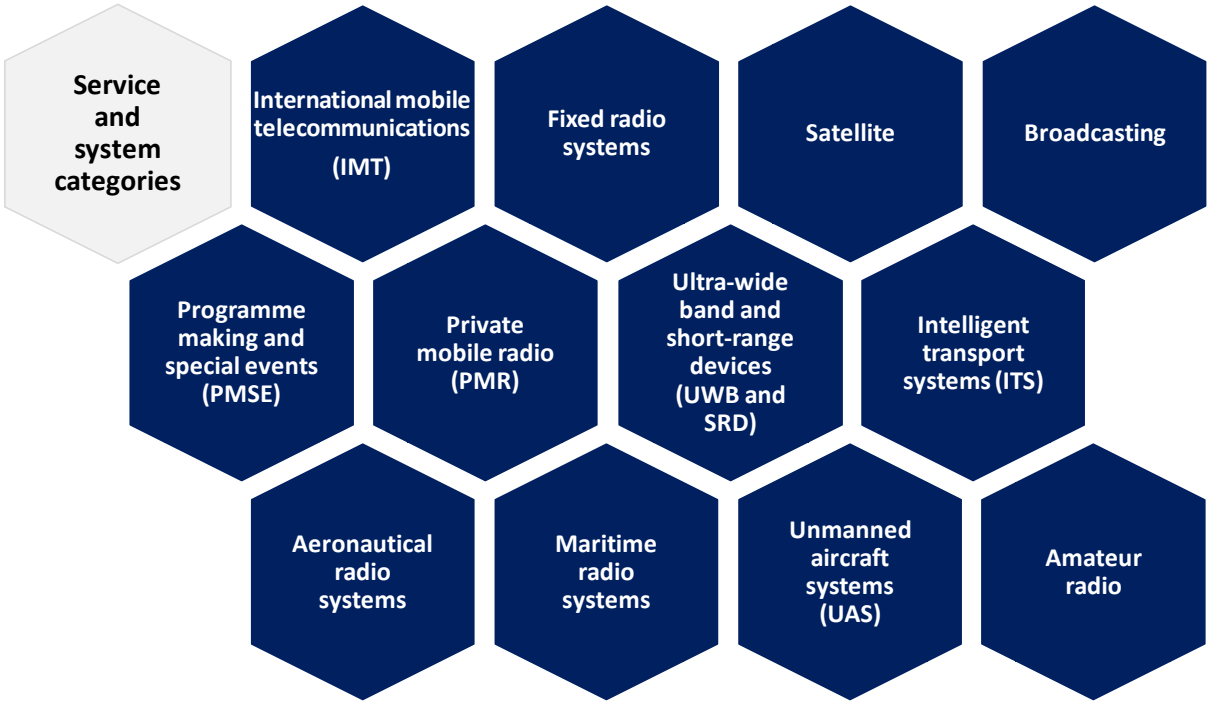
The diagram below shows a high-level illustration of the process the TRA will undertake to understand whether sharing mechanisms are relevant for certain bands in the UAE.



3. Review of wireless systems developments

The TRA has looked into wireless systems developments in terms of demand trends and technology that which will affect the demand for spectrum in the future, to understand the issues the wireless industry is going through and which need to be tackled by the TRA in the years to come. The UAE Spectrum Outlook should define relevant actions which help the industry to address those issues and support the development of the industry.

The review of technological trends and demand follows the categorisation of radio services and systems that are subject to TRA national regulations, as follows:



The TRA has taken into consideration frequencies from 3kHz to 94GHz, i.e. the frequencies allocated in the TRA's current National Frequency Plan and in use. There are currently no frequencies in use above 94GHz in the UAE.

Based on this review, a number of developments have been highlighted in relation to the potential changes in needs and demand for spectrum.

These developments are presented in the sub-sections below:

3.1 International mobile telecommunications

3.1.1 **Present status**: The two telecoms licensees (operators), Etisalat and du, are authorized to offer all telecoms services including public cellular mobile services also known as International Mobile Telecommunications (IMT). The two licensees have deployed the IMT networks supporting different air interfaces like GSM (2G), UMTS (3G), LTE (4G) and OFDM (5G), using spectrum in various bands from 700MHz to 3.8GHz. It is the operators' domain to decide on air interface and

network management as the TRA maintains a technology-neutral approach. Both operators are currently in the process of enhancing the coverage of IMT(5G) networks in line with international technology and standards developments in the mobile sector, with IMT(5G) already commercially available in several urban areas. 5G has been launched in the UAE, providing enhanced mobile broadband (eMBB) and fixed broadband wireless access (FWA). The operators are expected to deploy 5G nationwide to offer greater capacity, scalability, reliability and flexibility in order to cater for new and evolving mobile demands including the needs of industrial users, and the Internet of Things (IoT).

3.1.2 **Future trends for IMT**: Further development of IMT(5G) is the most significant evolution that is expected in the mobile market: by 2025, it is expected that 5G networks will offer near-nationwide availability in the UAE and will support new and innovative use cases. Implementing 5G networks is a key step towards a full digital transformation in mobile networks, bringing considerable improvements in capacity, speed, reliability and latency, and forming the basis of a wealth of new applications. Over time, 5G is expected to support new solutions and services (use cases), e.g. smart cities, intelligent transportation system, etc. It will be important for such solutions and services to be able to develop in the UAE and the TRA has issued a “UAE Strategy for 5G and beyond” also for the period 2020–2025. The future trend for IMT will be access to more frequency bands in millimetre wave (mmWave) above 24GHz for capacity and high throughput. For coverage, additional frequency bands will be required below 1GHz.

3.1.3 **Spectrum outlook for IMT**: The TRA will strive to maintain alignment with ITU-R, 3GPP standards and regional agreements (GCC and ASMG), given the importance of keeping spectrum harmonised – this means translating all WRC-19 decisions related to mmWave into the local regulatory framework and participating in future studies in the relevant ITU-R study groups on future IMT spectrum issues. The TRA will also continue participating in regional spectrum groups such as the GCC Technical Committee and ASMG to build a harmonised strategy for the region, such as the ASMG agreement in December 2018 to allocate 3.3–3.8GHz band for IMT.

The TRA will undertake its re-planning and sharing studies to allow deployments of IMT in the mmWave bands identified at WRC-19. Some existing allocated frequency ranges for IMT in the UAE will also require re-planning to make allocations contiguous for enhanced efficiency. The TRA will endeavour to take into account the needs of other uses such as satellite services to ensure service compatibility and protection where relevant. Additional frequency ranges will be considered at WRC-23 and WRC-27 for novel uses such as UAS operating on IMT networks.

3.2 Fixed radio systems

3.2.1 **Present status:** The licensees Etisalat and du are currently the main users of fixed services for mobile backhaul, point-to-point links in the UAE. Other users of fixed radio systems include oil companies, the financial sector, utility companies, and government users (including for public protection and disaster relief). Frequencies between from around 3GHz up to 95GHz are included in the UAE national regulation for fixed radio systems.

3.2.2 **Future trends for fixed radio systems:** In the next few years, fixed radio system users will increasingly require greater bandwidth to be available for high-capacity fixed-link deployment, due to the growing demand for very high bit rates, and low latency. The development of fibre networks is having an impact on the architecture of mobile networks, affecting the demand for fixed links, particularly high-capacity links at the edge of networks. Mobile networks are expected to provide considerably higher data throughputs to end users in future, and small-cell deployments are widely expected alongside higher macro-cell capacity requirements. This may have a significant impact on backhaul capacity requirements in both existing and new (higher) fixed-link bands.

3.2.3 **Spectrum outlook for fixed radio systems**: Some of the spectrum allocated and used by fixed services below 20GHz is increasingly being considered for other uses, including IMT(5G) and other technologies such as high-altitude platform stations (HAPS). The TRA will consider sharing studies for relevant bands and services. Traditional bands used for fixed radio systems have insufficient capacity to provide the very high capacity fixed links that will be needed to support future networks. The TRA will encourage take-up of high frequencies by fixed radio services, where additional bandwidth is available, and ensure than the needs of the users are not adversely affected by allocation of frequencies to other services. In addition, the TRA will follow development in the convergence of fixed and mobile technologies and services, considering the impact in the UAE. The TRA will update the TRA Regulation on “fixed radio systems” in line with international developments and WRC-19 decisions.

3.3 Satellite

3.3.1 **Present status:** There is a dynamic satellite sector in the UAE. Satellite services include mobile and fixed satellite services. The main users of Earth stations in the fixed satellite service are Etisalat and du, as well as Yahsat, Thuraya and Media Zone “Intaj”. The main UAE satellite operators include Yahsat, Thuraya (now acquired by Yahsat), Inmarsat and Mohammed Bin Rashid Space Center (DubaiSat). These satellite operators offer fixed satellite service (FSS), broadcasting satellite service (BSS), mobile satellite service (MSS) and Earth exploration satellite service (EESS). Demand for spectrum from satellite services is continuing to grow worldwide, particularly in higher-frequency bands. Satellites

services also play an important role in the scientific sector including Earth exploration into climate change, weather forecasting, space exploration and many other research and scientific applications. Bandwidth requirements are driven by the increasing capacity needs of applications that use satellite connectivity, such as broadcasting, backhaul, entertainment, satellite navigation and others.

3.3.2 **Future trends for satellite:** Technological advances in the satellite sector are making satellite connectivity cheaper, faster to deploy and more attractive due to ubiquity, coverage and improved latency.

Future plans include new low Earth orbit (LEO) and non-geostationary-satellite orbit (NGSO) systems, as well as geostationary-satellite orbit (GSO) systems, increasing use of Earth stations in motion (ESIM) terminals, hybrid satellite and terrestrial IMT systems, use of IoT/M2M technology via satellite, massive machine-type communications (mMTC), high-density fixed satellite systems (HDFSS), low-power data collection systems via NGSO, unmanned aircraft systems control and non-payload communications links (UAS CNPC), enhanced synthetic-aperture radar (SAR) capabilities, meteorological satellites spectrum, etc.

3.3.3 **Spectrum outlook for satellite:** The satellite industry is facing a key challenge that bands allocated for satellite use are increasingly being subdivided and considered for different alternate and shared uses. Planned new constellations using many smaller satellites must be co-ordinated within existing satellite bands. Unlike fixed radio systems, it is not possible to redeploy existing satellite services in higher bands, due to the bespoke nature of satellite constellations, which will continue to rely on the bands they currently use. The TRA will be implementing WRC-19 decisions and updating satellite regulations as well as following international developments relating to new satellite systems and associated spectrum needs.

3.4 Broadcasting

3.4.1 **Present status:** Sound broadcasting is a strong media platform in the UAE, including shortwave radio (high frequency, or HF), and analogue sound broadcasting using amplitude modulation (AM) and frequency modulation (FM) technology, which uses spectrum from 87.5–108MHz. Many radio listeners in the UAE are still using analogue AM/FM sets, especially in their vehicles. While digital audio broadcasting (DAB) standards have been developed internationally, these services are yet to increase market share in the UAE due to high penetration of FM receivers in vehicles. The FM band is fully utilised and no frequencies are available for new channels, which underlines the importance of DAB deployment.

Terrestrial television also uses radio spectrum in the ultra-high frequency (UHF) portion of spectrum. Whilst terrestrial television was historically broadcast using analogue technology, a migration to digital terrestrial television (DTT) has taken

place over the last decade. Analogue terrestrial TV, which has traditionally used UHF spectrum, has now largely been replaced with digital terrestrial TV (DTT). Based on the results of the questionnaire carried out by the TRA, broadcasters expressed their desire to provide digital terrestrial television as a strategic option, especially in emergency and crisis situations, and not on a commercial basis. In the UAE, digital TV viewers use alternative platforms, such as cable, fibre and satellite TV instead of DTT. There are also alternative internet video streaming services emerging internationally, which use broadband networks to provide on-demand and streaming video into the home. As such, this raises questions concerning the most efficient use of the UHF spectrum (470–694MHz) in the longer term.

3.4.2 **Future trends for broadcasting:** The technology trend for audio broadcasting is moving towards digital audio broadcast (DAB), internet radio and other online audio services. The TRA intends to encourage the broadcasting industry to continue with implementation of DAB networks, which the TRA sees as being an important step to alleviate congestion in the limited frequency bands available for analogue (FM) radio stations.

In the TV broadcasting sector, traditional content providers are facing strong competition from internet players, which are taking an increasing share of the viewership and relieving the pressure on broadcasting spectrum. Whilst this trend is occurring internationally, the low take-up of digital TV using DTT in the UAE raises questions concerning the best use of UHF spectrum in the longer term.

Technology developments might also lead to greater convergence between broadcasting and IMT networks in future – a topic that is expected to be studied as part of an agenda item for the WRC-23. The TRA will consider encouraging technological trials from broadcasting over 5G networks and work with stakeholders with interest in these developments.

3.4.3 **Spectrum outlook for broadcasting:** The TRA will be further encouraging the introduction of DAB technology to ensure a more rapid transition from FM. The TRA will also initiate at ASMG, studies for an efficient use of the frequency spectrum from 470–694MHz for a regional decision ahead of WRC-23. The TRA will then determine the best strategy for this band.

3.5 Programme making and special events

3.5.1 **Present status:** Audio and video programme making and special events (PMSE) are important for the smooth running of small and major events taking place in the UAE. The UAE hosts several international events where demand for PMSE spectrum is at a peak. Major events occurring in the UAE (e.g. Abu Dhabi Formula One Grand Prix) create location- and time-specific peaks in demand for PMSE spectrum. There are broadly two categories, audio PMSE and video PMSE. Audio

PMSE, which includes equipment such as wireless microphones, typically uses spectrum in several bands in the UAE from 138MHz up to 1900MHz (but with most use currently in the UHF spectrum between 470MHz and 694MHz). Video PMSE includes wireless cameras and video links and typically uses frequencies from around 1.98GHz up to 9.1GHz (but with a significant majority of use currently in the UHF spectrum between 2.2-2.4GHz). All PMSE equipment in the UAE is subject to the UAE regulations for PMSE.

3.5.2 **Future trends for PMSE:** Technological developments are enabling PMSE equipment to use spectrum more efficiently (e.g. video compression in the PMSE video sector, and evolution to digital technology in both the audio and video PMSE sectors). Indeed, technological developments and wider availability of digital equipment are meaning that use of higher-spectrum frequencies is now becoming practical, such as wireless cameras operating in the 7GHz band, and above. Audio PMSE typically uses UHF spectrum and it will be important to ensure that sufficient spectrum is provisioned for audio PMSE if future changes to allocations in the 470–694MHz band are made based on future WRC decisions, affecting the spectrum that is currently used by audio PMSE.

3.5.3 **Spectrum outlook for PMSE:** The TRA will take into account the needs of PMSE users and encourage the increase in quality of large-scale events in the UAE, learning for the management of such events in other countries. The TRA will also ensure that the PMSE stakeholders are suitably engaged and consulted in order to identify suitable frequencies.

3.6 Private mobile radio

3.6.1 **Present status:** The private mobile radio (PMR) sector is active in the UAE. PMR can be an attractive option for users looking for bespoke land mobile services or intending to have more control over the network they use. Additionally, with the growth of machine-to-machine (M2M) applications internationally, businesses may explore the option of PMR in order to get a more resilient service than the public networks can offer. PMR services in the UAE typically use frequencies between 137–174MHz and 401–470MHz.

To make more spectrum available for PMR use, the TRA has allocated 350–380MHz as additional spectrum for PMR. PMR446 and LPD433 has provided opportunities for UHF PMR to avail Class Authorization.

3.6.2 **Future trends for PMR:** The PMR sector is moving from analogue to digital (digital mobile radio Tier I-III, digital private mobile radio, etc.) with integrated data transmission. Enhanced modulation techniques, increased spectral efficiency, interworking with legacy analogue and optimisation of the total cost of ownership (TCO) are the key factors.

The future of PMR services will depend on their ability to adapt to new capacity and speed requirements.

3.6.3 **Spectrum outlook for PMR:** No immediate changes to spectrum availability for PMR are envisaged by the TRA in this UAE Spectrum Outlook 2020–2025.

Additional frequencies are being considered internationally for some types of land mobile use. Indeed, the ITU-R Report M.2417 provides technical and operational characteristics of land-mobile service applications in the frequency range 275–450GHz. This report details several types of land mobile use in these bands such as wireless kiosk links, ticket gate downloading mobile systems, inter-device communications and other close-proximity applications [2]. A recent WRC-19 decision supports the identification of the 275–296GHz, 306–313GHz, 318–333GHz, 356–450GHz bands for land mobile and fixed service applications.

3.7 Ultra-wide band and short-range devices

3.7.1 **Present status:** Ultra-wide band (UWB) and short-range devices (SRD) are used for numerous low-power wireless applications, ranging from active medical implants to automatic meter reading, domestic alarms and wireless access systems. SRD technology forms the basis of many IoT technologies and services. NB-IoT using cellular networks is expected to develop in parallel to SRD-based IoT, providing wider-area coverage where needed.

It is important to note that IoT using spectrum that is class authorised in the UAE is using frequencies covered within the UAE spectrum regulations for UWB and SRD, ranging from 9kHz to 246GHz. While NB-IoT and other cellular IoT technologies are deployed within IMT networks, using spectrum identified for IMT use and licensed to mobile operators (typically using licensed bands that the MNOs have access to below 2GHz).

3.7.2 **Future trends for UWB and SRD:** There have been several ITU-R working party studies related to NB-IoT deployed within IMT. Mobile satellite service (MSS) also offering IoT connectivity services. In addition, ITU-R Working Party 5A (WP5A) is working on a draft new report ITU-R M.[UTILITIES], which evaluates spectrum allocation for utilities and other critical infrastructure industries that provide essential energy and water services.

Numerous new applications are also developing using low-power wireless technologies in class authorised spectrum. Wireless power transmission (WPT) and wireless power transmission for electric vehicle (WPT-EV) applications are also being studied. Use of SRD in relation to medical applications is also on the

[2] For example, see https://news.itu.int/studies-on-the-use-of-frequency-bands-above-275-ghz-by-land-mobile-and-fixed-service-applications/

increase, with inductive ultra-low power active devices such as medical implants, membrane implants, animal implants (amongst others) operating in VLF, LF and MF spectrum bands. In addition, Wi-Fi 6 (802.11ax) technology is evolving and there is growing use of radio local area network (RLAN) both in the UAE and worldwide, which is driving demand for SRD spectrum in the 5GHz range especially.

3.7.3 **Spectrum outlook for UWB and SRD:** The TRA will implement WRC-19 decisions and update of the TRA UWB and SRD regulations with regards to WRC-19 decisions concerning the 5GHz band. The TRA will follow market and technology developments in SRD application and ensure that new applications are able to develop in the UAE and allocate additional spectrum, where relevant.

3.8 Intelligent transport systems

3.8.1 **Present state:** Intelligent transport systems (ITS) are regarded as an important technological development in the UAE, with applications across various modes of transportation including road and rail. The national railway company of the UAE (Etihad Rail) is already using GSM-R, which in the future may require LTE technology, providing additional data functionality for the railway systems. International developments in the automotive sector are driving demand for connected cars and, in future, fully autonomous vehicles.

3.8.2 **Future trends for ITS:** ITS is the future of transportation in railways (main and urban rail), integrated road transport (road toll, signage, sensors, safety, buses, taxi etc.), and the automotive industry. Many new connected vehicles use intelligent technologies in the vehicles' combined advanced traffic management, advanced traveller information, advanced public transportation management systems and/or advanced fleet management systems. Future vehicles are expected to use a range of technologies including LIDAR as well as low-powered wireless connectivity between roads and vehicles. These developments are taking place globally and it will be important for the UAE market to lead in these fields. In line with its ambitions in this field, the government has launched the "Dubai Autonomous Transportation Strategy" which aims to transform 25% of the total transportation in Dubai to autonomous mode by 2030.

3.8.3 **Spectrum outlook for ITS:** The outcome of WRC-19, highlighted the importance of progressing technical and operational studies on ITS in order to facilitate global or regional harmonized frequency bands, in particular for the implementation of railway radio systems between train and trackside (RSTT) and ITS implementation using existing mobile-service allocations. ITU has also published ITU-R Recommendations and Reports on ITS. The TRA will ensure that stakeholders are consulted in development of future ITS spectrum strategy and the TRA intends to produce a specific technical regulation for meeting ITS spectrum needs.

3.9 Aeronautical radio systems

3.9.1 **Present status:** The TRA's national regulations for aeronautical radio systems define various categories of aeronautical radio use, which use frequencies in several bands for beacons in the kHz range and several bands from around 3MHz to 94GHz which captures a wide range of equipment including mobile satellite and radar technology. Aeronautical regulations are co-ordinated internationally and hence the frequencies used for aeronautical radio systems are internationally defined and co-ordinated. The substantial growth of Emirates, Etihad and other UAE-based air carriers (such as flydubai and Air Arabia) in the past decade has established the airline industry in the country as one of the most important and progressive markets across the world.[3] In the Middle East, the International Air Transport Association has forecast an average annual growth rate of 5.0% from 2017 to 2036.[4] The number of aircraft registrations and new aeronautical radio authorisations has been increasing in the UAE. In the UAE, the aeronautical industry has been leading the international community with the deployment of wireless avionics intra-communications (WAIC), advanced surface movement guidance and control systems (A-SMGCS), cellular on board, Wi-Fi on board the aircraft and now broadband connectivity to aircraft through ESIM.

3.9.2 **Future trends for aeronautical radio systems:** The aeronautical sector is expected to see the development of fully autonomous and smart infrastructure implemented across the different functionalities of aeronautical transportation, making travel more flexible, safe and convenient. The airports are also expected to undergo developments with fully automated functionality for air traffic, passengers and luggage management. Airspace management will see technological developments such as enhanced 4D sensors and flexible trajectories to efficiently manage the air traffic.

High-throughput satellites are being developed to provide broadband connectivity to the aircraft, meeting data and 'infotainment' requirements for airlines and their passengers, and allowing for seamless connectivity at airports and during flights. Connected and autonomous aircraft features will require wireless connectivity. These developments are likely to increase the demand for spectrum which will be a critical enabler for the aeronautical sector. Urban air mobility (UAM) vehicles are also expected to emerge over time, creating demand for connectivity solutions for beyond-visual-line-of-sight (BVLOS) communications below commercial airspace. One potential connectivity solution to provide this BVLOS connectivity for UAS and UAM is to use IMT (4G/5G) networks. A provisional agenda item for WRC-27 will

[3] See https://www.forbes.com/sites/dominicdudley/2017/01/17/middle-east-airline-industry-growth/#105047eb6e9a

[4] See https://www.iata.org/pressroom/pr/Pages/2017-10-24-01.aspx

consider the use of existing IMT spectrum identifications in the 694–960MHz frequency range, and possible removal of the limitation regarding aeronautical mobile in the IMT, such that IMT networks can be used to connect devices (user equipment) that are airborne at low altitudes, such as for UAM and UAV. A separate item – using high-altitude platform stations as IMT base stations in IMT bands below 2.7GHz – has also been discussed internationally.

3.9.3 **Spectrum outlook for aeronautical radio systems:** The TRA will continue to follow all aviation sector wireless needs at international level through International Civil Aviation Organisation (ICAO) and ITU. The TRA will continue to collaborate with all aviation stakeholders during the execution phase of the UAE Spectrum Outlook. The TRA will update its regulations on aeronautical radio systems to meet the related spectrum needs and regulatory provisions as well as implement WRC-19 decisions.

It is important to note, however, that the need for global co-ordination of spectrum, technologies and requirements for aviation use means that access to spectrum for aeronautical radio systems in the UAE must be kept in alignment with internationally agreed spectrum bands.

3.10 Maritime radio systems

3.10.1 **Present status:** The maritime sector plays a pivotal role in the UAE, with Dubai being one of the biggest global container ports in the world. Maritime radio systems generally use frequencies between 415kHz and 14GHz for a range of different equipment according to the UAE spectrum regulation for maritime radio systems.

3.10.2 **Future trends for maritime radio systems:** In the maritime sector, a number of new technologies are being considered. For example, in the modernisation plan of the Global Maritime Distress and Safety System (GMDSS). These new technologies are expected to improve safety, move cargo more efficiently and maximise spectrum efficiency.

3.10.3 **Spectrum outlook for maritime radio systems:** The TRA will be implementing WRC-19 decisions and update the TRA regulations on maritime radio systems to meet the related spectrum needs and regulatory provisions from the WRC-19 decisions. The TRA will continue following international developments in the sector and participate in WRC-23 and WRC-27 studies affecting the maritime sector. Input from the maritime sector will be sought during the duration of the outlook.

3.11 Unmanned aircraft systems

3.11.1 **Present status:** TRA regulations for unmanned aircraft radio systems (UAS), currently provides frequency ranges for UAS, their use and applicable usage conditions, based on decisions taken at previous WRCs on use of satellite networks for UAS connectivity.

3.11.2 **Future trends for UAS:** In the future, UAS connectivity may use IMT (4G/5G) networks. UAS are increasingly being used for civil applications where it is not feasible or practical to rely on extended human-piloted flights; these include long-duration scientific research, remote sensing, firefighting, aerial photography, land and crops surveying, border protection and emergency management, among other uses.

The use of drones in the oil and gas industry is growing and the technology has a lot to offer for the industry. Drones are effective in midstream operations, providing efficient visual inspections of pipeline rights-of-ways and in other operations such as systemic sensing.

UAS are also envisioned to be the drivers of future delivery services. Companies focusing on e-commerce activities, such as Amazon, are already trialling the use of drones, not only to manage their warehouse stock but also to deliver goods to the end customer.

3.11.3 **Spectrum outlook for UAS:** The TRA will closely follow developments in sector and seek to understand the future spectrum needs of both the aeronautical sector and UAS-related developments including UAM. A provisional agenda item for the WRC-27 is seeking to review the status of mobile allocations between 694–960MHz with a view to removing the 'except aeronautical' limitation. This is being envisaged to enable use of IMT networks to provide air to ground, and ground to air, connectivity for UAS via airborne IMT user equipment.

3.12 Amateur radio

3.12.1 **Present status:** Amateur radio spectrum is primarily used for training and education by universities or as a leisure activity (e.g. a hobby for radio enthusiasts). Indeed, universities in the UAE are using amateur satellite spectrum in academic projects and in laboratory experiments.

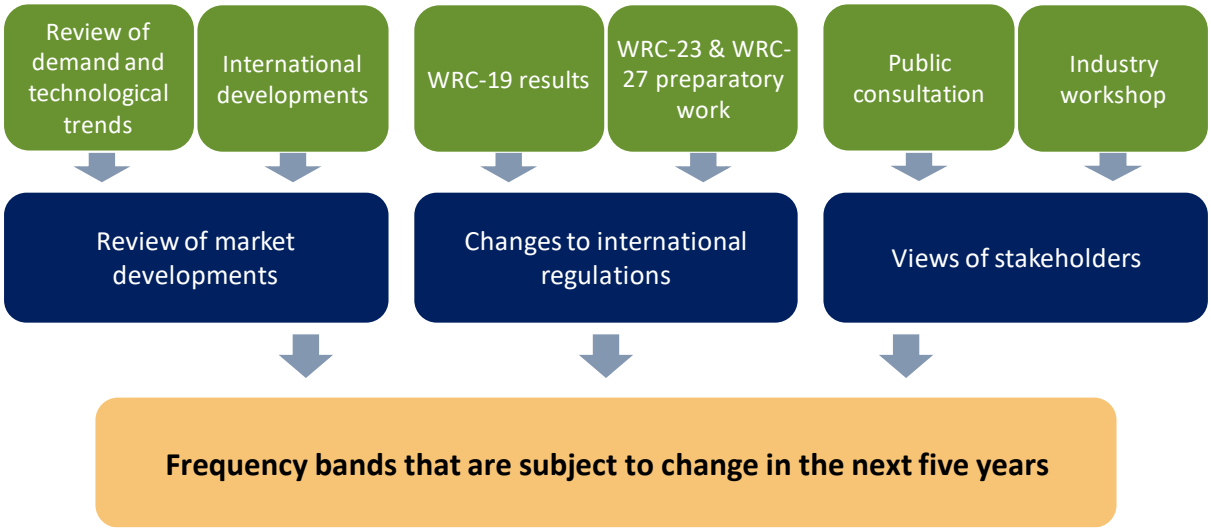
3.12.2 **Future trends for amateur radio:** The amateur sector is not expected to undergo significant changes in the next few years. Recent decisions taken at WRC-19 will provide a primary allocation for amateur use in the UAE between 50–54MHz.

3.12.3 **Spectrum outlook for amateur radio:** The TRA will update the TRA regulations on amateur radio systems to meet the related spectrum needs and decisions taken at WRC-19. The TRA will follow international developments and seek input from the amateur community, when required.

4. Indicative spectrum re-planning roadmap

The roadmap for future spectrum use and associated re-planning activities takes account of future trends that have been identified in the review of wireless systems development, international developments and anticipated future demand for spectrum. The roadmap also takes account of comments received in response to the TRA's public consultation on the draft UAE Spectrum Outlook, issue date 30 September 2019.

To identify frequency bands that might be subject to change in use over the next five years, the TRA has thus taken account of several inputs, as summarised below:



To implement changes, the TRA will need to take different actions depending on the nature of the band in question and the nature of the changes being proposed. Actions that the TRA will need to take are summarised as follows:

Change of use

- Bands which are currently used by an existing service in the UAE, which are to be studied for a change of use taking account of UAE market demand, and which might include studies on existing usage, sharing, re-planning and changes to existing UAE spectrum national regulations, etc.

Spectrum release

- Bands which are currently unused, or where parts of the band are available for new use, which can be immediately planned for spectrum release (i.e. without a need to re-plan existing use)

Further study

- Bands that might be subject to a future change of use in the UAE, but subject to decisions of a future WRC – which might be the subject of further studies that the TRA should carry out

Follow international developments

- Bands that are the subject of international developments, which the TRA should follow in order to identify their relevance to the UAE

It is important to note, however, that this roadmap is indicative and will have to remain flexible and dynamic to align with developments in:

- equipment availability
- market demand
- changes in industry standards.

The tables below summarise the actions identified for the TRA over the period 2020–2025 of this spectrum outlook.

IMT

The following table identifies bands subject to potential changes relevant to public mobile and IMT, with the proposed period indicative and subject to change based on the above.

Proposed period	Frequency band	Comment
Change of use		
2020–2021	*26.5–27.5GHz*	Since no fixed links are currently operational in the band, initiate actions to make the band available for IMT (5G) use, with the relevant technical conditions in regulations in line with mobile equipment specifications and to ensure protection of EESS (passive) as agreed by WRC-19.
2020–2021	*2.3–2.4GHz*	Study existing usage of the band and plan for deployment of PPDR 5G networks.
2021–2022	*24.25–26GHz*	Initiate studies and collaborate with operators to share parts of this band between fixed and mobile or change the use from fixed to mobile/IMT use. Taking account of the two-stage mechanism for the protection of passive services in 23.6–24GHz as agreed by WRC-19, when preparing regulations for use of this band by IMT systems, ensure that the regulations include limits for the protection of EESS (passive).
2023–2024	*37–40.5GHz*	Initiate studies and collaborate with operators to share parts of this band between fixed and mobile or change the use from fixed to mobile, for use by IMT (5G) systems. When authorising for IMT, ensure protection of EESS (passive) in the 36–37GHz band, according to WRC-19.
2023–2024	*40.5–43.5GHz*	Conduct industry consultation to consider making available parts of this band for IMT(5G) systems, based on standards development and equipment availability.
2023–2024	*66–71GHz*	Initiate studies to bring into use the band for IMT, taking account of the decision at WRC-19.

Spectrum release		
2020–2021	*1427–1518MHz*	Commence detailed planning to authorise spectrum in this band for IMT use to mobile operators, based on standards development and equipment availability.
2021–2024	*Release of any other bands confirmed by change of use studies, as above*	
Further study		
2020–2023	*Various*	Participate in studies for WRC-23 for the potential use of IMT technology for fixed wireless broadband in the frequency bands allocated to the fixed services on primary basis, in accordance with Resolution COM6/18 (WRC-19).
2020–2023	*6.425–7.125GHz*	Participate in studies for WRC-23 on consideration on potential identification of spectrum in the 6425–7025MHz and 7025–7125MHz bands for IMT.
2020–2023	*694–960MHz*	Participate in WRC-23 studies (under WRC-23 agenda item (A.I.) 1.4) on the potential use of HAPS as IMT base stations (HIBS) in the mobile service in selected frequency bands below 2.7GHz already identified for IMT, on a global or regional level.
	1710–1885MHz	
	2.5–2.69MHz	
2024–2027	*694–960MHz*	Participate in studies in preparation for decisions at WRC-27 consideration of the possible removal of the limitation regarding aeronautical mobile in IMT, for the use of IMT networks for air-to-ground and ground-to-air connectivity for airborne user equipment in the 694–960MHz frequency range (Region 1).
Follow international development		
2020–2024	*Follow international developments relevant to IMT standards and technology and consider their relevance in the UAE.*	

Fixed radio systems

The following table identifies bands subject to potential changes relevant to fixed radio systems, with the proposed period indicative and subject to change based on the above.

Proposed period	Frequency band	Comment
Change of use		
2020–2022	*31–31.3GHz*	In line with WRC-19 decision, initiate actions for the introduction of HAPS with protection measures for existing services.
2020–2022	*38–39.5GHz*	In line with WRC-19 decision, initiate actions for the introduction of HAPS with protection measures for existing services.
2020–2022	*47.2–47.5GHz*	In line with WRC-19 decision, refine the technical/regulatory provisions made to the allocation of the spectrum for HAPS.
	47.9–48.2GHz	
2023–2024	*275–296GHz*	Consider making available some or all of these bands to land mobile and fixed service applications in accordance with decisions taken at WRC-19, and taking account of technology developments, while maintaining the protection of EESS as per the WRC-19 decision.
	306–313GHz	
	318–333GHz	
	356–450GHz	
Spectrum release		
2024 and beyond	*275–296GHz*	Implement necessary changes in UAE regulations for fixed radio systems to make these bands available for point-to-point and point-to-multipoint use, subject to market demand, and taking account of the studies above, along with equipment availability.
	306–313GHz	
	318–333GHz	
	356–450GHz	

Further study		
2024 and beyond	*71–76GHz*	Participate in WRC-27 studies on review of technical conditions associated with use of these bands including sharing between fixed radio systems and NGSO satellite services.
	81–86GHz	
Follow international development		
2024 and beyond	*Above 95GHz*	Follow international developments in relation to equipment availability and use of bands above 95GHz for fixed radio systems.

Satellite

The following table identifies bands subject to potential changes relevant to satellite services, with the proposed period indicative and subject to change based on the above.

Proposed period	Frequency band	Comment
Change of use		
2020–2022	*137–138MHz*	In line with WRC-19 decisions, initiate actions to facilitates the use of the bands in the UAE for space operation services associated with short-duration mission satellite systems.
	148–149.9MHz	
2020–2022	*401–403MHz*	In line with WRC-19 decisions, initiate actions to adjust regulation for in-band power limits for EESS and MetSat systems in this band.
2020–2022	*399.9–400.02MHz*	In line with WRC-19 decisions, initiate actions to adjust national regulations relating to in-band power limits for MSS in this band.
2020–2022	*17.7–19.7GHz*	In line with WRC-19 decisions, initiate actions to allow use of these bands for Earth stations in motion (ESIM) communicating with GSO FSS satellites, with associated emission limits as decided by WRC-19.
	27.5–30GHz	

2020–2022	*37.5–39.5GHz*	In line with WRC-19 decisions, take actions to develop the regulatory framework for non GSO FSS satellite systems that may operate in 37.5–39.5GHz (s-E), 39.5–42.5GHz (s-E), 47.2–50.2GHz (E-s) and 50.4–51.4GHz (E-s) with the associated limits as agreed by WRC-19. See also actions in the table above relating to consideration of use of parts of the 37–43.5GHz band for mobile services, for IMT.
	39.5–42.5GHz	
	47.2–50.2GHz	
	50.4–51.4GHz	
2020–2022	*51.4–52.4GHz*	In line with WRC-19 decisions, initiate actions to implement a new primary allocation for the FSS (Earth-to-space) in the UAE national frequency plan.
Spectrum release		
Update and revise Earth station regulations for any bands confirmed by change of use studies above for satellite use		
Further study		
2020–2023	*45MHz (around)*	Participate in studies planned for consideration at WRC-23 on spectrum needs for a possible new secondary allocation to EESS for spaceborne radar sounders, taking into account the protection of incumbent services.
2020–2023	*2010–2025MHz*	Participate in WRC-23 studies relating to spectrum and operational needs and potential new allocations to the mobile-satellite service for future development of narrowband mobile-satellite systems, in this band and in several other bands (1695–1710MHz, 3300–3315MHz and 3385–3400MHz), as determined by WRC-19.
2020–2023	*11.7–12.7GHz*	In preparation for WRC-23, participate in studies to consider the appropriate regulatory actions for the provision of inter-satellite links in specific frequency bands, or portions thereof, including in 11.7–12.7GHz, 18.1–18.6GHz, 18.8–20.2GHz and 27.5–30GHz, or portions thereof, as determined by WRC-19.

2020–2023	*14.8–15.35GHz*	Participate in studies leading up to WRC-23 consideration of a possible upgrade of the allocation to the space research service, as determined by WRC-19.
2020–2023	*17.7–18.6GHz*	Participate in studies for consideration at WRC-23 concerning the development of technical, operational and regulatory measures to facilitate the use of the frequency bands 17.7–18.6GHz and 18.8–19.3GHz, 19.7–20.2GHz as well as 27.5—29.1GHz and 29.5–30GHz by non-GSO FSS Earth stations in motion, while ensuring due protection of existing services.
	18.8–19.3GHz	
2020–2023	*27.5–30GHz*	In preparation for WRC-23, participate in studies to consider the appropriate regulatory actions for the provision of inter-satellite links in specific frequency bands, or portions thereof, including in 11.7–12.7GHz, 18.1–18.6GHz, 18.8–20.2GHz and 27.5–30GHz, or portions thereof, as determined by WRC-19.
2020–2023	*231.5–252GHz*	For WRC-23, participate in studies to review and consider possible adjustments of the existing or possible new primary frequency allocations to EESS (passive) to ensure alignment with the latest remote-sensing observation requirements.
2022–2023	*18.1–18.6GHz*	In preparation for WRC-23, participate in studies to consider the appropriate regulatory actions for the provision of inter-satellite links in specific frequency bands, or portions thereof, including in 11.7–12.7GHz, 18.1–18.6GHz, 18.8–20.2GHz and 27.5–30GHz, or portions thereof, as determined by WRC-19.
	18.8–20.2GHz	
2022–2023	*19.7–20.2GHz*	Participate in studies for consideration at WRC-23 concerning the development of technical, operational and regulatory measures to facilitate the use of the frequency bands 17.7–18.6GHz and 18.8–19.3GHz, 19.7–20.2GHz as well as 27.5—29.1GHz and 29.5–30GHz by non-GSO FSS Earth stations in motion, while ensuring due protection of existing services.
	27.5–29.1GHz	
	29.5–30GHz	
2024 and beyond	*1.5–5GHz (or parts thereof)*	Participate in possible studies being considered for inclusion in the agenda for WRC-27 on spectrum needs

		and possible worldwide allocation to the mobile satellite service for the future development of narrowband mobile-satellite systems in frequency bands in the range 1.5–5GHz (exact frequencies to be confirmed, as determined by WRC-19 and subsequent studies leading up to WRC-23).
2024 and beyond	*1525–1544MHz*	Participate in possible studies being considered for inclusion in the agenda for WRC-27 studies of the technical and operational matters, and regulatory provisions, for space-to-space links among non-geostationary and geostationary satellites operating in the mobile-satellite service in these frequency bands, as determined by WRC-19 and in accordance with the preliminary agenda for WRC-27.
	1545–1559MHz	
	1610–1645.5MHz	
	1646.5–1660.5MHz	
	2483.5–2500MHz	
2024 and beyond	*22.55–23.15GHz*	Participate in possible studies being considered for inclusion in the agenda for WRC-27 relating to consideration of a new EESS (Earth-to-space) allocation in the band 22.55–23.15GHz, as determined by WRC-19.
2024 and beyond	*43.5–45.5GHz*	Participate in possible studies being considered for inclusion in the agenda for WRC-27 relating to consideration of the allocation of all or part of this band to the fixed-satellite service.
2024 and beyond	*71-76GHz*	Participate in possible studies being considered for inclusion in the agenda for WRC-27 relating to review of the conditions for the use by stations in the satellite services to ensure compatibility with passive services.
	81–86GHz	Participate in studies for consideration at WRC-27 relating to consideration of the development of regulatory provisions for non-geostationary fixed-satellite system feeder links in these bands.

Follow international development	
2020-2024	*Follow international developments relevant to satellite services and consider their relevance in the UAE.*

Broadcasting

The following table identifies bands subject to potential changes relevant to broadcasting, with the proposed period indicative and subject to change based on the above.

Proposed period	Frequency band	Comment
Change of use		
2020–2022	*174–230MHz*	Work with relevant stakeholders in the broadcasting sector and government of UAE to encourage the industry to continue to prepare for launch of DAB networks, to facilitate new digital radio services.
Spectrum release		
2020–2024	*Release of any bands confirmed by change of use studies, as above.*	
Further study		
2020–2023	*470–694MHz*	Initiate discussions and studies at the Gulf regional level (Gulf Cooperation Council, GCC, and Arab Spectrum Management Group, or ASMG) to evaluate the present use of spectrum in this band, and potential future use by IMT. In addition, participate in international studies for review at WRC-23 in relation to the same subject, including the spectrum use and spectrum needs of existing services and possible regulatory actions to facilitate future services in the frequency band 470–694MHz.

Follow international development		
2020–2023	*470–694MHz*	Follow international developments in IMT and broadcast technologies within this frequency range and consider future strategy for distribution of digital terrestrial television in the UAE and future use of the 470–694MHz spectrum, taking account of the studies identified above in relation to regional and international developments in future use of the 470–649MHz band.

PMSE

The following table identifies bands subject to potential changes relevant to PMSE, with the proposed period indicative and subject to change based on the above.

Proposed period	Frequency band	Comment
Change of use		
2020–2024	*Study the change of use of bands identified as relevant in further studies.*	
Spectrum release		
2020–2024	*Update and revise PMSE regulations for any bands confirmed by change of use studies, as above.*	
Further study		
2024–2027	*470–694MHz*	Assess the impact of any allocation changes in the 470–694MHz band on spectrum availability for PMSE.
Follow international development		
2020–2024	*Various*	The TRA will endeavour to take a proactive approach in following equipment and market developments for PMSE.
2020–2024	*The TRA will collaborate with PMSE stakeholders on any changes to spectrum use resulting from the Spectrum Outlook 2020–25, which impact the PMSE sector.*	

PMR

No significant changes in the PMR sector are expected within the next five years. The TRA will continue to follow international developments relevant to PMR and consider their relevance in the UAE.

UWB and SRD

The following table identifies bands subject to potential changes relevant to UWB and SRD, with the proposed period indicative and subject to change based on the above.

Proposed period	Frequency band	Comment
Change of use		
2020–2022	*5150–5250MHz*	In line with decisions agreed by WRC-19, initiate actions to update SRD regulations to allow usage indoors in trains and cars as well as outdoor usage to a baseline level of up to 200mW eirp, with an option to transmit up to 1W (30 dBm) eirp with a choice of 3 optional eirp masks, as determined by WRC-19 modifications to ITU-R Resolution 229.
2020–2022	*5650–5850MHz*	In line with decision taken at WRC-19, update SRD regulations to reflect new primary allocation for mobile use (for Wi-Fi use) in the UAE in the 5650–5850MHz band.
Spectrum release		
2020–2024	*Update and revise UWB and SRD regulations for any bands confirmed by change of use studies, as above.*	
Further study		
2020–2022	*5.925–6.425GHz*	Undertake sharing and compatibility studies to assess the feasibility of an allocation to the mobile service for use by Wi-Fi in this range, in line with developments in other parts of Region 1 (e.g. CEPT).

Follow international development		
2020–2023	*Below 45MHz*	Follow market and technology developments in SRD applications and ensure that new applications are able to develop in the UAE.
2024 and beyond	*6.425–7.125GHz*	Follow developments in relation to possible additional spectrum for use by Wi-Fi.

ITS

The following table identifies bands subject to potential changes relevant to ITS, with the proposed period indicative and subject to change based on the above.

Proposed period	Frequency band	Comment
Change of use		
2020–2024	*Study the change of use of bands identified as relevant in further studies.*	
Spectrum release		
2020–2024	*Incorporate results of studies above in proposed new spectrum regulations for ITS.*	
Further study		
2020–2022	*5850–5925MHz*	Conduct national studies and consult with industry concerning implementation of DSRC and/or C-V2X (‘PC5’) systems in this band in the UAE, for ITS.
2020–2022	Participate in studies which look to facilitate global or regional harmonised frequency bands to support railway radiocommunication systems between train and trackside within existing mobile service allocations, as determined by WRC-19.	
2020–2023	*470–960MHz*	Evaluate the need of making additional spectrum available for 4G/5G-based railway systems in the UAE, such as 874.4–880MHz and 919.4–925MHz bands.

2024 and beyond	*76–81GHz*	Take account of the use of automotive radars operating in the band 76–81GHz when participating in studies on future use of 71–76GHz and 81–86GHz in preparation for WRC-27.
Follow international development		
2023 and beyond	The TRA to consider launching a public consultation focusing solely on ITS with the aim to produce a specific spectrum regulation for ITS.	

Aeronautical radio systems

The following table identifies bands subject to potential changes relevant to aeronautical radio systems, with the proposed period indicative and subject to change based on the above.

Proposed period	Frequency band	Comment
Change of use		
2020–2024	*Study the change of use of bands identified as relevant in further studies.*	
Spectrum release		
2020–2024	*Update and revise aeronautical radio systems regulations for any bands confirmed by change of use studies, as above.*	
Further study		
2020–2023	*2850–22000kHz*	Participate in the WRC-23 studies looking to accommodate digital technologies for commercial aviation safety-of-life applications in existing HF bands allocated to the aeronautical mobile (route) service and ensure coexistence of current HF systems alongside modernised HF systems.

2020–2023	*117.975–137MHz*	Participate in the WRC-23 studies assessing a new aeronautical mobile-satellite (R) service (AMS(R)S) allocation for both the Earth-to-space and space-to-Earth directions of aeronautical VHF communications in all or part of the band, while preventing any undue constraints on existing VHF systems operating in the AM(R)S, the ARNS, and in adjacent frequency bands.
2020–2023	*4.8–4.99GHz*	Participate in the WRC-23 studies assessing possible measures to address protection of stations of the aeronautical and maritime mobile services located in international airspace and waters from other stations located within national territories.
2020–2023	*12.75–13.25GHz*	Participate in the WRC-23 studies to consider use of the band by Earth stations on aircraft and vessels communicating with geostationary space stations in the fixed-satellite service globally.
2020–2023	*15.4–15.7GHz*	Participate in the WRC-23 sharing and compatibility studies on possible new primary allocations to the aeronautical mobile service for non-safety aeronautical applications, while ensuring the protection of primary services.
2020–2023	*22–22.21GHz*	Participate in the WRC-23 sharing and compatibility studies, order to evaluate the possible revision or deletion of the “except aeronautical mobile” restriction to facilitate new air-to-ground and ground-to-air and air-to-air communications of aircraft systems while ensuring the protection of primary services.
2024 and beyond	*37.5–39.5GHz*	Participate in the WRC-27 studies to develop technical, operational and regulatory measures, to facilitate the use of these bands by aeronautical and maritime Earth stations in motion communicating with geostationary space stations in the fixed-satellite service.
	40.5–42.5GHz	
	47.2–50.2GHz	
	50.4–51.4GHz	
2024 and beyond	Participate in the WRC-27 studies on spectrum needs, coexistence with radiocommunication services and regulatory measures for possible new	

	allocations for the aeronautical mobile service for the use of non-safety aeronautical mobile applications.
Follow international development	
2020–2024	*Follow international developments relevant to aeronautical radio systems and consider their relevance in the UAE.*

Maritime radio systems

The following table identifies bands subject to potential changes relevant to maritime radio systems, with the proposed period indicative and subject to change based on the above.

Proposed period	Frequency band	Comment
Change of use		
2020–2022	*156–162.05MHz*	In line with the decisions of WRC-19, initiate actions to implement the allocation of spectrum for autonomous maritime radio devices in this band.
2020–2022	*156.0125–157.4375MHz*	In line with the decisions of WRC-19, initiate actions to implement the new spectrum allocations to the maritime mobile-satellite service to enable a new VHF data exchange system satellite component.
	160.6125–162.0375MHz	
2020–2022	*1621.35–1626.5MHz*	In line with the decisions of WRC-19, initiate actions to implement the primary allocation to the mobile maritime-satellite to be used for the GMDSS, noting requirements as determined by WRC-19 for protection of existing services in adjacent bands (including the Inmarsat system).
Spectrum release		
2020–2024	*Update and revise maritime radio systems regulations for any bands confirmed by change of use studies, as above.*	

Further study		
2020–2023	*12.75–13.25GHz*	Participate in the WRC-23 studies to consider use of the band by Earth stations on aircraft and vessels communicating with geostationary space stations in the fixed-satellite service globally.
2020–2023	Participate in the WRC-23 studies reviewing the possible regulatory actions to support the modernization of the Global Maritime Distress and Safety System and the implementation of e-navigation.	
2024 and beyond	*37.5–39.5GHz*	Participate in the WRC-27 studies and develop technical, operational and regulatory measures, to facilitate the use by aeronautical and maritime Earth stations in motion communicating with geostationary space stations in the fixed-satellite service.
	40.5–42.5GHz	
	47.2–50.2GHz	
	50.4–51.4GHz	
Follow international development		
2020–2024	*Follow international developments relevant to maritime radio systems and consider their relevance in the UAE.*	

Amateur radio

The following table identifies bands subject to potential changes relevant to amateur services, with the proposed period indicative and subject to change based on the above.

Proposed period	Frequency band	Comment
Change of use		
2020–2021	*50–54MHz*	In line with decision taken at WRC-19, initiate actions to implement the allocation of the 50–54MHz band to amateur services on a primary basis in the UAE.

Spectrum release		
2020–2024	*Update and revise amateur radio systems regulations for any bands confirmed by change of use studies, as above.*	
Further study		
2021–2023	*1240–1300MHz*	Participate in the WRC-23 review of the amateur service and the amateur-satellite service allocations to determine if additional measures are required to ensure protection of the radio-navigation satellite (space-to-Earth) service operating in the same band.
Follow international development		
2020–2024	*Follow international developments relevant to amateur systems and consider their relevance in the UAE.*	

5. Impact of the UAE Spectrum Outlook

The UAE Spectrum Outlook 2020–2025 has been the result of a review of the main spectrum uses, and the demand and technological trends that are affecting spectrum needs. This review process was undertaken in collaboration with the industry, in order to understand stakeholders' concerns and needs in relation to spectrum.

The resulting indicative roadmap summarises the main actions which the TRA may undertake in each year as it attempts to foresee which upcoming technological developments have the potential to affect spectrum requirements in the next five years.

The upcoming five-year period is an exciting one. Many governments and private-sector organisations worldwide are realising the importance of ICT and are undergoing digitalisation, in an attempt to reap the benefits of ICT and accelerate progress towards their economic and societal objectives. This is also the case of the UAE, where relevant strategies and initiatives have been put forward to stimulate and co-ordinate efforts towards the objective of a happy nation relying on a diversified and flexible knowledge-based economy. The objective of establishing a global leadership position of UAE in the ICT sector perfectly fits with all this. With a growing number of wireless devices of all forms, shapes and technology supported across all economic sectors, and with the upcoming wave of new investment into wireless infrastructure, the challenge now is that spectrum will need to become available to foster innovation and enable investment – while ensuring that past investment in wireless infrastructure is safeguarded.

The TRA's transparent approach, driven by the principles that lead the TRA's action and in particular in terms of spectrum management, is bringing alignment and predictability to the wireless industry as a whole – including not only all spectrum users but also their technology partners. The TRA is of the view that this will in turn allow the wireless industry in the UAE to unlock further the colossal benefits of spectrum as an enabler and an innovation catalyst for other industries which use wireless technologies for economic activities, as well as for the safety, the security and the happiness of citizens and residents of the UAE.

Annex A List of acronyms and abbreviations

The table below lists the acronyms and abbreviations used in this report.

Acronym	Meaning
5G	5th generation mobile communication network
3GPP	3rd Generation Partnership Project
4D	Four dimensions
4G	4th generation mobile communication network
5G	5th generation mobile communication network
AM	Amplitude modulation
AM(R)S	Aeronautical mobile (R) service
ARNS	Aeronautical radio-navigation service
A-SMGCS	Advanced surface movement guidance and control systems
AWAIC	Wireless avionics intra-communications
BVLOS	Beyond visual line of sight
CBRS	Citizens Broadband Radio Services
CEPT	European Conference of Postal and Telecommunications Administrations
C-V2X	Communication - Vehicle to X
DAB	Digital audio broadcast
DSRC	Digital short-range communications

Acronym	Meaning
DTT	Digital terrestrial TV
EESS	Earth exploration satellite services
eMBB	Enhanced mobile broadband
E-S	Earth to space
ESIM	Earth stations in motion
FM	Frequency modulation
FSS	Fixed satellite service
FWA	Fixed wireless access
GHz	Gigahertz
GMDSS	Global maritime distress and safety system
GSM-R	Global system for mobile communications – railway
GSO	Geostationary-satellite orbit
HAPS	High-altitude platform stations
HDFSS	High-density fixed satellite systems
HF	High frequency
ICAO	International Civil Aviation Organisation
ICT	Information communication technology
IMT	International mobile telecommunications
IMT(5G)	Fifth generation of international mobile telecommunications
IoT	Internet of Things
ITS	Intelligent transport systems
ITU	International Telecommunication Union
ITU-R	ITU radiocommunication sector
kHz	kilohertz
LEO	Low Earth orbit
LF	Low frequency
LTE	Long-term evolution

Acronym	Meaning
M2M	Machine to machine
MetSat	Meteorological satellite
MF	Medium frequency
MHz	Megahertz
mMTC	Massive machine-type communications
mmWave	Millimetre wave
MSS	Mobile satellite service
NB-IOT	Narrowband Internet of Things
NGSO	Non-geostationary satellite orbit
PMR	Private mobile radio
PMSE	Programme making and special events
RLAN	Radio local area network
RSTT	Railway radio systems between train and trackside
SAR	Synthetic-aperture radar
SAS	Spectrum access system
s-E	Space to Earth
TCO	Total cost of ownership
TETRA	Terrestrial trunked radio
TRA	Telecommunication Regulatory Authority
TV	Television
UAE	United Arab Emirates
UAM	Urban air mobility
UAS	Unmanned aircraft systems
UAS CNPC	Unmanned aircraft systems control and non-payload communications links
UHF	Ultra-high frequency
UK	United Kingdom

Acronym	Meaning
USA	United States of America
UWB and SRD	Ultra-wide band and short-range devices
VHF	Very high frequency
VLF	Very low frequency
Wi-Fi	Wireless fidelity
WP5A	Working party 5A (ITU-R)
WPT	Wireless power transmission
WPT-EV	Wireless power transmission for electric vehicle
WRC-19	World Radiocommunication Conference 2019
WRC-23	World Radiocommunication Conference 2023
WRC-27	World Radiocommunication Conference 2027