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| **SOUTH ASIAN TELECOMMUNICATIONS REGULATOR’S COUNCIL** **(SATRC)** |  |
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**SATRC REPORT ON**

**DEVELOPING SPECTRUM ROADMAP IN SATRC COUNTRIES FOR FUTURE MOBILE BROADBAND**

**Prepared by**

**SATRC Working Group on Spectrum**

Adopted by

**19th Meeting of the South Asian Telecommunications Regulator’s Council**

13 – 15 December 2018, Islamabad, Pakistan

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# **EXECUTIVE SUMMARY**

The development in technologies and the trend of using mobile broadband service in the whole world realize the necessity of developing a national spectrum roadmap. Specially for a clear idea on the investment from operator side and understanding the significance of a particular band from the regulator side, this roadmap is required. It helps to prepare the framework on spectrum re-farming and enhances the international cooperation on spectrum management in harmonized manner in the countries.

This report consists 5 sections that are comprised of 10 sub-sections. In the section-1, the need of the roadmap is described. In section-2 of this report, the process to develop a roadmap has been described. Section-3 contains the best practices on developing a spectrum roadmap for mobile broadband service in this report, Section-4 contains the analysis and recommendation on developing such roadmap and finally in Section-5, there is conclusion.

During preparing this report, it is found that in the SATRC countries, developing a spectrum roadmap is not very common. But the significance of this is for a better regulatory and investment friendly environment. To develop such, the forecast on national need and global trend are the key issue. Based on the replies on questionnaire, the prioritized bands are recommended in this report for future mobile broadband. The parameters to develop a spectrum roadmap for future mobile broadband have been discussed in this report for reference. Hence, the methodology and analysis may help the regulators in SATRC countries to develop their national spectrum roadmap for the mobile broadband service-the most discussed service.

# **1. Introduction**

Every regulator needs an accurate understanding of changes in technology and market demand, both for new and existing spectrum uses, to inform the way they plan and make spectrum available. The regulators should consult annually with industry about its spectrum management priorities. It shall cover at least five financial years, be updated and published each financial year after consultation with stakeholders before finalizing. A roadmap provides an overview of the technology, market, and policy drivers to predict the demand for, and supply of, spectrum over the next five years.

It takes a broad view of trends in technology and spectrum uses that inform the regulators medium-term planning, allocation and reallocation activities. Monitoring of developments in radiocommunications technology, in spectrum use markets may help to identify the resources allocation and thus the regulatory efficiency.

The broad goals and objectives associated with spectrum roadmap are enhancing the capacity of the mobile network, maximizing the economic benefits from use of the spectrum resource, ensuring the users benefit from the use of the spectrum resource and Estimating spectrum demand & supply.

## 1.1 Rationality

Demand for new spectrum and changes to existing arrangements continue to evolve quickly, requiring the regulators to regularly reassess the priority of its work to reform and update planning arrangements in particular bands, as new opportunities arise to maximize the overall public benefit derived from allocating and using spectrum.

Harmonization of spectrum bands and its usage set the indicators of growth of eco systems. Now the international trends are driving demand for spectrum that fade away the distinctions between fixed and mobile broadband. Technology continues to develop to more efficiently exploit available spectrum.

Every regulator’s response to these demand pressures is outlined in more detail in the planning and allocation roadmap. The preparation of a spectrum roadmap has the intention to alert stakeholders to the pressures likely to shape future rearrangement. A notice needs to be issued to spectrum incumbents about the pressures emerging on planning arrangements in bands they possess.

Demand for spectrum to support wireless broadband continues to be a major driver for changes in highest-value spectrum use across a number of bands. Mobile broadband continues to be the largest but not the only source of demand. So further spectrum will be needed to support the growth in broadband applications and mobile data in particular.

# **2. Developing Spectrum Roadmap for Mobile Broadband**

## 2.1 Method

To develop a spectrum roadmap, industry must be consulted. Developing a roadmap for mobile broadband, mobile operators along with the equipment providers need to participate in this work initiated by the regulators.

To develop a roadmap following things should be considered:

* What we want to achieve from that particular band
* Comparatively is this beneficial than the existing allocation
* What activities need to be performed to achieve the goal
* A time period must be specified to complete this roadmap
* Periodic review of the roadmap is essential

## 2.2 Activities

After considering the above issues, to develop spectrum roadmap for mobile broadband in particular band, the following activities need to be performed:

* planning
* allocations
* regulatory review and reform
* pricing
* international involvement

This roadmap remains responsive to short-term changes in spectrum demand, technological developments, government priorities and available resourcing.

### 2.2.1 Planning

The aim of the Regulator is to optimize planning arrangements in each band for the use or uses that maximize the overall public benefit. Planning arrangements in bands should enable the allocation of spectrum to specific users with no, or minimal, further regulatory intervention, and may remain stable over long periods of time.

Where there is evidence of changes in the optimal use or uses of bands, however, the Regulator may identify that there is a net public benefit in the band moving to a new or changed use or being re-configured to better support an existing use. Consulting where appropriate with existing and future users, the Regulator will then consider how best to accommodate additional uses or users within the available spectrum.

Planning activities are divided into two main sections:

* major band (re)planning activities to support the establishment of new spectrum uses. This may require the re-farming and reallocation of spectrum from an existing use and users to mobile broadband use and users

optimising established planning frameworks for existing spectrum use through updating technical coordination arrangements. This can include addressing sharing demands, defragmentation and optimising planning configurations.

Planning is based on domestic and international demand for spectrum uses, developments in international spectrum harmonization and technology standardization paths, and evolution of communications technology. The planning information must be included in the activities and reflects expected developments over a two to five-year time frame.

### 2.2.2 Allocation

To keep pace with the changing demand, timely access to spectrum is of increasing importance to an innovative and dynamic communications sector. For incumbent and prospective spectrum users, this allocation provides information for stakeholders about the planning status and possible allocation timing and sequencing of particular spectrum bands, to better support the strategic network planning by spectrum users, technology deployment planning and information relevant to capital-raising activities.

Any kind of specific allocations may depend on Regulators decisions during the planning stage and should reflect other relevant government policy considerations about planning priorities. Information from incumbent and prospective spectrum users about the demand for access to specific bands and the timing of any possible allocation will also provide important input to allocation decisions. The allocation should not be guaranteed before the final arrangement on that particular band.

To move towards an allocation, the allocation timing, allocation methodologies, etc. are all dependent on planning decisions to be made. The Regulators shall take account of feedback from industry about likely demand and their priorities for access to particular spectrum bands.

### 2.2.3 Regulatory Review

A review based on industry feedback is required once the roadmap is prepared. According to the trend in technology, the spectrum release roadmap should be re arranged. Stakeholders may express concerns about the regulatory policy, particularly the maintenance of existing rights of licensees and specific issues such as license term and renewal. Sometimes stakeholders may ask for the interim arrangements of licensing. In any case, Regulators should consult with the stakeholders on the development of the new regulatory arrangements, including instruments.

### 2.2.4 Pricing

Spectrum pricing always play a vital role on the spectrum roadmap. Due to the popularity of Mobile Broadband, more spectrum is needed for this. But price of these spectrum bands encourages or discourage the acquisition of the spectrum. Regulators must set and review the price concerning the practical impact of it. To provide good quality of service an operator must posses adequate spectrum or install adequate number of equipment. To discourage the installation of more number of equipment, more spectrum need to be acquired. Only if the price of spectrum is less than the installation cost of equipment, the operators will acquire more spectrum. To implement recommendations of the Spectrum Pricing Review, the Regulators may take following steps:

* for transparency and to make the investors understand the pricing procedure a spectrum pricing guideline is to publish
* a periodic review of the spectrum pricing inclusive of administrative cost to be done

### 2.2.5 International Involvement

By participating in international radiocommunications forums, every Regulators must take care and protect, sometime promote also its national interest in spectrum management, including spectrum harmonization and international frequency coordination.

In World Radiocommunication Conference (WRC), a forum of International Telecommunication Union’s (ITU), that reviews and revises the Radio Regulations, the international treaty regarding use of the spectrum Regulators must express their concerns to prepare an efficient and sustainable roadmap. In WRC-19 an agenda item is focused on identification of IMT spectrum especially suitable for 5G. Regulators must participate WRC-19, as well as other key policy-related WRC-related ITU and Asia-Pacific Telecommunity (APT) meetings including the APT Conference Preparatory Group for WRC-19 (APG-19) for understanding the global trend of technology development. In addition to the policy-related meetings, there are a number of other forums within the ITU and regionally within the APT that consider issues of significance to spectrum management, such as ITU-R Study Groups and Working Parties, and the APT Wireless Group (AWG). The Regulators along with industry, should provide technical expertise for the preparatory groups contributing to these forums.

This engagement is invaluable in both coordinating international activities and in sharing information and learnings from other spectrum managers on issues of common interest.

# 3. Spectrum Roadmap for Mobile Broadband- Best Practices

## 3.1 Australia

Australian Communication and Media Authority (ACMA) has finalized a five-year spectrum plan named as Five-Year Spectrum Outlook (FYSO) 2018-22. It has been prepared after consultation with the stake holders. This document will be reviewed every year and modified as necessary. It focused on the revising existing spectrum usage and upcoming spectrum requirement to keep pace with the technological evolution. It prioritized the following concerns:

* Part 1—Environmental outlook

Suggestions for a broader focus by the ACMA on the spectrum demand pressures arising from the Internet of Things, space and satellite industry, 5G and mobile broadband developments to be taken up over the course of the year and reflected in future updates.

* Part 2—2018–19 Spectrum work program

Suggestions for better explaining the basis for changes to our spectrum management priorities.

Planning priority changes

Fast-moving developments in the international environment and changing demand from industry, as expressed in submissions to the FYSO, has led the ACMA to reprioritise and bring forward planning work in a number of key bands: 2GHz, 3.3-3.4 GHz, 3.4-3.575 GHz, 3.7-4.2 GHz, 26 GHz, 28 GHz.

Forward allocation work program

The updated planning priorities have consequences for the timing and sequencing of spectrum that may become available for allocation by auction. In response to feedback, the ACMA has prioritised action on the 26 GHz band. The potential timing of allocations has been amended to reflect these changes.

 Potential timing of allocations

|  | ACMA planning decision | Minister decision where applicable | Auction | Notes |
| --- | --- | --- | --- | --- |
| 3.6 GHz band | Q2 2017–18 | Q3 2017–18 | Q2 2018–19 | Applications for this auction opened on 6 August 2018. The auction is expected to commence in late November 2018 |
| 26 GHz | Q3–4 2018–19 | Q1 2019–20  | Q1–Q2 2020–21 | May be allocated under new Act |
| 850/900 MHz | Q2 2018–19\* | Q1–2 2019–20” | Q1–Q2 2020–21 | May be allocated under new Act |
| 1.5 GHz | Q3–4 2019–20 | Q3–4 2019–20 | Q3–4 2020–21 | May be allocated under new Act  |

The details of FYSO 2018-22 can be found in the following link:

<https://acma.gov.au/Industry/Spectrum/Spectrum-projects/5-Year-Spectrum-Outlook>

## 3.2 New Zealand

Radio Spectrum Management (RSM) is a business unit of the Ministry of Business, Innovation and Employment (MBIE) and is responsible for efficiently and effectively managing the radio spectrum in New Zealand. This includes allocating rights for the use of the spectrum, and enforcing compliance with the requirements to ensure legitimate users are able to enjoy their rights. In 2017, RSM has prepared a five-year spectrum outlook. This Five-Year Spectrum Outlook provides industry with an overview of Radio Spectrum Management’s recent activities, discusses emerging developments in wireless communications and reports on international spectrum decisions relevant to New Zealand’s management of radio spectrum. It also provides an indicative work program for RSM for the period 2017-2021.

The document focused on the spectrum trend driving changes, development on different telecommunication sector, like, mobile broadband, fixed service, aeronautical & maritime service, broadcasting service, etc. and summarize the action points for these sectors development. Finally, it helps to prepare the work program on spectrum management for the period 2017-2021.

The details of RSM 2017-2021spectrum outlook can be found in the following link:

<https://www.rsm.govt.nz/online-services-resources/publications/annual-reports-and-business-plans>

## 3.3 United Kingdom

Ofcom has published their spectrum management annual plan 2018/19. In the document, the projects in 2018/19 are highlighted. It sets out the key spectrum-related work areas for the current year, as well as our broader program of ongoing work that includes:

* Preparing for future awards of spectrum bands as they are cleared and released (including the award of the 700 MHz and 3.6-3.8 GHz bands)
* Spectrum authorization (including work on sharing)
* Work to make sufficient spectrum available for 5G
* Studies to inform future requirements for spectrum (such as mobile data, the satellite and space science sectors and fixed wireless uses)
* Spectrum assurance and enforcement

Ofcom has Mobile Data Strategy, published on 2016. This document addresses the increasing use of data by mobile devices like smartphones, tablets and laptops. Spectrum plays a key role in enabling future mobile data growth, and our role is to secure the optimal use of spectrum to benefit citizen and consumers and make communications work for everyone. The strategy was first set out in a document published in May 2014 but, as this is a fast-moving industry, Ofcom will update stakeholders from time to time on any changes based on priorities.

There have been some changes in the landscape for mobile data since May 2014 due to technological and international developments - in particular the early development of 5G technology. Although most of the strategy continues to be fit for purpose, some adjustments should be made to continue to ensure that the UK is at the forefront of mobile technology. The prioritized bands are as follows:

|  |  |  |
| --- | --- | --- |
| Priority for further work  | 2014  | 2016  |
| Current priorities  | • 700 MHz • 2.3 GHz, 3.4 GHz • UHF white space (shared)  | • 700 MHz • 2.3 GHz, 3.4 GHz • Implemented  |
| High  | • 1452-1492 MHz • 1980-2010 / 2170-2200 MHz (‘2 GHz MSS’) • 3.6-3.8 GHz • 5-6 GHz Wi-Fi (5350-5470 MHz, 5725-5925 MHz) (shared)  | • Implemented • 1427-1452 & 1492-1518 MHz (increased priority) • Removed • 3.6-3.8 GHz • 5-6 GHz Wi-Fi (emphasis now on 5725-5850 MHz) • mmWave bands added  |
| Medium-High  | • 1427-1452 MHz (shared) • 3.8-4.2 GHz (shared)  | • Increased priority • Examining responses to a call for inputs  |
| Medium  | • 470-694 MHz (very long term) • 2.7-2.9 GHz • 1492-1518 MHz • 5.925 – 6.425 GHz  | • 470-694 MHz (very long term) • Removed • Increased priority • Removed  |

The detail of this plans available at the link: <https://www.ofcom.org.uk/consultations-and-statements/category-1/mobile-data-strategy>

# **4. Analysis and Recommendation on Developing Spectrum Roadmap**

After analyzing the replies on questionnaire from Bangladesh, Bhutan, India, I. R. of Iran and Sri Lanka, it is clear that maximum countries do not have their own/individual spectrum roadmap to meet future need. Among the SATRC countries, I.R of Iran has their roadmap on spectrum release for mobile broadband. Though the spectrum release is market driven in maximum countries throughout the world, every regulator must have a roadmap of spectrum release for clear understanding on the investment and sector growth. To keep pace with the global trend and national requirement, the forecast on mobile broadband growth is very important. To introduce a new technology, a spectrum band may need to be re-farmed, re assigned. To do such, the allocation and pricing of the band, industry feed back and best practices of the world is required. After completion of these, regulatory framework for introducing that technology needs to be developed. The harmonization of the band to avoid harmful interference plays an important role prior to release that band.

Depending upon the global trend and the replies from the questionnaires as circulated, it is found that the common IMT bands like 1800 MHz, 2100 MHz are not fully utilized in all SATRC countries yet. To provide good quality of service and to introduce the new technologies in future mobile broadband, spectrum bands may be prioritized as below:

|  |  |
| --- | --- |
| Priority for further work | Spectrum Band |
| Near Future | • 700 MHz • 2.6 GHz • 3.4 GHz • mmWave bands  |
| Future | • 617-698 MHz (very long term) • 617-698 MHz |

# **5. Conclusion**

In this report, we introduced the parameters to develop a spectrum roadmap specially for mobile broadband services. The rapid growth in telecommunication sector is mainly due to the fastest development on mobile broadband service. We are now more connected than ever before and new forms of connectivity are rapidly emerging and changing our living pattern. It gives us the challenge to plan effectively and implementing in timely manner. Regulators have to accommodate new innovations and the increased demand for spectrum use while, at the same time, protect existing investments and maintain a sustainable wireless ecosystem. To achieve this, Government and industry must work in collaboration. Investors must have a clear vision on their upcoming investment for mobile broadband, hence Regulators must have a spectrum roadmap compatible with the global trend. The methodology and analysis may help the regulators in SATRC countries to develop their national spectrum roadmap for the mobile broadband service-the most discussed service.

# **Appendix-1: Questionnaires**

**Objectives of Spectrum roadmap:**

The broad goals and objectives associated with spectrum roadmap are:

* Enhanching the capacity of the mobile network.
* Maximizing the economic benefits from use of the spectrum resource.
* Ensuring the users benefit from the use of the spectrum resource.
* Estimating spectrum demand and supply.
* Computing the relation between spectrum and base station sites.

In order to make the spectrum roadmap, the following informations to be needed from the SATRC member countries.

Q1. Please provide the data of the mobile network operation (from the beginning to date or as old as you find record) as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Operator’s name | Year | Mobile Subscribers | Installed BTS sites | Assigned spectrum in MHz |
|  |  |  |  |  |
|  |  |  |  |  |
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Q2. How much average voice traffic per subscriber in busy hour (According to the TRAI report 2010, average busy hour voice traffic per subscriber in India is 0.05 Erlangs)?

Q3. How much percentage of traffic carried by GSM Half-Rate channel in busy hour?

Q4. How much average data usages per subscriber per month in GB?

Q5. How much average data speed per user is provided from the current network in busy hour?

1. Uplink ---------------- Kbps?
2. Downlink ----------- -Kbps?

Q6. How much expected average data speed per user in busy hour after 2020?

a. Uplink ---------------- Kbps?

b. Downlink ----------- Kbps?

Q7. Do you have 4G network? If you have, do the operators use the carrier aggregation technology?

 a. Channel bandwidth before carrier aggregation technology-------------- MHz?

1. Channel bandwidth after carrier aggregation technology---------------- MHz?
2. Spectrum bands are using for carrier aggregation technology?

Q8. Cell area (coverage area per BTS site) in sq. km.

|  |  |  |  |
| --- | --- | --- | --- |
| Geographical area | 2G network | 3G network | 4G/LTE network |
| Dense urban |  |  |  |
| Urban |  |  |  |
| Sub-urban |  |  |  |
| Rural |  |  |  |

Q9. Maximum busy hour traffic per BTS site (voice traffic in Erlangs and data traffic in GB)

|  |  |  |  |
| --- | --- | --- | --- |
| Geographical area | 2G network | 3G network | 4G/LTE network |
| Voice | Data | Voice | Data | Voice | Data |
| Dense urban |  |  |  |  |  |  |
| Urban |  |  |  |  |  |  |
| Sub-urban |  |  |  |  |  |  |
| Rural |  |  |  |  |  |  |

Q10. Cost per BTS site

1. Capital expenditure for the BTS equipment in US$.
2. 700 MHz
3. 800 MHz
4. 900 MHz
5. 1800 MHz
6. 2100 MHz
7. 2.5 GHz
8. Cost per year per BTS site for electricity, rental and maintenance.
9. Total cost for the radio equipment per BTS site (because more than one BTS equipment is installed per site such as single band, dual band, 3G, 4G etc.)
10. Total cost for the civil construction for Greenfield site and roof top site (tower, masts, building etc.)
11. Amortized capex per BTS site for the radio equipment
12. Life time for the radio equipment and civil construction
13. Rate of interest for estimating the amortized capex
14. Cost per BTS for converting from 2G to 3G and 4G network (In case of technology neutrality)
15. Additional cost for the carrier aggregation technology in case of 4G network.

Q11. Status of the spectrum bands identified for IMT

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Spectrum bandin MHz | Spectrum assigned to the operators in MHz | Date of assignment | Acquisition fee per MHz in US$ or LCU | Spectrum assignment procedure(Auction/Beauty contest etc.) | Technology used | Amount of unused spectrum | Expected date of launching 4G, if it is not yet deployed | Expected time frame for the assignment of unused spectrum |
| 450-470  |  |  |  |  |  |  |  |  |
| 703-748/758-803  |  |  |  |  |  |  |  |  |
| 825-850/870-890  |  |  |  |  |  |  |  |  |
| 880-890/925-935  |  |  |  |  |  |  |  |  |
| 890-915/935-960 |  |  |  |  |  |  |  |  |
| 1710-1785/1805-1880  |  |  |  |  |  |  |  |  |
| 1920-1980/2110-2170  |  |  |  |  |  |  |  |  |
| 2510-2690  |  |  |  |  |  |  |  |  |
| 3300-3400  |  |  |  |  |  |  |  |  |
| 3400-3600  |  |  |  |  |  |  |  |  |

Q12. Do you have any spectrum road map in your country? If yes, which parameters have been considered in preparing it?

Q13. Do you have planned or potential future services and applications in the bands listed in WRC-19 AI 1.13 (or part(s) bands), if YES, what is/are planned or potential future services and applications in the bands?

|  |  |  |  |
| --- | --- | --- | --- |
| **Frequency** **Ranges** | **Sub****Ranges** | **Planned/Future services and applications**  | **Timeline** |
| 24.25-27.5 GHz | aa-bb GHz | 1 |  |
| 2 |  |
| … |  |
| cc-dd GHz |  |  |
| …… |  |  |
| 31.8-33.4 GHz |  |  |  |
| 37-43.5 GHz |  |  |  |
| 45.5-50.2GHz50.4-52.6GHz |  |  |  |
| 66-76 GHz81-86GHz |  |  |  |