



**Report of the  
Comptroller and Auditor General of India  
on  
Management of Spectrum assigned on  
the Administrative basis to Government  
Departments/ Agencies**



लोकहितार्थं सत्यनिष्ठा  
Dedicated to Truth in Public Interest



AM



FM TV



Cell Phones



Radar



TV Remote



Light Bulb



Sun



X-ray machine



Radioactive Elements

Extremely Low  
Frequency

Radio waves

Microwaves

Infrared

Ultraviolet

X-rays

Gamma rays

**Union Government  
Ministry of Communications  
Department of Telecommunications  
Report No. 2 of 2022  
(Performance Audit)**



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## Preface

Spectrum as an economic resource is unusual in that it is both non-exhaustible and non-storable, although it may become increasingly congested. It's essential that these scarce resources are used rationally, optimally, efficiently and economically so that equitable access could be available to large radio communication networks in an interference free radio environment. With the emerging new technologies and the phenomenal growth of radio communication services, requirements for the radio frequency spectrum and the satellite orbit are increasing. The social and economic benefits of spectrum are expected to be wide ranging, and Department of Telecommunications needs to work closely with industry, Government users and the community to make spectrum available in a manner that maximizes the benefits for all.

Government Departments/ Agencies had been allotted/assigned spectrum administratively when there was little spectrum scarcity and therefore historically there was no pressure on such users to consider the efficient use of their spectrum resources. This is no longer the case with ever increasing demand for spectrum. As such there is a need to periodically assess the requirement of spectrum for use by the Public Sector bodies. Telecom Regulatory Authority of India (TRAI) had recommended to the Government to conduct the audit of spectrum in its various recommendations issued from time to time. DoT has conducted internally only one Audit of spectrum in 450-3600 MHz Band, during 2017-2018.

The Performance Audit (PA) carried out by the C&AG on **Management of Spectrum assigned on the Administrative basis to Government Departments/ Agencies**, revealed deficiencies in database of spectrum assignments in both Department of Telecommunications and user Departments/ Agencies, absence of policy for assignment of spectrum to captive users, delayed decision making in DoT and non-availability of a permanent mechanism for monitoring spectrum utilisation, instances of sub optimal utilization of spectrum in important bands suitable for commercial services, utilisation of spectrum by users without valid licenses from Department of Telecommunications, lack of infrastructure/ resources in DoT for effective monitoring of spectrum users and penal action wanting against unauthorized users. The need for corrective action by the Government is highlighted in the specific recommendations made in the PA Report.

This Report had been prepared for submission to the President of India under Article 151 of the Constitution of India, for laying before the Parliament.



## Executive Summary

### Spectrum Management

Spectrum (radio waves) is an important natural, scarce resource with economic value, needed for all wireless applications. Today, Radio Frequency (RF) spectrum affects virtually everyone's life and has become a significant contributor to national economic growth. It has been recognized world-over as an important tool for socio-economic development of a nation.

Since radio waves do not stop at national frontiers, the need for international planning of frequency allocations, protection of the legitimate use of radio spectrum are key issues in Spectrum Management whereas global compatibility of devices and technology are the key issues in Spectrum Utilisation. At the global level, the International Telecommunication Union (ITU), is the specialized planning agency of the UN. At the national level, the Wireless Planning & Coordination (WPC) Wing of Department of Telecommunications (DoT), is the nodal agency of the Government of India (GoI) for radio frequency regulation, responsible for planning, regulating, and managing the limited resources of RF spectrum.

Spectrum Management involves regulatory, administrative, supervisory, and specialized technical procedures necessary to ensure the efficient operation of radio communication services. It includes frequency planning, assignments, and licensing to spectrum users. The Nodal agency is required to balance the demands of government users and private service providers. Government departments use spectrum for providing national public services, whereas private players contribute towards value-added services. Rapid changes in technology, liberalization of markets, globalization and public welfare are important factors that go into strategic planning of Spectrum. In Spectrum Management short term, medium term and long-term planning is an absolute necessity for management of requirements due to dynamic changes in spectrum uses and technology.

Owing to increased importance and demand for valuable RF spectrum, allocations and allotments to Government Ministries/ Departments need to be revisited for ensuring optimal utilisation of spectrum. A balance needs to be ensured between demands for Spectrum by Government and Private Telecom Operators, since many Departments such as Defence and Space are also major holders of RF Spectrum.

Historically, Spectrum was assigned to users on administrative basis, wherein user applications would be analysed on the basis of available spectrum and requirements. Licenses for frequency utilization were issued for specific purposes. Where the demand for RF spectrum has increased exponentially, market mechanism is being used for spectrum allotment and assignment. As such there is a need to periodically assess the requirement of spectrum for use by the Public Sector bodies and balance their requirements with the need to making available sufficient spectrum for commercial services. This would enhance provision of communication services, bridge digital divide and anchor the nation towards digital sovereignty.

In India, spectrum in frequency bands 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz and 3.3-3.6 GHz bands had been allotted/ assigned for Telecom Access Services (communications services used by subscribers and spectrum used for it is known as access services and access spectrum). The use and consequent economic value of a spectrum

band depends upon the development of technology and the spectrum bands that were initially used for first/ second generation (1G/ 2G) mobile services can be now used for next generation (3G/4G/5G, etc.) mobile services, with enhanced appropriate technology.

### **Why did we decide to conduct this Performance Audit?**

Government Ministries/ Departments/ Agencies had been assigned spectrum administratively in IMT bands suitable for commercial use, as well as in non IMT bands. Hence, assessment of utilization of spectrum assigned on administrative basis to such entities is important. Audit had earlier conducted a **Performance Audit on ‘Spectrum Management in DoT’**, whose scope was largely limited to DoT, and the audit findings were included in Chapter II of CAG’s Report Number 21 of 2018. The Ministry has submitted Action Taken Notes (ATNs) in respect of 15 out of 18 Paras which were to be followed up in Audit.

Additionally, DoT requested CAG (October 2020) to audit Ministries/ Departments/ Agencies who had been allotted spectrum administratively. It stated that spectrum being scarce, it is vital that each Ministry/ Department/ Agency makes optimal use of the allotted/ assigned spectrum and hence desired an audit of the utilization of Spectrum allotted administratively to Government Departments and Agencies.

The scope of the Performance Audit conducted against this background examined the important aspects of Spectrum Management like process of assignment of spectrum bands and pricing of spectrum to captive users, licensing and database management of frequencies assigned to Government Users, sharing of spectrum and utilization of spectrum by selected Government Departments/ Agencies.

The Performance Audit covering the period 2012 to 2021, conducted during the period March-July 2021 was done in Department of Telecommunications (DoT), Ministry of Defence (MoD), Department of Space (DoS), Ministry of Information and Broadcasting (MIB), Ministry of Home Affairs (MHA), Ministry of Railways, selected PSUs of Ministry of Petroleum and Natural Gas namely Oil and Natural Gas Corporation (ONGC), Indian Oil Corporation Limited (IOCL) and Gas Authority of India Limited (GAIL) and in Airports Authority of India (AAI).

### **Major Findings:**

#### **Spectrum Management in DoT**

1. One of the objectives of the National Digital Communication Policy (NDCP) 2018 is “Developing a transparent, normative and fair policy for spectrum assignments and allocations”, either through auction or administrative allotment. Post the Hon’ble SC judgement of February 2012 regarding allotment of spectrum for access services, there has been an adhoc arrangement in DoT of opening application windows for three/ six months regarding allotment/ assignment of spectrum administratively for both captive users as well as for other commercial services on provisional basis. This has not only caused uncertainties of availability of the resource among Government users but also delays in assignments and denial of spectrum to them in some cases.

Despite receiving a legal opinion (July 2021) on its own reference, regarding method for allotment of spectrum for captive uses including Government Departments, DoT had not finalized the policy for allotment/ assignment of spectrum for captive uses/ other commercial services with approval of the Digital Communications Commission, the Apex body for policy formulation. DoT had also not reviewed pricing of spectrum assigned for captive users administratively, on formulae basis since 2012, though a Committee had recommended for a periodical review of the pricing policy in 2013. There was no differential pricing for spectrum depending on features and usage of various spectrum bands assigned to users.

**[Paragraphs 3.2 and 3.3]**

2. There has been a Standing Committee since 1966 viz. SACFA (Standing Advisory Committee on Frequency Allocation) in DoT, to make recommendations on issues related to frequency allocation, deliberations at international forums like International Telecommunications Union (ITU) and Asia Pacific Telecommunity (APT), formulation of National Frequency Allocation Plan (NFAP) etc. However, its role has been limited to giving siting clearances for wireless installations. DoT had not constituted a Permanent Committee/ Group to advise them on complex issues related to Spectrum Management including refarming of spectrum, for efficient and optimal utilization of the scarce resource.

**[Paragraphs 1.8 and 3.4.1]**

3. **Decision making in DoT** was plagued with adhocism and absence of any Permanent Mechanism in the Department, constituting all Government stake holders to advise them on important issues relating to Spectrum Management comprising of spectrum allocation/ assignments/ utilization of assigned spectrum, refarming and sharing of spectrum amongst Government users etc. There were no arrangement in place to study technological developments worldwide for suggesting their deployment in India to spectrum users, as mandated by NDCP 2018.

They had instead constituted (June 2015) Seven Working Groups for identifying frequencies in specific spectrum bands viz. 470-520 MHz, 1215-1400 MHz, 1427-1500 MHz, 1800 MHz, 1880-1900 MHz, 2300-2400 MHz and 21.2-23.6 GHz for Government Users. Only four Groups had submitted their final recommendations between March 2016 and February 2021 though these working Groups were required to submit their recommendations within six months. However, DoT had not taken any final decision on recommendations received so far.

**[Paragraphs 3.4.1, 3.4.2 and 3.4.3]**

4. Spectrum allotted so far is liberalized one and can be utilised for all types of Access Services i.e. 2G/3G/4G and also 5G services with requisite technology. Spectrum allotted/ assigned to Government Departments in Bands 470-646 MHz, 700 MHz, 900 MHz, 1427-1500 MHz, 1800 MHz, 2100 MHz, 2300-2400 MHz, 2500-2690 MHz, 3300-3670 MHz, 24.25-28.5 GHz was found to be either sub optimally utilized or not utilized at all for years together for various reasons. For Spectrum assigned to

Government users, DoT had not taken any lead so far, for re-farming and sharing of spectrum in economically valuable IMT Bands. There was a large quantity of idle spectrum in these Bands, for which DoT had yet to take action for auction/ allotment to Government/ private users.

**[Paragraph 3.5]**

5. Utilization of spectrum by Ministry of Information and Broadcasting (MIB) in 470-698 MHz band allotted long ago (during the period from 1989 to 2013) and thereafter, is very suboptimal due to obsolete technology of Analogue Terrestrial Television (ATT) and non-viability of Digital Terrestrial Television (DTT). DoT had not finalized their decision in regard to the recommendations of the Working Group constituted for 470-520 MHz band and Committee of Secretaries (CoS) that 120 MHz (526-646 MHz) spectrum in these bands can be made available on pan India basis for IMT (5G) applications.

**[Paragraphs 3.5 and 6.2]**

6. Railways, had been allotted 1.6 MHz paired spectrum since 2003 on pan India basis in commercially important 900 MHz band for its GSM-R based Mobile Train Radio Communications (MTRC) system. They could commission MTRC equipment only in 57.90 per cent of routes planned covering nine out of 22 service areas. Utilisation of spectrum in this band is inefficient and sub optimal due to non-maintenance of equipment and unavailability of spare parts. However, this 1.6 MHz paired spectrum in 900 MHz band was not re-farmed from Railways as recommended by TRAI, where Railways has not commissioned its GSM-R based MTRC system (first in 13 service areas) and in phases in balance nine service areas.

Railways have been allotted 5 MHz Spectrum in 700 MHz IMT Band (June 2021) for roll-out of LTE based network, for which work was stated to be in progress.

**[Paragraph 3.5]**

7. Spectrum in 2100 MHz and 2300-2400 MHz frequency bands being IMT bands has huge commercial value. The spectrum in these commercially important bands were lying unutilized/ sub-optimally utilized, and needed to be harmonized or vacated.

**[Paragraph 3.5]**

8. Frequency band 2500-2690 MHz identified for IMT applications is currently being used for both terrestrial and satellite based services. Out of 190 MHz available Spectrum, only 40 MHz had been allotted/ assigned for IMT applications and satellites (GSAT 6, 7 and 17) had been launched for 100 MHz for satellite-based services for users. Launch of satellite for balance 50 MHz was under process. There has been interference in the existing operations and lack of coordination between DoT and DoS for proper technology solution for co-existence of both services, leading to sub optimal use of spectrum in this band.

**[Paragraph 3.5]**

9. Similarly, Spectrum in 3.3 GHz - 3.6 GHz had been identified for both terrestrial and satellite-based services. DoS and DoT had not identified an appropriate technology solution and limitations of use in such a manner that both services can co-exist in these bands. Therefore, non-utilization of 175 MHz of the total capacity, reserved for Broadband Wireless Access services was observed.

**[Paragraphs 3.5]**

10. Automated Spectrum Management System (ASMS) implemented by DoT in 2005 for engineering calculation of interference free frequency assignments and processing of applications, issue of licenses, generation of invoices, integration with monitoring organization, etc. is not being used for full functionalities as per International Telecommunications Union (ITU) standards/ guidelines. Obsolete and poorly maintained equipment/ systems lead to ineffective Spectrum Management in WPC (DoT). The National Frequency Register (NFR) was also not updated in the ASMS vis-à-vis cancellation and surrender of frequency authorization, change of frequency, etc. and there was largescale mismatch of database regarding spectrum assigned to Government Departments/ PSUs/ Agencies.

**[Paragraph 3.6]**

11. WPC (DoT) issues Agreement in principle (AIP)/ Decision Letters (DLs) before granting Wireless Operating licenses (WOL), which were legally required under Section 3 of Indian Wireless Telegraphy Act 1933 for establishing Wireless Telegraph Station. Audit observed that Several Departments/ Agencies were found using spectrum without getting valid Wireless Operating licenses as required, due to delays in disposal of their applications by WPC wing or non-compliance of terms and conditions of AIP/ Decision Letter by the users.

**[Paragraphs 6.1.2, 6.4.3, 6.5.2 and 6.7.3]**

### Monitoring of Spectrum Use

12. Monitoring of spectrum use is an important aspect of spectrum management. The Wireless Monitoring Organization (WMO), a field unit of DoT did not have sufficient and updated monitoring equipment, enforcement groups. Proposals for procurement of required equipment were pending at different stages awaiting approval in DoT. This adversely affected the effectiveness of monitoring activities and action on unauthorized use of spectrum.

Further, DoT did not have any institutionalized mechanism or any apparent MIS for monitoring of spectrum use by the Government Departments/ Agencies.

**[Paragraph 3.7]**

### Spectrum Management in Ministry of Defence

Ministry of Defence have historically been one of the largest users of RF Spectrum which has been assigned to them on Administrative basis. JCES Defence is the Nodal agency in MoD responsible for Spectrum Management for the Defence services. The Audit Findings relating to Spectrum Management in MoD have been issued separately to them due to their security concerns.

### Spectrum Management in Department of Space

13. Bandwidth capacities on GSAT 29, GSAT 19 and GSAT 11 remained idle for long periods since their launch in June 2017, November 2018, and December 2018 respectively. DoS allotted spectrum bandwidth to users only in 2020/ 2021, resulting in non-utilization spectrum bandwidth for several years.

[Paragraph 5.2.2]

14. The Orbit Spectrum Coordination and Acquisition Wing (OSCA) functioning under Satellite Communication Programme Office (SATCOM PO) of ISRO is the focal point for spectrum coordination and its management. Audit observed weakness in the supervision and review mechanism in OSCA to maintain strict discipline in the usage, management and surrender of IMT band spectrum.

[Paragraph 5.2.4]

### Spectrum Management in other Ministries/ Departments/ Agencies

15. Directorate of Coordination, Police Wireless (DCPW) being the nodal advisory body to the MHA for the police telecommunication has not devised any policy guidelines regarding spectrum and equipment required for meeting all emergency requirements.

[Paragraph 6.3.1]

16. POLNET, a nationwide Satellite based Captive Communication Network/ Digital Information Highway in C-band is not being utilised optimally as it was not yet fully commissioned due to some shortcomings in the Hub.

[Paragraph 6.3.2]

17. ONGC could not commission its planned networks due to poor contract management and surrendered the allotted spectrum in 3.3-3.4 GHz and 7 GHz respectively in December 2019 and November 2020. Thus, spectrum in these important bands remained unutilized for four to nine years.

[Paragraph 6.4.1]

18. Frequency spots assigned to Airports Authority of India remained unutilised for years together at various Airports owing to delayed procurement of equipment/ non completion of projects in time.

[Paragraphs 6.7.1 and 6.7.2]

## Summary of Recommendations

- i) *DoT may devise a policy on allotment and assignment of spectrum for Captive Users/ other commercial usage in alignment with statements made in NDCP 2018 and end adhocism in allotment of spectrum to Government Departments/ Agencies.*
- ii) *DoT may review the pricing mechanism of Spectrum for Captive Users in order to incentivize Ministries/ Departments/ Agencies and maintain spectrum management discipline. They may consider differential pricing depending on the features and usage of various spectrum Bands.*
- iii) *DoT may establish a Permanent set up comprising all stake holders for periodical review of spectrum planning, spectrum availability, allotments/ assignments, pricing, etc. to expedite decisions for efficient management and optimal utilisation of spectrum in India. They may also ensure that a MIS is put in place in DoT to get details of actual spectrum utilized by Government user Departments and Agencies.*
- iv) *DoT needs to encourage/ support research studies and other technical initiatives by user Departments/ entities as well as other organizations for technology solutions for efficient spectrum utilization.*
- v) *DoT in consultation with all the Departments may take proactive measures for finalization of recommendations of Working Groups and decisions of the Committee of Secretaries for reassignment/ re-allotment/ refarming of spectrum.*
- vi) *In pursuance of NDCP 2018, DoT may coordinate with Government users to provide spectrum in substitute bands for users in 1427-1500 MHz and 2300-2400 MHz bands, harmonization exercise in 2100 MHz, sharing of spectrum in 700 MHz band as these had been identified for IMT use and have scope for commercial utilization of spectrum.*
- vii) *All the stakeholders in the 2500 MHz band viz. DoT, DoS and others need to ensure synergy for which DoT may take the lead so that this important IMT band can be utilized optimally with proper technological solutions for co-existence of both terrestrial and satellite-based services without causing harmful interference.*
- viii) *DoT in consultation with Ministry of Information & Broadcasting may take immediate action to make available spectrum in frequency band 526-646 MHz for IMT/5G services, based on recommendation of Working Group and Committee of Secretaries that Doordarshan and other Government user could coexist in 470-520 MHz frequency band.*
- ix) *DoT and Railways may monitor the completion of LTE based network project in 700 MHz band so that Railways vacate the spectrum in 900 MHz band being used by them and it is made available for commercial utilization.*
- x) *DoT in consultation with TRAI may take early action for the auction/ utilization of IMT spectrum lying idle with them.*

- x i) DoT needs to acquire and implement an industry standard Automated Spectrum Management System. Further, DoT may update the existing database on spectrum users on priority before migration to the new system and make available the updated database on a timely basis to WMO for efficient monitoring of assigned Spectrum.*
- x ii) DoT may urgently upgrade the infrastructure and equipment of its WMO offices and its field units to strengthen their monitoring of spectrum. Further, DoT may also conduct a comprehensive review of the manpower and resource requirements of WMO units to enable them to discharge their monitoring responsibilities effectively and efficiently in an increased environment of spectrum users.*
- x iii) DoT may review the international best practices in Spectrum Management, for suitable incorporation of these best practices for Spectrum Management in India.*
- x iv) DoS and DoT need to work together to identify an appropriate technology solution in such a manner that both services can co-exist in important frequency bands.*
- x v) DoS needs to engage with client Departments and other potential users at an early stage before planning and launching the satellite capacity so as to minimize non-utilization of spectrum resources.*
- x vi) DoS needs to establish a mechanism for assessing and reviewing the utilization of spectrum in all bands, particularly in IMT bands and satellite bandwidth for ensuring optimal and efficient utilization of assigned spectrum. DoS may consolidate spectrum related information and make it available at a common platform for easy access and assessment of spectrum at Corporate Infocom level.*
- x vii) Ministry of Home Affairs may devise policy for spectrum management among Central Armed Police Forces. Further, efforts may be made for optimal utilisation of POLNET 2.0 by all State Police Departments and CAPFs and other related agencies for their operational requirements.*
- x viii) DoT may ensure that PSUs like ONGC and GAIL etc. use the assigned spectrum optimally and efficiently and surrender unutilised frequencies.*
- x ix) AAI may introduce a mechanism for periodical review of utilization of assigned frequencies and adhere to the regulatory provisions governing use of wireless equipment/ networks.*

# CHAPTER 1

## INTRODUCTION TO SPECTRUM AND ORGANISATIONAL SET UP





## CHAPTER

## 1

## Introduction to Spectrum and Organisational Set up

## A Introduction to Spectrum

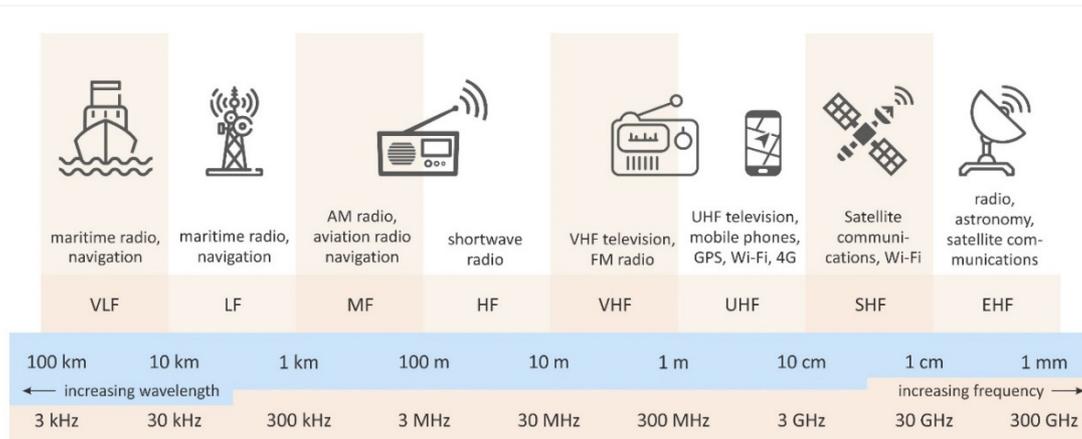
## 1.1 Electromagnetic Spectrum

Electromagnetic (EM) Spectrum is a range of wavelengths or frequencies of electro-magnetic radiation. It includes gamma rays, X-rays, ultraviolet rays, the visible spectrum (light), infrared rays, microwaves and radio frequency waves. The part of EM spectrum that can be used for communication is referred to as Radio Frequency (RF) spectrum.

RF spectrum is an important but scarce resource needed for wireless communication, and thus affects each person and had become recognized the world-over as an important tool for socio-economic development of a nation. The ability to carry energy and messages at a distance, with the speed of light and no cost, had made RF Spectrum a valuable resource with the potential for providing gains to everybody.

The RF spectrum corresponds to frequencies from 3 KHz<sup>1</sup> to 3,000 GHz<sup>2</sup>. This band had been further divided by the International Telecommunication Union<sup>3</sup> (ITU) into various categories. RF spectrum ranging from 8.3 KHz to 275 GHz had been allocated as per the table of Frequency Allocation under Article 5 of ITU's Radio Regulations (RRs) for various radio communication services. There were 41 different types of services defined in the Radio Regulations such as Fixed service, Mobile service, Broadcasting service, Space operation service, Aeronautical mobile service, Amateur service, Maritime mobile service, Land mobile service, Port operation service, Radio determination service, Mobile satellite service, Radiolocation service, Ship movement service, Meteorological aids service, etc. **Figure 1.1** illustrates different frequency bands and their applications.

**Figure 1.1: Frequency bands and its applications**



<sup>1</sup> **kHz** is the abbreviation for **kilohertz**. A unit of measurement of frequency, also known as cycles per second. One KiloHertz (kHz) is equal to 1,000 Hertz (Hz) or 1,000 cycles per second.

<sup>2</sup> One GigaHertz (GHz) is equal to 1,000 MHz ie 1000000 kHz

<sup>3</sup> ITU is a specialized agency of United Nations tasked with coordinating spectrum use at a global level with its headquarter in Geneva.

**Table 1.1** exhibits the different ITU frequency bands, wavelengths and major applications.

**Table 1.1: The ITU frequency bands and its applications**

Band	Symbol	Frequency (lower limit exclusive, upper limit inclusive)/ Wavelength	Major services/ applications
4	VLF	Very Low Frequency- 3 to 30KHz Myriametric waves 100 to 10 km	Meteorological aids, Navigation and position location
5	LF	Low Frequency- 30 to 300 KHz Kilometric waves 10 to 1 km	Radio navigation, Maritime mobile, beacons, Weather broadcast stations for air navigation
6	MF	Medium Frequency- 300 to 3000 KHz Hectometric waves 1000 to 100 m	Aeronautical radionavigation, Maritime mobile, AM broadcasting
7	HF	High Frequency- 3 to 30 MHz Decametric waves 100 to 10 m	Shortwave broadcasting, Maritime mobile, Aeronautical mobile.
8	VHF	Very High Frequency- 30 to 300 MHz Metric waves 10 to 1 m	Space operation, Space research, Maritime mobile, Radar, FM broadcasting, Mobile radio communications, Air traffic control
9	UHF	Ultra-High Frequency- 300 to 3000 MHz Decimetric waves 100 to 10 cm	Cellular telephones, TV broadcasting, Radar, Radio astronomy, Microwave links
10	SHF	Super High Frequency- 3 to 30 GHz Centimetric waves 10 to 1 cm	Radar, Satellite communications systems, Aircraft navigation, Radio astronomy, Remote sensing,
11	EHF	Extremely High Frequency- 30 to 300 GHz Millimetric waves 10 to 1 mm	Radar, Advance communications systems, Radio astronomy, Remote sensing,
12	THF	Tremendously High Frequency- 300 to 3000 GHz Decimillimetric waves 1 to 0.1 mm	Not allocated

There were several physical and technical limitations on the utilization of radio frequencies. Its use for communication purposes is dependent on availability of equipment and technology, propagation and operational constraints and suitability of different frequencies for specific applications. Therefore, only a limited portion of the RF spectrum is useful for specific telecommunication services. Some RF spectrum (such as in the UHF band, 300-3000 MHz, or slightly higher) is suitable for a wide variety of services and is thus in great demand.

Frequency bands in the microwave range<sup>4</sup> were designated by letters such as L, S, C, Ku, K and Ka, etc. which were standardized by US Institute of Electrical and Electronics Engineers (IEEE). The details of frequency band classification by US IEEE are given in **Annexure 1.1**. These terminologies are being commonly used in satellite-based spectrum.

## 1.2 Spectrum Allocation and Management

RF spectrum is not limited by national boundaries and is susceptible to interference as it is governed by laws of physics due to its propagation characteristics and it must be shared by all

<sup>4</sup> Microwave is a form of electromagnetic radiation with wavelengths ranging from about one meter to one millimeter.

countries for several telecommunication services. Since, radio waves are not limited by national boundaries the need for international planning for frequency allocations and protection of the legitimate use of RF spectrum had long been recognized.

### **1.2.1 Role of International Telecommunication Union**

At the global level, this task lies with the International Telecommunication Union (ITU) which is a specialized planning agency of the UN. ITU agreements on spectrum allocation are set out in the ITU Radio Regulations (ITU RRs) which have treaty status. RRs regulate the use of radio spectrum internationally and form the global framework for regional and national planning (although nations remain sovereign in their use of the radio spectrum in their own territory and Article 48 of the ITU Constitution states that ITU members may retain their freedom regarding military radio use). RRs are regularly reviewed and if necessary, revised through World Radio Conferences (WRC) which takes place every three to four years. The last WRC took place at Sharm el-Sheikh, Egypt during October-November 2019.

At the national level, the Wireless Planning & Coordination (WPC) Wing of Department of Telecommunications (DoT), is the nodal agency of the Government of India (GoI) for radio regulation and is responsible for planning, regulating, and managing the limited resources of RF spectrum and associated satellite orbits including geo-stationary satellite orbit, as well as licensing of wireless stations in the country. As the national radio regulator, WPC represents India in ITU forums.

## **1.3 Spectrum Allocation and Management Process and Policy in India**

### **1.3.1 National Frequency Allocation Plan (NFAP) and National Frequency Register (NFR)**

In India, the Indian Telegraph Act, 1885, the Indian Wireless Telegraphy Act, 1933 and related rules and procedures provide the legal basis for spectrum management.

The National Frequency Allocation Plan (NFAP) is an important policy document identifying band wise availability of spectrum for spectrum managers, wireless users and manufacturers in the country facilitating optimal utilization of radio frequency spectrum for various services and applications. It is developed in consultation with stakeholders within the framework of the International Frequency Allocation Table (IFAT) contained in Article 5 of the ITU Radio Regulations. The NFAP currently in vogue is NFAP-2018 which came into effect from October 25, 2018 aims to provide a roadmap for the availability and allocation of wireless spectrum to facilitate the development and deployment of next generation wireless services in the country viz. Machine to Machine (M2M) communications and Internet of Things (IOT), which would be supported in a large measure by the forthcoming 5G technology.

The National Frequency Register (NFR) is the basic record for all frequency assignments and is referred to for identifying assignable frequency for any new applicant.

### 1.3.2 Approaches to Spectrum Allotment: Administrative allotment and market-based allotment

Historically, spectrum allotment was done by assigning frequencies by issuing licenses to specific users for specific purposes and by limiting access to and use of RF spectrum; this is referred to as the administrative approach to spectrum management.

In India, spectrum auction was introduced in 2010 for 3G/ BWA services only. Post the Supreme Court judgement of February 2012 in the 2G Spectrum case, spectrum for telecom access services (2G/3G/4G) under the Unified License regime had been allotted through auctions. However, spectrum for other telecom services viz. Point to Point links, Internet Services, NLD/ ILD, VSAT, etc. and captive uses continues to be allotted administratively.

### 1.3.3 RF Spectrum users and types of licenses

In terms of spectrum usage, allotment and pricing, the spectrum users are broadly categorized as Captive users and Commercial users.

**(I) A ‘Captive user’** of RF spectrum is a person/ entity to whom the WPC had assigned one or more radio frequencies within specified space-time combination(s) to meet his own needs, but not for providing any kind of broadcasting or telecommunication service(s) to others (third parties) directly using the said frequencies. Major captive users are Central/ State Government Departments, Defence and Paramilitary Forces, Public Sector Undertakings (PSUs), State Police/ Fire services, Airport Authority and Aircrafts, Maritime, Ports and Ships, Captive Very Small Aperture Terminal (VSAT) Service Providers, Private entities and other users. Spectrum assigned to State Police organizations, Central Para Military Forces, Civil Aviation are primarily in non-International Mobile Telecommunications (IMT) bands<sup>5</sup> whereas spectrum to Defence and some PSUs are in both IMT and non-IMT bands. Spectrum assignment to Captive users is made through administrative pricing mechanism and not through market related process.

**(II) A ‘Commercial user’** of RF spectrum is an entity to whom the WPC had assigned one or more radio frequencies within specified space-time combination(s) for providing any kind of broadcasting or telecommunication service(s) to others (third parties) directly using the said frequencies. Telecom Service Providers (TSPs), Internet Service Providers (ISPs), Commercial Very Small Aperture Terminal (VSAT) Service Providers, National Long Distance (NLD) / International Long Distance (ILD) Service Providers, Public Mobile Trunking Service Providers and Private Frequency Modulation (FM) Broadcasters are major commercial users of RF spectrum. Satellite based services like Licensed Teleport Operators for Satellite uplinking, Licensed Digital Satellite News Gathering (DSNG)<sup>6</sup> Operators, Sound and Terrestrial TV Broadcasting (Prasar Bharti), etc. are also commercial users.

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<sup>5</sup> IMT bands refers to spectrum band used for providing public mobile telecom services.

<sup>6</sup> DSNG is a kind of electronic news gathering (ENG), which simply refers to all the electronic technologies that allow news reporters to broadcast from remote locations outside of a TV studio. It is a broadcasting service under satellite application.

### 1.3.4 Formulation of Telecom Policies and Spectrum Management

#### (a) Telecom Policies 1994, 1999 and 2012

Use of spectrum in India is governed by the provisions of Indian Wireless Telegraphy Act, 1933 and allocation of spectrum is made under the framework of National Frequency Allocation Plan (NFAP) which is revised from time to time. Cellular services using spectrum was introduced in the country in 1994 in pursuance of National Telecom Policy (NTP) 1994. However, NTP 1994 was silent about spectrum management policy. Subsequently, NTP 1999 was formulated which identified the issues relating to spectrum management and emphasized that spectrum be utilized efficiently, economically, rationally, and optimally. It further identified the need for re-farming of spectrum from Defence and other departments and to charge a spectrum usage fee.

In the backdrop of significant growth and penetration of telecommunication services in the country and controversies relating to continued administrative allotment of spectrum to Telecom Service Providers (TSPs), NTP 2012 was formulated. It provided for delinking of allotment of spectrum with licenses and to make spectrum available at a price determined through market related processes. It further emphasized on liberalization of spectrum to enable use of spectrum in any band to provide any service in any technology as well as to permit spectrum pooling, sharing and trading to enable optimal utilization of spectrum. A road map is to be prepared every five years to continuously assess the additional availability of spectrum.

#### (b) National Digital Communication Policy 2018

Communication sector in the country had been witnessing rapid growth and technological changes. To ensure the advantages of new technologies and promote policies that increase opportunities for social and economic development in the country, a new policy statement viz. National Digital Communication Policy (NDCP) 2018 was announced, whose salient features are as follows:

- i. Developing a transparent, normative, and fair policy for spectrum assignments and allocations.
- ii. Identifying and making available new spectrum bands for Access and Backhaul segments for timely deployment and growth of 5G networks.
- iii. Making available harmonized and contiguous spectrum required for deployment of next generation access technologies.
- iv. Coordinating with Government departments for freeing underutilized/ substitutable spectrum, and its assignment along with unutilized spectrum for efficient and productive use.
- v. Ensuring the optimum utilization of spectrum by management of interference free spectrum and encouraging new technologies and consolidation
- vi. Monitoring efficient utilization of spectrum by conducting systematic audits of the spectrum allocated to both commercial and government organizations.
- vii. Recognizing mid-band spectrum, particularly the 3 GHz to 43GHz range, as central to India's strategy for Next-Generation Networks.

- viii. Promoting the effective utilization of high capacity backhaul E-band (71-76/ 81-86 GHz) and V-band (57-64 MHz) spectrum in line with international best practices.
- ix. Rationalizing annual royalty charges for microwave links for backhaul connectivity.

#### 1.4 Availability of spectrum for Telecom Services in India

Table 1.2 indicates frequency bands or parts thereof that had been identified for implementation of IMT as per IFAT and NFAP 2018.

**Table 1.2: Frequency band under IFAT and NFAP**

Frequency Band	IFAT foot Note No.	IND foot Note No.	Remarks
<b>450-470 MHz</b>	5.286AA	IND 16, 18	Identified as IMT band but not yet allotted for commercial use. Major users in this band are <b>Railways, Airports Authority of India, Other Government user and PSUs.</b>
<b>470-610 MHz</b>	5.296A	IND 16	(a) Large part of the band 470-698 MHz <sup>7</sup> is used for broadcasting services by <b>MIB</b> . (b) As per band plan adopted in India for 700 MHz band, 45+45 MHz (703-748 MHz/ 758-803 MHz) is available for use, but only 30+30 MHz was put to auction held in March 2021. 5+5 MHz for <b>Railways</b> and 10+10 MHz is earmarked for <b>other Government user</b> .
<b>610-890 MHz</b>	5.313A	IND 16, 18	(c) 806-824 MHz/ 851-869 MHz earmarked for Public Protection and Disaster Relief (PPDR) and Public Mobile Radio Trunking (PMRT) services. (d) 824-844 MHz/ 869-889 MHz (800 MHz band) allotted for telecom use. Some spectrums also assigned to a <b>Government user</b> in a few service areas.
<b>890-960 MHz</b>	5.317A	IND 16, 26	In the 900 MHz band (890-915 MHz/ 935-960 MHz) earmarked for telecom use, some parts of it allotted to <b>Railways</b> and <b>other Government user</b> .
<b>1427-1518 MHz</b>	5.341C, 5.346A	IND 16	Identified as IMT band but not yet allotted for commercial use. Major users in this band are <b>MIB, other Government user, Fire Brigade and PSUs.</b>
<b>1710-2200 MHz</b>	5.384A 5.388	IND 16	(a) In the 1800 MHz band (1710-1785 MHz/ 1805-1880 MHz), 20+20 MHz had been allotted for a <b>Government user</b> and 55+55 MHz allotted for telecom use (Access services). (b) In the 2100 MHz band (1920-1980 paired with 2110-2170 MHz), 40+40 MHz allotted for

<sup>7</sup> This band is yet to be coordinated at ITU for IMT applications in India, however, it had been identified as IMT in NFAP 2018.

Frequency Band	IFAT foot Note No.	IND foot Note No.	Remarks
			telecom use.20+15 MHz had been earmarked for a <b>Government user</b> .
<b>2300-2400 MHz</b>	5.384A	IND 16	As per band plan for 2300 MHz band adopted in India, 100 MHz in TDD <sup>8</sup> mode (2300-2400 MHz) is identified for IMT. 80 MHz made available for commercial use and 20 MHz earmarked for a <b>Government user</b> .
<b>2500-2690 MHz</b>	5.384A	IND 16	2500 MHz band in TDD mode is identified for IMT. Out of it, only 40 MHz is coordinated for telecom use and balance is for <b>DoS</b> and other users.
<b>3300-3400 MHz</b>	5.429 5.429F	IND 16	As per band plan, 3300-3400 MHz in TDD mode is identified for IMT. It is likely to emerge as primary band for IMT 2020 (5G) system.
<b>3400-3600 MHz</b>	5.432A, 5.432B, 5.433A	IND 16	As per band plan, 3400-3600 MHz in TDD mode is identified for IMT. Out of the 200 MHz available in this band, 25 MHz spectrum is allotted for <b>ISRO</b> 's use and the remaining 175 MHz spectrum is available for commercial (5G) services.

### 1.5 Process of allocation/ assignment of spectrum

In India, assignment of frequencies for various services is based on the NFAP. WPC is the license issuing authority for different services/ purposes. All licenses issued by WPC can be categorized into network license for using radio frequency and non-network license viz. Import licenses, DPL/ NDPL, Experimental licenses, etc.

In furtherance of Government's policy on ease of doing business and making the licensing process transparent, DoT introduced a Web based Portal, 'SARALSANCHAR'(Simplified Application for Registration and Licenses) for issuing various types of licenses and registration certificates as part of various Digital India programs. Different modules for different licenses were launched in July and November 2020.

Applicants seeking to use radio frequencies are initially issued Letters of Intent (LoI) intimating the license fee and royalty (spectrum charges) payable. After receipt of payment, the application is processed first for issue of an Agreement in Principle (AIP) or Decision Letter (DL) and then issue of Wireless Operating License (WOL). The Standing Advisory Committee for Frequency Allocation (SACFA) clearance is required for all fixed wireless stations and compliance to conditions of AIP/ DL are prerequisite for issue of WOL.

For providing space-based services such as communications, meteorology, navigation, etc., Department of Space (DoS) allocates satellite capacities on Geo-stationary satellites to the users. A user is required to obtain service license from the concerned licensing Ministry viz.

<sup>8</sup> In lower frequency bands, channel plan is normally made in Frequency Division Duplex (FDD) mode where separate frequency band is allotted for uplinking and downlinking. However, in higher frequency bands, channel plan is made in Time Division Duplex (TDD) mode where both uplinking and downlinking is done in same frequency band.

Ministry of Information & Broadcasting (MIB)/ DoT, apply to DoS for the satellite capacity and wait for the allotment by DoS. After obtaining the satellite capacity, the user must obtain operating license from WPC/ DOT for assignment and use of the spectrum. The user must finally obtain network licence from Network Operation Control Centre (NOCC) of DOT before utilising the network. The user pays spectrum charges to WPC/ DOT and transponder lease charges to DoS for the satellite capacity allocated.

## **B Organizational Setup in DoT**

### **1.6 Department of Telecommunications and Digital Communication Commission**

The work relating to formulation of Telecom policy, issue of licenses for various telecom services like Unified Access Services, Internet Services, VSAT services, etc., and frequency management (spectrum allotment) in the field of radio communications in close coordination with the international bodies (ITU), is under the overall control of DoT under the Ministry of Communications (MoC). It also enforces wireless regulatory measures by monitoring wireless transmission of all users in the country.

Digital Communication Commission (DCC) (erstwhile Telecom Commission) is the apex body in DoT which is responsible for policy formulation in DoT. An Apex Committee comprising officers from DoT, DoS and MIB had been constituted for coordination and management of satellite-based spectrum.

### **1.7 Wireless Planning & Coordination Wing**

The WPC Wing of DoT created in 1952, is the National Radio Regulatory Nodal agency of Government of India. Broad functions of WPC include-

- a. Coordination and assignment of frequencies for all wireless operations in India.
- b. Regulating, planning, and administering the usage of frequencies and radio spectrum in India.
- c. International conferences and agreements and the implementation of the decisions taken at these conferences and all associated work, so far as wireless is concerned.
- d. Negotiating with other countries and all associated matters connected with wireless communications.
- e. Licensing, regulations, and associated matters in the field of wireless, except broadcast receivers.
- f. Discharging all other responsibilities of the MoC as the central coordinating and regulatory authority of the country on all matters relating to wireless communications.

Apart from licensing of wireless stations in the country, WPC is responsible for planning, regulating, and managing the limited resources of RF spectrum and associated satellite orbits, including geo-stationary satellite orbit as well as licensing of wireless stations in the country. It is headed by the Wireless Advisor to the GoI. It exercises the statutory functions of the Central Government and issues licenses to establish, maintain and operate wireless stations.

### **1.8 Standing Advisory Committee on Radio Frequency Allocations**

SACFA, constituted in 1966, is a high-level committee chaired by Secretary (DoT) and heads of major wireless users/ administrative ministries of the GoI, and had other senior officers of

DoT/ WPC as its members. It was reconstituted in 2007 with the Secretary (DoT) remaining chairman and four other members being the Wireless Advisor to GoI, Director, JCES, Ministry of Defence, Executive Director, Airports Authority of India and the Director, Directorate of Coordination Police Wireless. The WPC wing of the DoT provides secretarial help to the committee. Joint Wireless Adviser, WPC wing is the member-secretary of the Committee. The main functions of the Committee are to make recommendations on: -

- a. Major Frequency Allocation issues
- b. Formulation of National Frequency Allocation Plan
- c. Making recommendations on various issues related to ITU such as India's views on various agenda items of WRCs, Study Group Meetings and Bilateral coordination meetings, etc.
- d. Making recommendations on various issues dealt at APT (Asia Pacific Telecommunity) including views on regional issues
- e. To sort out problems referred to the Committee by various users including clearances of all wireless installations in the country.

SACFA clearances are issued after getting a 'no objection' from various SACFA members who must carry out detailed technical evaluation including field surveys, etc. The technical evaluation is done primarily for-

1. Aviation hazards.
2. Obstruction to line of site of existing/ planned networks
3. Interference (Electro Magnetic Interference (EMI)/ Electro Magnetic Compatibility (EMC)) to existing and proposed networks.

With the launch of Saral Sanchar, a web-based portal, issuance of SACFA clearance had been made fully automated since 2020.

At Present, the role of reconstituted Standing Advisory Committee on Frequency Allocations (SACFA) is restricted to site clearances of fixed wireless stations and does not look into the work related to Spectrum management.

## **1.9 Regional Licensing Offices**

In the past, spectrum users were predominantly in the Government sector and private sector was using spectrum for their captive uses. Wireless licenses were being issued by WPC wing of DoT. With the increase in number of spectrum users, certain wireless licenses (Radio paging, Import, Maritime mobile station, Experimental, etc.) were decentralized from WPC wing to five Regional Licensing Offices (RLOs) at Delhi, Mumbai, Kolkata, Chennai and Shillong (now Guwahati) since January 2007.

## **1.10 Wireless Monitoring Organization**

The Wireless Monitoring Organization (WMO) is the field organization of the WPC wing. Wireless monitoring is an integral part of spectrum management and this monitoring is carried out by WMO through a network of 22 Wireless Monitoring Stations (WMSs), five International Monitoring Stations (IMSs) and 1(one) International Satellite Monitoring Earth Station (ISMES) located all over India. WMO is also equipped with five Radio Noise Survey Units

(RNSUs), which undertake detailed and complicated measurements to aid in the spectrum management activity. WMO had 10 Inspection Units which carry out physical inspection of wireless installations. WMO is headquartered at New Delhi and had four Regional Headquarters (RHQs) at Delhi, Mumbai, Kolkata, and Chennai.

### **1.11 Other Entities**

**a. Telecom Regulatory Authority of India (TRAI)** was established by an Act of Parliament in March 1997 to regulate the telecommunication services, and for matters connected therewith or incidental thereto. Main functions of TRAI include- to recommend the need and timing for introduction of new service providers and the terms and conditions of license to a service provider, to ensure technical compatibility and effective inter-connection between different service providers, to render advice to the Central Government in matters relating to the development of telecommunication technology and any other matter related to telecommunication industry in general, etc. Its functions were strengthened by an amendment to the TRAI Act 1997 made in 2000.

**b. Telecom Disputes Settlement and Appellate Tribunal (TDSAT)** was established in 2000 by an amendment to TRAI Act 1997 to take over the adjudicatory dispute resolution functions of TRAI. The tribunal is mandated to adjudicate disputes between the licensor and licensees, between two or more service providers, between a service provider and a group of consumers, and to hear and dispose-off appeals from any direction, decision or order made by the TRAI.

# CHAPTER 2

## AUDIT APPROACH AND METHODOLOGY





## CHAPTER

## 2

## Audit Approach and Methodology

**2.1 Audit Objectives**

The objectives of the Performance Audit were to:

1. Examine whether utilization of spectrum assigned administratively to user Government Ministries/ Departments/ Agencies was optimal.
2. Examine measures taken by DoT for adequate management and monitoring of spectrum utilization.
3. Examine efforts made by user departments and DoT to enhance spectral efficiency and release/ surrender unused spectrum.

**2.2 Audit Scope and Sampling**

The Performance Audit covering the period 2012 to 2021 was conducted during March –July 2021 for examining the process of allotment/ assignment and utilization of RF spectrum assigned administratively<sup>9</sup> to different Departments/ Agencies. The PA involved scrutiny of relevant records of selected Departments/ agencies.

Two levels of sampling were employed in the audit – first at the level of Departments/ Agencies and second for selection of specific units of the selected Departments/ Agencies. The following criteria were adopted for selection of Ministries/ Departments/ Agencies to be covered:

- a. Quantum of spectrum allotted to Ministries/ Departments/ Agencies
- b. Frequency allotted in the IMT band
- c. Departments/ Agencies identified by DoT.
- d. Use/ allotment of both IMT and Non-IMT bands.

After analyzing the preliminary data of spectrum assigned to Government Departments/ Agencies made available by DoT, Ministries/ Departments/ Agencies were selected, details of which are given below:

- 1) Ministry of Defence (MoD)
- 2) Department of Space (DoS)
- 3) Ministry of Information & Broadcasting (MIB)
- 4) Ministry of Home Affairs (MHA)
- 5) Ministry of Railways,
- 6) PSUs under Ministry of Petroleum and Natural Gas i.e. Oil and Natural Gas Corporation (ONGC), Indian Oil Corporation Limited (IOCL) and Gas Authority of India Limited (GAIL)
- 7) Airports Authority of India

In the selected Ministries/ Departments/ Agencies, all spectrum allotted in IMT bands was covered. In case of spectrum in non-IMT bands, sample selection was restricted to 25 per cent of field audit units/ areas/ locations/ frequency spots.

<sup>9</sup> In case of satellite-based spectrum, the scope includes allotment and assignment to all types of users.

### 2.3 Audit Methodology

An entry meeting was held with the Secretary, DoT and officers of WPC and WPF wings of DoT on 26 February 2021. Entry meetings were also held by audit with the senior management of the selected Ministries/ Departments/ Agencies during March-April 2021. In the entry meeting, the scope and objectives of audit were explained. The audit was conducted on the basis of records/ information made available by the respective wings/ divisions/ zones/ authorities of the Ministries/ Departments/ Agencies. Audit also accessed public documents available on the website of DoT and selected Departments/ Agencies, TRAI, TDSAT and ITU. Additional data, information and clarifications were obtained through issue of Audit Memos.

Draft reports were issued to respective Ministries/ Departments/ Agencies and consolidated draft report was also issued to DoT in August 2021. Exit meetings were held by audit on 17 September 2021 under the chairmanship of Secretary (DoT) associated by senior officers from DoT/ WPC on the issues raised in the draft reports. Representatives from the Ministry of Defence (MoD), Ministry of Railways (MoR), Ministry of Information and Broadcasting (MIB) were present and officers from Department of Space (DoS) participated through video conferences. The Report considers the replies to audit observations furnished by the concerned authorities of the respective Ministries/ Departments/ Agencies.

### 2.4 Sources of Audit Criteria

The major sources of audit criteria used in the Audit include the following:

- (a) Indian Telegraph Act, 1885 and Indian Wireless Telegraphy Act, 1933 as amended from time to time and rules/ orders made there under.
- (b) National Telecom Policies (NTP 1999 and 2012) and National Digital Communications Policy 2018.
- (c) ITU Radio Regulations and relevant ITU recommendations.
- (d) NFAP of 2011 and 2018.
- (e) International practices of Spectrum Management
- (f) Laid down guidelines/ procedures for Spectrum Management by user Departments/ Agencies.
- (g) TRAI recommendations and Supreme Court judgement on spectrum allotment, use and on spectrum usage charges.
- (h) Government decisions/ recommendations including Cabinet, GoM, COS and reports of DoT's committees/ taskforce etc., on the subject.
- (i) Relevant orders issued by WPC and WPF wings of DoT.

### 2.5 Audit Constraints

Audit acknowledges the cooperation extended by the Management in the audited Ministries/ Departments/ Agencies in facilitating this audit. However, we were not provided complete and accurate records sought by us for analysis and scrutiny, in time by the authorities in the concerned Ministries/ Departments/ Agencies, hampering the pace and completeness of records sought for. WPC/ DoT did not furnish basic details about applications for frequency assignments and their status (rejected/ pending) despite repeated requests and reminders. Ministry of Defence delayed the provision of preliminary data and had not been forthright in

providing required details/ records for audit scrutiny on grounds of classified information. Air Force and Navy did not supply any data on spectrum utilization and hence we did not have any authentic confirmation from them about utilization of spectrum in bands assigned to them. Ministry of Railways and Information & Broadcasting also delayed information/ records with the plea that these were not maintained/ available at Apex level and are to be sought from field units.

Audit findings in different Chapters of this Report deal with constraints faced by us and its effect on audit conclusions and we had to draw conclusions based on limited records and information provided in DoT. **Audit findings relating to Ministry of Defence have been issued separately to them for their security concerns.**

Audit was also disrupted due to Covid-19 pandemic and resultant impact.



# CHAPTER 3

## SPECTRUM MANAGEMENT AND MONITORING IN DEPARTMENT OF TELECOMMUNICATIONS





## CHAPTER

## 3

Spectrum Management and Monitoring in  
Department of Telecommunications**3.1 Introduction**

Spectrum Management entails both administrative and technical procedures necessary to ensure efficient operation of radio communication services at the world and national level. Globally, this task lies with the International Telecommunication Union (ITU) which is a specialized agency of the UN.

The work relating to formation of Telecom Policy is under overall coordination of Department of Telecommunications (DoT). Most importantly, management of Spectrum lies with DoT and its Wireless Planning & Coordination (WPC) Wing. DoT monitors the usage of Spectrum through Wireless Monitoring Organisation and its field units. The audit issues relating to DoT/ WPC and WMO are discussed in the succeeding paragraphs.

**3.2 Ad hoc basis for assignment of Spectrum**

**In the absence of a fair and transparent policy on allotment and assignment of spectrum on administrative basis, there had been adhocism in assignment of spectrum and non-availability of spectrum on time.**

DoT introduced auction of spectrum in 2010 for 3G/ BWA services. Post Hon'ble Supreme Court (SC) judgement of February 2012 in 2G Spectrum case, spectrum for telecom access services (2G/3G/4G) under Unified License regime, had been allotted through auctions. However, spectrum for other telecom services viz. Point to Point links, Internet Services, NLD/ILD, VSAT, etc. and captive uses continues to be allotted administratively. One of the objectives of National Digital Communication Policy (NDCP) 2018 is “**Developing a transparent, normative and fair policy for spectrum assignments and allocations**”, either through auction or administrative allotment.

Audit found that post the Hon'ble SC judgement of February 2012 regarding allotment of spectrum for access services, there had been an adhoc arrangement regarding allotment/ assignment of spectrum administratively for both captive uses as well as for other commercial services. Assignment of spectrum to captive users is being done as an interim measure for periods of three/ six months on each occasion as shown in **Table 3.1**.

**Table 3.1: Details of interim measures for spectrum allotment**

Date of issue of Office Memorandum	Period of interim measure	Services applicable
<b>01-10-2013</b>	6 months from the date of issue	Captive usage, satellite networks of broadcasting and captive VSATs, commercial satellite usage (DSNG/ Commercial VSATs, Teleport/ DTH/ NLD/ ILD) and Community Radio Stations (CRS) with the condition that it is provisional allotment and subject to final decision on allotment and pricing of spectrum.
<b>09-01-2014</b>	Upto 31-03-2014	Public Mobile Radio Trunking Services (PMRTS) with the condition that it is provisional allotment and subject to final decision on allotment and pricing of spectrum.

Date of issue of Office Memorandum	Period of interim measure	Services applicable
10-09-2014	Upto 31-12-2014	Captive usage, satellite networks of broadcasting and captive VSATs, commercial satellite usage (DSNG/ Commercial VSATs, Teleport/ DTH/ NLD/ ILD), CRS and PMRTS.
27-07-2017	3 months from the date of issue	Captive and non-commercial use of the wireless users providing security, safety and/ or essential services with the condition that it is provisional allotment and subject to final decision on allotment and pricing of spectrum.
02-04-2019	3 months from the date of issue	Broadcasting (including community radio), H/V/UHF/SHF fixed mobile networks (including CMRTS but excluding PMRTS) radars, experimentations, demonstrations, and satellite-based applications with the condition that it is provisional allotment and subject to final decision on allotment and pricing of spectrum.
29-07-2019		
05-01-2021	6 months from the date of issue	

**Table 3.1** shows that there had been a practice of issuing provisional measures for allotment for the past nine years, causing uncertainties among users as well as spectrum manager. As evident above, assignment to PMRTS and several commercial services were withheld after December 2014. Spectrum to ISPs was also denied as seen in Audit. Further, WPC did not furnish the details of applications received for assignment of spectrum and their status viz. rejected or pending and reasons for rejection, pendency for captive users/ other commercial service providers (except TSPs). Audit was unable to comment on this aspect.

On being pointed out by audit, DoT stated (September 2021) that in addition to OMs mentioned in the **Table 3.1**, similar OMs (April 2014, April; June; December 2015, August 2016, December 2017, March; June; September; December 2018, April 2020 and July 2021) were issued for three/ six months. It was further stated that post legal opinion of Learned Attorney General (July 2020) on “Policy for normative and Transparent Assignment/ Authorization of Spectrum”, the matter was under consideration.

**Recommendation 1:** DoT may devise a policy on allotment and assignment of spectrum for Captive Users/ other commercial usage in alignment with statements made in NDCP 2018 and end adhocism in allotment of spectrum to Government Departments/ Agencies.

### 3.3 Pricing of spectrum assigned for captive uses

**Pricing of spectrum assigned for captive uses on formulae basis revised in 2012 was not reviewed till date despite DoT Committee recommending for periodical review in 2013. Present pricing method does not incentivize Ministries/ Departments/ Agencies to use spectrum efficiently.**

ITU-R recommendation SM.2012-6 “Economic aspects of spectrum management” requires that decisions and changes related to fee collection should be undertaken in an open manner through consultation with users and industry. It further elaborates that fees should take into consideration, to the maximum extent possible, the value of the spectrum. Fees should not be an impediment to innovation and use of new radio technologies, or to competition.

The allotment and charging methodology (formulae basis) for captive use in India is decided administratively and following are the features noticed:

- a. The default tenure of license is one year, which is extendable based on specific request of the licensee.
- b. All frequency bands had the same spectrum rates even though the demand substantially varies from one band to another. There is no incentive for Spectrum bands and locations where there is no demand or less demand.
- c. There is no incentive for efficient use of spectrum through spectrum efficient technology.

NDCP 2018 provides for optimal pricing of spectrum to ensure sustainable and affordable access to Digital Communications.

The spectrum fee for captive uses in India is levied on formulae basis which was last revised (increased) in March 2012 and made effective from 01 April 2012. Three formulae cover royalty charges for assignment of frequencies to captive users including government users according to single channel operations and multi-channel operations for fixed/ land/ land mobile/ terrestrial broadcasting and satellite-based systems irrespective of bands. However, differential (percentage increase over annual fee as per formulae) charging for highly demanded VHF/ UHF bands of 146-174 MHz and 338-470 MHz in some areas/ States<sup>10</sup> was prescribed (September 2012).

A Committee constituted by the Secretary (T) in December 2012 under the Chairmanship of Advisor (T) recommended (March 2013) for periodic review of spectrum price for administrative assignments.

The present formula-based pricing model is more suited in the frequency bands below 10 GHz due to lower bandwidth for its variety of applications. The fixed wireless links using bands from 10 GHz to 30 GHz permit maximum link lengths ranging from about 20 KM at the lower edge of this frequency range, to about 10 KM at the upper edge. The transport networks and mobile backhaul mainly use the frequency bands from 15 GHz. However, these microwave links are not capable of transporting data generated by 4G and 5G due to limited bandwidth capacity in microwave frequency range below 15 GHz, and hence there needs to be a commensurate pricing basis and not one price fits all. The higher frequency band i.e. more than 30 GHz is largely unutilized at this point of time and the present formulae based pricing cannot be applied to these bands considering the quantum of available spectrum and the different characteristics of these bands.

The present formula is based on two factors i.e. 'M' factor which corresponds to coverage distance and 'W' factor for channel bandwidth. This formula is best suited for lower bandwidths (upto 28 MHz) but in the case of higher bandwidth of the order of 250/ 500 MHz, the W factor becomes too high and the royalty of spectrum usage per annum for the shortest length of less than 1 KM happens to be higher than even alternate media like OFC.

Many users both in Government and private sectors had been assigned spectrum in commercially important IMT bands which are charged on formulae basis applicable for all bands. Further, communication sector had witnessed major technological changes and alternate communication channels had become available to the users.

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<sup>10</sup> Municipal/state areas of Mumbai (including Navi Mumbai and Brihan Mumbai), Delhi (including Ghaziabad, Noida and Gurgaon), Tamil Nadu, Karnataka and Andhra Pradesh.

Audit noticed (September 2021) that WPC had not undertaken any review of pricing policy for administratively assigned spectrum to captive users/ other commercial service providers (except TSPs) post revision of spectrum charges in April 2012 even though periodic review of spectrum price for administrative assignments was recommended by a DoT Committee in 2013.

We are of the view that the pricing formula should be such as to incentivize Ministries/ Departments/ Agencies to use spectrum efficiently in the important IMT bands and also to encourage use of spectrum in higher frequency bands presently not in use. Further, the pricing formula should be based on the opportunity cost of spectrum i.e. the more valuable the spectrum (e.g. in the IMT band) the more the price as well as to encourage users to shift to spectrum in non-IMT bands through viable pricing methods in view of availability of alternate communication systems.

DoT agreed (September 2021) to revisit the pricing mechanism for spectrum assigned on administrative basis.

**Recommendation 2:** DoT may review the pricing mechanism of Spectrum for Captive Users in order to incentivize Ministries/ Departments/ Agencies for optimal utilisation of available Spectrum and maintain spectrum management discipline. They may consider differential pricing depending on the features and usage of various spectrum Bands.

### 3.4 Decision making in DoT

#### 3.4.1 Absence of a Permanent Committee for Spectrum Management.

**There was no institutional mechanism in DoT for periodical review of spectrum planning, availability, allotments/ assignments and pricing for efficient Spectrum Management**

The task of frequency planning and assignment involves coordination with national users as well as foreign administrations. To seek coordination for major frequency allocations, presently no Standing Spectrum Management Committee had been constituted in WPC Wing as is existent in countries like USA and UK. In the past, Government had constituted several adhoc committees to deal with specific issues as given in **Table 3.2**.

**Table 3.2: Details of Committees constituted in DoT**

Committee/ Date of constitution	Compos ition	Brief ToR	Date of report	Brief recommendations	Action taken
<b>1. Spectrum Management Committee  16 Dec 1998</b>	Lt Gen (SO-in- C), DG NIC, WA, Dir (JCES)	To review procedures for spectrum allocation, ways to make more spectrum available for telecom, etc.	24 Dec 1998	Recommended solutions for additional spectrum after coordination from a Government user, pricing and auction, modernization of spectrum management system and reorganization of WPC.	Spectrum from a Government user were coordinated for mobile services.

Committee/ Date of constitution	Compos ition	Brief ToR	Date of report	Brief recommendations	Action taken
<b>2. Committee on Review of Spectrum Usage Charges</b>  <b>09 Dec 2010</b>	Sr DDG (WPF), DWAs (WPC), Dir (TEC), Dir (WR), Engineer (WPC)	To suggest appropriate method- logy for spectrum pricing for captive users and bringing other TSPs under the ambit of AGR	30 June 2011	Recommended methods for charging Royalty, License Fee, late fees from captive users and telecom services like ISP/ NLD/ ILD.	Spectrum charges revised w.e.f. 01 April 2012
<b>3. High Level Committee</b>  <b>14 Aug 2012</b>	Advisor (T), Sr DDG (WPF), DDGs (CS/ DS), JWA (RLO- WPC), DWA (WPC)	To look into issues raised in the representati ons on the revision of spectrum charges on recommen dations of Spectrum pricing Committee at Sl. No. 2	22 Aug 2012	Largely endorsed the recommendations of the Spectrum pricing Committee at Sl No 2	-
<b>4. Committee for issues related to Administrative Allotment/ Assignment of spectrum</b>  <b>10 Dec 2012</b>	Advisor (T), Sr DDG (WPF), DDG (CS), JWA (WPC) DWA (WPC)	To look into issues related to Administra tive Allotment/ Assignment of spectrum in various categories- CMRTS, PMRTS, Commercial VSAT and all captive users.	01 Mar 2013	Recommended re- farming of spectrum from government users, continuance of administrative allotment/ assignment of spectrum for captive usage, allotment of MW band for ISP/ NLD/ ILD through market related process, periodic review of spectrum price for administrative assignments, etc.	Re-farming of spectrum is an ongoing process. Final decision regarding administrative assignment pending

Committee/ Date of constitution	Compos ition	Brief ToR	Date of report	Brief recommendations	Action taken
<b>5. Expanded Committee</b>  <b>12 April 2013</b>	Advisor (T)/ JS (T), Sr DDG (TEC, WPF), DDGs (AS, CS, DS, LF) WA/ JWA Represen tatives from MIB, DoS	Review and revise the report dated 01 March 2013	1 <sup>st</sup> report on 02 July 2013 and 2 <sup>nd</sup> report on 02 Aug 2013	Recommended continuance of administrative allotment/ assignment of spectrum for captive usage and charging on administrative formulae basis	Final decision regarding administrative assignment pending

DoT again constituted a **Committee of Secretaries (CoS)** in October 2020 for examining the competing demands in identified bands and to recommend current and future spectrum allocation/ assignment to different Ministries/ Departments/ Users in the larger public and national interest, identify a mechanism which disincentivizes the holding of spectrum unnecessarily by Departments with recommendations on applicable disincentives, and provide a future roadmap regarding spectrum allocation and use.

DoT had stated (September 2021) that no Committee as on date exists on Spectrum Management. Beside above committees, Working Groups in line with ITU had been constituted for WRC preparatory meetings. Similarly, the work related to revision of NFAP, Committees under the Wireless Adviser and its Working Groups under the Chairmanship of JWAs were constituted. They accepted that there is no Committee in WPC/ DoT as an institutional mechanism for periodical review of spectrum planning, spectrum availability, allotments/ assignments, pricing, etc. to expedite decisions for efficient management of spectrum in India.

**Recommendation 3:** DoT may establish a Permanent set up comprising all stakeholders for periodical review of spectrum planning, spectrum availability, allotments/ assignments, pricing, etc. to expedite decisions for efficient management and optimal utilization of spectrum in India. They may also ensure that a MIS is put in place in DoT to get details of actual spectrum utilized by Government user Departments and Agencies.

### 3.4.2 Identification of advanced technology for efficient use of spectrum

**DoT had not formed any Committee/ Working Group to study technological developments worldwide and suggest their deployment to spectrum users in various frequency bands as mandated by NDCP 2018.**

NDCP-2018 inter alia provides for efficient spectrum utilization and management by ensuring interference free spectrum and encouraging new technologies and consolidation. It also emphasizes on “Constituting a Spectrum Advisory Team (SAT) consisting of experts, industry and academia to facilitate the identification of new bands, applications and efficiency measures

to catalyze innovation and efficient spectrum management”. Further, one of the broad functions of WPC/ WMO wing of DoT is to provide “Technical assistance to wireless user organizations”.

Spectrum planning must satisfy the resource availability for current demands and anticipate future demand. Spectrum planning might be carried out in line with technological developments, flexibility in use, international industry trends, innovation in the communications, market fluctuations, user needs, technological neutrality, especially considering public policies on national Defence, education, environment, and social integration.

The efficient use of spectrum can be achieved with the use of advanced engineering techniques and latest equipment for this purpose, it is necessary to identify the need for technology upgradation and deployment of latest communication network. Upgradation/ replacement of old spectrum inefficient equipment is required to be done keeping in view the life of equipment.

DoT accepted (June 2021) that no such Committee/ Group had been formed in WPC to study the technological development worldwide and suggest their deployment in India to the spectrum users in various frequency bands. As the role of SACFA had been limited to giving site clearances for fixed wireless stations, the need of a technical group as proposed in NDCP 2018 is urgently required to be addressed by DoT.

DoT agreed (September 2021) with the audit recommendation.

**Recommendation 4:** DoT needs to encourage/ support research studies and other technical initiatives by user Departments/ entities as well as other organizations for technology solutions for efficient spectrum utilization.

### 3.4.3 Delays in finalisation of Recommendations of Working Groups

**Out of seven Working Groups constituted by DoT in June 2015, only four Groups submitted their final recommendations between March 2016 to February 2021. DoT had not finalised any action on these recommendations.**

DoT constituted seven Working Groups in June 2015 for the identification of frequencies in specific spectrum Bands for Government Users in addition to the frequency sub bands identified as Defence Band. The Working Groups were required to submit their recommendations within six months. Terms of reference and status of recommendations of the Working Groups is given in **Table 3.3**.

**Table 3.3: Particulars of Working Groups**

Sl. No.	Frequency Bands	Terms of reference – To provide recommendations	Committee members from Departments	Remarks
1	1880-1900 MHz	On coexistence of low power cordless system in this band for operation of Government user.	DoT (4 members) MoD (1 member) DIPP (1 member) Telecom Sector Skill Council (1 member)	Final recommendation date – 08-03-2016.

Sl. No.	Frequency Bands	Terms of reference – To provide recommendations	Committee members from Departments	Remarks
2	21.2-23.6 GHz	On identification of 4 carriers of 28 MHz each in this band for a Government user.	DoT (5 members) MoD (1 member) DoS (1 member)	Final recommendation date – 23-08-2016.
3	1765-1785 MHz 1860-1880 MHz	On release of additional 15+15 MHz spectrum for Telecom Service in certain specified service area.	DoT (5 members) MoD (1 member)	Final recommendation date – 06-04-2017.
4	470-520 MHz	On spectrum requirement for various service/application in this band.	DoT (4 members) MoD (1 member) MIB (1 member) DeitY (1 member) IIT Kanpur (1 member)	Recommendation dated 16-02-2021 under circulation, which is yet to be approved.
5	1427-1500 MHz	On early identification of 3 carriers each of 8 MHz in this band for a Government user.	DoT (4 members) MoD (1 member) MIB (1 member)	Recommendation dated 17-02-2021 under circulation, which is yet to be approved.
6	2300-2400 MHz	On identification of one chunk of 20 MHz spectrum in this band for a Government user.	DoT (5 members) MoD (1 member)	Final recommendation date – 18-02-2021
7	1215-1400 MHz	On spectrum requirement for various service/application in this band.	DoT (4 members) MoD (1 member) DoS (1 member) AAI (1 member)	Recommendation dated 12-02-2021 under circulation, which is yet to be approved.

**Table 3.3** indicates that out of the seven Working Groups constituted in June 2015, only four Groups had submitted their final recommendations in March 2016, August 2016, April 2017, and February 2021, respectively. Though the Committee Members had agreed (February 2021) their final recommendations had not been received (July 2021). However, the Competent Authority in DoT, had not taken/ initiated final action on any of the recommendations received way back in 2016/ 2017.

**Recommendation 5:** DoT in consultation with all the Departments may take proactive measures for finalization of recommendations of Working Groups and decisions of the Committee of Secretaries for reassignment/ re-allotment/ refarming of spectrum.

### 3.5 Usage and Sharing of Spectrum in Existing Bands

Spectrum allotted administratively in 800, 900 and 1800 MHz bands before auction of spectrum (introduced in 2010) were authorized for 2G services only. Spectrum allotted through auctions were liberalized ones and can be used/ being used for all types of Access Services (2G/ 3G/ 4G) and can be used for 5G services also with requisite technology. Further, DoT issued guidelines in November 2015 and September 2016 for liberalization of administratively allotted spectrum in 800 & 1800 MHz bands and 900 MHz band respectively.

Our observations relating to important IMT bands based on records in DoT and recommendations of Working Groups/ Committees are described in the **Table 3.4** as given below:

**Table 3.4: Status of available in all Service Areas and unsold spectrum with DoT in IMT Spectrum Bands along with Audit observations**

Radio Frequency Band & User involved	Identified Technology	Spectrum available for Telecom Use	Unsold Spectrum with DoT	Audit Observations
<b>470-646 MHz</b> <b>Doordarshan/ MIB and others</b>	526-646 MHz for IMT (5G)	2640 MHz	2640 MHz (Not yet auctioned)	<p>Actual utilization of Spectrum in <b>frequency band 526-646</b> assigned to <b>Doordarshan</b> way back (during the period from 1989 to 2013) for broadcasting services was found to be sub optimal. Their Digital Terrestrial Television (DTT) project initiated in 2003 had not fructified. A Working Group constituted (June 2015) by DoT recommended that <b>Doordarshan and another Government user</b> would co-exist in the 470-520 MHz frequency band.</p> <p>CoS had also recently decided (January 2021) that <b>Ministry of Information and Broadcasting (MIB)</b> should vacate the frequency band in 526-646 MHz band and coexist with Government user in 470-520 MHz band. Frequency 526-646 is important IMT Band for 5G Services.</p>
<b>700 MHz band (703-748 MHz/ 758-803 MHz)</b> <b>Railways &amp; others</b>	IMT (4G/ 5G)	660+660 MHz	660+660 MHz	<p>Sharing of spectrum in a band by Government users with Commercial users or by a Government user with other Government user would result in efficient and optimal utilization of spectrum. In many countries in Europe and North America (<b>Box A and B – Para 3.8</b>), sharing of spectrum by Government users with other Commercial users had been a reality. In India, sharing of band between Government Departments had been possible.</p> <p>Audit noticed that WPC had not started deliberations with stakeholders to explore the feasibility of sharing spectrum by various <b>Government users</b> for 700 MHz band in pursuance of NDCP 2018 and TRAI recommendations (Oct 2019). The actual assignment to a Government user in 700 MHz band was less than 10 MHz (unpaired). Further, requirement of Indian Railways would be along the railway tracks and stations only. As such, TRAI recommended that option for co-existence of Railways and a Government user in the 5 MHz or 10 MHz sub band in 700 MHz band reserved for a Government user should be explored.</p>

Radio Frequency Band & User involved	Identified Technology	Spectrum available for Telecom Use	Unsold Spectrum with DoT	Audit Observations
				<p>Railways confirmed and agreed (June 2021) with this TRAI recommendation.</p> <p>If proper co-existence studies were done, 5 to 10 MHz (paired) out of 15 MHz (paired) earmarked for Railways and a Government user can be made available for IMT applications including upcoming 5G services.</p>
<p><b>900 MHz band (890-915 MHz/ 935-960 MHz)</b></p> <p><b>Railways &amp; Others</b></p>	IMT (2G/ 4G)	550+550 MHz	60.4+60.4 MHz	<p>Spectrum in commercially important 900 MHz band had been earmarked to <b>Railways</b> on pan India basis for deployment of their GSM-R (Global System for Mobile Communication-Railways in 2G) GSM-R based Mobile Train Radio Communications (MTRC) system.</p> <p>Audit noticed that MTRC system was commissioned for use only at 3,445 route KM out of the total 5,949 route KM sanctioned, covering 58 per cent of routes planned covering nine service areas out of 22 service areas. Utilisation of spectrum in this band is inefficient and sub optimal due to non-maintenance of equipment and unavailability of spare parts. However, 1.6 MHz paired spectrum in 900 MHz band was not re-farmed from Railways as recommended by TRAI.</p> <p>i) An audit observation was made in para No 2.1.7.2 of the CAG's report No. 21 of 2018. DoT in its ATN stated (Feb 2021) that spectrum in 900 MHz band would be taken back from Railways after the roll-out of LTE based proposed network. Railways were allotted 5 MHz spectrum in 700 MHz band (June 2021) for LTE based network. The fact remains that 1.6 MHz paired spectrum earmarked for Railways since 2003 remained unutilized in 13 service areas and only partly utilized in nine service areas. Furthermore, spectrum assigned to Railways is susceptible for unauthorized use by TSPs as it remains vacant outside Railways routes/ stations in a service area. Efforts should have been made to surrender the unused spectrum in the valuable Band in co-ordination with WPC.</p> <p>ii) An audit observation was made in Para No 2.1.7.1 of the CAG's Report No. 21 of 2018 wherein it was pointed out that DoT had not taken action for re-farming of spectrum in 900 MHz band.</p> <p>DoT had initiated the exercise of harmonization of spectrum in 900 MHz band in coordination</p>

Radio Frequency Band & User involved	Identified Technology	Spectrum available for Telecom Use	Unsold Spectrum with DoT	Audit Observations
				with a Government user and completed it in 2018 resulting in availability of additional 59.2 MHz spectrum in the Band.
<b>1427-1500 MHz MIB &amp; Others</b>	IMT	1606 MHz	1606 MHz (Not yet auctioned)	<p>NFAP 2018, had identified the frequency band 1427-1518 MHz for IMT applications in line with the ITU Radio Regulations. The frequency sub band 1427-1500 MHz is not identified as Defence band.</p> <p>As this Band has been identified for IMT applications and assignment for All India Radio and other Government user in this band is not on pan India basis in all service areas, there is scope to shift All India Radio and other Government user out of this band to any other Non IMT bands. Requirements of Government user can be taken care in other identified Bands, before Spectrum is put to auction.</p>
<b>1800 MHz band (1710-1785 MHz/ 1805-1880 MHz)</b> <b>Government user</b>	IMT (2G/ 4G)	1210+1210 MHz	202.8+202.8 MHz	<p>In the 1800 MHz band, (1710-1785 MHz paired with 1805-1880 MHz), 20 MHz (paired) was identified for a Government user in March 2015. The Working Group constituted recommended (April 2017) that 15 MHz spectrum in Kerala and Odisha service areas and 10 MHz spectrum in Haryana, Mumbai and Kolkata service areas can be made available for telecom services.</p> <p>Spectrum in 1800 MHz band is being used for IMT applications and available spectrum of 55+55 MHz earmarked for telecom services in this band had been largely assigned to TSPs. The recommendation of the Working Group had not been implemented.</p>
<b>2100 MHz band (1920-1980 MHz paired with 2110-2170 MHz)</b> <b>Government user</b>	IMT (3G/ 4G)	880+880 MHz	160+160 MHz	<p>As per frequency arrangements adopted by India for 2100 MHz band, 60 MHz paired (1920-1980 MHz paired with 2110-2170 MHz) spectrum band is available for commercial telecom use. Out of this 60+60 MHz, only 40+40 MHz had been allotted for telecom use which had largely been assigned/ allotted to TSPs. However, 20 MHz in uplink sub band and 15 MHz in downlink sub band was identified for a Government user in 2015. As per data made available to audit, assignments to a Government user were not pan India and at few stations in uplink sub band of 2100 MHz band (6 to 12 MHz) and 5 MHz was found assigned pan India (except J &amp; K) in downlink sub band of 2100 MHz band.</p>

Radio Frequency Band & User involved	Identified Technology	Spectrum available for Telecom Use	Unsold Spectrum with DoT	Audit Observations
				DoT should take up harmonization of allotments/ assignments in 2100 MHz, which may result in availability of more spectrum in the range of 5 to 10 MHz paired spectrum for telecom use in this band.
<b>2300 MHz band (2300-2400 MHz)</b>  <b>Government user</b>	IMT (4G)	1760 MHz	60 MHz	Spectrum in 2300-2400 MHz band had huge commercial and economic value. Working Group constituted (June 2015) recommended (Feb 2021) one block of 20 MHz in 2300-2400 MHz band to a Government user. Audit observed that assignments in this band had been upto 6 MHz at various locations of a Government user. There is scope for re-farming of minimum 10 MHz spectrum on pan India basis in this band for commercial use after realistic assessment of requirement of the Government user in this band and availability of alternate bands/ NFS, after coordination with the Government user.
<b>2500 MHz band (2500-2690 MHz)</b>  <b>Department of Space (DoS) and others</b>	IMT (4G)	880 MHz	230 MHz	Currently, this band or parts thereof had been allocated for Fixed, Fixed Satellite, Mobile except aeronautical mobile and Broadcasting Satellite services and some other services. Out of 190 MHz, only 40 MHz had been allotted/ assigned for IMT applications in this band and satellites (GSAT 6, 7 and 17) had been launched for 100 MHz for satellite-based services for Government users. Launch of satellite for balance 50 MHz was under process. This band had been identified for both terrestrial and satellite-based services and there had been interference in the existing operations in the band. Since the Band is predominantly in use for satellite based communication services, DoT, DoS and other Government users need to ensure synergy so that this important IMT band can be utilized optimally with proper technological solutions for co-existence of both terrestrial and satellite-based services without causing harmful interference.
<b>3300 – 3670 MHz</b>  <b>DoS</b>	IMT (5G)	8140 MHz	8140 MHz (Not yet auctioned)	3400 – 3600 MHz is identified as IMT bands for terrestrial services in NFAP 2018, which had already been coordinated by DoS with ITU for its space-based services. Thus, the same band had been identified for both the services causing overlap. It was seen that DoS and DoT had not identified an appropriate technology solution and limitations of use in such a manner that both services can co-exist in these bands.

Radio Frequency Band & User involved	Identified Technology	Spectrum available for Telecom Use	Unsold Spectrum with DoT	Audit Observations
				<p>In July 2011, DoT requested DoS that the frequency band 3400-3600 MHz was being considered for auction for BWA as per guidelines of GoI and requested to restrict their filings for space stations in frequency band 3600-4200 MHz instead of 3400-3425 MHz. However, DoT has not auctioned 175 MHz frequency (3425 – 3600 MHz) reserved for BWA services, and the same was lying unutilized since 2011.</p> <p>At present, part of the frequency band 3425-3600 MHz had been given to TSPs at few locations for 5G on experimental basis. With regard to plan for auction of spectrum, a reference had been sent to TRAI seeking its recommendations on issues involved in auction of spectrum in various frequency bands including 3300-3670 MHz.</p> <p>There had been an undue delay in finalizing the allocation of the said frequencies by DoT and 175 MHz frequency could neither be used for space-based services nor utilized for IMT services.</p>
<b>24.25–28.5 GHz</b>	IMT (5G)	93500 MHz	93500 MHz (Not yet auctioned)	<p>Spectrum band 24.25 to 28.5 GHz is already being used for 5G services globally. As per information made available to audit, no assignment had been made in the aforesaid frequency bands. CoS also recommended (January 2021) that spectrum in 24.25 GHz to 28.5 GHz would be used exclusively for IMT/ 5G except for a protection distance of 2.7 Km at 5 DoS stations.</p> <p>Based on the Government approval regarding new frequency bands for IMT/ 5G in India, DoT had informed that 24.25-28.5 GHz band had also been made a part of the reference sent to TRAI for providing its recommendations on issues involved in next spectrum auction. NFAP is also under revision and the mmWave bands identified for IMT applications would be reflected accordingly.</p>

The audit observations on utilization of spectrum by Ministries/ Departments/ Agencies who had been assigned spectrum on Administrative basis, indicate that IMT bands were either sub-optimally/ under-utilized or not utilized at all due to various reasons. Some bands had been identified to roll out 5G services in the country or there is a possibility that other bands are going to be offered to TSPs for 5G services due to technological advancement worldwide. Railways, Department of Space and other Government users, particularly had been assigned spectrum where there was a possibility for sharing or re-farming of spectrum for better utilization from economic point of view. **DoT in consultation with other Ministries/ Departments needs to take decision in this regard for re-farming/ sharing and optimal utilisation of spectrum in various bands.**

**Recommendation 6:** In pursuance of NDGP 2018, DoT may coordinate with Government users to provide spectrum in substitute bands for users in 1427-1500 MHz and 2300-2400 MHz bands, harmonize spectrum in 2100 MHz, for sharing of spectrum in 700 MHz band as these had been identified for IMT use and have scope for commercial utilization of spectrum.

**Recommendation 7:** All the stakeholders in the 2500 MHz band viz. DoT, DoS and other Government users need to ensure synergy for which DoT may take the lead so that this important IMT band can be utilized optimally with proper technological solutions for co-existence of both terrestrial and satellite-based services without causing harmful interference.

**Recommendation 8:** DoT in consultation with Ministry of Information & Broadcasting may take immediate action to make available frequency band 526-646 MHz for IMT/ 5G services, based on recommendations of Working Group and Committee of Secretaries that Doordarshan and other Government users, could coexist in 470-520 MHz frequency Band.

**Recommendation 9:** DoT and Railways may monitor the completion of LTE based network project in 700 MHz band so that Railways vacate the spectrum in 900 MHz band being used by them and it is made available for commercial utilization.

**Recommendation 10:** DoT in consultation with TRAI may take early action for the auction/ utilization of IMT spectrum lying idle with them.

### 3.6 Automated Spectrum Management System

**ASMS implemented by WPC in 2005 did not have an AMC and suffered from technical snags which resulted in non-updation of NFR. Further, there was large scale mismatch of database of spectrum assignments to Government users' viz. Railways, AAI and PSUs**

A computerized Spectrum management system incorporates administrative and technical data such as assigned frequencies, licensees, equipment characteristics, etc. An Automated Spectrum Management System (ASMS) would facilitate national spectrum management and monitoring, coordination among administrations and exchange of information with the Radiocommunication Bureau (BR)<sup>11</sup>, which maintains the Master International Frequency Register (MIFR). Coupling of spectrum management and spectrum monitoring makes possible an integrated system, which can automatically use measured data from the monitoring system and license information from the management database to detect frequencies of apparent unlicensed transmissions and other licensing violations for closer examination. Data analysis can facilitate better spectrum management for frequency withdrawal and reassignment.

#### **ITU Recommendations on Spectrum Management System**

In terms of ITU Recommendations/ guidelines, the ASMS should have the following important features among other technical aspects:

- a. That the ASMS should contain engineering calculation features for radio services and should be capable of using a terrain database for specific engineering calculations

<sup>11</sup> Radio communication Bureau is the executive arm of the Radio communication Sector of ITU and is headed by an elected Director who is responsible for the coordination of the work of the Sector.

- b. That output documents such as licenses and invoices should be easily generated.

Further, ITU recommendations of 2013 (revised edition of 2001) provides for “Automation and integration of spectrum monitoring systems with automated spectrum management”. Automation can support various functions of spectrum management that include:

- i. Frequency planning, allocations, assignment, licensing, coordination, and international notification,
- ii. Standards, specifications, equipment authorization and monitoring activities,
- iii. Storing and maintaining spectrum management data, statistical and advanced reporting and providing an interface for inquiries,
- iv. Fees and automatic notification of renewal and EMC calculations including propagation.

A properly maintained and integrated system would result in benefits through effective compliance, and the establishment of a more expeditious and fully documented, timely billing of customers for their use of spectrum.

### ***Spectrum Management System in India***

WPC implemented an ASMS in 2005. This had features like provisions for engineering calculation for interference free frequency assignments and processing of applications, issue of licenses, generation of invoices, integration with monitoring organization, etc. However, the ASMS implemented by WPC did not have any maintenance contract and WPC faced network issues. As a result, frequency assignments and licenses issued were not being updated in the system.

### ***Non-updation of National Frequency Register***

Audit noticed that the National Frequency Register (NFR) to be maintained by all administrations in the world to record the details of the frequency assignments made to licensed radio stations was not updated in the ASMS vis-à-vis cancellation and surrender of frequency authorization, change of frequency, etc. Surrender of spectrum assignments by users is an ongoing process. However, it was ascertained that the ASMS did not have the functionality to automatically reflect surrender/ cancellation of frequency authorization and it is being done manually, which is the prime reason for not having an updated NFR.

### ***Action Taken Note on CAG’s Report No. 21 of 2018***

Deficiencies in maintenance of NFR and ASMS viz. non updation of NFR w.r.t assignment of new frequencies (MW) and cancellation of quashed licenses, non-availability of updated NFR to monitoring organization and non-monitoring of realization of spectrum charges from private captive users were reported in **Para No. 2.1.11.1, 2.1.11.2 and 2.1.12.4** of the **CAG’s Report No. 21 of 2018**.

DoT in its ATN stated (February-May 2021) that, in case of surrender of license, it is done in physical form instead of ASMS. Such detail lies with the respective group. Since the existing ASMS software is very old and obsolete and had no maintenance contract, efforts were being undertaken to procure new Technical Analysis Software. It further stated that the WPC

licensing process had been migrated to Saral Sanchar. The migration of old data would take place in Phase-II of Saral Sanchar. The respective groups would update the existing NFR in view of the surrendered assignments before migrating to Saral Sanchar in Phase-II. In Phase-II, the integration between WPC and WMO would also be carried out whereby WMO can view the license information as soon as it is issued/ surrendered by WPC and would have access to all data automatically.

However, it was observed (July 2021) that

- ASMS in vogue in WPC was not being used even for basic functionalities of processing application for assignment of spectrum for various users and instead was being done by the respective Groups/ Sections of WPC. It did not have a system for generation of invoices for renewal and collection of spectrum fee. The ASMS was not integrated with the monitoring systems. Valid database of spectrum users and known radio environment viz. time-geography combination of a user, spectrum sensitivity, repeatability and equipment details could help in better utilization of available spectrum.
- Our analysis of database of spectrum assignments to selected Government users viz. Railways, AAI, GAIL, IOCL, ONGC, etc. revealed large scale mismatch. Many frequencies stated to be assigned as per WPC records were not available/ used by these Departments/ Agencies and many frequencies used by them were not found in the NFR of WPC. This indicates that database of spectrum users/ licenses/ authorizations maintained by WPC, DoT is not updated.
- Particulars/ details of surrender of spectrum in IMT bands by TSPs were found to be available with the respective groups of WPC, but proper database of surrender/ cancellation of spectrum assignments in non-IMT bands was not found to be maintained.
- Audit further noticed that the database for regular monitoring activities as well as monitoring for resolving interferences were maintained in manual registers/ excel sheets and often not updated.

The recently implemented Saral Sanchar for processing of application for assignment of spectrum is not a substitute of an ASMS; rather it is just an interface between the applicant and the WPC. No concrete action had been taken to procure any new system like Technical Analysis software or migration of old data to new system of Saral Sanchar (Phase II) or to update/ replace ASMS having full functionalities as per ITU recommendations.

Above deficiencies in the ASMS in vogue suggests that Spectrum Management in WPC, DoT continues to be inefficiently managed.

**Recommendation 11:** DoT needs to acquire and implement an industry standard Automated Spectrum Management System. Further, DoT may update the existing database on spectrum users on priority before migration to the new system and make available the updated database on a timely basis to WMO for efficient monitoring of assigned Spectrum.

### 3.7 Monitoring of Spectrum by Wireless Monitoring Organization

**Monitoring of spectrum by WMOs suffered from non-availability of sufficient monitoring equipment. No concrete action had been taken by DoT/ WPC on proposal of upgradation and repair of equipment resulting in improper monitoring of spectrum utilization. The Database with WMO Hqrs for wireless users was not updated and did not have access to the WPC database making monitoring of frequencies difficult.**

Spectrum monitoring provides a method of verification and “closes the loop” on the spectrum management process. Spectrum monitoring in turn also assists in the process of frequency planning, assignment, database management, etc. Monitoring in India is carried out by Wireless Monitoring Organization (WMO), a field unit of WPC. Main functions of WMO is to monitor the spectrum uses, identify and resolve interferences to authorized spectrum users, inspects the premises of licenses for checking the compliances of licenses and support the spectrum management functions by providing input required by WPC.

Audit observations on the functioning of WMO are described in succeeding paragraphs:

#### 3.7.1 Availability and procurement of monitoring equipment with WMO and its field units

WMO carries out spectrum monitoring through a network of One International Satellite Monitoring Earth Station (ISMES) and 27 Wireless Monitoring Stations (WMS)/ International Monitoring Stations (IMS), strategically located all over India. For conducting its monitoring activities in different frequency bands and with different network configuration standards, monitoring stations require specialized equipment. Audit noticed that there had been a lack of proper and sufficient equipment for carrying out the monitoring of spectrum uses.

##### (A) Availability of monitoring equipment at WMS/ IMS

1. In 1985, 19 VHF/ UHF equipment were procured to monitor the wireless users in VHF/ UHF radio frequency ranges. As of now only six VHF/ UHF equipment were in working condition.
2. In 1993, 34 HF equipment were procured for HF monitoring. As of now only five HF equipment were in working condition.
3. During 2006-07, under World Bank project, 21 Spectrum Analyzers Agilent and 21 EB 200 equipment were procured for Spectrum monitoring. Out of this only 10 Spectrum Analyzers Agilent and 12 EB 200 equipment i.e. around 50 per cent were in working condition.
4. Thereafter, during 2014 & 2015, 27 Handheld Spectrum Analyzers (N9344C) for each 27 WMS/ IMS were procured.
5. No monitoring equipment had been procured since then.



**Monitoring equipment used by WMOs**

**(B) Procurement of Monitoring Equipment**

WMO had proposed procurement of following monitoring equipment, considering the obsolete and faulty conditions of available monitoring equipment. However, their proposals remained pending with DoT for several years, at various stages, as given in **Table 3.5**.

**Table 3.5: Equipment proposed for procurement**

Sl No	Proposal for Equipment	Month/ year of proposal for procurement	Present status
1	Four Radio Network Analysis Equipment	October 2016	Revised proposal under consideration
2	28 Radio Receivers	February 2018	Approval of bid document stage.
3	Five Super High Frequency monitoring equipment	April 2019	Approval of bid document stage.
4	Six VHF/ UHF vehicle mounted mobile terminal	June 2014	Proposal yet to be approved
5	Six HF monitoring facility	June 2014	Approval of bid document stage.
6	Five Radio Noise Survey Unit	June 2014	Approval of bid document stage.
7	Non-Upgradation of Satellite Monitoring System	October 2019 by the In-charge of satellite monitoring station, Jalna	Proposal yet to be approved

Absence of modern and sufficient monitoring equipment resulted in inadequate monitoring and non-resolution of interferences as evident from following facts and figure.

- a. 2,490 interference cases (pertaining to the period from January 2012 to December 2020) were still pending with WMO. Further, 99 interference cases were more than four years old, and 1,860 interference cases were more than one year old.
- b. WPC issued instructions (December 2017) to WMO for spectrum audit in respect of operation of 16,982 frequencies in the frequency range 450 MHz - 3600 MHz through monitoring method. However, only 13,061 frequencies were monitored by WMSs/ IMSs during the period from January 2018 to November 2018. Further, 20 out of 27 WMSs/ IMSs could not complete the assigned frequencies for monitoring.
- c. WPC instructed (November 2018) WMO to carry out spectrum monitoring to find out the utilization of RF spectrum allocated to TSPs in six frequency bands (800/900/ 1800/ 2100/ 2300/ 2500 MHz). However, even after lapse of approximately two years only 2,140 out of 4,050 locations assigned were monitored. Further, review of the monitoring reports revealed that 44 vacant frequency channels were found occupied while monitoring 211 locations/ geo-coordinates. This indicates that these vacant bands were being used in an unauthorized manner. Further, out of these 44 channels, in case of only 12 channels, the name of the user/ IMT operators who were using these vacant frequency channels could be identified, whereas infringement notices were served only in six cases. No concrete legal action against the unauthorized users was found to be taken by WMO or WPC.

On this being pointed out by audit, WMO stated (June 2021) that spectrum monitoring is a complex, tedious, and technical exercise and 93.2 *per cent* of assignments had already been completed even with the crunch of resources. It was emphasized that WMO had done unprecedented works within limited manpower, equipment, resources, vehicles, financial powers and with few stations across the country. Limitation of financial powers within WMO is also a bottleneck in procurement of even petty items, servicing of vehicles, etc. Also, the availability of advanced sophisticated equipment and vehicles would enhance the overall spectrum monitoring capability.

Regarding unauthorized use of vacant band, WMO in their reply mentioned (June 2021) that during the last few years due to exponential rise in Public Telecom Services and wireless users across the country in different frequency bands and with different network configuration standards the cases of unauthorized usage of the spectrum had also increased. However, the manpower, vehicles, equipment of the WMO which were quite essential for the spectrum monitoring had not been increased in tune with this increase in the spectrum use and activities. Moreover, WMO primarily being a monitoring agency did not have any dedicated enforcement wing for taking punitive and legal actions on unauthorized usage on regular basis. Regarding non-identification of operators/ users occupying 32 vacant frequency channels, it was stated (June 2021) that carrier identification can be done by equipment like Cell ID kits and not by Spectrum Analyzer. In case Cell ID kit with laptop is not used by any station during monitoring, the identification of IMT signal could not be done.

DoT stated (September 2021) that proposals for procurement of equipment were under various stages of approval. As soon as necessary administrative and financial approvals were obtained, procurement would be done as per rules. It was also stated that a proposal was earlier sent for approval of the Competent Authority for increasing the financial powers of Director, WMO, being the Head of Department. Another proposal sent earlier with a request to extend the powers exercised by Sr. DDG, JS/ DDG (Wing Head) in the DoT HQ to approve Technical Evaluation Committee reports for procurement through GeM upto ₹ 50 Lakhs to Director, WMO. These proposals were being sent again for approval of the Competent Authority.

Further, DoT also did not have any institutionalized mechanism or any apparent MIS for monitoring of spectrum uses by the Government Departments/ Agencies.

Above admission by the WMO authorities establishes the fact that lack of suitable and sufficient monitoring equipment with monitoring stations had been the main reasons for non-identification of interferences and unauthorized use of spectrum by users. However, no concrete action to expedite the procedure for procurement of the required equipment was found to be taken by WPC/ DoT.

### **3.7.2 Manpower for Monitoring**

Manpower, vehicles, equipment of the WMO are essential for the spectrum monitoring. In this connection reference is invited to response of WMO mentioned in the para 3.7.1, wherein it was mentioned that the manpower, vehicles, equipment of the WMO which were quite essential for the spectrum monitoring had not been increased in tune with this increase in the spectrum

use and activities. Further, WMO had expressed need for more manpower in surveillance for detecting unauthorized use of spectrum.

It was seen that their sanctioned Manpower has remained the same despite exponential increase in Spectrum allotments and utilisation. DoT had not reviewed their manpower position and on the contrary there were vacancies in the technical staff - viz. Engineers (32 per cent), Junior Wireless Officers (eight per cent) etc. and other categories also. This shortage of manpower need to be addressed for enabling enhanced detection for unauthorized spectrum as only procuring modern equipment without equipping them with adequate manpower is not going to meet the objectives.

**Recommendation 12:** DoT may urgently upgrade the infrastructure and equipment of its WMO offices and its field units to strengthen the monitoring of spectrum. Further, DoT may also conduct a comprehensive review of the manpower and resource requirements of WMO units to discharge its monitoring responsibilities effectively and efficiently in an environment of increased spectrum users.

### 3.7.3 Database for monitoring

Accurate and reliable spectrum database is the starting point for spectrum monitoring. To achieve monitoring objectives, it is essential that WMO Headquarter/ Regional Headquarters (MHQ/ RHQ) and Monitoring Stations had accurate, complete and timely information on allocated band/ frequencies and wireless licenses. The need for updated data/ records with MHQ/ RHQ and Monitoring Stations is clearly spelt out in Wireless Monitoring Stations Manual. Monthly monitoring plans are decided by the four RHQs of WMO for WMSs/ IMSs under their jurisdiction. In addition to this monthly plans, special monitoring assignments are given by WMO Headquarter and WPC on need basis.

Test check of Data base/ NFR available with the MHQ Delhi revealed that they **did not have updated database of wireless users and no access to the database with WPC**. It was noticed that frequencies asked to be monitored by WPC were not included in the NFR available with the WMO. Few instances are as given in **Table 3.6**.

**Table 3.6: Frequency spots not entered in NFR**

Sl. No.	Frequency Spot/ Band (MHz)	Licensee
1	465.95-467.05	IOCL
2	461.9695-461.9805	ONGC
3	0734-0742, 495.25, 476.75, 482.665, 530.375,532.84	DD
4	1523.5, 1522, 1473, 1474.5	All India Radio

Non availability of aforesaid frequencies clearly indicate that the Database of wireless users/ NFR available with the WMO was not updated from time to time. Further, it was also noticed that many fields in database/ NFR is either incomplete or blank viz. name of licence holder, GEOCORD, TRANSLOC, RECLOC, EMISSION, UNIQUENO etc. and field like licence no./ date of expiry is not provided in the data.

On being pointed out by Audit, WMO stated (June 2021) that WMO receives data from WPC and updation of data is done by WPC Wing only. The last data was received on April 2017, however, as regards to IMT band data, last data was received on March 2019.

DoT stated (September 2021) that WPC agrees with the audit recommendation that "WPC/ DoT might make available the updated database on a timely basis to WMO for monitoring". SARAL SANCHAR Project is already under implementation in various stages. Moreover, it is worthwhile to mention here that possibility of Technical Analysis Software is being explored by WPC/ WMO.

As such updated NFR that forms the basic document for devising monitoring plans by RHQs was not supplied to WMO regularly which had adverse impact on preparing monitoring plans and actual monitoring activities.

**Recommendation 13:** WPC/ DoT may make available the updated database on a timely basis to WMO for its monitoring activities.

### 3.8 International practices in Spectrum Management

#### Box A: Salient features of Spectrum Management in USA<sup>12</sup>

**a. Joint Management of Spectrum:** In the United States, the National Telecommunications and Information Administration (NTIA) and the Federal Communications Commission (FCC) jointly manage the use of radio spectrum to balance the interests of the US government interests, private players and the public good. NTIA manages spectrum use by federal agencies, while the FCC manages non-federal use (private sector, state and local government uses). The two agencies coordinate in radio spectrum allocation and reallocation as specified in a Memorandum of Understanding.

**b. Coordinated approach:** The NTIA uses the Inter-department Radio Advisory Committee (IRAC) as an interagency radio spectrum radio coordination body which consists of technical representatives from many agencies. The IRAC advises the NTIA on federal radio spectrum needs so that it can represent the interests of federal agencies in discussions with the FCC.

**c. Sharing of Band:** "Repurposing" of spectrum – either on an exclusive or shared basis – to support commercial wireless services had been a facet of US spectrum policy, especially with a focus on mid-band spectrum i.e. 1 GHz to 10 GHz to increase the amount of such spectrum made available to facilitate and augment 5G. Often, repurposing requires significant effort to replace or modify sophisticated equipment, to find suitable bands for relocation, and to coordinate with new commercial entrants – all while federal agencies carry out their primary, and typically critical, missions.

**d. Spectrum Relocation Fund:** Through Acts of the US Congress, a Spectrum Relocation Fund (SRF) was created to reimburse the costs associated with relocating federal spectrum uses to new bands or agreeing to share use of their spectrum; this also provides funding for federal agencies to conduct studies to improve the efficiency and effectiveness of their spectrum use.

<sup>12</sup> Information in this section is adapted from the "Overview of Department of Defence Use of the Electromagnetic Spectrum" produced by the Congressional Research Service, updated March 31, 2021 and the "Second Annual Report on the Status of Spectrum Repurposing" of December 2020 by the US Department of Commerce.

**e. Spectrum Policy:** The Spectrum Pipeline Act required NTIA and the FCC to identify 130 MHz of federal and non-federal spectrum for repurposing, while the MOBILE NOW Act of 2018 requires NTIA and FCC to identify 255 MHz of federal and non-federal spectrum for mobile and fixed wireless broadband use by December 2022. In particular, a 100 MHz block of contiguous mid-band spectrum in the 3450-3550 MHz band would be made available for commercial use (e.g. 5G) and is expected to be auctioned in 2021. Further, new technologies that would enable dynamic spectrum sharing – automated sharing between federal and non-federal users – are stated to be under development.

**Box B: Salient features of Spectrum Management in UK<sup>13</sup>**

**a. Spectrum Policy:** The UK Prime Minister declared a vision through the UK spectrum strategy in 2014 to double spectrum’s annual contribution to the economy. The Public Sector Spectrum Release Programme (PSSRP) target, as announced in the 2016 Budget, stipulates that 750 MHz of valuable public spectrum in bands under 10 GHz will be made available by 2022, of which 500 MHz would be made available by 2020; this includes both “release” and “share”. Ofcom’s proposed spectrum management vision for the 2020s involves “providing flexibility in spectrum use to support innovation, with appropriate assurances for continued use” and “encouraging sustained improvements in the efficiency of spectrum use”; promoting spectrum sharing is one of the strategic themes.

**b. Administrative Incentive Pricing:** The Government had also set out a policy to incentivise government departments to release or share the spectrum they manage, known as Administrative Incentive Pricing (AIP), which sets out the opportunity cost for the frequency bands Departments use. This cost is calculated by Ofcom (the communications regulatory agency) on a frequency band using current license fees and recent spectrum bands; Ofcom recommends to the UK Government how much each frequency band is worth and how much each department should pay annually to retain access to the spectrum.

**Recommendation 14:** DoT may review the international best practices in Spectrum Management, for suitable incorporation of these best practices for Spectrum Management in India.

<sup>13</sup> Information in this section is adapted from the UK Ministry of Defence Electromagnetic Spectrum Blueprint – Version 1 – 9 August 2019 and a Consultation Paper from Ofcom “Supporting the UK’s wireless future: Our spectrum management strategy for the 2020s” published on 4 December 2020

# CHAPTER 4 SPECTRUM MANAGEMENT IN MINISTRY OF DEFENCE





## CHAPTER

## 4

## Spectrum Management in Ministry of Defence

**4.1 Introduction**

Defence had always been a major user of spectrum in India. Defence uses spectrum for strategic security related operations like air defence, command and control, information superiority, communication, and early warning systems. Effective spectrum management is fundamentally essential for all types of operations and should ensure that operations are conducted with minimal unintentional friendly interference (fratricide) and without negative Electromagnetic Environmental Effects. Lack of concise, pre-planned frequency coordination might have a disastrous effect upon operations.

The task of frequency coordination and all aspects of spectrum management in Defence Services had been entrusted to the Joint Communications and Electronics Staff (JCES). The respective Service Headquarters are responsible for planning their own radio communications within the allotted frequency bands. JCES is tasked with inter service coordination and other related aspects. JCES is the custodian of the Defence Services Frequency Allocation Registers.

**4.2 Audit findings**

**The audit findings relating to Spectrum Management by the Defence Services have been issued to Ministry of Defence separately, due to their security concerns.**



# CHAPTER 5 SPECTRUM MANAGEMENT IN DEPARTMENT OF SPACE





## CHAPTER

## 5

## Spectrum Management in Department of Space

## 5.1 Introduction

The Indian Space Research Organisation (ISRO) was established in August 1969 to carry out space research. In June 1972, Government of India (GoI) constituted the Space Commission and the Department of Space (DoS) and brought ISRO under DoS (September 1972). DoS implements various programmes such as satellite communication, earth observation, launch vehicle, space science, etc. through ISRO and its various units. The Orbit Spectrum Coordination and Acquisition Wing (OSCA) functioning under Satellite Communication Programme Office (SATCOM PO) of ISRO is the focal point for spectrum coordination and its management.

## 5.1.1 Types of Radio Frequency Spectrum available with DoS/ ISRO

The Radio Frequency Spectrum used by DoS/ ISRO are of the following two categories:

(i) **Orbit-frequency spectrum:** This is acquired and coordinated by SATCOM PO with International Telecommunication Union (ITU) through WPC/ DoT for its Geo satellites for providing space-based services such as communications, meteorology, navigation, etc. DoS allocates satellite capacities on these Geo satellites to the users. A user is required to obtain service license<sup>14</sup> and apply to DoS for the satellite capacity allotment. After obtaining the satellite capacity, the user must obtain operating license from WPC/ DoT for assignment and use of the spectrum. The user must finally obtain network licence from DoT before utilising the network. The user pays spectrum charges to WPC/ DoT and transponder lease charges to DoS for the satellite capacity allotted. The band wise and frequency wise allotment of the spectrum for Geo Satellites, Earth Observation Satellites and Inter Satellite Services of DoS/ ISRO is detailed in **Table 5.1**.

**Table 5.1: Radio Frequency Spectrum of DoS/ ISRO**

Band/ Frequency (MHz)	Range (MHz)		Service
	IMT/ Non-IMT		
<b>Geo satellites</b>			
UHF/ Below 450	137-138, 144-146, 148-149.9/ 435-438 (Non IMT)		Student Satellites
UHF/ Below 450	290-320/ 240-270, 402.5-402.85, 406.05 (Non IMT)		Defence Data Relay Transponders, Search and Rescue
UHF/ 450-3600	460-470 (IMT)		Ocean monitoring
L-MSS/ 450-3600	1980-2010/ 2170-2200 (IMT) 1518-1559/ 1610-1675 (Non IMT)		Mobile Satellite Service (MSS)
L&S Band/ 450-3600	1164.45-1188.45, 1563.42-1587.42, 2483.5-2500 (Non IMT)		Navigation, GPS Aided Geo Augmented Navigation (GAGAN)

<sup>14</sup> The licence obtained from the concerned Ministry/ Department for the service to be provided, e.g. service license is obtained from the Ministry of Information and Broadcasting for TV/DTH services and DoT for VSAT services.

Band/ Frequency (MHz)	Range (MHz)	Service
	IMT/ Non-IMT	
L&S Band 450-3600	1215-1300 (Non IMT)	Navigation
S Band	2655-2690/ 2500- 2535, 2555-2635 (IMT)	MSS, Broadcast Satellite Services (BSS)
Normal C/ Above 3600 MHz	5850-6425/ 3700-4200 (Non IMT)	Television, Digital Outdoor-Broadcast Digital Satellite News Gathering (DSNG), Telemetry Tracking and Command (TTC), Feeder link
L Ext C/ Above 3600	3400-3600 (IMT) 6425-6725/ 3600- 3700 (Non IMT)	Very Small Aperture Terminal (VSAT), GAGAN, TTC, Antarctica connectivity, Navigation Constellation Ranging
U Ext C/ Above 3600	6725-7025/ 4500-4800 (Non IMT)	VSAT, TTC, Feeder link
Ku FSS (Planned)/ Above 3600	12750-13250/ 10700-10950, 11200-11450, 17300-17800/ 11700-12200 17800-18100, 14500-14800 (Non IMT)	VSAT, Direct To Home (DTH), TTC
Normal Ku/ Above 3600	13750-14500/ 10950-11200, 11450-11700, 12200-12750 (Non IMT)	VSAT, DSNG, DTH
Ka Band/ Above 3600	27500-31000, 17700-21200 (Non IMT)	VSAT, Broadband
Q band/ Above 3600	42500-43500, 47200-50200, 50400-51400/ 37500-42500 (Non IMT)	VSAT, Broadband, Feeder link
V-band (Planned)/ Above 3600	71000-76000/ 81000-86000 (Non IMT)	VSAT, Broadband & Feeder link
<b>Earth Observation Satellites</b>		
S-band/ 450-3600	2025-2120 (IMT) 2200-2300 (Non IMT)	TTC and Data
X-band/ Above 3600	7145-7235/ 8025-8500 (Non IMT)	TTC and Data
Ka band/ Above 3600	25500-27000 (Non IMT)	Data downlink
L-band	1215-1300 (Non IMT)	Active sensor
C-band	5250-5475 (Non IMT)	Active sensor
X-band	9300-9900 (Non IMT)	Active sensor
Ku band	13250-13750 (Non IMT)	Active sensor
Ka and Higher band	18600-18800, 23600-24000, 36000-37000, 50000-64000, 86000-92000, 155500-158500, 174800-191800 (Non IMT)	Passive sensors
<b>Inter Satellite Services (Planned)</b>		
S-band/ 450-3600	2025-2110 (IMT) 2200-2290 (Non IMT)	Inter satellite
Ka band/ Above 3600	25250-27500 (IMT) 22500-23550 (Non IMT)	Inter satellite
V band/ Above 3600	66000 – 71000 (IMT) 59000-66000 (Non IMT)	Inter satellite

(ii) DoT/ WPC allots Spectrum administratively to DoS/ ISRO and its units for satellite technical support services and for experimental/ developmental projects, as detailed below:

(a) **Technical Support Services:** DoS/ ISRO and its units use space based and terrestrial based spectrum for technical support. The Space based spectrum includes Telemetry Tracking and Command (TT&C) for Geo-Stationary Orbit (GSO) and Non-GSO, SATCOM network and data download from NGSO. SATCOM PO identifies the frequencies for this spectrum and allots the transponder capacity to Centres/ Units for their SATCOM networks. Terrestrial based spectrum includes Radars, Walkie-Talkies, lab testing, etc. for which requirements are specific to a particular centre/ unit. In both cases, the respective Centres/ Units approach WPC directly for operating license. WPC grants license to the centre/ unit where the RF equipment is located.

ITU identifies the coordination requirements with the concerned countries for all kinds of satellites operating in Geo-Stationary Orbit (GSO) and for communication and navigation satellites operating in NGSO.

(b) **Experimental/ Developmental Projects:** The units of DoS utilise spectrum for their Research/ Experimental/ Developmental/ Projects. DoS/ ISRO is of view that no license is required to be obtained for these activities.

## 5.2. Audit Findings

Audit findings on the utilisation of spectrum are discussed in the following paragraphs:

### 5.2.1 Co-existence of Space based and Terrestrial services in IMT band

**DoS had coordinated for orbital slot and associated frequency slots with ITU. NFAP 2018 identified certain range of frequency bands for IMT services which causes overlap between satellite based and terrestrial services which need proper technological solution for coexistence.**

Orbit-frequency resource comprises of the Orbital slot, which is the position of the communication satellite in the sky; and frequency spectrum, which is the band and bandwidth in which the satellite operates. Orbit-frequency coordination with ITU includes coordination of both the orbital slot and the associated frequency spectrum.

The orbit-frequency rights are permitted by ITU on the principle of first-come-first-served basis. A satellite needs to be launched within a period of seven to eight years from the date of filing with ITU. Once launched, the satellite needs to be maintained at the designated orbital slot continuously for a period of 90 days. In case of failure of the satellite, a new satellite must be brought into the slot within a period of three years. Failure to do so would result in cancellation of the orbit-frequency resource.

Recognising the potential of this natural resource, many countries being early entrants had already occupied bulk of the orbital spectrum. India could coordinate limited orbit-frequency rights at 32.5°, 48°, 55°, 74°, 82°, 83°, 93.5° and 111.5° East. Since the signals of the satellites go beyond national boundaries, it is strategically important that India occupy the orbit-frequency resources in the Indian sky.

Satellite communication services generally require a minimum of 500 MHz to a few GHz of bandwidth in frequency bands like C, Ext-C, Ku, Ka, etc. Some of the frequency bands UHF, VHF, L, S band etc. using bandwidth in the range of KHz to few MHz are used to provide narrow band and thin route services like Search and Rescue, Satellite phones, etc.

NFAP 2018 identified a certain range of frequencies as IMT bands to be used for terrestrial mobile telephone services such as 2G/ 3G/ 4G/ 5G services. Audit observed that some of these IMT bands allocation had Fixed-satellite service (FSS) allocation as co-primary orbit-frequency spectrum to India/ DoS for satellite services. This created an overlap of frequencies identified for terrestrial and satellite-based systems as shown in **Table 5.2**.

**Table 5.2: Overlap in frequency range identified for IMT Band for terrestrial services with satellite services**

NFAP 2018 allocation for terrestrial system		Spectrum coordinated with ITU for satellite services		
Range of Frequency (MHz)	Bandwidth (MHz)	Frequency Bands (MHz)	Bandwidth (MHz)	Space craft
2500 - 2690	190	2500-2535	35	GSAT 17 (2500-2535 = 35 MHz) GSAT-7 (2513-2517 = 4 MHz)
		2555-2635	80	GSAT-6 (2560-2590 = 30 MHz)
		2655-2690	35	GSAT-6 (2670-2680 = 10 MHz) GSAT-7 (2683-2687 = 4 MHz) GSAT-17(2655-2690 = 35 MHz)
3300 - 3600	300	3400-3600	200	IRNSS Satellites

It can be seen from the **Table 5.2** that 3.4 GHz band (3400 – 3600 MHz) and 2.5 GHz (2500 – 2690 MHz) band are the two important bands identified as IMT bands for terrestrial services in NFAP 2018, which had already been coordinated by DoS with ITU for its space-based services. Thus, the same band had been identified for both the services causing overlap.

While acknowledging the position, ISRO stated (May 2021) that if co-existence is possible, both satellite and terrestrial services (including IMT) would operate in the same frequency with or without conditions to protect each other. However, if co-existence is not feasible, the national regulator (WPC/ DoT) would have to identify/ decide the frequency that had to be earmarked for satellite and terrestrial services. ISRO added that orbit-frequency resources allocated by ITU cannot be diverted for any other service including IMT services and any attempt to change the allocated frequencies to other frequency range to facilitate IMT would trigger the international coordination process to start afresh, which would be the main challenge.

Further, Committee of Secretaries (CoS) was constituted (October 2020) to optimize the use of spectrum; in the meeting (January 2021) it was decided that 3.3 GHz to 3.67 GHz sub-band would be used for IMT/ 5G throughout the country, subject to the following in respect of DoS:

- 25 MHz in 3.4 GHz to 3.425 GHz band would be made available for IMT thought out the country except in 6 DoS locations where the keep off distance of 40 to 130 Kms shall be maintained.

- DoS agreed to give up 3.6 to 3.67 GHz band for use by DoT for IMT/ 5G, hence, 3.6 to 3.67 GHz shall be used for IMT/ 5G.

In view of the above, Audit is of the view that DoS and DoT had not identified an appropriate technology solution and limitations of use in such a manner that both services can co-exist in these bands.

**Recommendation 15:** DoS and DoT need to work together to identify an appropriate technology solution in such a manner that both services can co-exist in important frequency bands.

## 5.2.2 Non-utilisation of spectrum in High Throughput Satellite

**Bandwidth capacities on GSAT 29, GSAT 19 and GSAT 11 remained idle for long periods since their launch in June 2017, November 2018, and December 2018 respectively, upto 2020-21, resulting in non-utilization of valuable spectrum for several years.**

Secretary DoT (Dec 2017) conveyed to Secretary DoS the data bandwidth requirement for satellite base connectivity at about 2,500 Gram Panchayats (GPs) under second phase of Bharat Net Project.

DoS launched three High Throughput Satellites<sup>15</sup> (HTS) (GSAT 19, GSAT 29 and GSAT 11) between June 2017 and December 2018 for various applications. DoT requested (April 2018) DoS to allot the entire capacity of GSAT 29 satellite for data connectivity requirement of Jammu & Kashmir and North Eastern Region (NER). Similarly, DoT, BBNL and BSNL requested DoS to utilise large capacity of GSAT 19 and GSAT 11 for their flagship programmes.

Considering the importance of the national programmes, the INSAT Coordination Committee<sup>16</sup> and DoS decided (December 2018) to allot the entire capacity of GSAT 29 as well as a large capacity on GSAT 19 and GSAT 11 to DoT/ BSNL/ BBNL as per their requirement on primary basis. The remaining capacity of GSAT 11 satellite was to be offered to other private users.

In a meeting held between the Secretary, DoT and the Secretary DoS (December 2018), a Committee was formed to bring out a joint Approach paper to finalise various issues including total bandwidth requirement for various DoT/ USOF funded projects and bandwidth requirement of BSNL and optimum utilization of available bandwidth from current HTS – GSAT-19, 11 and 29. Accordingly the Committee comprising of officers of DoS, BSNL and BBNL met during March – May 2019 and submitted the Approach paper on position of utilisation of Indigenous capacity jointly by DoS and DoT(May 2019).

As per Approach paper,

<sup>15</sup> **High-throughput Satellite** or **HTS** is a communication satellite that provides more throughput than conventional communication satellites (Fixed Satellite Service). Higher-throughput refers to a significant increase in capacity when using the same amount of orbital spectrum. The increase in capacity typically ranges from 2 to more than 100 times as much capacity as the classic FSS (Fixed Satellite Service).

<sup>16</sup> ICC is a high level multi-departmental control mechanism consisting of Secretaries of six Departments viz. DoS, Department of Economic Affairs, Department of Telecommunications, MIB, Department of Science and Technology and Department of Information Technology that is responsible for coordinating and monitoring the implementation of space and ground segments of satellite projects.

(i) Total capacity requirement for various DoT/ USOF funded projects and bandwidth requirement of BSNL are given in **Table 5.3**.

**Table 5.3: Capacity requirement as per Approach paper**

Project requirement		Requirement (Mbps)	
		Short Term	Long Term
1. Bharat Net (For NE, J&K, Himachal, Uttarakhand & other states)	7,128 Gram Panchayats on Satellite Media	21,384	71,280
2. Mobile Connectivity (For NE, J&K, Himachal, Uttarakhand)	1,146 BTSs	4,584	4,584
3. Backhaul for DHQ, BHQ (For NE, J&K, Himachal, Uttarakhand)	413 Sites	9,380	9,380
4. For NFS project	305 Sites	450	450
5. Connectivity at A & N and Lakshadweep Islands	-	8,000	8,000
6. LWE Area	-	1,600	1,600
7. Mobile connectivity at Meghalaya	-	320	320
	<b>Total</b>	<b>45,718</b>	<b>95,614</b>

(ii) The project demand was proposed to be met through the indigenous HTS capacity i.e. GSAT – 11, 19, 29 & 20 (GSAT 20 was scheduled to be launched by the end of 2019 but not yet launched). The remainder and further demands would be met through the planned HTS capacity in Ka & Ku bands in next 3-4 years.

Audit scrutiny revealed that the capacities on GSAT 29, GSAT 19 and GSAT 11 remained idle for long periods of time before they were allotted to users. The satellites were launched in June 2017, November 2018, and December 2018 respectively. The responsibility of establishment of ground segment (Gateways) was entrusted by WPC/ DoT to DoS/ ISRO. While the ground segment of GSAT-11 was ready by March 2019, GSAT-19 and GSAT-29 were ready by October 2020. DoS provisionally allotted (June 2020) the space segment capacity on GSAT-19 and GSAT-11 effective from 29 April 2020. The capacity of GSAT 29 however was not allotted to BSNL/ BBNL. The roll out of user segment and utilisation of the satellite capacity rest with DoT through its PSUs. There were delays on the part of DoS in completing the ground segments of the three satellites. The spacecraft wise capacity of the satellites, date of establishment of ground segment by DoS and allotted capacity utilization are detailed in **Table 5.4**.

**Table 5.4: Utilisation of spectrum in HTS**

Satellite Mission Life Spectrum capacity	Date of Launch	Date of establishment of ground segment	Date of allotment of transponder capacity	Expenditure on satellite launch from DoS budget <sup>17</sup> (₹ crore)	Total Usable Capacity (MHz)	Period of Allotment (excluding the first month from launch) <sup>18</sup>	Capacity allotted to the users in MHz	Unallotted capacity after leaving mandatory 20 per cent spare
<b>GSAT-19</b> <b>10 years</b> <b>1000</b> <b>MHz</b>	05.06.2017	Interim Gateways- (July 2017 & Oct 2018) Permanent Gateways- Oct 2020	29.04.2020	366.59	1,624	05.07.2017 to 28.04.2020	0	1,299
						29.04.2020 onwards	1,624	0
<b>GSAT-29</b> <b>10 years</b> <b>1000</b> <b>MHz</b>	14.11.2018	Oct 2020	10.05.2021	503.22	2,520	14.12.2018 to 09.05.2021	0	2,016
						10.05.21 onwards	81	<b>1,935</b>
<b>GSAT-11</b> <b>15 years</b> <b>2000</b> <b>MHz</b>	05.12.2018	Mar 2019	29.04.2020	1,618.62	7,424	05.01.2019 to 29.04.2020	0	5,939
						30.04.2020 to 28.02.2021	4,176	1,763
						01.03.2021 to 31.05.2021	4,196	<b>1,743</b>

In response ISRO stated (June 2021) that the Department was continuously pursuing with DoT to make use of the capacity of GSAT 29 satellite and had also proposed to bring the satellite capacity under open allotment to any interested user. ISRO added (July 2021) that based on the clearance from DoT, 81 MHz of the capacity was allotted to a private service provider.

In respect of GSAT 19, ISRO stated (June 2021) that though the satellite was operational from July 2017, the satellite capacity was allotted to BBNL and BSNL from April 2020 due to delay in conducting in-orbit pay load tests, connectivity tests and demonstrations using HTS Platform which was inducted for the first time in the country. DoS added (August 2021) that in addition, readiness of the user segment for utilisation of the satellite, which is the responsibility of the users, also took some time.

Regarding delays in launch of services, for GSAT 11, ISRO stated (June 2021) that user beams had been allotted to BSNL/ BBNL, as per direction of DoT for connectivity in J&K, NER, Hilly states, LWE and Islands from April 2020. It was also stated that though other private players were approached for left over capacity (after use by BSNL/ BBNL), it did not materialise due to the COVID 19 situation. ISRO further stated (July 2021) that in general 100 per cent of beams of the HTS were not planned to be utilised in the beginning and only 60 per cent utilisation was considered. DoS added (August 2021) that HTS technologies were

<sup>17</sup> Includes cost of the satellite, launch cost and cost of establishing Ground Segment.

<sup>18</sup> After launch of satellite, the satellite is made operational within a reasonable period of one month and satellite transponder capacity is allocated to users.

being introduced for the first time in the country due to which users required time to get acquainted and deploy the user systems in a gradual manner. DoS also stated that it had now adopted a demand driven approach, whereby firm commitments would be obtained from the users before releasing the satellites.

Further, as per information provided by WPC/ DoT (July 2021),

- (i) BSNL had applied (July 2021) for WOL for 928 MHz in GSAT 11 Satellite and 428 MHz in GSAT 19 Satellite (For Commercial VSAT).
- (ii) Hughes Communication India Pvt. Ltd. (May 2021) applied for WOL for 81 MHz in GSAT 29 (For Commercial VSAT).
- (iii) BBNL had not yet applied for WOL.

It was also informed by WPC/ DoT that no WOL had been issued as on date for operation of satellite bandwidth on GSAT-11, GSAT-19 and GSAT-29.

BBNL had informed that Bandwidth allotted to them, from GSAT 19 & GSAT 11 is 4,444 MHz for implementing the Satellite base connectivity at 5,521 (GPs<sup>19</sup>, DSPTs<sup>20</sup> and additional sites) under Bharat Net Project. It was also stated that Project is still under implementation and filing of application for obtaining the WOL is under process.

BSNL in response stated that Bandwidth allotted to them from GSAT 19 & GSAT 11 is 428 MHz and 928 MHz respectively, and their application for WOL on 01 July 2021 was pending with DoT.

**The above facts corroborate that valuable satellite capacity had remained unutilised for a long period of time, due to delays in launching, testing/ readying the ground segment and allotting spectrum capacity to users. WPC had not issued WOL (June 2021) and assigned spectrum to user agencies leading to non-realisation of spectrum capacity due to delays by all stakeholders.**

***Recommendation 16:** DoS needs to engage with client Departments and other potential users at an early stage before planning and launching the satellite capacity to minimize non-utilization of spectrum resources.*

### **5.2.3 Future satellites planned for operation in spectrum bands identified for terrestrial purpose**

**DoS had planned and coordinated spectrum with ITU to launch future satellites for various services. These frequency bands had also been identified for terrestrial IMT services which had caused a concern for interference and needs technological solution for co-existence.**

Audit observed cases in which DoS/ ISRO had coordinated spectrum with ITU for satellites planned to be launched in future in frequency bands that had already been identified for terrestrial purposes for IMT services. The cases are detailed in **Table 5.5**.

<sup>19</sup> Gram Panchayats

<sup>20</sup> Digital Satellite Phone Terminals.

**Table 5.5: Future satellites planned in bands identified for terrestrial purpose**

Frequency Band (MHz)	Bandwidth (MHz)	Satellite Services planned	Remarks
2170 - 2200	30	Mobile Satellite Services (MSS)	DoS/ ISRO made its filings with ITU for Geo Satellite Services to provide MSS. Audit observed that the same band had also been identified for IMT services. The Department is however, yet to acquire this spectrum resource from ITU. ISRO stated (July 2021) that this band is highly useful for space to earth MSS and that there was no viable alternative to this band for MSS. However, ISRO did not indicate as to how the band is planned to be used interference free.
1980 - 2010	30		
2025 – 2110	85	Inter Satellite Services	DoS planned its Inter-satellites IDRSS 1 & 2 satellites under these bands for communication with planned Human Space mission (Gaganyaan) from the deep space ground network at ISTRAC, Bengaluru whenever the mission is not visible from the ground station. ISRO replied (July 2021) that the band is not identified for IMT by ITU. ISRO added that the same had been communicated to DoT/ WPC and DoS had requested WPC to revise NFAP in line with ITU RR so that the services of ISRO can be provided interference free.
460-470	10	Meteorological satellite services (Space to earth)	DoS planned this spectrum in its upcoming satellite GSAT 32 to be utilised for ocean monitoring purpose. The plan of action of DoS to utilise the spectrum on non-interference and non-protection basis was not on record. ISRO replied (July 2021) that the band would be used on non-protection basis without causing interference to IMT services planned in the band since ocean monitoring services are limited to ocean only.

It can be seen from the **Table 5.5** that capacities in orbital resources coordinated for future satellite-based services had also been identified for delivering terrestrial IMT services, which had raised a concern of interference. This is particularly critical in the case of MSS in the bands 1980 – 2010 MHz and 2170 - 2200 MHz, which was stated to be highly useful for space to earth MSS and for which there was no viable alternative.

DoS stated (August 2021) that National Working/ Study Groups had been constituted to work out a strategy for coexistence of space and terrestrial based services.

**Recommendation 17:** DoT and DoS may work out a strategy so that space-based and terrestrial services can co-exist to address the problem of spectrum co-ordinated with ITU for planned satellite launches in frequency bands already identified for terrestrial purposes for IMT services.

#### 5.2.4 Management of administratively assigned projects

**DoS did not have any centralised mechanism for spectrum management as different ISRO units/ centres were allotted spectrum in non-IMT bands without being routed through SATCOM PO.**

The SATCOM PO wing in ISRO is the focal point in DoS for spectrum coordination and its management. Out of 249 projects where spectrum was specifically allotted by DoT/ WPC administratively to DoS and its units against specific requests, 10 projects utilising a total of 566.75 MHz were in IMT bands. The remaining 239 projects utilising 37,135.40 MHz were in Non-IMT bands.

Audit selected all the 10 projects in IMT bands (utilising 566.75 MHz) and 60 projects in Non IMT bands (utilising 37,086.79 MHz<sup>21</sup>) for detailed examination.

Of the 566.75 MHz in IMT bands, 540.75 MHz (95 per cent) was used towards Technical Support Services such as TTC services for Earth Observation Satellites, Surface Imaging, Ground Segment Activities, Satellite support Services, Lab Test Services etc., and 25 MHz was used towards Research/ Laboratory Test/ Experimental/ Demonstration purpose in one project allotted to SAC, Ahmedabad. Similarly, 31924.79 MHz of the spectrum (86 per cent) from Non-IMT bands was used towards Technical Support Services and 5162 MHz was used towards Research/ Experimental/ Demonstration purpose in 13 projects as shown in **Table 5.6**.

**Table 5.6: Non-IMT spectrum used for Research/ Experimental/ Demonstration purpose**

Centre	Frequency Band	Band	Bandwidth (MHz)	Remarks
SAC	425 – 450 MHz	UHF	25.00	
SAC	9600 MHz	X	675.00	
SAC	1250 MHz	L	75.00	
SAC	3200 MHz	S	75.00	
SAC	29879 – 29889 MHz	Ka	10.00	Temporary allotment.
SAC	11329 – 11339MHz	Ku	10.00	Temporary allotment.
SAC	13129 – 13139 MHz	Ku	10.00	Temporary allotment.
SAC	20079 – 20089MHz	Ka	10.00	Temporary allotment.
SAC	220000 -230000 MHz	Ka & Higher	2000.00	
SAC	330000 – 345000 MHz	Ka & Higher	2000.00	
VSSC	1 – 22.6 MHz	VHF	22.00	No commercial use/ value.
NARL	1280 MHz	L	10.00	
SAC	35610 MHz	Ka	240.00	
<b>Total</b>			<b>5162.00</b>	

Audit observed that the requests of individual ISRO centres/ units for frequency allotment were not routed through SATCOM PO. The papers maintained at the units of ISRO were not furnished to Audit. As such, Audit could not ascertain if the spectrum requests of DoS units for IMT spectrum could have been allotted under Non-IMT Bands.

<sup>21</sup> 37603.54 MHz of the 70 Selected Projects the spectrum pertains to 60 Non IMT band projects were 37086.79 MHz after deducting 516.75 MHz of IMT Band projects.

Audit also observed that there was no supervision and review mechanism in OSCA to maintain strict discipline in the usage, management and surrender of IMT band spectrum. Detailed guidelines on document flow, process flow, utilisation, timely surrender, etc. were not in place. There was no system of submission of periodic returns/ reports to check whether the system was running smoothly. Absence of such a mechanism exposes the system to the risk of inefficient utilisation, idling capacity, etc. For instance, it can be seen from **Table 5.6** that in four projects, spectrum was allotted on temporary basis. SATCOM PO did not review the requirement and the possibility of surrendering the spectrum allotted for Temporary Research and Development activities.

ISRO stated (July 2021) that in view of the expansion of activities in DoS and its units and the fact that the licensing process had been made online by WPC, individual units/ centres of DoS had been permitted to apply directly with WPC. DoS stated (August 2021) that a centralised mechanism for supervision, review and control of usage of spectrum by centres/ units was not felt necessary, as the spectrum required by the centres/ units was specific to them and they manage/ utilise the spectrum themselves.

As management of the spectrum, particularly IMT band is critical for its optimal utilisation, DoS may seriously consider putting in place a centralised monitoring/ control mechanism for ensuring strict discipline in usage and management of the spectrum as well as timely surrender of unutilised spectrum.

**Recommendation 18:** DoS may establish a centralized monitoring/ control mechanism for supervision and review of utilisation of spectrum by the users.



# CHAPTER 6

## SPECTRUM UTILISATION IN OTHER MINISTRIES/ DEPARTMENTS/ AGENCIES





**CHAPTER****6****Spectrum Utilisation in other Ministries/ Departments/ Agencies**

This Chapter deals with issues relating to Spectrum Management in the Ministries/ Departments/ Agencies such as Ministry of Home Affairs (MHA), Ministry of Railways, Ministry of Information and Broadcasting (MIB), Oil and Natural Gas Corporation, Airports Authority of India, Indian Oil Corporation Limited and Gas Authority of India Limited.

**A. Spectrum Management in Indian Railways****6.1 Introduction**

Indian Railways (IR) had a network of over 68,000 route KM connecting more than 8,000 stations on which 21,000 passenger and freight trains run every day. Highest decision-making body in IR is the Railway Board (RB) headed by the Chief Executive Officer (CEO) and Chairman. The RB comprises Members, Secretary and Director General of various wings. IR carries out its rail transportation through 17 Zonal Railways headed by General Managers. Operation and maintenance of rail transportation under a zonal railways is looked after by its Divisional Offices. In addition to Zonal Railways, there were Production units, Central Public Sector Undertakings, and other Administrative units under the control of RB.

Indian Railways uses spectrum for radio communication for (i) Traffic Control, (ii) Communication in the train between Guard & Driver, (iii) Mobile Communication between moving train/ vehicle with fixed location (Station) or another moving train/ vehicle, (iv) Emergency Communication between driver, guard, station master & Cabin, etc.

RB approaches Wireless Planning and Coordination (WPC) Wing of DoT for allotment of spectrum. After getting approval for allotment of spectrum from WPC, Zonal Railways/ units directly apply to DoT on SARAL SANCHAR portal for obtaining license. RB had issued (March 2006) “Guidelines for dealing with WPC” and prescribed the procedure for obtaining the WOL by Zonal Railways.

The details of frequencies, their use, surrendering of frequencies etc. were not maintained centrally either at RB or at Zonal Railways. It is being maintained at the Divisional Offices/ sub-units where frequencies were being used for radio communication. As per available records, details of spectrum available at IR for radio communication are given in **Table 6.1**.

**Table 6.1: Spectrum bands and systems being used by Indian Railways**

Sl. No.	Frequency band allotted to IR	Purpose of frequencies
1	146 MHz-174 MHz	Walkie-Talkie sets being used by Driver, Guard, Station Masters, RPF and Maintenance staff.
2	380.15 MHz-396.75 MHz	Terrestrial Trunked Radio communication (TETRA) <sup>22</sup> .

<sup>22</sup> Terrestrial Trunked Radio (TETRA) is a professional land mobile radio standard specifically designed for use by government agencies, emergency services, public safety networks, rail transportation etc. In Railways, TETRA network is used both for operational voice communications between train drivers and train controllers as well as to carry train signaling and control information.

Sl. No.	Frequency band allotted to IR	Purpose of frequencies
3	400 MHz-417 MHz	End of Train Telemetry (EoTT), a proven, low cost, radio telemetry-based device which replaces Guard and Break Van in freight trains. This technology is used to establish communication between the locomotive driver and last wagon of the train to ensure that the train is running with all coaches/ wagons as a complete unit.
4	406 MHz-407 MHz	Distributed Power Wireless Control System <sup>23</sup> , used in Electric locomotives in all Indian Railways.
5	416.8 MHz-466.8 MHz	Train Collision Avoidance System <sup>24</sup> being used in 250 route km in South Central Railway.
6	MHz-445 MHz and MHz-470 MHz	The frequencies in UHF band are currently not being used for voice channel. However, spot frequency of 441.8/ 466.8 MHz for Train Collision Avoidance System (TCAS) are also known as KAVACH.
7	890 MHz-960 MHz (900 MHz band)	Mobile Train Radio Communication between train driver/ guard to the station master or section controller based on GSM-R technology (2G), commissioned for use at 3,445 route km.

### 6.1.1 Non maintenance of database of spectrum assigned and lack of monitoring of spectrum usage by Railways

#### Railways had not maintained a proper central database of spectrum assigned/ being used or surrendered by it.

Railways uses spectrum in various bands for different services. However, neither Railway Board nor the Zonal Railways maintained proper database of spectrum assigned/ being used or surrendered by it. Test check of records of Northern Railway zone at Delhi revealed that Microwave and UHF bands were not in use from December 2011 and January 2013 respectively. However, no details of surrender of frequencies under these two bands were made available to audit. Audit also observed that even the units using the frequencies had not maintained proper records of Spectrum being used/ not in use by them. Even WPC could not state (September 2021) the details of frequency surrendered by Railways in Microwave and UHF bands though as per the ASMS data base (NFR), it stands assigned to Railways.

On being pointed out by audit, Railways stated (September 2021) that present MIS is planned to be replaced with a new MIS covering all aspects of spectrum utilization and related asset management in the near future, subject to availability of funds.

This indicates inherent deficiencies in maintenance of database of spectrum assigned to Railways by both the Departments.

<sup>23</sup> **Distributed Power Wireless Control System (DPWCS)** of locomotives is a method to increase the throughput (or line capacity) of a railway line with minimal incremental inputs. In DPWCS, more than one MU Consist are provided in a train, the Master Locomotive is provided with crew but Slave Locomotive (s) are operated based on commands from Master Locomotive through wireless communication.

<sup>24</sup> **Train Collision Avoidance System (TCAS)** is an indigenously developed **Automatic Train Protection (ATP)** System meant to provide protection to trains against **Signal Passing at Danger (SPAD)**, **excessive speed and collisions**. TCAS provides continuous update of **Movement Authority** (distance up to which the train is permitted to travel without danger). Hence during unsafe situations when brake application is necessitated, and the Crew had either failed to do so, or is not in position to do so, automatic brake application shall take place.

### 6.1.2 Use of spectrum without obtaining valid operating license

WPC (DoT) issues Agreement in-principal (AIP)/ Decision Letters (DLs) before granting WOL for establishing Wireless Telegraph Station, subject to various conditions. The operation of the stations should commence after obtaining license for the same from WPC. Audit observed that in the following instances operation of wireless stations was started after obtaining DLs only but without obtaining required operating license as given in **Table 6.2**.

**Table 6.2: Use of spectrum by IR without valid wireless license from WPC**

Zone	Particulars of Decision Letters issued	Frequency band	Purpose/ services
<b>Northern Railway</b>	Five DLs issued during September 2006 to October 2011	900 MHz band	MTRC
<b>North Frontier Railway</b>	Three DLs issued April 2003 to February 2008	900 MHz band	MTRC
<b>Kolkata Metro Railway</b>	One DL issued in March 2013	900 MHz band	MTRC
<b>Northern Central Railway</b>	Four DLs issued during December 2018 to September 2020	146.4 MHz to 161.15 MHz.	Radio communication

Thus, Railways had been using spectrum without obtaining valid WOL from WPC (DoT) in violation of provisions under Indian Wireless Telegraphy Act, 1933. Further, Railway Board did not have updated/ real time database of use of spectrum at railways in view of absence of relevant periodical returns/ reports.

On being pointed out by audit, Railways stated (September 2021) that a few Zonal Railways commenced operations based on DLs received from the WPC. However, Railways had been paying the due spectrum charges for usage of GSM-R after the issue of DL to DoT. SACFA clearance and other formalities required in connection with the issue of WOL had been requested. The concerned Zonal Railways were also being advised to further pursue the case with WPC for issue of operating license.

DoT in response stated (September 2021) that WPC wing had assigned 1.6 MHz spectrum in 900 MHz band and issued five DLs/ Licenses to Northern Railways for operation of MTRC System in 900 MHz band for different routes, among others. It was mentioned that as per information and records available, Railways had not submitted any requisite documents such as SACFA siting clearance, equipment invoice etc. for issue of WOL, therefore, no WOL had been issued to Railways against these DLs. It was also added that Indian Railways had requested for surrender of 24 nos. of FX stations and 400 nos. of VM & HH stations (100 VM & 300 HH), however, no frequency had been surrendered by IR in 900 MHz.

Fact remains that Railways had been using spectrum without obtaining valid WOL from WPC.

**Recommendations 19:** Indian Railways may maintain proper data base of spectrum assigned/ surrendered after reconciliation with WPC data. RB may introduce periodic returns/ reports from Zonal/ Unit levels in respect of information on management of spectrum, to ensure efficient, timely and effective utilization or surrender of the spectrum assigned to IR by DoT and timely renew/ obtain WOL for spectrum assigned to IR.

## B. Spectrum Management in Ministry of Information and Broadcasting

### 6.2 Introduction

**Doordarshan was providing broadcast service in 470-646 MHz band in Analog as well as Digital Terrestrial Television mode. As ATT has become obsolete technology with public audience of only 0.3 per cent and implementation of DTT was only in four per cent of transmitters, scope exists for Doordarshan to vacate 526-646 MHz band and coexist with other Government user in 470-526 MHz band.**

DD was broadcasting seven national channels and 28 regional channels through its own Analog and Digital Terrestrial Transmitters (DTT) using RF spectrum and Direct to Home (DTH) (Free Dish) services using satellite-based spectrum.

**a) Analog Terrestrial Television (ATT):** ATT was the original television technology that uses analog signals to transmit video and audio. However, analog signals vary over a continuous range and are susceptible to electronic noise and interference, causing a moderately weak signal to become snowy. This technology requires dedicated transmitter for broadcast of each channel. A substantial DD's transmission network has been created for ATT and currently 566 of the total 589 (96 per cent) transmitters were ATT transmitters. However, a study was conducted by Doordarshan in February 2017, thereafter no public domain information of Audience Research Unit of DD, BARC<sup>25</sup> data, independent third-party survey exists to indicate the audience coverage of ATT. During Audit, information about audience research data, periodical operation reports, periodical inspection reports indicating operation of these transmitters and utilisation of earmarked frequencies was sought from DD. However, the same was not provided.

**b) Digital Terrestrial Television (DTT):** DTT is a better technology compared to ATT as DTT technology can carry multiple channels and is a more spectrally efficient technology giving an enhanced viewing experience. Scheme of converting ATT to DTT was underway since 2003 at DD and currently, there were 23 DTT transmitters at 19 locations<sup>26</sup>. Reception from DTT requires DTT compatible devices and setting up of an alternate ecosystem comprising of manufacturing/ import/ marketing of DTT compatible devices, trained personnel for installation, troubleshooting, tuning, repair, and maintenance of these devices. Otherwise, content transmitted in this manner on any mobile device/ TV cannot be viewed. However, requisite hardware was not available at any Doordarshan Kendra or any e-commerce site. It was apparent that after a lapse of about 18 years since introduction of DTT broadcast, defeating

<sup>25</sup> Broadcasting Audience Research Council

<sup>26</sup> Delhi, Mumbai, Kolkata, Chennai (2 DTT each), Guwahati, Patna, Ranchi, Cuttack, Lucknow, Jalandhar, Raipur, Indore, Aurangabad, Bhopal, Bengaluru, Ahmedabad, Hyderabad, Trivandrum and Srinagar.

the very objective of introducing DTT for public broadcasting, was not served leading to non-utilisation of spectrum assigned for this technology.

### c) Alternative methods of broadcast available with DD

Besides having captive RF resources for ATT and DTT broadcast, Doordarshan is using satellite-based spectrum for providing DTH Services (FreeDish) in C-Band in Andaman & Nicobar Islands and Ku-Band in Rest of India. Also, being a public service broadcaster, DD gets regulatory support in broadcasting its content over private television broadcast infrastructure and all private Cable operators, Multi-service Operators, DTH operators, IPTV operators who were mandatorily required to carry 23 Doordarshan channels over their networks to deliver its content to audience.

Test check of records at DTT transmitter at Delhi revealed that frequency band 582-646 MHz was not utilised for any transmitter, but DD continues to occupy this band citing future plans.

Prasar Bharati defended holding of spectrum for DTT/ ATT services citing future plans; objective of providing infotainment to public in far flung areas; compulsory requirement to fulfil its mandate; and provide robust all-weather platform. However, there was minuscule audience (0.3 per cent in 2017 as per the study conducted by Doordarshan; data after 2017 not available) of terrestrial television and DTT was primarily focused in big cities.

MIB in its reply (November 2021) stated that Prasar Bharati has entered into an MoU with IIT Kanpur to develop Next Gen Broadcast solution/ roadmap for Digital Terrestrial Broadcasting consistent with emerging standards such as 5G Broadcast and defended holding of spectrum for future plans.

Reply of the MIB is not acceptable as CoS had also recently decided (January 2021) that MIB should vacate the frequency band in 526-646 MHz band and coexist with other Government User in 470-520 MHz band. Frequency 526-646 is important IMT Band for 5G Services.

**Recommendation 20:** MIB may vacate unutilised frequency band 526-646 MHz which was occupied by them citing future plans.

## C. Spectrum Management in Ministry of Home Affairs

### 6.3 Introduction

Ministry of Home Affairs (MHA) discharges multifarious responsibilities, which inter-alia include border management, internal security, and disaster management. To discharge these responsibilities, MHA maintains eight Central Armed Police Forces<sup>27</sup> (CAPFs) which had different objectives viz. border management (ITBP, SSB and BSF), internal security (IB, CRPF, CISF), anti-terrorism/ anti-hijacking (NSG) and disaster management (NDRF). These CAPFs require radio-frequency bands/ spots to fulfil their peacetime and operational communication requirements.

<sup>27</sup> Border Security Force (BSF), Central Reserve Police Force (CRPF), Central Industrial Security Force (CISF), Intelligence Bureau (IB), Indo-Tibetan Border Police (ITBP), National Disaster Response Force (NDRF), National Security Guard (NSG) and Sashastra Seema Bal (SSB)

Directorate of Coordination, Police Wireless (DCPW), is the nodal advisory body to the MHA for police telecommunication in the country and is also responsible for coordinating various police communication services of CAPFs and laying down technical specifications for communication equipment to be inducted in the police forces. Besides, DCPW maintains a reserve stock of radio communication sets to meet the emergent communication needs of CAPFs. DCPW had also created a VSAT network e.g. POLNET for providing connectivity to all district/ state headquarters and national capital Delhi for various police organisations including CAPFs. CAPFs use spectrum in non-IMT bands below 450 MHz and in 450-470 MHz in IMT band for their communication networks and NDRF uses satellite-based spectrum in addition to the frequencies in VHF, UHF and HF bands.

Audit examined the records regarding spectrum management by eight CAPFs and audit findings are described in succeeding paragraphs.

### **6.3.1 Lack of coordination between DCPW and CAPFs with respect to communication requirements of CAPFs**

**Directorate of Coordination, Police Wireless of Ministry of Home Affairs had not devised any policy for spectrum management among Central Armed Police Forces. CAPFs have been independently applying to WPC for spectrum allotment without consulting DCPW.**

CAPFs independently apply to DoT for allocation of frequency spots in UHF, VHF and HF bands without any consultation with DCPW. There was no method of independent analysis of spectrum requirements of CAPFs in DCPW. Frequency, redundancy, and equipment requirements were worked out by each CAPF based on their own perception of need. Although DCPW broadly coordinates with DoT for spectrum requirements of all police forces, it had not conducted any objective requirement analysis for frequency spots for each CAPF after considering its role, need and area of operation. With the advent of latest technologies and availability of alternative communication infrastructure, CAPFs had multi-layered communication networks<sup>28</sup> besides captive RF based communication methods. The CAPFs primarily use these methods to meet majority of their communication needs such as Audio/Data communication, Video Conferencing, etc. Most of the CAPFs indicated that even though RF equipment (primarily HF) were being regularly tested for operational readiness, these were primarily used in extreme emergency situations in case of failure of all alternate methods of communication and normal communications through Walkie Talkie and other wireless communication devices.

DCPW had not devised any policy guidelines regarding spectrum and equipment redundancy that should be maintained to meet all emergency requirements. In the absence of any policy guidelines regarding quantum of spectrum for emergency use and equipment redundancy, the possibility of excess redundancy of RF spectrum and sub-optimal utilisation of frequency spots cannot be ruled out.

On being pointed out by audit it was replied (September 2021) that DCPW being the nodal agency under MHA coordinates with WPC/ DoT for allocation of spectrum as and when

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<sup>28</sup> Captive VSAT terminals, Satellite Phones, Satellite based broadband, Fiber optic/line-based connectivity and POLNET

requested by States/ UTs Police/ CAPFs/ CPOs. There were no instructions from MHA for mandatory scrutiny of proposal of CAPFs/ CPOs by DCPW before approaching WPC. However, DCPW provides expert advice as and when sought by CAPFs/ CPOs user organization. It was upto CAPFs user organization to approach DCPW in case they need any help.

Acting as technically competent nodal agency and advisory body to MHA, it was expected that DCPW should coordinate efficiently between the CAPFs and recommend effective strategies that would not only spare redundant RF spots but would prevent burden and cost of acquiring and maintaining a variety of equipment and communication services in CAPFs.

### 6.3.2 Unutilized capacity of POLNET 2.0

**POLNET 2.0 is not fully commissioned for use by CAPFs. Out of 614 projected requirements of VSAT terminals (2015) for six CAPFs, only 213 terminals were installed. ITBP and NSG had not taken any terminals.**

POLNET is a nationwide Satellite based Captive Communication Network/ Digital Information Highway for the police organisations of the Country. Currently, POLNET 1.0 had been upgraded to POLNET 2.0 in order to achieve efficient utilisation of bandwidth and to support high speed multimedia applications viz. Video, Voice, Data and Messaging. POLNET 2.0 started functioning from February 2021.

Test check in audit revealed that POLNET 2.0 was not fully commissioned due to some shortcomings in the Hub.

Against the projected requirements during 2015 for six CAPFs of 614 VSAT terminals, they had taken 262 terminals and only 213 terminals were installed as on date.

POLNET 2.0 was operational from February 2021 and against the estimated cost of ₹ 18.25 crore, total expenditure incurred on POLNET 2.0 till August 2021 was ₹ 14.14 crore (including cost on Hub Equipment ₹ 8.65 crore) and recurring annual expenditure of ₹ 11.38 crore on payment of spectrum charges, transponder charges, etc.

On being pointed out by audit it was replied (September 2021) that the POLNET 2.0 was a cost effective proposition for States/ UTs Police/ CAPFs as only equipment cost was to be borne by them and all recurring regulatory charges were bore by DCPW. Currently various Police Organisation work in silos. If States/ UTs Police/ CAPFs were on a common network, then communication, coordination & interoperability between these organisations would be effective while achieving efficient utilisation of available resources.

Keeping in view the expenditure of incurred on the installation of POLNET 2.0 and recurring annual expenditure, it is imperative that services of all the terminals of POLNET 2.0 may be optimally utilised by all State Police Departments and CAPFs and other related agencies for their operational requirements.

**Recommendations 21:** Ministry of Home Affairs may devise policy for spectrum management among Central Armed Police Forces. Further, effort may be made for optimal utilisation of POLNET 2.0 by all State Police Departments and CAPFs and other related agencies for their operational requirements.

## **D. Spectrum management by PSUs under Ministry of Petroleum and Natural Gas**

### **6.4 Oil and Natural Gas Corporation (ONGC)**

Oil and Natural Gas Corporation (ONGC) is a public sector company having In-house service capabilities in areas of Exploration and Production of oil & gas and related oil-field services. Presently, ONGC had 13 Onshore & four Offshore Assets (Producing Hydrocarbons), seven Basins (engaged in all facets of hydrocarbon exploration activities), three Plants (Processing Crude Oil and Gas), 16 Institutes (providing specialized R & D and other services in specific business areas) and 22 Service Groups (providing common & specialized services across ONGC).

To support ONGC's operations spread across India in geographically remote and difficult terrains/ areas, Corporate INFOCOM<sup>29</sup> was responsible for creation and upkeep of Information and Communication infrastructure and providing uninterrupted network connectivity for local area network/ wide area network (LAN/ WAN) at locations across ONGC. From 1980s onwards, ONGC started its Satellite based Communication Network, which was progressively augmented over the years. Applications were submitted by individual user groups, plants, assets, work centers, etc. in ONGC. Based on the requests and the information shared by ONGC work centers spread across India, Corporate Infocom, New Delhi expedites and follows up on these requests. On need basis executives from work centers also approach WPC/DoT directly. In addition, spectrum group also looks after the hiring of space segment on satellite transponder, signing of annual agreement with DoS and payments thereof.

#### **6.4.1 Non utilization of allotted spectrum by ONGC due to poor contract management relating to communication network projects**

**Poor contract management by ONGC in executing communication network systems on turnkey basis resulted in non-utilization of spectrum in 3300-3400 MHz and 7 GHz bands for seven and three years respectively.**

##### **(a) Non utilization of allotted spectrum in 3300-3400 MHz band**

DoT gave network approval (June 2012) for establishing RF spectrum-based communication network in frequency range of 3300-3400 MHz to ONGC for operations in North East and Southern Parts of India. ONGC had existing communication network in this frequency band in Gujarat region/ Offshore. ONGC placed (May 2012) the Notification of Award (NOA) on M/s Essel Shyam Technologies Limited, Noida (contractor) for execution of network system on Turnkey basis with scheduled completion date as 21 July 2013 for Phase-I and 21 October 2013 for phase-II from the date of NOA. ONGC was liable to pay license fee and royalty from date of commissioning of the project or 18 months from the date of issue of network approval by DoT, whichever was earlier.

The work could not be completed even after providing the required extension to the contractor and hence the contract was terminated (November 2014) with PBG amounting to ₹ 3.54 crore being invoked. A fresh tender was floated in April 2016 with a total cost of ₹ 39.97 crore. The second contractor also failed in completing the work within the extended period and it was

<sup>29</sup> Corporate unit of ONGC for Management of communication system including spectrum management in ONGC

finally terminated in November 2019. ONGC surrendered the spectrum in December 2019 without utilizing it for a single day and had to pay ₹ 38.12 crore towards spectrum charges to DoT.

DoT issued (March 2018) notices to ONGC and others (ISPs/ IOCL) to vacate spectrum assigned to them in 3300-3400 MHz band as this had been identified for introduction of IMT 2020 (5G) services.

DoT in reply stated (September 2021) that M/s ONGC (December 2019) surrendered their frequency assignments in the frequency band 3.3-3.4 GHz issued for NER and Southern region. It was also stated that M/s ONGC (December 2019) had requested for frequency assignment in 7 GHz band in place of frequency band 3.3-3.4 GHz in the onshore locations in western region of Gujarat service areas. Accordingly, M/s ONGC had been issued frequency assignments in 7 GHz band in Gujarat service area. Further, M/s ONGC (December 2019) stated that various networks were operational in 3.3-3.4 GHz in off-shore region, and would continue to be in operation till the end of their useful life of equipment (tentatively till 2024) and would be replaced in a phased manner.

The fact remains that the network approved in June 2012 was not implemented due to poor contract management by ONGC and finally the spectrum allotted to them in June 2012 for North East and Southern regions was surrendered (December 2019) resulting in non-utilization of spectrum in 3300-3400 MHz band by ONGC for almost five years. Existing network in this band in Gujarat region/ Offshore was in use and spectrum was yet to be surrendered by ONGC.

#### **(b) Non utilization of allotted spectrum in 7 GHz band**

ONGC requested (March 2017) WPC for frequency authorization for deployment of Onshore Microwave Backbone Network at Mumbai to cater to high bandwidth requirements at 10 links<sup>30</sup> to meet various communications connectivity for operational activities like ERP application, SCADA<sup>31</sup> data networks, Surveillance Network, Access Control Networks and Security Networks System. WPC approved (October 2017) frequency authorization in 7 GHz band for interconnecting all offices through point-to-point microwave links radio networks and DL was issued in August 2018. In the meantime, ONGC floated (April 2017) a tender for supply, installation and commissioning of Onshore Microwave network project with one-year warranty and five-year comprehensive annual maintenance service and the contract was awarded (October 2018) to M/s. TECL with scheduled completion within 10 months i.e. 08 August 2019. ONGC was to supervise, co-ordinate and monitor the performance and progress of the project. However, in view of slow progress and delays, ONGC terminated the contract on 02 November 2020. Subsequently, ONGC surrendered the spectrum on 17 November 2020 after paying license fee/ royalty of ₹ 5.76 crore.

<sup>30</sup> NBPGH to 11 High, VB to 11 High, VB to Trombay, Trombay to NSB, Trombay to Parshik Hill, Panvel Ph-II to Parshik Hill, Panvel Ph-II to Panvel Ph-I, Trombay to Jawahar Dweep and Jawahar Dweep to JNPT.

<sup>31</sup> Supervisory Control and Data Acquisition (SCADA) systems is used for collecting data during Production & Drilling operations for the monitoring and management of the production of Oil & Gas and drilling activities.

On being pointed out by audit, Management did not produce any documentary evidence to substantiate that timely monitoring of the contract was undertaken. It further stated (September 2021) about framing the guidelines for addressing the issues relating to statutory clearances, project monitoring tool for project valuing less than ₹ 50 crore.

DoT in response stated (September 2021) that ONGC was issued frequency assignments in 7 GHz band for their Mumbai onshore project during the year 2017-2018 and ONGC (November 2020) requested for surrender of these DLs stating that the project did not commence due to unavoidable reasons. It was also stated that M/s ONGC had paid the spectrum charges against these DLs for the period up to 30 September 2021 and ONGC requested for refund of the spectrum charges paid against these DLs stating that the Microwave Backbone project did not commence, and the system could not be installed. Refund/ adjustment of spectrum charges paid for the period 01 December 2020 to 30 September 2021 would be considered after surrender of the above DLs.

Thus, poor contract management resulted in surrender of allotted spectrum in November 2020 without any installation and commissioning of network leading to non-utilization of spectrum.

#### **6.4.2 Delay in upgradation of the existing network system by ONGC for efficient utilization of satellite-based spectrum**

**Delay in upgradation of satellite based network due to poor contract management by ONGC caused non-utilization of satellite bandwidth hired from DoS for more than four years.**

ONGC constituted (June 2011) a Technical Task Force, which *inter-alia* recommended (December 2012) induction of new Technologies to meet the application requirement to upgrade/ replace obsolete equipment and to hire one more 36 MHz full transponder. In view of the above it was proposed (March 2014) to implement the project “revamping of C-Band communication infrastructure” on lump-sum turnkey basis. ISRO offered (August 2015) additional transponder on GSAT-16 Satellite. ONGC awarded (September 2016) a Turnkey Contract to M/s. HCIL Comtel Limited for revamping of C-Band Communication Infrastructure project at a cost of ₹ 45.28 crore with scheduled completion period of 12 months from date of award.

The contractor could complete the installation, configuration, and testing of system in August 2019 against the scheduled date of July 2017. Subsequently after Site Acceptance Test (SAT) in November 2019 and June 2020 for Onshore and Offshore network, the handing over of system & project completion was done in February 2020 and June 2020. Due to persistent delays in completion of required activities, the satellite network could not be utilized during the period 2015-16 to 2019-20.

On being pointed out by audit Management replied (July 2021) that prior to allotment of space capacity on GSAT-16, the offshore sites were getting connectivity through GSAT-10. These sites continued to get connectivity through Space capacity on GSAT-10 till the time it was shifted to GSAT-16. Further, the offshore network on GSAT-16 was put into use since March 2017 and was being utilized since then. It further stated (September 2017) that delay was mainly due to several meetings of tender committee to finalize the tender and multiple

rounds of clarifications. It was also stated (September 2021) that several improvements such as adherence of Material Management guidelines for tender processing, introduction of category management policy were being followed to strengthen financial bid evaluation.

Management reply of use of GSAT-16 bandwidth since March 2017 is not acceptable as the system installation and configuration was completed by the contractor in August 2019 and the site acceptance test could only be conducted during November 2019 and June 2020 for Onshore Network and Offshore Network respectively as elaborated above. The Management had not provided any documentary evidence/ report to substantiate the network utilization to audit.

The above observations suggest that satellite-based spectrum could not be efficiently utilized for almost four years.

### **6.4.3 Operation of network systems without obtaining valid license (WOL) from WPC** **ONGC did not obtain requisite WOL for several frequencies being used by it.**

Section 3 of Indian Wireless Telegraphy Act 1933 stipulates that

*'save as provided in Section 4, no person is supposed to possess wireless telegraphy apparatus except under and in accordance with a valid license issued under this Act.'*

Audit noticed that ONGC had seven frequency assignments in IMT band (450-3600 MHz), 10 frequency assignments in spectrum band beyond 3600 MHz range and 173 frequency assignments in spectrum band below 450 MHz as on 31 March 2021. In case of IMT band spectrum having frequency of 3329.75/ 3379.75, 3333.25/ 3383.25 MHz, DLs were issued in respect of 32 locations during the years 2008 to 2016. Out of these 32 locations, WOL for only five locations were obtained from DoT/ WPC in August 2014. WOL were not obtained in respect of remaining 27 locations for use of these frequencies till July 2021.

ONGC had obtained DLs for 19 locations for utilization of spectrum for three frequencies viz. 9410 (eight locations), 7327.5 (four locations) and 7299.5 (seven locations) MHz during the period from 2011 to 2020; WOL for only one location (9410 MHz) was obtained till date (July 2021), though these frequencies were in use.

In respect of frequencies in the spectrum band below 450 MHz, out of total 143 active frequencies in use in ONGC as on 31 March 2021, 34 frequencies were examined. It was noticed that ONGC had obtained WOL in respect of only six frequencies till date (July 2021).

On being pointed out by audit, the Management replied (July 2021) that WOL were pending from DoT although requisite formalities had been completed by ONGC. It further stated (September 2021) that it would take steps to obtain WOL for pending cases at the earliest and SOP & guidelines were being framed for addressing statutory issues including obtaining WOL.

DoT in response stated (September 2021) that based on the request and supply of requisite documents such as SACFA, Equipment Invoice, payment details etc., WOL had been issued against the DLs. WOL had not been issued against remaining DLs as ONGC had not applied and submitted the requisite documents for the same.

However, the fact remains that ONGC had been using spectrum without obtaining WOLs which was a statutory requirement to be completed for utilization of spectrum as per the Indian Wireless Telegraphy Act 1933.

#### 6.4.4 Absence of laid down procedure/ protocol for ensuring optimal and efficient utilization of spectrum in ONGC

**ONGC uses spectrum in both IMT and non IMT bands but did not have any laid down guidelines, procedure for spectrum management to ensure its optimal use.**

ONGC had been assigned spectrum administratively in both IMT and non IMT bands with huge economic value. Therefore, the objective of spectrum management should be to ensure efficient and effective use of spectrum. ONGC should plan for requirement of spectrum band with due care, establish latest technology network system and monitor the usage of spectrum on regular basis. However, Audit did not find any laid down guidelines, procedure for spectrum management to ensure its optimal use. Audit observed that applications for spectrum to DoT/ WPC were directly submitted by individual work centers which indicated that there was no mechanism in place for assessing/ reviewing and updating the spectrum use at Corporate Infocom level. Above mentioned audit findings clearly suggest poor contract management relating to communication networks using spectrum.

On being pointed out by audit, the Management stated (March 2021) that the Company had a well-established mechanism for reviewing/ assessing and updating spectrum technology requirement and its utilization. At times wherever envisaged, independent opinion was also taken. The Management further replied (July 2021) that the communication requirement for various work centers of ONGC were addressed by Infocom Services and accordingly network permission/ frequency allotment were taken up by local Infocom offices, except for requirement in 0-450 MHz. The requirement for 0-450 MHz spectrum was processed by local unit itself.

Management further stated (September 2021) that efforts had been initiated for consolidation of spectrum information and making it available on common platform for easy access, assessment, monitoring, optimization, etc. and suitable SOPs, guidelines would be framed for adoption in ONGC.

The fact remains that ONGC had not laid down guidelines, procedure for spectrum management to ensure its optimal use.

**Recommendations 22:** *ONGC may effectively monitor the contracts for establishing the network facilities to ensure timely utilization of the allotted spectrum. There is also a need to establish a mechanism for assessing and reviewing the utilization of spectrum in all bands, particularly in IMT bands and satellite bandwidth for ensuring optimal and efficient utilization of assigned spectrum. It may timely renew/ obtain WOL for the spectrum assigned to ONGC. It may consolidate spectrum related information and make it available at a common platform for easy access and assessment of spectrum at Corporate Infocom level.*

#### 6.5 Indian Oil Corporation Limited (IOCL)

Indian Oil Corporation Limited (IOCL) is engaged in the business of refining, transportation, and marketing of petroleum products. It owns and operates nine refineries, one Naphtha Cracker Plant and 14,600 km cross-country pipelines network. To monitor performance and safety of crude/ product pipeline through SCADA, an application software, the Company had laid approximately 8,631 km of OFC cables en-route its cross-country pipeline network. In line

with the Petroleum and Natural Gas Board and Oil Industrial Safety Directorate provisions regarding dealing in highly hazardous/ inflammable products, the Company had obtained licenses for wireless networks from DoT/ WPC in VHF/ UHF for the safety and security of its refineries/ pipeline/ marketing locations situated across the country.

#### **6.5.1 Absence of laid down policy/ procedure/ guidelines for optimum utilization of spectrum**

**IOCL uses spectrum in both IMT and non IMT bands but did not have any laid down policy/ procedure/ guidelines for spectrum management to ensure its optimal use.**

Spectrum being a scarce natural resource should be used optimally, for which a user organization like IOCL should have laid down policy/ procedure/ guidelines for assessing its use, requirements, upgradation of wireless communication networks in view of changing technologies. However, Audit noticed that the Company had neither maintained a central record of licenses/ spectrum as assigned by DoT nor formulated any policy/ guidelines for ensuring the optimal and efficient utilization of spectrum.

Further, the Company also failed to provide any document suggesting it had reviewed/ assessed or updated its requirement of spectrum or had identified unused spectrum and changed its utilization requirements with time and technological changes. Hence, audit could not make any observation about the utilization efficiency or surplus frequency.

On being pointed out by Audit, the Management accepted (May 2021) the fact that there was no defined policy or specific Divisional procedure/ protocol for ensuring optimal and efficient utilization of spectrum/ bandwidth as assigned by DoT/ WPC. It further stated (August 2021) that it had developed a format for maintaining central record of licenses/ spectrum as assigned by DoT, to each division for monitoring optimum and efficient utilization of assigned frequencies.

#### **6.5.2 Utilization of spectrum in IMT bands based on DoT/ WPC authority letter without having a valid license**

**IOCL did not obtain requisite WOL for several frequencies being used by it.**

Section 3 of Indian Wireless Telegraphy Act 1933 stipulates that

*‘save as exempted provided by the Central Government in accordance with Section 4 of the Act, no person is supposed to possess wireless telegraphy apparatus except under and in accordance with a valid license issued under this Act.’*

However, Audit noticed that the Company had been using frequencies below 450 MHz, 806/ 851 MHz bands along with several wireless walkie-talkie sets after obtaining the authority letter from DoT. However they had not obtained a valid license (WOL) for use of the same at Naphtha Cracker Plant Panipat, Gujrat Refinery Jamnagar, Digboi Refinery Assam and Gorakhpur (Marketing location).

Management stated (August 2021) that based on the decision to grant license they were using these licenses by making timely payment of all requisite charges associated with spectrum allotment. All documents required for issue of Wireless Operating License had been submitted to DoT and regular follow up was being done for the same.

However, DoT in reply stated (September 2021) that M/s IOCL had been issued WOL no. TG-41/ 1-440 in 800 MHz band for their CMRT operation at their Naphtha Cracker Plant from T-Group of WPC Wing, which is valid up to 30 June 2022. They were silent on issue of WOL for Gujrat Refinery Jamnagar, Digboi Refinery Assam, and Gorakhpur (Marketing location).

**Recommendations 23:** IOCL may laid down policy/ procedure/ guidelines for spectrum management to ensure its optimal use. They may renew/ obtain WOL in time for the spectrum assigned to them.

## 6.6 Gas Authority of India Limited (GAIL)

Gas Authority of India Limited (GAIL) is India's leading natural gas company with diversified interests across the natural gas value chain of trading, transmission, LPG production & transmission, LNG re-gasification, petrochemicals, city gas, E&P, etc. It owns and operates a network of around 13,340 km of natural gas pipelines spread across the length and breadth of the country. In order to ensure effective and reliable communication within plants, pipeline installations, compressor stations (CS)/ Pump Stations (PS) and Townships, licenses for wireless communication systems in the frequency ranges of below 450 MHz, 806/ 851 MHz and in 1.4 GHz bands had been taken from WPC for its captive uses. Besides, GAIL had also obtained registration/ licenses for commercial services viz. Infrastructure Provider (IP) I & II and ISP. The license for IP-II and ISP had since expired.

GAIL had a policy regarding management of spectrum allotted to them by DoT and had created a separate department known as GAILTEL to look after matters relating to Spectrum. All licenses/ registration/ statutory permissions/ statutory compliance issues related to GAILTEL business were dealt with by CO-GAILTEL<sup>32</sup>. During the project phase, GAILTEL-Project<sup>33</sup> was responsible for providing the desired licenses along with the system and handing over the same to the GAILTEL O&M. Payment of applicable Royalty/ License fee/ Radio Spectrum fees wherever applicable was to be ensured by respective site units of GAIL.

### 6.6.1 Underutilization of spectrum by GAIL in 1.4 GHz band

**GAIL had obtained license in three frequency ranges for 58 Wireless Telegraph stations but using only 30 stations.**

GAIL obtained (March 2011) license in three frequency ranges 1448/ 1497, 1456/ 1505 and 1464/ 1513 for 58 Wireless Telegraph stations. The license fees for point to point/ multipoint was ₹ 58,000 and royalty fees was ₹ 1.80 crore. However, GAIL had been using only 30 stations instead of 58 stations and paying the spectrum charges of ₹ 1,80,58,000 per annum applicable for 58 stations. GAIL had not taken any action for surrender of frequency authorizations for 28 stations and to revise the spectrum charges payable.

<sup>32</sup> Corporate GAILTEL is responsible for formulation and implementation of policy and guidelines, pertaining to operation and maintenance of OFC, Telecom & SCADA systems installed across GAIL. Licenses/ registration/statutory permissions/statutory compliance issues related to dark-fiber lease business shall be dealt with by CO-GAILTEL.

<sup>33</sup> Projects GAILTEL group is responsible for design, engineering & planning of the OFC, Telecom, SCADA network for all new pipelines. During the project phase, GAILTEL-Project is responsible to provide the desired licenses along with the system and handover the same to the GAILTEL O&M.

On being pointed out by audit, the Management stated (July 2021) that it paid only ₹ 28,000 per annum in excess as license fee and there was no change in royalty fee.

However, the management has not assessed the actual requirement of frequency authorization in this band and surrender the frequency no more required by it.

**Recommendations 24:** *GAIL needs to establish a mechanism for assessing and reviewing the utilization of spectrum in all bands for ensuring optimal and efficient utilization of assigned spectrum. GAIL may assess the actual requirement of frequency and surrender the frequency no more required by it.*

## E. Spectrum Management in Airports Authority of India

### 6.7 Introduction

Airports Authority of India (AAI) was constituted by an Act of Parliament and came into being on 01 April 1995 by merging erstwhile National Airports Authority and International Airports Authority of India. It functions under the administrative control of Ministry of Civil Aviation (MoCA), GoI. AAI is responsible for providing Air Navigation Services (ANS) over the designated Indian airspace and adjoining oceanic airspace for purposes relating to the safety, regularity, and efficiency of air navigation. In pursuit of this goal, AAI provides Communication, Navigation & Surveillance (CNS) facilities, which completely depend on the availability of radio frequency spectrum and its rational utilization within the aeronautical bands. To avoid harmful interference, it was incumbent on AAI to ensure that all aeronautical and non-aeronautical systems in-use were duly authorized and licensed from WPC.

CNS were the three main functions which constitute the foundation of Air Traffic Management (ATM) infrastructure and were vital for a safe and reliable air travel. The CNS activities were handled in AAI by the CNS wing headed by Member (ANS) of AAI. The Directorate is responsible for planning, procurement, maintenance of equipment, implementation, and installation of systems etc. These services were provided over the Indian Air Space by the AAI which had CNS/ ATM facilities at 137 Airports.

### Spectrum Management in AAI

An Aeronautical Frequency Spectrum Management (AFSM) Cell had been established and was operational in the Directorate of CNS-OM at AAI Headquarters. The General Manager (Communication) was the designated authority for the administration of aeronautical frequency spectrum. This Cell was responsible for planning, selection and assignment of frequencies. The initial mandatory regulatory clearances (frequency clearances) from the WPC wing of DoT were obtained by this Cell. At the Regional Headquarter level (RHQ), GM (CNS-R) at Chennai, Delhi, Guwahati, Kolkata and Mumbai, were responsible for obtaining, maintaining and regularly renewing (annually) each WOL for all airports under the jurisdiction of the concerned RHQ. The regulatory requirements at metro Airports in Chennai, Delhi, Kolkata, Bengaluru, Hyderabad, and Mumbai were fulfilled by the concerned GM (CNS). In respect of non-aeronautical facilities such as walkie-talkie use, the responsibility was delegated to all Senior Manager/ Assistant General Manager level field stations.

AAI also coordinates and assists WPC in such a manner that the competing and conflicting demands of non-AAI users (military, airline operators etc.) for frequencies in the aviation band were met in an optimum manner to avoid harmful interference. As one of the key members in National Preparatory Committee (NPC) for WRC, there was close coordination between AAI and WPC as their respective activities mature into preliminary views and Indian proposals. AAI also participates in the National Working Group constituted under NPC to study aeronautical, maritime, and amateur issues. AAI participates in the meetings held to revise the NFAP after every WRC to ensure that the aeronautical bands are protected.

### 6.7.1 Non utilization of spectrum in VHF bands by various Airports

**Frequency spots assigned to AAI remained unutilized for periods from three to 12 years due to non-completion of related projects at Airports.**

Audit noticed cases of non-utilization of frequencies allotted to AAI in different bands for various projects/ systems planned by AAI as detailed in **Table 6.5**.

**Table 6.5: Cases of non-utilization of frequency by AAI**

Sl. No.	Airport	Frequency allotted	Month of allotment of frequency/ issue of DL by WPC	Purpose	Present status
1	Kolkata	120.025, 124.650, 132.700, 134.375, 134.125 MHz	April to August 2014	Stand by frequencies for UAH project <sup>34</sup>	UAH project implemented by AAI at Kolkata airport during August 2015 without utilization of standby frequencies
2	Imphal	119.775 and 121.5 MHz	April 2014	For operation of Transmitter/ Receiver	Installation of equipment still in planning stage
3	Chennai	108.900, 329.300, 987(Tx)/ 1050 (Rx) MHz	July to August 2008	Instrument Landing System (ILS), a component of navigational system	Proposal cancelled (September 2013)
4	Hyderabad	1118/ 1181 MHz	June 2018	For Distance Measuring Equipment – High Power (DME-HP) facility	Equipment required for operations of DME-HP facility was yet to be received

Above instances indicate non utilization of frequencies allotted to AAI for periods ranging from 3-13 years due to reasons stated above. Non surrender of allotted frequencies for such a long period leads to inefficient and sub optimal utilization of spectrum.

On being pointed out by Audit, the AAI stated (September 2021) that procurement action had a considerable lead time and accepted systematic gap in procurement. It also attributed delay

<sup>34</sup> Upper Airspace Harmonization - upper airspace is the space above a specific flight level (26,000 ft and above) dedicated to overflight, while lower airspace is the space below that flight level, dedicated to airport approaches

in procurement due to the moratorium on issuance of any new frequency by WPC due to court directive and the pandemic. However, the non-utilization of allotted frequencies for such a long duration by the AAI cannot be justified and indicates systemic deficiencies in procurement of radio equipment and frequency management.

### 6.7.2 Under-utilization of spectrum assigned for navigational services by AAI

**Frequency spots assigned to AAI remained under utilised for periods ranging from three to five years due to delay in receipt of equipment.**

WPC allots frequency by issue of DL which should normally be used within one year. Audit noticed instances of underutilization of frequencies by AAI due to delay in operationalization of equipment/ systems as detailed in **Table 6.6**.

**Table 6.6: Cases of underutilization of frequency by AAI**

Sl. No.	Airport	Frequency allotted	Month of allotment of frequency/ issue of DL by WPC	Purpose	Present status
1	Bhubaneswar	121.500 MHz	April 2014	Emergency purpose of aeronautical communication/ radio-navigation service	Put to use w.e.f. 20 September 2020 being the date of operationalization of equipment after lapse of more than five years of allotment.
2	Lucknow	121.625 MHz	January 2016	For Surface Movement & Control (SMC-main) facility.	Lying unutilized for more than four years due to unavailability of Tx and Rx equipment, though it had been received now (July 2021).
3	Jaipur	1090 MHz	July 2012	For Automatic Dependant Surveillance Broadcast (ADS-B) a ground-based facility that receives the ADS-B information (position, altitude, aircraft identification and velocity).	ADS-B facility commissioned (January 2017) even though provisional commissioning was done in February 2014.

Above instances show under-utilization of frequencies allotted to AAI due to delay for periods ranging from 3-5 years.

On being pointed out by Audit, the AAI stated (September 2021) that radio equipment could not be arranged at Bhubaneswar due to diversion, delay in procurement, etc. Further, ADS-B facility was inducted for the first time in India and there were no clear guidelines for commissioning of the facility. As per DGCA instruction (December 2013), AAI Chennai team

carried out the analysis/ assessment and accordingly, provisional commissioning (February 2014) of the facility was done by DGCA on 18 February 2014.

Management did not offer any valid reasons for delay in receipt of equipment and consequent under-utilization of allotted frequency and delay of almost three years between provisional and permanent commissioning of the facility.

### 6.7.3 Use of spectrum without obtaining valid Wireless Operating License (WOL)

**AAI had been utilizing frequency spots at 10 Airports without getting requisite WOL from DoT for period ranging from five to 25 years.**

WOL is a mandatory requirement to possess and operate any wireless telegraphy apparatus (radio equipment) in India and the possession/ operation of wireless equipment without a valid WOL is in violation of the Indian Wireless Telegraphy Act, 1933. All aeronautical (CNS) or non-aeronautical systems viz. walkie-talkie etc. must be commissioned for regular operation only after obtaining the WOL from WPC wing of DOT. Audit observed cases of utilization of frequencies without obtaining valid WOL from WPC as detailed in **Table 6.7**.

**Table 6.7: Cases of utilization of frequency by AAI without valid license from WPC**

Sl. No.	Airport	Frequency spots	Used since	Purpose	Remarks
1	Guwahati	75 MHz	February 2003	VHF Marker beacons (Outer marker and middle marker)	Outer marker and Middle Marker facility were withdrawn from operation from 12 October 2017 and 07 March 2017 respectively.
2	Chennai	109.700 323.200 995/ 1058 MHz	2006	ILS facility at runway 25	Management (July 2021) stated that no DL was available, and station was in the process of applying for WOL for ILS facility at Runway 25.
3	Chennai	1096/ 1159 MHz	September 2012	DME-HP facility	DL for above frequency was obtained (November 2019) after a delay of almost seven years since date of commissioning of the equipment.
4	Bhubaneswar	302 KHz	August 2005	Non-Directional radio Beacons (NDB) facility	Facility from Bhubaneswar airport withdrawn during December 2013 and transferred to Jharsuguda airport in Odisha, but no DL found on record.

Sl. No.	Airport	Frequency spots	Used since	Purpose	Remarks
5	Kolkata	110.3, 111.3, 332.3, 335, 385, 1001/ 1064, 1011/ 1074 MHz	April 2002 to January 2013	Navigational equipment like Glide path, DME-LP, Localisers.	These frequencies were being used for a period from eight years to 19 years without any authorization from WPC
6	Delhi	In the range of 108.5-335 MHz and 1046-1206/ 983-1143 MHz	September 2008 to January 2020	28 navigational equipment	Out of 28 equipment being operated on 28 frequency spots, 13 were being operated without any authorization from WPC.
7	Imphal	115.9 MHz, 110.3 MHz and 335.0 MHz	March 1998 to March 2001	Navigational equipment	These equipment were operated without frequency authorization from WPC till Mar-May 2019.
8	Guwahati	401 KHz, 110.3, 335, 342.3, 342.8, 357.3, 357.8, 1001/ 1064,MHz	April 2000 to January 2013	Navigational equipment	Out of 22 frequency allotted, authorization in case of 15 frequencies found. DL in case of two obtained in March 2019 after 19 years and five frequencies being used without any authorization for periods ranging from 13 to 19 years.
9	Hyderabad	110.1, 334.400 999/ 1062 MHz	May to August 1995	Navigational equipment	Out of 38 frequencies, three frequencies used without any DL/ WOL from WPC upto April-July 2019 as such unauthorized use continued for more than 25 years
10	Jaipur	295 KHz, 109.9, 333.8 997/ 1060 MHz	December 1999 to July 2008	Navigational equipment	Out of 15 frequencies, four frequencies being used unauthorizedly for 13 to 22 years.
11	Imphal	2861 MHz	December 2015	operation of surveillance radar (ASR/ MSSR)	WPC authorized frequency 2878/ 2898 MHz to operate ASR/ MSR's Tx/ Rx. However, AAI was using frequency 2861/ 2898 MHz against the allotted 2878/ 2898 MHz and did not surrender 2878 MHz.

Sl. No.	Airport	Frequency spots	Used since	Purpose	Remarks
12	Imphal	289 KHz, 161.825 and 1064/ 1001 MHz	2004 to 2009	Walkie – Talkie, navigational equipment	These three frequencies in addition to other 13 authorized frequencies, was being used without any DL/ WOL.

**Above instances of use of frequencies by AAI for its CNS activities without proper frequency authorization by WPC indicates weak internal controls in WPC and AAI as well since deficient monitoring mechanism by DoT resulted in violation of regulatory provisions governing uses of spectrum.**

On being pointed out by Audit, the AAI stated (September 2021) that the facilities were very old and records pertaining to the facility could not be located. Prior to 2007-08 the requirements of WPC were not very stringent and the awareness level within AAI towards license requirements was being established. AAI had initiated the internal audit process and would identify any deficiencies and take corrective action accordingly.

Above indicates systematic deficiencies in the frequency management by WPC/ AAI and needs to be strengthened.

#### **6.7.4 Irregularities in utilization of frequency 161.825/ 166.525 MHz assigned for walkie talkie (communication) service at AAI Airports**

**AAI had been using excess/ short wireless equipment beyond those authorized by WPC without getting it further authorized by WPC.**

As per the provisions of the Indian Telegraph Act-1885 read with the Indian Wireless Telegraphy Act 1933, a need may arise to amend the DL issued by WPC due to changes to equipment quantity (addition/ deletion), location details, etc. or inclusion of additional Remote Communications Air/ Ground (RCAG) networks. Further, the licensee shall be responsible to apply for the renewal of the existing frequency authorization or WOL, within a period of 30 days before the expiry of the said WOL/ AIP/ DL. Audit noticed instances of major deviation in using of communication equipment as detailed in **Table 6.8**.

**Table 6.8: Excess/ short wireless equipment used by AAI other than authorized**

Sl. No.	Airport	Month of issue of DL	No of authorized equipment	No of equipment used as on 31 March 2021	Deviations
1	Jaipur	August 2003	20 equipment (Fixed and Handheld)	131 equipment (Fixed and Handheld)	Excess use of 111 equipment
2	Bhubaneswar	August 2018	71 equipment (Handheld)	174 equipment (Fixed and Handheld)	Excess use of 103 equipment
3	Imphal	January 2014	22 equipment (fixed and handheld)	71 equipment	Excess use of 49 equipment

Sl. No.	Airport	Month of issue of DL	No of authorized equipment	No of equipment used as on 31 March 2021	Deviations
4	Chennai	April 2018	26 equipment (fixed and handheld)	20 equipment (fixed and handheld)	six less equipment being used.
5	Guwahati	October 2018	115 numbers of equipment	122 equipment (fixed and handheld)	Excess use of seven equipment

Use of excess/ short wireless equipment beyond those authorized by WPC without getting it further authorized indicates weak internal controls in adhering to regulatory provisions governing use of wireless equipment.

**Recommendation 25:** AAI may introduce a mechanism for periodical review of utilization of assigned frequencies and adhere to the regulatory provisions governing use of wireless equipment/ networks.



# CHAPTER 7 CONCLUSION





## CHAPTER

7

## Conclusion

The spectrum management process is not restricted to frequency assignments but also encompasses efficient spectrum planning, spectrum engineering and utilization of spectrum monitoring techniques and tools. The increased demand for spectrum in the recent years had made it mandatory for users to utilize spectrum efficient techniques.

Government Ministries/ Departments/ Agencies had been assigned spectrum administratively in both IMT bands suitable for commercial use with huge economic value as well as in non IMT bands. Most of the spectrum allocations were made years ago by administrative assignment, when there was little spectrum scarcity and therefore no pressure for users to consider the efficiency of use of their spectrum resources. This is no longer the case. Further, the spectrum usage is dynamic and not static in view of fast changing communication network technology and equipment. In this context assessment of utilization of spectrum assigned on administrative basis to the Government Ministries/ Departments/ Agencies like Ministry of Defence, Department of Space, Ministry of Railways, Airports Authority of India, other PSUs, was important in view of the possibility of low and sub-optimal utilization of spectrum by these users. As such there is a need to periodically assess the requirement of spectrum for use by the Public Sector bodies. This Performance Audit was conducted in this background.

The Performance Audit was conducted during March –July 2021 with a view to examine the process of allotment/ assignment and utilization of RF spectrum assigned administratively<sup>35</sup> to different Departments/ Agencies and involved audit scrutiny of the relevant records of selected Departments/ Agencies. An entry meeting was held with the Secretary, DoT and officers of WPC and WPF wings of DoT on 26 February 2021. Entry meetings were also held by audit with the senior management of the selected Ministries/ Departments/ Agencies during March-April 2021. In the entry meeting, the scope and objectives of audit were explained.

Important audit findings are summarized in succeeding sections:

### A. Spectrum Management in DoT

Audit findings relating to Spectrum Management in DoT are summarized as under:

- Post SC judgement of 2012 in 2G case that spectrum being a valuable natural resource has to be auctioned wherever there is demand, there had been adhoc mechanism for assignment of spectrum to needy users for captive uses as well as for commercial services other than telecom access services. This had caused delay and denial in assignment of spectrum, causing uncertainties amongst potential users.
- Pricing policies for administrative assignment of spectrum had not been reviewed since 2012, depending on the usage and demand for spectrum.
- DoT had not constituted a Permanent Committee/ Group to advise them on complex issues related to Spectrum Management including re-farming of spectrum for efficient

<sup>35</sup> In case of satellite-based spectrum, the scope includes allotment and assignment to all types of users.

and optimal utilization of the scarce resource. There was no MIS in place in DoT to get a feedback on actual utilization of spectrum assigned to Government users

- Automated Spectrum Management System (ASMS) implemented by WPC in 2005 is not in line with the standards/ guidelines of the ITU and did not had any maintenance contract and WPC faced network issues. As a result, frequency assignments and licenses issued were not being updated in the system.
- The National Frequency Register (NFR) remained un-updated and was not the correct reflection of the frequency assignments with various users. Large scale mismatch between the database of frequency assignments as per DoT and frequencies uses by the selected Departments/ PSUs were noticed.
- Spectrum is susceptible to harmful, illegal, and unauthorized uses by unscrupulous agencies. There were serious deficiencies in the maintenance of infrastructure for effective monitoring of spectrum, even though it was one of the most critical responsibilities of DoT. Available equipment was not maintained properly and no concrete action for replacements/ procurement of advance monitoring equipment was taken, despite recognizing the need in view of tremendous growth in wireless uses and deployment of advance technologies by the users of such monitoring equipment. Due to available vehicles not being in operational condition, mobile monitoring could not be done up to desired level.
- Due to inadequate monitoring equipment and ineffective infrastructure, unauthorized uses of spectrum had been noticed by audit, but no effective action was found to be taken against the unauthorized users.

## B. Utilization of Spectrum

Important Spectrum band wise utilization by the various Ministries/ Departments/ Agencies and scope for re-farming/ sharing and release of spectrum audit findings are summarized in the **Table 7.1**.

**Table 7.1: Utilization of Spectrum**

Ministry/ Department/ Agencies	Frequency Band/ IMT-Non-IMT	Remarks
<b>Ministry of Information and Broadcasting</b>	470-698 MHz (IMT)	<b>Suboptimal utilization</b> due to obsolete technology of Analogue Terrestrial Television (ATT) and non-viability of Digital Terrestrial Television (DTT); 120 MHz of 526-646 MHz can be made available for IMT/ 5G services on pan India basis.
<b>Ministry of Railways and other Government user</b>	698-806 MHz (700 MHz) band (IMT)	If proper study for <b>sharing of spectrum</b> between Railways and other Government user in this band was done, 5 to 10 MHz (paired) in different service areas may be available for commercial use out of 15 MHz (paired) allotted to Railways and other Government user.
<b>Ministry of Railways</b>	900 MHz (IMT)	<b>Suboptimal utilization</b> of GSM-R based MTRC System. 1.6 MHz (paired) in nine service areas can be re-farmed for IMT applications.

Ministry/ Department/ Agencies	Frequency Band/ IMT-Non-IMT	Remarks
<b>Government users</b>	1800 MHz band (IMT)	15 MHz spectrum in Kerala, Odisha and 10 MHz spectrum in Haryana, Mumbai and Kolkata service areas can be <b>re-farmed</b> from a Government user for IMT applications. If NFS was handed over to the Government user, possibility of re-farming spectrum in the range of 10 to 15 MHz in rest of the service areas can also be explored, resulting in availability of more spectrum for IMT applications.
	2100 MHz band (IMT)	5 to 10 MHz (paired) spectrum for IMT applications might be made available if proper <b>harmonization</b> from Government user was done.
	2300-2400 MHz band (IMT)	Considering the actual use of spectrum by Government user in 2300-2400 MHz band and availability of alternate bands, <b>10 MHz out of 20 MHz allotted for Government user can be made available for IMT applications.</b>
<b>Department of Space</b>	2500-2690 MHz band (IMT)	<b>DoS and DOT need to work together to identify an appropriate technology solution</b> with limitations of use in such a manner that both terrestrial and satellite services can co-exist in important frequency bands.
	3400-3600 MHz band (IMT)	Suitable technological solution was required for utilization of 175 MHz spectrum in the band for co-existence of IMT applications and space-based applications.
	Ka, Ku band	Spectrum capacity of GSAT-19, GSAT-29 and GSAT-11 created for Government use (DoT, BBNL, BSNL) remains <b>unutilized</b> since their launch in 2017 & 2018.
<b>Oil and Natural Gas Corporation</b>	3300-3400 MHz (IMT)	<b>Non-utilization</b> of allotted spectrum due to poor contract management by ONGC and surrendered subsequently.
<b>Department of Telecommunications</b>	1427-1500 MHz band (IMT)	Decision regarding making available spectrum in these bands for IMT applications and backhaul services needs to be expedited for timely and smooth introduction of 5G services in the country.
	mmWave bands (24.25–27.5 GHz band; 37–43.5 GHz band and 66–71 GHz band)	
<b>Airports Authority of India</b>	Various frequencies in non IMT bands	Non utilization, <b>under-utilization</b> of frequency bands by AAI due to delay in implementation of projects.

### C. Spectrum Management issues in other Ministries/ Departments/ Agencies

Audit had come across specific audit issues relating to other Ministries/ Departments/ Agencies which are summarized as under:

- **DoS** had planned and coordinated for satellite-based applications in 460-470 MHz, 1980-2010 MHz, 2025-2110 MHz and 2170-2200 MHz band which are IMT band. This needs coordination by DoT and DoS for better utilization.
- Instances of use of spectrum by **Department of Space, Indian Railways, ONGC, AAI** without obtaining valid licenses from WPC were noticed
- **Indian Railways** did not have proper database of spectrum assigned to them, in use or surrendered by user units.

The Report was discussed with DoT and representatives of Ministry of Defence, Information & Broadcasting, Railways and Department of Space in Exit Meeting held in September 2021. Views expressed in the meeting had been suitably incorporated in the Report.

**New Delhi**  
**Dated: 21 March 2022**

  
**(MANISH KUMAR)**  
Director General of Audit  
Finance & Communication

*Countersigned*

**New Delhi**  
**Dated: 24 March 2022**

  
**(GIRISH CHANDRA MURMU)**  
Comptroller and Auditor General of India

# ANNEXURE





**Annexure 1.1**  
*(Referred to in Paragraph 1.1)*

**Frequency Bands according to IEEE and Classification of Space Radio Communications**

Letter symbol	Radar (GHz)		Space Radio communications	
	Spectrum regions	Examples	Nominal designations	Examples
<b>L</b> (Long Wave)	1-2	1.215-1.4	1.5 GHz band	1.525-1.710
<b>S</b> (Short Wave)	2-4	2.3-2.5, 2.7-3.4	2.5 GHz band	2.5-2.690
<b>C</b>	4-8	5.25-5.85	4/6 GHz band	3.4-4.2, 4.5-4.8, 5.85-7.075
<b>X</b>	8-12	8.5-10.5	-	-
<b>Ku</b>	12-18	13.4-14.0, 15.3-17.3	11/14 GHz band 12/14 GHz band	10.7-13.25 14.0-14.5
<b>K</b>	18-27	24.05-24.25	20 GHz band	17.7-20.2
<b>Ka</b>	27-40	33.4-36.0	30 GHz band	27.5-30.0
<b>V</b>	40-75	-	40 GHz band	37.5-42.5 47.2-50.2
<b>W</b>	75-110			
<b>mm or G</b>	100-300			

## Abbreviations

Acronyms	Description
<b>AAI</b>	Airports Authority of India
<b>AFSM</b>	Aeronautical Frequency Spectrum Management
<b>AIP</b>	Agreement in Principle
<b>AIR</b>	All India Radio
<b>AMC</b>	Annual Maintenance Contract
<b>APT</b>	Asia Pacific Tele-community
<b>ATM</b>	Air Traffic Management
<b>ATNs</b>	Action Taken Notes
<b>ATT</b>	Analogue Terrestrial Television
<b>ASMS</b>	Automated Spectrum Management System
<b>BARC</b>	Broadcasting Audience Research Council
<b>BBNL</b>	Bharat Broadband Network Limited
<b>BSF</b>	Border Security Force
<b>BSNL</b>	Bharat Sanchar Nigam Limited
<b>BTS</b>	Base Trans receiver Station
<b>CAPF</b>	Central Armed police Forces
<b>CEO</b>	Chief Executive Officer
<b>CFA</b>	Competent Financial Authority
<b>CISF</b>	Central Industrial Security Force
<b>CMRTS</b>	Captive Mobile Radio Trunking Services
<b>CNS</b>	Communication, Navigation & Surveillance
<b>CoS</b>	Committee of Secretaries
<b>CRPF</b>	Central Reserve Police Force
<b>DCC</b>	Digital Communication Commission
<b>DCN</b>	Draft Cabinet Note
<b>DCPW</b>	Directorate of Coordination, Police Wireless
<b>DD</b>	Doordarshan
<b>DDG</b>	Deputy Director General
<b>DL</b>	Decision Letter
<b>DTH</b>	Direct To Home
<b>DTT</b>	Digital Terrestrial Television

<b>DoS</b>	Department of Space
<b>DoT</b>	Department of Telecommunication
<b>DPL</b>	Dealers Possession License
<b>DSNG</b>	Digital Satellite News Gathering
<b>DSPT</b>	Digital Satellite Phone Terminals
<b>EMC</b>	Electro Magnetic Compatibility
<b>EMI</b>	Electro Magnetic Interference
<b>EMS</b>	Electromagnetic Spectrum
<b>ENG</b>	Electronic News Gathering
<b>FDD</b>	Frequency Division Duplex
<b>FSS</b>	Fixed-satellite service
<b>GAIL</b>	Gas Authority of India Limited
<b>GHz</b>	Giga Hertz
<b>GIS</b>	Geographic Information System
<b>GPs</b>	Gram Panchayats
<b>GSAT</b>	Geostationary Satellite
<b>GSM-R</b>	Global System for Mobile Communication-Railway
<b>GSQR</b>	General Staff Qualitative Requirement
<b>GSO</b>	Geo Stationary Orbit
<b>HLMC</b>	High Level Monitoring Committee
<b>HTS</b>	High Throughput Satellite
<b>IB</b>	International Borders/ Intelligence Bureau
<b>ICC</b>	INSAT Coordination Committee
<b>IEEE</b>	Institute of Electrical and Electronics Engineers
<b>IFAT</b>	International Frequency Allocation Table
<b>ILD</b>	International Long Distance
<b>ILS</b>	Instrument Landing System
<b>IMS</b>	International Monitoring Stations
<b>IMT</b>	International Mobile Telecommunications
<b>IOCL</b>	Indian Oil Corporation Limited
<b>IOT</b>	Internet of Things
<b>IR</b>	Indian Railway
<b>ITBP</b>	Indo Tibetan Border Police
<b>ITU</b>	International Telecommunication Union

<b>ISP</b>	Internet Service Providers
<b>ISRO</b>	Indian Space Research Organisation
<b>ISTRAC</b>	ISRO Telemetry, Tracking and Command Network
<b>JCES</b>	Joint Communications and Electronics Staff
<b>JWA</b>	Joint Wireless Advisor
<b>KHz</b>	Kilo Hertz
<b>LAN</b>	Local Area Network
<b>LEC</b>	Lower extended C Band
<b>LOI</b>	Letters of Intent
<b>LOS</b>	Line of Sight
<b>LSA</b>	Licensed Service Areas
<b>LTE</b>	Long Term Evolution
<b>MHA</b>	Ministry of Home Affairs
<b>MHz</b>	Mega Hertz
<b>MIB</b>	Ministry of Information & Broadcasting
<b>MOC</b>	Ministry of Communication
<b>MoCA</b>	Ministry of Civil Aviation
<b>MOD</b>	Ministry of Defence
<b>MOR</b>	Ministry of Railways
<b>MSS</b>	Mobile Satellite Services
<b>MTRC</b>	Mobile Train Radio Communication
<b>MWA</b>	Microwave Access
<b>MWB</b>	Microwave Backbone
<b>M2M</b>	Machine to Machine
<b>NATO</b>	North Atlantic Treaty Organisation
<b>NDCP</b>	National Digital Communication Policy
<b>NDRF</b>	National Disaster Relief Force
<b>NFAP</b>	National Frequency Allocation Plan
<b>NFR</b>	National Frequency Register
<b>NFS</b>	Network for Spectrum
<b>NGSO</b>	Non-Geo Stationary Orbit
<b>NLD</b>	National Long Distance
<b>NPC</b>	National Preparatory Committee
<b>NOA</b>	Notification of Award

<b>NOCC</b>	Network Operations Control Center
<b>NRSC</b>	National Remote Sensing Centre
<b>NSG</b>	National Security Guard
<b>NTP</b>	National/ New Telecom Policy
<b>OM</b>	Office Memorandum
<b>OFC</b>	Optical Fibre Cable
<b>ONGC</b>	Oil and Natural Gas Corporation
<b>OSCA</b>	Orbit Spectrum Coordination and Acquisition
<b>PMRTS</b>	Public Mobile Radio Trunking Services
<b>POLNET</b>	Police Network
<b>PSU</b>	Public Sector Undertakings
<b>RB</b>	Railway Board
<b>RF</b>	Radio Frequency
<b>RLOs</b>	Regional Licensing Offices
<b>RRs</b>	Radio Regulations
<b>SACFA</b>	Standing Advisory Committee for Frequency Allocation
<b>SCADA</b>	Supervisory Control and Data Acquisition systems
<b>SARALSANCHAR</b>	Simplified Application for Registration and Licenses
<b>SAS</b>	South Asia Satellite
<b>SMEMBS</b>	System for Management of Electromagnetic Battle Space
<b>SATCOM PO</b>	Satellite Communication Programme Office
<b>SSB</b>	Seema Suraksha Bal
<b>STL</b>	Studio Transmitter Links
<b>TDD</b>	Time Division Duplex
<b>TDSAT</b>	Telecom Disputes Settlement and Appellate Tribunal
<b>TRAI</b>	Telecom Regulatory Authority of India
<b>TSPs</b>	Telecom Service Providers
<b>TTC</b>	Telemetry Tracking and Command
<b>UAV</b>	Unmanned Aerial Vehicle
<b>UHF</b>	Ultra-High Frequency
<b>VHF</b>	Very High Frequency
<b>VSAT</b>	Very Small Aperture Terminal
<b>WAN</b>	Wide Area Network
<b>WMO</b>	Wireless Monitoring Organization

<b>WMS</b>	Wireless Monitoring Station
<b>WOL</b>	Wireless Operating License
<b>WPC</b>	Wireless Planning & Coordination
<b>WRC</b>	World Radio Conferences



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