

Consultation Paper: 8/2019



Telecom Regulatory Authority of India



Consultation Paper

on

Allotment of spectrum to Indian Railways for Public Safety and Security services

24th June 2019

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New Delhi- 110002**

Written Comments on the draft Consultation Paper are invited from the stakeholders by 22nd July 2019 and counter-comments by 5th August 2019. Comments and counter-comments will be posted on TRAI's website www.trai.gov.in. The comments and counter-comments may be sent, preferably in electronic form, to Shri Syed Tausif Abbas, Advisor (Networks, Spectrum and Licensing), TRAI on the email ID advmn@traigov.in. For any clarification/ information, he may be contacted at Telephone No. +91-11-23210481.

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CHAPTER- I: INTRODUCTION

A. Background

- 1.1 The Department of Telecommunications (DoT), through its letter No. L-14001/01/2019-NTG dated 27th February 2019 (**Annexure-I**), informed that Ministry of Railways has proposed to install an Ultra-high-speed LTE based communication corridor along their rail network for Train-Ground and Train-Train communication. Ministry of Railways has requested DoT to reserve 15 MHz of spectrum in 700 MHz band for this purpose and to begin with, 10 MHz to be allocated free of cost as this proposal is devoid of any commercial gain, but only enhancing security and passenger amenities. Vide the said letter dated 27th February 2019, DoT has also requested TRAI to provide recommendations on administrative allotment of spectrum to Indian Railways and the quantum, price, appropriate frequency band (including 450-470 MHz band) and any other related issue, under the terms of clause 11(1)(a) of TRAI Act, 1997 as amended by TRAI Amendment Act, 2000.
- 1.2 Indian Railways (IR) is India's national railway system operated by the Ministry of Railways. IR has a network size of over 66000 Route Km connecting more than 8000 stations on which 21000 passenger and freight trains run every day to move 8 billion passengers and 1 billion tons of freight annually.
- 1.3 Approximately 2.2 Crore passengers use trains daily, their safety and security are of paramount concern and priority for IR. Further, ever increasing demands for introduction of more trains and stoppages from different parts of the country coupled with IR's limited fixed infrastructure and rolling stock availability, there is a need to ramp up the speed and throughput of trains by upgrading carrying and handling capacity of the existing IR networks.

- 1.4 IR is presently using GSM-R based network similar to various Railways networks deployed around the world. In India, 1.6 MHz (paired) spectrum in 900 MHz band has been assigned to IR on administrative basis for captive usage of their GSM-R based network.
- 1.5 "Development of Ultra-high-speed wireless corridor along IR's network" was identified as one of the enabler for transformation of IR in the Chintan Shivar held under the guidance of Hon'ble PM in November 2017. A series of transformational initiatives have been contemplated by IR to bring big strategic shift in Railways operations, passenger safety & security regime, capacity to carry traffic, market share & efficiency, enhancing passenger satisfaction and improve financial health of Railways. One of the key initiatives in this regard is the proposal to install a Modern Railway Signalling and Train Control System based on Mobile Communication system.

B. Submissions of Indian Railways

- 1.6 Long Term Evolution (LTE) is 4th Generation (4G) Mobile Communication System and is emerging as Global Standard for all new Train Control and Railway Signalling applications replacing the incumbent 2nd Generation (2G) GSM-R technology and is likely to see the broadest deployment of any new wireless technology over the next decade in Railway Safety, Security and Passenger experience applications.
- 1.7 Installing an Ultra-high-speed LTE based communication corridor along IR network would cater to the current and future data and voice needs for Train-Ground and Train-Train communication for improved train operations, passenger safety and passenger security services and remote rail asset monitoring & management. The applications of LTE can be classified under the following three broad categories-

- (i) Passenger safety & service:
 - Advanced Signalling systems like European Train Control System (ETCS) Level 2.
 - Emergency communications from train to control, train to stations and between train to train, etc.
 - Advanced signaling systems allow more trains to run across a given point or segment of the track which effectively increase the carrying capacity (throughput) of the same fixed civil and electrical infrastructure.
- (ii) Live surveillance camera feeds from trains will ensure security of passengers coupled with video analytics, this can help in prevention and detection of crime, not only in Indian Railways network but also outside in the peripheral areas.
- (iii) Internal improved Railway management:
 - Staff communication system.
 - Remote monitoring of Railways asset to improve their availability.

1.8 Ensuring appropriate network coverage will require investment in terms of building appropriate infrastructure for creating the radio network along railway lines, including fibre optical network & IP core, passive infrastructure (Network towers), active infrastructure (BTS/eNodeB devices etc.). IR will invest in software enhancements to operationalize Railway specific communication requirements and devices to facilitate use of the LTE network on-board.

1.9 Active infrastructure including the BTSs, antennae and associated equipment are responsible for the creation of the radio access network, on which the mobile devices connect to get access to data. With 700 MHz spectrum, active infrastructure (BTS specifically) spacing requirements will be in sync with location of railway stations spaced every 8-10 Kms.

Consequently, mid-section radio infrastructure requirements will almost disappear.

- 1.10 The ITU-R has identified the digital dividend spectrum in the frequency band 698-806 MHz for IMT in Region-3 (Asia-Pacific). This frequency range can provide effective mobile broadband services for Public Safety network and thus is most suitable for Indian Railways requirement.
- 1.11 Adoption of 700 MHz frequency spectrum is growing across world's railways because of its inherent advantages such as wide coverage, low Capex, efficient network utilization etc. Another driving force is the ability in 700 MHz spectrum of LTE to provide efficient high speed, low latency, low setup time, and high-security data connectivity, which is the precondition to provide multimedia and especially mission critical multimedia communication for safety and security application on Railways.
- 1.12 The bandwidth requirements in 700 MHz depend on data usage needs and capacity to carry projected amount of data. IR envisages following applications/facilities which will fuel growth in data usage on deploying LTE technology in 700 MHz:
 - a) Mission Critical Passenger Safety Services & Applications through ETCS Level 2 or similar Railway Signalling system on IR.
 - b) Video Surveillance (Live Feed) through CCTV cameras in trains along with Video Analytics for Passenger Security.
 - c) Faster data network Communication for voice, video and other related application.
 - d) More network-enabled devices (IoT based Asset reliability Monitoring).
 - e) Providing Wi-Fi facility in trains.
 - f) Train and way side Telemetry through Mobile communications.

- 1.13 Spectral bandwidth (critical) requirement (considering 10 Km average distance between towers) for data traffic requirement of Railway for Railway Mobile communication with various applications like provision of Wi-Fi in the trains, Safety critical Signaling system equivalent to European Train Control System Level 2 (ETCS Level 2), provision of downloading of select Video feed/alerts from CCTV cameras in moving trains comes to around 12 MHz.
- 1.14 IR has submitted that in light of the finite capacities of LTE and high bandwidth demands of Railway safety and security applications, a chunk of 15 MHz of spectrum for LTE shall be needed. Initially, since Railways may not start operating all services together, the network must have at least 10 MHz of spectrum to begin with as anything less than 10 MHz would not be suitable.
- 1.15 IR has requested that since frequency is proposed to be used for Passenger Safety and Security services and is not intended for any commercial use, the allotment of spectrum in 700 MHz band be made free of cost.
- 1.16 To sum up, IR has made the following requests to the Department of Telecommunications (DoT):
- (i) To reserve 15 MHz spectrum in 700 MHz frequency band for Indian Railways in the revised National Frequency Allocation Plan.
 - (ii) To begin with, allot 10 MHz of spectrum to Indian Railways in 700 MHz frequency band.
 - (iii) The spectrum of 10 MHz in 700 MHz frequency band to be allotted free of cost to Indian Railways as it is needed in the Public interest for Mission Critical Safety, Security and Passenger amenities applications by Indian Railways.

C. Views of DoT

1.17 DoT examined the request of Ministry of Railways and provided its comments vide letter dated 2nd November 2018. Subsequently, Ministry of Railways vide its letter dated 17th January 2019 informed that the Ministry of Finance and Ministry of Law & Justice, apart from many other Ministries have supported the Railway's Demand for allotment of 10 MHz spectrum in 700 MHz band free of cost and also submitted its response to the comments/issues raised by DoT. The issue-wise comments of DoT, response of Ministry of Railways and views of DoT are summarized below.

a. 700 MHz and other candidate bands for LTE deployments

1.18 DoT has observed that 700 MHz band is a globally harmonised band deployed for the IMT (International Mobile Telecommunication) applications in the telecommunications service by various countries. In India, this band has been earmarked for the potential IMT services which can be deployed by the Telecom Service providers. This frequency band is spanning from 703-748 MHz/758-803 MHz, occupying total of 45 MHz paired spectrum. Before the availability of this band was announced, 10 MHz paired spectrum of this band had been carved out from this 45 MHz for the Defence use as part of the Defence band commitment. DoT is now left with 35 MHz of paired spectrum in this band.

1.19 Further, TRAI vide its recommendations dated 1st August 2018, has provided the reserve price and other conditions for auction of various frequency bands including 700 MHz on the request of DoT. TRAI in these recommendations has, inter-alia, noted the following:

- a) With the increased demand for data services and uptake of data hungry applications, the need for spectrum has been ever increasing. Availability of sufficient spectrum is crucial in achieving the objectives of 'Digital India'.

- b) The 700 MHz band is being used worldwide for deployment of 4G and evolution of 5G services due to its excellent propagation characteristics and therefore it is one of the most sought after bands for deployment of LTE.
- c) TRAI has also recognized the vibrant, ever growing ecosystem that uses 700 MHz for new generation telecom services globally and has advocated auctioning the entire 35 MHz spectrum, so as to emulate the success of APT700 (FDD) plan in India as was employed in more than 50 countries.

1.20 In view of the above, DoT through its letter dated 2nd November 2018, commented that as LTE based enhancements are available in 450 MHz - up to 6 GHz, as mentioned in ITU-R Report (Rep. ITU-R M.2418) on “Description of RSTT” and also, NFAP makes a provision for considering requirements of IMT applications in 450-470 MHz; possibility of deployment of LTE based network of IR may be explored in other frequency bands (e.g. 450-470 MHz etc.).

1.21 In response, Ministry of Railways mentioned that RSTT deployments in 450-470 MHz band has the following challenges:

- a) Limited ecosystem, no handheld devices available and functionality like Push-To-Talk (PTT) is not available which is must for critical communication services, very limited market and very small number of commercial networks on LTE in this band.
- b) Bandwidth limitation may limit the possibility of mobile broadband capacity and limit the use case like video surveillance and on-board broadband services, Radio Network Redundancy is not possible to implement as it requires minimum 10 MHz to implement redundancy to ensure zero point of failure.

- c) Requirement of 5 MHz guard band between uplink and downlink.
- 1.22 DoT is of the view that in 450-470 MHz band, TDD plan is available which would not require guard band between uplink and downlink as required in FDD plan. Further, 450-470 MHz band has a contiguous 20 MHz bandwidth available as against IR's requirement of 15 MHz. Accordingly, DoT viewed that possibility of deployment of LTE based network of IR may be explored in 450-470 MHz band.
- 1.23 DoT has further viewed that Resolution 236 (World Radiocommunication Conference (WRC)-15) invites WRC-19, based on the results of ITU-R studies, to take necessary actions, as appropriate, to facilitate global or regional harmonized frequency bands, to the extent possible, for the implementation of Railway Radiocommunication Systems between Train and Trackside (RSTT), within existing mobile service allocations. This agenda item (AI 1.11) would be addressed in WRC-19 to be held this year. Based on the ITU-R studies, detailed characteristics, implementations of current and planned RSTT and spectrum needs of RSTT would be finalized. Also, possible harmonization of frequency ranges for RSTT on global or regional basis would be done. This would ensure availability of radio systems operating in globally or regionally harmonized frequency ranges which may lead to economies of scale. Accordingly, DoT viewed that it would be prudent to take decision on proposal of spectrum assignment to the Indian Railways based on the outcomes of WRC-19 to be held in November-2019.

b. Scarcity of spectrum in 700 MHz band for commercial telecom networks

- 1.24 DoT commented that in case the request of Indian Railways for allotment of 15 MHz spectrum is considered, only 20 MHz spectrum in 700 MHz band will be left for IMT services for the Access network. This may not be

sufficient for 4G/5G services considering that 3 to 4 service providers will be providing services in each service area. Reserving 15 MHz spectrum in 700 MHz band for Indian Railways may limit the supply of the spectrum and hamper the growth plans of the Telecom operators. Further, frequency bands below 700 MHz band are not presently available for allotment for IMT services in India. Therefore, 700 MHz band is the prime band for providing better coverage in rural areas.

- 1.25 In response, Ministry of Railways mentioned that critical requirement of IR is of 10 MHz, reserving 10 MHz for IR will leave 25 MHz for allotment to IMT services in India. Better rural coverage is possible even in lower frequency bands like 600 MHz, 450-470 MHz.
- 1.26 DoT has viewed that 700 MHz band is the lowest frequency band in which Access spectrum may be assigned to commercial Telecom Service Providers in India. Accordingly, spectrum in this band was put to auction in October 2016 and will again be offered for bidding in the upcoming auction. Reserving 15 MHz spectrum in 700 MHz band for Indian Railways may limit the supply of the spectrum that potentially would hike up the price of this crucial spectrum and could jeopardise the growth plans of the Telecom operators. Accordingly, spectrum in frequency bands other than 700 MHz band (e.g. 450-470 MHz) may be explored for meeting requirements of Indian Railways.

c. Requirement of Indian Railways along the track only, not complete geographical coverage

- 1.27 DoT commented that LTE based communication is proposed to be used along the Rail tracks laid by IR for which 15 MHz of 700 MHz spectrum has been demanded from DoT. If this quantum of spectrum is reserved for Railways network, the same spectrum cannot be reused by Telecom operators in respective service areas. This is because potential

interference prevents sharing of the same spectrum between Railways for covering the railway tracks and Telecom operators in their licensed service area.

- 1.28 In response to the above, Ministry of Railways submitted that the contention of potential interference between railway communication network and Telecom operators' network is not appropriate due to guard band between various frequencies deployed in the network.
- 1.29 In this context, DoT has mentioned that Indian Railways requires its network to be deployed along the track only. Current assignments to Indian Railways' GSM-R network in 900 MHz band are also in use along the track only. However, considering potential interference between railway communication network and Telecom operators' network, frequency carriers assigned to Indian Railways' network along the track in 900 MHz band are not assigned for commercial telecom networks.
- 1.30 DoT has further mentioned that in 450-470 MHz band, contiguous 20 MHz bandwidth in TDD plan is available for exploitation by Indian Railways. Also, this spectrum in 450-470 MHz band has not yet been planned for assignment to commercial telecom operators through auction. Accordingly, DoT is of the view that possibility of assignment of spectrum to Indian Railways in 450-470 MHz band may be explored.

d. Legality in administrative allotment of spectrum for Indian Railways in light of Hon'ble Supreme Court judgment dated 2nd February 2012 in 2G case

- 1.31 DoT vide comments provided on 2nd November 2018, had mentioned that a policy decision is also required to be taken as to whether spectrum can be assigned to Indian Railways administratively in light of the judgment dated 2nd February 2012 of Hon'ble Supreme Court in Writ Petition (Civil) No. 423 of 2010 (2G case). Accordingly, DoT commented that views of

Department of Legal Affairs, Ministry of Law and Justice, may be taken regarding administrative allotment of spectrum for Indian Railways.

- 1.32 In response to this, Ministry of Railways has mentioned that Ministry of Law and Justice has supported the request of Indian Railways and have provided favourable comments on the Draft Cabinet Note circulated by Ministry of Railways in this regard.

e. Pricing of Spectrum in 700 MHz band

- 1.33 DoT vide comments provided on 2nd November 2018, had mentioned that spectrum in 700 MHz band is a valuable spectrum as the reserve price provided by TRAI in their recommendations dated 1st August 2018 on pan-India basis comes out to be Rs. 98,520 crore for 15 MHz (paired) spectrum.
- 1.34 In response to this, Ministry of Railways has mentioned that Ministry of Finance has supported the request of Indian Railways for allotment of spectrum free of cost and have provided favourable comments on the Draft Cabinet Note circulated by Ministry of Railways in this regard.
- 1.35 DoT has viewed that Indian Railways has sought 15 MHz (10 MHz for the time being) in 700 MHz band free of cost for enhancing safety, security and passenger amenities for unlimited period whereas the spectrum has, at current TRAI recommendations Reserve Price, the potential to fetch about Rs. 1 Lakh crore as upfront for only 20 years. During all these 20 years, it would also fetch few Thousand crore of rupees in the form of Spectrum Usage Charges (SUC) accruable quarterly. 450-470 MHz band, on the other hand, has no demand from the Industry and service providers at present. Further, instead of 15 MHz spectrum as requested by Indian Railways, 450-470 MHz band has a total of 20 MHz spectrum for exploitation.

1.36 DoT also mentioned that Indian Railways has been assigned 1.6 MHz (paired) spectrum in 900 MHz band for their existing GSM-R based Public Safety and Security network for which no upfront payment towards assignment of spectrum has been paid. However, spectrum charges, on formula basis are payable annually by Indian Railways for their existing radiocommunication networks, including GSM-R based network.

D. Reference Received from DoT

1.37 The Department of Telecommunications (DoT), through its letter No. L-14001/01/2019-NTG dated 27th February 2019 (**Annexure-I**), informed that Ministry of Railways had proposed to install an Ultra-high-speed LTE based communication corridor along their network for Train-Ground and Train-Train communication. Ministry of Railways had also requested DoT to reserve 15 MHz of spectrum in 700 MHz band for this purpose and to begin with 10 MHz to be allocated free of cost as this proposal is devoid of any commercial gain, but only enhancing security and passenger amenities. After examining the Draft cabinet note circulated by Ministry of Railways in this regard, DoT provided its comments on 2nd November 2018. Later, Ministry of Railways vide their letter dated 17th January 2019, while furnishing its response to DoT's comments, informed that that the Ministry of Finance and Ministry of Law & justice, apart from many other Ministries have supported the Railways demand of 10 MHz spectrum in 700 MHz band free of cost and also requested that the issue may be reconsidered favourably. The request of Indian Railways was considered in the Digital Communications Commissions (DCC) and it was decided that the matter may be referred to TRAI. In this view, DoT requested TRAI to provide recommendations on administrative allotment of spectrum to Indian Railways and the quantum, price, appropriate frequency band (including 450-470 MHz band) and any other related

issue, under the terms of clause 11(1)(a) of TRAI Act, 1997 as amended by TRAI Amendment Act, 2000.

- 1.38 As the information given in its reference dated 27th February 2019 was not sufficient, the Authority vide its letter dated 19th March 2019 had sought additional information on some of the issues from DoT. Through its letter dated 10th May 2019 (**Annexure-II**), DoT provided the information sought by the Authority.
- 1.39 In view of the above, this consultation paper has been prepared to discuss the issues involved. This chapter provides background information. Chapter-II provides information on Railway Radiocommunication Systems between Train and Trackside (RSTT), Chapter-III provides the International practice, Chapter-IV examines the request of Ministry of Railways and discusses the issues involved and Chapter V summarizes the issues for consultation.

CHAPTER- II: RAILWAY RADIOCOMMUNICATION SYSTEMS BETWEEN TRAIN AND TRACKSIDE (RSTT)

2.1 Railway Radiocommunication Systems between Train and Trackside (RSTT) provide improved railway traffic control, passenger safety and improved security for train operations. It carries train control, voice dispatching, command, operational information as well as monitoring data between on-board radio equipment and related radio infrastructure located along trackside. Radiocommunication networks supporting RSTT are critical for train operations and have stringent requirements for reliability, availability, safety and security.

A. Generic Architecture of RSTT

2.2 The main elements¹ of the RSTT may consist of on-board radio equipment, radio access units and other trackside radio infrastructure. Other systems, such as the core network, fiber loop etc., are supporting systems for the RSTT.

- Radio Access Unit: including antenna and base station, aiming to provide radio access to the terminals (especially cab radio).
- On board radio equipment: Radio equipment installed on train as well as handsets. For example, mobile terminals of automatic train control (ATC).
- Other trackside radio infrastructure: Radio infrastructure operating along trackside. For example: shunting radio devices.

¹ http://www.apr.int/sites/default/files/Upload-files/AWG/APR-AWG-REP-78_APR_Report_RSTT_System_Description.docx

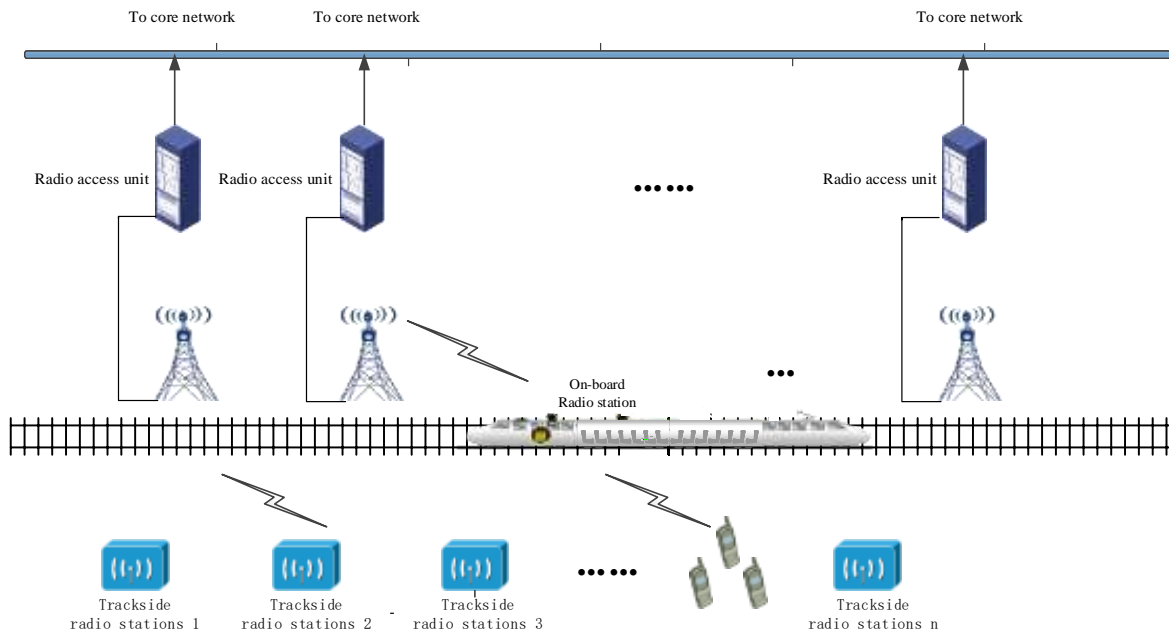


Figure 2.1: Diagram of the architecture of RSTT (Source: APT)

B. Various communications under RSTT

2.3 In general, the main application² of RSTT can be categorized into four types, including train radio, train positioning, train remote and train surveillance.

- Train radio: Train radio provides mobile interconnect to landline and mobile-to-mobile voice communication and serves as the data transmission channel within various bearer services (Maintenance, Emergency, Train Control (Movement Authorization), Train information (both to train operators & Passengers). For voice communication Train radio provides call functions (point-to-point / group / emergency / conference/ broadcast) with specialized modes of operation (e.g. location depending addressing, functional addressing, call priorities, Push-to-Talk, late-entry, and pre-emption).

² https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2418-2017-PDF-E.pdf

- Train positioning information: It provides high precision information about the position of trains, location of all units on trackside, motion parameter (speed, distance) of the approaching rolling stock and any obstacle on the tracks in normal and high-speed operation. This information is obtained by detection systems such as Balises, Loops/Leaky cable, Annunciators, Radars, Axle counters. The relevant positioning information can be repeated also by other means, e.g. train radio.
- Train surveillance: Train surveillance systems enable the capture and transmission of video of the public and trackside areas, driver cabs, passenger compartments, platforms and device monitoring. A set of cameras at specific locations (front, interior, rear view) is used in low to high resolution, low and high framerates depending on the event. Data may be either stored on-board/locally or streamed (e.g. real-time video) to control centres via dedicated radio communication system.
- Train remote: This application provides data communication between a locomotive and a ground-based system in order to control the engine. It enables remote controlled movement of trains typically for shunting operation in depots, shunting yards.

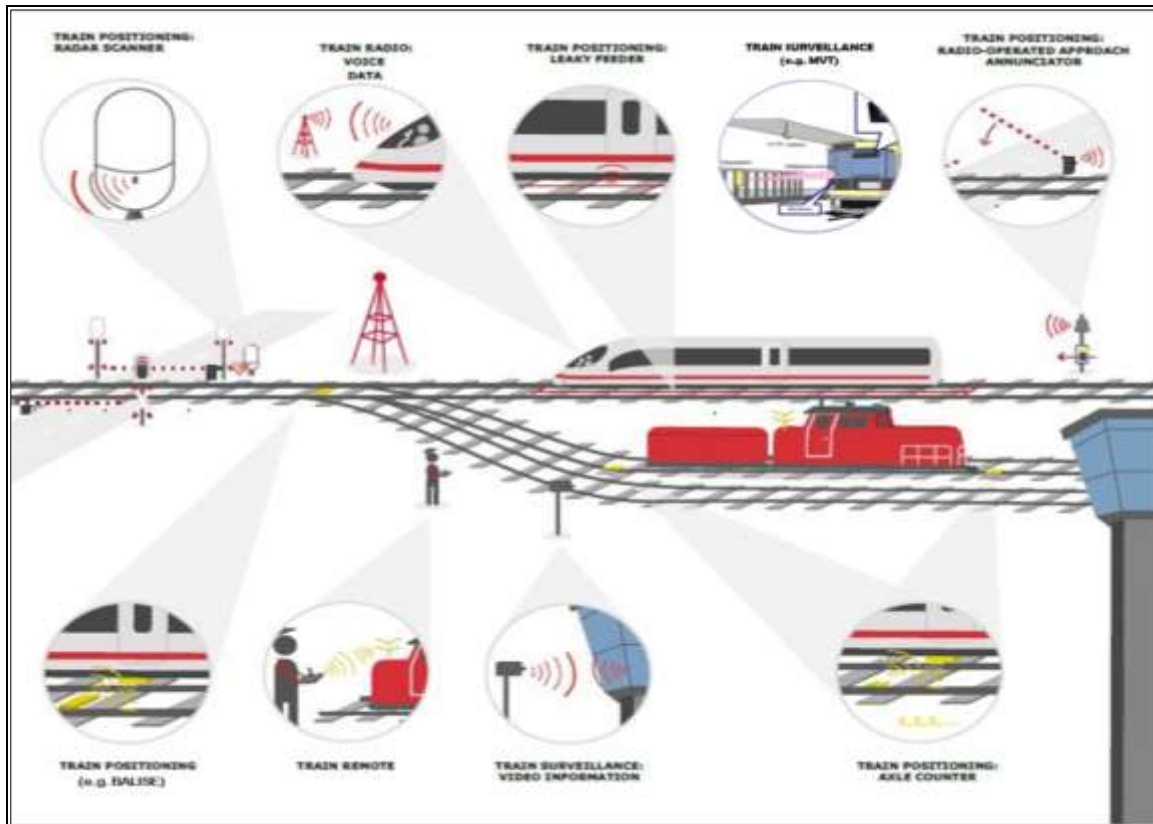


Figure 2.2: RSTT Services (Source: ITU)

C. Reports of ITU on RSTT

2.4 Resolution 236 (WRC-15)³ recognized that timely studies are required on technologies providing for railway radiocommunication and that international standards and harmonized spectrum would facilitate worldwide deployment of RSTT. Further, it invited ITU Radiocommunication Sector (ITU-R) to study the spectrum needs, technical and operational characteristics and implementation of RSTT. Consequently, ITU-R Study Group 5 is studying relevant technical and operational characteristics for railway radiocommunication systems.

³ https://www.itu.int/dms_pub/itu-r/oth/0c/0a/ROCOA00000C0012PDFE.pdf

- 2.5 Report ITU-R M.2418-0 (11/2017)⁴ addresses the architecture, applications, technologies and operational scenarios of RSTT for all types of trains (e.g. high-speed trains, passenger trains, freight trains, and metro trains). It also provides some elements for studies in preparation of WRC-19 agenda item 1.11, in response to Resolution 236 (WRC-15). Report ITU-R M.2442-0 (11/2018)⁵ addresses the technical & operational characteristics and the spectrum usage of current and planned RSTT.
- 2.6 From the above information, it can be derived that the work on RSTT is under progress in ITU-R. The standardization process and spectrum identification are expected to be completed after WRC-19.
- 2.7 Ongoing study within Working Party 5A is the working document towards a preliminary draft new Recommendation⁶ ITU-R M.[RSTT_FRQ] “Harmonization of frequency bands for railway radiocommunication systems between train and trackside”. As highlighted in the working document, frequency ranges in Table 2.1 are under consideration in ITU-R for a possible regional/global spectrum harmonization for RSTT.

⁴ https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2418-2017-PDF-E.pdf

⁵ https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2442-2019-PDF-E.pdf

⁶ <https://www.itu.int/md/R15-WP5A-C-1065/en>

Table 2.1: Frequency ranges under consideration in ITU for a possible regional/global spectrum harmonization for RSTT proposed from within regional groups

	Region 1		Region 2	Region 3	Global
	Frequency ranges considered for harmonization by Regional group	Harmonized Frequency ranges for Region 1	Frequency ranges considered for harmonization by Regional group	Frequency ranges considered for harmonization by Regional group	Frequency ranges considered for harmonization by Regional group
Train Radio	ATU: 138-170 MHz, 406.1-430 MHz, 440-470 MHz;873-880 MHz / 918-925 MHz	876-880 MHz / 921-925 MHz	See Note 2	138-174 MHz, 335.4-470 MHz, 703-748 MHz, 758-803 MHz, 873-915 MHz, 918-960 MHz, 1 770-1 880 MHz, 43.5-45.5 GHz and 92-109.5 GHz	APT: 138-174 MHz, 335.4-470 MHz, 873-915 MHz, and 918-960 MHz
	ASMG: 876-880 MHz/921-925 MHz				
	For CEPT: 876-880 MHz / 921-925 MHz				
	RCC: 138-174 MHz; 406.2-430 MHz /440-470 MHz; 876-880 MHz / 921-925 MHz				
Train Positioning	CEPT: 0.984 - 7.484 MHz 27.09 - 27.10 MHz	See Note 1	See Note 2	See Note 1	See Note 1
Train Remote	RCC: 138-174 MHz; 406.2-430 MHz /440-470 MHz; 876-880 MHz / 921-925 MHz	See Note 1	See Note 2	See Note 1	See Note 1
Train Surveillance	See Note 1	See Note 1	See Note 2	See Note 1	See Note 1

Note 1: No Frequency ranges for this RSTT application are harmonized at this time.

Note 2: Region 2 does not have any harmonized frequency bands identified for RSTT at this time.

D. Development of Global Standards for RSTT

2.8 No global standards are presently available for LTE based RSTT systems. 3GPP⁷ is working to develop standards for the Future Railway Mobile Communication System (FRMCS). In Release 16, 3GPP TS 22.289 will specify new service requirements for the Mobile Communication Systems for Railways, beyond the Phase 1 specs:

- 3GPP TS 22.280: Mission Critical Services Common Requirements (MCCoRe)
- 3GPP TS 22.179: Mission Critical Push to Talk (MCPTT); Stage 1
- 3GPP TS 22.281: Mission Critical Video services
- 3GPP TS 22.282: Mission Critical Data services

E. European Railway Traffic Management System (ERTMS)

2.9 European Railway Traffic Management System (ERTMS)⁸ was developed by European signaling suppliers (UNISIG), European Railways and the GSM-R industry acting together under the guidance of the European Commission. It comprises of European Train Control System (ETCS) for signaling, control and train protection & Global System for Mobile Communications – Railways (GSM-R) for voice and data communication between the track and the train.

2.10 ETCS⁹ aims to standardize the signaling and train control systems and remove the hindrance to the development of international rail traffic. It specifies for compliance with the High Speed and Conventional Interoperability Directives. It provides an inherently safe operational environment for the movement of trains throughout the network, while facilitating a greater network carrying capacity. It does this through the real-time monitoring, capture and analysis of data relating to movement authorities, precise train location, train speed, braking curves and system integrity. Based upon the analysis of this data,

⁷ https://www.3gpp.org/news-events/partners-news/1964-frmcs_r16

⁸ <http://irse.org.hk/eNewsletter/issue06/Technical-Articles/ETCS/ETCS.htm>

⁹ <https://www.rssb.co.uk/rgs/standards/GEEN8605%20Iss%201.pdf>

appropriate control orders are issued so that rail traffic operates with the shortest, most efficient, but safest headways.

2.11 ETCS offers five functional levels¹⁰ - Level 0, Level STM, Level 1, Level 2, Level 3. The definition of the level depends on how the route is equipped and the way in which information is transmitted to the train.

- Level 0 is meant for trains equipped with ETCS running along non-equipped lines.
- Level STM, is meant for trains equipped with ETCS running on lines where the class B system needs to be operated. Regarding the STM level, the ETCS acts as an interface between the driver and the national ATP.
- Level 1 involves continuous supervision of train movement while a non-continuous communication between train and trackside (normally by means of Euro-balises). Lineside signals are necessary and train detection is performed by the trackside equipment.
- Level 2 involves continuous supervision of train movement with continuous communication, which is provided by GSM-R, between both the train and trackside. Lineside signals are optional in this case, and train detection is performed by the trackside equipment.
- Level 3 is also a signaling system that provides continuous train supervision with continuous communication between the train and trackside. The main difference with level 2 is that the train location and integrity is managed within the scope of the ERTMS system, i.e. there is no need for lineside signals or train detection systems on the trackside other than Euro-balises. Train integrity is supervised by the train, i.e. the train supervises itself to ensure that no coach is accidentally split.

¹⁰ https://ec.europa.eu/transport/modes/rail/ertms/what-is-ertms/levels_and_modes_en

F. Train Radio Technologies

2.12 The railway industry has been using wireless systems¹¹ for operational applications for many years. Many long distance and high-speed trains deploy GSM-R and TETRA (another European Standard) networks both for operational voice communications between train drivers and train controllers as well as to carry train signaling and control information. To enhance the Railway Radiocommunication System with broadband capabilities in order to get a greater degree of graphical, and real-time audio-visual functions, along with extensive real-time train monitoring and control, the next generation of Train Radio technology based on LTE is being developed.

TETRA

2.13 Terrestrial Trunked Radio (TETRA) is a professional land mobile radio standard specifically designed for use by government agencies, emergency services, public safety networks, rail transport, transport services and the military. It is a European Telecommunications Standards Institute (ETSI) standard. It uses Time Division Multiple Access (TDMA) with PI/4 QPSK modulation with four user channels on one radio carrier and 25 kHz channel raster. Both point-to-point and point-to-multipoint transfer can be used. TETRA mobile stations can communicate direct-mode operation (DMO) or using trunked-mode operation (TMO). In addition to voice and dispatch services, the TETRA system supports several types of data communication. Status messages and short data services (SDS) are provided over the system's main control channel, while packet-switched data or circuit-switched data communication uses specifically assigned channels. TETRA provides for authentication of terminals towards infrastructure and vice versa. For protection against eavesdropping, air interface encryption and end-to-end encryption is available.

¹¹ http://www.apr.int/sites/default/files/Upload-files/AWG/APT-AWG-REP-78_APT_Report_RSTT_System_Description.docx

Table 2.2: Usage of TETRA (Source: ITU)¹²

Country	Frequency	Data Rates	Transmission distance
South Korea	806-811 851-865	36 kbps	-
Finland	380-385, 390-395, + direct mode channels	4,567/7,2 kbps	5-35 km
Thailand	380-399.9	-	-
Qatar	410-430	-	-
Vietnam	410-430	-	-
Germany	410-430, 440-443, 445-448	7.2 kbps	-
Russia	457.4-458.45 467.4-468.45	-	12 km
South Africa	410-450	-	-
Australia	450-470	-	5-40 km

GSM-R

2.14 GSM-R, Global System for Mobile Communications – Railway (Figure 2.4) is a wireless communications standard for railway communication and applications. As a sub-system of European Rail Traffic Management System (ERTMS), it is used for communication between train and the track. GSM-R is built on GSM technology, and benefits from the economies of scale of its GSM technology. GSM-R is a secure platform for voice and data communication between railway operational staff, including drivers, dispatchers, shunting team members, train engineers, and station controllers. It delivers features such as group calls (VGCS), voice broadcast (VBS), location-based connections, and call pre-emption in case of an emergency.

Table 2.3: Usage of GSM-R (Source: ITU)¹³

Country	Frequency Range	Data Rates	Transmission distance
China	885-889 / 930-934	-	-
Conference of European Postal And Telecommunication	876-880/921-925 (optional extension on	Voice: 13 CSD: 4.8	7 km

¹² https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2442-2019-PDF-E.pdf

¹³ https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2442-2019-PDF-E.pdf

Country	Frequency Range	Data Rates	Transmission distance
(CEPT)	national basis 873-876/918-921)	GPRS/EDGE: 8 to 29.6	
United Arab Emirates	876-880 / 921-925	-	5-10 km
South Africa	876-880 / 921-925	-	-
Mozambique	876-880 / 921-925	-	-
Eswatini	876-880 / 921-925	-	-
Thailand	885-890 / 930-935	-	-
Russia	876-880 / 921-925	8 × 22.8	Max 20 km
Zambia	876-880 / 921-925	-	-
Australia	1710-1880	Voice: 13 CSD: 4.8 GPRS/EDGE: 8 to 29.6	1-3 km
Mexico	876-880 / 921-925	-	-
India	907.8-909.4/952.8-954.4	-	-

LTE-R

2.15 LTE wireless communications has been picked up by many countries as the technology of choice to support mission-critical voice and broadband services for RSTT. LTE characterizes high speed, high security and high-bandwidth capacity that allows it to carry voice and data for train control, on-board video surveillance and infotainment services for passengers on a single IP network. It has latency as 10 milliseconds allowing for support of time-sensitive applications and providing quality of service management. As for GSM-R, LTE-R includes specifically designed algorithms to deliver superior Quality of Services at highest train speeds.

Table 2.4: Usage of LTE based RSTT (Source: ITU)¹⁴

Country	Radiocomm unication Standards	Specific Name	Frequency Range	Data Rates (kbps)	Transmission distance
South Korea	TTAK.KO-06.0438	LTE-R	718-728 773-783	DL: 75000 UL: 37000	-
Australia	3GPP LTE-Adv	Trans-continental NextG (ARTC)	703-803	DL (max): 75000 UL (max): 37000	10-72 km

¹⁴ https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2442-2019-PDF-E.pdf

Country	Radiocommunication Standards	Specific Name	Frequency Range	Data Rates (kbps)	Transmission distance
Australia	3GPP LTE-Adv	Urban Train Radio	1710-1880	DL (max): 34000 UL (max): 16000	10-30 km
Australia	3GPP LTE-Adv and beyond	Train Control Radio Digital Train Radio System (DTRS) ETCS Level 2 (proposed)	UL: 1770-1785 / DL: 1865-1880	DL (max): 110000 MIMO UL (max): 38000	1-5 km

G. Studies on spectrum needs of RSTT

2.16 Various studies¹⁵ have been conducted globally to estimate the amount of spectrum required for RSTT services. Some of those studies are-

(i) China's study on the spectrum needs of RSTT with respect to the train radio application

- With the consideration that a future integrated system will realize most of the main applications of RSTT, and that voice, data and messaging are implemented using mobile IP service, the study calculated the spectrum needs with respect to train radio of RSTT in China by 2020.
- During the study, the XIN FENG ZHEN area (3.2 km × 0.45 km) located in Xi'an City of China was considered.
- Since the area of XIN FENG ZHEN is 1.6 km² and the shunting yard, line, station and maintenance base are covered in this deployment scenario, so when calculating the spectrum needs of RSTT with respect to the train radio application, the simplified condition (one cell coverage) was considered.
- The spectrum efficiency parameters were based on a field test and adjusted accordingly for different speeds and environments.
- The frequency range used for the study on the spectrum need is 450 MHz band.

¹⁵ https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2442-2019-PDF-E.pdf

- Under the conditions of this study, spectrum needs of RSTT with respect to Train radio application for the year 2020 at XIN FENG ZHEN area is:
 - Minimum spectrum needs: 11.9 MHz (uplink), 4.7 MHz (downlink);
 - Maximum spectrum needs: 14.04 MHz (uplink), 8.38 MHz (downlink).
- Further, while deploying the RSTT network, more factors may need to be taken into consideration and some measures would be introduced to further improve the spectrum usage efficiency, such as multi-cell layout in some of the deployment scenarios of RSTT.

(ii) Japan's study spectrum needs of 100 GHz RSTT which supports Condition Based Maintenance (CBM) with high resolution CCTVs

- The information volume (the amount of data received during 1 km distance travelled by the train) is estimated to be in between 1 GB/km and 5 GB/km in this scenario.
- If the train speed is 600 km/h, the time of 6 seconds is required to move 1km. In order to transmit an information volume of 5 GB within 6s, an aggregate data rate of 14 Gbit/s is needed.
- The 100 GHz RSTT system has 17 channels (1 channel = 400 MHz) for both up and down links, and an aggregate data rate of 14 Gbit/s can be achieved using 16QAM modulation.
- Based on this consideration, the spectrum of 13.6 GHz is required for future RSTT systems.

CHAPTER- III: INTERNATIONAL PRACTICE

- 3.1 RSTT applications, especially Train Radio applications, are mostly deployed below 1 GHz. In some countries, higher frequency bands such as millimetric bands (40 GHz bands) are also used for Train Radio applications and Train Surveillance applications of RSTT. In order to meet the requirement of high-speed railway transportations and to adapt to more complex environment of railway radiocommunications, some countries are considering use of evolving technologies for RSTT and are planning for the migration. Generally, the analogue RSTT systems are likely to be replaced by digital systems for RSTT, by using technologies such as TETRA, GSM-R, Digital Mobile Radio (DMR), LTE-based, and some technologies using millimetric wave bands. Some countries are carrying out field tests to verify their technical migrations for RSTT.
- 3.2 The predicted obsolescence of GSM-R by 2030, combined with the long-term life expectancy of ETCS (2050) and the Railway business needs, have led to the European Railway community initiating work to identify a successor for GSM-R¹⁶. The successor has to be future proof, learn from past experiences / lessons and comply with Railway requirements.
- 3.3 Future Railway Mobile Communication System (FRMCS) is the future worldwide telecommunication system designed by UIC¹⁷, based on identification of railways' needs, in close cooperation with the different stakeholders from the rail sector. FRMCS is being developed not only as the successor of GSM-R but also as a key enabler for rail transport digitalisation. FRMCS will be a key driver for rail digitalisation. It will optimise infrastructure cost of ownership while improving service quality and available capacity for users, all within the context of complete interoperability.

¹⁶ https://uic.org/IMG/pdf/frmcs_user_requirements_specification_version_4.0.0.pdf

¹⁷ UIC (French: Union internationale des chemins de fer) or International Union of Railways is an international rail transport industry body

Japan¹⁸

3.4 In Japan, 100 kHz-band, 150 MHz-band, 300 MHz-band and 400 MHz-band have been allocated to the RSTT and are being used for safety and stable train operation since 1960s. The high-speed railway uses digital train radio systems for RSTT, which also provide high-speed data to the train crews and passengers. Japan has studied the 40-GHz band millimetre-wave for Train Radio applications, named Train Radio System in the 40 GHz band (TRS-40 GHz) and in the year 2018 started the construction of the system for actual use, which is expected to be completed by 2019.

3.5 Table 3.1 lists the major RSTT used in Japan.

TABLE 3.1: Major RSTT used in Japan

Name of System	Frequency	Applications and Users of the system
Train Radio System (TRS)	60 MHz band 150 MHz band 300 MHz band 400 MHz band	<i>Application</i> <ul style="list-style-type: none"> • Traffic control information for drivers • Automatic train control • Vehicle status monitoring for maintenance crews • Passenger guidance for conductors <i>Users</i> <ul style="list-style-type: none"> • Train traffic controllers • Train drivers and conductors • Automatic train control equipment • Station managers • Maintenance crews
Radiocommunication system for High Speed Train (RHST)	400 MHz band	<i>Application</i> <ul style="list-style-type: none"> • Traffic control • Automatic train control • Vehicle status monitoring, Passenger guidance, Cabin monitoring <i>Users</i> <ul style="list-style-type: none"> • Train traffic controllers • Train drivers and conductors • Automatic train control equipment • Maintenance crews

¹⁸ ITU-R Recommendations-M.2442-2019

Name of System	Frequency	Applications and Users of the system
Emergency Alarm Radio System (EARS)	300 MHz band	<p><i>Application</i></p> <ul style="list-style-type: none"> • Emergency signals from train or ground to trains to alert some dangers situations to surrounding drivers by buzzer <p><i>Users</i></p> <ul style="list-style-type: none"> • Train drivers and conductors • Train traffic controllers • Station attendants
Radiocommunication system for Emergency Cut Off System (REMCOS)	150 MHz band 300 MHz band	<p><i>Application</i></p> <ul style="list-style-type: none"> • Emergency signal from train to ground to stop trains by powering Cut Off <p><i>Users</i></p> <ul style="list-style-type: none"> • Train drivers and conductors • Train traffic controllers • Ground maintenance crews
Radiocommunication system for Electronic Blocking System (REBS)	300 MHz band	<p><i>Application</i></p> <ul style="list-style-type: none"> • Trigger signal transmission from train to ground to control block section <p><i>Users</i></p> <ul style="list-style-type: none"> • Train drivers • Ground Interlocking equipment
Radiocommunication system for Japan Radio Train Control system (JRTC Radio)	300 MHz band	<p><i>Application</i></p> <ul style="list-style-type: none"> • Automatic train control <p><i>Users</i></p> <ul style="list-style-type: none"> • Ground Train controller equipment • On-board train controller equipment
Yard Radio (YR)	150 MHz band 300 MHz band 400 MHz band	<p><i>Application</i></p> <ul style="list-style-type: none"> • Vehicle maintenance • Shunting <p><i>Users</i></p> <ul style="list-style-type: none"> • Train drivers • Ground maintenance crews
Millimetre wave Video Transmission system (MVT)	43 GHz band	<p><i>Application</i></p> <ul style="list-style-type: none"> • Platform Monitoring <p><i>Users</i></p> <ul style="list-style-type: none"> • Train drivers and conductors

Name of System	Frequency	Applications and Users of the system
Train Radio System in the 40 GHz	44 GHz band	<p><i>Application</i></p> <ul style="list-style-type: none"> • Voice/ Dispatch • Maintenance (Voice communication) • Maintenance (Data communications for maintenance services in railway infrastructure, e.g. Vehicle's Detailed Condition Data Transmission, Outside Surveillance Video Transmission etc.) • Train Information (Railway transportation information for drivers and conductors) <ul style="list-style-type: none"> – Train Information (Passenger guidance) – Cabin Video Stream Transmission <p><i>Users</i></p> <ul style="list-style-type: none"> • Train traffic controllers • Train drivers and conductors • Maintenance crews • Passengers

3.6 Table 3.2 shows details of frequency usage of RSTT used in Japan. This table also shows frequency usage of future RSTT under study.

Table 3.2: Details of frequency usage of RSTT used in Japan

Frequency bands	Systems
340-360 MHz	Train Radio System, JRTC radio, Radiocommunication system for Emergency Cut-Off system, Yard Radio
360-370 MHz	Radiocommunication system for Emergency Cut-Off system, Yard Radio
370-380 MHz	Emergency Alarm Radio System, Yard Radio
380-387 MHz, 387-390 MHz, 390-399.9 MHz	Yard Radio
410-420 MHz	Radiocommunication system for High Speed Train,
414.4-415.5 MHz	Train Radio System
450-462 MHz	Radiocommunication system for High Speed Train
455-456 MHz, 456-459 MHz, 459-460 MHz, 460-470 MHz	Yard Radio
43.5-45.5 GHz	Millimetre wave Video Transmission system, Train Radio System in the 40 GHz
92-94 GHz, 94.1-100 GHz, 102-109.5 GHz	Future radio communication system for high speed trains (under study)

Korea

- 3.7 Korean railway uses 150 MHz, 400 MHz, 700 MHz, 800 MHz and 18 GHz band for RSTT that carries train control, command, operational information as well as monitoring data between on-board radio equipment and related radio infrastructure located along trackside. Very High Frequency (VHF) system using 150 MHz band supports only voice calls between control centre/base station and a train crew or inter-mobile station radiocommunication. Train Radio Protection Device (TRPD) system is used to alert some dangerous situations to trains within about 4 km range through emergency signals at the 400 MHz band.
- 3.8 LTE-R system of Korea provides various RSTT functions using LTE based wireless communication operated at the 700 MHz band. Korea is using two Trunked Radio Systems (TRS) schemes, i.e. TRS-ASTRO and TRS-TETRA. These systems are operated at the 800 MHz band for transferring operational information between train and control centre. The government has a plan to replace these TRS systems to LTE-R systems.
- 3.9 In addition, CCTV video systems are used to monitor the platform situations. The system transmits these cameras' video stream to driver's room using a wireless communication operated at the 18 GHz band. Train positioning system is based on Balise operating at the 4.234 MHz and the 27.095 MHz.
- 3.10 Table 3.3 is the list of RSTTs used in Korea.

Table 3.3: RSTT used in Korea

	Name of the Systems	Frequency bands in use
1	LTE-R	718-728 MHz (uplink), 773-783 MHz (downlink)
2	VHF	153 MHz
3	TRS	ASTRO: 806-811 MHz (uplink), 851-856 MHz (downlink) TETRA: 806-811 MHz (uplink), 851-856 MHz (downlink)
4	TRPD	433.3125 MHz
5	Video for Platform	18.86-18.92 GHz, 19.20-19.26 GHz
6	Balise	3.951-4.516 MHz, 27.09-27.10 MHz

Russia

- 3.11 Radiocommunication systems are widely used in railway transportation in Russia. The systems provide for railway traffic management and control, and railway transportation safety. The systems also provide train crews, conductors and passengers with services associated with different information exchange. State Radiofrequency Commission Decisions allotted different HF (2.124 - 2.136 MHz / 2.144 - 2.156 MHz), VHF (146 -174 MHz; 155.075 - 155.275 MHz) and UHF (457.40 - 458.45 MHz; 467.40-468.45 MHz) bands for operation of these systems.
- 3.12 It is planned to migrate a number of VHF-band analog radiocommunication networks to work with the DMR, GSM-R and LTE-standard radio interface.
- 3.13 Additionally, in Russia, a radar system "PRISMA-K" operating in the SHF Band, range 76 GHz (76.35-76.65 MHz) is beginning to be used for measuring range and speed of moving objects. In this system, Radar operating in the range 76 GHz is installed at the stationary obstacles on the railway track (e.g. track focus stalled on railroad tracks). This radar measures the motion parameters of the approaching rolling stock (speed, distance) and transmits that data into a comprehensive system of safety on the dead-end paths, passenger stations for high-speed, passenger, suburban trains and shunting "PRISMA-K".

Australia

- 3.14 Australia's Rail industry is the sixth largest network in the world, moving more than 850 million people per year and 1.4 billion tonnes of freight. The rail entities in Australia still utilise the legacy bands and systems for communication. The Rail industry's telecommunications networks in Australia rely heavily on radio spectrum within the 400 MHz band and increasingly 1800 MHz band. Use of radio systems operating in this radiofrequency band are the basis for harmonisation

and interoperability of mobile communications systems used for safety and operational purposes across all facets of the Rail industry.

3.15 In broad terms, the 400 MHz spectrum is required to support existing infrastructure and is primarily used for voice and long-distance communications. The 1800 MHz spectrum is required for new train control broadband systems. Together, 400 MHz and 1800 MHz spectrum are used¹⁹ for Track maintenance safety, Train control, Prevention of derailments, Emergency response and safety critical train radio communications, Signalling, Automatic train protection/braking, Security, Passenger safety through on-train help points, Train speed control and Shunting.

3.16 Train control radio and maintenance radio in South east Queensland is currently migrating to Tier 3 DMR. The details of frequency bands and their applications are as per the table 3.4²⁰ below:

Table 3.4: Details of frequency bands and their applications

Frequency band	Main railway application	Signal characteristics	Other comments
70-88 MHz	Train radio, shunting, maintenance	6.25/12.5 kHz FM channels	Mainly voice and low-rate FSK data
148-174 MHz	Train radio, shunting, maintenance	6.25/12.5 kHz FM channels	Mainly voice and low-rate FSK data
403-420 MHz	Train radio, shunting, maintenance	6.25/12.5 kHz FM channels	Mainly voice and low-rate FSK data
450-520 MHz	Train radio, shunting, maintenance	6.25/12.5 kHz FM channels	Mainly voice and low-rate FSK data
703-803 MHz	Train radio, train monitoring, location tracking, MB signaling	3GPP LTE Rel.14	Voice and broadband data

¹⁹ Australian Railway Association : RSTT Spectrum in Australia - 2018 available at <https://ara.net.au/sites/default/files/ARA%20RSTT%20Spectrum%20in%20Australia%20%20-%202018%20Submission%20final%20.pdf>

²⁰ Annex 4 to ITU-R - Working Party 5A Chairman's Report dated 10th May 2019

Frequency band	Main railway application	Signal characteristics	Other comments
803-960 MHz	Train radio, shunting, maintenance	Digital trunked systems	Voice and medium-rate data
1710-1880 MHz	Train radio, train monitoring, location tracking, passenger intercom	3GPP LTE Rel.14	Voice and broadband data

China

- 3.17 Chinese railway radiocommunication technology has witnessed rapid development since 1950s, especially in the 450 MHz wireless train dispatching system and 900 MHz GSM-R system. These systems have been implemented into the whole Chinese railway network, which is of great importance for the safety of railway transportation. In addition, balises are widely deployed at railway lines, stations, maintenance bases and shunting yards.
- 3.18 The existing 450 MHz (457.200-458.650 MHz and 467.200-468.650 MHz) wireless train dispatching system, which is being used for voice communication and dispatching order transmission, might be gradually replaced by advanced technologies in China, for instance the GSM-R or other next generation railway radiocommunication technologies. As of 2017, 450 MHz system has been deployed over 80000 Km lines in China.
- 3.19 Digital radio in 400 MHz (403-423.5 MHz) is also used in China for train radio applications of RSTT. Typical scenarios of this system include railway line, railway station, shunting yard and Maintenance Base.
- 3.20 Further, 900 MHz (885~889 MHz (uplink) and 930~934 MHz (downlink)) GSM-R system has also been implemented in all new lines from 2006, since the first deployment of GSM-R system in the Qinghai-Tibet Railway. As of 2017, GSM-R has been implemented over 43000 Km lines in China, including part of existing regular lines and all high-

speed lines. In China, GSM-R system provides voice service and data service for railway transportation.

- 3.21 In China, balises are used to notify the exact location a train, in Chinese Train Control System (CTCS) -3 system for high speed railway. The RF characteristics of Balise are

Channel 1: 27.095 MHz

Channel 2: 3.951 MHz

Channel 3: 4.516 MHz

- 3.22 The Chinese Train Control System (CTCS), levels 2 and 3, has been optimised and developed in recent years and is the backbone of China's high-speed rail network. Level 2 is mainly used on 200-250km/h lines, while Level 3 is mainly applied to lines with a maximum of 250km/h or above²¹.

- 3.23 All CTCS levels are continuous data transmission control systems, which can effectively improve the safety and operational efficiency of the train control system. Level 2 uses track circuits to provide continuous movement authority, while Level 3 uses GSM-R to provide continuous movement authority through a Radio Block Centre (RBC) and train-trackside bi-directional information transmission.

- 3.24 Fallback systems are available for CTCS levels 2 and 3. Level 2 system adopts Level 0 as the fallback, while Level 3 system adopts Level 2. The transition between levels 3 and 2 and their respective fallback systems can be achieved automatically during train operation, and there is no need to stop the train.

- 3.25 China's high-speed rail network has achieved full interoperability. This means that trains can switch between lines equipped with Level 3 and Level 2 without stopping. Onboard interoperability of different platforms has also been achieved, so that trains equipped with

²¹ International Railway Journal dated July 16, 2018; available at following link https://www.railjournal.com/in_depth/chinas-next-generation-signalling-system-targets-automatic-operation

different ATP platforms can operate flexibly on the lines with different RBC platforms.

- 3.26 Automatic Train Operation (ATO), is the future of the high-speed network. ATO is the general class of train protection systems for the railways wherein the speed control mechanism works in response to the external inputs. ATO can increase capacity, reduce power consumption and the workload for train drivers. A Level 2+ATO system was put into operation on March 2016 on the Guangdong inter-city railway with a maximum operating speed of 200km/h. CTCS Level 3+ATO will be operational on the new Beijing – Zhangjiakou high-speed line in time for the Beijing Winter Olympics in 2022.
- 3.27 An Artificial Intelligence -based high-speed train control system has also been developed, which has several functions including intelligent dynamic dispatching, intelligent coordinated control, intelligent transfer dispatching, and intelligent failure diagnosis. The system optimises train dispatching across the entire network, improves emergency decision making and response, and improves operating efficiency and passenger satisfaction.

Thailand

- 3.28 The frequency bands 885-890 / 930-935 MHz have been allocated to support the planned introduction of GSM-R system. The pair of five-megahertz blocks on the 800MHz spectrum will be used to provide an internal wireless communication network system for the Thai-Chinese high-speed railway project. Thailand has reserved the frequency bands 419.375-420 / 429.375-430 MHz for future usage of RSTT.
- 3.29 The national telecom regulator, National Broadcasting and Telecommunications Commission (NBTC) has also allocated the 380-400MHz spectrum to the Transport Ministry for use in the trunked radio system of the subway operating system.

The Netherlands

3.30 GSM-R: Future spectrum options for GSM-R to consider are: Extension of the UIC band width:

UL: 873-876 MHz; DL: 918-921 MHz;

UL: 698-703 MHz, DL: 753-758 MHz and/or

UL: 733-736 MHz, DL: 788-791 MHz

3.31 The GSM-R system is planned to be replaced when it has reached “end of life” around 2030. The successor of GSM-R is unknown at the moment and is currently defined by the FRMCS (Future Radio Mobile Communications System) program under the UIC.

3.32 The number of microwaves in the GSM-R network are to be reduced and replaced with fixed fibre connections. The number of Euro-balises will grow significantly the coming years when ERTMS is further deployed in the Netherlands. The Marine VHF Radio is used for a small number of bridges. Replacement to other technologies is not foreseen.

3.33 Autonomous vehicle technology for rail is already being planned on routes around the world. Fully autonomous, heavy-haul, long-distance trains for transporting goods are being developed and, in the Netherlands, it has been announced that trials for automated operating freight trains are being planned.

CHAPTER- IV: EXAMINATION OF REQUEST OF MINISTRY OF RAILWAYS

A. Need to upgrade from GSM-R

- 4.1 At present, IR is using GSM-R based networks similar to various Railway networks deployed around the world. In India, 1.6 MHz (paired) spectrum in 900 MHz band has been assigned to Indian Railways for deployment of its GSM-R based network.
- 4.2 As approximately 2.2 Crore passengers use trains daily, their Safety and Security is of paramount concern and priority for IR. Further, due to ever increasing demands for introduction of more trains and stoppages from different parts of the country coupled with IR's limited fixed infrastructure and rolling stock availability, there is need to ramp up the speed and throughput of trains by upgrading carrying and handling capacity of the existing IR networks.
- 4.3 In the last decade, public networks have evolved from voice-centric second-generation systems, e.g., Global System for Mobile Communications (GSM) with limited capabilities, to fourth-generation (4G) broad-band systems that offer higher data rates, e.g., long-term evolution (LTE). The GSM communications systems are being decommissioned as the public communication market is evolving toward the Third Generation Partnership Project (3GPP) LTE. As a consequence, GSM-R also has a foreseeable end to its lifetime. It is thus relevant to replace the current GSM-R technology with the next-generation railway-dedicated communication system providing improved capacity and capability.
- 4.4 There has always been a demand for increase in speed of trains. A new system is required to fulfill High Speed Rails (HSR) operational needs, with the capability of being consistent with LTE, offering new services but still coexisting with GSM-R for a long period of time. The selection of a suitable wireless communication system for HSRs needs to consider issues such as performance, service attributes, frequency

band, and industrial support. Compared with GSM systems, LTE has a simple flat architecture, high data rate, and low latency, making it an acknowledged acceptable bearer for real-time HSR applications.

4.5 GSM-R is voice-centric second-generation systems, e.g., Global System for Mobile Communications. It has limited capacity and capability. LTE-R, which will be based on the LTE standard, is a likely candidate to replace GSM-R in the future for the following reasons.

- i) LTE has many advantages over GSM in terms of capacity and capabilities.
- ii) As a fully packet-switched-based network, LTE is better suited for data communications.
- iii) LTE offers a more efficient network architecture and thus has a reduced packet delay, which is one of the crucial requirements for providing ETCS messages.
- iv) LTE has a high throughput radio access, as it consists of a number of improvements that increase spectral efficiency, such as advanced multiplexing and modulation.
- v) LTE is also a well-established and off-the-shelf system and provides standardized interworking mechanisms with GSM.

4.6 As already discussed, use of LTE based communication corridor along the network of Railways for Train-Ground and Train-Train communication will yield many benefits, such as:

- (i) Passenger Safety & Service:
 - Advanced Signalling systems like European Train Control System (ETCS) Level 2.
 - Emergency communications from train to control, train to stations and between train to train, etc.
 - Increased carrying capacity (throughput) Advanced signaling systems allow more trains to run across a given point or segment of the track which effectively increase the carrying capacity (throughput) of the same fixed civil and electrical infrastructure.

- (ii) Live surveillance camera feeds from trains will ensure security of passengers coupled with video analytics, this can help in prevention and detection of crime, not only in Indian Railways network but also outside in the peripheral areas.
- (iii) Internal improved Railway management:
 - Staff communication system.
 - Remote monitoring of Railways asset to improve their availability.

4.7 IR envisages following applications/facilities which will fuel growth in data usage on deploying LTE technology in 700 MHz:

- i) Mission Critical Passenger Safety Services & Applications through ETCS Level 2 or similar Railway Signalling system on IR.
- ii) Video Surveillance (Live Feed) through CCTV cameras in trains along with Video Analytics for Passenger Security.
- iii) Faster data network Communication for voice, video and other related application.
- iv) More network-enabled devices (IoT based Asset reliability Monitoring).
- v) Providing Wi-Fi facility in trains.
- vi) Train and way side Telemetry through Mobile communications.

4.8 According to the information submitted by Ministry of Railways, GPRS for data communication upto 14.4 Kbps is supported by GSM-R for data transport in the same way as with the regular GSM system. IR envisages that with the proposed LTE system in 700 MHz frequency band, it will yield peak data rate of 50/10 (DL/UL) Mbps and peak spectral efficiency of 2.55 bps/Hz.

B. Other countries having plans to upgrade from GSM-R

4.9 World-over, countries are planning to shift to LTE based communication services. ITU collected information on usage of Railway Radiocommunications Systems in 2016 by way of circulating a questionnaire. The questionnaire, inter-alia, asked about plans to

migrate existing railway system. ITU published the responses²² received from 27 countries in 2017. The table 4.1 provides a summary of the relevant responses received from the countries having plans to migrate to LTE based system or upgrade their existing systems.

Table 4.1: Summary of the relevant responses to ITU Questionnaire

S.No.	Country	Response on plans to migrate existing system
1	South Korea	South Korea has already launched LTE-R using 718-728/773-783 MHz (U/D) frequencies.
2	Australia (Queensland Rail)	It has proposed to use ETCS level 2 and it is likely to be LTE based.
3	France	It is planning to migrate its GSM-R to a new technology to be defined by 2022 at EU level.
4	Japan	Is interested in the RSTT to provide the high-speed data to the train crews and passengers from the train communication network. So, Japan is studying mmWave band radiocommunication systems for railway systems to provide high-speed data to the train crews and passengers to realize more secure and comfortable railway transport services.
5	China	China is planning to migrate the system. A field test related to LTE-based next generation railway radiocommunication system is planned to be carried out in 2018 on some high-speed railway line to verify system capacity and technical characteristics for RSTT in different typical scenarios.
6	Qatar	Migration to LTE will be assessed once technology is fully standardized and matured in rail environment.
7	Spain	GSM-R will be migrated in the future to a new broadband radiocommunication system. This new system is under definition in this moment by UIC (Railways International Union) and ERA (European Railway Agency).
8	Switzerland	The successor system of GSM-R (FRMCS) will originally be operated in 7 MHz of the 873-876 / 876-880 MHz and 918-921 / 921-925 MHz band. The services of GSM-P in 2G and 3G for non-critical railway applications will be migrated by 4G/LTE in 800 MHz, 1800 MHz, 2100 MHz and 2600 MHz.
9	United Kingdom	No programme is in place to replace the existing system, although a proposal to deploy GPRS over GSM-R is under review to support European Rail Traffic Management System (ERTMS) roll-out.

²² https://www.itu.int/dms_pub/itu-r/md/.../R15-WP5A-C-0469!N17-P2!MSW-E.docx

- 4.10 In 2017, South Korea launched LTE-R for commercial use with 10 MHz (paired) spectrum. However, the assigned 10 MHz (paired) spectrum is common for integrated public network shared for Public Safety-LTE, LTE-Maritime and LTE-Railway. The State-run Korea Rail Network Authority designated KT, Korea's second largest wireless carrier for the project. To optimize interference, the concerned agencies (Ministry of Land, Infrastructure & Transport; Ministry of Interior & Safety; and Ministry of Oceans & Fisheries) have established Standard Operating Procedure (SOP). RAN Sharing takes place between integrated public networks, resource allocation rules and standard interworking procedures have been set up.
- 4.11 Further, eLTE is being used in China on the Zhengzhou Metro Line 1, where it provides wireless ground-to-train voice, data and video channels, and on Shuo Huang Railway (the freight operator in China) between the multiple locomotives (slave and driver) of the freight trains using 1800 MHz LTE TDD network, which has resulted in significant capacity augmentation of the freight line.

C. Options for migration from GSM-R

- 4.12 One of the areas of concern would be to decide the radio technology on which the new Railway Radiocommunication platform should be based. 4G Long Term Evolution (LTE) would appear the natural choice at this point. However, with 5G technologies set to become available by the 2020, it could also be another option for railways.
- 4.13 An article on "Beyond GSM-R: the future of railway radio" published in International Railway Journal, mentions "*Transport in particular is one area where 5G can play a role. And from a time perspective, the availability of the first 5G products is in line with the future generation of railway communication at around 2020-21.*"
- 4.14 In this background, the following section deliberates the issues involved.

D. Issue wise analysis

i) Spectrum Requirement

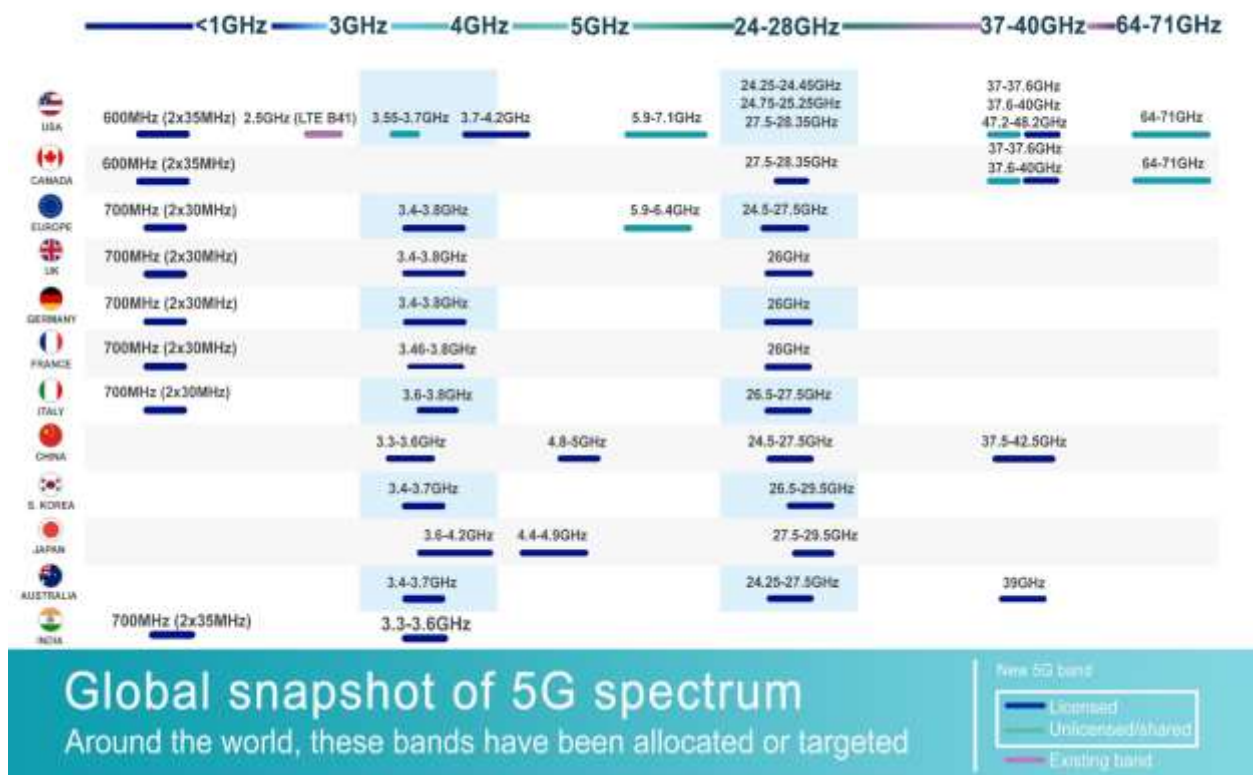
4.15 Presently, spectrum assignment for IMT services in India is being done through auction process and the spectrum sold is liberalized (technology agnostic) i.e. the service provider has the freedom to decide the technology to be deployed in the given spectrum band. With the passage of time, several spectrum bands have been earmarked for IMT services in India. Table 4.2 provides the details of these spectrum bands.

Table 4.2: Spectrum bands earmarked for IMT services in India

Band	Uplink Frequency (MHz)	Downlink Frequency (MHz)	3GPP band no.	Duplexing Scheme
700 MHz	703 -748 MHz	758-803 MHz	28	FDD
	(35 MHz has been earmarked for Access services)			
800 MHz	824-844 MHz	869-889 MHz	5	FDD
900 MHz	890-915 MHz	935-960 MHz	8	FDD
1800 MHz	1710-1785 MHz	1805-1880 MHz	3	FDD
	(55 MHz has been earmarked for Access services)			
2100 MHz	1920-1980 MHz	2110-2170 MHz	1	FDD
	(40 MHz has been earmarked for Access services)			
2300 MHz	2300-2400 MHz		40	TDD
	(80 MHz has been earmarked for Access services)			
2500 MHz	2500-2690 MHz		41	TDD
	(40 MHz has been earmarked for Access services)			
3300 -3600 MHz	3300-3600 MHz (25 MHz spectrum (3400 MHz - 3425 MHz) is identified for ISRO's use in Indian Regional Navigation Satellite System (IRNSS))		Not yet auctioned but TRAI has recommended: (i) TDD Duplexing scheme (ii) Barring the specific locations where ISRO is using the 25 MHz of spectrum, the entire spectrum from 3300 MHz to 3600 MHz should be made available for access services	

4.16 IR has requested to reserve 15 MHz (paired) in 700 MHz band and initially assign 10 MHz (paired) for LTE based communication corridor along their network for Train-ground and Train-Train Communication.

- 4.17 The 700 MHz band is being used worldwide for deployment of 4G due to its excellent propagation characteristics and therefore it is one of the most sought-after band for deployment of LTE. LTE device ecosystem is developing fast in this band.
- 4.18 Further, 5G is the latest iteration of cellular technology that will provide seamless coverage, high data rate, low latency, and highly reliable communications. It will increase energy efficiency, spectrum efficiency, network efficiency as well as efficiency of other systems. It will provide enhanced connectivity not only to the individuals but will also help in digitalizing various industrial verticals. Thus, 5G will have a much larger economic impact on a country. Among the sub-1 GHz bands, 700 MHz band is the pioneer band for 5G services.
- 4.19 The commercial deployment of 5G was earlier expected in 2020. However, the completion of the first 5G New Radio (5G NR) standard for a Non-Standalone (NSA) solution in December 2017 and for Stand Alone (SA) standard in June 2018 has set the stage for the global mobile industry to start full-scale development of 5G NR for large-scale trials and commercial deployments as early as in 2019. In several countries such as South Korea, US, UK, Spain, Poland etc., 5G has already been rolled out. The India's 5G High Level Forum envisages 5G to be deployed in India by 2020 along with the rest of the world.
- 4.20 3GPP has undertaken studies to identify suitable bands for 5G. In its Release 15, among the identified bands, 700 MHz, 3.5 GHz, 26/28 GHz are the 5G pioneer bands. The figure 4.1 shows the global snapshot of 5G Spectrum.



Source: Qualcomm

Figure 4.1 Global Snapshot of 5G Spectrum

4.21 In 5G vision, the spectrum availability is one of the most important issues. In order to realize the potential of 5G, it is crucial that enough spectrum is made available in appropriate frequency bands. Recognizing this fact, the 5G High Level Forum (5G HLF) set up by the Government, has recommended three tiers of access spectrum release for 5G based on availability and readiness-

- i. Announce Tier – here certain bands are declared as being made available for 5G rollout, providing certainty to the ecosystem. [698-803 MHz, 3300-3600 MHz, 24.25-27.5 GHz, and 27.5 – 29.5 GHz]
- ii. Identify Tier – here bands are designated for potential 5G use which can be moved to the Announce Tier after coordination with other domestic users. [617-698 MHz, 1427-1518 MHz, 29.5 to 31.3 GHz and 37.0 to 43.5 GHz]

- iii. Study Tier – here bands are designated for exploratory studies for 5G use. These bands should be considered as only of potential availability for 5G networks. [3600-3700 MHz]
- 4.22 From the above, it can be seen that the Announce Tier includes the 700 MHz. HLF has also suggested the government to announce these bands as candidate bands for 5G and allow its use for research trials. It can also be inferred that the mid band i.e. 3400-3800 MHz band, together with the 700 MHz and 26/28 GHz bands, is key for the success of 5G.
- 4.23 Low Mobility Large Cell (LMLC) reflects the needs of rural India and other similarly placed countries, where mobility is low. Indian villages are spread out, with clusters of houses and fields in between, requiring base stations which can cover a large area. Using LMLC, a single base station could serve many villages. On the standards front, DoT and Telecommunications Standards Development Society, India (TSDSI) in collaboration with the academia, have been successful in getting LMLC use case accepted in the International Mobile Telecommunications-2020 (IMT-2020) requirements. TSDSI is currently working with 3GPP to include specifications in Release 15 standard that support the LMLC use case. To actualize the LMLC use case, 700 MHz spectrum band being the lowest frequency band presently available for IMT, is the pioneer band.
- 4.24 As viewed by DoT, in 700 MHz band, only 35 MHz (paired) is available for TSPs and considering the fact that there are about four TSPs in each LSA, reserving 15 MHz spectrum in 700 MHz band for Indian Railways may limit the supply of the spectrum that potentially would hike up the price of this crucial spectrum and could jeopardise the growth plans of the Telecom operators. Considering the physical characteristics of the spectrum bands, lower frequency bands provide wider coverage and better penetration. Currently, 700 MHz band is the lowest frequency band available for allotment for IMT services in India. Therefore, 700 MHz band is the prime band for providing better coverage.

- 4.25 Further, IR would be using the spectrum along the railway track. If same frequencies are allotted to TSPs, it may cause interference issues. If the frequencies assigned to IR for entire country, it may lead to inefficient utilization of this precious spectrum band.
- 4.26 DoT has also viewed that spectrum in 450-470 MHz is available and has not been earmarked for IMT services. Some countries are using this band for Railway Radiocommunication. 20 MHz spectrum is available in this band, which could be made available for IR. Being a lower frequency band, this can also meet the coverage requirement of IR.
- 4.27 As per a report²³ on High-Speed Railway Communications from GSM-R to LTE-R published in IEEE vehicular technology magazine in September 2016, the 450-470 MHz band is already well adopted by the railway industry; therefore, dedicated bandwidth for professional use can still be allocated from local regulators. Furthermore, the carrier aggregation capability of LTE will permit the use of different bands to overcome problems of capacity.
- 4.28 In the ITU-R Report M.2442-0 (11/2018) on “Current and future usage of railway radiocommunication systems between train and trackside”, following has been mentioned:

“China plans to extend the length of railways to 175 000 kilometres, including 38 000 kilometres high-speed railways (account for 21.7%) by 2025. According to China railway’s medium and long-term development plan, the railway traffic would strongly increase approximately from 2020. In order to meet the increased railway service requirements, China Railway Corporation (CRC) has proposed the evolution of future RSTT, which is a FDD LTE-based system. Currently, CRC is planning to carry out a field trial of LTE-based RSTT in 2018. The test will be conducted on a high-speed line, from BEIJING to SHENYANG, and the system under test will be operated at 450 MHz frequency band (i.e. LTE band 31).”

- 4.29 DoT has also viewed that Resolution 236 (WRC-15) invites WRC-19, based on the results of ITU-R studies, to take necessary actions, as

²³ https://www.researchgate.net/publication/307518255_High-Speed_Railway_Communications_From_GSM-R_to_LTE-R

appropriate, to facilitate global or regional harmonized frequency bands, to the extent possible, for the implementation of RSTT, within existing mobile service allocations. This agenda item (AI 1.11) would be addressed in WRC-19 to be held this year. Based on the ITU-R studies; detailed characteristics, implementations of current and planned RSTT and spectrum needs of RSTT would be finalized. Also, possible harmonization of frequency ranges for RSTT on global or regional basis would be done. This would ensure availability of radio systems operating in globally or regionally harmonized frequency ranges which may lead to economies of scale. Therefore, DoT has viewed that it would be prudent to take decision on proposal of spectrum assignment to the Indian Railways based on the outcomes of WRC-19 to be held in November-2019.

- 4.30 As regards quantum of spectrum, IR has submitted that spectral bandwidth (critical) requirement (considering 10 Km average distance between towers) for data traffic requirement of Railway for Railway Mobile communication with various applications like provision of Wi-Fi in the trains, Safety critical Signaling system equivalent to European Train Control System Level 2 (ETCS Level 2), provision of downloading of select Video feed/alerts from CCTV cameras in moving trains comes to around 12 MHz.
- 4.31 IR has also submitted that in light of the finite capacities of LTE and high bandwidth demands of Railway Safety and Security applications, 15 MHz of spectrum for LTE shall be needed. Initially since Railways may not operate all services, the network must have at least 10 MHz of spectrum to begin with. Anything less than 10 MHz would not be suitable due to applications performing unreliably or system not being available 100%.
- 4.32 South Korea launched LTE-R for commercial use in 2017. A common 10 MHz spectrum in 700 MHz band has been assigned for integrated public network for public safety-LTE, LTE-Maritime and LTE-Railway.

4.33 As per a study undertaken by China²⁴ on spectrum needs of Railway RSTT with respect to train radio applications considering frequency range of 450 MHz band, spectrum needs of RSTT arrived at were:

	Uplink	Downlink
Minimum spectrum needs	11.9 MHz	4.7 MHz
Maximum spectrum needs	14.04 MHz	8.38 MHz

4.34 Since there are not many examples available, it is difficult to assess the ideal spectrum requirement for deployment of LTE-R. If we consider the experience from Indian TSPs, many TSPs launched LTE based services using 5 MHz (paired) spectrum.

4.35 It may be worth mentioning that the request of IR for spectrum allocation is for deployment of LTE-R based signaling system, which will provide mission critical passenger safety service and applications through ETCS Level 2 system. Therefore, allotment of suitable spectrum to IR for deployment of LTE-R based RSTT system is of prime importance.

4.36 In view of the above, it needs to be deliberated which spectrum band i.e. 700 MHz, 450-470 MHz or any other band, would be more appropriate for assignment to Indian Railways for RSTT and how much spectrum may be assigned to IR for RSTT.

Issues for consultation

Q1. Whether spectrum in 700 MHz band should be assigned to Indian Railways for RSTT in India? Please provide justification for your response.

Q2. In case your answer to Q1 is in affirmative, how much spectrum should be assigned to Indian Railways?

²⁴ Report ITU-R M.2442 'Current and future usage of railway radiocommunication systems between train and trackside'. (https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2442-2019-PDF-E.pdf)

Q3. In case your answer to Q1 is negative,

- i) what are the other bands (including 450-470 MHz) in which spectrum can be assigned for RSTT,**
- ii) how much spectrum should be assigned to Indian Railways?**

b. Spectrum Assignment Methodology

- 4.37 The Hon'ble Supreme Court of India through its judgment dated 2nd February 2012 quashed the licences granted on or after 10th January 2008 and ordered to issue fresh licences by auctions. This decision of the Hon'ble Supreme Court had a major bearing on the process of the award of spectrum, the assignment of which was earlier done administratively. Since 2012, total five auctions have been held for assignment of spectrum in various access bands. In August 2018, the Authority sent its recommendations on auction of spectrum in different access spectrum bands, including 700 MHz band.
- 4.38 It may be worth mentioning here that while access spectrum is being assigned through auctions to wireless access service providers, spectrum assignment is being made administratively at administrative spectrum charges on formula basis to certain category of captive / public / commercial service providers such as Internet Service Providers (ISPs) and PMRTS for providing public/ commercial service.
- 4.39 Presently, 1.6 MHz spectrum in 900 MHz band has been assigned to IR on administrative basis for captive usage of their GSM-R based network. However, spectrum charges for this spectrum are levied on formula basis as per Orders No. P-11014/34/2009-PP(II) and P-11014/34/2009-PP(IV) dated 22nd March 2012 (Annexure 3 to Annexure-II).
- 4.40 IR has requested that the spectrum in 700 MHz be assigned free of cost as the proposal is devoid of any commercial gain, but only for enhancing safety, security and passenger amenities. Ministry of Railways has also mentioned that Ministry of Law & Justice and

Ministry of Finance have supported the request of Indian Railways and have provided favourable comments on the Draft Cabinet Note circulated by Ministry of Railways in this regard.

4.41 In its letter dated 28th March 2019 to DoT, IR has further clarified that the bandwidth requirement of 10 MHz in 700 MHz frequency band is for data usage needs for following safety and security applications/facilities:

- (i) Mission Critical Passenger Safety Services & Applications through a Modern Train Control System for Railway Signalling system on IR. Modern Train control will augment train carrying capacity on Railway network because of increased speed and less fixed distance between the trains. This will allow more number of trains to be handled safely on the same fixed infrastructure.
- (ii) Video Surveillance (Live feed) through CCTV networks in trains along with Video Analytics for passenger Security.
- (iii) Faster data network Communication for voice, video and other related applications like IoT based Asset reliability, Monitoring and Train and way side telemetry through Mobile communications.

4.42 Through its earlier letter, IR had also mentioned that they envisage provision of Wi-Fi facility onboard and the spectrum requirement indicated by IR also considers provision of Wi-Fi in the trains.

4.43 From the above, it can be inferred that upon implementation of LTE based systems, the speed of the trains can be increased safely and also the inter-train fixed distance can be reduced substantially and therefore, IR would be able to increase the carrying capacity on the existing fixed infrastructure i.e. more number of passengers may be served using the same fixed infrastructure. Further, use of IoT based asset monitoring would result in reduction in operational and maintenance cost for IR.

- 4.44 As mentioned earlier, IR has submitted that the spectrum in 700 MHz be assigned free of cost as the proposal is devoid of any commercial gain. However, in respect of services being provided by IR, there could be differing views. One view could be that IR is not a commercial entity. It is being run by the Government (Ministry of Railways) to provide a basic mode of transport to the people as well as for goods and with the implementation of LTE-R, it would be able to serve in better and secured manner. Another view could be that IR is a commercial entity as it is collecting charges for the services from the people/entities. In any case, since Indian Railways is not into providing telecom services, as per the existing framework, it would not be able to take part in spectrum auctions. Further, in case, it is decided to assign spectrum in 450-470 MHz band to IR, which is not intended to be assigned to the TSPs, conducting auction for a single entity would not be logical.
- 4.45 In view of the foregoing discussion, the following issues needs deliberation.

Issues for consultation

- Q4. In case it is decided that spectrum in IMT bands which have already been earmarked for mobile services, be assigned to Indian Railways for RSTT in India, what should be the methodology (including price) of allotment of spectrum?**
- Q5. In case it is decided to assign spectrum in other spectrum bands (including 450-470 MHz band), what should be the methodology (including price) of allotment of spectrum?**
- Q6. Do you foresee any challenges, if IR makes internet services available onboard i.e. within the train using spectrum allocated for signaling purpose?**

c. Any other method by which Railway can implement LTE based radiocommunication system

- 4.46 As already discussed, IR has requested for spectrum in 700 MHz band for deployment of Pan-India LTE-R network for the ETCS Level 2 operation along the 66000 route Km of railway line. It will be the biggest project of signaling system in Indian Railways. As viewed by DoT, if 15 MHz spectrum in 700 MHz band is reserved for Railways network, the same spectrum cannot be reused by Telecom operators in respective service areas. This is because potential interference prevents sharing of the same spectrum between Railways for covering the railway tracks and Telecom operators in the licensed service area. Thus, the spectrum reserved for IR will remain under-utilized in terms of geographical use. Therefore, it would be prudent that other options are also explored.
- 4.47 One option could be to get the LTE-R based network built and deployed through one of the existing TSP who may have spectrum in 700 MHz band²⁵. In this scenario, the TSP will build the network for IR along the railway track for ETCS Level 2 based on LTE-R standards and at the same time utilize the same frequencies for its commercial operation elsewhere. This will take care of the effective utilization of the spectrum and state of art LTE-R network for IR. The control, use and operation of the LTE-R may be with IR only whereas the maintenance and SLA could be maintained by the concerned TSP. It may be worth mentioning here that in 2017, South Korea launched LTE-R for commercial use, wherein the State-run Korea Rail Network Authority designated KT, Korea's second largest wireless carrier for the project.
- 4.48 Another option could be to have an integrated network for Public Safety i.e. Public Protection and Disaster Relief (PPDR) and Railways, similar to the way implemented in South Korea. As discussed earlier,

²⁵ Spectrum in 700 MHz is to be put up for auction by DoT in the forthcoming auction expected to be held in late 2019.

South Korea launched LTE-R for commercial use with 10 MHz (paired) spectrum in 2017. However, the assigned 10 MHz (paired) spectrum is common for integrated public network shared for Public Safety-LTE, LTE-Maritime and LTE-Railway. The State-run Korea Rail Network Authority designated KT, Korea's second largest wireless carrier for the project. To optimize interference, the concerned agencies (Ministry of Land, Infrastructure & Transport; Ministry of Interior & Safety; and Ministry of Oceans & Fisheries) have established Standard Operating Procedure (SOP). RAN Sharing takes place between integrated public networks, resource allocation rules and standard interworking procedures have been set up.

4.49 PPDR communication supports a wide range of services related to day to day life of public such as maintenance of law and order, protection of life and property, disaster relief and emergency responses. PPDR and Railways, both have the requirement of a robust communication system. Since requirement of railway is limited to the rail network, it could be possible that a common network is put in place which can be used for PPDR as well as railway communication.

4.50 The Authority in its recommendations on “Next Generation Public Protection and Disaster Relief (PPDR) communication networks” dated 4th June 2018 has, *inter-alia*, recommended the following:

- Government to set up pan-India integrated Broadband PPDR (BB-PPDR) Communication Network (to be called “National BB-PPDR Network”) based on 3GPP PS-LTE technology.
- 2x10 MHz of dedicated spectrum should be allocated nationwide to the Special Purpose Vehicle (SPV) under Ministry of Home Affairs (MHA) on no-cost basis for LTE based broadband PPDR networks.
- 814-824/859-869 MHz should be assigned for nationwide BB-PPDR services.

- 20 MHz of spectrum in the frequency range 440-470 MHz (preferably 450-470 MHz) should be allocated for future evolution of broadband PPDR.

4.51 From the above, it can be seen that the Authority has recommended that 10 MHz (paired) spectrum in 800 MHz spectrum band be allocated for nationwide PPDR network. This 10 MHz (paired) spectrum could be used for PPDR as well as Railway communication. A single TSP may deploy integrated network using 10 MHz (paired) spectrum having PS-LTE deployment for PPDR agencies and LTE-R deployment for Indian Railways. This will require coordination and Standard Operating Procedures (SOP) between Ministry of Home Affairs and Indian Railways.

4.52 In view of the foregoing discussion, following issues arise for deliberation.

Issues for Consultation

Q7. Whether the requirement of IR for RSTT can be fulfilled using the following alternate methods:

i) Alternate method suggested in para 4.47, wherein a TSP could build, deploy and maintain LTE-R network for IR; while the control, use and operation of the LTE-R network may be with IR.

OR

ii) Alternate method suggested in para 4.48, wherein there could be a common integrated network (with common spectrum) for Public Safety i.e. Public Protection and Disaster Relief (PPDR) and Railways, using PS-LTE and LTE-R technology respectively.

OR

iii) Any other method as may be suggested by the stakeholders.

(Please provide detailed response with justifications and required enabling provisions.)

Q8. If there are any other issues/suggestions relevant to the subject, stakeholders may submit the same with proper explanation and justification.

CHAPTER- V: ISSUES FOR CONSULTATION

- Q.1 Whether spectrum in 700 MHz band should be assigned to Indian Railways for RSTT in India? Please provide justification for your response.**
- Q.2 In case your answer to Q1 is in affirmative, how much spectrum should be assigned to Indian Railways?**
- Q.3 In case your answer to Q1 is negative,**
- i) what are the other bands (including 450-470 MHz) in which spectrum can be assigned for RSTT,**
 - ii) how much spectrum should be assigned to Indian Railways?**
- Q.4 In case it is decided that spectrum in IMT bands which have already been earmarked for mobile services, be assigned to Indian Railways for RSTT in India, what should be the methodology (including price) of allotment of spectrum?**
- Q.5 In case it is decided to assign spectrum in other spectrum bands (including 450-470 MHz band), what should be the methodology (including price) of allotment of spectrum?**
- Q.6 Do you foresee any challenges, if IR makes internet services available onboard i.e. within the train using spectrum allocated for signaling purpose?**
- Q.7 Whether the requirement of IR for RSTT can be fulfilled using the following alternate methods:**
- i) Alternate method suggested in para 4.47, wherein a TSP could build, deploy and maintain LTE-R network for IR; while the control, use and operation of the LTE-R network may be with IR.**
- OR**
- ii) Alternate method suggested in para 4.48, wherein there could be a common integrated network (with common spectrum) for Public Safety i.e. Public Protection and Disaster Relief (PPDR) and Railways, using PS-LTE and LTE-R technology respectively.**

OR

iii) Any other method as may be suggested by the stakeholders.

(Please provide detailed response with justifications and required enabling provisions.)

Q.8 If there are any other issues/suggestions relevant to the subject, stakeholders may submit the same with proper explanation and justification.

Annexure I
(Without its Annexures)

Government of India
Ministry of Communications
Department of Telecommunications
Wireless Planning & Coordination Wing
6th floor, Sanchar Bhawan,
20, Ashoka Road, New Delhi-110001.

No.: L-14001/01/2019-NTG

Date: 27.02.2019

The Secretary
Telecom Regulatory Authority of India
Mahanagar Doorsanchar Bhawan
Jawahar Lal Nehru Marg (Old Minto Road)
New Delhi - 110002.

Subject: Recommendations of TRAI on administrative allotment of spectrum to Indian Railways for Public Safety and Security services at stations and in the trains and the quantum, price and appropriate frequency band (including 450-470 MHz band).

Sir,

This is to inform that Indian Railways has proposed to install an Ultra high speed LTE based communication corridor along their network for Train-ground and Train-Train communication. Ministry of Railways had requested Department of Telecom (DoT) to reserve 15 MHz of spectrum in 700 MHz band for this purpose and to begin with 10 MHz to be allocated free of cost as this proposal is devoid of any commercial gain, but only for enhancing security and passenger amenities.


2. The Draft cabinet note circulated by Ministry of Railways in this regard was examined and comments of DoT were provided on 02.11.2018. Copies of the Draft Cabinet Note and DoT comments dated 02.11.2018 thereon are placed at **Annexure-I** and **Annexure-II** respectively.
- 2.1. Later, Ministry of Railways vide their letter dated 17.01.2019 (**Annexure-III**) has informed that the Ministry of Finance and Ministry of Law & Justice, apart from many other Ministries have supported the Railway's demand for allotment of 10 MHz spectrum in 700 MHz band free of cost.
- 2.2. In view of the comments received from Ministry of Finance and Ministry of Law & Justice, apart from other Ministries, Ministry of Railways has requested that the issue may be reconsidered as their requirement is devoid of any commercial gain and necessary for effective implementation of the project on Indian Railways to enhance safety of running trains, provide secured travel for passengers and improve on board amenities.

3. The request of Indian Railways was considered in the Digital Communications Commission (DCC). A brief on the issues considered by DCC is placed at **Appendix**. After discussion, it was decided that the matter may be referred to TRAI. The decision of the DCC is annexed as **Annexure-IV**.
4. In view of the above, TRAI is requested to provide:
 - i. Recommendations on administrative allotment of spectrum to Indian Railways and the quantum, price and appropriate frequency band (including 450-470 MHz band) under the terms of clause 11 (1)(a) of TRAI Act, 1997 as amended by TRAI Amendment Act 2000.

TRAI may examine the request of the Indian Railways in the context of its earlier recommendations with respect to auction of spectrum including its recommendation dated 01.08.2018 wherein TRAI has recommended that all available spectrum in 700 MHz band may be put to auction.

- ii. Any other recommendations deemed fit for the purpose.

Encl: As above.


(M. P. S. Alawa)
Sr. Deputy Wireless Adviser

Brief on Indian Railways' request regarding their proposal for installation of Public Safety and Security services at stations and in the trains

1. Indian Railways has proposed to install an Ultra high speed LTE based communication corridor along their network for Train-ground and Train-Train communication. Ministry of Railways had requested Department of Telecom (DoT) to reserve 15 MHz of spectrum in 700 MHz band for this purpose and to begin with 10 MHz to be allocated free of cost as this proposal is devoid of any commercial gain, but only for enhancing security and passenger amenities.
2. Draft cabinet note circulated by Ministry of Railways in this regard was examined and comments of DoT were provided on 02.11.2018. Copies of the Draft Cabinet Note and DoT comments dated 02.11.2018 thereon are placed at **Annexure-I** and **Annexure-II**.
- 2.1. Later, Ministry of Railways vide their letter dated 17.01.2019 (**Annexure-III**) has informed that the Ministry of Finance and Ministry of Law & Justice, apart from many other Ministries have supported the Railway's demand for allotment of 10 MHz spectrum in 700 MHz band free of cost.
- 2.2. In view of the favourable comments received from Ministry of Finance and Ministry of Law & Justice, apart from other Ministries, Ministry of Railways has requested that the issue may be reconsidered favourably as their requirement is devoid of any commercial gain and necessary for effective implementation of the project on Indian Railways to enhance safety of running trains, provide secured level for passengers and improve on board amenities.
3. The request of Indian Railways was considered in the Digital Communications Commission (DCC). In this matter, the following was considered by DCC:
 - 3.1. **700 MHz and other candidate bands for LTE deployments**
 - 3.1.1. 700 MHz band is a globally harmonised band deployed for the IMT (International Mobile Telecommunication) applications in the telecommunications service by various countries. In India, this band has been earmarked for the potential IMT services which can be deployed by the Telecom Service providers. This frequency band is spanning from 703-748 MHz/758-803 MHz, occupying total of 45 MHz paired spectrum (45+45). Before the availability of this band was announced, 10 MHz paired spectrum (10+10) of this band had been carved out from this 45 MHz for the Defence use as part of the Defence band commitment. Department is now left with 35 MHz of paired spectrum in this band.
 - 3.1.2. Further, TRAI vide recommendations dated 01.08.2018 has provided the reserve price and other conditions for auction of various frequency bands including 700 MHz on the request of DoT. In these recommendations TRAI has noted the following:

- i. With the increased demand for data services and uptake of data hungry applications, the need for spectrum has been ever increasing. Availability of sufficient spectrum is crucial in achieving the objectives of 'Digital India'.
 - ii. The 700 MHz band is being used worldwide for deployment of 4G and evolution of 5G services due to its excellent propagation characteristics and therefore it is one of the most sought after band for deployment of LTE.
 - iii. TRAI has also recognised the vibrant, ever growing eco system that uses 700 MHz for new generation telecom services globally and has advocated auctioning the entire 35 MHz spectrum, so as to emulate the success of APT700 (FDD) plan in India as was employed in more than 50 countries.
- 3.1.3. Ministry of Railways, in their Draft Cabinet Note had also identified the advantages of choosing the 700 MHz for their network which coincidentally by similar logic has been attributed by TRAI for patronising this band for the exclusive Telecom service in India.
- 3.1.4. In this context, it was mentioned by DoT (in comments dated 02.11.2018) that High frequency bands have larger propagation loss and more severe fading; therefore, lower frequency bands may be preferred for deployment of **Railway Radiocommunication Systems between Train and Trackside (RSTT)** network which is expected to cover a wider geographical area.
- 3.1.5. Further, as LTE based enhancements are available in 450 MHz – up to 6 GHz, as mentioned in ITU-R Report (Rep. ITU-R M.2418) on Description of RSTT (**Annexure IV**) and also, NFAP makes a provision for considering requirements of IMT applications in 450 - 470 MHz; possibility of deployment of LTE based network of Indian Railways may be explored in other frequency bands (e.g. 450-470 MHz etc.).
- 3.1.6. In response to this, Ministry of Railways has mentioned that RSTT deployments in 450-470 MHz band has the following challenges:
- a) Limited ecosystem, no handheld devices available and functionality like PTT is not available which is must for critical communication services, very limited market and very small number of commercial networks on LTE in this band.
 - b) Bandwidth limitation may limit the possibility of mobile broadband capacity and limits the use case like video surveillance and on-board broadband services, Radio Network Redundancy is not possible to implement as it requires minimum 10 MHz to implement redundancy to ensure zero point of failure.
 - c) Interference challenges (5 MHz guard band between uplink and downlink).
- 3.1.7. In this context, it may be noted that in 450 - 470 MHz band, TDD plan is available which would not require guard band between uplink and downlink as required in FDD plan available in 700 MHz band. Further, 450 - 470 MHz band has a contiguous 20 MHz bandwidth available as against Indian railways' requirement of 15 MHz.

Accordingly, possibility of deployment of LTE based network of Indian Railways may be explored in 450-470 MHz band.

- 3.1.8. It may further be noted that Resolution 236 (WRC-15) invites WRC-19, based on the results of ITU-R studies, to take necessary actions, as appropriate, to facilitate global or regional harmonized frequency bands, to the extent possible, for the implementation of railway radiocommunication systems between train and trackside (RSTT), within existing mobile service allocations.
 - 3.1.8.1. To address this agenda item (AI 1.11), ITU-R has undertaken studies towards the development of two ITU-R Reports and one Recommendation. ITU-R studied the generic architecture, main applications, current technologies, generic operating scenarios of RSTT and developed Report ITU-R M.2418. ITU-R circulated a questionnaire to administrations of Member States, gathering information on the usage of RSTT. Responses received have been included in Report ITU-R M.[RSTT.USAGE] which also includes the detailed characteristics, implementations of current and planned RSTT and the spectrum needs of RSTT. ITU-R commenced development of Recommendation ITU-R M.[RSTT_FRQ], which provides possible harmonization of frequency ranges and frequency arrangements for RSTT on global or regional basis. Copy of relevant extract from the draft CPM (Conference Preparatory Meeting) Report issued in this regard is placed at **Annexure-V**.
 - 3.1.8.2. Based on the Report ITU-R M.2418, it was conveyed to Ministry of Railways to explore possibility of deployment of LTE based network of Indian Railways other frequency bands (e.g. 450-470 MHz etc.).
 - 3.1.8.3. This agenda item (AI 1.11) would be addressed in WRC-19 to be held this year. Based on the ITU-R studies; detailed characteristics, implementations of current and planned RSTT and spectrum needs of RSTT would be finalized. Also, possible harmonization of frequency ranges for RSTT on global or regional basis would be done. This would ensure availability of radio systems operating in globally or regionally harmonized frequency ranges which may lead to economies of scale. In view of the above, it would be prudent to take decision on proposal of spectrum assignment to the Indian Railways based on the outcomes of WRC-19.
- 3.2. **Scarcity of spectrum in 700 MHz band for commercial telecom networks**
 - 3.2.1. DoT *vide* comments provided on 02.11.2018, had further mentioned that while considering the request of Indian Railways for allotment of 15 MHz spectrum, only 20 MHz spectrum in 700 MHz band will be left for IMT services for their Access network. This may not be sufficient for 4G/5G services considering that 3 to 4 service providers will be providing services in each service area. Reserving 15 MHz spectrum in 700 MHz band for Indian Railways may limit the supply of the spectrum that potentially would hike up the price of this crucial spectrum and could jeopardise the growth plans of the Telecom operators. It may further be mentioned that frequency bands below 700 MHz band are not available for allotment for IMT

services in India. Therefore, 700 MHz band is the prime band for providing better coverage in rural areas.

3.2.2. In response to this, Ministry of Railways has mentioned that critical requirement of Indian Railways of 10 MHz for Indian Railways will leave 25 MHz for allotment to IMT services in India. Better rural coverage is possible even in lower frequency bands like 600 MHz, 450-470 MHz.

3.2.3. In this context, it may be mentioned that 700 MHz band is the lowest frequency band in which Access spectrum may be assigned to commercial telecom service providers in India. Accordingly, spectrum in this band was put to auction in October-2016 and will again be offered for bidding in the upcoming auction. Reserving 15 MHz spectrum in 700 MHz band for Indian Railways may limit the supply of the spectrum that potentially would hike up the price of this crucial spectrum and could jeopardise the growth plans of the Telecom operators. Accordingly, spectrum in frequency bands other than 700 MHz band (e.g. 450-470 MHz) may be explored for meeting requirements of Indian Railways.

3.3. **Requirement of Indian Railways along the track only, not complete geographical coverage**

3.3.1. DoT *vide* comments provided on 02.11.2018, had mentioned that LTE based communication is proposed to be used along the Rail tracks laid by Indian Railways for which 15 MHz of 700 MHz spectrum is demanded from DoT. If this quantum of spectrum is reserved for Railways network, the same spectrum cannot be reused by Telecom operators in respective service areas. This is because potential interference prevents sharing of the same spectrum between Railways for covering the railway tracks and Telecom operators in rest of the areas in a particular service area.

3.3.2. In response to this, Ministry of Railways has mentioned that the contention of Potential interference between railway communication network and Telecom operators' network is not appropriate due to guard band between various frequencies deployed in the network.

3.3.3. In this context, it may be mentioned that Indian Railways requires its network to be deployed along the track only. Current assignments to Indian Railways' GSM-R network in 900 MHz band are also in use along the track only. However, considering potential interference between railway communication network and Telecom operators' network, frequency carriers assigned to Indian Railways' network along the track are not assigned in other areas to commercial telecom networks.

3.3.4. Further, in 450 - 470 MHz band, contiguous 20 MHz bandwidth in TDD plan is available for exploitation by Indian Railways. Also, this spectrum in 450 - 470 MHz band has not yet been planned for assignment to commercial telecom operators through auction. Therefore, possibility of assignment of spectrum to Indian Railways in 450 - 470 MHz band may be explored.

3.4. Legality in administrative allotment of spectrum for Indian Railways in light of Hon'ble Supreme Court judgment dated 02.02.2012 in 2G case

- 3.4.1. DoT *vide* comments provided on 02.11.2018, had further mentioned that a policy decision is also required to be taken as to whether spectrum can be assigned to Indian Railways administratively in light of the judgment dated 02.02.2012 of Supreme Court in Writ Petition (Civil) No. 423 of 2010 (2G case). Views of Department of Legal Affairs, Ministry of Law and Justice, may be taken regarding administrative allotment of spectrum for Indian Railways.
- 3.4.2. In response to this, Ministry of Railways has mentioned that Ministry of Law and Justice has supported the request of Indian Railways and have provided favourable comments on the Draft Cabinet Note circulated by Ministry of Railways in this regard.

3.5. Pricing of Spectrum in 700 MHz band

- 3.5.1. DoT *vide* comments provided on 02.11.2018, had further mentioned that spectrum in 700 MHz band is a valuable spectrum as the reserve price as provided by TRAI in their recommendations dated 01.08.2018 on pan-India basis comes out to be Rs. 98,520 crore.
- 3.5.2. In response to this, Ministry of Railways has mentioned that Ministry of Finance has supported the request of Indian Railways for allotment of spectrum free of cost and have provided favourable comments on the Draft Cabinet Note circulated by Ministry of Railways in this regard.
- 3.5.3. In this context, it may be mentioned that Indian Railways has sought for 15 MHz (10 MHz for the time being) in 700 MHz band to be allocated free of cost only for enhancing safety, security and passenger amenities for eternity whereas the spectrum has, at current TRAI recommendations Reserve Price, the potential to fetch about Rs. 1 lakh crore as upfront for only 20 years. During all these 20 years, it would also fetch few thousand crore of rupees in the form of Spectrum Usage Charges (SUC) accruable quarterly. 450 - 470 MHz band, on the other hand, has no demand from the Industry and service providers at present. Instead of 15 MHz spectrum as requested by Indian Railways, 450 - 470 MHz band has a total of 20 MHz spectrum for exploitation.
- 3.5.4. It may also be noted that Indian Railways has been assigned 1.6 MHz (paired) spectrum in 900 MHz band for their existing GSM-R based Public Safety and Security network for which no upfront payment towards assignment of spectrum has been paid. However, spectrum charges on formula basis are payable annually by Indian Railways for their existing radiocommunication networks including GSM-R based network.

- 3.6. Considering the above, DCC decided to seek recommendations of TRAI on the issue of administrative allotment of spectrum to Indian Railways and the quantum, price and appropriate frequency band (including 450-470 MHz band).

Government of India
Ministry of Communications
Department of Telecommunications
Wireless Planning & Coordination Wing

6th floor, Sanchar Bhawan,
20, Ashoka Road, New Delhi-110001.

No.: L-14001/01/2019-NTG

Date: 10.05.2019

To,

The Secretary
Telecom Regulatory Authority of India
Mahanagar Doorsanchar Bhawan
Jawahar Lal Nehru Marg (Old Minto Road)
New Delhi - 110002.

Subject: Additional information sought by TRAI in the matter of administrative allotment of spectrum to Indian Railways for Public Safety and Security services at stations and in the trains and the quantum, price and appropriate frequency band (including 450-470 MHz band).

Reference: (1) DoT letter No. L-14001/01/2019-NTG dated 27.02.2019.
(2) TRAI letter No. 103-2/2019-NSL-II dated 19.03.2019.

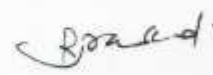
Sir,

Kind attention is invited to DoT's letter dated 27.02.2019 referred above, wherein recommendations were sought from TRAI in the matter of administrative allotment of spectrum to Indian Railways for Public Safety and Security services at stations and in the trains and the quantum, price and appropriate frequency band (including 450-470 MHz band).

2. TRAI vide their letter dated 19.03.2019 informed that certain documents have been provided by DoT, however, in order to get more clarity on related aspects and to examine the matter, detailed clarification on some of the points and some additional information is required. In this regard, certain information was sought from Ministry of Railways. A copy of response received from Ministry of Railways vide their letter dated 28.03.2019 is enclosed as **Annexure 1**.

3. Point-wise information/clarification as sought by TRAI vide letter dated 19.03.2019 is placed at **Annexure 2**.

Encl: As above.


(R. B. Prasad)
Joint Wireless Adviser
Phone: 2337 2183

F 35-38012/1
11/4/2019

Annexure 3
PSC/WPC
2402/17/102/12/19
29/3/19

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
RAILWAY BOARD

No. 2017/Tele/14(1)/1 Pt-1

Dated: 28.03.2019

✓ Wireless Adviser,
Wireless Planning & Coordination Wing,
Ministry of Communications,
Department of Telecommunications,
6th Floor, Sanchar Bhawan, 20, Ashoka Road,
New Delhi.

Sub: Additional information/clarifications regarding administrative allotment of spectrum in 700 MHz frequency band to Indian Railways for proposed LTE Network to enhance Public Safety and to improve security regime at stations and in trains.

Ref: - (i) Telecom Regulatory Authority of India's letter No.103-2/2019-NSL-II dt. 19.03.2019.
(ii) Wireless Planning & Coordination Wing's letter No.L-14001/01/2019-NTG dated 26.03.2019

This is in reference to Digital Communication Commission (DCC) decision to seek recommendations from Telecom Regulatory Authority (TRAI) for administrative allotment of spectrum in 700 MHz frequency band to Indian Railways. The proposed LTE based communication backbone network in 700 MHz frequency band is to enhance passenger Safety and to improve Security regime at stations and in trains. TRAI vide reference (i) has sought additional information and clarifications to get more clarity on the related aspects to examine the matter. Accordingly, item wise remarks are as below:-

SNo	Clarification item	Remarks of Indian Railway
1	Provide in detail the systems functionalities and purpose for which the spectrum in 700 MHz band is proposed to be used by Indian Railways.	<ul style="list-style-type: none"> ❖ Indian Railways(IR) has a network size of over 66,000 Route KMs (RKM) connecting more than 8,000 stations on which 21,000 Passenger and Freight trains run every day to move over 8 billion passengers and 1 billion tons of freight annually. 2.25 Crore passengers (approx) use train services daily, their Safety and Security is of paramount concern and priority for IR. Furthermore, the ever-increasing demands for introduction of more trains and stoppages from different parts of the country coupled with IR's limited fixed infrastructure and rolling stock availability, there is need to ramp up the speed of trains to upgrade carrying and handling capacity of the existing Railway networks. ❖ Indian Railways is looking to operationalize applications around Safety (ETCS Level 2, emergency communications etc.), Internal management (staff communication, remote asset monitoring, etc.) and passenger security/experience (free

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		<p>browsing, free audio/video entertainment, live CCTV monitoring etc.).</p> <ul style="list-style-type: none"> ❖ These requirements are highly varied in their bandwidth and network latency. Also, live on-board CCTV monitoring over the mainline requires high bandwidth (8 cameras per coach with H.265 Codec). ❖ Global benchmarking shows that railway operators are presently not using such an application – the data is stored in the train and is used for post-processing as required. ❖ Considering various options, IR has planned to deploy Global Standard LTE for mission critical Railway application. LTE is poised to replace the incumbent 2nd Generation (2G) GSM-R technology.
(ii)	What is the total length of Railway track in Route kms for which the proposed system will be deployed in 700 MHz	The proposed LTE communication system in 700 MHz frequency band is planned to be deployed over entire Indian Railways network. Uniform backbone communication system will enhance Passenger Safety, security and asset reliability applications progressively over 66,000 Route KMs (RKM) connecting more than 8,000 stations and covering about 21000 passenger and goods trains running daily.
(iii)	What is the time frame in which the system is proposed to deploy and made operational by Indian Railways?	The LTE back bone communication system is proposed to be deployed and made operational on Indian Railways in a time frame of 3-5 yrs from allotment of spectrum in 700 MHz frequency band to IR.
(iv)	What is the system presently used by Indian Railways for the purpose of Radio communication between Train and Trackside(RSTT)	<p>Radio communication between Train and Trackside (RSTT) at present is GSM-R of 2G version mobile communication system. It has been presently deployed over 2500 Rkms on IR. On the Balance network, RSTT is achieved using 5W and 25 W VHF sets.</p> <p>Thus, the present RSTT i.e GSM-R & VHF sets are primarily voice based with hardly any data handling capability of to serve applications like monitoring alerts from CCTV cameras from coaches, Remote monitoring and diagnostics of rolling stock, free infotainment etc.</p>
(v)	For the purpose of GSM-R, DoT has allocated 1.6 MHz paired spectrum to Indian Railways in 900MHz band. How the allocated 1.6 MHz paired spectrum is being utilized by Indian Railways	<p>GSM-R in 900 MHz spectrum band (890-915/935-960 MHz) in 1.6 MHz paired bandwidth has been functional on Indian Railways. Since available spectrum bandwidth is limited to 1.6 MHz in 8 spots, therefore Railway specific application of Mobile Communication only has been functional which includes <i>functional addressing</i> (Calling a user by assigned function, rather than by a fixed number) and <i>location dependent addressing</i>. Additionally, Railway-specific characteristic includes <i>Advanced Speech Call Item (ASCI)</i> such as <i>Voice Broadcast Service (VBS)</i> to communicate to a group of handsets simultaneously is also available.</p>
(vi)	What is the data rate (data speed) of the present system deployed by Indian Railways for the communication between Train and Trackside?	<p>GSM-R characteristics are similar to GSM 2G system in general. The General Packet Radio Services (GPRS) for data communication upto 14.4 Kbps is supported by GSM-R for data transport in the same way as with the regular GSM system.</p>
(vii)	What is the future/proposed data speed requirement of Indian Railways for the	<p>IR's data speed requirement envisaged in the proposed LTE system in 700 MHz frequency band are as under:-</p> <ul style="list-style-type: none"> ○ Peak data rate, downlink/uplink of 50/10 Mbps, ○ Peak spectral efficiency of 2.55 bps/Hz,

	proposed system in 700 MHz band?	
(viii)	Which technology/system is proposed to be deployed by Indian Railways in 700 MHz for communication between Train and Trackside?	<ul style="list-style-type: none"> o In April 2017, Samsung Electronics launched LTE solution on the 41km-long Busan Metro line 1 that covers 40 stations in the region. o In China, Huawei has deployed on ShuoHuang Railways (The Freight operator in China) LTE communication between the multiple locomotives (slave and driver) of the freight trains. The implementation has resulted in the significant capacity augmentation of the freight line. o IR proposes to take a lead by leveraging its vast network and scale railways operations in evolving defining and introducing LTE of 4G/5G compatibility.
(ix)	Whether such system can operate in other frequency bands also? If yes, what are those frequency bands?	Yes, such system can operate in 800/900 MHz band other than 700 MHz frequency band.
(x)	Whether any commercial telecom services are proposed to be provided by Indian Railways to its passengers using spectrum in 700 MHz band, besides RSTT communications?	<p>Indian Railways has sought for spectrum in 700 MHz frequency band to be allocated free of cost as this proposal is devoid of any commercial gain, but only for enhancing safety, security and passenger amenities.</p> <p>The bandwidth requirements of 10 MHz in 700 MHz frequency band is for data usage needs for following safety and security applications/facilities:</p> <p>(i) Mission Critical Passenger Safety Services & Applications through a Modern Train Control System for Railway Signaling system on IR. Modern Train Control system will augment trains carrying capacity on Railway network because of increased speed and less fixed distance between the trains. This will allow more number of trains to be handled safely on the same fixed infrastructure.</p> <p>(ii) Video Surveillance (Live Feed) through CCTV networks in trains along with Video Analytics for Passenger Security.</p> <p>(iii) Faster data network Communication for voice, video and other related application like IoT based Asset reliability Monitoring and Train and way side Telemetry through Mobile communications.</p>


(Sunil Gupta) 28/5/19

Exec. Director (Tele. Dev)
E-Mail: edtd@rb.railnet.gov.in
Fax: 030-44198/011-23304198

Information sought by TRAI vide their letter No. 103-2/2019-NSL-II dated 19.03.2019

S. No.	Clarification Item	Remarks
(i)	Provide in detail the systems functionalities and purposes for which spectrum in 700 MHz band is proposed to be used by Indian Railways.	<ul style="list-style-type: none"> • Indian Railways (IR) has a network size of over 66,000 Route KMs (RKMs) connecting more than 8,000 stations on which 21,000 Passengers and Freight trains run every day to move over 8 billion passengers and 1 billion tons of freight annually. 2.25 Crore passengers (approx) use train services daily, their Safety and Security is of paramount concern and priority for IR. Furthermore, the ever-increasing demands for introduction of more trains and stoppages from different parts of the country coupled with IR's limited fixed infrastructure and rolling stock availability, there is need to ramp up the speed of trains to upgrade carrying and handling capacity of the existing Railway network. • Indian Railways is looking to operationalize applications around Safety (ETCS Level 2, emergency communications etc.), internal management (staff communication, remote asset monitoring etc.) and passenger security/experience (free browsing, free audio/video entertainment, live CCTV monitoring etc.). • These requirements are highly varied in their bandwidth and network latency. Also, live on-board CCTV monitoring over the marine requires high bandwidth (8 cameras per coach with H.265 Codec). • Global benchmarking shows that railway operators are presently not using such an application - the data is stored in the train and is used for post-processing as required. • Considering various options, IR has planned to deploy Global Standard LTE for mission critical Railway application. LTE is poised to replace the incumbent 2nd Generation (2G) GSM-R technology.
(ii)	What is the total length of Railway Track in Route Kilometers for which the	The proposed LTE communication system in 700 MHz frequency band is planned to be deployed over entire Indian Railways network. Uniform

	proposed system will be deployed in 700 MHz band?	backbone communication system will enhance Passenger Safety, security and asset reliability applications progressively over 66,000 Route KMs (RKMs) connecting more than 8,000 stations and covering about 21000 passenger and goods trains running daily.
(iii)	What is the time frame in which the system is proposed to be deployed and made operational by Indian Railways?	The LTE back bone communication system is proposed to be deployed and made operational on Indian Railways in a time frame of 3-5 years from allotment of spectrum in 700 MHz frequency band to IR.
(iv)	What is the system presently used by Indian Railways for the purpose of Radio communication between Train and Trackside (RSTT)?	Radio communication between Train and Trackside (RSTT) at present is GSM-R of 2G version mobile communication system. It has been presently deployed over 2500 Rkms on IR. On the balance network, RSTT is achieved using 5W and 25 W VHF sets. Thus, the present RSTT i.e. GSM-R and VHF sets are primarily voice based with hardly any data handling capability of to serve applications like monitoring alerts from CCTV cameras from coaches, Remote monitoring and diagnostics of rolling stock, free infotainment etc.
(v)	For the purpose of GSM-R, DoT has allocated 1.6 MHz paired spectrum to India Railways in 900 MHz band. How the allocated 1.6 MHz paired spectrum is being utilized by Indian Railways?	GSM-R in 900 MHz spectrum band (890-915/936-960 MHz) in 1.6 MHz paired bandwidth has been functional on Indian Railways. Since available spectrum bandwidth is limited to 1.6 MHz in 8 spots, therefore Railway specific application of Mobile Communication only has been functional which includes <i>functional addressing</i> (Calling a user by assigned function, rather than by a fixed number) and <i>location dependent addressing</i> . Additionally, Railway-specific characteristic include Advanced Speech Call Item (ASCI) such as <i>Voice Broadcast Service</i> (VBS) to communicate to a group of handsets simultaneously is also available.
(vi)	What allocation methodology has been adopted by DoT while allocating the 1.6 MHz paired spectrum to Indian Railways in 900 MHz band?	1.6 MHz (paired) spectrum in 900 MHz band has been assigned to Indian Railways on administrative basis for captive usage of their GSM-R based network.
(vii)	What are the charges being levied (along with the basis for such charges) to Indian	Spectrum charges for this spectrum are levied on formula basis as per Order No. P-11014/34/2009-PP dated 22.03.2012(Copy enclosed as Annexure 3).

	Railways for the allocated GSM-R spectrum?	Amount of spectrum charges per BTS are 7,69,000/- (which include Royalty of Rs. 7,68,000/- and License Fee of Rs. 1,000/-). For handheld and vehicle-mounted stations, only license fee @ Rs. 250/- per station is charged.
(viii)	What is the data rate (data speed) of the present system deployed by Indian Railways for the communication between Train and Trackside?	GSM-R characteristics are similar to GSM 2G system in general. The General Packet Radio Services (GPRS) for data communication upto 14.4 Kbps is supported by GSM-R for data transport in the same way as with the regular GSM system.
(ix)	What is the future/proposed data speed requirement of Indian Railways for the proposed system in 700 MHz band?	IR's data speed requirement envisaged in the proposed LTE system in 700 MHz frequency band are as under: <ul style="list-style-type: none"> o Peak data rate, downlink/uplink of 50/10 Mbps, o Peak spectral efficiency of 2.55 bps/Hz.
(x)	Which technology/system is proposed to be deployed by Indian Railways in 700 MHz for communication between Train and Trackside?	<ul style="list-style-type: none"> o In April 2017, Samsung Electronics launched LTE solution on the 41 km-long Busan Metro line that covers 40 stations in the region. o In China, Huawei has deployed on ShuoHuang Railways (The Freight operator in China) LTE communication between the multiple locomotives (slave and driver) of the freight trains. The implementation has resulted in the significant capacity augmentation of the freight line. o IR proposes to take a lead by leveraging its vast network and scale railways operations in evolving defining and introducing LTE of 4G/5G compatibility.
(xi)	Whether such system can operate in other frequency bands also? If yes, what are those frequency band(s)?	Yes, such systems can operate in 800/900 MHz band other than 700 MHz frequency band.
(xii)	Whether any commercial telecom services are proposed to be provided by Indian Railways to its passengers using spectrum in 700 MHz band, besides RSTT communications?	<p>Indian Railways has sought for spectrum in 700 MHz frequency band to be allocated free of cost as this proposal is devoid of any commercial gains, but only for enhancing safety, security and passenger amenities.</p> <p>The bandwidth requirements of 10 MHz in 700 MHz frequency band is for data usage needs for following safety and security applications/facilities:</p> <p>i. Mission Critical Passenger Safety Services &</p>

		<p>Applications through a Modern Train Control System for Railway Signalling system on IR. Modern Train Control System will augment trains carrying capacity on Railway network because of increased speed and less fixed distance between the trains. This will allow more number of trains to be handled safely on the same fixed infrastructure.</p> <p>ii. Video Surveillance (Live Feed) through CCTV networks in trains along with Video Analytics for Passenger Security.</p> <p>iii. Faster data network Communication for voice, video and other related applications like IoT based Asset reliability Monitoring and Train and way side Telemetry through Mobile communications.</p>
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Annexure 3

Government of India
Ministry of Communications & IT
Department of Telecommunication
Wireless Planning & Co-ordination (WPC) Wing

Sanchar Bhavan,
20, Ashoka Road,
New Delhi-110 001

No. P-11014/34/2009-PP (II)

Date: 22nd March, 2012

ORDER

Subject: Royalty charges for Assignments of Frequencies to 'Captive Users' (users being charged on formula basis) including all Government Users, involving **Multi Channel** Operations for Fixed/ Land/ Land Mobile Stations.

In pursuance of Power conferred by section 4 of the Indian Telegraph Act, 1885(13 of 1885) and in supersession of this Ministry's Orders No. R-11014/26/2002-LR dated 06.05.2003, No. R-11014/26/2002-LR dated 01.04.2003, No. R-11014/4/87-LR (pt.) dated 20.07.1995 and No. R-11014/4/87-LR dated 09.12.1987, the Central Government has decided the following Royalty charges for Assignments of Frequencies to 'Captive Users' (users being charged on formula basis) including all Government Users, involving **Multi Channel** Operations for Fixed/ Land/ Land Mobile Stations:-

2. *Annual Royalty* is calculated as per the following formula and rules:

$$\text{Annual Royalty (in Rupees)} = \sum_{i=1}^n M_i \times W, \text{ where } n = \text{no. of carriers.}$$

- i. The Basic Royalty (M) given below is for *one* carrier frequency in a *Basic Link* (simplex) of 2 Fixed/ Land/ Land Mobile stations (1 station for broadcasting).
- ii. Duplex circuits (with two central frequencies) and Semi-duplex circuits shall be charged at twice the rate of simplex (single central frequency) circuits.
- iii. For multi-frequency circuits, even if operating in simplex mode, the Basic Royalty shall be charged for each frequency separately.
- iv. For the purpose of charging Royalty under Table-B, the *Bandwidth Factor W* shall be as per *Table-C*, given below.
- v. For all carrier frequencies, the chargeable bandwidth shall include the *Guard Bands* required to be provided as per *ITUs*.
- vi. The rates of Royalty apply to the specified *polarization(s)* of the assigned frequencies.
- vii. In addition to above, the explanatory "Notes" on the applicability of royalty charges, are as following:
 - To determine the "Maximum Distance" slab applicable to a case, the 'maximum power rating/ assigned' of the transmission equipment be considered, and expressly recorded in the assignment instrument Decision Letter, Agreement-in-Principle, or Wireless Operating License (DL/ AIP/ WOL).



Royalty Charges for Multi-channel

- The *duration* of a radio frequency assignment will normally be one or two years. If an applicant desires, and frequencies are available, the duration of assignment may be fixed as three or four or five years.
- Before issuing any DL/ AIP/ WOL, full amounts of Royalty shall be submitted by the applicant in advance for the entire duration of the DL/ AIP/ WOL.
- For all assignments of frequencies, all applicants or users shall pay the applicable Royalty, License Fee, etc. at the rates and terms in force from time to time, all previously paid amounts being adjusted on pro-rata basis.

Table-B For The 'M' Factor

Distance Cat.	"Maximum Distance (KM) Over Which the F/L/LM Network would operate"	Royalty Charges (in Rs.) for of the Basic Link.
		<i>M</i>
I	<= 2	1500
II	<= 5	3000
III	> 5 <= 25	6000
IV	> 25 <= 60	12000
V	> 60 <= 120	22500
VI	> 120 <= 500	37500
VII	> 500	50000

Table-C for The 'W' Factor

Slabs of Adjacent Channel Separation (BW), in MHz	Values of W
Up to and including 2	30
More than 2 but < = 3.5	40
More than 3.5 but < = 7	60
More than 7 but < = 14	90
More than 14 but < = 28	120
> 28	$120+30 \times (\text{Excess bandwidth to } 28 \text{ MHz} / 7) @$

@: That is, in steps of 7 MHz or part thereof.

- viii. Any "single channel service" that uses a channel bandwidth in excess of 375 KHz shall be covered by Charging Table-C above, where the Bandwidth Factor "W" is used from the lowest value of 30 onwards.

3. For Charging of "Licence fee and other fees, Surcharge/ late fee and Charging Methodologies for Royalty / licence fees, Order No. No. P-11014/34/2009-PP (IV) dated 22nd March, 2012 shall be applicable

[Signature]
2012

Royalty Charges for Multi-channel

4. This issues with the concurrence of the Wireless Finance Division, vide this Dy. No.482/Sr.DDG(WPF), dated 19/3/12.
5. This Order shall come into force from 1st April 2012.


(Viresh Goel)

Deputy Wireless Advisor
to the Government of India

Copy to:

1. All concerned
2. Wireless Finance Division
3. Wireless Monitoring Organisation
4. Director, IT DoT for uploading on DoT website
5. DWA(ASMS) for uploading on WPC Wing website

Government of India
Ministry of Communications & IT
Department of Telecommunication
Wireless Planning & Co-ordination (WPC) Wing

Sanchar Bhavan,
20, Ashoka Road,
New Delhi-110 001

No. P-11014/34/2009-PP (IV)

Date: 22nd March, 2012

ORDER

Subject: Licence fee and other fees, Surcharge/ late fee and Charging Methodologies for Royalty / licence fees for 'Captive Users' (users being charged on formula basis) including all Government Users.

In pursuance of Power conferred by section 4 of the Indian Telegraph Act, 1885(13 of 1885) and in supersession of this Ministry's Orders No. R-11014/28/2004-LR dated 23.03.2005, and No. R-11014/4/87-LR dated 20.07.1995 the Central Government has decided the following rates of Licensee fees, and other fees, Surcharge/ late fee and Charging Methodologies for Royalty / licence fees for different types of Assignments of Frequencies to 'Captive Users' (users being charged on formula basis) including all Government Users. :-

2. License Fees

Sl. No.	Type of License	Annual License Fee, Rs.	Remarks
i.	Fixed/ Land Station	500	Per station
ii.	Land Mobile Station	250	Per station
iii.	Captive paging (Hub)	2000	Per Hub
iv.	Maritime Mobile Station (fishing trawlers)	500	Per trawler
v.	Maritime Mobile Station (Ships)	5000	Per ship
vi.	Aero-mobile Station	5000	Per aircraft
vii.	USR (short range)	250	Per station
viii.	Fixed station of Microwave links/ Radar Station/NLD station/BTS	1000	Per station
ix.	CMRTS fixed station	500	Per fixed station
x.	CMRTS Mobile Station	250	Per mobile station; vehicle mounted or hand-held
xi.	Fixed station in Satellite Network, e.g., DTH/ Teleport/ DSNG/ NLD/ ILD/ DCP/ IP-II	1000	Per Fixed Station
xii.	Captive V-SAT	500	Per Hub or Terminal
xiii.	INMARSAT	250	For Mobile terminal
xiv.	INMARSAT	500	For Fixed terminal

NOTE: License Fee for standby sets shall also be charged at the same rates.

License fee, late fee and Charging Methodologies

3. Fees for issuing duplicate copies and License Modification

Sl. No.	Type	Fee in Rupees
i.	Duplicate copy of License (Without Schedule)	500
ii.	Duplicate copy of Schedule(s) of a License	500
iii.	Duplicate copy of Renewal Certificate	250
iv.	License Modification	1000

4. Charging Methodologies for Royalty / licence fees:

- i. No radio frequency be assigned, reserved, or blocked through a Decision Letter, Agreement-in-Principle, or any other instrument of like nature *unless* the applicant pays, in advance, all applicable license fees and royalty charges for the full duration of authorization/ assignment of the radio frequency, or minimum of one year, whichever is less.
- ii. Upon successful processing of an application requesting for an assignment of radio frequency (RF), the applicant be informed about the License Fees and Royalty required to be deposited by him. These shall be calculated for the full period of the requested assignment. Where the period is greater than one year, the wireless user/ applicant has to pay the license fee and royalty in annual installments in advance every year.
- iii. Immediately thereafter, but in no case later than thirty (30) days from the date of issue of the said letter, the applicant shall pay the charges for issue of License/ DL/ AIP, if otherwise permissible. If, on the other hand, the payment is not received within this period of 30 days, the application will be treated as *cancelled* and the frequencies shall be freed for being assigned to others. If the same applicant wants to subsequently pursue the application, he shall be required to submit a *fresh* application.
- iv. The amounts due for different periods may be determined as follows.

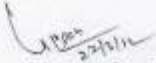
License Period	License Fee payable	Royalty payable from the date of DL/ AIP/ WOL, as the case may be	Method of payment
One month or less	At specified flat rate.	Annual royalty divided by 12.	Full license fee & royalty to be paid in advance at the time of issue of DL/ AIP/ license.
More than one month but up to one year	At specified flat rate.	On pro-rata basis. However, part of a month shall be taken as one month.	-- do --
More than one year	At specified flat rate.	On pro-rata basis. However, part of a month shall be taken as one month.	Pay the L/ fee plus Royalty for the entire duration in advance at issue of DL/ AIP/ license, OR pay it in annual advance instalments.

- v. In case the licensee defaults on one of the annual installment payments, all the remaining installments shall become immediately payable.

L/10/2017

Licence fee, late fee and Charging Methodologies

- vi. A Licensee shall be responsible to apply for the renewal of his/ her existing frequency authorization or wireless operating license (WOL), within a period of thirty (30) days *before* the expiry of the said WOL/ AIP/ DL.
 - vii. **Surrender of a License/ AIP/ DL:** Spectrum charges are payable minimum for one month and thus on surrender of licenses the Royalty charges in excess of one month can be adjusted. However, any monetary refund can only be made if the payments have been received for more than one year and surrender results the Royalty charges in excess of 1 year. The word "surrender" in this paragraph shall mean surrender of a complete License/ AIP/ DL with all its frequency assignments.
5. **Surcharge/Late Fee for Late Renewal of Wireless Station Licenses:** Surcharge/ Late fee for delayed renewal of various licenses shall be levied on the total amount due (i.e. license fee *plus* royalty charges) @ 2% per month or part thereof, subject to the minimum of Rs. 250/- per license. In case the delay is more than one year the said late fee shall be applied in an *annually compounded* manner.
6. This issues with the concurrence of the Wireless Finance Division, vide this Dy. No.482/Sr.DDG(WPF), dated 19/3/12.
7. This Order shall come into force from 1st April 2012.


(Viresh Goel)
Deputy Wireless Advisor
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