# TANZANIA COMMUNICATIONS REGULATORY AUTHORITY

## RADIO FREQUENCY BAND PLAN FOR RAILWAY COMMUNICATION SERVICES

First Version

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# RADIO FREQUENCY BAND PLAN FOR RAILWAY COMMUNICATION SERVICES

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## Acronyms and Abbreviations

For the purpose of this document, the following abbreviation applies: -

| | |
|---|---|
| RSTT | Railway Communication System between Train and Track Side |
| GSM-R | Global System for Mobile Communication-Railway |
| LTE-R | Long Term Evolution-Railway |
| LCX | Leaky Coaxial Cable |
| D2D | Device-to-Device |
| CSPs | Communication Service Providers |
| FRCMS | Future Railway Communications Mobile Systems |
| RAN | Radio Access Network |
| UIC | International Union of Railway |

## PART 1: Introduction

The Tanzania Communications Regulatory Authority (TCRA) Act of 2003, and Electronic and Postal Communications Act of 2010, mandate TCRA to manage, assign and promote the efficient use of the radio frequency spectrum resource in the United Republic of Tanzania.

The radio frequency spectrum is part of electromagnetic waves propagated in space and used as a communication medium for all wireless systems. The radio frequency spectrum is scarce public resource and thus subject to transparent, predictable and coherent governing policies, legislations and regulations. It requires proper and timely management in order to accommodate the current and future emerging technologies.

The radio frequencies used for Railway Communication Services in Tanzania are in line with the frequency allocation under International Telecommunication Union (ITU) region 1.

Railway transportation contributes to global economic and social development, especially for developing countries. Various radiocommunication technologies have been used for many years to carry railway operational applications in many countries. The communications industry has been continuously going through disruptive changes. To remain relevant, all industries globally are transiting to new technologies.

Railway communication systems too are undergoing a paradigm shift. Global System for Mobile Communications for Railways (GSM-R), is evolving to 5G based Future Railway Mobile Communication System (FRMCS).

GSM-R is the current technology the railway industry uses for its radio mobile communications. It is a modified off the-shelf technology system, based around commercial 2G based GSM (Global System for Mobile Communications) offerings for handheld mobiles but enhanced to deliver the specific railway functionality. GSM-R was introduced in the late 1990s, its specifications were developed by the International Union of Railways.

## PART 2: Scope and Purpose

This document details the Radio Frequency Spectrum Allocated for Railway Communication Services.

## PART 3: ITU-R Reports related to railway radiocommunications services

| TITLE | REPORT |
|---|---|
| Current and future usage of railway radiocommunication systems between train and trackside. | Report ITU-R M. 2442-0 |
| Description of Railway Radiocommunication Systems between Train and Tack Side. | Report ITU-R M. 2418-0 |
| Introduction to railway communication systems. | Report ITU-R M. 2395-0 |
| Digital land mobile systems for dispatch traffic. | Report ITU-R M. 2014-3 |

## PART 4: Technologies Used for Railway Communication Services

The following sections outline some of the technologies that have already been deployed around the world or are being considered for deployment in the next decade.

### (i) GSM-R

GSM-R, Global System for Mobile Communications – Railway is a radio communications standard for railway communication and applications. GSM-R supports mobile radio connectivity between train and trackside and serves units mounted on or integrated in trains from base stations along the trackside. The specification is being maintained by the International Union of Railways (UIC). GSM-R has been allocated two frequency bands 876**-880 MHz (train to ground), and 921-925 MHz (ground to train).** It is expected that GSM-R will be in service until 2030+.

### (ii) TETRA

Terrestrial Trunked Radio (TETRA) is a land mobile radio standard utilizing a control channel for resource management and designed for use by many government agencies, professional and emergency services, including railway transport. TETRA can communicate with direct mode or trunked mode operation. In addition to voice and dispatch services, TETRA systems support several types of data communication.

### (iii) LTE for Railways (LTE-R)

Long Term Evolution for Railways (LTE-R) is a next-gen communications network dedicated for rail-way services, enabling high-speed wireless voice and data communications inside trains, from the train to the ground and from train to train. This network supports voice communication among drivers, control centre operators, maintenance and other railway staff supporting; push-to-talk group communication, broadcasting, location-dependent addressing and multilevel prioritization; data communication for the train control signalling and other operation and maintenance as well as text messaging during voice communication; multimedia communication for wireless video surveillance, mobile video conference, file sharing, mobile office and passenger infotainment services.

**PART 5: Allocation of Frequency Bands for GSM-R**

GSM-R is the current technology the railway industry uses for its radio mobile communications. It is a modified off the-shelf technology system, based around commercial 2G based GSM (Global System for Mobile Communications) offerings for handheld mobiles but enhanced to deliver the specific railway functionality. GSM-R was introduced in the late 1990s, its specifications were developed by the International Union of Railways.

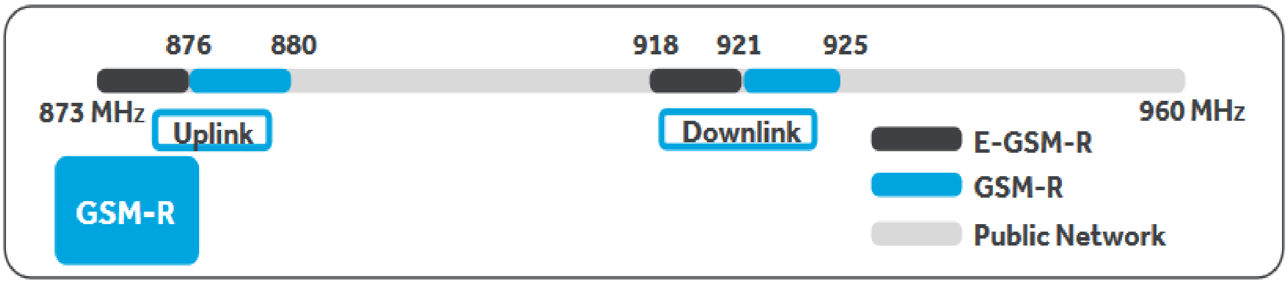


Figure 1. Allocation of frequency bands for GSM-R

**PART 6: GSM-R Services**

Various Communication services provided by GSM-R are as below: -

| S/N | Communication Type | Description |
|---|---|---|
| 1. | Point to Point (P2P) Call | Allows User to make a distinct call |
| 2. | Voice Broadcast Call | Allows groups of users to receive common information |
| 3. | Voice Group Call | Allows group of users to make calls within/among the groups |
| 4. | Emergency Call | Allows users to call controller by a short code or button during emergencies |
| 5. | Functional Addressing | Allows a user or an application to be reached by a number which identifies the relevant function and not the physical terminal |
| 6. | Location Dependent Addressing | Provides the routing of mobile originated calls to the correct controller, Example relative to geographic area |

| | | |
|---|---|---|
| 7. | eMLPP (enhanced Multi-Level Precedence and Pre-emption | Allows resource pre-emption for priority calls |

## PART 7: Allocated frequency Range for Railway Communication Services in Tanzania

The table below specifies the allocated frequency range for railway communication systems in Tanzania

| HF FREQUENCIES | |
|---|---|
| S/N | FREQUENCIES |
| 1 | 3 - 13 MHz |
| UHF FREQUENCY | |
| S/N | FREQUENCIES |
| 1. | 400 MHz |
| VHF FREQUENCIES | |
| S/N | FREQUENCIES |
| 1. | 148 - 155 MHz |
| GSM-R FREQUENCY BAND | |
| S/N | FREQUENCIES |
| 1. | 876 - 880 MHz / 921 - 925 MHz |
| FRMCS FREQUENCY BANDS | |
| S/N | FREQUENCIES |
| 1. | 874.4 - 880 MHz / 919.4 - 925 MHz |
| 2. | 1900 - 1910 MHz |

## PART 8: Main Functions of Railway Radio Communication System Between Train and Track Side (RSST)

The main functionalities of RSTT might be categorized as dispatching communication, train control and railway information. The characteristics of each kind of the functionalities are described below: -

### (i) Dispatching Communication

Dispatching communication is dedicated to carry voice and data between railway dispatchers and operators to perform railway specific operations within a specific time frame and to coordinate various railway specific operations in different locations.

### (ii) Train Control

Train control provides train movement related functions, including those associated with signalling, control and protection. RSTT is also designed to provide safe, reliable data transmission link for the train control system. With this train control function, the railway transportation efficiency, safety integration level as well as the operation interval has been improved.

### (iii) Railway information

Generally, railway information transmitted by RSTT could be classified into two kinds:

- to provide the railway transportation information for the operators, such as train operating status, mobile ticketing and check-in services etc.
- to provide relevant railway transportation information for passengers, such as travel information inquiry etc.

## PART 9: Internet of Things in Transportation Industry

The industrial IoT has also had a major impact on the transportation industry with the advent of innovations like autonomous vehicles and improved cargo management. Sensors can be deployed on railway tracks to monitor air and track temperatures and stress gauges. The introduction of IP networking will also allow more sensors to be deployed. The trackside network will provide data on track status, including faults and obstacles. Other connected devices will interact independently with sensors on the network to measure things such as water table levels, which can affect railway embankments should the ground become waterlogged and in ground sensors will detect actual and potential landslides. The following are the applications of Internet of Things (IoT) in Railway Industry: -

### (i) IoT for Passenger Trains

An integrated journey planner application could recommend the fastest or most comfortable trip, allowing for road conditions to the station, live train times, available car parking capacities, passenger loading, etc. Passengers would be able to make informed choices about what would provide them with the best experience according to their personal circumstances. The inclusion of historic data would enable evaluation for current trips as well as for future trips in a predictive way, based upon what is normal for the planned travel day and time.

Social networking apps could also be used in conjunction with passenger loading information from trains to help spread demand peaks. The same base of information could be shared at a terminal to help passengers select the destination platform efficiently, considering the loadings of other inbound trains. Sharing the same information on the train could enable a more even distribution of passengers within the carriages, potentially allowing standing passengers to find a seat.

### (ii) IoT for Freight Trains

IoT also offers benefits for freight trains. It could allow for each freight car to be monitored and data transmitted, allowing for the manifest of each car to be identified. The monitoring system on freight cars can now provide the data necessary to determine each freight car's location to within a meter. This makes it possible to seamlessly track and monitor rail transport activities. Furthermore, the sensors located inside the freight car can provide data on variables such as temperature and air humidity. Because of this, transport conditions can be monitored at each point along the route, ensuring that items such as foodstuffs in refrigerated wagons always arrive fresh at their destination. If critical temperature limits are exceeded, the system will immediately sound an alarm and notify the control centre.

Providing data information on car doors that have been opened would also increase the security of goods in transit. In addition, shock monitoring functionality can be added for monitoring heavy shocks during manoeuvrings, or during transfer of freight onto railway cars. This makes it possible to properly assess the causes of damage to freight cars and freight, in addition to analysing transport conditions.

The mileage of railcars is a matter of great importance. Providing the precise mileage for each car would help in the planning of repair and maintenance work.

### (iii) IoT and Rail Safety

Safety is a key element of IoT applications and solutions for train management. For example, onboard train location and detection systems enable trains to be "aware" of the positions of other trains. This reduces the risk of collisions by allowing trains to operate safely in close proximity to one another. This is essential for transit systems such as GO Transit.

Speed monitoring and control is another important safety application. Systems have been developed that can display train velocity for drivers and report speeds back to central control systems. Onboard monitoring systems are interconnected with outdoor signalling systems that can regulate train speeds and remotely command trains to stop based on track conditions, the positions of switches, and/or the presence of other trains on the track.

**PART 10: Future Railway Mobile Communication System (FRMCS)**

Future Railway Mobile Communications System (FRMCS) is a new 5G-based framework, allowing railway operators to modernize train services and help stay on track for business success. Digitalization is triggering innovation in 5G networks and use-cases across every industry segment. Moving to the latest technology will allow the railway industry to benefit from the cost competitiveness of the global 5G landscape and 3GPP standards. FRMCS will be based on dedicated 5G bands for railways. 5G was originally designed to support high mobility services requiring high reliability and low latency which are in alignment with the performance requirements of railway communications defined by the UIC. Railway applications relying on critical data communications have latency requirements below 10 ms. The 5G New Radio (NR) features that support low and bounded latency can enable such use cases. While operators will benefit from the low latency and high bandwidth of the new spectrum available for rail, the passengers will benefit from a much higher quality of rail services.

Thus, with 5G NR as its critical enabler, FRMCS is set to become the global standard for railway communications. This mobile broadband-ready technology will not only help improve operational efficiency but also accelerate digital transformation leading to improved safety and support for innovative passenger services. Some of the advantages of 5G based FRMCS include:

(a) **Ubiquitous connectivity** to keep railway passengers connected at all times. This will improve infotainment services such as multimedia passenger information systems and streaming services tremendously.

(b) **Downloadable app** to allow passengers to use apps that integrate on-board video content, providing real-time situational awareness. For example, real-time video of train station locations or rail carriage occupation levels.

(c) **Enhanced safety and reliability** of services to commuters and freight operators at reduced cost and better security, including:

(i) Automatic train operations supported by automation and sensor communications. Sensors will be deployed for monitoring tracks, rolling stock, power systems, and environmental conditions. 5G will enable all this data to be connected in real time.

(ii) When combined with software analytics and machine learning, 5G will enable railway operators to carry out preventive maintenance, predict failures, and anticipate floods and other events that could interrupt services.

(iii) Higher bandwidth of 5G will allow much greater usage of high-quality video for security, communications between operational personnel, improved situational awareness during emergency events, drone inspections, and a host of other applications that generate video and/or high amounts of data.

(iv) Using IoT data to predict maintenance requirements will increase the availability and productivity of rail assets. It will facilitate higher standards of protection from cybersecurity attacks and physical threats.

(v) 5G will enable analytics that identify potential incidents at rail crossings before they happen.

The table below itemizes the Future Railway Mobile Communication System (FRMCS) Use Cases:

| **FRMCS** | |
|---|---|
| **Use Cases** | **Description** |
| Voice Services | ▪ Already implemented in GSM-R, used for communication in incident and emergency.<br>▪ Comprise features as location dependent addressing, and group call services |
| Automatic Train Operations | ▪ Operation is based on “Journey Profiles” (JP) to run the train safely under the best working conditions<br>▪ JP are used to control the driving behaviour of the train (e.g., intended acceleration and breaking according to the maps and segment profiles)<br>▪ Onboard devices send status information to trackside control (e.g., running speed, train control policy, accurate intra-station stopping) |

| | |
|---|---|
| Remote Driving | ▪ Operate the train in case of incidents (in case no staff is on the train), with remote driver located at a distributed operation centre receiving video data from the train cameras and operates the train remotely on sight |
| Onboard/ Line side Video Surveillance | ▪ Aim to improve efficiency of operation and safety<br>▪ Empower remote staff located at a distributed location to identify and act on critical situations inside and outside the train<br>▪ Supported as P2P, P2MP, area- or user-based video group call services |

## PART 11: Document Administration

### 11.1 Amendment

TCRA may from time-to-time, review, update or modify this document to ensure its continued service in alignment with national and international performance requirements.

### 11.2 Compliance

Appropriate provisions of the TCRA Act, 2003, the Electronic and Postal Communications Act, 2010 and the Electronic and Postal Communications (Radiocommunication and Frequency Spectrum) Regulations, 2018, shall be utilized to ensure compliance of this document. The document will come into use from the official date of its publication.

### 11.3 Publication

This document shall be published on the TCRA website https://www.tcra.go.tz for public information, compliance and reference purposes.

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