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RDSO-TELE0LKO(TECH)/3/2019-O/o ED/Tele-I/RDSO

Date: 01.06.2022

Executive Director,
Center for Development of Telematics,
Mehrauli,
New Delhi, 110030

(Kind Attention: Pooja Gupta, Project Coordinator)

Sub: Functional Requirements Specifications of LTE for Proof of Concept for Indian Railways

Ref: Railway board letter no. 2020/Tele dev/Implementation of LTE dated: 29.01.2022

Vide letter under reference, RDSO/Lucknow has to certify, the PoC has been in line with the requirements and specifications envisaged by Railways. In this regard Functional Requirement Specification of LTE for PoC has been prepared and approved by competent authority. The same has been uploaded on RDSO website at following path.

https://rdso.indianrailways.gov.in/view_section.jsp?lang=0&id=0,2,6669,6670,6673

Further course of action for PoC may be taken accordingly.

1/6/22

(G. Pavan Kumar)
Executive Director/Telecom-II
For Director/General/RDSO/Telecom

Copy:
ED/TD/Railway Board for kind information
PCSTE/SCR for kind information
DG/IRISET for kind information

सत्यमेव जयते

GOVERNMENT OF INDIA
(भारत सरकार)

MINISTRY OF RAILWAYS
(रेल मंत्रालय)

Functional Requirements Specifications of LTE for Proof of Concept for Indian Railways.

FRS No.

Version 0 d0

May-2022

Issued by

SIGNAL & TELECOM DIRECTORATE
RESEARCH, DESIGNS & STANDARDS ORGANISATION
MINISTRY OF RAILWAYS
MANAK NAGAR
LUCKNOW – 226 011

अअमासं RDSO
रेल अग्रदूत Transforming Railways
www.rdso.gov.in

DOCUMENT DATA SHEET		
FRS/LTE		Version 0.0
Title of Document **Functional Requirements Specifications of** LTE for Proof of Concept for Indian Railways.		
Authors See Document Control Sheet		
Approved by RDSO **Name: Shri Rajendra Dhambel** Designation: Principal Executive Director/S&T/RDSO		
Abstract This document covers **Functional Requirements Specifications of LTE for Proof of Concept for Indian Railways.**		

DOCUMENT CONTROL SHEET

Name	**Organization**	**Function**	**Level**
Shri Govind Pandey, JRE/Tele	**RDSO**	Member	Prepare
Shri C.S. Mahoviya SSE/Tele	**RDSO**	Member	Prepare
Shri Vijay Garg Director Tele-I	**RDSO**	Member	Verification
Shri G. Pavan ED/Tele-II	**RDSO**	Member Secretary	Recommend
Shri Rajendra Dhambel PED/S&T/RDSO	**RDSO**	Approving Authority	Approve

List of Abbreviations:

3GPP	Third Generation Partnership Project
AC	Alternating Current
CA	Carrier Aggregation
CAT6	Category 6
CDoT	Centre for Development of Telematics
CISPR	International Special Committee on Radio Interference
DoS	Deniel of Service
CR	Cab Radio
CRC	Cyclic Redundancy Check
CTC	Centralized Traffic Control
dBm	decibel-milliwatts
DC	Direct Current
DEMU	Diesel Electrical Multiple Unit
DoT	Department Of Telecommunication
DPWCS	Distributed Power Wireless Control System
EIRENE	European Integrated Railway Radio Enhanced Network
EMC	Electromagnetic Compatibility
EMU	Electrical Multiple Unit
EoTT	End of Train Telemetry
EPC	Evolved Packet Core
EPS	Evolved Packet System
ESS	Environmental Stress Screening
ETCS	European Train Control System
ETSI	European Telecommunications Standards Institute
E-UTRAN	Evolved Universal Mobile Telecommunications System (UMTS) Terrestrial Radio Access Network
FA	Functional Addressing
FDD	Frequency Division Duplexing
FRS	Functional Requirement Specification
GBR	Guranteed Bit Rate
GPS	Global Positioning System
GSM	Global System for Mobile communications
GSM-R	GSM – Railway
GW	Gateway

Hq	Head Quarter
HLR	Home Location Register
HSS	Home Subscriber Server
ID	Identity Number
IEC	International Electrotechnical Commission
IMS	IP multimedia subsystem
IMSI	International Mobile Subscriber Identity
IP	Ingress Protection/Internet Protocol
IP-MPLS	Internet protocol Multi-protocol label switching
IPv4	Internet Protocol Version 4
IPv6	Internet Protocol Version 6
IRNSS	Indian Regional Navigation Satellite System
IR	Indian Railway
IS	Indian Standard
KAS	KAVACH Application Server
KHz	Kilohertz
KMS	Key Management System
KV	Kilovolt
LDA	Location Dependent Addressing
LES	Loco Exchange Server
LTE	Long Term Evolution
M	Mandatory
MAC	Media Access control
MC	Mission Critical
MCData	Mission Critical Data
MCPTT	Mission Critical Push To Talk
MCVideo	Mission Critical Video
MCX	Mission Critical X, with X = PTT or X= Video or X= Data
MCX Service	Mission Critical Service
MEMU	Mainline Electric Multiple Unit
MHz	Mega Hertz
MME	Mobility Management Entity
MMI	Man-Machine Interface
MSB	Most Significant Bit
MSISDN	Mobile Station International Subscriber Directory Number.

MSN	Mobile Subscriber Number
MVB	Multifunction Vehicle Bus
NB-IoT	Narrow Band Internet of Things
NMS	Network Management System
Non-GBR	Non Guranteed Bit Rate
NSS	Network Sub-System
OFC	Optical Fibre Cable
OTT	Over the Top
OVK	Onboard Vital Kavach
PCRF	Policy and Charging Rules Function
PDN	Packed Data Network
PoC	Proof of concept
QCI	QoS Class Identifier
QoS	Quality of Service
RAN	Radio Access Network
REC	Railway Emergency Call
RH	Relative Humidity
RMS	Root Mean Square
SDF	Service Data Flow
SCR	South Central Railway
SIP	Session Initiation Protocol
SIM	Subscriber Identity Module
SM	Station Master
SNMP	Simple Network Management Protocol
SVK	Stationary Vital Kavach
SOF	Start Of Frame
TEC	Telecommunication Engineering Centre
TSR	Train Speed Restriction
TSRMS	Train Speed Restriction Management System
UE	User Equipment
UHF	Ultra High Frequency
URL	Uniform Resource Locator
V2V	Vehicle-to-Vehicle
V2X	Vehicle-to-Everything
VBS	Voice Broadcast Service
VGCS	Voice Group Call Service

List of Definitions

i. **Acceptance Tests**: Tests carried out on the equipment/ system for the purpose of acceptance of the equipment/ system.

ii. **Active Cab**: The active cab is the cab associated with an onboard KAVACH, from which the traction is controlled.

iii. **Broadcast call**: A call made to all members of a pre-defined group within a local geographical area. Only the initiator of the call may talk, with all other group members listening only.

iv. **Carrer Aggregation:** Carrier aggregation is a technique that is used in wireless communication to increase the data rate per user, whereby multiple frequency blocks (called component carriers) are assigned to the same user.

v. **Emergency Call**: A call of highest priority for warning a dangerous situation in a pre defined area

vi. **Frequency division Duplexing (FDD):** Frequency-division duplexing (FDD) is a method for establishing a full-duplex communications link that uses two different radio frequencies for transmitter and receiver operation.

vii. **Functional Acceptance Tests**: Tests carried out by installing some equipment in the field to prove that the system performs in accordance with this specification & the local configuration data is acceptable.

viii. **Functional Addressing**: An addressing scheme shall be provided which permits users to be identified by numbers corresponding to their functional roles rather than by numbers tied to the terminal equipment that they are using.

ix. **GBR bearer**: An EPS bearer with reserved (guaranteed) bitrate resources. GBR SDF aggregates are typically authorized "on demand" which requires dynamic policy and charging control

x. **Group call:** A call made to all members of a pre-defined group within a local geographical area. Only one member of the group may talk at any instant, with all other group members listening only.

xi. **KAVACH:** It is the brand name of Automatic TrainProtection System developed for Indian Railways.

xii. **Location Dependent Addressing**: Location dependent addressing shall be provided to route calls for a given function to a destination number that is dependent upon the user's location

xiii. **Multi-party call**: A voice communication method whereby a number of parties defined by the call initiator may participate in the call. All parties may talk simultaneously.

xiv. **Non-GBR bearer**: An EPS bearer with no reserved (guaranteed) bitrate resources. A Non GBR SDF aggregate may be pre-authorized through static policy and charging control.

xv. **Public emergency call:** A point-to-point voice call which is used to notify non-railway authorities (such as Police, Fire, Disaster Management and Ambulance services) of an emergency situation.

xvi. **Shunting mode:** A radio is considered in "Shunting Mode" when it is prepared to receive shunting emergency calls but cannot receive train emergency calls.

1. Executive Summary

This document covers the functional requirements of LTE (Long Term Evolution) for Indian Railways. (Ref. Railway board letter for PoC no. 2020/Tele dev/Implementation of LTE dated 29.01.2022).

2. Forward

This Functional Requirements Specification for Long Term Evolution (LTE) is released to address the requirements that are relevant for field trials to be conducted in Secunderabad – Lingampalli automatic section of South Central Railway with the objective to conduct following tests:

(i) Voice, Video & Data Communication.
(ii) Interface requirements of KAVACH over LTE.
(iii) Mission Critical applications pertaining to Railways.

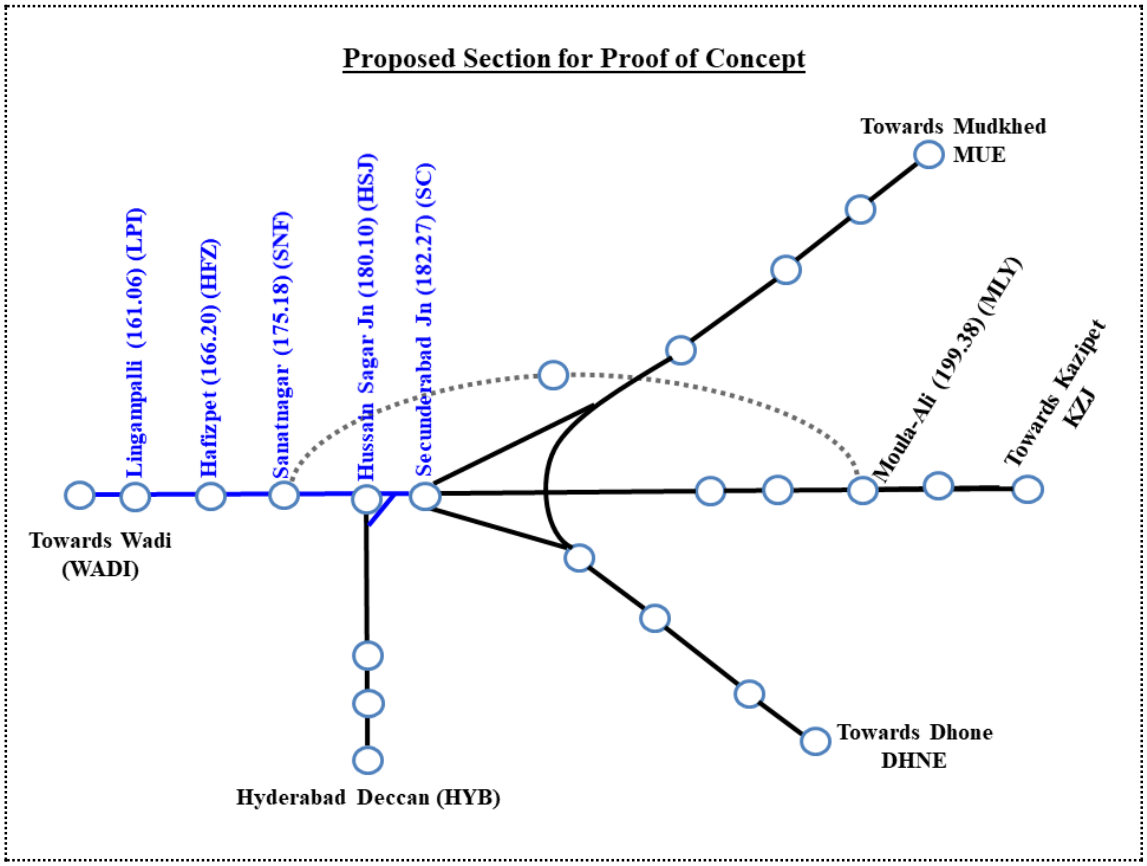
3. Section proposed for proof of concept

Secunderabad – Lingampalli section of Secunderabad Division in South Central Railway is proposed for the Proof of Concept. The section is a part of the automatic signalling territory carrying major sub-urban traffic of SCR. The section has been proposed to cover varied aspects of KAVACH and telecommunication needs of Indian Railways. The characteristics of the section are briefly reproduced below:

Station	**Secunderabad Jn**	**Hussain Sagar Jn**	**Sanatnagar**	**Hafizpet**	**Lingampalli**
KM	182.27	180.1	175.18	166.2	161.06
No. of Platforms	Ten	Nil	Three	Two	Six
KAVACH Equipped	No*	No	Yes	Yes	Yes
Make of KAVACH	Medha	-	Medha	Kernex	HBL
Tower available	Yes	No	Yes	Yes	Yes
Height of Tower	40 m	-	30 m	30 m	30 m
Type of Tower	Lattice	-	Lattice	Monopole	Lattice
Shunting Needs	High	Low	High	Medium	Medium
No. of Station Radio at station	3	1	1	1	1
No. of Handheld PTT Sets Required#	2	1	1	1	1
No. of Cab Radios	6 Nos. to be installed in loco of 3 trains				

*Will be commissioned shortly

Six numbers of Handheld PTT Sets Required for locos in 3 trains



In addition to above, there are several halt stations with two platforms in this section. Three KAVACH equipped EMUs will be nominated for the Proof of Concept by SCR. These are to be equipped with six LTE router, six cab radios and six MCPTT sets.

4. Scope

4.1 LTE for Railways consists of User Equipment, Evolved Universal Terrestrial Radio Access Network, Evolved Packet Core with MCX capabilities for Mission-Critical Push To Talk (MCPTT), Mission Critical Data (MC Data) and Mission Critical Video (MC Video) application, normal voice communications.

4.2 The LTE Functional Requirements Specification defines the requirements of a radio system satisfying the mobile communications needs of the Indian railways. It encompasses ground-train voice and data communications, together with the ground-based mobile communications needs of trackside workers, station, depot staff and railway administrative and managerial personnel.

4.3 All voice call services shall be able to operate between any combination of fixed and mobile equipment users.

4.4 To meet the functionality and performance requirements of LTE, the following system services are required:

4.4.1 The system shall be designed to work in 700 MHz spectrum (703-748 MHz Uplink & 758-803 MHz Downlink, 3GPP/ETSI Band 28) with 5 MHz (paired) spectrum in the spectrum

block 713-718/768-773 MHz Carrier bandwidth allocated to Indian Railways as per Ministry of Communication, Department of Telecommunication Letter No. L-14001/01/2019-NTG (pt.) dated 22.10.2021.

4.4.2 LTE shall be able to support Frequency Division Duplexing (FDD). The system shall support minimum channel bandwidth of 5 MHz and 25 Transmission Bandwidth configurations (Ref. Doc. No. ETSI TS 136 101 V13).

4.4.3 The system shall also support Carrier Aggregation (CA) as per 3GPP/ETSI specification(O).

4.4.4 The LTE Radio Network shall be planned with double radio coverage (100% Coverage Overlap) where in case of one eNode-B failure; the adjacent eNode-Bs will cover the requirements.

4.4.5 The System shall support broadcast based V2V application. V2X application is preferable (Ref. Doc. No. ETSI TS 122 185 V14). These applications are required for Collision prevention by KAVACH, DPWCS and EoTT.

4.4.6 MCX should be a completely integrated solution or OTT solution (whichever C-DoT is comfortable with) and support to define MCX aliases for functional addressing (FA) and location dependent addressing (LDA).

4.5 The EPC is composed of network elements: the Serving Gateway (Serving GW), the PDN Gateway (PDN GW), the MME, PCRF and the HSS.

(i) PCRF: It shall apply Gating control, QoS control and Usage monitoring control.

(ii) Serving Gateway & PDN Gateway: The control plane shall reside near EPC. User planes shall be provided at the Secunderabad and Lingampalli stations in a georedundant manner.

4.6 MCX Solution shall provide voice, data and video capabilities to the LTE system by using LTE terminals.

4.7 Interoperability with GSM-R is not covered in the scope of PoC.

4.8 Software update of any part of the LTE system should be possible with minimal disruption to operations and should not lead to undesired situations.

5. LTE system requirements

(i) Frequency of operation: 700MHZ.
(ii) OFC Backbone: IPMPLS
(iii) Radio network planning with 30m of coverage on either side of railway track.
(iv) SIP/IMS server for which C-DOT is Comfortable.
(v) Onboard LTE router modems.
(vi) Interface development with KAVACH at EPC end.
(vii) MCPTT handsets and Dispatcher terminals.
(viii) SIM cards- Approx 50.
(ix) V2V Communication (Preferable)
(x) LTE shall support in band and guard operational modes of NB-IoT (O).

6. Test related to voice, MC voice, MC Data & MC Video

6.1 The following Voice services are to be tested:

(i) Voice broadcast service.
(ii) Voice group call service.
(iii) Point to point voice calls.
(iv) The system shall support multi-party voice communications. Any of the parties involved in a multi-party voice call shall be able to talk simultaneously.

6.2 Railway specific applications to be tested:

(i) Support for functional addressing by train, engine or driving coach number[1] or functional number.[1]
(ii) Call specific persons depending upon user location.
  a) Location dependent addressing: Location dependent addressing shall be provided to route calls for a given function to a destination number that is dependent upon the user's location.
  b) The functions to which calls shall be routed based upon the location of the mobile shall include:
    - Primary controller
    -Secondary controller
    -Station Master
  c) For Location dependent addressing, the jurisdiction of Station Master will be from Distant Signal of his station to Distant Signal of Next Station.
  d) In Location dependent addressing, during ongoing call, if the train crosses the jurisdiction of existing station master/controller, the call should not get disconnected until user deliberately disconnects the call. However once disconnected, the next call should be connected as per new jurisdiction.
(iii) Specific mode for shunting operations providing a link assurance signal.
(iv) Multiple Loco Pilot communications within the same train.
(v) Railway operational emergency calls.

6.3 Mission Critical Voice Services to be tested:

(i) Priority MCPTT Point to Point Calls.
(ii) Priority MCPTT Group Calls.
(iii) Broadcast Group Calls from authorized MCPTT Group Members.
(iv) Private call and Private Call (with Floor control).
(v) MCPTT Emergency Group Calls with highest priority over all other MCPTT Group transmissions.
(vi) Support the confidentiality and integrity of all user traffic and signalling at the application layer.

[1] Train no. is 5 digit, Engine/driving coach no. varies from 5 to 6 digits.

6.4 The Following Data Services to be tested:

6.4.1 Data Services:

(i) Text Messages – point-to-point and point-to-multipoint text messages.
(ii) General data application - timetable information, maintenance and diagnostic information, email, remote database access.

6.4.2 Mission Critical Data Services:

(i) Train Control applications such as KAVACH etc.

6.5 Mission Critical Video Services to be tested:

(i) Video Surveillance;
(ii) Emergency Alert;
(iii) The MCVideo service shall support MCVideo UEs that are capable of only transmitting, only receiving and both transmitting and receiving videos;
(iv) Remote camera control;
(v) Video Conferencing;
(vi) The MCVideo Service shall enable MCVideo Service Administrator to create a hierarchy for determining which Participants, Participant types, and urgent transmission types, if any, shall be granted a request to override an active MCVideo Service transmission.

7. Call related services

7.1 The network shall support as a minimum following call related services:

(i) Display of identity of called/calling user;
(ii) Restriction of display of called/calling user; (O)
(iii) Priority and pre-emption;
(iv) Call forwarding – unconditional(M), busy(M), no reply (O), not reachable (O)
(v) Call hold;
(vi) Call waiting;
(vii) Call barring (O).

Note:- (O) : Optional requirement as given in EIRENE standards.
(M) : Mandatory requirement as givenin EIRENE standards

7.2 Railway specific features:

(i) Set-up of urgent or frequent calls through single keystroke or similar.
(ii) Display of functional identity of calling/called party in case of Functional Addressing.
(iii) Fast and guaranteed call set-up.
(iv) Seamless communication support for train speeds up to 250 Kmph (Design). To be tested up to the maximum permissible speed of the trial section.
(v) Automatic and manual test modes with fault indications.
(vi) Control over mobile network selection.
(vii) Control over system configuration.

Autorized person shall be able to configure software (i.e. numbering scheme, user related services etc.) and hardware components of the network system according to the requirement.

7.3 High Priority point to point call connectivity should be as shown in table below (O) :-

		Receiving Party									
Initiating Party		Primary Controller	Secondary Controller	Approaching SM	Rear SM	Ahead SM	Cabin	Loco Pilot	Assistant Loco Pilot	Guard	Other Train Loco Pilot
	Primary Controller		Yes	Yes	Yes	Yes	No	Yes		Yes	
	Secondary Controller	Yes		Yes	Yes	Yes	No	Yes		Yes	
	Approaching SM	Yes	Yes		Yes	Yes	Yes	Yes		Yes	
	Rear SM	Yes	Yes	Yes							
	Ahead SM	Yes	Yes	Yes							
	Cabin	No	No	Yes				Yes		Yes	
	Loco Pilot	Yes	Yes	Yes			Yes		Yes	Yes	Yes
	Assistant Loco Pilot			Yes			Yes	Yes		Yes	Yes
	Guard	Yes	Yes	Yes			Yes	Yes	Yes		
	Other Train Loco Pilot							Yes	Yes		

8. Bearer service for external applications

Other applications for which LTE shall provide the bearer service may include public address system and on-train intercom.

9. Network Configuration

(i) The LTE radio network shall have double radio coverage (100 % overlap), so that if one eNode-B fails, the requirements will be fulfilled by the adjacent eNode-Bs.

(ii) The E-UTRAN shall provide coverage up to a distance of 30 meters from the nearest running rail in all the directions.

(iii) The level of coverage should be at least 95% of the time over 95% of the designated coverage area for a radio installed in a vehicle with an external antenna.

(iv) Call set up Requirements:

a) Call set-up time shall be less than two seconds for normal call and less than one second for emergency calls. The required call set-up times shall be achieved in 95% of cases.

b) The handover success rate should be at least 99.5% over train routes under design load conditions.

10. Services and Facilities

10.1 The following voice telephony services are to be supported for each type of mobile radio:

Features	Cab Radio	UE	Dis-patcher	Station Radio
Point-to-point voice calls	M	M	M	M
Public emergency voice calls	O	O	M	M
Broadcast voice calls	M	M	M	M
Group voice calls	M	M	M	M
Multi-party voice calls	M	O	M	M

Note:- M = Mandatory requirement.
O = Optional requirement.
N/A = Not Applicable.

10.2 The following data applications are to be supported for each type of mobile radio:

Features	Cab Radio	UE	Dis-patcher	Station Radio
Text message service	M	M	M	M
General data applications	M	O	M	M

10.3 The following call related services are to be supported for each type of radio:

Features	Cab Radio	UE	Dis-patcher	Station Radio
Display of calling user identity	M	M	M	M
Display of called user identity	M	M	M	M
Restriction of display of user identity	O	O	O	O
Call forwarding	-	-	-	-
(a) Unconditional	M	O	O	O
(b) If user busy	O	O	O	O
(c) If no reply	O	O	O	O

Features	Cab Radio	UE	Dispatcher	Station Radio
(d) If not reachable	O	O	O	O
Call Hold	M	O	M	M
Call Waiting	M	M	M	M
Call Barring	M	O	M	M
Auto answer service	M	O	M	M
Call supervisory information	O	O	O	O

10.4 The following features are to be supported for each type of radio:

Features	Cab Radio	UE	Dispatcher	Station Radio
Functional addressing	M	M	M	M
Location dependent addressing	M	O	M	M
Shunting Mode	M	M	M	M
Multiple Loco Pilot Communications with the same train	M	N/A	M	M
Railway Emergency Calls	M	M	M	M

11. Environmental Requirements (The equipment used in PoC need not be tested, but they shall be certified preferably)

11.1 Environmental Requirements:

Sr.	Test Type	Equipment Condition	Severity	Specification
1	Dry heat test (Operation)	Operating	For functional trials: Temp. 70 ºC Duration: 16 hrs.	IS: 9000 Pt. III Section: V
	Dry heat test (Storage)	Non-operating	Temp. 75ºC Duration: 16 hrs.	
2	Cold Test (Operation)	Operating	Temp. –10ºC +/- 3^0C, Duration: 2 hrs.	IS: 9000, Pt. II
3	Rapid variation temperature test	Operating	-10 to +70ºC, Duration: 7 hrs at each temperature. Rate of change: 1ºC per Minute. No. of cycle: 03	IS: 9000 Pt. XIV Section: II
4	Damp heat test (steady state storage)	Operating	RH 95% @ 40ºC Duration = 4 days	IS: 9000 Pt. IV

5	Damp heat test (Cyclic)	Operating	RH 95% @ 40ºC (high) , 25ºC (low) Duration: 12 + 12 = 24 hrs cyclic No. of cycles = 6	IS: 9000 Pt. V Section-II
6	Bump Test (Package)	Non-operating	40g peak, 4000 bumps per axis Duration: 6 milliseconds No. of axes: 03	IS: 9000 Pt. VII Section II
7	Mechanical Shock Stationary and Loco unit	Power off Condition	11 millisecond (half sign pulse), 20g peak.	IS: 9000 Pt. VII ,Section-I
8	**Vibration test**			IS: 9001 Pt. XIII
(i)	Onboard	Non-operating	5 Hz to 150 Hz Acceleration A: 3g 20 sweep cycles on 3 axes	
(ii)	Stationary	Non-operating	5 Hz to 35 Hz Acceleration A: 2g 20 sweep cycles on 3 axes	
9	Salt Mist test			IS: 9000 Pt. XI
(i)	On Board (inside cab)	Non-operating	Procedure 3: Salt: 2hrs, Mist Duration =22 hours 35(+/-)3ºC, RH: 95% No. of cycles: 03	
(ii)	On Board (outside cab)	Non-operating	Procedure 2: Salt: 2hrs, Mist: Duration=7 days 35(+/-)3ºC, RH: 95% No. of cycles: 04	
(iii)	In door	Non-operating	Procedure 3: Salt: 2hrs, Mist Duration =22 hours 35(+/-)3ºC, RH: 95% No. of cycles: 03	
(iv)	Out door (On Track /Track side)	Non-operating	Procedure 2: Salt: 2hrs, Mist: Duration=7 days 35(+/-)3ºC, RH: 95% No. of cycles: 04	
10	Dust test	Non-operating	1 hour only	IS: 9000 Pt. XII
11	7 KV discharge Test	Non operational	.....	RDSO/SPN/144/2006: Clause 9.4.1.
12	Environmental Stress Screening (ESS) test	(PCB Cards)	……	RDSO/SPN/144/2006: Clause 9.3 serial no.13
(i)	Thermal Cycling	Non operational	.....	

(ii)	Power Cycling	Non operational	.....	

11.2 Other type tests :(Only Applicable for Rolling stock equipment)

(i) Variation and interruption of voltage supply (Class: S2) to equipment tests as per clause 5.1.1.2 and 5.1.1.3 of IEC 60571 -2012 or relevant clause of latest amendment / issue.

(ii) Supply over-voltage and surges tests as per clause 5.2 & 12.2.7 of IEC 60571 - 2012 or relevant clause of latest amendment / issue. Electrostatic discharge tests shall be carried out as per Clause 9.4.1 of RDSO/SPN/144/2006 or relevant clause of latest amendment.

(iii) Transient burst and susceptibility test as per clause 5.5 of IEC 60571-2012 or relevant clause of latest amendment / issue.

(iv) Radio interference test as per clause 5.5 & 12.2.8 of IEC 60571-2012 or relevant clause of latest amendment / issue.

(v) Insulation test as per clause 12.2.10 of IEC 60571 -2012 or relevant clause of latest amendment / issue.

11.3 EMI/ EMC requirements for LTE base Station shall be as below as applicable:-

#	**Parameter**	**Standard**
i)	Conducted and Radiated Emission	CISPR 22 (2008) OR CISPR 32 Class-A
ii)	Immunity to Electrostatic discharge: Contact discharge level 2 {± 4 kV}	IEC-61000-4-2 Performance Criteria-B, Clause 9
iii)	Immunity to Electrostatic discharge: Air discharge level 3 {± 8 kV}	IEC-61000-4-2 Performance Criteria-B, Clause 9
iv)	Immunity to radiated RF: (a) Radio Frequency: 80 MHz to 1 GHz, Electromagnetic field: 3V/m (b) Radio Frequency: 800 MHz to 960 MHz, Electromagnetic field: 10V/m (c) Radio Frequency: 1.4 GHz to 6 GHz, Electromagnetic field: 10V/m	IEC 61000-4-3 (2010); Performance Criteria-A, Clause 9
v)	Immunity to fast transients (burst): Test Level 2: (a) 1 kV for AC/DC power port (b) 0. 5 kV for signal / control / data / telecom lines.	IEC 61000- 4- 4 {2012); Performance Criteria-B, Clause 9
vi)	Immunity to surges: AC/DC ports a. 2 kV peak open circuit voltage for line to ground b. 1kV peak open circuit voltage for line to line	IEC 61000-4-5 (2014) Performance Criteria-B, Clause 9

#	Parameter	Standard
vii)	Immunity to surges: Telecom ports (a) 2 kV peak open circuit voltage for line to ground coupling. (b) 2 kV peak open circuit voltage for line to line coupling.	IEC 61000-4-5 (2014) Performance Criteria-C, Clause 9
viii)	Immunity to conducted disturbance induced by Radio frequency fields: Under the test level 2 {3 V r.m.s.} in the frequency range 150 kHz-80 MHz for AC / DC lines and Signal /Control/telecom lines.	IEC 61000-4-6 (2013) Performance Criteria-A, Clause 9
ix)	Immunity to voltage dips & short interruptions (applicable to only ac mains power input ports, if any): **Limits: -** (a) a voltage dip corresponding to a reduction of the supply voltage of 30% for 500ms (i.e. 70% supply voltage for 500ms) (b) a voltage dip corresponding to a reduction of the supply voltage of 60% for 200ms; (i.e.40% supply voltage for 200ms) (c) a voltage interruption corresponding to a reduction of supply voltage of > 95% for 5s. (d) a voltage interruption corresponding to a reduction of supply voltage of >95% for 10ms.	IEC 61000-4-11 (2004): a. Performance Criteria B for Reduction of Supply 30% for 500ms or Dip to reduction of 60% for 100ms b. Performance Criteria C for Reduction of 60% for 200ms c. Performance criteria C for Voltage Interruption>95% for 5 s (Note: In case of Battery back-up performance criteria A is applicable). d. Performance Criteria B for Voltage Interruption >95% duration :10ms (Note: In case of Battery back-up Performance Criteria A is applicable for above conditions.)

11.4 Safety requirements for LTE base Station may be as below as applicable:-

S. No.	Parameter	Standard
i)	The equipment shall conform to IS 13252 part 1:2010- "Information Technology Equipment – Safety- Part 1: General Requirements" [equivalent to IEC 60950-1 {2005} "Information Technology Equipment –Safety- Part 1: General Requirements"] Or IEC 62368-I:2014	IS 13252 part 1:2010 / IEC 60950-1 {2005} part 1; or IEC 62368-I:2014

11.5 Electromagnetic Radiation: The LTE shall meet Department of Telecom (DoT) latest guidelines and regulations for Electromagnetic Radiation from Antennae (LTE Base station).

11.6 As per DoT, "Licensee shall conduct audit and provide self certificates after every two year as per procedure prescribed by Telecommunication Engineering Centre (TEC)/ or any other agency authorised by Licensor from time to time for conforming

to limits/levels for Antennae (Base Station) Emissions for general public exposure as prescribed by the Licensor from time to time. The present limits/levels* are reproduced as below:-

Frequency Range	E-Field Strength (Volt/Meter (V/m))	H Field Strength (Amp/Meter (A/m))	Power Density (Watts/Sq. Meter (W/Sq.m))
400 MHz to 2000 MHz	0.434 $\mathbf{f}^{1/2}$	0.0011 $\mathbf{f}^{1/2}$	**f** / 2000
3 GHZ to 300 GHz	19.29	0.05	1

(**f** = frequency in MHz)" (*as per DoT letter no. 800-15/ 2010-V AS, dated 26/06/2013)

11.7 The typical requirement for Temperature and Humidity and Ingress Protection is mentioned below:-

Equipment	Ingress Protection (IP)
Indoor Installation	IP 54 or higher
Outdoor Installation	IP 67 or higher

11.8 For indoor installations, provision of Air Conditioning is mandatory.

11.9 In case, equipment is housed in an enclosure then the enclosure shall meet IP requirements.

12. Functional Requirement of Mobile Equipment

12.1 Cab Radio System

12.1.1 Each Train Engine (Loco) shall be provided with 2 nos. of Cab Radio Systems in for Indian Railways front and Rear Loco compartments.The Cab Radio System shall provide mission critical Voice and Data communication for train operational requirements.

12.1.2 The Cab Radio System shall work on the spectrum assigned for LTE to Indian Railways.

12.1.3 The equipment shall work on DC supply source normally consisting of accumulator battery and / or an auxiliary generator. The nominal and limits of voltage in which the equipment shall operate satisfactorily are as under:

Type of Locomotive	Nominal Voltage	Limits of voltage
Diesel-Electric	72 Volts DC	50 to 90 Volts DC

Electric, EMUs, DEMUs, MEMUs, Train Set etc.,	110 Volts DC	79 to 136 Volts DC

12.1.4 Cab Radio shall boot when the supply voltage is applied. The Cab Radio shall be activated by inserting BL key (Electric Locos) or placing Reverser handle in the forward position (in Diesel Locos).

12.1.5 It shall give an audible and visual indication is given that connection to a LTE network was not possible.

12.1.6 It shall have facility to adjust brightness and contrast.

12.1.7 It shall have facility to register/deregister the train number and Engine or Driving Coach number. Engine or driving coach number shall not get erased until; they are authenticated by the authorized personnel.

12.1.8 The Engine or Driving Coach number is to be transmitted as functional number if no train number is registered by the Cab Radio. The engine number shall be displayed to the called party. This also facilitates ease of shunting.

12.1.9 It shall have facility to register/deregister the functional address to other Loco Pilot, (non-leading Loco Pilot) and guard.

12.1.10 It shall have facility for point to point call, voice group call and emergency call.

12.1.11 It shall have automatic answering of call from primary controller.

12.1.12 A point-to-point call can be placed on hold and a second point-to-point call can then be initiated.

12.1.13 It shall handover during incoming and outgoing point to point or group call (cell change in the same or different location area).

12.1.14 The Cab Radio shall be capable to initiate a Voice Group Call Service by selecting the number from a phonebook.

12.1.15 It shall be possible for multiple Loco Pilot communications within the same train by the leading Loco Pilot. The call from the controller (primary or secondary) shall be automatically accepted and added to the "Multi Loco Pilot Communication" established by the leading Loco Pilot.

12.1.16 Cab Radio automatically receives an ongoing group call after switching-on. The ongoing group call will be joined automatically if automatic answering applies.

12.1.17 Group call "other LPs in the area" is initiated and managed by the Cab Radio.

12.1.18 Cab Radio shall have provision to mute / unmute the speech in order to listen to the talking controller and avoid unintelligible echo.

12.1.19 The Cab Radio shall be able to receive and join an incoming train emergency call any time. The ongoing multi Loco Pilots' conference call is pre-empted.

12.1.20 The Cab Radio shall initiate a train emergency call at any time i.e. also during an ongoing point to point/multi Loco Pilot call.

12.1.21 Shunting: Entering shunting mode is supported by the CR..

12.1.22 The Cab Radio shall have the following minimum functions/features:-

(a) Loco Pilot call related functions:

i. Call controller.
ii. Call other Loco Pilot in the area.
iii. Send railway emergency call.
iv. Confirm receipt of railway emergency calls.
v. Communicate with other Loco Pilots on the same train.
vi. Call train staff.
vii. Call other authorized users.
viii. Receive incoming voice calls.
ix. Terminate calls.
x. Receive text messages.
xi. Enter/leave shunting mode.
xii. Monitor calls to other on train users/devices.
xiii. Forward calls/cancel call forwarding to/from Loco Pilot hand held.

(b) Other Loco Pilot related functions:

i. Powering up radio.
ii. Switch radio MMI on and off.
iii. Adjust loud speaker volume.
iv. Select mobile radio network.
v. Register and deregister train number.
vi. Register and deregister on train users.
vii. Register and deregister stock numbers.
viii. Store/retrieve numbers and their details.
ix. Invoke supplementary services-Call Deflection, Calling Line Identification Presentation, Calling Line Identification Restriction, Connected Line Identification Presentation, Connected Line Identification Restriction, Call Forwarding-unconditional, user busy, no reply, not reachable.
x. Invoke tests.

(c) Other Cab Radio functions:

i. Automatic connection of incoming calls to appropriate on-train users or devices (conductor, public address system, data systems, etc).
ii. Automatic establishment of outgoing calls initiated by on-train users or devices.
iii. Automatic handling of calls of varying priorities.
iv. Transmit Railway emergency call event indication to train-borne recorder.
v. Run time diagnostics:
   a. Upon the request of the Loco Pilot, the Cab Radio should be able to perform a suite of run-time diagnostic tests on all physical interfaces (O).
   b. If run-time diagnostics are implemented, failure of an interface shall be reported to the Loco Pilot via the display.
   c. If run-time diagnostics are implemented, diagnostic tests shall not interfere with normal operation of the Cab Radio.
   d. If run-time diagnostics are implemented, all failures should be available to be recorded (O).

12.1.23 The Cab Radio System may include the following sub systems:-

i. LTE Router/ Modem (Central Control Unit)
ii. Control Panel (MMI) & Display Unit
iii. Microphone & Speaker and MC PTT Handset and Cradle
iv. Rail Rooftop Low Profile Antenna
v. Dual Redundant Power Supply

12.1.24 One Cab Radio System shall consist of at least two Mobile network terminations, in active/ standby configuration i.e. comprising of minimum two mobile equipments and SIM cards.

12.1.25 The SIM cards shall be physically integrated with the Cab Radio set and shall not be able to be removed except by maintenance staff.

12.1.26 The Control Panel shall consist of capacitive touch screen display unit of day light readable type for displaying information. Control panel shall have dedicated hard buttons configurable for specific functions.

12.1.27 Cab Radio System shall receive remote software upgrades via a ground-based management terminal. Cab Radio System shall also support software updates via USB Stick. There shall be provision for retrieving system logs from USB/Ethernet ports.Also periodically, Cab Radio shall be able to send the system log to central server.

12.1.28 The Speakers in the Loco Pilot Cab shall be loud enough to be audible in the running Train. The radio should be able to provide five levels of adjustment (numbered 1 to 5) for each volume range setting. The following table details the levels of adjustment and the three (Quiet, Normal and Noisy cab) loudspeaker ranges to be provided.

Levels of adjustment		**Loco Pilot adjustment**		
		Quiet cab	**Normal cab**	**Noisy cab**
250 mW	24 dBm	1	1	
355 mW	25.5 dBm	2		
500 mW	27 dBm	3 (Default)	2	1
1 W	30 dBm	4	3 (Default)	2
2 W	33 dBm	5	4	3 (Default)
4 W	36 dBm		5	4
8.5 W	39 dBm			5

12.2 Roof top Antenna

12.2.1 Separate Rail Rooftop Low Profile Antenna shall be provided for each Cab Radio System

12.3 LTE Router modem equipment

12.3.1 LTE Router modem equipment shall provide interface for the following applications:

(i) KAVACH
(ii) Cab Radio
(iii) IoT
(iv) Survelliance

12.3.2 The equipment in the Cab and their redundant equipment shall be connected over Optical Fibre Media or any other media of industry standard in Ring Arrangement.

12.3.3 The various systems/sub systems in the Cab Radio System for voice and data shall be connected with suitable cables and wires complying with relevant specifications and standards for Rolling Stock Application.

12.3.4 The Ethernet interface between Cab Radio and client application shall be on industrial grade fibre or CAT6 cable with suitable M12/M23 connectors.

12.3.5 An emergency power supply should be provided for Cab Radio Systems which will enable the Loco Pilot‟s radio to continue to operate for a period of at least 2 hour in the event of failure of the train‟s main power supply.

13. Radio Jamming

13.1 Radio jamming could be an act of an illegitimate radio device attempting to disrupt radio communication between a legitimate sender and a legitimate receiver.

13.2 Undetected or un-prevented radio jamming could potentially have following impacts in some cases:

- DoS attack on UE
- DoS attack on network

13.3 Radio jamming should not be feasible in the LTE network of Railways.

14. Time Synchronization

14.1 LTE shall provide time synchronization facility to all the elements in its network.

14.2 The time sync shall be from GPS or IRNSS.

15. Quality of Service (QoS) Requirements:

The one-to-one mapping of standardized QCI values to standardized characteristics for the tentative services shall be as per **Annexure-A**.

16. Numbering Plan

16.1 Numbering Scheme for Mobile Communication Network for Indian Railways is given in Annexure-B of this document.

16.2 This section addresses the following:

i. Numbering plan requirements.
ii. Standardized telephone numbers.
iii. Group numbers.

16.3 Numbering plan requirements

16.3.1 The LTE system shall enable users to originate and receive calls by functional number.

16.3.2 Each mobile shall be identified by a unique telephone number.

16.4 Use of train number

16.4.1 The use of train numbers to address trains must not result in any ambiguities.

16.4.2 Every on-train function shall be identified by a unique standard number.

16.5 Use of engine/coach number

16.5.1 The use of engine/coach numbers to address trains must not result in any ambiguities.

16.5.2 Every on-engine/coach function shall be identified by a unique standard number.

16.6 Use of shunting team, maintenance team or controller number

16.6.1 Every shunting team number shall be based on an association of:

i. Service area identifier.
ii. Shunting team identifier.

16.6.2 Every maintenance team number shall be based on an association of:

i. Service area identifier.
ii. Type of maintenance team (specialty code).
iii. Maintenance team identifier.

16.6.3 Every controller number shall be based on an association of:

i. Controller location.
ii. Controller identifier.

16.6.4 The numbering for other teams shall be treated in the same way as maintenance teams.

16.7 Use of group calls

16.7.1 Group call service areas are freely configurable within the operational responsibility of each railway network.

16.8 Telephone numbers

16.8.1 For certain functions, standardized telephone numbers shall be implemented. These functions are:

i. Railway emergency call.
ii. Route call to primary controller.
iii. Route call to secondary controller.
iv. Route call to power supply controller.
v. Public emergency call

17. Onboard LTE Router

Indian Railways requires a modem-router to interface between the KAVACH system and the LTE radio system. It shall also have facility to provide Onboard to other Onboard and Front end to Rear end communication preferably without the involvement of EPC.

17.1 Over the Air Requirements of Onboard LTE router

i. QoS on Uplink shall be on QCI 69 for KAVACH.
ii. Operating system – Shall not be from land border sharing countries.
iii. Support MVB, RS-422, RS-485 (O)
iv. Suppport reception of GPS and IRNSS(O).
v. Support Software defined LAN (Virtual LAN).
vi. Support SNMP v3

18. KAVACH Interface Requirements (Extract of Annexure E of KAVACH specification)

18.1 Each stationary KAVACH (SVK) shall be connected to the PGW of EPC through Railways L3 VPN implemented using IPMPLS existing OFC network. This OFC network shall be of redundant architecture.

18.2 Each loco shall have provision of redundant LTE radio modems, to which the Onboard KAVACH (OVK) system is connected via IP interface.

18.3 EPC shall generate dynamic IP addresses to the OVK which are accessing request to stabilise communication.

18.4 OVK shall have the URL of KAVACH Application Server (KAS) and Loco Exchange Server (LES).

18.5 The LTE modem of loco communicates with eNodeB on the wayside over RF.

18.6 KAS shall consist of a lookup table as shown below:

Field Description	Field Width (Bytes)	Comment
Station ID	2	Station ID (MSB in first byte)
Station IP Status	1	0: Not Available 1: IPv4 Station 2: IPv6 Station 3: UHF Station
Station IP Number 1	4/16	MSB in first byte (IPv4-4Bytes, IPv6 - 16Bytes)
Station Port Number 1	2	MSB in first byte
Station IP Number 2	4/16	MSB in first byte (IPv4-4Bytes, IPv6 - 16Bytes)
Station Port Number 2	2	MSB in first byte
NMS IP Status	1	0: Not Available 1: IPv4 Station 2: IPv6 Station 3: UHF Station
NMS IP Number 1	4/16	MSB in first byte (IPv4-4Bytes, IPv6 - 16Bytes)
NMS Port Number 1	2	MSB in first byte
NMS IP Number 2	4/16	MSB in first byte (IPv4-4Bytes, IPv6 - 16Bytes)
NMS Port Number 2	2	MSB in first byte
TSR IP Status	1	0: Not Available 1: IPv4 Station 2: IPv6 Station 3: UHF Station
TSR IP Number 1	4/16	MSB in first byte (IPv4-4Bytes, IPv6 - 16Bytes)
TSR Port Number 1	2	MSB in first byte
TSR IP Number 2	4/16	MSB in first byte (IPv4-4Bytes, IPv6 - 16Bytes)
TSR Port Number 2	2	MSB in first byte

Field Description	Field Width (Bytes)	Comment
CTC IP Status	1	0: Not Available 1: IPv4 Station 2: IPv6 Station 3: UHF Station
CTC IP Number 1	4/16	MSB in first byte (IPv4-4Bytes, IPv6 - 16Bytes)
CTC Port Number 1	2	MSB in first byte
CTC IP Number 2	4/16	MSB in first byte (IPv4-4Bytes, IPv6 - 16Bytes)
CTC Port Number 2	2	MSB in first byte

Server random number of two bytes shall be generated whenever the information is passed on by the KAS to OVK. KAS shall be capable of handling IPV4 and IPV6 address.

18.7 Flow of data from OVK to SVKis detailed below:

a. EPC shall allot IP address to OVK dynamically on registration.

b. OVK shall have the URL of KAVACH Application Server.

c. On entering to KAVACH territory, OVK shall communicate its Loco ID and approaching SVK ID to KAS.

d. Based on the approaching SVK ID communicated by OVK, KAS shall communicate applicable IP addresses of Stationary KAVACH, NMS, TSRMS and CTC from the lookup table to OVK.

e. Based on the SVK IP address received, the OVK shall request access from the Stationary KAVACH.

f. The SVK shall establish communication with OVK based on the access request packet request received from OVK.

g. With the communication established between SVK and Onboard KAVACH, the communication between them shall take place with SVK to OVK and OVK to SVK regular packets.

h. OVK shall obtain IP address from KAS for establishing communication with next SVK or restoration of a communication failure.

i. The same procedure is to be followed for NMS, TSRMS and CTC.

18.8 KAS shall pass on the Driving unit/loco ID, its IP addresses and the location details to Loco Exchange Server.

18.9 Loco Exchange Server[2] shall populate a dynamic lookup table of loco IDs and their

[2] Application servers were used for enabling OVK to OVK communication as intermediary approach as the V2V and V2X communication is not readily available with C-DOT as on date. V2V communication is required for handling collision prevention in KAVACH. V2X communication is required for handling operations of DPWCS and EOTT. If this communication is not possible through LTE, then the frequency spots used for these applications cannot be surrendered. Hence, CDOT may get the V2V and V2X communication scheme as prescribed in 3GPP, as the LTE is developed indigenously by them and they posses total control of the development. However, the FRS for PoC includes both V2V and V2X communication and use of application server (look up table) to facilitate C-DOT.

IP addresses within a geographical region. This geographical region shall cover all the locos with a distance of 5000 m (configurable).

18.10 Flow of data from OVK to OVK in its vicinity is detailed below:

a. Loco Exchange Server shall populate a dynamic lookup table of loco IDs and their IP address within the vicinity of the loco based on the data received from KAVACH Application Server.

b. OVK shall have the URL of Loco Exchange Server.

c. OVK shall communicate its Access Request Packet to Loco Exchange Server through Onboard KAVACH to Loco Exchange Server packet.

d. Loco Exchange Server shall aggregate the OVK access request packets received from all the locos in the geographical area and send Onboard access request packets to each loco in the geographical area through Loco Exchange Server to OVK packet.

e. OVK shall decode the above information and validate it for SoS and collision scenarios.

18.11 Protocols for compatibility of KAVACH and LTE are enclosed as Annexure -C.

18.12 **IP Address Management:** The IP address of Stationary KAVACH is dynamic and shall be as follows:

Primary station IP address	xxx.yyy.aaa.bbb/ppppp aaa:bbb – Station ID (0xAABB)
Secondary station IP address	xxx.yyy.aaa.bbb/ppppp aaa:bbb – Station ID (0xAABB)

18.12.1 Sample IP address allocation for IPv4 with inclusion of Stationary KAVACH Id in IP addresses is given in below table.

Stationary KAVACH – ID	**Stationary KAVACH – IP Address**
500 (01.244)	172.16.01.244/60000
500 (01.244)	172.16.01.244/60001

18.13 A parallel KMS server shall also be got installed in PoC. SVK and OVK are required to do Key Management using this server.

Annexure-A

Quality of services (QOS) Requirements:-

This table is extract of Table 6.1.7 of ETSI TS 123 203 V 14.6.0. For further clarification, may please refer to this document.

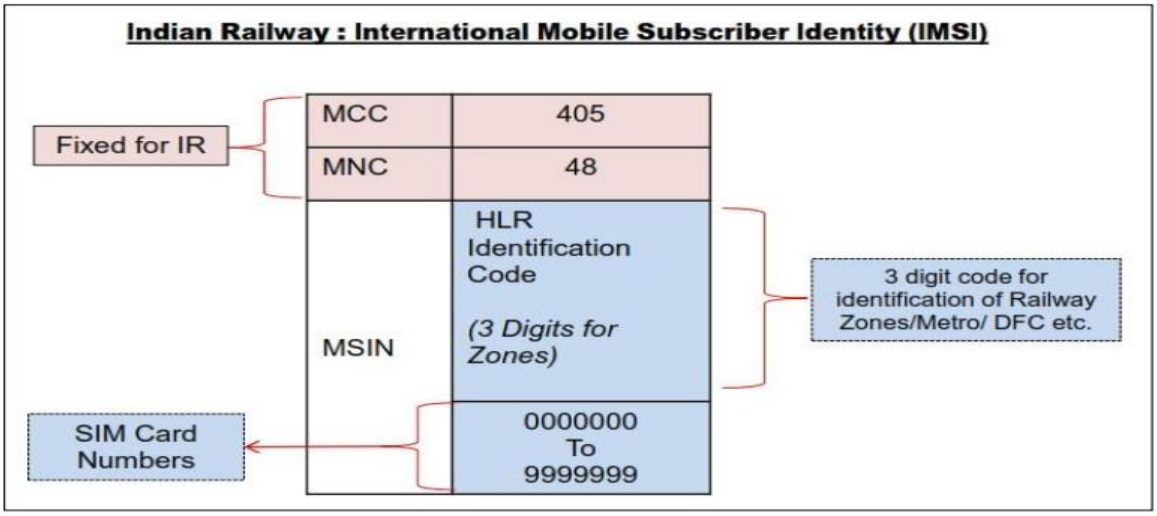
QCI	Resource Type	Priority Level	Packet Delay Budget (ms)	Packet Error Loss Rate	Example Services	Mapping of Indian Railway applications (Tentative)
1	GBR	2	100	10^{-2}	Conversational Voice	Voice Mobile Communication
2		4	150	10^{-3}	Conversational Video (Live Streaming)	Live Video Streaming from Accident Site (ART) or similar
3		3	50	10^{-3}	V2X messages	V2X messages
4		5	300	10^{-6}	Non-Conversational Video (Buffered Streaming)	Live Video Streaming from Accident Site (ART)
65		0.7	75	10^{-2}	Mission Critical user plane Push To Talk voice (e.g., MCPTT)	Mission Critical Services
66		2	100	10^{-2}	Non-Mission-Critical user plane Push To Talk voice	Voice Mobile Communication
67		1.5	100	10^{-3}	Mission Critical Video user plane	Mission Critical Video user plane

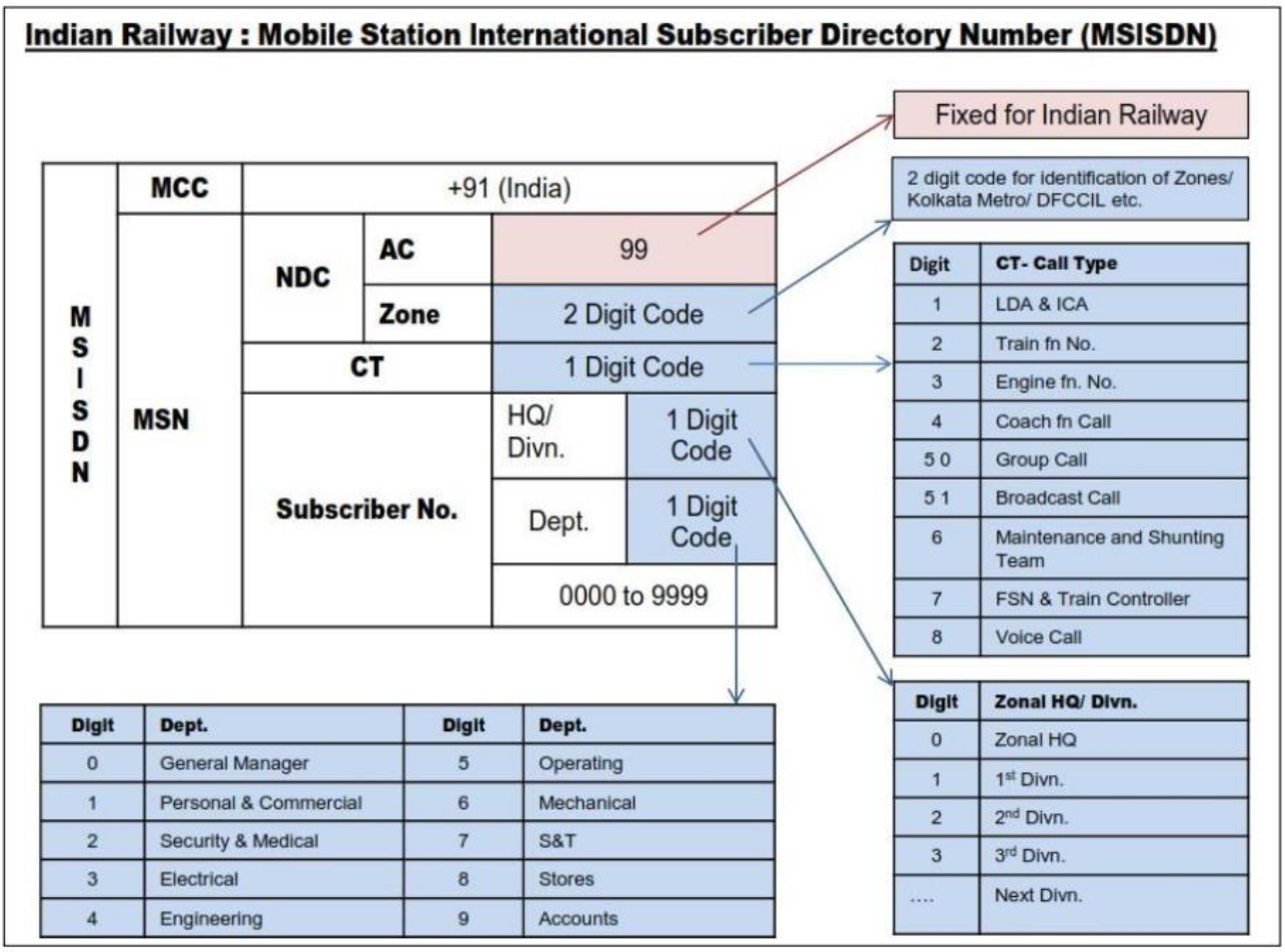
QCI	Resource Type	Priority Level	Packet Delay Budget (ms)	Packet Error Loss Rate	Example Services	Mapping of Indian Railway applications (Tentative)
5	Non-GBR	1	100	10^{-6}	IMS Signalling	
6		6 (If network support muli-media priority services)	300	10^{-6}	Video (Buffered Streaming) (e.g., www, e-mail, chat, ftp, p2p file sharing, progressive video, etc.)	Video Surveillance System (CCTV), Passenger Information System and Real Time Train Information System , IoT Services etc
7		7	100	10^{-3}	Voice, Video (Live Streaming)	Voice Mobile Communication, Streaming from Accident Site (ART) & Video Surveillance System (CCTV)
8		8 (For premium bearer)	300	10^{-6}	Video (Buffered Streaming) TCP-based (e.g., www, e-mail, chat, ftp, p2p file sharing, progressive video, etc.)	Video Surveillance System (CCTV), Passenger Information System and Real Time Train Information System , IoT Services etc
9		9 (For default bearer)				
69		0.5	60	10^{-6}	Mission Critical delay sensitive signalling (e.g., MC-PTT signalling)	Train Automation and Protection Services i.e. KAVACH, ETCS and other services
70		5.5		10^{-6}	Mission Critical Data (e.g. example services are the same as QCI 6/8/9)	Mission Critical Services
79		6.5	50	10^{-2}	V2X messages	V2X messages

Annexure-B

Numbering scheme for mobile communication network for Indian Railways:-

The IMSI and MSISDN for Indian Railways shall be as below:-





Annexure – C

Compatibility Scheme for LTE and KAVACH

1. **OVK to KAS IP Look Up request Packet Structure**

Field No	Field Description	Field Width (Bytes)	Comment
1	Start of Frame (SOF)	2	0xA5CC
2	Packet Version	1	1
3	Message Type	1	0: Not used 1: OVK to KAS IP Look Up request Packet 2: KAS to OVK IP Look Up response Packet 3: OVK to LES Access Request Packet 4: LES to OVK Access Request Packet Structure 5: Onboard KAVACH to Stationary KAVACH 6: Stationary KAVACH to Onboard KAVACH 7: Onboard KAVACH to NMS Event 8: Onboard KAVACH to NMS Fault 9: NMS Acknowledgement 10: Onboard KAVACH to CTC 11: Onboard KAVACH to TSR Server 12: TSR server to Onboard KAVACH
4	Message Length	2	In Bytes from field “Message Type ” to “CRC” (inclusive of both) 22 Bytes
5	Message Sequence	2	0-65535
6	Date	3	DD/MM/YY 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 27/04/18 → 0x1B-0x04-0x12

Field No	Field Description	Field Width (Bytes)	Comment
7	Time	3	HH:MM:SS (IST time) 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 06:36:10 → 0x06-0x24-0x0A
8	Loco ID	3	Loco ID (MSB in first byte)
9	Station ID	2	Station ID (MSB in first byte)
10	Loco Random Number	2	MSB in first byte

2. **KAS to OVK IP Look Up response Packet Structure**

Field No	Field Description	Field Width (Bytes)	Comment
1	Start of Frame (SOF)	2	0xA5CC
2	Packet Version	1	1
3	Message Type	1	0: Not used 1: OVK to KAS IP Look Up request Packet 2: KAS to OVK IP Look Up response Packet 3: OVK to LES Access Request Packet 4: LES to OVK Access Request Packet Structure 5: Onboard KAVACH to Stationary KAVACH 6: Stationary KAVACH to Onboard KAVACH 7: Onboard KAVACH to NMS Event 8: Onboard KAVACH to NMS Fault 9: NMS Acknowledgement 10: Onboard KAVACH to CTC 11: Onboard KAVACH to TSR Server 12: TSR server to Onboard KAVACH
4	Message Length	2	In Bytes from field “Message Type ” to “CRC” (inclusive of both)

Field No	Field Description	Field Width (Bytes)	Comment
5	Message Sequence	2	0-65535
6	Date	3	DD/MM/YY 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 27/04/18 → 0x1B-0x04-0x12
7	Time	3	HH:MM:SS (IST time) 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 06:36:10 → 0x06-0x24-0x0A
8	Loco ID	3	Loco ID (MSB in first byte)
9	Station ID	2	Station ID (MSB in first byte)
10	Station IP Status	1	0: Not Available 1: IPv4 Station 2: IPv6 Station 3: UHF Station
11	Station IP Number 1	4/16	MSB in first byte (IPv4-4Bytes, IPv6 -16Bytes)
12	Station Port Number 1	2	MSB in first byte
13	Station IP Number 2	4/16	MSB in first byte (IPv4-4Bytes, IPv6 -16Bytes)
14	Station Port Number 2	2	MSB in first byte
15	NMS IP Status	1	0: Not Available 1: IPv4 Station 2: IPv6 Station 3: UHF Station
16	NMS IP Number 1	4/16	MSB in first byte (IPv4-4Bytes, IPv6 -16Bytes)
17	NMS Port Number 1	2	MSB in first byte
18	NMS IP Number 2	4/16	MSB in first byte (IPv4-4Bytes, IPv6 -16Bytes)
19	NMS Port Number 2	2	MSB in first byte

Field No	Field Description	Field Width (Bytes)	Comment
20	TSR IP Status	1	0: Not Available 1: IPv4 Station 2: IPv6 Station 3: UHF Station
21	TSR IP Number 1	4/16	MSB in first byte (IPv4-4Bytes, IPv6 -16Bytes)
22	TSR Port Number 1	2	MSB in first byte
23	TSR IP Number 2	4/16	MSB in first byte (IPv4-4Bytes, IPv6 -16Bytes)
24	TSR Port Number 2	2	MSB in first byte
25	CTC IP Status	1	0: Not Available 1: IPv4 Station 2: IPv6 Station 3: UHF Station
26	CTC IP Number 1	4/16	MSB in first byte (IPv4-4Bytes, IPv6 -16Bytes)
27	CTC Port Number 1	2	MSB in first byte
28	CTC IP Number 2	4/16	MSB in first byte (IPv4-4Bytes, IPv6 -16Bytes)
29	CTC Port Number 2	2	MSB in first byte
30	Server Random Number	2	MSB in first byte
31	MAC	2	MSB in first byte, Message type to Server Random Number, Additional fill zeros to make block multiple of 128 bits
32	CRC	4	CRC 32 bit (Polynomial EEB88320), (Message type to MAC)

3. **OVK to LES Access Request Packet Structure**

Field No	Field Description	Field Width (Bytes)	Comment
1	Start of Frame (SOF)	2	0xA5CC
2	Packet Version	1	1

Field No	Field Description	Field Width (Bytes)	Comment
3	Message Type	1	0: Not used 1: OVK to KAS IP Look Up request Packet 2: KAS to OVK IP Look Up response Packet 3: OVK to LES Access Request Packet 4: LES to OVK Access Request Packet Structure 5: Onboard KAVACH to Stationary KAVACH 6: Stationary KAVACH to Onboard KAVACH 7: Onboard KAVACH to NMS Event 8: Onboard KAVACH to NMS Fault 9: NMS Acknowledgement 10: Onboard KAVACH to CTC 11: Onboard KAVACH to TSR Server 12: TSR server to Onboard KAVACH
4	Message Length	2	In Bytes from field "Message Type " to "CRC" (inclusive of both)
5	Message Sequence	2	0-65535
6	Date	3	DD/MM/YY 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 27/04/18 → 0x1B-0x04-0x12
7	Time	3	HH:MM:SS (IST time) 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 06:36:10 → 0x06-0x24-0x0A
	Loco Access Request Packet		

Field No	Field Description	Field Width (Bytes)	Comment
9	CRC	4	CRC 32 bit (Polynomial EEB88320), (Message type to MAC)

4. **LES to OVK Access Request Packet Structure**

Field No	Field Description	Field Width (Bytes)	Comment
1	Start of Frame (SOF)	2	0xA5CC
2	Packet Version	1	1
3	Message Type	1	0: Not used 1: OVK to KAS IP Look Up request Packet 2: KAS to OVK IP Look Up response Packet 3: OVK to LES Access Request Packet 4: LES to OVK Access Request Packet Structure 5: Loco to Stationary KAVACH 6: Stationary KAVACH to Loco 7: Loco to NMS Event 8: Loco to NMS Fault 9: NMS Acknowledgement 10: Loco to CTC 11: Loco to TSR Server 12: TSR server to Loco
4	Message Length	2	In Bytes from field “Message Type ” to “CRC” (inclusive of both)
5	Message Sequence	2	0-65535
6	Date	3	DD/MM/YY 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 27/04/18 → 0x1B-0x04-0x12

Field No	Field Description	Field Width (Bytes)	Comment
7	Time	3	HH:MM:SS (IST time) 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 06:36:10 → 0x06-0x24-0x0A
8	Number of Loco Packets	1	Indicate number of Loco Packets below (Max 20)
9	Loco Access Request Packet1		
10	Loco Access Request Packet2		
	-		
	-		
28	Loco Access Request Packet 20		
29	MAC	2	MSB in first byte, Message type to Server Random Number, Additional fill zeros to make block multiple of 128 bits
30	CRC	4	CRC 32 bit (Polynomial EEB88320), (Message type to MAC)

5. Onboard KAVACH to Stationary KAVACH Packet Structure

Field No	Field Description	Field Width (Bytes)	Comment
1	Start of Frame (SOF)	2	0xA5CC
2	Packet Version	1	1
3	Message Type	1	0: Not used 1: OVK to KAS IP Look Up request Packet 2: KAS to OVK IP Look Up response Packet 3: OVK to LES Access Request Packet 4: LES to OVK Access Request Packet Structure 5: Loco to Stationary KAVACH 6: Stationary KAVACH to Loco 7: Loco to NMS Event 8: Loco to NMS Fault 9: NMS Acknowledgement 10: Loco to CTC 11: Loco to TSR Server 12: TSR server to Loco

Field No	Field Description	Field Width (Bytes)	Comment
4	Message Length	2	In Bytes from field "Message Type " to "CRC" (inclusive of both)
5	Message Sequence	2	0-65535
6	Date	3	DD/MM/YY 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 27/04/18 → 0x1B-0x04-0x12
7	Time	3	HH:MM:SS (IST time) 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 06:36:10 → 0x06-0x24-0x0A
	Onboard KAVACH access request packet/Regular packet		
9	CRC	4	CRC 32 bit (Polynomial EEB88320), (Message type to End of Loco Packet)

6. **Stationary KAVACH to Onboard KAVACH Packet Structure**

Field No	Field Description	Field Width (Bytes)	Comment
1	Start of Frame (SOF)	2	0xA5CC
2	Packet Version	1	1
3	Message Type	1	0: Not used 1: OVK to KAS IP Look Up request Packet 2: KAS to OVK IP Look Up response Packet 3: OVK to LES Access Request Packet 4: LES to OVK Access Request Packet Structure 5: Onboard KAVACH to Stationary KAVACH 6: Stationary KAVACH to Onboard KAVACH 7: Onboard KAVACH to NMS Event 8: Onboard KAVACH to NMS Fault 9: NMS Acknowledgement 10: Onboard KAVACH to CTC 11: Onboard KAVACH to TSR Server 12: TSR server to Onboard KAVACH
4	Message Length	2	In Bytes from field "Message Type " to "CRC" (inclusive of both)
5	Message Sequence	2	0-65535
6	Date	3	DD/MM/YY 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 27/04/18 → 0x1B-0x04-0x12

Field No	Field Description	Field Width (Bytes)	Comment
7	Time	3	HH:MM:SS (IST time) 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 06:36:10 → 0x06-0x24-0x0A
8	Station Access Response Packet / Station Regular Packet & TRACK PROFILE Packet / TSR Packet		
9	CRC	4	CRC 32 bit (Polynomial EEB88320), (Message type to End of Station Packet)

7. Onboard KAVACH to NMS Packet Structure

Field No	Field Description	Field Width (Bytes)	Comment
1	Start of Frame (SOF)	2	0xA5CC
2	Packet Version	1	1
3	Message Type	1	0: Not used 1: OVK to KAS IP Look Up request Packet 2: KAS to OVK IP Look Up response Packet 3: OVK to LES Access Request Packet 4: LES to OVK Access Request Packet Structure 5: Onboard KAVACH to Stationary KAVACH 6: Stationary KAVACH to Onboard KAVACH 7: Onboard KAVACH to NMS Event 8: Onboard KAVACH to NMS Fault 9: NMS Acknowledgement 10: Onboard KAVACH to CTC 11: Onboard KAVACH to TSR Server 12: TSR server to Onboard KAVACH

Field No	Field Description	Field Width (Bytes)	Comment
4	Message Length	2	In Bytes from field "Message Type " to "CRC" (inclusive of both)
5	Message Sequence	2	0-65535
6	Date	3	DD/MM/YY 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 27/04/18 → 0x1B-0x04-0x12
7	Time	3	HH:MM:SS (IST time) 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 06:36:10 → 0x06-0x24-0x0A
8	ONBOARDKAVACH ID	3	
9	System Version	1	1
10	Event Count	1	
11	Event Id	2	
12	Event Data	m	
13	CRC	4	CRC 32 bit (Polynomial EEB88320), (Message type to End of Loco Packet)
Onboard KAVACH Event Table			
Event ID	Field	Field Width (Bytes) – m	Description
1	Radio-1 Health	1	1: OK 2: Diagnostic Link Fail 3: Radio Fail
2	Radio-2 Health	1	1: OK 2: Diagnostic Link Fail 3: Radio Fail
3	Radio-1 Input supply	1	Value: 10V-30V - On change of voltage by 1V
4	Radio-2 Input supply	1	Value: 10V-30V - On change of voltage by 1V
5	Radio-1 Temperature	1	Value: -30°C to 70°C (1 byte Signed) - On change of temperature by 3°C

Field No	Field Description	Field Width (Bytes)	Comment
6	Radio-2 Temperature	1	Value: -30°C to 70°C (1 byte Signed) - On change of temperature by 3°C
7	Radio-1 PA Temperature	1	Value:20°C to 100°C - On change of temperature by 3°C
8	Radio-2 PA Temperature	1	Value:20°C to 100°C - On change of temperature by 3°C
9	Radio-1 PA Supply Voltage	1	Value: 11V-13V - On change of voltage by 1V
10	Radio-2 PA Supply Voltage	1	Value: 11V-13V - On change of voltage by 1V
11	Radio-1 Tx PA Current	1	Value: 1.5A to 3.2A - On change of current
12	Radio-2 Tx PA Current	1	Value: 1.5A to 3.2A - On change of current
13	Radio-1 Reverse Power	1	Value received from Radio Eg: Value received from Radio is 0x01 = 0.1W (Value: 0x01)
14	Radio-2 Reverse Power	1	Value received from Radio Eg: Value received from Radio is 0x0F = 1.5W (Value: 0x0F)
15	Radio-1 Forward Power	1	Value received from Radio Eg: Value received from Radio is 0x36 = 5.4W (Value: 0x36)
16	Radio-2 Forward Power	1	Value received from Radio Eg: Value received from Radio is 0x78 = 12W (Value: 0x78)
17	Radio-1 RSSI	2	Value received from Radio Eg: Value received from Radio is 0xBDBF = -132.5dBm (Value: 0xBDBF)
18	Radio-2 RSSI	2	Value received from Radio Eg: Value received from Radio is 0xBDBF = -132.5dBm (Value: 0xBDBF)
19	Stationary Regular packet received time offset	2	0-2000 ms
20	Active GPS Number	1	GPS used for frame number calculation 0 – No Active GPS 1 – GPS 1 2 – GPS 2 3 – Both GPS - on change of GPS

Field No	Field Description	Field Width (Bytes)	Comment
21	GPS-1 View Status	1	0 – No Data 1 – V 2 – A - on detection of change of event
22	GPS-2 View Status	1	0 – No Data 1 – V 2 – A - on detection of change of event
23	GPS-1 Seconds	1	0 to 59 seconds - on change of value
24	GPS-2 Seconds	1	0 to 59 seconds - on change of value
25	GPS-1 Satellites in View	1	Value received from GPS receiver - On change of value
26	GPS-1 CNO (Max)	1	Maximum CNO Value received from GPS receiver - On change of value
27	GPS-2 Satellites in View	1	Value received from GPS receiver - On change of value
28	GPS-2 CNO (Max)	1	Maximum CNO Value received from GPS receiver - On change of value
29	GPS-1 link status	2	0-Both GPS link and PPS fail 1- GPS link fail and PPS ok 2- GPS link ok and PPS fail 3- GPS link ok and PPS ok
30	GPS-2 link status	2	0-Both GPS link and PPS fail 1- GPS link fail and PPS ok 2- GPS link ok and PPS fail 3- GPS link ok and PPS ok
31	GSM-1 RSSI	1	Value received from GSM module - On change of value
32	GSM-2 RSSI	1	Value received from GSM module - On change of value
33	Current Running Key	1	0: Default key set, 1-30: KMS key set - on change of Key Set
34	Remaining Number of Keys	1	0: No keys, 1-30: Remaining KMS key sets - on change of value
35	Session Key Checksum	2	Checksum of 16 bytes session key - for every 2s at the time of Authentication only
36	DMI-1 link status	2	0-NOT OK 1-OK
37	DMI-2 link status	2	0-NOT OK 1-OK

Field No	Field Description	Field Width (Bytes)	Comment
38	RFID Reader-1 link status	2	0-NOT OK 1-OK
39	RFID Reader-2 link status	2	0-NOT OK 1-OK
40	Duplicate Missing RFID Tag	2	RFID Tag Number
41	Missing linked RFID Tag	4	B3-B1: Linked RFID Tag B0: Linking direction
42	Computed TLM Status	4	B3-B1: Station Id B0: TLM Status Values: 1 – TLM Updated 2 – TLM Timeout
43	Train Configuration	1	0 – No Change 1 – Updated
44	Train Brakes Test	1	0 – Brake Test failed 1 – Brake Test Successful
45	Selected Train formation	1	TBD
46	Selected Cab	1	1 – Cab1 Selected 2 – Cab2 Selected
47	Brake application reason	1	0-Not used 1-Reverse movement detected 2-Unusual stopage detected 3-Overspeed 4-Rollback detected 5-MBT selected 6- No LP Acknowledge 7- MA Shortened 8-Headon collision detected 9-Rearend collision detected 10-Loco Specific SoS received 11-Station General SoS received
48	Station General SoS	3	B2-B1: Station Id B0: General SoS status (1 – Received, 2 – Cancelled)
49	Station Loco Specific SoS	3	B2-B1: Station Id B0: Specific SoS status (1 – Received, 2 – Cancelled)

Field No	Field Description	Field Width (Bytes)	Comment
50	Collision Detection	4	B3-B1: Loco Id B0: SoS code Values: 1 – Manual SoS received 2 – Manual SoS cancelled 3 – Unusual stopage detected 4 – Unusual stopage end 5 – Head-on collision detected 6 – Head-on collision end 7 – Rear-end collision detected 8 – Rear-end collision end
51	Loco Self SoS	1	1 – Manual SoS 2 – Manual SoS end 3 – Unusual stopage start 4 – Unusual stopage end
52	KAVACH Connection	1	1 – KAVACH Isolated 2 – KAVACH Connected
53	BIU Isolated	1	1 – BIU Isolated 2 – BIU Connected
54	EB Bypassed	1	1 – EB Connected 2 – EB Bypassed
55	KAVACH Territory	1	1 – KAVACH Entry 2 – KAVACH Exit
56-199	Reserved		
200-254	Firm specific events	2	This field Information is specific to KAVACH firm
255	Specific value		Not to be used

8. Onboard KAVACH to NMS Fault Packet Structure

Field No	Field Description	Field Width (Bytes)	Comment
1	Start of Frame (SOF)	2	0xA5CC
2	Packet Version	1	1

Field No	Field Description	Field Width (Bytes)	Comment
3	Message Type	1	0: Not used 1: OVK to KAS IP Look Up request Packet 2: KAS to OVK IP Look Up response Packet 3: OVK to LES Access Request Packet 4: LES to OVK Access Request Packet Structure 5: Onboard KAVACH to Stationary KAVACH 6: Stationary KAVACH to Onboard KAVACH 7: Onboard KAVACH to NMS Event 8: Onboard KAVACH to NMS Fault 9: NMS Acknowledgement 10: Onboard KAVACH to CTC 11: Onboard KAVACH to TSR Server 12: TSR server to Onboard KAVACH
4	Message Length	2	In Bytes from field "Message Type " to "CRC" (inclusive of both)
5	Message Sequence	2	0-65535
6	Date	3	DD/MM/YY 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 27/04/18 → 0x1B-0x04-0x12
7	Time	3	HH:MM:SS (IST time) 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 06:36:10 → 0x06-0x24-0x0A

Field No	Field Description	Field Width (Bytes)	Comment
8	KAVACH subsystem type	1	0x11 – Stationary KAVACH 0x22 – OnboardKAVACH 0x33 – TSRMS
9	KAVACH Subsystem ID	3	
10	System Version	1	1
11	Total Fault Codes (F)	1	Max number of faults shall be 10
12	Fault Code	2*F	Firm specific code to be decoded by NMS
13	CRC	4	CRC 32 bit (Polynomial EEB88320), (Message type to End of Loco Packet)

9. NMS Acknowledgment Packet Structure

Field No	Field Description	Field Width (Bytes)	Comment
1	Start of Frame (SOF)	2	0xA5CC
2	Packet Version	1	1
3	Message Type	1	0: Not used 1: OVK to KAS IP Look Up request Packet 2: KAS to OVK IP Look Up response Packet 3: OVK to LES Access Request Packet 4: LES to OVK Access Request Packet Structure 5: Onboard KAVACH to Stationary KAVACH 6: Stationary KAVACH to Onboard KAVACH 7: Onboard KAVACH to NMS Event 8: Onboard KAVACH to NMS Fault 9: NMS Acknowledgement 10: Onboard KAVACH to CTC 11: Onboard KAVACH to TSR Server 12: TSR server to Onboard KAVACH
4	Message Length	2	In Bytes from field “Message Type ” to “CRC” (inclusive of both)

Field No	Field Description	Field Width (Bytes)	Comment
5	Message Sequence	2	0-65535
6	Date	3	DD/MM/YY 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 27/04/18 → 0x1B-0x04-0x12
7	Time	3	HH:MM:SS (IST time) 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 06:36:10 → 0x06-0x24-0x0A
8	KAVACH subsystem type	1	0x11 – Stationary KAVACH 0x22 – OnboardKAVACH 0x33 – TSRMS
9	KAVACH Subsystem ID	3	
10	System Version	1	1
11	Total Fault Codes (F)	1	Max number of faults shall be 10
12	Fault Code	2*F	Firm specific code to be decoded by NMS
13	CRC	4	CRC 32 bit (Polynomial EEB88320), (Message type to End of Loco Packet)

10. Onboard KAVACH to CTC Packet Structure

Field No	Field Description	Field Width (Bytes)	Comment
1	Start of Frame (SOF)	2	0xA5CC
2	Packet Version	1	1

Field No	Field Description	Field Width (Bytes)	Comment
3	Message Type	1	0: Not used 1: OVK to KAS IP Look Up request Packet 2: KAS to OVK IP Look Up response Packet 3: OVK to LES Access Request Packet 4: LES to OVK Access Request Packet Structure 5: Onboard KAVACH to Stationary KAVACH 6: Stationary KAVACH to Onboard KAVACH 7: Onboard KAVACH to NMS Event 8: Onboard KAVACH to NMS Fault 9: NMS Acknowledgement 10: Onboard KAVACH to CTC 11: Onboard KAVACH to TSR Server 12: TSR server to Onboard KAVACH
4	Message Length	2	In Bytes from field “Message Type ” to “CRC” (inclusive of both)
5	Message Sequence	2	0-65535
6	Date	3	DD/MM/YY 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 27/04/18 → 0x1B-0x04-0x12
7	Time	3	HH:MM:SS (IST time) 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 06:36:10 → 0x06-0x24-0x0A
8	Train Position to CTC		

Field No	Field Description	Field Width (Bytes)	Comment
9	CRC	4	CRC 32 bit (Polynomial EEB88320), (Message type to End of Loco Packet)

11. Onboard KAVACH to TSR Server

Field No	Field Description	Field Width (Bytes)	Comment
1	Start of Frame (SOF)	2	0xA5CC
2	Packet Version	1	1
3	Message Type	1	0: Not used 1: OVK to KAS IP Look Up request Packet 2: KAS to OVK IP Look Up response Packet 3: OVK to LES Access Request Packet 4: LES to OVK Access Request Packet Structure 5: Onboard KAVACH to Stationary KAVACH 6: Stationary KAVACH to Onboard KAVACH 7: Onboard KAVACH to NMS Event 8: Onboard KAVACH to NMS Fault 9: NMS Acknowledgement 10: Onboard KAVACH to CTC 11: Onboard KAVACH to TSR Server 12: TSR server to Onboard KAVACH
4	Message Length	2	In Bytes from field “Message Type ” to “CRC” (inclusive of both)
5	Message Sequence	2	0-65535
6	Date	3	DD/MM/YY 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 27/04/18 → 0x1B-0x04-0x12

Field No	Field Description	Field Width (Bytes)	Comment
7	Time	3	HH:MM:SS (IST time) 00-99: official year, 100-126: not used, 127: year unknown 01-12: official month, 0,13,14: not used, 15: month unknown 01-31: official day, 0: month unknown Eg: 06:36:10 → 0x06-0x24-0x0A
8	Loco to TSR Server Access Request / Regular Packet / Link Check Packet		
9	CRC	4	CRC 32 bit (Polynomial EEB88320), (Message type to End of Loco Packet)