सत्यमेव जयते

GOVERNMENT OF INDIA

(भारत सरकार)

MINISTRY OF RAILWAYS

(रेल मंत्रालय)

Annexure – G

KAVACH

Network Monitoring System Protocol

Amdt-3

Issued by

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REVISION HISTORY

Amdt	Date of issue	Amendment
1	13.06.2023	• Figure-1 -KAVACH Network arrangement diagram is modified • Clause 4.1- Station Active Radio - modified and • ~~Loco Regular / Access Request Packet (As per KAVACH Radio Communication Protocol~~ Shifted in clause G.4.2. • Cl. G-4.2 - Loco KAVACH Position Information Message- New clause added • Cl. G 4.3 Adjacent Kavach Information –New clause added. • Cl. G..4.4 Field Input Status Message- New clause • Cl.G.4.5 Field Inputs Event Message- New clause • Cl. G.4.7 Onboard KAVACH Health Packet to NMS- Modified • Cl. G.4.8 KAVACH Fault message to NMS Server-modified • Cl. G.4.9 NMS Acknowledge message to KAVACH Subsystem- Modified. • Cl. G.6.1.24- modified for additional fault message.
2	06.11.2023	• CL.G.2.2-Modified with addition of "The same network may be used for connection TSRMS network". CL.G.2.3- deleted "~~The IB huts shall be connected to the nearest Station in T network.~~ Figure-1 for connectivity with NMS modified. • Cl. G.3- The NMS message structure from Stationary KAVACH corrected. • CL.G.4.1-Modified in field Station Active Radio with addition of "0xE1: if Ethernet 1 is active, 0xE2: if Ethernet 2 is active, Any other data: Active radio un-known". • CL.G.4.2-Modified in field onboard Active Radio with addition of "0xE1: if Ethernet 1 is active, 0xE2: if Ethernet 2 is active, Any other data: Active radio un-known". • CL.4.3- TSR Information Message from stationary KAVACH to NMS- New Packet added. • CL4.4 - ~~**Adjacent Kavach Information- Field 10 & 11 is deleted.**~~
3	16.12.2023	• CL.G.2.3- New clause added- for storing of vital events in data event logger card. • CL.G.4.2- Modified in Loco Regular/ Access Request Packet. a) ~~Current Route ID~~ No of MA section count "~~Current route is the Route ID in which train occupied.~~ Defines

		the train route in which MA is extended". b) ~~Next~~ Route ID -~~ Next route is the approaching signal Route ID in which train will enter.~~ List of MA sections starting from train front end occupied section to EOA section. • CL.G.4.3- Deleted ~~TSR Data Integrity test message. Acknowledge Medssage~~ in Field No. 10. Modified CRC Field Width ~~32~~4 in Field No. 11. • CL.G.4.4- Deleted ~~Heart Beat message~~ in Field No. 10. • CL.G.4.6 –Field Input event message-Field-17- Registered Loco_Count, 18- Loco _ID, 19- Abs_Loc_1, 20& 23- Frequency channel Nunmber & 22- Abs_Loc_2. • CL.G.4.8- Onboard KAVACH Health Packet to NMS- Field-16- Stationary_KAVACH_ID, 17-Abs_Loc_1 , 18 &21 - Frequency Channel Number & 20- Abs_Loc_2.

G.1 Introduction

This document describes the protocol for Centralized Intelligent KAVACH Network Monitoring System (CIKMS) for the purpose of KAVACH System.

G.2 Interface details for Stationary KAVACH to NMS & Stationary KAVACH to Stationary KAVACH Communication on E1 Interface

G.2.1 KAVACH NMS Network shall be built on E1 interface which is provided by the Indian Railways. This network shall be used for centralized monitoring of KAVACH equipped Trains and Stations within the network. Centralized monitoring of a group of stations is achieved by collecting signal aspects, track occupancy, loco absolute position etc., from each of the Stationary KAVACH unit within the network. Stationary KAVACH units shall communicate with NMS unit using the predefined packets, as explained in Packet Structure in the subsequent clauses.

G.2.2 Using E1 interface, each Stationary KAVACH (SVK) unit is connected to adjacent stationary KAVACH unit/Network Management System to form a network, as shown in Figure 1. Using Ethernet protocol over this network, Stationary KAVACH units will exchange Stationary-Stationary communication packets with adjacent Stationary KAVACH units and NMS. The same network may be used for connection TSRMS network.

G.2.3 Event logger module of Onboard KAVACH and Stationary KAVACH shall store all the Vital events, messages exchanged between Radio or other unit and diagnostic related messages of all the other module. The modification in NMS protocol may be possible without change in executive logic of vital card.

G.2.4 Number of Stationary KAVACH units in one E1/Ethernet rings shall be limited to 10.

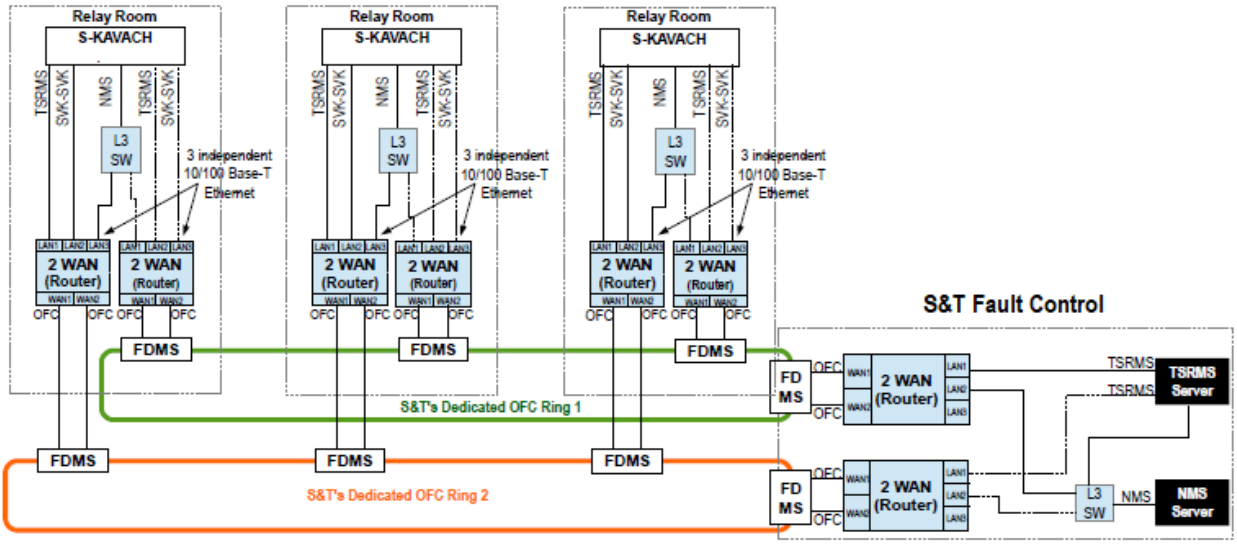


Figure 1 Connectivity with NMS

G.3 The NMS message structure from Stationary KAVACH:

The different types of messages are as defined belowfor logging in NMS

Message Type	Value	Purpose
Stationary KAVACH information Message to NMS server	0x11	Stationary KAVACH will send all packet of Station Regular / Access Authority & Additional Emergency Packet.
Loco KAVACH Position Information Message	0x12	Stationary KAVACH will send all packet of Loco Regular / Access Request Packet.
TSR Information Message from stationary KAVACH to NMS	0x13	The information received from TSRMS to Stationary KAVACH packet.
Adjacent Kavach Information	0x14	The information log in NMS are Command PDI version check Message PDI version check, Heart Beat message, Train Handover Request Message, Train RRI Message, Train Taken Over Message, Train Handover Cancellation message, Train Length Information message, Train Length Acknowledgement, TSL Route Request message, TSL Information message, Field Elements Status Request message & Field element Status message.

Field Input Status Message	0x15	The information received from Stationary KAVACH field input status.
Field Inputs Event Message	0x16	The information received from Stationary KAVACH field input event change message.
Stationary KAVACH Health Message to NMS Server	0x17	The health message received from Stationary KAVACH.
Onboard KAVACH Health Packet to NMS	0x18	The health message received from onboard KAVACH packet.
KAVACH Fault message to NMS Server	0x19	The fault code message received from stationary KAVACH.
NMS Acknowledge message to KAVACH Subsystem	0x1F	NMS acknowledgement.

Stationary KAVACH NMS Packet Structure

G.3.1 Fields highlighted (marked with Gray color) are of dynamic in size.

G.3.2 Loco to Station packet and Station to Loco packets are the RAW packets which are received/transmitted from/to the radio unit except SOF fields (0xA5, 0xC3). SOF fields shall not be included in Loco to Station Packet and Station to Loco packet.

G.3.3 Loco to Station Packet SOF and Station to Loco packet SOF fields should be repeated for all the packets.

G.4 NMS Packet Structure for version 4.0

G.4.1 Stationary KAVACH information Message to NMS server

Field No	Field Description	Field Width (Byte)	Comment
1	Start of Frame (SOF)	2	0xAAAA
2	Message Type	1	0x11
3	Message Length	2	In Bytes from field "Message Type" to "CRC" (inclusive of both)
4	Message Sequence	2	0-65535
5	Stationary KAVACH ID	2	Unique Code, Valid values from 1 to 65535 (Purchaser Railway to Decide)
6	NMS system ID	2	It is one of the stationary KAVACH ID
7	System Version	1	0x00-Version 3.2 0x01- Version 4.0
8	Date	3	DD/MM/YY 00-99: official year; 100-254: not used; 255: year unknown 01-12: official month; 0,13 to 254: not used; 255: month unknown 01-31: official day; 0, 32-254: not used; 255: day unknown Eg: 27/04/18 → 0x1B-0x04-0x12
9	Time	3	HH:MM:SS (IST time- Configura-ble) 00-23: official hour; 24-254: not used; 255: hour unknown 00-59: official minutes, 60-254: not used, 255: minutes unknown 00-59: official seconds, 60-254: not used, 255: seconds unknown Eg: 06:36:10 → 0x06-0x24-0x0A
10	Station Active Radio	1	0xF1: if Radio 1 is active. 0xF2: if Radio 2 is active. 0xE1: if Ethernet 1 is active. 0xE2: if Ethernet 2 is active. Any other data: Active radio un-known
11	SOF Tx byte 1	1	0xA5

Field No	Field Description	Field Width (Byte)	Comment
12	SOF Tx byte 2	1	0xC3
Station Regular / Access Authority / Additional Emergency Packet / etc. (As per KAVACH Radio Communication Protocol)			
13	CRC	4	CCITT- 32 Bit CRC (0x04C11DB7) excluding SOF field.

G.4.2 **Loco KAVACH Position Information Message**

Loco KAVACH Position Information Message			
For Every cycle (1 cycle = 2s) when locos registered with SKAVACH			
Field No	**Field Description**	**Field Width (Bytes)**	**Comment**
1	Start of Frame (SOF)	2	0xAAAA
2	Message Type	1	0x12
3	Message Length	2	In Bytes from field “Message Type” to “CRC” (inclusive of both)
4	Message Sequence	2	0-65535
5	Stationary KAVACH ID	2	Unique Code, Valid values from 1 to 65535 (Purchaser Railway to Decide)
6	NMS system ID	2	It is one of the stationary KAVACH ID
7	System Version	1	1
8	Date	3	DD/MM/YY 00-99: official year; 100-254: not used; 255: year unknown 01-12: official month; 0,13 to 254: not used; 255: month unknown 01-31: official day; 0, 32-254: not used; 255: day unknown Eg: 27/04/18 → 0x1B-0x04-0x12
9	Time	3	HH:MM:SS (IST time) 00-23: official hour; 24-254: not used; 255: hour unknown 00-59: official minutes, 60-254: not used, 255: minutes unknown 00-59: official seconds, 60-254: not used, 255: seconds unknown Eg: 06:36:10 → 0x06-0x24-0x0A

10	Onboard Active Radio	1	0xF1: if Radio 1 is active. 0xF2: if Radio 2 is active. 0xE1: if Ethernet 1 is active. 0xE2: if Ethernet 2 is active. Any other data: Active radio un-known
11	SOF Tx byte 1	1	0xA5
12	SOF Tx byte 2	1	0xC3
Loco Regular / Access Request Packet (As per KAVACH Radio Communication Protocol)			
13	~~Current Route ID~~ No of MA section count	~~2~~ 1	~~Current route is the Route ID in which train occupied.~~ Defines the train route in which MA is extended.
14	~~Next~~ Route ID	2	~~Next route is the approaching signal Route ID in which train will enter.~~ List of MA sections starting from train front end occupied section to EOA section.
15	CRC	4	CCITT- 32 Bit CRC (0x04C11DB7) excluding SOF (0xAAAA) field.

G.4.3 TSR Information Message from stationary KAVACH to NMS

Field No	Field Description	Field Width (Bytes)	Comment
1	Start of Frame (SOF)	2	0xAAAA
2	Message Type	1	0x13
3	Message Length	2	In Bytes from field "Message Type" to "CRC" (inclusive of both)
4	Message Sequence	2	0-65535
5	Stationary KAVACH ID	2	
6	NMS system ID	2	
7	System Version	1	1
8	Date	3	DD/MM/YY 00-99: official year; 100-254: not used; 255: year unknown 01-12: official month; 0,13 to 254: not used; 255: month unknown 01-31: official day; 0, 32-254: not used; 255: day unknown Eg: 27/04/18 → 0x1B-0x04-0x12
9	Time	3	HH:MM:SS (IST time) 00-23: official hour; 24-254: not used; 255: hour unknown 00-59: official minutes, 60-254: not used, 255: minutes unknown 00-59: official seconds, 60-254: not used, 255: seconds unknown Eg: 06:36:10 → 0x06-0x24-0x0A
10	**All TSR Information message** (As per TSRMS-SKAVACH Communication Protocol) (Command PDI version check, Message PDI version check, All TSR Information message, Get TSR Information message, SKAVACH TSR data message, ~~TSR Data Integrity test message, Acknowledge Message~~)		
11	CRC	~~32~~ 4	CCITT- 32 Bit CRC (0x04C11DB7) excluding SOF field.

G.4.4 **Adjacent Kavach Information:** When handover of Train is in progress.

Field No	Field Description	Field Width (Bytes)	Comment
1	Start of Frame (SOF)	2	0xAAAA
2	Message Type	1	0x14
3	Message Length	2	In Bytes from field "Message Type" to "CRC" (inclusive of both)
4	Message Sequence	2	0-65535
5	Stationary KAVACH ID	2	Unique Code, Valid values from 1 to 65535 (Purchaser Railway to Decide)
6	NMS system ID	2	It is one of the stationary KAVACH ID
7	System Version	1	1
8	Date	3	DD/MM/YY 00-99: official year; 100-254: not used; 255: year unknown 01-12: official month; 0,13 to 254: not used; 255: month unknown 01-31: official day; 0, 32-254: not used; 255: day unknown Eg: 27/04/18 → 0x1B-0x04-0x12
9	Time	3	HH:MM:SS (IST time) 00-23: official hour; 24-254: not used; 255: hour unknown 00-59: official minutes, 60-254: not used, 255: minutes unknown 00-59: official seconds, 60-254: not used, 255: seconds unknown Eg: 06:36:10 → 0x06-0x24-0x0A
10	As per SKAVACH-SKAVACH Communication Protocol) Command PDI version check Message PDI version check, ~~Heart Beat message~~, Train Handover Request Message Train RRI Message, Train Taken Over Message, Train Handover Cancellation message Train Length Information message, Train Length Acknowledgement, TSL Route Request message, TSL Information message, Field Elements Status Request message & Field element Status message.		
11	CRC	4	CCITT- 32 Bit CRC (0x04C11DB7) excluding SOF field.

G.4.5 **Field Input Status Message:** On power on of SKAVACH, On Link fail recovery & periodically defined by Railways (for play back reason)

Field No	Field Description	Field Width (Bytes)	Comment
1	Start of Frame (SOF)	2	0xAAAA
2	Message Type	1	0x15
3	Message Length	2	In Bytes from field "Message Type" to "CRC" (inclusive of both)
4	Message Sequence	2	0-65535
5	Stationary KAVACH ID	2	Unique Code, Valid values from 1 to 65535 (Purchaser Railway to Decide)
6	NMS system ID	2	It is one of the stationary KAVACH ID
7	System Version	1	1
8	Date	3	DD/MM/YY 00-99: official year; 100-254: not used; 255: year unknown 01-12: official month; 0,13 to 254: not used; 255: month unknown 01-31: official day; 0, 32-254: not used; 255: day unknown Eg: 27/04/18 → 0x1B-0x04-0x12
9	Time	3	HH:MM: SS (IST time) 00-23: official hour; 24-254: not used; 255: hour unknown 00-59: official minutes, 60-254: not used, 255: minutes unknown 00-59: official seconds, 60-254: not used, 255: seconds unknown Eg: 06:36:10 → 0x06-0x24-0x0A
10	Total Event Relays (E)	2	The total number of relays (in bytes) for which information is transmitted in this packet shall be specified.
11	Relay Status Image	Round off (E/8) Bytes	Each bit indicates status of each input. ('0' – Drop, '1' – Pickup) LSB of first byte indicates status of first input. This data contains status of all Track Identification Numbers (TIN) and Station Inputs. Status of all TINs (0 to 255) shall be

Field No	Field Description	Field Width (Bytes)	Comment
			framed first while preparing the packet. All TINs status shall be sent irrespective of TIN allocation in the Station. First input of Stationary KAVACH shall start from 256th bit. Relay status image shall be multiple of 8. Unconnected/Unallocated inputs shall be filled with Zero. Ex: If No. of Stationary KAVACH inputs is 66, Relay Status image shall be 25 Bytes (32 bytes TIN + 9 bytes Station-ary KAVACH inputs).
12	CRC	4	CCITT- 32 Bit CRC (0x04C11DB7) excluding SOF field.

G.4.6 **Field Inputs Event Message:** On change of any relay status.

Field No	Field Description	Field Width (Bytes)	Comment
1	Start of Frame (SOF)	2	0xAAAA
2	Message Type	1	0x16
3	Message Length	2	In Bytes from field “Message Type” to “CRC” (inclusive of both)
4	Message Sequence	2	0-65535
5	Stationary KAVACH ID	2	Unique Code, Valid values from 1 to 65535 (Purchaser Railway to Decide)
6	NMS system ID	2	It is one of the stationary KAVACH ID
7	System Version	1	1
8	Date	3	DD/MM/YY 00-99: official year; 100-254: not used; 255: year unknown 01-12: official month; 0,13 to 254: not used; 255: month unknown 01-31: official day; 0, 32-254: not used; 255: day unknown Eg: 27/04/18 → 0x1B-0x04-0x12

Field No	Field Description	Field Width (Bytes)	Comment
9	Time	3	HH:MM:SS (IST time) 00-23: official hour; 24-254: not used; 255: hour unknown 00-59: official minutes, 60-254: not used, 255: minutes unknown 00-59: official seconds, 60-254: not used, 255: seconds unknown Eg: 06:36:10 → 0x06-0x24-0x0A
10	Relay Event Count	1	Total events detected in same time
11	Relay Address	2	
12	Relay Status	1	0x00 – Drop Down 0x01 – Picked Up
13	CRC	4	CCITT- 32 Bit CRC (0x04C11DB7) excluding SOF field.

G.4.7 Stationary KAVACH Health Message to NMS Server

Field No	Field Description	Field Width (Bytes)	Comment
1	Start of Frame (SOF)	2	0xAAAA
2	Message Type	1	0x17
3	Message Length	2	In Bytes from field “Message Type” to “CRC” (inclusive of both)
4	Message Sequence	2	0-65535
5	Stationary KAVACH ID	2	Unique Code, Valid values from 1 to 65535 (Purchaser Railway to Decide)
6	NMS system ID	2	It is one of the stationary KAVACH ID
7	System Version	1	1
8	Date	3	DD/MM/YY 00-99: official year; 100-254: not used; 255: year unknown 01-12: official month; 0,13 to 254: not used; 255: month unknown 01-31: official day; 0, 32-254: not used; 255: day unknown Eg: 27/04/18 → 0x1B-0x04-0x12
9	Time	3	HH:MM:SS (IST time) 00-23: official hour; 24-254: not used; 255: hour

Field No	Field Description	Field Width (Bytes)	Comment
			unknown 00-59: official minutes, 60-254: not used, 255: minutes unknown 00-59: official seconds, 60-254: not used, 255: seconds unknown Eg: 06:36:10 → 0x06-0x24-0x0A
10	Event Count	1	
11	Event Id	2	Stationary KAVACH Health
12	Event Data	m	
13	CRC	4	CCITT- 32 Bit CRC (0x04C11DB7) excluding SOF field.
Event Field			
1.	System Temperature	1	System Temperature value (1 byte Signed) *- On change of temperature by 3°C*
2.	Active Radio Number	1	0: not used 1: Radio 1 2: Radio 2 3: Both Radio active
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*
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 Tempera-ture	1	Value:20°C to 100°C *- On change of temperature by 3°C*
8.	Radio-2 PA Tempera-ture	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	1	Value: 11V-13V

Field No	Field Description	Field Width (Bytes)	Comment
	Voltage		*- 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) - on Change of Reverse power by 0.1W
14.	Radio-2 Reverse Power	1	Value received from Radio Eg: Value received from Radio is 0x0F = 1.5W (Value: 0x0F) - on Change of Reverse power by 0.1W
15.	Radio-1 Forward Power	1	Value received from Radio Eg: Value received from Radio is 0x36 = 5.4W (Value: 0x36) - on Change of Forward power by 0.1W
16.	Radio-2 Forward Power	1	Value received from Radio Eg: Value received from Radio is 0x78 = 12W (Value: 0x78) - on Change of Forward power by 0.1W
17.	Registered Loco_Count	1	No of loco registered with stationary KAVACH.
18.	Loco _ID	3	Loco ID
19.	Abs_Loc_1	3	Absolute location of Loco when received through Radio-1
20.	Frequency Chan-nel_Number	2	Channel Number of received frequency including control to be appended for Radio-1.
21.	Radio-1 RSSI	2	Value received from Radio (16bit Signed) Eg: Value received from Radio is 0xBDBF = -132.5dBm (Value: 0xBDBF) *- On change of value*
22.	Abs_Loc_2	3	Absolute location of Loco when received through Radio-2
23.	Frequency Chan-nel_Number	2	Channel Number of received frequency including control to be appended for Radio-2.
24.	Radio-2 RSSI	2	Value received from Radio (16bit Signed) Eg: Value received from Radio is 0xBDBF = -132.5dBm (Value: 0xBDBF) *- On change of value*
25.	Current Running Key	1	0: Default key set,

Field No	Field Description	Field Width (Bytes)	Comment
			1-30: KMS key set - on change of Key Set
26.	Remaining Number of Keys	1	0: No keys, 1-30: Remaining KMS key sets - on change of value
27.	Session Key Checksum	2	Checksum of 16 bytes session key - for every 2s at the time of Authentication only
28.	Allocated time slot for new loco	1	1-50 - for every 2s at the time of Authentication only
29.	New Loco Regular packet received time offset	2	0-2000ms - At the time of successful registration only
30.	Loco Count	1	Value: 0-50 Noof Locos supervised by Stationary KAVACH - *On change of value*
31.	Radio-1 Rx Packet Count	1	Value: 0-50 Total Loco regular packets received from Radio-1 in 2s time frame - *for every 2s time frame when locos are present*
32.	Radio-2 Rx Packet Count	1	Total Loco regular packets received from Radio-2 in 2s time frame - *for every 2s time frame when locos are present*
33.	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
34.	GPS-1 View	1	0 – No Data 1 – V 2 – A - on detection of change *of event*
35.	GPS-2 View	1	0 – No Data 1 – V 2 – A - on detection of change *of event*
36.	GPS-1 Seconds	1	0 to 59 seconds - on change of value
37.	GPS-2 Seconds	1	0 to 59 seconds - on change of value

Field No	Field Description	Field Width (Bytes)	Comment
38.	GPS-1 Satellites in View	1	Value received from GPS receiver *- On change of value*
39.	GPS-1 CNO (Max)	1	Maximum CNO Value received from GPS receiver *- On change of value*
40.	GPS-2 Satellites in View	1	Value received from GPS receiver *- On change of value*
41.	GPS-2 CNO (Max)	1	Maximum CNO Value received from GPS receiver *- On change of value*
42.	GSM-1 RSSI	1	Value received from GSM module *- for every 30 minutes*
43.	GSM-2 RSSI	1	Value received from GSM module *- for every 30 minutes*
44.	Missing RFID	2	- on detection of Missing RFID
45.	Invalid RFID	2	- on detection of Invalid RFID
46.	Conflict Route RFID	2	- on detection of conflicting route RFID
47.	Conflicting TIN	2	Conflicting TIN in the route occupied by another train *- On detection of event*
48.	Override TIN	2	TIN which is cleared due to RFID reader failure *- On detection of event*
49.	Loco Specific SoS	4	B3 to B1: Loco ID B0: SoS Code given below 1: SoS generated due to wrong route Tag 2: SoS due to collision detection 3: SoS due to shunt limits violation 4: SoS due to Invalid position report 5: SoS due to signal set to conflicting route *- On detection of event*
50.	Train exit mode	4	B3 to B1: Loco ID B0: Exit Code given below 1: Loco exit due to unknown direction in SR or SB mode 2: Loco exit due to out of station boundary 3: Loco exit due to specific mode (IS or NL mode) 4: Loco exit due to authentication failure 5: Loco exit due to communication timeout *- On detection of event*
51.	Station Modules Health	2	b15-b4: Module ID b3-b0: Module Health *- On detection of event*

Field No	Field Description	Field Width (Bytes)	Comment
52-199	Reserved		
200-254	Firm specific events	2	This field Information is specific to KAVACH firm
255	Specific value		Not to be used

G.4.8 **Onboard KAVACH Health Packet to NMS**

Event ID	Onboard KAVACH Health	Field Width (Bytes)	Description
1.	Start of Frame (SOF)	2	0xBBBB
2.	Message Type	1	0x18
3.	Message Length	2	In Bytes from field "Message Type" to "CRC" (inclusive of both)
4.	Message Sequence	2	0-65535
5.	Onboard KAVACH ID	3	
6.	NMS System ID	2	Onboard KAVACH shall identify the NMS system ID from domain name server / Stationary KAVACH shall send the NMS ID during session establishment
7.	System Version	1	1
8.	Date	3	DD/MM/YY (IST Time- Configurable) 00-99: official year; 100-254: not used; 255: year unknown 01-12: official month; 0,13 to 254: not used; 255: month unknown 01-31: official day; 0, 32-254: not used; 255: day unknown Eg: 27/04/18 → 0x1B-0x04-0x12
9.	Time	3	HH:MM:SS (IST time-Configurable) 00-23: official hour; 24-254: not used; 255: hour unknown 00-59: official minutes, 60-254: not used, 255: minutes unknown 00-59: official seconds, 60-254: not used, 255: seconds unknown Eg: 06:36:10 → 0x06-0x24-0x0A
10.	Event Count	1	
11.	Event Id	2	Onboard KAVACH Health
12.	Event Data	m	

13.	CRC	4	CCITT- 32 Bit CRC (0x04C11DB7) excluding SOF field.
Event ID	**Loco KAVACH Health**	**Field Width (Bytes) – m**	**Description**
1.	Radio-2 Health	1	1: OK 2: Diagnostic Link Fail 3: Radio Fail
2.	Radio-1 Input supply	1	Value: 10V-30V *- On change of voltage by 1V*
3.	Radio-2 Input supply	1	Value: 10V-30V *- On change of voltage by 1V*
4.	Radio-1 Temperature	1	Value: -30°C to 70°C (1 byte Signed) *- On change of temperature by 3°C*
5.	Radio-2 Temperature	1	Value: -30°C to 70°C (1 byte Signed) *- On change of temperature by 3°C*
6.	Radio-1 PA Tempera-ture	1	Value:20°C to 100°C *- On change of temperature by 3°C*
7.	Radio-2 PA Tempera-ture	1	Value:20°C to 100°C *- On change of temperature by 3°C*
8.	Radio-1 PA Supply Voltage	1	Value: 11V-13V *- On change of voltage by 1V*
9.	Radio-2 PA Supply Voltage	1	Value: 11V-13V *- On change of voltage by 1V*
10.	Radio-1 Tx PA Current	1	Value: 1.5A to 3.2A *- On change of current*
11.	Radio-2 Tx PA Current	1	Value: 1.5A to 3.2A *- On change of current*
12.	Radio-1 Reverse Power	1	Value received from Radio Eg: Value received from Radio is 0x01 = 0.1W (Value: 0x01)
13.	Radio-2 Reverse Power	1	Value received from Radio Eg: Value received from Radio is 0x0F = 1.5W (Value: 0x0F)
14.	Radio-1 Forward Power	1	Value received from Radio Eg: Value received from Radio is 0x36 = 5.4W (Value: 0x36)
15.	Radio-2 Forward Power	1	Value received from Radio Eg: Value received from Radio is 0x78 = 12W (Value: 0x78)
16.	Stationary_KAVACH_ID	3	Stationary KAVACH ID

17.	Abs_Loc_1	3	Absolute location of Loco when received through Radio-1
18.	Frequency Chan-nel_Number	2	Channel Number of received frequency in-cluding control to be appended for Radio-1.
19.	Radio-1 RSSI	2	Value received from Radio Eg: Value received from Radio is 0xBDBF = -132.5dBm (Value: 0xBDBF)
20.	Abs_Loc_2	3	Absolute location of Loco when received through Radio-2
21.	Frequency Chan-nel_Number	2	Channel Number of received frequency in-cluding control to be appended for Radio-2.
22.	Radio-2 RSSI	2	Value received from Radio Eg: Value received from Radio is 0xBDBF = -132.5dBm (Value: 0xBDBF)
23.	Stationary Regular packet received time offset	2	0-2000 ms
24.	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
25.	GPS-1 View Status	1	0 – No Data 1 – V 2 – A - on detection of change *of event*
26.	GPS-2 View Status	1	0 – No Data 1 – V 2 – A - on detection of change *of event*
27.	GPS-1 Seconds	1	0 to 59 seconds - on change of value
28.	GPS-2 Seconds	1	0 to 59 seconds - on change of value
29.	GPS-1 Satellites in View	1	Value received from GPS receiver - *On change of value*
30.	GPS-1 CNO (Max)	1	Maximum CNO Value received from GPS receiver - *On change of value*
31.	GPS-2 Satellites in View	1	Value received from GPS receiver

			- *On change of value*
32.	GPS-2 CNO (Max)	1	Maximum CNO Value received from GPS receiver - *On change of value*
33.	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 - *On change of event*
34.	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 - *On change of event*
35.	GSM-1 RSSI	1	Value received from GSM module - *On change of value*
36.	GSM-2 RSSI	1	Value received from GSM module - *On change of value*
37.	Current Running Key	1	0: Default key set, 1-30: KMS key set - on change of Key Set
38.	Remaining Number of Keys	1	0: No keys, 1-30: Remaining KMS key sets - on change of value
39.	Session Key Checksum	2	Checksum of 16 bytes session key - for every 2s at the time of Authentication only
40.	DMI-1 link status	2	0-NOT OK 1-OK - *On change of event*
41.	DMI-2 link status	2	0-NOT OK 1-OK - *On change of event*
42.	RFID Reader-1 link status	2	0-NOT OK 1-OK - *On change of event*
43.	RFID Reader-2 link status	2	0-NOT OK 1-OK - *On change of event*
44.	Duplicate Missing RFID Tag	2	RFID Tag Number
45.	Missing linked RFID Tag	4	B3-B1: Linked RFID Tag B0: Linking direction

46.	Computed TLM Status	4	B3-B2: Station Id B1-B0: TLM Status b11-b0: Computed TLM Value b15-b12: TLM Status TLM Status: 1 – TLM Updated 2 – TLM Timeout
47.	Train Configuration change	1	0 – No 1 – Yes
48.	Bootup Sequence Error	1	0 – Brake Test failed 1 – MR not available *- On detection of event*
49.	Selected Train for-mation	1	1 - Light Engine (120kmph) 2 - Light Engine Multi (120kmph) 3 - Passenger Train 3 to 7 Coach (120kmph) 4 - Passenger Train 8 to 13 Coach (120kmph) 5 - Passenger Train 14 to 20 Coach (120kmph) 6 - Passenger Train 21 to 27 Coach(120kmph) 7 - Goods 59 BOXN Empty (1000 - 1999 Ton, 75kmph) 8 - Goods 59 BOXN Half Load(2000 -3499 Ton, 75kmph) 9 - Goods 59 BOXN Full Load(3500 -5500 Ton, 60kmph) 10 - Goods 42 BCN Empty (1000 - 1999 Ton, 75kmph) 11 - Goods 42 BCN Half Load(2000 -3499 Ton, 75kmph) 12 - Goods 42 BCN Full Load(3500 -5500 Ton, 60kmph) 13 - Light Engine WAP5 (170kmph) 14 - WAP5-8LHB Coaches (170kmph) 15 - Light Engine WAP7 (140kmph) *- On detection of event*
50.	Selected Cab	1	0 – No Cab Selected 1 – Cab1 Selected 2 – Cab2 Selected 3 – Both Cabs Selected *- On detection of event*
51.	Brake application rea-son	1	0-Not used 1-Reverse movement detected

			2-Unusual stoppage 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 *- On detection of event*
52.	Station General SoS	3	B2-B1: Station Id B0: General SoS status (1 – Received, 2 – Cancelled) *- On detection of event*
53.	Station Loco Specific SoS	3	B2-B1: Station Id B0: Specific SoS status (1 – Received, 2 – Cancelled) *- On detection of event*
54.	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 9 – Train parting detected 10 – Train parting end *- On detection of event*
55.	Loco Self SoS	1	1 – Manual SoS 2 – Manual SoS end 3 – Unusual stopage start 4 – Unusual stopage end *- On detection of event*
56.	KAVACH Connection	1	1 – KAVACH Isolated 2 – KAVACH Connected *- On detection of event*
57.	BIU Isolated	1	1 – BIU Isolated 2 – BIU Connected
58.	EB Bypassed	1	1 – EB Connected

			2 – EB Bypassed *- On detection of event*
59.	KAVACH Territory	1	1 – KAVACH Entry 2 – KAVACH Exit 3 – ETCS Entry 4 – ETCS Exit *- On detection of event*
60.	Brake Interface Error	1	IRAB CCB E70
61.	Onboard KAVACH Modules Health	2	b15-b4: Module ID b3-b0: Module Health Module Health: 0-NOT OK 1-OK *- On detection of event*
62.	Conflict Route RFID	2	-On detection of conflicting route RFID
61-199	Reserved		
200-254	Firm specific events	2	This field Information is specific to KAVACH firm
255	Specific value		Not to be used

G.4.9 KAVACH Fault message to NMS Server

Field No	Field Description	Field Width (Bytes)	Comment
1	Start of Frame (SOF)	2	0xAAAA (E1 Channel/Network Channel) 0xBBBB (GPRS Channel)
2	Message Type	1	0x19
3	Message Length	2	In Bytes from field “Message Type” to “CRC” (inclusive of both)
4	Message Sequence	2	0-65535 Last received KAVACH subsystem message sequence number
5	KAVACH Subsystem ID	3	
6	NMS System ID	2	Loco KAVACH shall identify the NMS system ID from domain name server / Stationary KAVACH shall send the NMS ID during session establishment
7	System Version	1	

Field No	Field Description	Field Width (Bytes)	Comment
8	Date	3	DD/MM/YY 00-99: official year; 100-254: not used; 255: year unknown 01-12: official month; 0,13 to 254: not used; 255: month unknown 01-31: official day; 0, 32-254: not used; 255: day unknown Eg: 27/04/18 → 0x1B-0x04-0x12
9	Time	3	HH:MM:SS (IST time) 00-23: official hour; 24-254: not used; 255: hour unknown 00-59: official minutes, 60-254: not used, 255: minutes unknown 00-59: official seconds, 60-254: not used, 255: seconds unknown Eg: 06:36:10 → 0x06-0x24-0x0A
10	KAVACH subsystem type	1	0x11 – Stationary KAVACH 0x22 – Onboard KAVACH 0x33 – TSRMS
11	Total Fault Codes (F)	1	Max number of faults shall be 10
12	Module ID	1	Firm Specific
13	Fault Code Type	1	1: Fault Code 2: Recovery Code
14	Fault Code	2	Firm Specific
15	CRC	4	CCITT- 32 Bit CRC (0x04C11DB7) excluding SOF field.

G.4.10 **NMS Acknowledge message to KAVACH Subsystem**

Field No	Field Description	Field Width (Bytes)	Comment
1	Start of Frame (SOF)	2	0xBBBB for GPRS channel (Messages to be Ack on GPRS: 0x19) 0xAAAA for E1 channel (Messages to be Ack: 0x11, 0x12, 0x13, 0x14)
2	Message Type	1	0x1F

Field No	Field Description	Field Width (Bytes)	Comment
3	Message Length	2	In Bytes from field "Message Type" to "CRC" (inclusive of both)
4	Message Sequence	2	0-65535 Last received KAVACH subsystem message sequence number
5	NMS system ID	2	It is one of stationary KAVACH ID
6	KAVACH Sub system ID	3	Unique Code, Valid values from 1 to 65535 (Purchaser Railway to Decide)
8	KAVACH subsystem type	1	0x11 – Stationary KAVACH 0x22 – Onboard KAVACH 0x33 – TSRMS
9	CRC	4	CCITT- 32 Bit CRC (0x04C11DB7) excluding SOF field.

G.4.11 **Example of Signal Allocation Table in Mantatti Station:**

Signal ID as per SIP	Signal Logical ID (to be decided by the firm)
S1D	1
S1ID	2
S1	3
S3	4
S4	5
S6	6
S25	7
S26	8
S27	9
S28	10

Signal ID as per SIP	Signal Logical ID (to be decided by the firm)
S30	11
S30ID	12
S30D	13
S1D of TDU (Next station Distant Signal in UP Direction)	14
S1D(2) of NAW (Next station Distant Signal in DN Direction)	15

G.4.12 **Example of Relay Address Allocation Table for Mantatti Station (MVH):**

Relay Name	Relay Address (to be decided by the firm)
Track Identification Relays (TINs)	0 to 127
26_28TPR	128
25TPR	129
3_4TPR	130
6TPR	131
S25LCPR	132
S6LCPR	133
DLTPR	134
DMTPR	135
UMTPR	136
CLTPR	137
1ATPR	138
30ATPR	139
S1DHHECR	140
S1DDECR	141
S1DHECR	142
S1IDHHECR	143
S1IDDECR	144
S1IDHECR	145

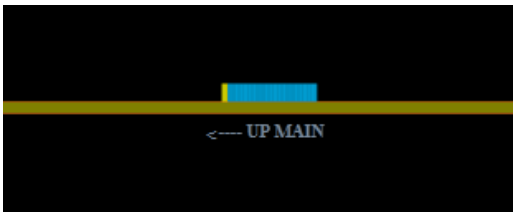
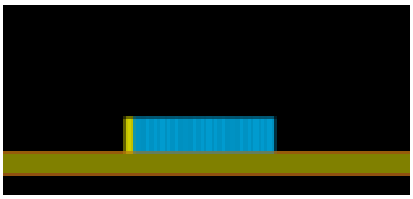
Relay Name	Relay Address (to be decided by the firm)
S1DECR	146
S1UGR_CL	147
S1UECR	148
S1HECR	149
S1RECR	150
S1AHECR	151
S3DECR	152
S3HECR	153
S3RECR	154
S4HECR	155
S4RECR	156
S6DECR	157
S6RECR	158
S25DECR	159
S25RECR	160
S26HECR	161
S26RECR	162
S27HECR	163
S27RECR	164
S28DECR	165
S28HECR	166
S28RECR	167
S30DHHECR	168
S30DDECR	169
S30DHECR	170
S30IDHHECR	171
S30IDDECR	172

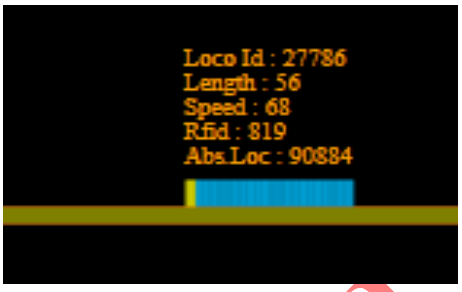
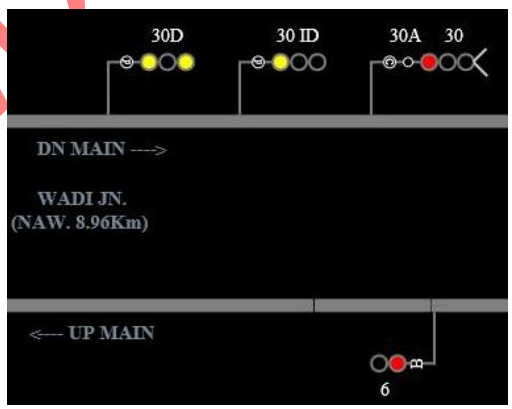
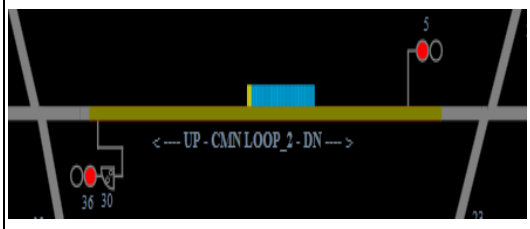
Relay Name	Relay Address (to be decided by the firm)
S30IDHECR	173
S30DECR	174
S30UGR_DL	175
S30UGR_CL	176
S30UECR	177
S30HECR	178
S30RECR	179
S30AHECR	180
11NWKR	181
11RWKR	182
12NWKR	183
12RWKR	184
13NWKR	185
13RWKR	186
18NWKR	187
18RWKR	188
19NWKR	189
19RWKR	190

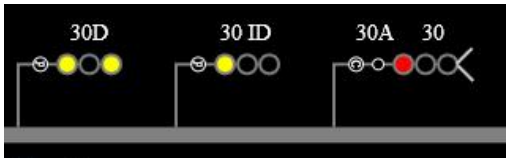
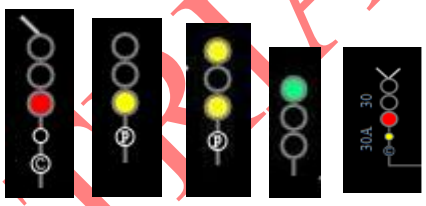
Relay Name	Relay Address (to be decided by the firm)
20NWKR	191
20RWKR	192
17KLNWKR	193
Total Event Relays (E) for Mantatti Station shall be 25 bytes. Relay Status Image for Mantatti Station shall be 200 bits. Status of 194th Relay to 200th Relay shall be filled with Zeros.	

G.5 Color representation used for different elements in Stationary KAVACH VDU

Color representation used for different elements in Stationary KAVACH is given below:

SNo	Element	Color	Screen shot
1	Screen Back-ground	Black	
2	Track	Gray	
3	Train	Deep Sky Blue	
4	Train Engine	Yellow	

5	Train In-for-mation	Orange	
6	Berthing Track (When Non-KAVACH equipped Train is occu-pied)	Red	
7	Text	White/Gr ay	
8	TIN Oc-cupancy	Olive	

9	Signal Post	Gray	
10	Signal Aspects	Red Yellow Double Yellow Green Yellow (Calling-On As-pect)	
11	Route Indicator	Yellow	
12	Text Font	Text Name: Times New Roman/ Sans Serif Font Size: Station Name: 20 Other Text: 14	

G.6 **Features of NMS**

G.6.1 The following typical features shall be provided as part of NMS:

G.6.1.1 Real time display of train movement on NMS monitors.

G.6.1.2 Offline display of train movement on NMS monitors at Normal, 2x, 4x, 8x, 16x & 32x speed.

G.6.1.3 Display of Datalog in Spreadsheet (Excel Format).

G.6.1.4 Display of "Permitted Speed+ Current Speed Vs Location" and" Permitted Speed+ Current Speed V/s Time" including information whether brake command is applied by KAVACH or not in Normal Mode - Pseudo Real-time and Offline.

G.6.1.5 Ability to watch the NMS at Distant Location through Internet (Password protected).

G.6.1.6 Ability to extract offline data log through NMS.

G.6.1.7 Support branching of incoming data stream to be forwarded to another port in interoperable manner.

G.6.1.8 Generation of Exception Reports – Onboard KAVACH Unit-wise, Stationary KAVACH Unit-wise.

G.6.1.9 Generation of Statistical data such as availability, category-wise braking cases.

G.6.1.10 Prompt through NMS for missing one of the two RFID tags of same set.

G.6.1.11 Prompt through NMS for missing both RFID tags of same set.

G.6.1.12 Prompt through NMS for missing communication packets overall below a set level (say 20%) for moving train in Communication mandatory zone.

G.6.1.13 SMS Alert for repeated same RFID tag missing events in Full Supervision Mode.

G.6.1.14 SMS Alert for any brake application command by KAVACH Loco forcing train to bring to dead stop in Full Supervision Mode.

G.6.1.15 SMS Alert for SPAD (Sample SMS Format: KAVACH NMS#01:<Enter>L:28016<Enter>SPAD at 15:07:37 on 3l-Jul-2014<Enter>Abs Location: km 69.70).

G.6.1.16 SMS Alert for SPAD Prevention by KAVACH.

G.6.1.17 Optional SMS Alert for Isolation Mode.

G.6.1.18 Optional SMS Alert for manually invoking SR Mode.

G.6.1.19 Optional SMS Alert for "Communication Failure between NMS and Stationery KAVACH" cases.

G.6.1.20 Filtering Stations with poor communication based upon missing data communication packets.

G.6.1.21 Filtering Locomotives with poor communication based upon missing data communication packets.

G.6.1.22 Capturing of speed restrictions imposed by TSR Management System from Stationary KAVACH after every update.

G.6.1.23 Capturing of health status and event log from Onboard KAVACH if LTE is available.

G.6.1.24 Following structure shall be used by Onboard KAVACH for transmitting Health bits to Stationary KAVACH in access request / regular packet.

Logical ID	Bit Number	Fault Description
1.	B0	System Internal Fault
2.	B1	Speed sensor1 Fault
3.	B2	EB Drive Fault
4.	B3	EB Application (Feedback) Fault
5.	B4	RFID Reader1 Link Fail
6.	B5	RFID Reader2 Link Fail
7.	B6	Radio1 Link Fail
8.	B7	Radio2 Link Fail
9.	B8	LP-OCIP (DMI)1 Link Fail
10.	B9	LP-OCIP (DMI)2 Link Fail
11.	B10	GPS1/PPS1 Fail
12.	B11	GPS2/PPS2 Fail
13.	B12	GPS1view not available since 2 hrs
14.	B13	GPS2 view not available since 2 hrs
15.	B14	Tag linking incorrect
16.	B15	GSM1 Fault
17.	B16	GSM2 Fault
18.	B17	Radio 1 RSSI Weak
19.	B18	Radio 2 RSSI Weak
20.	B19	Session Key Mismatch
21.	B20	Remaining keys < 5
22.	B21	BIU connectivity fault
23.	B22	Speed Sensor 2 fault
24.	B23	Cab Input fault

G.6.2 The Fault message structure from KAVACH System/Subsystem to NMS shall be as follows:

Field descriptor	Number of bytes	Remarks
Start of Frame	2	0xA5, 0xC3
Message Type	1	0xFC
Message Length	2	Length in terms of bytes from Date field to CRC field (inclusive of both)
Date	3	DD/MM/YY
Time	3	HH:MM:SS
Type of KAVACH sub-system	1	0x11 – Stationary KAVACH 0x22 – Onboard KAVACH 0x33- TSRMS
KAVACH Subsystem ID	3	Stationary KAVACH ID / Onboard KAVACH ID/TSRMS in Hex
Total Fault Codes (F)	1	Max number of faults shall be 10
Fault Code	2 * F	
32-Bit CCITT CRC	4	

G.6.3 The following structure shall be used to acknowledge receipt of Fault Message from NMS to KAVACH System/Sub system:

Field descriptor	Number of bytes	Remarks
Start of Frame	2	0xA5, 0xC3
Message Type	1	0xFD
Message Length	2	Length in terms of bytes from Date field to CRC field (inclusive of both)
Date	3	DD/MM/YY
Time	3	HH:MM:SS
Type of KAVACH sub-system	1	0x11 – Stationary KAVACH 0x22 – Onboard KAVACH 0x33-TSRMS
KAVACH Subsystem ID	3	Stationary KAVACH ID/Onboard KAVACH ID/TSRMS in Hex
32-Bit CCITT CRC	4	