TTA Standard

정보통신단체표준(잠정표준)

TTAI.KO-06.0407/R1 개정일: 2016년 12월 xx일

# LTE 기반 철도 통신 시스템 요구 사항(일반·고속 철도)

# LTE based Railway Communication System Requirements (Conventional and High Speed Railway)

본 문서는 TTA 국문 표준의 영문본으로, 국문본과 영문본의 차이가 있는 경우, 국문본이 우선합니다. 본 영문본은 참조용으로만 제공됩니다.

This document is the English translation version of TTA Korean Standards. In case of discrepancies between the Korean version and the English translation, the Korean version has priority. This English translation version is for reference purposes only.

TTA 한국정보통신기술협회
Telecommunications Technology Association

Copyright ⓒ 2016 All Rights Reserved by Telecommunications Technology Association (TTA). All or part of this document may not be duplicated or distributed for commercial purpose without prior consent of TTA.

IPR information statements related to this standard declared to TTA before the publication has been specified in Appendix I-1 and declared to TTA after the publication can be found in the TTA website
No guarantee can be given as to the existence of other IPRs not referenced on the TTA website.

Publisher: President of Telecommunications Technology Association
Publishing: Telecommunications Technology Association
13591, 47 Bundang-ro, Bundang-gu, Seongnam, Gyunggi-do
Republic of Korea
Tel: +82-31-724-0114, Fax: +82-31-724-0109
Publishing Date: 2016.xx

# Preface

## 1. Purpose of Standard

The purpose of this standard is to define both user requirements and system requirements for controls and operations of LTE based railway communication systems.

## 2. Summary

The main content of this document defines service concept, the functional and performance requirements on train control data service, voice call, data and video service. The basic configuration of Conventional and High Speed Railway Wireless Communication System and its functional and performance requirements are defined.

## 3. Relationship to Reference Standards

None.

# Contents

1. Scope ····· 1

2. Reference Standards ····· 1

3. Terms Definition ····· 1

4. Abbreviations ····· 3

5. Service Overview on Railway Mobile Communication System ····· 4

6. User Requirements for Railway Mobile Communication System ····· 5

6.1. User Functional Requirements ····· 5

6.2. User Performance Requirements ····· 11

7. Railway Mobile Communication System Requirements ····· 12

7.1. System Functional Requirements ····· 13

7.2. System Performance Requirements ····· 19

Appendix I-1. IPR Information Statement ····· 22

I-2. Testing and Certification ····· 23

I-3. Family Standards ····· 24

I-4. Bibliography ····· 25

I-5. Korean Abstract of English Standard ····· 26

I-6. History of Standard ····· 27

# LTE based Railway Communication System Requirements
# (Conventional and High Speed Railway)

## 1. Scope

The purpose of this standard is to define user functional and performance requirements, system functional and performance requirements. These user and system requirements consider interface with PS-LTE and existing railway mobile communication networks. And these will provide interoperability among vendors of the equipment when system has been developed.

## 2. Reference Standards

None

## 3. Terms Definition

### 3.1. Public Safety LTE (PS-LTE)

Public Safety LTE is a communication network to perform rescue and safety management, disaster precaution and operation management efficiently by disaster related agency

### 3.2. LTE based Railway Mobile Communication System (LTE-R)

This consists of train control system, LTE-R mobile communication network and terminal for conventional and high speed train operation and management. It provides train control data service, voice service and video service. And it provides interworking with PS-LTE, VHF and TRS mobile communication network. This system is called as integrated railway mobile communication networks.

### 3.3. LTE-R Mobile Communication Network

This consists of LTE-R core network and radio access network. It provides voice, data and video service by using subscriber information and Quality of Service information.

### 3.4. Train Control System

This consists of central control equipment, radio block center and location detection device. It collects train driving information and generates train control message for train control management.

### 3.5. LTE-R Terminal

This has two types of terminals; portable terminal and train mobile station. Portable terminal is convenient to carry and has 'Push to Talk (PTT)' function. Train mobile station is installed on train engine control room.

### 3.6. Portable Terminal

This is convenient to carry and has 'Push to Talk (PTT)' function. It is used by train operation and maintenance workers.

### 3.7. Train Mobile Station

This is installed in train engine control room. It is used by train driver.

### 3.8. Train Traffic Control Center (called as "Control Center")

This means control center and communication facilities to monitor railway traffic status and control railway traffic.

### 3.9. Location Detection Device

This is circuits and equipment which is installed on the railway track and monitor the location information. It indicates generally track circuit and balise.

### 3.10. Radio Block Center

This is an equipment to monitor train location in real time, determine train operation profile and transmit train control message to train mobile station.

### 3.11. Central Control Equipment

This is able to connect train and track equipment and conduct central control, remote control and operation message transmission.

## 4. Abbreviations

| | |
|---|---|
| 3GPP | 3rd Generation Partnership Project |
| ASTRO | ASTRO Digital Radio System |
| AuC | Authentication Center |
| DU | Digital Unit |
| eNB | Evolved Universal Terrestrial Radio Access Network Node B |
| HSS | Home Subscriber Subsystem |
| IP | Internet Protocol |
| KRTCS | Korea Radio based Train Control System |
| LTE | Long Term Evolution |
| MME | Mobility Management Entity |
| NME | Network Management Entity |
| PS-LTE | Public Safety - Long Term Evolution |
| PTT | Push-To-Talk |
| RU | Radio Unit |
| SGW | Serving Gateway |
| TETRA | Terrestrial Trunked Radio |
| TRS | Trunked Radio System |
| VHF | Very High Frequency |

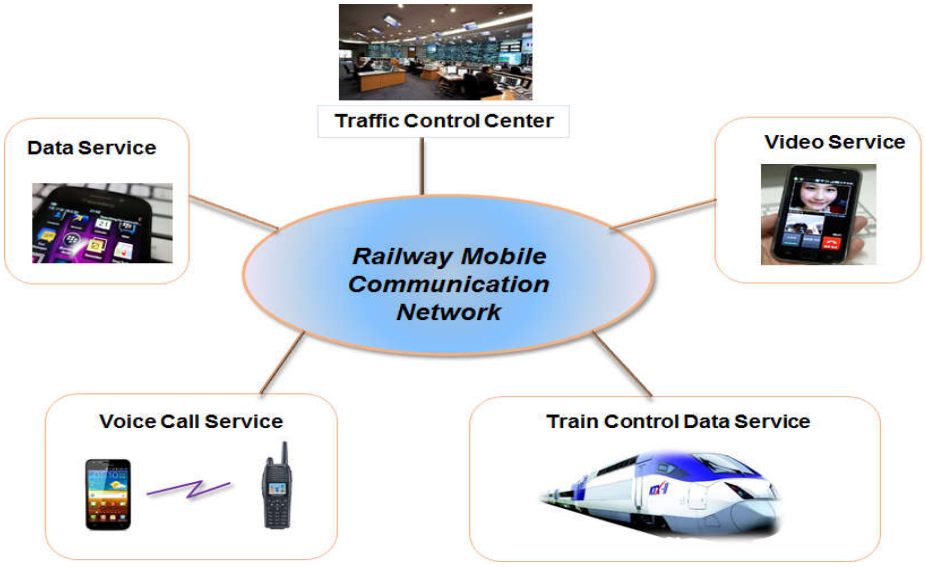
## 5. Service Overview on Railway Mobile Communication System

LTE based railway mobile communication system provides train control data service, voice call, data and video service. Train control data service conducts train status monitoring and train control for safe operation by communicating between control center and train mobile station. Train status monitoring is done by using track line circuit or LTE-R mobile communication network. And it contains train location and speed data, its message length is normally less than 64 bytes. It has KRTCS signaling and interface. It requires high communication reliability and the highest service priority.

Voice call service is needed for train control center manager, train driver, train officer and maintenance workers on the track. It provides private call, emergency call, group call, multi-party voice call and direct call between terminals. It has to support less than 300msec timing delay.

Data service is needed for train control center manager, train officer and maintenance workers on the track. It provides train operation data, on-site maintenance data, train approaching warning data and track related data. Video service is a service by using video information and has high data rate.

The above four services have priority. The train control data service has the highest priority and next priority is voice call, data service and video service. Its operation rule is determined by operation authority.




(Figure 5-1) Service concept of LTE based railway mobile communication system

# 6. User requirements for LTE based railway communication system

## 6.1. User functional requirements

This section describes functional requirements on train control data service, voice call service, data service and video service.

### 6.1.1. Train control data service

Train control data service shall provide the below functional requirements.

#### 6.1.1.1. Interface between train mobile station and radio block center

Train control data service shall provide interface between train mobile station and radio block center for train location monitoring and train control message transmission.

#### 6.1.1.2. Train operation monitoring service

This service shall provide train location and speed information transmission.

#### 6.1.1.3. Train moving authority data transmission

This service shall transmit train Moving Authority (MA) information to train mobile station for train safe operation.

### 6.1.2. Voice call service

Voice call service has the below functional requirements.

#### 6.1.2.1. Private voice call

This service shall provide voice call among control center manager, train driver, train office and maintenance workers on the track.

#### 6.1.2.2. Emergency call

Emergency call has public emergency call (119, 112, and the like) and train emergency call. Public emergency call shall meet the call setup time which is defined by commercial emergency call.

Train emergency call has two operation modes, which have train emergency call and shunting emergency call. Train emergency call is determined by the train situation. If the emergency button is pressed in shunting mode, shunting emergency call is initiated. And if the emergency button is pressed in emergency situation, emergency call is initiated.

If train emergency call is initiated, group call process shall be done among the train manager, driver and related officer, and shall be reported to radio block center and PS-LTE. And it shall have highest service priority to meet the call setup time and delay.

Train emergency call shall have the following service priority.

| Service Type | Priority | Service drop when overload |
|---|---|---|
| Train emergency call | 0 | Public emergency call |
| Train control safety message | 0 | Public emergency call |
| Public emergency call | 1 | Train operation related voice call(train driver or control manager originated call) |
| Train operation related voice call(train driver or control manager originated call) | 2 | Train information service and general voice call |
| Train information service and general voice call | 3 | - |

### 6.1.2.3. Voice broadcasting call

This service shall provide voice broadcasting to the per-assigned group members, voice call originators shall talk and group members shall listen. It should be provided optionally.

### 6.1.2.4. Group voice call

This service is voice call among the pre-assigned group members. When one member presses Push-To-Talk button, other members will listen. The group members shall be able to configure local area, train operation line or special functional number.

#### 6.1.2.5. Train paging

This service shall page the train number to communicate from control center to train mobile station without using unique number of mobile station.

#### 6.1.2.6. Location based call

This service shall support location based call from train driver to control manager even though he does not know the terminal number of the control manager.

#### 6.1.2.7. Shunting mode call

This service shall provide group voice call among control center and maintenance workers.

#### 6.1.2.8. Direct call

This service shall provide optionally direct voice communication between two terminals less than 1km range.

#### 6.1.2.9. Assistance communication

This service is extra communication service which is not related to train movement or train operation. For example, broadcasting, train direction, maintenance and time information service are included.

#### 6.1.2.10. Voice call recording

This service shall provide voice call recording to analyze the post-accident

#### 6.1.2.11. Inter-working to PS-LTE

This service shall provide voice call to PS-LTE network.

#### 6.1.2.12. Inter-working to existing mobile communication network

This service shall provide voice call to VHF mobile communication network, TETRA mobile communication network and ASTRO mobile communication network.

### 6.1.3. Data service

Data service shall provide the below functional requirements.

#### 6.1.3.1. Data service priority

Data service shall provide service priority in voice call between train control center and train mobile station or among LTE-R terminals.

#### 6.1.3.2. Inter-working to PS-LTE

LTE based railway mobile communication system shall provide voice call to PS-LTE network and data service.

### 6.1.4. Video service

Video service shall provide the below functional requirements.

#### 6.1.4.1. Group Video Call (Video PTT)

This service is video call among the pre-assigned group members. When one member presses Push-To-Talk button, other members will receive video. The group

members shall be able to configure local area, train operation line or special functional number.

#### 6.1.4.2. Video data transmission

This service shall transmit video data which contains train situation, platform and track situation to prevent accident or cope with the accident.

#### 6.1.4.3. Video data recording

This service shall provide video data recording to analyze the post-accident.

#### 6.1.4.4. Inter-working to PS-LTE

This service shall provide inter-working to PS-LTE network and video call service.

### 6.1.5. Authentication and encryption service

Authentication and encryption service shall provide the below functional requirements.

#### 6.1.5.1. Subscriber authentication

Train mobile station and portable terminal shall be authenticated when it is registered.

#### 6.1.5.2. Encryption

Train control data service, voice and video call service shall be encrypted for information security.

### 6.2. User performance requirements

Train control service, voice call service, data service and video service shall provide the below functional requirements.

#### 6.2.1. Transmission time delay of train control data

Train Moving Authority (MA) message of train control data service shall be delivered in 300msec from radio block center to train mobile station while train drives at the speed of 350 km/h.

#### 6.2.2. Call setup time of voice call

Call setup time shall be less than 1 second and success rate of call setup shall be more than 99% when train drives at the speed of 350 km/h.

#### 6.2.3. Data reception rate

Data reception rate of data service shall be more than 99% when train drives at the speed of 350 km/h.

#### 6.2.4. Video reception rate

Video reception rate of video service shall be more than 99% when train drives at the speed of 350 km/h.

#### 6.2.5. Hand-over success rate

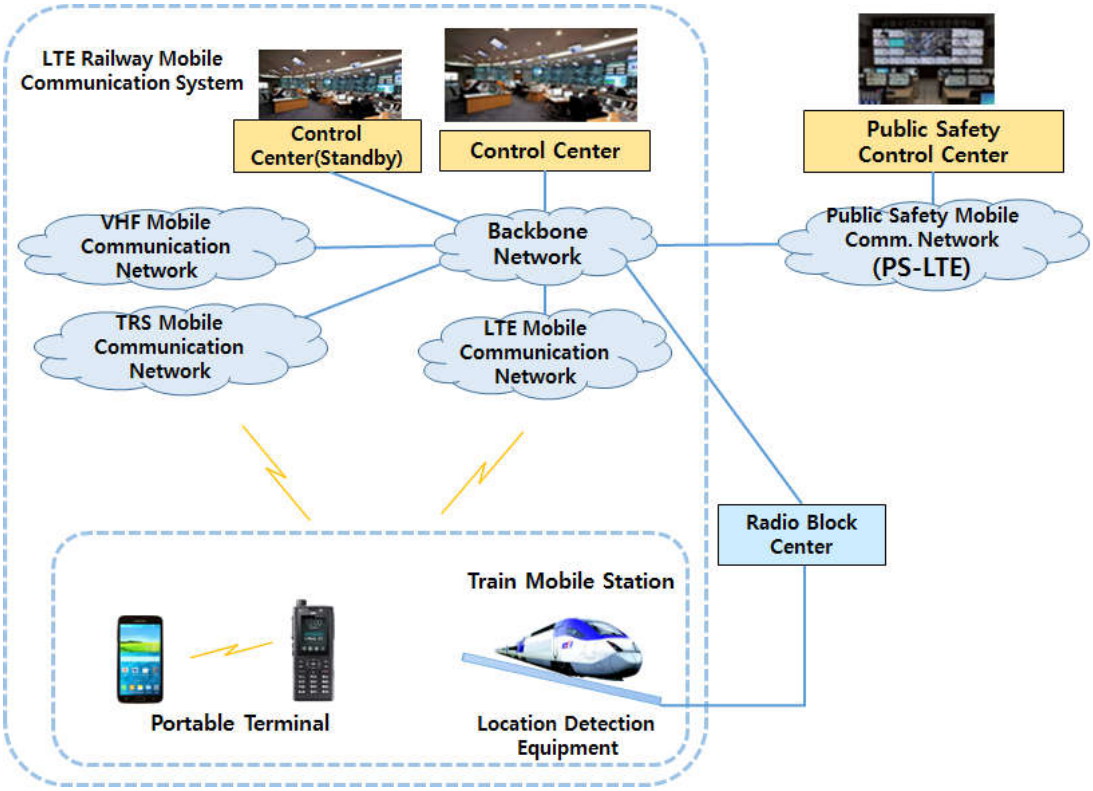
Train control service, voice call service, data service and video service shall provide seamless service continuity between two adjacent cells. Hand-over success rate shall be more than 99% when train drives at the speed of 350 km/h.

## 7. Requirements for LTE-based Railway Communication System

The LTE-based railway communication system consists of the LTE-R mobile communication network and LTE-R terminals as shown in Figure 7-1. The system provides the train control data service, voice call service, data service and video service.

The train control data service is provided via interworking between the control center, the backbone network, the LTE-R mobile communication networks, the train mobile station, the location detection equipment and the radio block center.

The voice call, data and video service are provided between interworking between the control center, the backbone network, the LTE-R mobile communication network, the train mobile station and LTE-R terminals. The system also interworks with the VHF mobile communication network and the TETRA mobile communication network currently in service, and with the new public safety mobile communication network (PS-LTE). Interruption between the LTE-based railway communication system and PS-LTE shall be minimized. The train control data service has the highest QoS, and performance degradation caused by interruption must be minimized.




(Figure 7-1) LTE Railway Mobile Communication System Architecture

## 7.1. Requirements for System Functions

This section describes the requirements for interworking, authentication and security between the backbone network, the LTE-R mobile communication network, the train mobile station, portable terminals and the railway signal control system.

### 7.1.1. Requirements for Functions of the Backbone Network

#### 7.1.1.1. Transmission

The system shall provide information via the wired network between the mobile communication networks (VHF, TETRA, LTE) and the control center.

#### 7.1.1.2. Interworking with the Control Center

The backbone network shall interwork with the control center for monitoring and control of the railway operation states.

### 7.1.2. Requirements for Functions of the LTE-R Mobile Communication Network

#### 7.1.2.1. Compliance with the Communication Standard

The mobile communication networks shall provide mobile access between the train mobile station or portable terminals and the base stations in compliance with the 3GPP standard.

#### 7.1.2.2. Network Redundancy

The LTE-R mobile communication network shall be duplicated for improved availability and reliability of the mobile communication section.

#### 7.1.2.3. Functions of Base Station

A base station of the LTE-R mobile communication network consists of DU, RU and repeaters which expand the mobile network coverage. The base station shall provide the mobile interface with portable terminals, and the wired interface with the backbone network.

#### 7.1.2.4. PS-LTE and Prevention of Interruption

Interruption between the LTE-R mobile communication network and PS-LTE must be minimized.

#### 7.1.2.5. Mobility Management Entity (MME)

The LTE-R mobile communication network shall provide the signaling function for mobility and security of users.

#### 7.1.2.6. Network Management Entity (NME)

The LTE-R mobile communication network shall provide operators with the information on normal operation or failure of each node of the LTE-based railway communication system.

#### 7.1.2.7. Home Subscriber Server (HSS)

The LTE-R mobile communication network shall provide the mobility management functions, such as location registration for processing of calls of the LTE-based railway communication system. In addition, the system shall establish the authentication center (AuC) as a separate function to handle authentication and security.

#### 7.1.2.8. Serving Gateway (SGW)

The LTE-R mobile communication network shall process IP packets through the mobile access with LTE-R terminals, and process inter-base station handover in real time.

#### 7.1.2.9. Packet data network Gateway (PGW)

The LTE-R mobile communication network shall provide the gateway function to support interworking with other IP packet networks.

#### 7.1.2.10. Data Usage Checking

The LTE-R mobile communication network shall check the data usage by user and time.

#### 7.1.2.11. Interworking with Mobile Network

The LTE-R mobile communication network shall provide interworking with the current VHF mobile communication network and TETRA mobile communication network via the backbone network.

#### 7.1.2.12. Interworking with Radio Block Center

The LTE-R mobile communication network shall interwork with the radio block center to deliver information on the location and speed of the train.

### 7.1.3. Requirements for Functions of Train Mobile Station

#### 7.1.3.1. User Interface

The train mobile station shall provide the human interface for voice, data and video calls.

#### 7.1.3.2. Train Control System Interface

The train mobile station shall provide various interfaces with the train control system via RS-422 and RS-485.

#### 7.1.3.3. Fault Tolerance

The train mobile station shall be composed of main and sub train mobile station. In

case of fault of the main mobile station, the sub mobile station shall take over.

#### 7.1.3.4. Voice Announcement

The train mobile station shall provide the train voice announcement and the onboard announcement function.

#### 7.1.3.5. Location Detection

The train mobile station shall provide the location detection function.

#### 7.1.3.6. Handover

The train mobile station shall provide the inter-base station handover function.

#### 7.1.3.7. Software Update

The train mobile station shall enable the user to select auto or manual updating of software.

#### 7.1.3.8. Inter-network Switchover

The train mobile station shall access the LTE mobile communication network, the VHF mobile communication network and the TETRA mobile network through the train gateway, and support the inter-network switchover.

#### 7.1.3.9. Receiving Remote Start Information

The train mobile station shall receive information on remote start.

#### 7.1.4. Requirements for Functions of LTE-R Terminals

##### 7.1.4.1. User Interface

The LTE-R terminal shall provide the human interface for voice, data and video calls.

##### 7.1.4.2. Handover

The LTE-R terminal shall provide the inter-base station handover function.

##### 7.1.4.3. PTT Button

The LTE-R terminal shall have an outside PTT button for users with thick gloves.

#### 7.1.5. Requirements for Interworking of the Train Signal Control System

##### 7.1.5.1. Interworking between LTE-R Mobile Communication Network and the Radio Block Center

The mobile communication network shall interwork with the radio block center to deliver the train control right information to the train mobile station.

##### 7.1.5.2. Interface with Korea Radio-based Train Control System (KRTCS)

The mobile communication network shall interwork with the wayside radio-based train control system (KRTCS).

#### 7.1.6. Requirements for Authentication and Security

The system shall meet the following requirements for authentication and security

service.

#### 7.1.6.1. Interworking with Security Module

The train mobile station and LTE-R terminals shall interwork with the security module.

#### 7.1.6.2. Key Management

The system shall support key storage and deletion for authentication and security functions.

### 7.2. Requirements for System Performance

The LTE-based railway communication system shall meet the following performance requirements.

#### 7.2.1. Requirements for Performance of the Backbone Network

#### 7.2.1.1. Capacity of the Backbone Network

The backbone network shall support expansion of capacity to 1Gbps in order to support high-speed data transmission.

#### 7.2.1.2. Stability of the Backbone Network

The backbone network shall secure stability through network redundancy in order to meet the requirements for train control and main services.

#### 7.2.2. Requirements for Performance of the Mobile Communication Network

#### 7.2.2.1. Data Transmission Capacity (Throughput)

The system shall transmit voice, data and video at the mobile environment of 350Km/h (at least SD class).

#### 7.2.2.2. Delay in Transmission of Train Control Information

The mobile communication network shall transmit the train control right information to the train mobile station within 300msec.

#### 7.2.2.3. Data Reception Rate

The mobile communication network shall provide the train control data reception rate of 99% or higher.

#### 7.2.2.4. Handover Switchover Time

The handover switchover time of the mobile communication network shall be within 300msec.

### 7.2.3. Requirements for Performance of Train Mobile Station

#### 7.2.3.1. TX Output

The maximum output power of the train mobile station shall be 200mW.

#### 7.2.3.2. Mobility

The train mobile station shall meet the service performance requirements specified in 6.2 at the mobile environment of 350km/h.

#### 7.2.3.3. Emergency Call Access Time

The train mobile station shall connect emergency calls to the control center within 300msec under the mobile environment of 350km/h with the call connection success rate of 99% or higher.

### 7.2.4. Requirements for Performance of LTE-R Terminal

#### 7.2.4.1. TX Output

The maximum output power of a LTE-R terminal shall be 200mW.

#### 7.2.4.2. Mobility

The LTE-R terminal shall meet the service performance requirements specified in subclasue 6.2 at the mobile environment of 350km/h.

#### 7.2.4.3. Emergency Call Access Time

The LTE-R terminal shall connect emergency calls to the control center within 300msec.

#### 7.2.4.4. Battery Duration

The battery duration of LTE-R terminal shall be 2 hours for voice call, 30 minutes for video call, and 8 hours in the standby mode.

#### 7.2.4.5. Operation Conditions

The LTE-R terminals shall guarantee waterproof and dustproof capability of at least IP67, considering that they are used under the unfavorable conditions.

# Appendix Ⅰ-1

(This appendix is an informative part of standard)

## Intellectual Property Right (IPR) Information Statements

None

※ The information pertaining to these IPRs, if any, is available on the TTA Website. No guarantee can be given as to the existence of other IPRs not referenced on the TTA website.

# Appendix Ⅰ-2

(This appendix is an informative part of standard)

# Testing and Certification

None

# Appendix Ⅰ-3

(This appendix is an informative part of standard)

## Family Standards

None

# Appendix Ⅰ-4

(This appendix is an informative part of standard)

# Bibliography


[1] EIRENE, “Functional Requirements Specification”, Version 7.4.0, 2014.

[2] EIRENE, “System Requirements Specification”, Version 15.4.0, 2014.

[3] ETSI EN 301 515, “Global System for Mobile communication (GSM); Requirements for GSM operation on railways“

[4] TTA, TTAI.KO-06.0390, “Pubic Safety Network - LTE (PS-LTE) : Functional Requirements”, TTA, 2015.06.23.

[5] TTA, TTAK.KO-06.0369, “LTE Railway Communication Function Requirements”, Oct., 2014.

[6] TTA, TTAK.KO-06.0370, “LTE Railway Communication User Requirements”, Oct., 2014.

[7] TTA, TTAT.3G-36.101(R10-10.6.0), “3GPP- E-UTRA; Terminal Radio Transmission & Reception (R10)”, August, 2012.

[8] TTA, TTAT.3G-36.104(R10-10.6.0), “3GPP- E-UTRA; Base Station Transmission & Reception (R10)”, August, 2012.

[9] TTA, TTAT.3G-36.300(R10-10.7.0), “3GPP - E-UTRA와 E-UTRAN; Overall Description (Stage 2)(R10)”, August, 2012.

# Appendix Ⅰ-5

(This appendix is an informative part of standard)

## Korean Abstract of English Standard

None

# Appendix Ⅰ-6

(This appendix is an informative part of standard)

# History of Standard

| Edition | Issued date | Standard Number | Remarks | Committee |
|---|---|---|---|---|
| Published | 2015.12.16. | TTAI.KO-06.0407 | | ITS/Vehicular ICT Project Group (PG905) |
| 1st Revision | 2016.xx.xx | TTAI.KO-06.0407/R1 | | |