|  |  |
| --- | --- |
| **Radiocommunication Study Groups** |  |
|  |  |
|  |  |
| Source: Document 5A/TEMP/265Subject: Question ITU-R [205-5/5](http://www.itu.int/pub/R-QUE-SG05.205) | **Annex 11 to****Document 5A/636-E** |
| **10 November 2014** |
| **English only** |
| Annex 11 to Working Party 5A Chairman’s Report |
| working document toward a preliminary draft new recommendation ITU-R M.[V2X] |
| Radio interface standards of vehicle-to-vehicle and vehicle-to-infrastructure communications for intelligent transport systems applications  |

(Question ITU-R 205-5/5)

Scope

This Recommendation identifies specific radio interface standards of vehicle-to-vehicle and vehicle-to-infrastructure communications for ITS applications. The technical and operational characteristics described in this Recommendation are based on current and existing frequency bands already identified for ITS and the applications in the mobile service.

Keywords

ITS, vehicle-to-vehicle communications, vehicle-to-infrastructure communications

Acronyms and abbreviations

ARIB Association of Radio Industries and Businesses

BPSK Binary phase shift keying

CSMA/CA Carrier sense multiple access/collision avoidance

DSRC Dedicated short range communications

ETSI European Telecommunications Standards Institute

FEC Forward error correction

IEEE Institute of Electrical and Electronics Engineers

ITS Intelligent transport systems

OFDM Orthogonal frequency-division multiplexing

QAM Quadrature amplitude modulation

QPSK Quadrature phase shift keying

TTA Telecommunications Technology Association

V2I Vehicle-to-infrastructure

V2V Vehicle-to-vehicle

Related ITU Recommendations

Recommendation ITU-R [M.1453](http://www.itu.int/rec/R-REC-M.1453/en) Intelligent Transport Systems – dedicated short-range communications at 5.8 GHz

Recommendation ITU-R [M.1890](http://www.itu.int/rec/R-REC-M.1890/en) Intelligent Transport Systems – Guidelines and Objectives

The ITU Radiocommunication Assembly,

considering

*a)* that standards development organizations (SDOs) are developing specific standards for vehicle-to-vehicle and vehicle-to-infrastructure communication in the intelligent transport system (ITS) service;

*b)* that using the ITU-R Recommendation identifying these standards, manufacturers and operators should be able to determine the most suitable standards for their needs,

noting

Recommendation ITU-R M.1453, which recommends dedicated short-range communications (DSRC) operating at 5.8 GHz,

recommends

that the radio interface standards in Annexes 1 to 4 should be used for vehicle-to-vehicle and vehicle-to-infrastructure communication.

Annex 1

# ETSI standards

ETSI Standards developed for the access and media layer are based on features such as:

– 5,9 GHz spectrum usage;

– multichannel operation;

– decentralized congestion control (DCC);

– coexistence of ITS and EFC (CEN DSRC) services in the 5.8 GHz and 5.9 GHz bands.

TABLE 1

Base standards for the access and media layer

|  |  |
| --- | --- |
| Standard title | Standard number |
| Intelligent transport systems (ITS);Radiocommunication equipment operating in the 5 855 MHz to 5 925 MHz frequency band;Harmonized EN covering the essential requirements of Article 3.2 of the R&TTE Directive | ETSI EN 302 571 |
| Intelligent transport systems (ITS);Access layer specification for intelligent transport systems operating in the 5 GHz frequency band | ETSI EN 302 663 |
| Intelligent transport systems (ITS);Decentralized congestion control mechanisms for intelligent transport systems operating in the 5 GHz range;Access layer part | ETSI TS 102 687 |
| Intelligent transport systems (ITS);Mitigation techniques to avoid interference between European CEN dedicated short-range communication (CEN DSRC) equipment and intelligent transport systems (ITS) operating in the 5 GHz frequency range | ETSI TS 102 792 |
| Intelligent transport systems (ITS);Harmonized channel specifications for intelligent transport systems (ITS) operating in the 5 GHz frequency band | ETSI TS 102 724 |

TABLE 2

Testing standards for the access and media layer

|  |  |
| --- | --- |
| Testing Standard title | Standard number |
| Intelligent transport systems (ITS);Test specifications for the channel congestion control algorithms operating in the 5.9 GHz range;Part 1: Protocol implementation conformance statement (PICS) | ETSI TS 102 917-1 |
| Intelligent transport systems (ITS);Test specifications for the channel congestion control algorithms operating in the 5.9 GHz range;Part 2: Test suite structure and test purposes (TSS & TP) | ETSI TS 102 917-2 |
| Intelligent transport systems (ITS);Test specifications for the channel congestion control algorithms operating in the 5.9 GHz range;Part 3: Abstract test suite (ATS) and partial protocol implementation eXtra information for testing (PIXIT) | ETSI TS 102 917-3 |
| Intelligent transport systems (ITS);Test specifications for the methods to ensure coexistence of cooperative ITS G5 with RTTT DSRC;Part 1: Protocol implementation conformance statement (PICS) | ETSI TS 102 916-1 |
| Intelligent transport systems (ITS);Test specifications for the methods to ensure coexistence of cooperative ITS G5 with RTTT DSRC;Part 2: Test suite structure and test purposes (TSS&TP) | ETSI TS 102 916-2 |
| Intelligent transport systems (ITS);Test specifications for the methods to ensure coexistence of cooperative ITS G5 with RTTT DSRC;Part 3: Abstract test suite (ATS) and partial protocol implementation eXtra information for testing (PIXIT) | ETSI TS 102 916-3 |

Annex 2

# IEEE standards

[*Editor’s Note: Administrations, Sector Members or IEEE may wish to contribute to the November 2013 meeting, similar to the IEEE specifications provided in Document* [*5A/262*](http://www.itu.int/md/R12-WP5A-C-0262/en)*.*]

Annex 3

ARIB standard

In Japan, for the use of the safe driving support systems, a part of the 700 MHz band (755.5‑764.5 MHz) has been assigned in new spectrum allocation on a primary basis in the digital dividend band. The technical characteristics of vehicle-to-vehicle and vehicle-to-infrastructure communications for safe driving support systems are shown in Table 3.

TABLE 3

Characteristics of the transmission scheme

|  |  |
| --- | --- |
| Item | Technical characteristic |
| Operating frequency range | 755.5–764.5 MHz (Single channel) |
| Occupied bandwidth | Less than 9 MHz |
| Modulation scheme | BPSK OFDM. QPSK OFDM, 16QAM OFDM |
| Forward error correction | Convolutional coding, rate = 1/2, 3/4 |
| Data transmission rate | 3 Mbit/s, 4.5 Mbit/s, 6 Mbit/s, 9 Mbit/s, 12 Mbit/s, 18 Mbit/s |
| Media access control | CSMA/CA |

Table 3 shows basic specifications of ARIB standard; ARIB STD-T109[[1]](#footnote-1), 700 MHz band intelligent transport systems (ITS) which have been developed in February 2012.

A 9 MHz channel width in the 700 MHz radio frequency band will be used for the safe driving support systems.

Data transmission rate is variable based on the selection of Modulation scheme and coding rate (R) as follows:

– 3 Mbit/s (BPSK OFDM, R = 1/2), 4.5 Mbit/s (BPSK OFDM, R = 3/4);

– 6 Mbit/s (QPSK OFDM/, R = 1/2), 9 Mbit/s (QPSK OFDM, R = 3/4);

– 12 Mbit/s (16QAM OFDM, R = 1/2), 18 Mbit/s (16QAM OFDM, R = 3/4).

The single channel accommodates both vehicle-to-vehicle and vehicle-to-infrastructure communications based on CSMA/CA media access control.

Annex 4

TTA standards

# 1 Technical characteristics

The advanced ITS radiocommunications system has to consider the described V2V/V2I communications and its service requirements and WAVE standards for international harmonization. In V2V applications, it is required to consider the low packet latency because the life-saving time of safety message is useful in the span of 100 m/s. Also it requires a highly activated radio channel when many vehicles try to activate radio channel simultaneously. In V2I applications, it needs to adopt the long packet transmission which includes a short message, map information and image information to be order of 2 Kbytes in a packet size in high mobility condition.

Thus the advanced ITS radiocommunication system has the following features as shown in Table 4.

TABLE 4

Technical characteristics

| Item | Technical characteristic |
| --- | --- |
| RF frequency | 5855 ~ 5925 MHz[ (experimental)] |
| RF channel bandwidth  | 10 MHz |
| RF Transmit power | 23 dBm |
| Modulation type | OFDM(BPSK, QPSK, 16QAM, Option : 64QAM) |
| Data rate | 3, 4.5, 6, 9, 12, 18 Mbit/s, Option : 24, 27 Mbit/s  |
| MAC | CSMA/CA, Option : Time Slot based CSMA/CA |
| Networking | IPv4/IPv6, VMP(WSMP compatible) |
| Multi-hop | Location information based routing |

# 2 TTA Standards related to advanced ITS radiocommunications

In the Republic of Korea, Telecommunication Technology Association (TTA) established four standards for advanced ITS radiocommunications. The detailed information of these standards is shown in Table 5.

TABLE 5

Base standards related to advanced ITS radiocommunications

|  |  |
| --- | --- |
| Standard title | Standard number |
| Vehicle communication system Stage 1: Requirements | TTAK.KO-06.0175/R1 |
| Vehicle communication system Stage 2: Architecture | TTAK.KO-06.0193/R1 |
| Vehicle communication system Stage 3: PHY/MAC | TTAK.KO-06.0216/R1 |
| Vehicle communication system State 3: Networking | TTAK.KO-06.0234/R1 |

Annex 5

# Technical characteristics of standards

Technical characteristics of each standard are shown in Table 6.

TABLE 6

Technical characteristics

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | ETSI (Annex 1) | IEEE (Annex 2) | ARIB (Annex 3) | TTA (Annex 4) |
| Operating frequency range | 5855 – 5925 MHz |  | 755.5–764.5 MHz (Single channel) | 5855 – 5925 MHz [(experimental)] |
| RF channel bandwidth | 10 MHz |  | Less than 9 MHz | Less than 10 MHz |
| RF Transmit Power/EIRP | Max 33dBm EIRP |  |  | 23 dBm |
| Modulation scheme | BPSK OFDM, QPSK OFDM, 16QAM OFDM, 64QAM OFDM |  | BPSK OFDM, QPSK OFDM, 16QAM OFDM | BPSK OFDM, QPSK OFDM, 16QAM OFDM,Option: 64QAM |
| Forward error correction | Convolutional coding, rate = 1/2, 3/4, 2/3 |  | Convolutional coding, rate = 1/2, 3/4 | Convolutional coding, rate = 1/2, 3/4 |
| Data transmission rate | 3 Mbit/s, 4.5 Mbit/s, 6 Mbit/s, 9 Mbit/s, 12 Mbit/s, 18 Mbit/s, 24Mbit/s, 27Mbit/s |  | 3 Mbit/s, 4.5 Mbit/s, 6 Mbit/s, 9 Mbit/s, 12 Mbit/s, 18 Mbit/s | 3, 4.5, 6, 9, 12, 18 Mbit/s,Option: 24, 27 Mbit/s |
| Media access control | CSMA/CA |  | CSMA/CA | CSMA/CA,Option: Time Slot based CSMA/CA |
| Duplex method | TDD |  | TDD | TDD |
| Packet Error Ratio |  |  |  | 10% |

1. ARIB standard; ARIB STD-T109, 700MHz band intelligent transport systems
(<http://www.arib.or.jp/english/html/overview/doc/5-STD-T109v1_2-E1.pdf>). [↑](#footnote-ref-1)