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TECHNICAL SPECIFICATION

Electromagnetic compatibility and Radio spectrum Matters (ERM); Digital Mobile Radio (DMR) Systems; Part 1: DMR Air Interface (AI) protocol

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

The present document is part 1 of a multi-part deliverable covering the Technical Requirements for Digital Mobile Radio (DMR), as identified below:

Part 1: "DMR Air Interface (AI) protocol";

Part 2: "DMR voice and generic services and facilities";

Part 3: "DMR data protocol";

Part 4: "DMR trunking protocol".

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1 Scope

The present document contains technical requirements for Digital Mobile Radio (DMR) operating in the existing licensed land mobile service frequency bands, as identified in CEPT/ERC/T/R 25-08 [i.3].

The present document describes the Air Interface of a scalable Digital Mobile Radio system which covers three tiers of possible products:

- Tier I: DMR equipment having an integral antenna and working in direct mode (communication without infrastructure) under a general authorization with no individual rights operation.
- Tier II: DMR systems operating under individual licences working in direct mode or using a Base Station (BS) for repeating.
- Tier III: DMR trunking systems under individual licences operating with a controller function that automatically regulates the communications.

NOTE 1: Tier II and Tier III products encompass both simulcast and non-simulcast systems.

NOTE 2: The three tiers of possible products will work only independently and not interoperable.

(For more information please see the System reference documents ETSI TR 102 335-1 [i.1] and ETSI TR 10 335 2 [i.2].)

The present document specifies the Air Interface, complying with either ETSI EN 300 113-1 [1] and ETSI EN 300 113-2 [2] or ETSI EN 300 390-1 [3] and ETSI EN 300 390-2 [4], that has been specifically developed with the intention of being suitable for all identified product tiers. A polite spectrum access protocol for sharing the physical channel has also been specified. Specifically, in this case for use in the existing land mobile service bands with the intention of causing minimum change to the spectrum planning and regulations. Thus the DMR protocol is intended to be applicable to the land mobile frequency bands, physical channel offset, duplex spacing, range assumptions and all other spectrum parameters without need for any change.

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The following referenced documents are necessary for the application of the present document.

[1] ETSI EN 300 113-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land mobile service; Radio equipment intended for the transmission of data (and/or speech) using constant or non-constant envelope modulation and having an antenna connector; Part 1: Technical characteristics and methods of measurement".

[2] ETSI EN 300 113-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land mobile service; Radio equipment intended for the transmission of data (and/or speech) using constant or non-constant envelope modulation and having an antenna connector; Part 2: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive".

[3] ETSI EN 300 390-1: "ElectroMagnetic Compatibility and Radio Spectrum Matters (ERM); Land Mobile Service; Radio equipment intended for the transmission of data (and speech) and using an integral antenna; Part 1: Technical characteristics and test conditions".

[4] ETSI EN 300 390-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Radio equipment intended for the transmission of data (and speech) and using an integral antenna; Part 2: Harmonized EN covering essential requirements under article 3.2 of the R&TTE Directive".

[5] ETSI TS 102 361-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Digital Mobile Radio (DMR) Systems; Part 2: DMR voice and generic services and facilities".

[6] IETF RFC 791: "Internet Protocol; DARPA Internet Program; Protocol Specification".

[7] Void.

[8] IEC 61162-1: "Maritime navigation and radiocommunication equipment and systems - Digital interfaces - Part 1: Single talker and multiple listeners".

[9] ISO/IEC 646: "Information technology -- ISO 7-bit coded character set for information interchange".

[10] ISO/IEC 8859: "Information technology -- 8-bit single-byte coded graphic character sets".

[11] ETSI TS 102 361-4: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Digital Mobile Radio (DMR) Systems; Part 4: DMR trunking protocol".

[12] ETSI TS 102 361-3: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Digital Mobile Radio (DMR) Systems; Part 3: DMR data protocol".

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[i.1] ETSI TR 102 335-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); System reference document for harmonized use of Digital Mobile Radio (DMR); Part 1: Tier 1 DMR#, expected to be for general authorization with no individual rights operation".

[i.2] ETSI TR 102 335-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); System reference document for harmonized use of Digital Mobile Radio (DMR); Part 2: Systems operating under individual licences in the existing land mobile service spectrum bands".

[i.3] CEPT/ERC/T/R 25-08: "Planning criteria and co-ordination of frequencies in the Land Mobile Service in the range 29,7 - 921 MHz".

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3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

1:1-mode: 1 traffic channel mode

NOTE: 1:1-mode supports one "MS to fixed end" duplex call or one simplex call with an optional inbound RC using a two frequency BS.

2:1-mode: 2 traffic channel mode

NOTE: 2:1-mode supports two independent calls which may be either "MS to fixed end" duplex calls, simplex calls using a two frequency BS or simplex calls between MS units on a single frequency.

backward: logical channel from target to source in direct mode

Base Station (BS): fixed end equipment that is used to obtain DMR services

bearer service: telecommunication service providing the capability for information transfer between access points

burst: elementary amount of bits within the physical channel

NOTE 1: Three different bursts exist with different number of bits. The Traffic burst contains 264 bits, the CACH burst contains 24 bits and the RC burst contains 96 bits.

NOTE 2: The burst may include a guard time at the beginning and end of the burst used for power ramp-up and ramp-down.

NOTE 3: For detailed burst definition see clause 4.2.1.

call: complete sequence of related transactions between MSs

NOTE: Transactions may be one or more bursts containing specific call related information.

channel slot timing: timeslot 1 and timeslot 2 timing boundaries established by a TDMA direct mode leader

Control plane (C-plane): part of the DMR protocol stack dedicated to control and data services

conventional: non-trunked communication

NOTE: This is a communication technique where any radio unit (MS) may communicate with one or more other radio units (MSs) without using a trunking protocol, and may be either in direct mode or using any additional equipment (e.g. BS).

Digital Mobile Radio (DMR): physical grouping that contains all of the mobile and/or fixed end equipment that is used to obtain DMR services

direct mode: mode of operation where MSs may communicate outside the control of a network

NOTE 1: This is communication technique where any radio unit (MS) may communicate with one or more other radio units (MSs) without the need for any additional equipment (e.g. BS).

NOTE 2: Supports one transmission per 12,5 kHz frequency; 12,5 kHz equivalent (12,5e) spectral efficiency.

duplex: mode of operation by which information can be transferred in both directions and where the two directions are independent

NOTE: Duplex is also known as full duplex.

forward: logical channel from source to target in direct mode

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frame: two contiguous timeslots labelled 1 and 2

NOTE: A frame has a length of 60 ms.

Golay code: type of error correcting code named Golay

Hamming code: type of error correcting code named Hamming

inbound: MS to BS transmission

logical channel: distinct data path between logical endpoints

NOTE: The logical channels are labelled 1 and 2. The logical channel may consist of sub-channels, e.g. SYNC, embedded signalling, etc.

Mobile Station (MS): physical grouping that contains all of the mobile equipment that is used to obtain DMR mobile services

outbound: BS to MS transmission

payload: bits in the information field

physical channel: RF carrier that is modulated with information bits of the bursts

NOTE: The RF carrier may be a single frequency or a duplex pair of frequencies. The physical channel of a DMR subsystem is required to support the logical channels.

polite protocol: "Listen Before Transmit" (LBT) protocol

NOTE: This is a medium access protocol that implements a LBT function in order to ensure that the channel is free before transmitting.

privacy: secret transformation

NOTE: Any transformation of transmitted information that is derived from a shared secret between the sender and receiver.

Protocol Data Unit (PDU): unit of information consisting of protocol control information (signalling) and possibly user data exchanged between peer protocol layer entities

Radio Frequency channel: radio frequency carrier (RF carrier)

NOTE: This is a specified portion of the RF spectrum. In DMR, the RF carrier separation is 12,5 kHz. The physical channel may be a single frequency or a duplex spaced pair of frequencies.

Received Signal Strength Indication (RSSI): root mean squared (rms) value of the signal received at the receiver antenna

Reed-Solomon code: type of error correcting code named Reed-Solomon

repeater mode: mode of operation where MSs may communicate through a BS

NOTE: This is a communication technique where any radio unit (MS) may communicate with one or more other radio units (MSs) with the need for an intermediate BS.

Reverse Channel (RC): signalling burst from target to source

signalling: exchange of information specifically concerned with the establishment and control of connections, and with management, in a telecommunication network

simplex: mode of working by which information can be transferred in both directions but not at the same time

superframe: 6 continuous traffic bursts on a logical channel labelled "A" to "F"

NOTE: A superframe has a length of 360 ms and is used for voice traffic only.

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