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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 3 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".

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 [3].

The present document describes the packet data protocol (PDP) 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.

The present document specifies the Packet Data Protocol (PDP) of DMR that has been specifically developed with the intention of being suitable for all identified product tiers. 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.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

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2.1 Normative references

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

[1] ETSI TS 102 361-1: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Digital Mobile Radio (DMR) Systems; Part 1: DMR Air Interface (AI) protocol".

[2] 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".

[3] CEPT/ERC T/R 25-08: "Planning criteria and coordination of frequencies in the land mobile service in the range 29,7 - 921 MHz".

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

[5] IETF RFC 792: "Internet Control Message Protocol; DARPA Internet Program; Protocol Specification".

[6] IETF RFC 1918: "Address Allocation for Private Internets".

[7] IETF RFC 826: "Ethernet Address Resolution Protocol: Or converting network protocol addresses to 48.bit Ethernet address for transmission on Ethernet hardware".

[8] IETF RFC 2460: "Internet Protocol, Version 6 (IPv6) Specification ".

[9] IETF RFC 2529: "Transmission of IPv6 over IPv4 Domains without Explicit Tunnels".

[10] IETF RFC 3056: "Connection of IPv6 Domains via IPv4 Clouds".

[11] IETF RFC 3142: "An IPv6-to-IPv4 Transport Relay Translator".

[12] IETF RFC 4213: "Basic Transition Mechanisms for IPv6 Hosts and Routers".

[13] ETSI TS 100 392-18-1: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D) and Direct Mode Operation (DMO); Part 18: Air Interface optimized applications; Sub-part 1: Location Information Protocol (LIP)".

[14] IETF RFC 768: "User Datagram Protocol".

[15] IETF RFC 2781: "UTF-16, an encoding of ISO 10646".

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

Not applicable.

3 Definitions and abbreviations

3.1 Definitions

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

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 point

burst: elementary amount of bits within the physical channel

NOTE: For detailed burst definition see clause 4.2.1 in TS 102 361-1 [1].

call: complete sequence of related transactions between MSs

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

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: 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).

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.

frame: two contiguous time slots labelled 1 and 2

NOTE: A frame has a length of 60 ms.

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

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.

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.

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.

sliding window: DLL confirmed data transmission flow control procedure that requires the target to store multiple data packets and provide a confirmed response on all the stored data upon request from the source

stop and wait: DLL confirmed data transmission flow control procedure that requires the target to send a confirmation response after receiving each data packet

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.

time slot (or slot): elementary timing of the physical channel

NOTE: A timeslot has a length of 30 ms and will be numbered "1" or "2".

transmission: transfer period of bursts containing information or signalling

NOTE: The transmission may be continuous, i.e. multiple bursts transmission without ramp-up, ramp-down, or discontinuous, i.e. single burst transmission with ramp-up and ramp-down period.

trunking: network controlled communication

NOTE: This is a communication technique where any radio unit (MS) may communicate with one or more other radio units (MSs) using a trunking protocol and all MSs will be under control of a network.

User plane (U-plane): part of the DMR protocol stack dedicated to user voice services

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AB	Appended Block
ACK	(positive) ACKnowledgement
AI	Air Interface
ARP	Address Resolution Protocol
AT	Access Type
BMP	Basic Multilingual Plane
BS	Base Station

NOTE: A reference designating a fixed end device.

CACH	Common Announcement CHannel
CCL	Call Control Layer
CRC	Cyclic Redundancy Checksum for data error detection
C-plane	Control plane
DAID	Destination (IP) Address IDentifier
DD	Defined Data
DLL	Data Link Layer
DMR	Digital Mobile Radio
DNF	Do Not Fragment
DPF	Data Packet Format
DPID	(UDP) Destination Port IDentifier
ERC	European Radiocommunication Committee
FEC	Forward Error Correction
FID	Feature set ID
FLCO	Full Link Control Opcode
FMF	Full Message Flag
FULL LC	Full Link Control
HMSC	High level Message Sequence Chart
ICMP	Internet Control Message Protocol
ID	Identifier
IHL	Internet Header Length
IP	Internet Protocol
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
IT	Impolite Type
LAN	Local Area Network
LC	Link Control
LLC	Link Layer Control
LLID	Logical Link ID
LSB	Least Significant Bit
MAC	Medium Access Control
MFID	Manufacturer's FID
MS	Mobile Station

NOTE: A reference designating a mobile or portable radio.

MSB	Most Significant Bit
MSC	Message Sequence Chart
MTU	Maximum Transfer Unit
NA	Not Applicable
NACK	Negative ACKnowledgement
NAT	Network Address Translator
PDP	Packet Data Protocol
PDU	Protocol Data Unit
PF	Protect Flag
PL	Physical Layer
RAN	Radio Area Network
RF	Radio Frequency

RFC	Request For Comments
RX	Receive
RX_LB	Receive Last Block
SACK	Selective ACKnowledgement
SAID	Source (IP) Address IDentifier
SAP	Service Access Point

NOTE: Where a network provides a service.

SARQ	Selective Automatic Repeat reQuest
SDL	Specification and Description Language
SPID	(UDP) Source Port IDentifier
TCP	Transmission Control Protocol
TD	Terminator Data
TDMA	Time Division Multiple Access
TOS	Type Of Service
TX	Transmit
UDP	User Datagram Protocol
USB	Universal Serial Bus
UTF-16BE	Unicode Transformation Format 16 bit Big-Endian
U-plane	User plane

4 Overview

The present document describes a Digital Mobile Radio (DMR) system for Tier I, Tier II and Tier III products which employ a Time Division Multiple Access (TDMA) technology using a 2-slot TDMA solution and RF carrier bandwidth of 12,5 kHz (see note 1).

NOTE 1: DMR system for Tier I products employs a continuous transmission variation of the previously mentioned technology.

The present document describes the Call Control Layer (CCL) of the DMR Air Interface (AI) for packet data call control. Radio equipment (fixed, mobile or portable) which conform to the present document shall be interoperable at the Air Interface with equipment from other manufacturers. Radio equipment of the present document shall also comply with TS 102 361-1 [1].

The present document will not provide the specification or operational detail for system implementations which include but are not limited to trunking, roaming, network management, vocoder, security, voice and generic services and facilities, subsystems interfaces and data between private and public switched telephone networks. It describes only the appropriate access requirements compatible with the Air Interface.

NOTE 2: The DMR standard consists of a multi-part deliverable, which will be referred to in the present document if needed.

4.1 Protocol architecture

The purpose of this clause is to provide a model where the different functions and processes are identified and allocated to different layers in the DMR protocol stack.

The protocol stack in this clause and all other related clauses describe and specify the interfaces, but these stacks do not imply or restrict any implementation.

The DMR protocol architecture which is defined herein follows the generic layered structure, which is accepted for reference description and specification of layered communication architectures.

The DMR standard defines the protocols for the following 3 layered model as shown in figure 4.1.

The base of the protocol stack is the Physical Layer (PL) which is the layer 1.

The Data Link Layer (DLL), which is the layer 2, shall handle sharing of the medium by a number of users. At the DLL, the protocol stack shall be divided vertically into two parts, the User plane (U-plane), for transporting information without addressing capability (e.g. voice), and the Control plane (C-plane) for signalling information, both control and data, with addressing capability, as illustrated by figure 4.1.

NOTE 1: It is appropriate to bear in mind the different requirements of C-plane and U-plane information. C-plane information needs only a discrete (or non-continuous) physical link to pass information although it needs a continuous virtual link to support the service. This may also be called signalling or packet mode service. Acknowledgements may or may not be requested. U-plane information, on the other hand, requires a regular physical link to be available so that a constant delay service can be supported. This may also be called circuit mode service.

NOTE 2: The DLL identified in figure 4.1 may be further sub-divided in the air interface protocol to separate the functionality of Medium Access Control (MAC) and Logical Link Control (LLC), which is often performed in radio air interface protocols due to the specialized nature of these two tasks. Such separation is not presented in the present document and is implementation specific. It is further implementation specific if layer 2 at U-plane offers only MAC for the service.

The Call Control Layer (CCL), which is layer 3, lies in the C-plane and is responsible for control of the call (addressing, features, etc.), provides the services supported by DMR, and supports Short Data and Packet Data service. U-plane access at layer 2 (DLL) supports voice service which is available in DMR. The Control Layer for data call control offered by DMR is described in the present document. The voice and generic services and facilities offered by DMR are described in TS 102 361-2 [2].

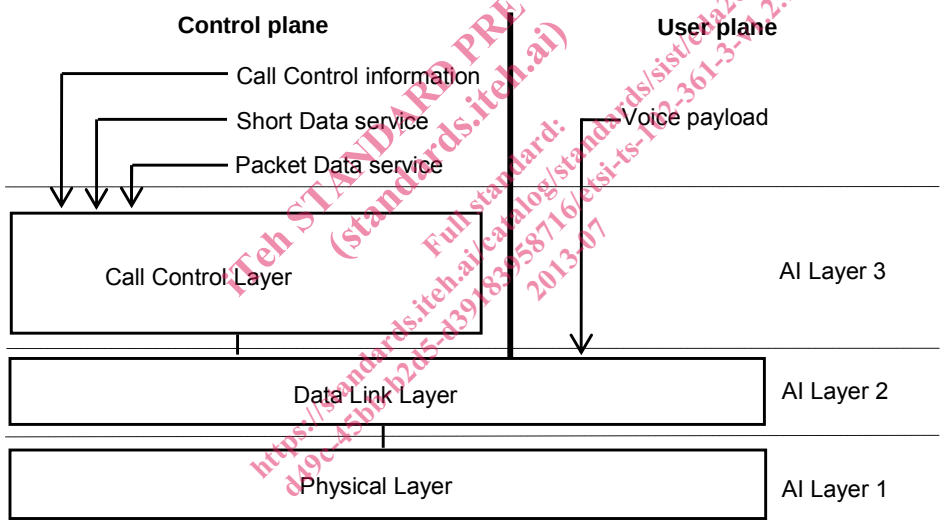

Figure 4.1: DMR protocol stack

4.1.1 Air Interface Physical Layer (layer 1)

The Air Interface layer 1 shall be the physical interface. It shall deal with the physical burst, composed of bits, which is to be sent and/or received. The Physical Layer is described in TS 102 361-1 [1].

The Air Interface layer 1 contains the following functions:

- modulation and demodulation;
- transmitter and receiver switching;
- RF characteristics;
- bits and symbol definition;
- frequency and symbol synchronization;
- burst building.

4.1.2 Air Interface Data Link Layer (layer 2)

The Air Interface layer 2 shall handle logical connections and shall hide the physical medium from the upper layers. The Data Link Layer is described in TS 102 361-1 [1].

The main functions are as follows:

- channel coding (FEC, CRC);
- interleaving, de-interleaving and bit ordering;
- acknowledgement and retry mechanism;
- media access control and channel management;
- framing, superframe building and synchronization;
- burst and parameter definition;
- link addressing (source and/or destination);
- interfacing of voice applications (vocoder data) with the PL;
- data bearer services;
- exchanging signalling and/or user data with the CCL.

Packet Data Protocol specific DLL features are described in the present document.

4.1.3 Air Interface Call Control Layer (layer 3)

Air Interface layer 3 (CCL) is applicable only to the C-plane, and shall be an entity for the services and features supported by DMR on top of the layer 2 functionality. The Call Control Layer functionality for voice and generic services and facilities is described in clause 5 of TS 102 361-2 [2].

The CCL provides the following functions:

- BS activation;
- establishing, maintaining and terminating of calls;
- individual or group call transmission and reception;
- destination addressing (DMR IDs or gateway as appropriate);
- support of intrinsic services (emergency signalling, pre-emption, late entry, etc.);
- announcement signalling.

Packet Data Protocol specific CCL features that are described in the Internet Protocol bearer service clause of the present document refer to the IP layer.

4.2 Overview of the DMR Packet Data Protocol (PDP)

The Packet Data Protocol described for DMR is related to packet data transmission procedures, e.g. unconfirmed data, confirmed data, confirmed data response etc. The Packet Data Protocol defined for DMR contains intrinsic (embedded) signalling or procedures which may relate to one or more packet data transmission procedures.

All users related signalling or presentation above layer 3 are not part of the present document and are implementation specific.