SLOVENSKI STANDARD
SIST EN 300 396-7 V1.2.1:2003

01-december-2003

Prizemni snopovni radio (TETRA) ï Tehniļne zahteve za neposredni naļin delovanja (DMO) ï 7. del: Radijski vmesnik tipa 2 za ponavljalnike (repetitorje)

Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 7: Type 2 repeater air interface

Ta slovenski standard je istoveten z: EN 300 396-7 Version 1.2.1

ICS:

33.070.10	Prizemni snopovni radio (TETRA)	Terrestrial Trunked Radio (TETRA)

SIST EN 300 396-7 V1.2.1:2003 **en**

ETSI EN 300 396-7 V1.2.1 (2000-12)

European Standard (Telecommunications series)

Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 7: Type 2 repeater air interface

Reference
DEN/TETRA-02007-7

Keywords
TETRA, radio, security

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

Individual copies of the present document can be downloaded from:
http://www.etsi.org

The present document may be made available in more than one electronic version or in print. In any case of existing or perceived difference in contents between such versions, the reference version is the Portable Document Format (PDF). In case of dispute, the reference shall be the printing on ETSI printers of the PDF version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at http://www.etsi.org/tb/status/

If you find errors in the present document, send your comment to:
editor@etsi.fr

Copyright Notification

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://www.etsi.org/ipr).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

This European Standard (Telecommunications series) has been produced by ETSI Project Terrestrial Trunked Radio (TETRA).

The present document had been submitted to Public Enquiry as ETS 300 396-7. During the processing for Vote it was converted into an EN.

The present document is part 7 of a multi-part deliverable covering the Technical requirements for Direct Mode Operation (DMO), as identified below:

Part 1: "General network design";

Part 2: "Radio aspects";

Part 3: "Mobile Station to Mobile Station (MS-MS) Air Interface (AI) protocol";

Part 4: "Type 1 repeater air interface";

Part 5: "Gateway air interface";

Part 6: "Security";

Part 7: "Type 2 repeater air interface";

Part 8: "Protocol Implementation Conformance Statement (PICS) proforma specification".

National transposition dates	
Date of adoption of this EN:	8 December 2000
Date of latest announcement of this EN (doa):	31 March 2001
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	30 September 2001
Date of withdrawal of any conflicting National Standard (dow):	30 September 2001

1 Scope

The present document defines the Terrestrial Trunked Radio (TETRA) Direct Mode Operation (DMO). It specifies the basic air interface, the inter-working between Direct Mode (DM) groups via repeaters, and inter-working with the TETRA Voice plus Data (V+D) system via gateways. It also specifies the security aspects in TETRA DMO, and the intrinsic services that are supported in addition to the basic bearer and teleservices.

This part applies to the TETRA Direct Mode Repeater (DM-REP) air interface and contains the specifications, where applicable, of the physical, data link and network layers according to the ISO model.

The specifications contained herein apply to a DM-REP as a stand-alone unit supporting two calls on the air interface (type 2 DM-REP). They also cover the operation of a Direct Mode Mobile Station (DM-MS) with a type 2 DM-REP.

NOTE 1: The specifications for a Direct Mode Repeater/Gateway (DM-REP/GATE) combined implementation are provided in ETS 300 396-5 [5], together with the specifications for a Direct Mode Gateway (DM-GATE).

NOTE 2: The specifications for a DM-REP as a stand-alone unit supporting a single call on the air interface (type 1 DM-REP) are provided in EN 300 396-4 [4].

The protocol for a DM-MS operating with a type 2 DM-REP is specified in clauses 5 through 8, 10 and 11. Much of this protocol is defined in the form of a "delta document" relative to the specifications provided in ETS 300 396-2 [2] and ETS 300 396-3 [3] for direct MS-MS operation, and EN 300 396-4 [4] for type 1 DM-REP operation. These clauses define where the protocol in parts 2, 3 and 4 applies without change, or where it applies with the specified amendments, replacements or additions. Where no reference to parts 2, 3 or 4 exists, the subclause should be regarded as independent.

The protocol for the DM-REP is specified in clauses 9 and 12.

The normative annex mainly specifies the parameter values used in the protocol.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.

[1] ETSI ETS 300 396-1: "Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 1: General network design".

[2] ETSI ETS 300 396-2: "Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 2: Radio aspects".

[3] ETSI ETS 300 396-3 (1998): "Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 3: Mobile Station to Mobile Station (MS-MS) Air Interface (AI) protocol".

[4] ETSI EN 300 396-4: "Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 4: Type 1 repeater air interface".

[5] ETSI ETS 300 396-5: "Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 5: Gateway air interface".

[6] ETSI ETS 300 396-6: "Terrestrial Trunked Radio (TETRA); Direct Mode Operation (DMO); Part 6: Security".

[7] ETSI EN 300 392-2: "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 2: Air Interface (AI)".

3 Definitions and abbreviations

3.1 Definitions

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

Bit Error Ratio (BER): ratio of the bits wrongly received to all bits received in a given logical channel

call: there are two types of call, individual call or group call. An individual call is a complete sequence of related call transactions between two DM-MSs. There are always two participants in an individual call. A group call is a complete sequence of related call transactions involving two or more DM-MSs. The number of participants in a group call is not fixed, but is at least two. Participants may join (late entry) and leave an ongoing group call

call transaction: all of the functions associated with a complete unidirectional transmission of information during a call. A call is made up of one or more call transactions. In a simplex call these call transactions are sequential

called user application: user application which receives an incoming call

calling user application: user application which initiates an outgoing call

changeover: within a call, the process of effecting a transfer of the master role (and hence transmitting MS) at the end of one call transaction so that another can commence

Direct Mode (DM): mode of simplex operation where mobile subscriber radio units may communicate using radio frequencies which may be monitored by, but which are outside the control of, the TETRA V+D network. DM is performed without intervention of any base station

Direct Mode Call Control (DMCC): layer 3 entity responsible for setting up and maintaining a call in DMO

DM channel: specific grouping of timeslots in the DM multiplex structure related to a particular DM RF carrier i.e. DM frequency (or to a pair of duplex-spaced RF carriers for operation with a type 1B or type 2 DM-REP or a type 1B DM-REP/GATE). The grouping may not always be fixed, but in DMO when operating in frequency efficient mode as an example, there are two DM channels, identified by the letters A and B

Direct Mode Mobile Station (DM-MS): physical grouping that contains all of the mobile equipment that is used to obtain TETRA DM services. A DM-MS may have one of three roles:

- **master:** if the DM-MS is either active in a call transaction transmitting traffic or control data, or is reserving the channel by means of channel reservation signalling;
- **slave:** if the DM-MS is receiving traffic and/or signalling in a call; or
- **idle:** if the DM-MS is not in a call

DM-REP presence signal: message transmitted by a DM-REP in order to indicate its presence on an RF carrier

Dual Watch Mobile Station (DW-MS): MS that is capable of both TETRA DMO and TETRA V+D operation. The MS is capable of periodically monitoring the V+D control channel while in a DM call, a DM RF carrier while in a V+D call and, when idle, it periodically monitors both the DM RF carrier and the V+D control channel

Direct Mode gateway: device that provides gateway connectivity between DM-MS(s) and the TETRA V+D network. The gateway provides the interface between TETRA DMO and TETRA V+D mode. A gateway may provide only the gateway function (DM-GATE) or may provide the functions of both a DM repeater and a DM gateway during a call (DM-REP/GATE)

Direct Mode REPeater (DM-REP): device that operates in TETRA DMO and provides a repeater function to enable two or more DM-MSs to extend their coverage range. It may be either a type 1 DM-REP, capable of supporting only a single call on the air interface, or a type 2 DM-REP, capable of supporting two calls on the air interface. A type 1 DM-REP may operate on either a single RF carrier (type 1A DM-REP) or a pair of duplex-spaced RF carriers (type 1B DM-REP). A type 2 DM-REP operates on a pair of duplex-spaced RF carriers

frame number: counter indicating the timing of frames within a DMO multiframe

frequency efficient mode: mode of operation where two independent DM communications are supported on a single RF carrier (or pair of duplex-spaced RF carriers for operation with a type 2 DM-REP). In frequency efficient mode the two DM channels are identified as channel A and channel B

logical channel: generic term for any distinct data path. Logical channels are considered to operate between logical endpoints

master link: communication link used for transmissions between master DM-MS and DM-REP

Medium Access Control (MAC) block: unit of information transferred between the upper MAC and lower MAC for a particular logical channel (e.g. SCH/F or STCH). The lower MAC performs channel coding for insertion into the appropriate physical slot or half slot

Message Erasure Rate (MER): ratio of the messages detected as wrong by the receiver to all messages received in a given logical channel

normal mode: mode of operation where only one DM communication is supported on an RF carrier (or pair of duplex-spaced RF carriers for operation with a type 1B DM-REP or type 1B DM-REP/GATE)

presence signal: message transmitted by a DM-REP or a gateway in order to indicate its presence on an RF carrier

Quarter symbol Number (QN): timing of quarter symbol duration 125/9 µs within a burst

recent user: DM-MS that was master of the call transaction immediately prior to the current master's call transaction in a call

recent user priority: service which gives the recent user a preferred access to request transmission when the current master is ceasing its call transaction in a group call. This service is controlled by the current master

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

slave link: communication link used for transmissions between the DM-REP and slave or idle DM-MSs

surveillance: process of determining the current state of the DM RF carrier when in idle mode

timebase: device which determines the timing state of signals transmitted by a DM-MS

timeslot number: counter indicating the timing of timeslots within a DMO frame

type 1 call: call using the protocol defined in EN 300 396-4 [4]. There are two varieties of type 1 call:

- **type 1A call:** which is a call through a type 1A DM-REP;
- **type 1B call:** which is a call using the protocol for operation with a type 1B DM-REP.

A DM-MS may make a type 1B call through a type 1B DM-REP. It may also make a type 1B call through a type 2 DM-REP if permitted by the DM-REP

type 1 DM-REP: DM repeater that supports a single call on the air interface. There are two varieties of type 1 DM-REP:

- **type 1A DM-REP:** which operates on a single RF carrier;
- **type 1B DM-REP:** which operates on a pair of duplex-spaced RF carriers, one used as the "uplink" from DM-MSs to the DM-REP and the other used as the "downlink" from the DM-REP to DM-MSs.

The protocol for operation with a type 1 DM-REP (either a type 1A or a type 1B DM-REP) is based on the protocol for normal mode in ETS 300 396-3 [3]

type 2 call: call using the protocol defined in the present document. A DM-MS may make a type 2 call only through a type 2 DM-REP

type 2 DM-REP: DM repeater that is capable of supporting two simultaneous type 2 calls on the air interface. A type 2 DM-REP operates on a pair of duplex-spaced RF carriers, one used as the "uplink" from DM-MSs to the DM-REP and the other used as the "downlink" from the DM-REP to DM-MSs. The protocol for type 2 calls through a type 2 DM-REP is based on the protocol for frequency efficient mode in ETS 300 396-3 [3]. (A type 2 DM-REP may also optionally offer type 1B calls using the protocol defined in EN 300 396-4 [4])

V+D operation: mode of operation where MSs may communicate via the TETRA V+D air interface which is controlled by the TETRA Switching and Management Infrastructure (SwMI)

3.2 Abbreviations

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

BER	Bit Error Ratio
DLB	Direct Mode Linearization Burst
DLL	Data Link Layer
DM	Direct Mode
DM-GATE	Direct Mode Gateway
DM-MS	Direct Mode Mobile Station
DM-REP	Direct Mode Repeater
DM-REP/GATE	Direct Mode Repeater/Gateway
DMCC	Direct Mode Call Control entity
DMO	Direct Mode Operation
DNB	Direct Mode Normal Burst
DO-MS	Direct Mode Only Mobile Station
DSB	Direct Mode Synchronization Burst
DU-MS	Dual Mode (V+D / Direct Mode) switchable Mobile Station
DW-MS	Dual Watch Mobile Station
FN	Frame Number
LCH	Linearization Channel
MAC	Medium Access Control
MCCH	Main Control Channel
MER	Message Erasure Rate
mod	modulo (base for counting)
PDU	Protocol Data Unit
PL	Physical Layer
QN	Quarter symbol Number
RF	Radio Frequency
SCCH	Secondary Control Channel
SCH	Signalling Channel
SDS	Short Data Service
SDU	Service Data Unit
STCH	Stealing Channel
SwMI	Switching and Management Infrastructure
TCH	Traffic Channel
TN	Timeslot Number
V+D	Voice plus Data

4 Overview of protocol

4.1 General

TETRA DMO using a DM repeater (DM-REP) offers the possibility to support DM communications over an enhanced coverage area from that typically achieved in direct MS-MS operation.

A DM-REP re-transmits information received from one DM-MS to other DM-MS(s) over the DM air interface. It normally performs de-encoding and re-encoding operations on the DM-MS transmission bits prior to regeneration in order to improve BER performance.

The DM-REP may optionally generate a presence signal. The purpose of this signal is to inform any DM-MSs monitoring the RF carrier (i.e. frequency) that the DM-REP is now present and available for service.

The DM-REP is specifically addressed by a DM-MS if the DM-MS wishes the DM-REP to support a call, by inclusion of the repeater address within the call set-up messages. When a DM-REP is supporting a call, the recipient DM-MSs receive the signalling and traffic via the DM-REP.

NOTE 1: The present document does not support operation in which some DM-MSs receive a call via the DM-REP while other DM-MSs receive that call directly from the calling DM-MS.

In order to operate with a DM-REP, a DM-MS needs to implement some additional protocol procedures not needed for direct MS-MS operation. The additional procedures for operation with a type 1 DM-REP are described in EN 300 396-4 [4]; the additional procedures for operation with a type 2 DM-REP are described in the present document.

The following types of DM-REP are standardized in the present document:

Type 1: single-call regenerating repeater:

A type 1 DM-REP can support only one call at a time. There are two varieties of type 1 DM-REP:

a) A type 1A DM-REP conducts transmit and receive operations on a single RF carrier, re-transmitting bursts received from a DM-MS during one timeslot to other DM-MS(s) in a different timeslot.

b) A type 1B DM-REP is similar to a type 1A DM-REP except that it uses a pair of duplex-spaced RF carriers, one as an "uplink" from DM-MSs to the DM-REP (RF carrier f_1) and the other as the "downlink" from the DM-REP to DM-MSs (RF carrier f_2).

The protocol for operation with a type 1 DM-REP (either a type 1A or a type 1B DM-REP) is based on the protocol for normal mode in ETS 300 396-3 [3].

Type 2: two-call regenerating repeater:

A type 2 DM-REP is capable of supporting two simultaneous calls on the air interface. It uses a pair of duplex-spaced RF carriers, one as an "uplink" from DM-MSs to the DM-REP (RF carrier f_1) and the other as the "downlink" from the DM-REP to DM-MSs (RF carrier f_2). The protocol for operation with a type 2 DM-REP is based on the protocol for frequency efficient mode in ETS 300 396-3 [3].

NOTE 2: In the present document, the term "frequency efficient mode" is used in the description of the protocol with a type 2 DM-REP. Similarly, in EN 300 396-4 [4], the term "normal mode" is used in the description of the protocol with a type 1 DM-REP. These terms are used for compatibility with ETS 300 396-3 [3], since the type 1 DM-REP air interface supports a single call at a time (as for normal mode in ETS 300 396-3 [3]) whereas the type 2 DM-REP air interface supports two calls at a time (as for frequency efficient mode in ETS 300 396-3 [3]). However it should be noted that the efficiency of frequency usage with a type 1A DM-REP is actually the same as with a type 2 DM-REP i.e. the efficiency of frequency usage with one call on one RF carrier is the same as with two calls on two RF carriers.

The method of selection of the appropriate DM RF carrier(s) is not standardized in the present document.

Both type 1 and type 2 DM-REPs are primarily layer 2 devices comprising a Physical Layer (PL) (layer 1) and a Data Link Layer (DLL) (layer 2). The protocol stack applicable to either type 1 or type 2 DM-REPs is shown in figure 1.

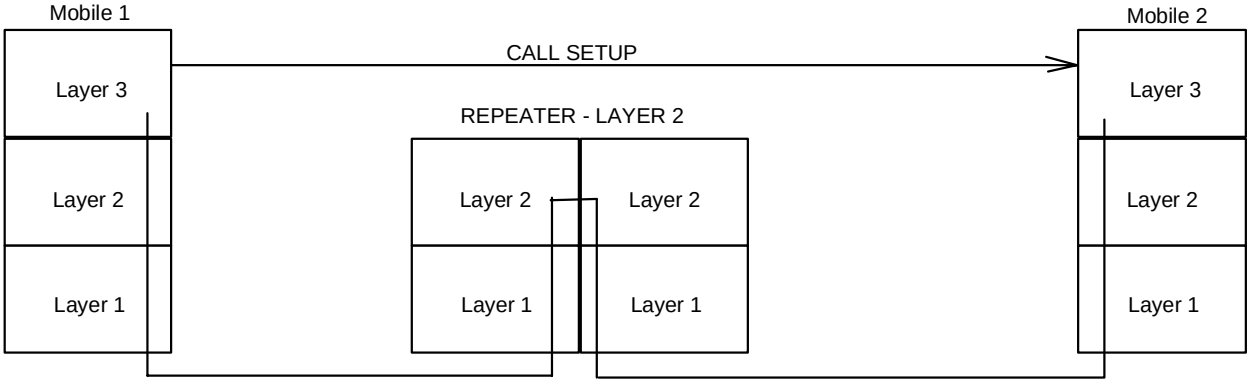

Figure 1: Protocol stack of DM-REP

It is optional for a DM-MS to support operation with a DM-REP. If a DM-MS supports operation with a DM-REP then it may support operation with one or more of the following: a type 1A DM-REP, a type 1B DM-REP or a type 2 DM-REP.

NOTE 3: There are some differences in the DM-MS procedures between operation with a type 1A DM-REP, type 1B DM-REP and type 2 DM-REP. The differences between operation with a type 1A DM-REP and type 1B DM-REP are basically only the RF differences resulting from the use of one or two RF carriers. However there are protocol differences between operation with a type 1 DM-REP and type 2 DM-REP.

A DM-REP needs more physical capabilities than those needed for a DM-MS. As described in subclause 9.3, a type 2 DM-REP is required to be capable of frequency full duplex operation.

The present document covers only the operation of a type 2 DM-REP and the operation of a DM-MS with a type 2 DM-REP.

The operation of a type 1 DM-REP (either a type 1A or a type 1B DM-REP) and the operation of a DM-MS with a type 1 DM-REP (either a type 1A or a type 1B DM-REP) are described in EN 300 396-4 [4].

The remainder of this clause contains an introduction to the protocol for operation with a type 2 DM-REP.

4.2 The DM channel

A DM call takes place on a "DM channel". Two DM channels (designated channel A and channel B) may exist on the pair of duplex-spaced RF carriers. A call using channel A is primarily conducted in timeslots 1 and 3 in each frame on each of the RF carriers, whereas a call using channel B occupies the other two timeslots. From the perception of the DM-MSs on channel B, the channel B timeslots are also regarded as being timeslots 1 and 3.

A DM channel can be perceived as being in one of three states:

- free, where there is no activity on the channel (or in the case where a DM-REP provides a signal indicating its presence, when this presence signal indicates that the channel is free);
- occupied, where a call transaction is in progress on the channel;
- reserved, where a "channel reservation" signal is present on the channel.

The actions and procedures followed by a DM-MS wishing to make a call through a DM-REP vary depending on the state of the channel.

When the channel is free, it is available for use by any DM-MS which can tune to that channel.