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Foreword

This Technical Report (TR) has been produced by ETSI Project Terrestrial Trunked Radio (TETRA).

Introduction

The present document describes the technical requirements for TETRA Managed Direct Mode (MDM) operation. It is based on ETSI Technical Sub-Committee EPT WG1 input documents.

1 Scope

The present document is an outline of possible ways of introducing a control mechanism in the presently specified operation of TETRA Direct Mode (DMO) in order to prevent the possibility, under some circumstances, of DMO equipment causing interference to other legitimate users.

The objective of the present document is to describe the control mechanism, described from now on as TETRA Managed Direct Mode Operation, and to identify and define the services and facilities to be standardized for TETRA Managed Direct Mode Operation.

TETRA Direct Mode Operation developed as a concept where a suitably equipped Mobile Station had the capability to communicate either via a base station in TETRA-Trunking mode and also in a direct terminal to terminal mode using TETRA-derived transmission standards and technology without the need for an intervening base station.

Managed Direct Mode operation is proposed for those occasions when channels harmonized across all of the European countries for the use of Direct Mode are not available, and it will therefore be necessary to constrain the geographic area in which a terminal may use Direct Mode.

The present document is intended to provide the starting point for system design and should provide sufficient criteria against which a number of possible system options can be evaluated and considered. The basis for the design is a proposal which was prepared for and discussed by EPT WG1 and WG2. The proposal included certain recommendations for methods by which the cost of implementation may be minimized. These recommendations form the basis for the notes within the document but are not binding upon the team assessing and defining the method by which these requirements may be met.

The present document is applicable to both public and private networks.

Managed Direct Mode Operation should not preclude special services and user features, which are not specifically defined in the present document.

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.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

- [1] ETS 300 396-1: "Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 1: General network design.
- [2] ETS 300 396-3: "Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 3: Mobile Station to Mobile Station (MS-MS) Air Interface (AI) protocol.
- [3] ETS 300 396-4: "Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 4: Repeater type 1".
- [4] ETS 300 396-5: "Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 5: Gateways".
- [5] ETS 300 396-7: "Terrestrial Trunked Radio (TETRA); Technical requirements for Direct Mode Operation (DMO); Part 7: Repeater type 2".

3 Definitions and abbreviations

3.1 Definitions

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

direct mode operation: 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 trunked network. DM operation is performed without intervention of any base station

direct mode presence signal: signal defined in ETS 300 396-3 [2] which is transmitted by direct mode gateways, direct mode repeaters and direct mode repeater/gateways. It permits direct mode terminals which receive this signal to know that the gateway, repeater or repeater/gateway is within operating range

Dual Watch: mode of operation in which a dual-mode TETRA terminal (MS), which can be in either trunking or direct mode, periodically monitoring (scanning) one or both systems for calls (signals) which are directed to it

gateway: device which will enable the interconnecting of two networks which inherently use different and incompatible protocols

mobile station (MS): physical grouping that contains all of the mobile equipment that is used to obtain TETRA services. By definition, a MS contains at least one Mobile Radio Stack (MRS)

managed direct mode: method of operation in which a direct mode terminal is only permitted to transmit when it may receive a signal authorizing it to do so

repeater/gateway: terminal which offers the services of both a gateway and a repeater. Where a repeater is assumed to be a terminal which may receive a signal from one terminal and re-transmit it for reception by another or other terminals

trunked voice and data network: network which uses the TETRA trunking mode operation (see below)

trunking mode operation: mode of operation where mobile terminals may communicate via the TETRA voice and data 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:

AI	Air Interface
ASSI	Alias Short Subscriber Identity
DM	Direct Mode DM-MS Direct Mode capable Mobile Station
DMO	Direct Mode Operation
EPT	ETSI Project TETRA
ETS	European Telecommunication Standard
ETSI	European Telecommunications Standards Institute
GPS	Geographical Positioning System
GTSI	Group TETRA Subscriber Identity
MS	Mobile Station
SwMI	TETRA Switching and Management Infrastructure
TETRA	Terrestrial Trunked Radio
TR	Technical Report
Ud	TETRA Direct Mode air interface
Um	TETRA air interface V+D Voice Plus Data
WG1	Working Group 1 of EPT
WG2	Working Group 2 of EPT

4 Terminal types

Terminals used for Managed Direct Mode will be similar to but not identical to those used for Direct Mode.

It is envisaged that there will be several types of Managed Direct Mode terminal. The key differences between Managed Direct Mode terminals and the direct mode terminals described in ETS 300 396-1 [1] is that managed direct mode terminals will only transmit when they have been authorized to do so. This authorization may be conveyed directly from the trunked voice and data network- as in the case of Dual-Watch, or may have the form of membership of a group which will appear in the managed direct mode presence signal. This process is described in subclause 7.1 Authorization.

4.1 Managed Direct Mode Terminal

This terminal may communicate with another managed direct mode terminal following the receipt of an authorization to transmit and when in receipt of a Managed Direct Mode presence signal using either terminal to terminal direct mode or a repeater. An alternative form of authorization will take the form of membership of a group, which appears in the presence signal. Once authorized the terminal may also access a managed direct mode gate.

4.2 Managed Dual Watch Terminal

This terminal may communicate with another managed direct mode terminal following the receipt of an authorization to transmit and a channel allocation from the network system, and when in receipt of a Managed Direct Mode presence signal using either terminal to terminal direct mode or a repeater. An alternative form of authorization will take the form of membership of a group, which appears in the presence signal. Once authorized the terminal may also access a managed direct mode gate.

4.3 Managed Direct Mode Gate

The managed direct mode gate offers the same services as the direct mode gate which is specified in ETS 300 396-1 [1] but includes the ability to generate a managed direct mode presence signal when both authorized to do so and in the presence of the signal from the specified base station on the trunked network for which this authority has been granted.

4.4 Managed Direct Mode Extended Range Gate

The managed direct mode gate may generate a managed direct mode gate presence signal in the geographic area and for the period of time for which it has been authorized to do so by the trunked voice and data network.

4.5 Managed Direct Mode Repeater/Gateway

The managed direct mode repeater gateway may generate a managed direct mode repeater presence signal in the geographical area and for a period of time for which it has been authorized to do so by the trunked voice and data network.

5 Reference models

In this clause a number of reference models are identified. The purpose behind these models is to assist in providing a clear and unambiguous definition of the interfaces which exist between the various terminal types and, if relevant, to any other involved terminal or network entities.

5.1 Standard TETRA reference model

As a reference basis for comparison of the differences between standard TETRA trunked mode operation and TETRA DM operation, figure 1 shows the most basic standard TETRA trunked reference model.

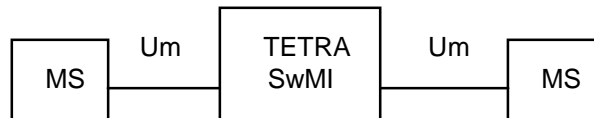


Figure 1: Standard TETRA configuration using a TETRA SwMI

Communication via the MSs is over the TETRA trunked mode air interface Um, as specified in the TETRA trunked mode standard and connectivity is provided via the TETRA Switching & Management Infrastructure (SwMI).

There are many other possible TETRA trunked model configurations but these are not relevant to this definition of direct mode models and so will not be discussed further here.

5.2 Direct mode reference model

The basic reference model for managed direct mode requires that a terminal shall use the standard direct mode air interface for terminal to terminal communication as specified in ETS 300 396-3 [2]. The standard direct mode air interface is shown in figure 2.

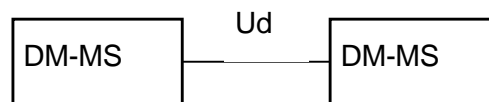


Figure 2: DM-MS connected to DM-MS via DM air interface

The managed direct mode version differs from the normal direct mode version in that this form of communication will only be available when there is a presence signal which is being generated by a managed direct mode gateway.

5.3 Dual Watch mobile station (DW-MS)

This reference model applies to a DM-MS, a multi-mode equipment capable of dual watch operation.

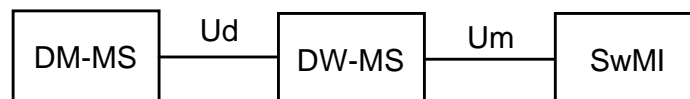


Figure 3: Dual Watch reference model

The DW-MS is either idle in both modes and periodically monitoring both the trunking mode control channel and a selected DM frequency; or communicating with another DM-MS and monitoring the trunking mode control channel without interrupting direct mode operation; or communicating with the TETRA Switching and Management Infrastructure (SwMI) in trunking mode and periodically monitoring a network allocated DM channel without interrupting trunking mode operation.

The same reference model applies also for Managed dual watch terminal, receiving authorization from SwMI via Um and passing it on to Managed DM terminals via Ud.

5.4 Managed direct mode gate reference models

The managed direct mode gateway may offer the same services as the direct mode gateway which is specified in ETS 300 396-1 [1] but varies in that it will produce a managed direct mode presence signal when authorized to do so by the trunked voice and data network. It will continue to generate this signal until either the authorization is withdrawn or it ceases to communicate with the base station for which that authorization was granted. When a terminal has changed base station then it may apply for authorization on the new base station.

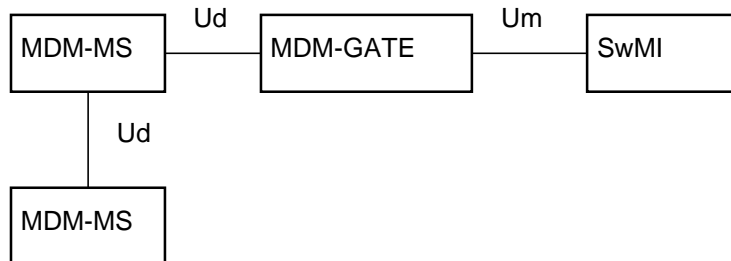


Figure 4: Gateway into a TETRA SwMI

The managed direct mode gate will also authorize direct mode terminal to terminal communication using group mode for terminals which are active within a group number which shall be available from the presence signal even though these terminals will not have been specifically authorized to use this gate by the trunked voice and data network.

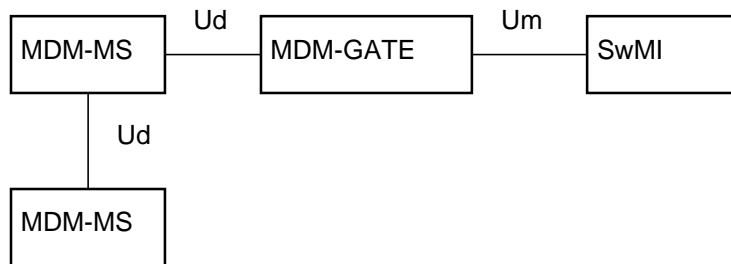


Figure 5: Gate with Group Communication

Terminals which are capable of both monitoring the gateway presence signal whilst simultaneously engaged in terminal to terminal direct mode operations are essential for the managed direct mode service.

5.5 Managed direct mode repeater/gateway combination reference models

The managed direct mode repeater/gateway may serve as a repeater/gateway whilst within the coverage of the network using the service model described in ETS 300 396-1 [1] and shown below.

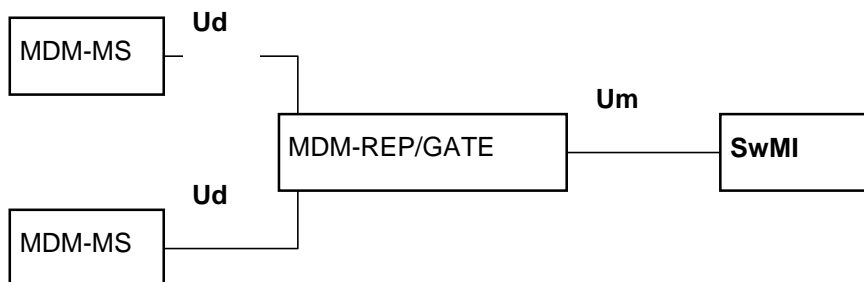


Figure 6: Repeater/gateway combination into a TETRA SwMI

The managed direct mode repeater/gateway may also operate as a repeater when out of coverage of the trunked voice and data network when authorized to do so by the trunked network and within the geographical position and time constraints which may be imposed upon it by the network.

The geographical constraint will be defined as a geographical location, which may be found using a GPS receiver and a radius around that point.

5.6 Protocol stacks in the MS

The protocol stacks used for managed direct mode will be identical to those used within the direct mode service which is defined in ETS 300 396-1 [1].

6 Operating Scenarios

6.1 Objective of the Management Process

The objective of Managed DMO is to so constrain the transmission by the terminals using DMO and being managed, such that they will not radiate a signal in a geographical area in which they are not authorized to do so.

For the description of the management process it is assumed that the structure of the network approximates to the layout shown in Figure 6. When a group of terminals wishes to use Managed DMO the leader of the team would request the service from the dispatcher. The dispatcher would then send a request to an application resident on a computer which offers the channel assignment process. This would assign a channel based on the Managed DMO channels which are in use within the geographic area and the task under consideration and communicate the authority to use that channel via the SwMI.

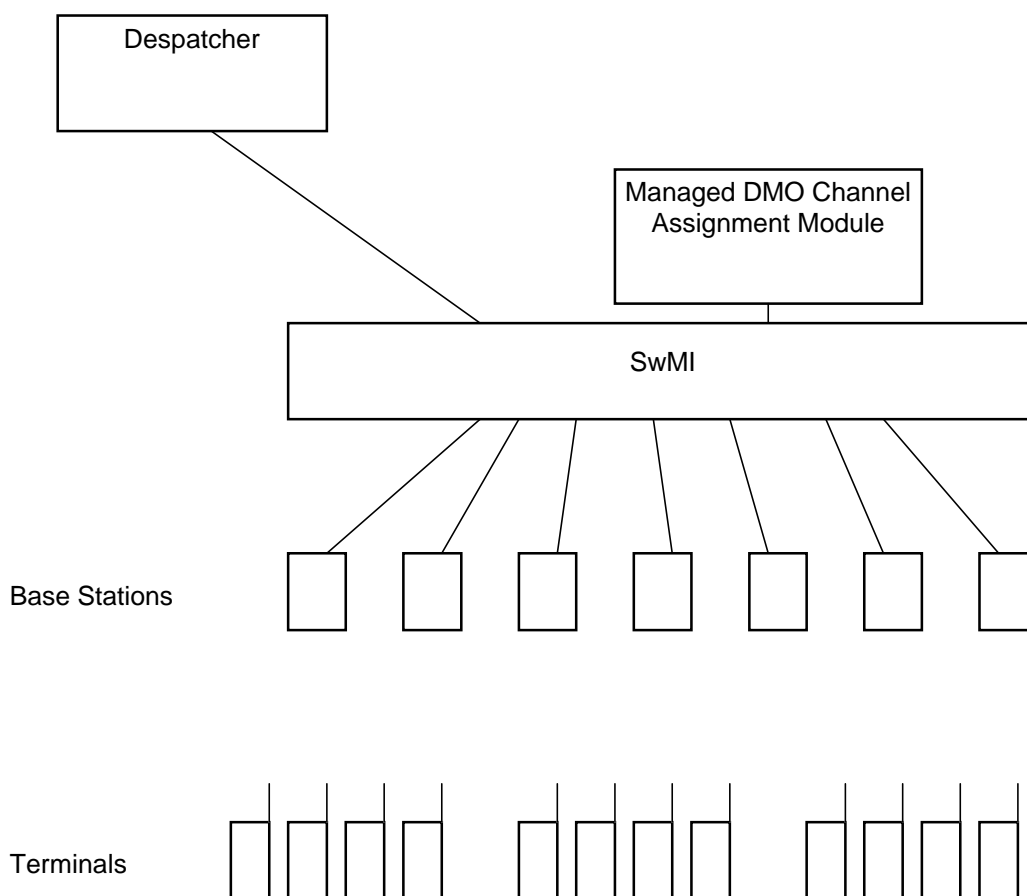


Figure 7: Infrastructure Managing DMO Channels

6.1.1 Managing the Channels

The process of managing the channels assigned to the terminals and the geographic areas in which they may be assigned does not form part of this requirement however for clarification it is intended that:

- terminals using DMO should not be permitted to do so beyond the geographic territory for which a controlling voice and data network has the authority to radiate signals. Typically for a regional network this may be the region whilst for a national network it will limit the use of these channels to that nation;
- the re-use of DMO channels shall be optimized by constraining the territory in which the terminal which provides the authority to transmit may offer that authority;
- DMO will be able to offer services in areas in which the controlling voice and data network does not offer coverage. The extent of this service will be capable of being constrained.

6.2 In or Out of Coverage

The authority to transmit will be transmitted to the managed terminals from the trunked voice and data network. It is anticipated that both the managing terminals, that is terminal types ii, iii iv and v, and the terminals to be managed may be either in or out of coverage of the trunked voice and data network during the time period that they will be permitted to authorize DMO or to transmit using DMO. The following two subclauses outline the process of authorization.

A terminal may proceed without authorization from the trunked network if the terminal is capable of operating with one of the groups which may be included in the presence signal.

6.2.1 In Coverage

It is planned that terminals which are within the coverage of the trunked voice and data shall be authorized to transmit only whilst a terminal which offers either, a gate service or a gateway repeater service, in which this terminal acts as a gateway to the controlling network, can continue to maintain communications with the network from which the authorization has been provided.

The network which has provided the authorization may be a network onto which the terminal has migrated. In this case the terminal may be assigned an ASSI and offer the managed DMO service within the coverage of the specified cells within that network.

6.2.2 Out of Coverage

It is planned that a suitably equipped terminal of types iii or iv may offer the terminals, which will monitor the signals which this terminal shall generate, the authority to use the DMO services whilst those terminals continue to receive the signal from the special terminal. It is planned that the signals which shall provide authority to these subsidiary terminals shall either be, or shall be similar to, the existing gateway presence signal or the repeater presence signal.

The specially equipped terminal shall be equipped with a GPS receiver (or equivalent) and an accurate method of maintaining the time. Based on the information from these sources this terminal may be restricted to authorizing the use of DMO whilst it remains within an area which may be defined by a point on the surface of the earth and a radius around it. It may also be restricted to authorizing the use of DMO for a limited period of time.

6.3 Gateways and Repeaters

It is planned that only modified forms of the DM Gate and DM Repeater/Gateways may offer the managed service although those terminals, being managed, will be similar to the existing DMO terminals defined in ETS 300 396-1 [1] except that they shall only be able to transmit a DMO signal when they are receiving a presence signal which authorizes them to do so.

6.3.1 Gate

The Managed DM Gate, the type ii terminal, will be similar to a DM Gate but will be modified such that, having received an authorization signal from the network to offer DMO authority to the terminals which are both within range and authorized to use it as a gateway, it will transmit a gateway presence signal. The terminals which are authorized to use it as a gateway may then use either terminal to terminal direct mode or may use the gateway service.

The Managed DM Gate may offer a presence signal in which is included GTSIs to permit terminals for whom that group is in use to access the services without specific authorization.

6.3.2 Extended Range Gate

The Managed DM Extended Range Gate will offer the same services as the gate, described in subclause 6.3.1, but will include the option to continue to provide a presence signal when the terminal is out of coverage using the process of geographical restriction which is outlined in subclause 6.2.2.

6.3.3 Gateway/Repeaters

The Managed DM Gateway/Repeater will be modified such that, having been authorized by the network to offer DMO authority to the terminals which are both within range and authorized to use it as a gateway, it will transmit a presence signal. Terminals authorized to use this gateway/repeater may then use the services of the repeater or the gateway but will not communicate using terminal to terminal DMO.

The Managed DM Gateway/Repeater will offer the ability the presence signal whilst out of coverage of the Trunked Voice and Data network by using the process of geographical restriction which is outlined in subclause 6.2.2.

6.4 Terminal to Terminal DMO without a Presence Signal

The use of terminal to terminal DMO without a presence signal is expressly forbidden however it is inevitable that there may be brief interruptions to presence signal and that it will be necessary that the terminals may continue to operate for a period of seconds after the presence signal has ceased to be received.

There is a requirement that terminals using terminal to terminal DMO shall be enabled to continue to do so for a period of time after they have ceased to be able to receive the presence signal provided by the gateway. This may be provided by extending slightly the period of time after the presence signal has ceased for which the terminals may continue to use terminal to terminal DMO.

NOTE: This facility has been specifically requested by water companies for employees who may work briefly underground. The period of time for which this may be permitted must be kept brief in order to maintain the management concept within Managed DMO.

7 Services Supported

It is planned that Managed DMO will support those TETRA services provided by the DMO standards as appropriate for the mobile to mobile, gateway and gateway/repeater methods of operation. These are described in the following standards:

- ETS 300 396-3 [2] Mobile to mobile DMO;
- ETS 300 396-5 [4] DMO Gateway;
- ETS 300 396-4 [3] DMO Repeater type 1;
- ETS 300 396-7 [5] DMO Repeater type 2.

7.1 Authorization

Terminals type (i) shall be able to gain authorization to use the gateway or gateway/repeater either when they have direct contact with the voice and data network or when they do not have contact with the voice and data network. In each case it will be necessary that the terminal shall have an authorization which takes the form of either the specific repeater to use or the ability to read the presence signal and to match a group identifier which has already been loaded into the terminal.

7.1.1 Authorization from the Voice and Data Network

The terminal should be able to gain authority to use direct mode when it hears a presence signal for which the characteristics have been sent to it from the voice and data network.

NOTE: It has been proposed that this authority should take the form of DMO Gateway Identifier. It has also been proposed that the method of transmission should be SDS-4 using the Transport Layer.

7.1.1.1 Downlink Data

The downlink authorization shall contain data fields, which shall include the following:

- ITSI of terminal;
- gate number;
- channel number;
- upper or lower channel.

7.1.1.2 Uplink Data

The data contents of the uplink request for the attachment of a terminal to a gate is beyond the scope of the present document. The methods of request should be expected to be varied. It is anticipated that, in the majority of cases assignment to a gate would be made by a dispatcher and conveyed to the terminal.

7.1.2 Authorization by Group Identifier

A terminal will have authority to use both the gate service and where available the repeater service whilst not having been specifically authorized to do so if a group identifier (GTSI) which is currently active within the terminal is also present in the presence signal. The GTSI in the terminal may be either static or dynamic.

7.1.3 Authorization beyond the Range of the Voice and Data Network

It is necessary that a terminal should be capable of being turned on whilst beyond the range of a voice and data network and communicate using the authority granted by the gateway or gateway/repeater. To support this service there will be occasions when it will be necessary that the process of terminal authorization shall take place at the location of the gate or repeater/gateway.

A terminal that does not have authority may make the initial connection using authorization by group identifier as described above.

7.1.4 Authorization of Out of Coverage Gates and Gateway/Repeaters

The authorization for a gate or gateway/repeater to operate whilst out of coverage of the network will be supplied whilst the terminal is in coverage. This information will constrain the area of operation and will include as a minimum:

- ITSI of gate or gateway/repeater;
- channel number;
- upper or lower channel;
- gateway number;
- position as Latitude and Longitude;
- radius in 10s of metres;
- validity period of authority.

The information content of the request is beyond the scope of the present document.

8 Security

Managed Direct Mode should provide for the same level of security as that available in TETRA trunked mode.

9 Performance figures

The performance of the managed direct mode terminals will not vary from that of the normal direct mode terminals.

History

Document history		
V1.1.1	April 1999	Publication