



# DMR: Latest Features

**Tom Johnson**

Chair DMR Association Technical Working Group

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## The DMR Association

### About

The DMR Association is a global organization whose purpose is to help grow the DMR market by removing barriers to interoperability and supporting innovation and adoption of the standard via the creation of new devices and services.

### Mission

To ensure that LMR buyers of today's digital radio technology gain ongoing value through the competition and choice derived from an open, multi-vendor value chain.

### Activities

- Interoperability certification of DMR products
- Development of enhanced features
- Feedback to ETSI
- Information & Promotion

[www.dmrassociation.org](http://www.dmrassociation.org)

### Facts and Figures

Founded in 2005

- 2006 decision to adopt the AMBE+2 Vocoder
- 2009 Technical Working Group and a Marketing Working Group established
- 2011 Incorporated in the UK as limited company
- Three categories of Membership
  - Category 1      Equipment Manufacturers
  - Category 2      Application Developers, Test Equipment Manufacturers, Systems Integrators & Test Houses
  - Category 3      Users, Regulators & Operators
- Today the DMR Association counts over 150 Members, including over 60 manufacturers

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## Technical Working Group (TWG)

- TWG meets every 6 weeks approximately.
- Consists of representatives from DMR equipment manufacturers.
- Considers matters relating to
  - DMR Standards
  - Interoperability (IOP)
  - DMRA Standards (Encryption/AIS etc)
  - Conformance and compliance.
- Direct input to ETSI (TGDMR)
- Chaired by Tom Johnson (Ex Fylde Chief Engineer, Network and Hardware/Software Design engineer).

### Current (September 2019) Standard

- ETSI TS 102 361-1 V2.5.1 (2017-10)      DMR Air Interface Protocol
- ETSI TS 102 361-2 V2.4.1 (2017-10)      DMR Voice and Generic Services
- ETSI TS 102 361-3 V1.3.1 (2017-10)      DMR Data Protocol
- ETSI TS 102 361-4 V1.10.1 (2019-08)      DMR Trunking Protocol
  
- ETSI TR 102 398 V1.4.1 (2018-11)      DMR General System Design

*All these documents can be freely downloaded from the  
ETSI or DMR Association websites:*

[www.etsi.org](http://www.etsi.org)

[www.dmrassociation.org](http://www.dmrassociation.org)



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### **DMR Tier I: Unlicensed**

- Products for license-free, non-professional use: PMR446

### **DMR Tier II: Conventional**

- Professional licensed conventional radio systems operating in PMR frequency bands 30 to 1000 MHz. Targeted at users who need smooth migration from analogue with existing spectrum & licensing, spectral efficiency, advanced voice features and integrated IP data services in licensed bands

### **DMR Tier III: Trunked**

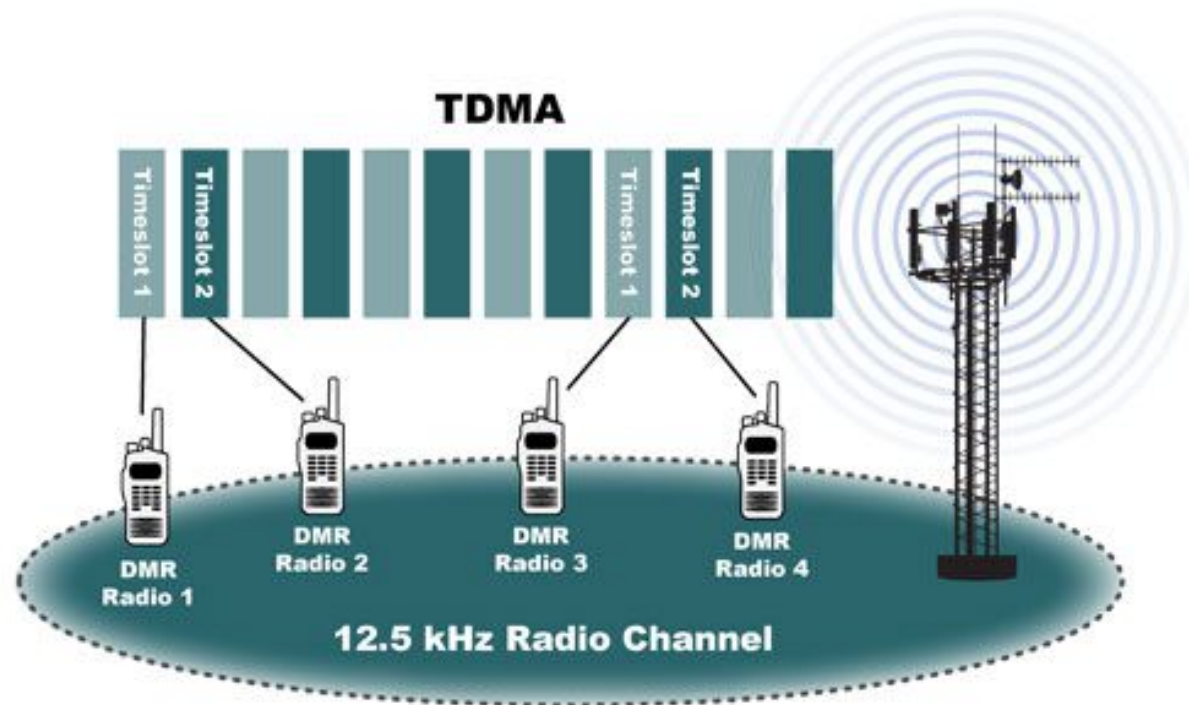
- Professional trunking operation in frequency bands 30 to 1000 MHz. The ETSI Tier III standard is derived from MPT1327 and is based on Tier II building blocks and features with plenty of additional added-value features



### DMR Overview

- 12.5 kHz channel compatible with current analogue frequency allocation schemes
- Free combination of tx and rx frequencies (for complex freq. assignments)
- 9.6 kbps gross bit rate
- 4FSK modulation: constant envelope for simple RF design
- 2 slot TDMA channel => 6,25 kHz equivalent channel: 2 communication paths; permitting forward and reverse transmission on a time division basis
- Built around a 30ms slot structure
- 50% duty cycle slot structure allows
- Transmission can be used either for voice, data or signalling
- Low cost, low complexity
- Great range: same or better link budget than analogue
- Conventional (Tier II), Trunking (Tier III), Simulcast

## DMR 2 Slot TDMA



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- Tier III has a huge portfolio of voice and data services and features - we will discuss some of these in the following slides.
- Note that not all DMR manufacturers may have implemented all the following features, check with the vendor.
- Some vendors may offer proprietary features or proprietary implementations of the following features, this is not a problem but may not be interoperable with other vendors DMR equipment.
- Check with DMRA on interoperability reports.
- DMRA is currently extending its Tier III Interoperability Scheme to cover all of the major new DMR features.



## Basic Features

- Mobile Station (MS) Access control and management
- MS Location by Radio Site Identification and Registration
- MS and BaseStation (BS) Authentication
- Message / Transmission / Quasi-Transmission Trunking
- Aligned and Offset Timing (enables full-duplex calls)
- Unified Data Transport (UDT) to support Short Data Service, Supplementary User Data service and Gateway addresses
- Broadcast of system parameters to MS
- Reverse Channel (to control transmitting MS's)
- Dedicated and Non-Dedicated Control Channel
- Secondary Control Channel (TSCCAS) (to manage more MS's and/or more bandwidth for location data)

## Voice Features

- Talkgroup Call
- Late Entry (for Talkgroup Call)
- OACSU (Off Air Call Set Up) Individual Call
- FOACSU (Full Off Air Call Set Up) Individual Call
- Priority and Emergency Call
- Broadcast Call (mono-directional)
- All MS Call (mono-directional to pre-defined Talkgroup Addresses)
- Gateway Calls (PSTN, PABX, Dispatch) Half- and Full-Duplex
- Full-Duplex MS to MS Call

## Generic Data Features

- Protected data with  $\frac{1}{2}$  rate (high protection),  $\frac{3}{4}$  rate (medium protection) and rate 1 (unprotected) Forward Error Correction
- Acknowledged and unacknowledged

The following building blocks are used:

- Control Signalling Block (CSBK, for signalling purposes)
- Unified Data Transfer (UDT) Short Data Message service
- Packet Data service: IP over DMR + UDP/IP header compression
- Unified Single Block Data : USBD (e.g. for high throughput positioning data)

**NOTE:** these are the building blocks of the User Data Features

## User Data Features

- Text Messaging over UDT
- Text Messaging over UDP/IP
- Location Messaging over UDT (basic approach – smaller fleets)
- Location Messaging over UDP/IP – Location Information Protocol (LIP) (compatible with IP-based location applications)
- Voice associated in-band data features (radio position and talker alias together with speech)
- Unified Single Block Data Polling – LIP Positioning (advanced approach – up to 1000 terminals per minute in one Timeslot of the TDMA channel)
- Generic IP data
- Full-Duplex MS to MS Packet Data Call

## Supplementary Features

- Common Dialling Plan and Native Addressing (new)
- Talker Identification
- Radio Check
- Short Data Polling
- Status Delivery
- Status Polling
- MS Stun and Revive
- MS Kill
- Answer Call (immediate or deferred)
- Cancel Call
- Call Diversion
- Ambient Listening (if enabled)

### **Supplementary Features** (continuation)

- Channel Authorisation (to avoid collisions in Talkgroup Calls)
- Supplementary User Data Transfer (e.g. sensor data at call set-up time)
- Network System Announcements
- Emergency Alarm (e.g. transmission of alarm status to Control Rooms)
- Emergency Pre-emptive Call
- PTT De-key
- Transmit Interrupt
- MS Dynamic Power Control
- Group Subscription/Attachment
- Dynamic Group Number Assignment
- Trunk Station Control Channel Alternate Slot management
- Optional End-to End Encryption (ARC4, DES, AES128, AES256 – managed by the DMR Association)

- Lets look in detail at a few of the newer features of DMR
  - i. Unified Single Block Data and TSCCAS (alternate control channel).
  - ii. Transmit Interrupt for Emergency Preemption
  - iii. Talkgroup Attachment and Subscription services
  - iv. Voice and Data Encryption
  - v. Native addressing

## USBD Polling – LIP Positioning: how it works

The USBD Polling Service supports LIP Immediate Reporting.

Can be done on Control Channel or Secondary Alternate Control Channel

MS's when idle listen to a control channel (TSCC) typically on slot 1 of the control channel frequency.

Whilst doing this they can also listen on Slot 2. Slot 2 can therefore host the USBD polling service. This is known as the Alternate control channel (TSCCAS).

Using TSCCAS, combined with the USBD Polling Service provides a highly efficient method of supporting large quantities of location updates:

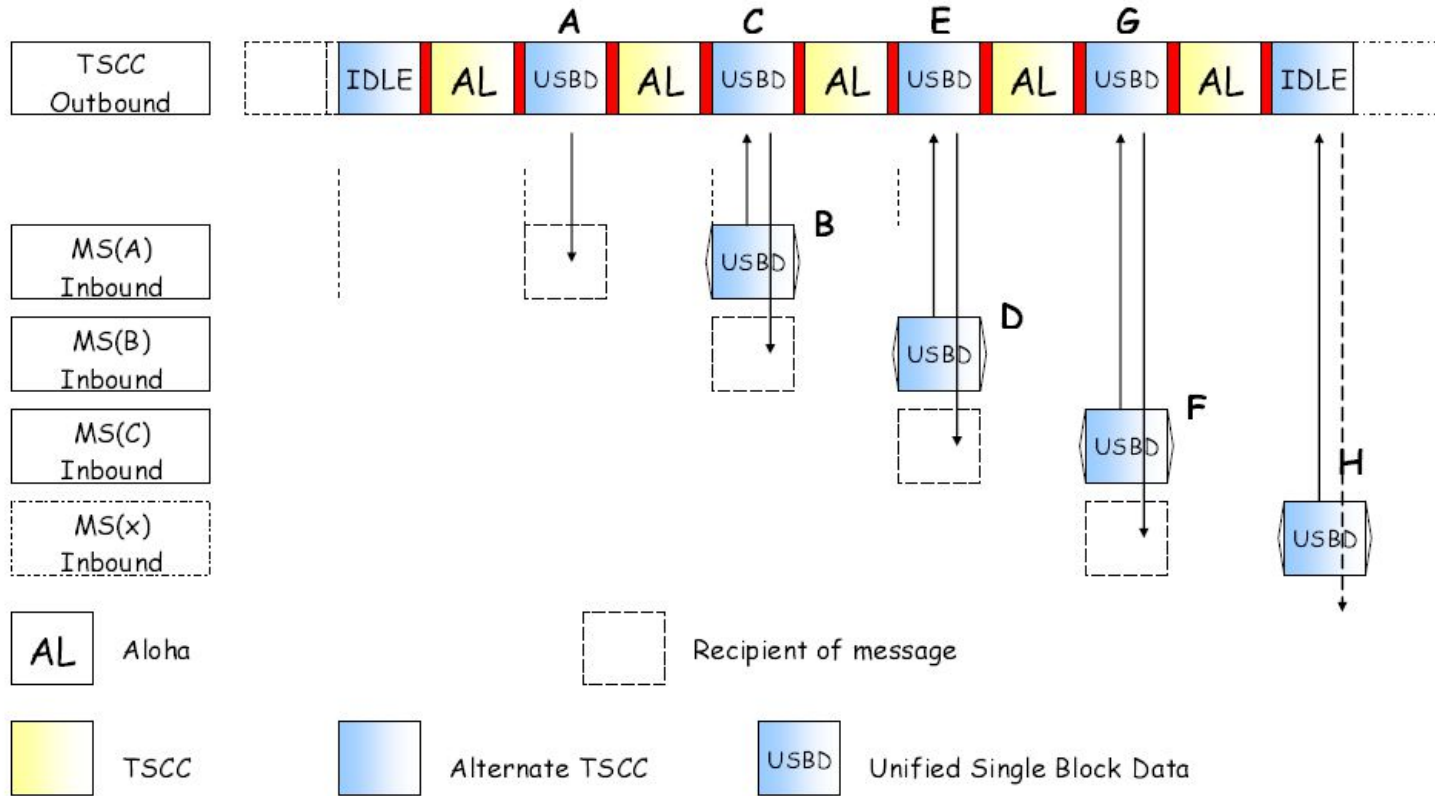
- LIP messages are compressed to be sent as DMR air interface PDU's
- Latitude, Longitude, Velocity and Direction of Travel are conveyed
- There is no impact on any other logical channels (all voice, data and signalling ongoing activities are unaffected)

**The 2 slot TDMA channel of DMR with a 30 ms slot structure allows for a positioning data update to be sent every 60 ms**

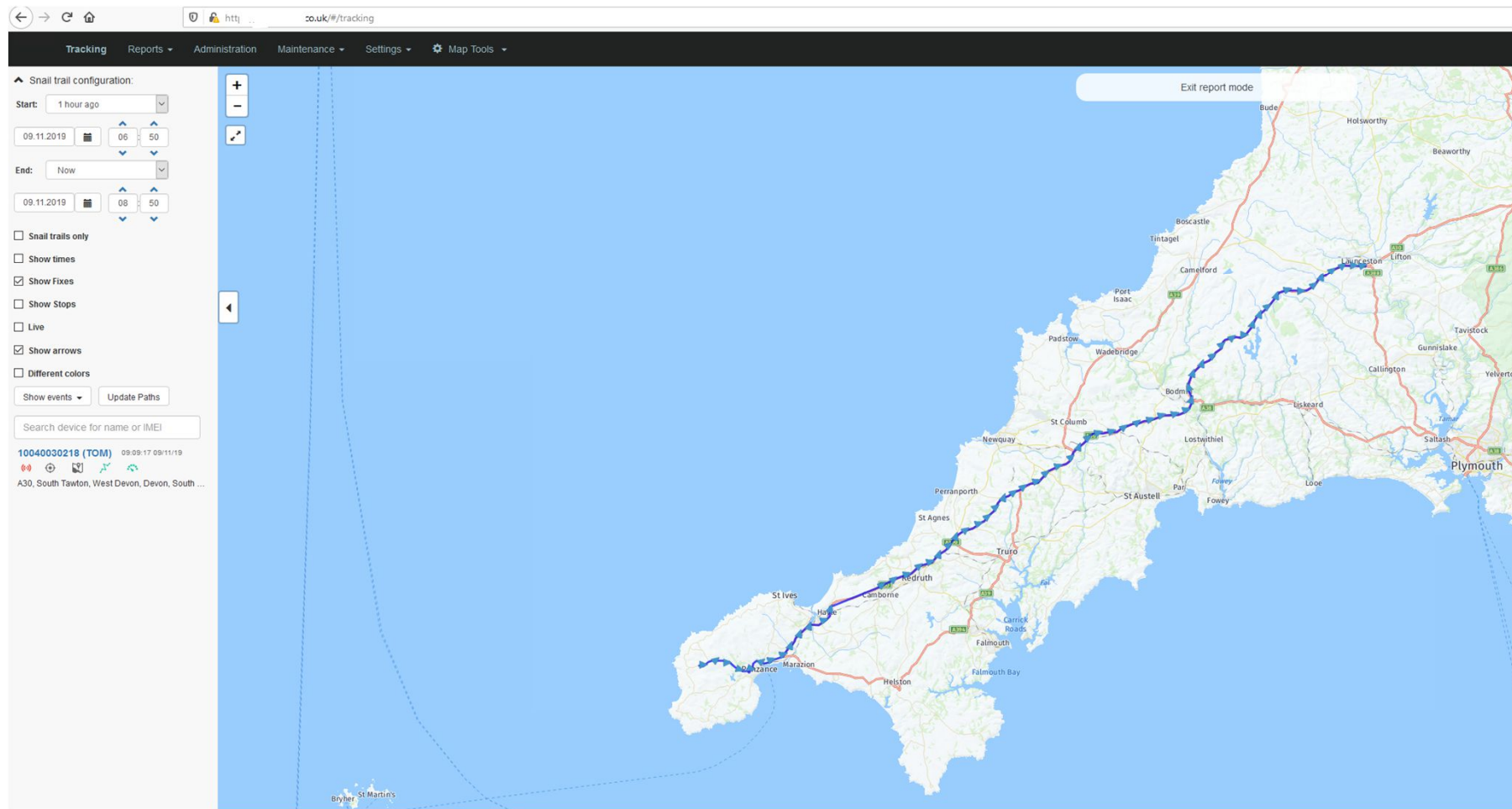
**⇒ up to 1000 radios per minute can be polled using just one Timeslot of the TDMA channel**



# USB-D Polling – LIP Positioning: how it works



# USBD Polling – Example USBD on Tier III network



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# USBD Polling – Example Data

	A	B	C	D	E	F	G
1	Vehicle	Date	Latitude	Longitude	Course	Speed	Address
2	10040030218 (TOM)	09/11/2019 07:20:05	50.1230011	-5.655200005	90	34.09999847	Chimney A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
3	10040030218 (TOM)	09/11/2019 07:20:10	50.12279892	-5.653999805	90	36.70000076	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
4	10040030218 (TOM)	09/11/2019 07:20:15	50.12269974	-5.652999878	67	31.60000038	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
5	10040030218 (TOM)	09/11/2019 07:20:20	50.12269974	-5.652100086	90	34.09999847	Chimney A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
6	10040030218 (TOM)	09/11/2019 07:20:25	50.12250137	-5.650800228	90	36.70000076	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
7	10040030218 (TOM)	09/11/2019 07:20:30	50.12229919	-5.649700165	90	34.09999847	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
8	10040030218 (TOM)	09/11/2019 07:20:35	50.12229919	-5.648600101	67	35.40000153	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
9	10040030218 (TOM)	09/11/2019 07:20:46	50.12269974	-5.646299839	45	41	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
10	10040030218 (TOM)	09/11/2019 07:20:51	50.12319946	-5.645199776	45	44.20000076	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
11	10040030218 (TOM)	09/11/2019 07:20:56	50.12369919	-5.644000053	45	44.20000076	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
12	10040030218 (TOM)	09/11/2019 07:21:06	50.12469864	-5.641900063	22	39.5	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
13	10040030218 (TOM)	09/11/2019 07:21:11	50.12530136	-5.640999794	45	36.70000076	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
14	10040030218 (TOM)	09/11/2019 07:21:21	50.12609863	-5.639400005	45	36.70000076	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
15	10040030218 (TOM)	09/11/2019 07:21:26	50.12659836	-5.638500214	45	34.09999847	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
16	10040030218 (TOM)	09/11/2019 07:21:31	50.12720108	-5.637599945	45	35.40000153	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
17	10040030218 (TOM)	09/11/2019 07:21:36	50.12749863	-5.636799812	67	36.70000076	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
18	10040030218 (TOM)	09/11/2019 07:21:41	50.12770081	-5.635700226	45	38.09999847	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
19	10040030218 (TOM)	09/11/2019 07:21:46	50.12810135	-5.634300232	45	41	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
20	10040030218 (TOM)	09/11/2019 07:21:56	50.12870026	-5.631700039	67	42.59999847	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
21	10040030218 (TOM)	09/11/2019 07:22:01	50.12910008	-5.63049984	45	44.20000076	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
22	10040030218 (TOM)	09/11/2019 07:22:11	50.12979889	-5.627999783	67	32.79999924	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
23	10040030218 (TOM)	09/11/2019 07:22:16	50.12969971	-5.626900196	90	36.70000076	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
24	10040030218 (TOM)	09/11/2019 07:22:21	50.12960052	-5.625899792	112	31.60000038	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
25	10040030218 (TOM)	09/11/2019 07:22:26	50.12939835	-5.624800205	90	35.40000153	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
26	10040030218 (TOM)	09/11/2019 07:22:31	50.12950134	-5.623600006	67	38.09999847	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
27	10040030218 (TOM)	09/11/2019 07:22:36	50.12950134	-5.622399807	67	39.5	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
28	10040030218 (TOM)	09/11/2019 07:22:41	50.12950134	-5.621399879	67	41	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
29	10040030218 (TOM)	09/11/2019 07:22:46	50.12950134	-5.619800091	67	41	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
30	10040030218 (TOM)	09/11/2019 07:22:51	50.12960052	-5.618599892	67	34.09999847	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
31	10040030218 (TOM)	09/11/2019 07:22:56	50.12960052	-5.6177001	90	34.09999847	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
32	10040030218 (TOM)	09/11/2019 07:23:01	50.12939835	-5.61619997	90	44.20000076	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
33	10040030218 (TOM)	09/11/2019 07:23:06	50.12929916	-5.614799976	90	45.90000153	A3071 St. Just Jericho Cornwall South West England England TR19 7QX UK
34	10040030218 (TOM)	09/11/2019 07:23:16	50.12900162	-5.612100124	90	38.09999847	A3071 Sancreed Lower Bodina Cornwall South West England England TR20 8QH UK
35	10040030218 (TOM)	09/11/2019 07:23:21	50.12910008	-5.610899925	67	38.09999847	A3071 Sancreed Lower Bodina Cornwall South West England England TR20 8QH UK
36	10040030218 (TOM)	09/11/2019 07:23:31	50.12910008	-5.608500004	90	31.60000038	A3071 Sancreed Lower Bodina Cornwall South West England England TR20 8QH UK
37	10040030218 (TOM)	09/11/2019 07:23:36	50.12900162	-5.607699871	90	27.20000076	Telephone Box A3071 Sancreed Newbridge Cornwall South West England England TR20 8 UK
38	10040030218 (TOM)	09/11/2019 07:23:41	50.12900162	-5.606800079	90	26.20000076	A3071 Sancreed Newbridge Cornwall South West England England TR20 8 UK
39	10040030218 (TOM)	09/11/2019 07:23:46	50.12889862	-5.605999947	90	26.20000076	The Fountain Inn A3071 Sancreed Newbridge Cornwall South West England England TR20 8 UK
40	10040030218 (TOM)	09/11/2019 07:23:51	50.12870026	-5.605199814	90	28.29999924	The Fountain Inn A3071 Sancreed Newbridge Cornwall South West England England TR20 8 UK
41	10040030218 (TOM)	09/11/2019 07:23:56	50.12860107	-5.604300022	90	28.29999924	A3071 Sancreed Newbridge Cornwall South West England England TR20 8 UK
42	10040030218 (TOM)	09/11/2019 07:24:01	50.12850189	-5.603499889	90	29.29999924	A3071 Madron Newbridge Cornwall South West England England TR20 8 UK
43	10040030218 (TOM)	09/11/2019 07:24:06	50.12829971	-5.602399826	90	31.60000038	A3071 Madron Newbridge Cornwall South West England England TR20 8 UK
44	10040030218 (TOM)	09/11/2019 07:24:11	50.1283989	-5.601399899	67	31.60000038	A3071 Madron Tremayne Cornwall South West England England TR20 8QH UK
45	10040030218 (TOM)	09/11/2019 07:24:17	50.1283989	-5.600599766	90	31.60000038	A3071 Madron Tremayne Cornwall South West England England TR20 8QH UK
46	10040030218 (TOM)	09/11/2019 07:24:27	50.12779999	-5.59829998	112	32.79999924	A3071 Madron Tremayne Cornwall South West England England TR20 8QH UK
47	10040030218 (TOM)	09/11/2019 07:24:37	50.12739944	-5.596300125	112	35.40000153	A3071 Madron Tremayne Cornwall South West England England TR20 8QH UK
48	10040030218 (TOM)	09/11/2019 07:24:42	50.12689972	-5.595399857	112	32.79999924	A3071 Madron Tremayne Cornwall South West England England TR20 8QH UK
49	10040030218 (TOM)	09/11/2019 07:24:47	50.12659836	-5.594500065	112	35.40000153	A3071 Madron Tremayne Cornwall South West England England TR20 8QH UK
50	10040030218 (TOM)	09/11/2019 07:24:52	50.12620163	-5.593500137	112	36.70000076	A3071 Madron Tremayne Cornwall South West England England TR20 8QH UK
51	10040030218 (TOM)	09/11/2019 07:24:57	50.12580109	-5.592199802	112	38.09999847	A3071 Madron Tremayne Cornwall South West England England TR20 8QH UK
52	10040030218 (TOM)	09/11/2019 07:25:07	50.12480164	-5.590600014	135	41	A3071 Madron Tremayne Cornwall South West England England TR20 8QH UK
53	10040030218 (TOM)	09/11/2019 07:25:12	50.12400055	-5.58949995	135	44.20000076	A3071 Madron Tremayne Cornwall South West England England TR20 8QH UK
54	10040030218 (TOM)	09/11/2019 07:25:17	50.12340164	-5.588600159	135	44.20000076	A3071 Madron Tremayne Cornwall South West England England TR20 8QH UK

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## Emergency Pre-emptive Call: how it works

- The system may force an existing non-emergency call to be prematurely cleared down, if a payload channel is not available at the time an Emergency Pre-emptive Call is initiated. The TSCC is then able to connect the Emergency Pre-emptive Call on that payload channel.
- Reverse Channel signalling is used to free the payload channel (PTT De-key), if one of the radios in the call is transmitting (PTT pressed).

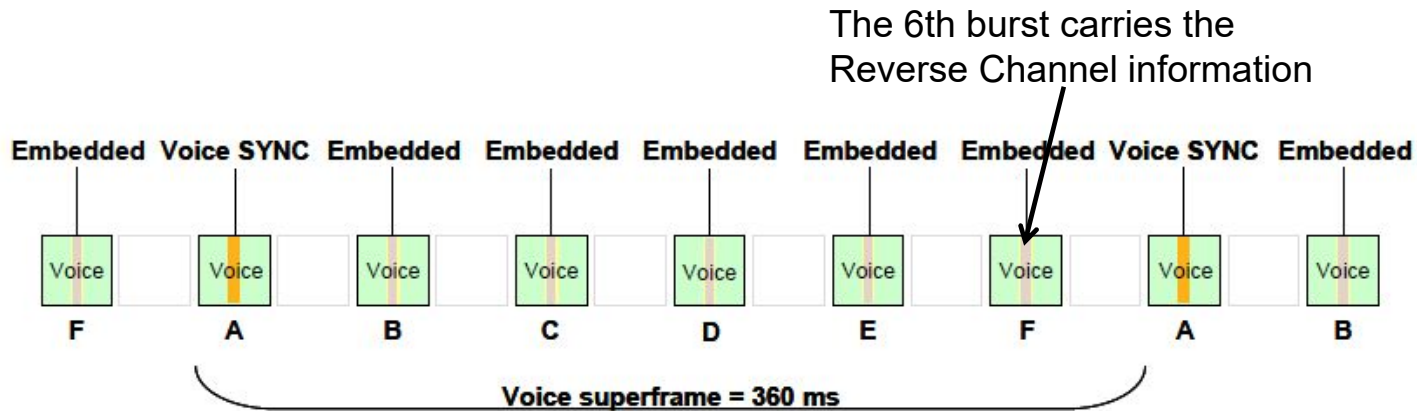
## DMR Tier III: Emergency Pre-emptive Call: how it works

A transmitting MS has some time to sample the signaling in the slot after the slot it has transmitted it in.

For example if the MS is transmitting in Slot 2, it will have some time to detect signaling in Slot 1 before it starts to transmit again in Slot 2. This is called Reverse Channel Signalling.

The outbound bursts, which carry the traffic for call "A", contain SYNC or embedded signalling data, see picture below, as dictated by the content of call "A", except for every 6th burst which carries the Reverse Channel information for call "B", when needed.

The radio transmitting in call "B" in the same physical channel as call "A" can revert to reception, listen to this Reverse Channel information, stop transmitting and free the channel.



- Talkgroup Subscription allows an MS to inform the TSCC of a particular talkgroup of interest.
- The TSCC can make use of this information, when setting up a talkgroup call
- Network then only includes radio sites that contain subscribed MS units.
- This results in optimized system frequency usage and better grade of service, as the call is not set-up on radio sites that do not contain subscribed MS units.

- Talkgroup attachment is a process to ensure that when an MS selects a talkgroup to use, the MS is authorized to use it and the network knows the MS individual address that is affiliated to that group.
- When the MS user selects a talkgroup to use, the talkgroup ID attachment procedure enables MS and the TSCC to exchange information about the currently attached talkgroup identities in the MS
- Until a talkgroup attach procedure has completed successfully that talkgroup group is not available to the MS.
- An MS may attach to one or more talkgroups.
- The MS may attach talkgroup identities when it initially registers with a TSCC.
- The MS may also later initiate the attachment procedure by another registration procedure (perhaps to add another talkgroup).
- (Except for the the permanently held talkgroups) an MS shall only be included in a talkgroup call if the MS has previously successfully attached using the procedures in this clause.

- The DMRA manages an interoperable voice and data encryption scheme for DMR.
- 40 Bit ARC4, 64 bit DES, 128 and 256 bit AES options.
- Interoperable between manufacturers
- Supports Late Entry
- Multiple Keys
- No discernible degradation of voice quality



## Further Features

- Possibility of implementing specific encryption algorithms
- Application Interface Specification (AIS - Introduced and managed by the DMR Association, Issue 1.5 about to be published)
- Flexibility to introduce new and/or proprietary features
- Database queries
- SCADA

Included in TS 102 361-4 V1.10.1 there is now a normative requirement for all MS units to be able to address all other MS units.

From Annex G of the standard:

- *To ensure interoperability between different manufacturers MS, each MS shall be capable of calling all valid IDs within the DMR addressing range.*
- *The full requirement is:*
  - *1) the ability to personalise an MS terminal with MS addresses (see clause 4.3) that may be anywhere within the addressable range 000 001 to 16 776 415;*
  - *2) the ability to address a called party (individual or talkgroup) for all call services supported by the MS within the addressable range 00 000 001 to 16 776 415; and*
  - *3) if supported by the MS, the ability to address ALLMSIDL (16 777 213), ALLMSIDZ (16 777 214), ALLMSID (16 777 215).*

## Application development on DMR technology

- Community of 100's of application developers who are developing vertical market and customer specific applications



## DMR as a more sophisticated business tool

The feature set of DMR Tier III has grown significantly over the passed couple of years.

We believe that the combination of radio link performance, set of functions, number of suppliers and simplicity makes DMR the first choice for business critical mobile radio applications.



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**Thank you!**

**For more info:**

**<https://dmrassociation.org>**