

DMR (DIGITAL MOBILE RADIO)

Release 6.8.1 of WAVECOM's decoding software includes a new digital mode, DMR, designed for land mobile services. In Asia the mode is also known as XiR.

Introduction

In the ever ongoing effort to squeeze more capacity out of a finite resource, the electro-magnetic spectrum, a new digital standard, Digital Mobile Radio (DMR) is emerging. Whereas the older analogue PMR (Private Mobile Radio) requires 25 kHz channels or for newer systems 12.5 kHz, DMR offers two channels within 12.5 kHz. DMR offers both voice and data communications and interfacing to external networks. Voice communications offer features as call alert, emergency call, remote monitoring, silent worker, Push-to-Talk ID, radio check, all call, stunning etc.

Architecture

DMR has been standardized by ETSI. The standard describe three tiers of DMR,

- Tier I: Direct mode communication without infra-structure
- Tier II: Direct mode and base station repeater
- Tier III: Trunking with a controller managing communications, including simulcast and multicast

To distinguish between adjacent and repeater stations with overlapping coverage, DMR introduces the concept of Color Code.

Interlinking of repeaters or base stations is outside the scope of the ETSI standard, but Motorola's implementation of DMR called Mototrbo allows this feature using an ordinary IP connection.

Protocol stack

The DMR protocol stack is shown in fig.1.

The air interface physical layer is responsible for,

- modulation and demodulation
- transmitter and receiver switching
- HF characteristics
- bits and symbol definition
- frequency and symbol synchronization
- burst building

DMR uses 4FSK modulation at 4800 symbols/second with the dibits mapped to +1944 Hz, +648 Hz, -648 Hz and -1944 Hz in relation to the center frequency.

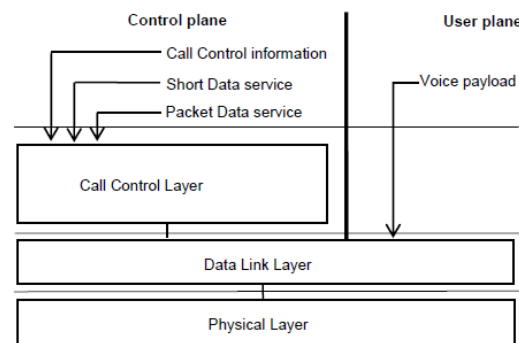


Fig. 1 DMR protocol stack

The data link layer main functions are,

- channel coding
- media access control
- link addressing
- interfacing of voice
- data bearer services
- acknowledgement mechanisms
- interleaving

The third layer is the call control layer in the control plane which provides,

- base station activation and deactivation
- call setup, maintenance and tear-down
- destination addressing
- built-in services (pre-emption, emergency signaling, etc.)
- data call control
- announcement signaling

DMR supports 2-channel TDMA (Time Division Multiple Access). In fig. 2 below the outbound (from a base station) is labeled "BS TX" and the inbound (from a mobile station) "MS TX". Each burst is 30 ms long. Two bursts constitute a frame and 6 frames constitute a super frame used for voice transmissions.

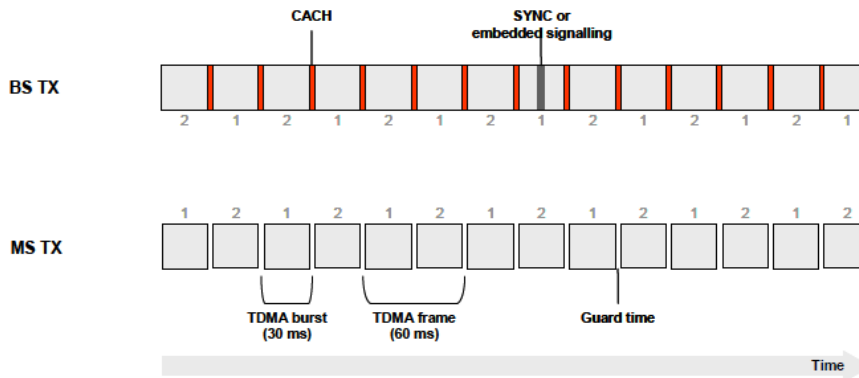
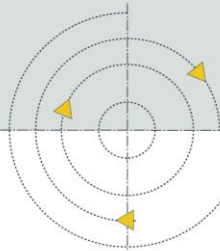


Fig. 2 Two- frequency TDMA timing

The outbound channel is continuously transmitted when the BS (Base Station) is active, whereas the MS (Mobile Station) will stop transmission when it has no more traffic to transmit. The outbound channel contains a Common Announcement Channel (CACH), between individual bursts, used for traffic channel management and

signaling. The inbound channel has an empty guard time between the bursts to allow for propagation delays. Finally a synchronization or signaling field is embedded in the centre of the burst. The BS and MS burst and frame structures are shown in fig. 3, fig. 4 and fig. 5.

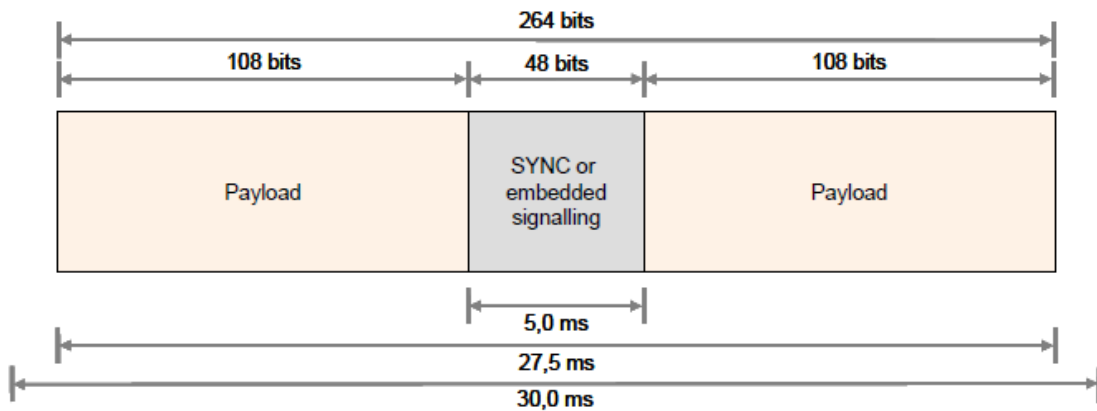


Fig. 3 BS burst

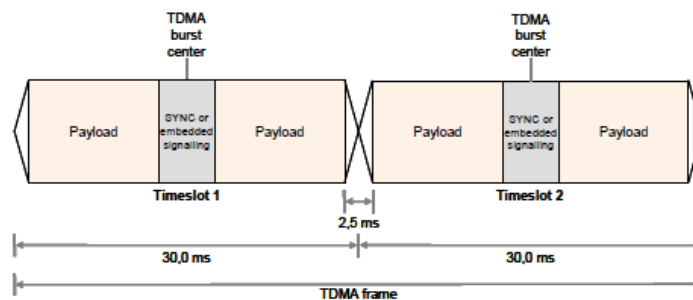


Fig. 4 MS bursts

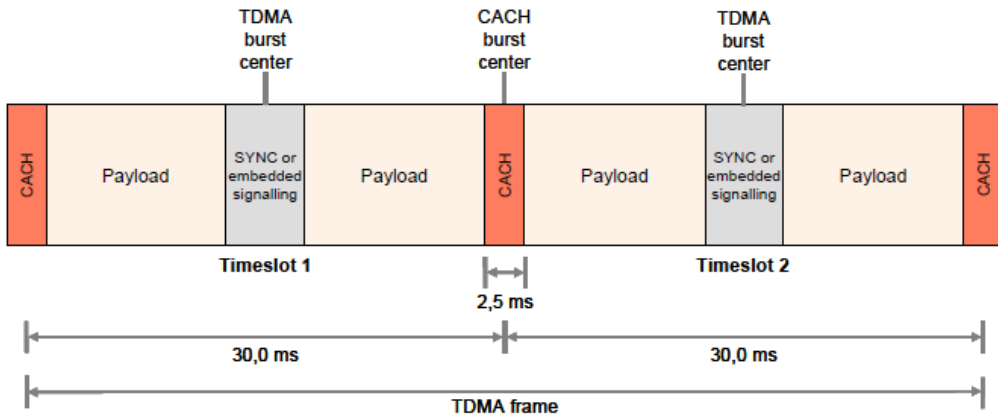
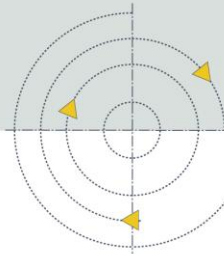


Fig. 5 BS frame structure

DMR also supports a Reverse Channel (RC) which is used for signaling. In the outbound direction the RC replaces the burst center sync field, whereas in

the inbound direction a special short burst is used, see fig. 6.

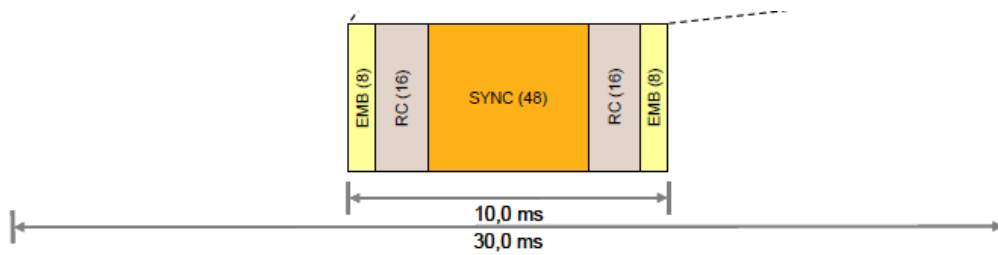


Fig. 6 RC burst structure

For voice transmissions a super frame of use several burst and timeslots, see fig. 7. The individual voice bursts are labeled from A to F.

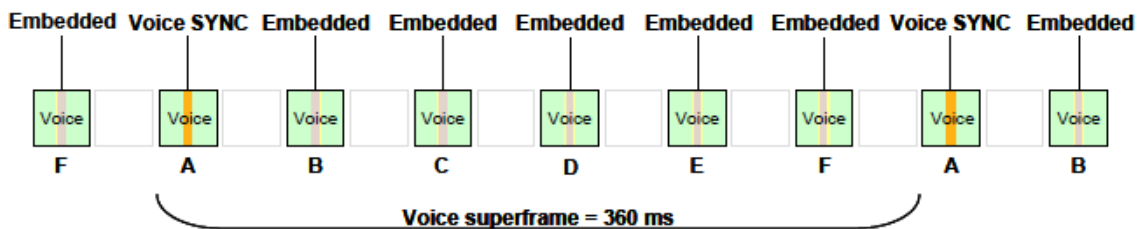


Fig. 7 Voice format

DMR also has the ability for text messaging using either the Short Data Service, a SMS-like function or IP datagram's, see fig. 8. The ability to use IP facilitates the integration with other IP networks. A DMR terminal has its own IP

address and contains a DHCP server, which allocates IP addresses to peripheral devices. These devices often connect physically via a USB connector.

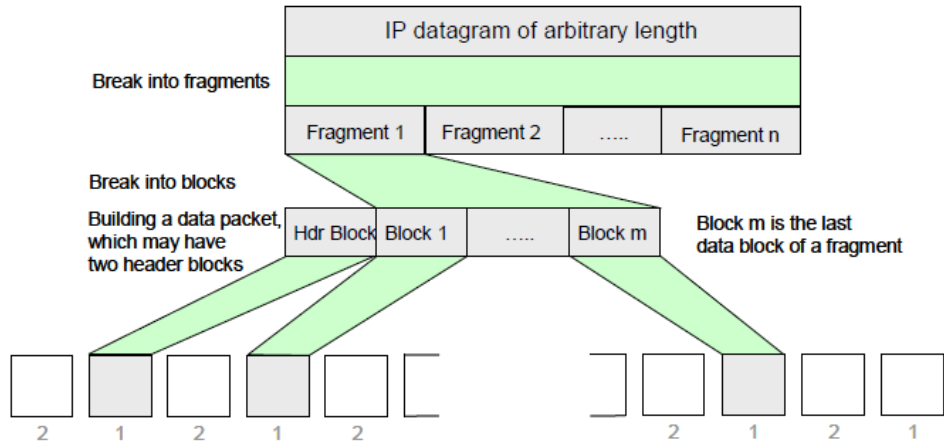
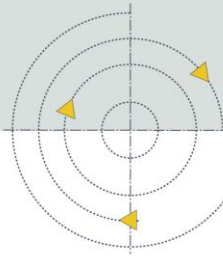


Fig. 8 Fragmentation of IP datagram

Implementation

The current WAVECOM implementation of DMR is limited to Tier II "Direct Mode", but will decode text as well as voice communication. Voice is decoded

and output in real-time and the most recent voice call is saved to a WAV file. Fig. 9 below shows a decoded DMR data test transmission.

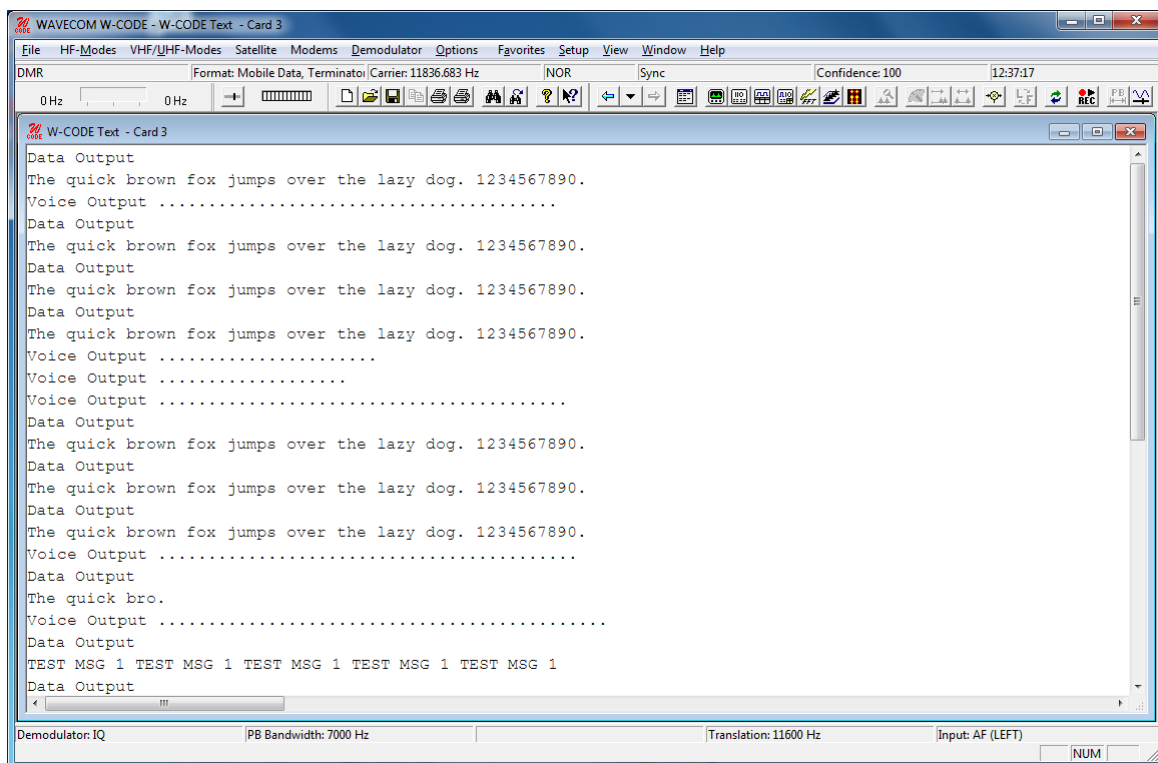


Fig. 9 Decoded DMR data output

References:

Structure and timing diagrams have been borrowed from ETSI TS 102-361, which is the standard governing DMR.