MOTOROLA

REGULATORY WHITE PAPER

FOR

ETSI DMR COMPLIANT SYSTEMS

MAY 2007

Introduction to DMR

DMR (which stands for "Digital Mobile Radio") is an ETSI Air Interface standard which was approved and published by ETSI in March 2005. The DMR standard itself (ETSI TS 102 361) is split into three tiers as follows:

- **Tier 1**: An unlicensed standard which provides a digital alternative to analogue PMR446. A new band of licence-exempt frequencies has been identified for DMR Tier 1 solutions (446.1 – 446.2MHz) but is not yet available in many countries. DMR Tier 1 specifies low power (500mW), an integral antenna and is restricted to the licence-exempt frequency band.
- **Tier 2**: A licensed conventional (i.e. non-trunking) standard which provides a digital migration path for the core of Motorola's professional analogue two-way business serving the vast majority of our customers.
- **Tier 3:** A licensed trunking standard which was originally targeted at providing a digital migration path for the existing analogue MPT1327 solution.

MOTOTRBO™ and DMR

MOTOTRBO™ is Motorola's new digital professional two-way conventional radio solution which conforms to the ETSI DMR Tier 2 standard. Although Motorola supported the DMR standardisation work to define all Tiers of the DMR standard, we do not believe that Tiers 1 and 3 warrant product development investment in the short-term.

Analogue Coexistence

The ETSI DMR standard group recognised the fact that RF spectrum is a scarce commodity and so DMR was specifically designed from the onset to coexist with legacy analogue professional two-way radio systems. The DMR standard itself defines a protocol which fits into existing 12.5kHz channel rasters and complies with existing RF specifications and regulatory requirements (e.g. EN 300-113). Furthermore, the DMR standard defines extremely flexible channel access rules which enable DMR systems to be "polite" or "impolite" to other digital and analogue systems. This flexibility enables DMR systems (radios and repeaters) to be configured such that they will refrain from transmitting when analogue transmissions are already present on the channel.

In summary, DMR systems (radios and repeaters) can be deployed onto 12.5KHz channels where legacy analogue systems are already operational and the two technologies will coexist. DMR therefore fits seamlessly into the existing licensed 12.5KHz PMR bands without the need for re-banding or re-licensing and there is no risk of new forms of radio channel interference.

Interference Considerations

Since DMR complies with existing RF specifications and regulatory requirements there are no RF interference issues associated with deploying DMR digital systems on bands and channels where legacy analogue systems are already deployed.

However, its important to note that where DMR digital and legacy analogue systems coexist on the same channels, then the legacy analogue systems need to employ signal detection mechanisms such as CTCSS/DCS and/or 5-tone in order to prevent unwanted activation by digital transmissions (for example, an analogue radio employing only carrier squelch will un-mute to digital transmissions, and "annoying noise" will be heard through the speaker, while an analogue radio employing

CTCSS/DCS and/or 5-tone signalling will not un-mute to such digital transmissions). For regulators, this should only ever be of concern on channels where there is risk of interference from other licencees (e.g. on shared channels). However, users on such channels where interference is an issue should already be employing CTCSS/DCS signalling anyway.

From a digital perspective, analogue transmissions will not activate DMR systems since DMR systems always employs sophisticated over-air signalling.

DMR Spectrum Planning and Reuse

DMR utilises the proven TDMA method of improving the spectral efficiency of a 12.5kHz channel by dividing the channel into two equal time slots. This preserves the well-known RF performance characteristics of the 12.5kHz signal while at the same time allowing many more people to communicate over the 12.5KHz channel. By preserving the RF performance characteristics, the distance over which the 12.5KHz signal propagates remains unchanged which means that existing analogue spectrum planning and reuse modelling still applies. However, it is very important to note that the DMR signal incorporates error-correction techniques which enable a much better quality of service compared to analogue over a greater part of the RF coverage area.

Shared Channels

Today, many EU regulators assign CTCSS/DCS tones to analogue PMR licences in order to separate multiple licencees on shared channels. CTCSS/DCS tones however are an analogue form of signalling which do not apply to digital protocols such as DMR. Instead, DMR provides a 4-bit “colour code” which is used to separate multiple licencees on shared channels. However the DMR "colour code” is not a direct digital equivalent of the analogue CTCSS/DCS tone. Analogue CTCSS/DCS tones are used both to separate multiple licencees on shared channels AND to enable limited selective calling. DMR "colour codes" on the other hand are used only to separate multiple licencees on shared channels (for selective calling, DMR provides an immensely more capable 24-bit addressing scheme). For this reason, only a single DMR “colour code” needs to be assigned per licencee which means that DMR does NOT need to support nearly so many unique "colour codes" as there are CTCSS/DCS tones.

In summary, the regulatory requirement to avoid interference to users’ communications that prompted tone codes for legacy analogue systems is met by the “colour code” for DMR digital systems.

Channel Licensing

The regulatory environment for MOTOTRBO has been in place for some time now following the Europe wide ECC Decision 06(06) in 2006 which makes provision for the deployment of narrow band digital (specifically DMR) equipment into existing analogue PMR bands (mid-band, VHF and UHF). However, its important that EU regulators are aware of and implement this EEC decision in their respective countries. From the information contained in this white paper it should be apparent that regulators do not need to clear existing bands of incumbent analogue users before implementing this ECC decision because DMR systems are able to coexist with legacy analogue systems. However, when granting new “digital” licences (or converting existing “analogue” licences) for DMR systems on shared channels, if the regulator wishes to separate the different “digital” licencees on that channel, then the regulator needs to assign a single DMR colour code (in the range 0 to15) to each “digital” licencee on the channel.