
DRM in the FM Band for Australian Communities

Introduction

The Digital Radio Mondiale Consortium welcomes the ACMA consultation on the Australian community radio's transition path to digital radio and the wish to give community stations a digital future rather than leave them as second class, analogue stations. After all, localism is one of the great advantages of audio broadcasting.

The international, not-for-profit DRM Consortium acknowledges the need to respect the legislative requirements and to use the existing multiplex infrastructure existent in parts of Australia. It also understands that there is an allocation of two-ninths of digital radio multiplex transmitter capacity for the digitisation of community stations in keeping with the stated "deeming principles".

These three principles create a tight framework, "a size fits all" type of solution that seems to us to start from the needs of the stations already on multiplexes and maybe less so from the needs of the community stations themselves. This is a size that squeezes in a very diverse reality:

1. The Department of Communications has specified that a Category 1 DAB+ licence is divided into 9 blocks, 7 for commercial broadcasters and 2 shared between city wide community broadcasters. This is also called a multiplex. Commercial Radio Australia has no control over the content of community stations, only ACMA does. Commercial Broadcasting Australia's subsidiaries own all Category 1 transmitters who charge community broadcasters for access to the transmitter.
2. DAB+ multiplexes are only available in the capital cities + Mandurah WA. Community broadcasters have been allocated 256 kbit/s on each transmission site by the ACMA. Many community broadcasters are using 32 kbit/s audio using the less efficient HE-AAC V2 compression, which gives poorer sound than the newer xHE-AAC sound compression used by DRM. This means eight sound-only community broadcasters per transmitter. Brisbane, Sydney and Melbourne have a pair of DAB+ transmitters, each enabling 16 sound community broadcasters in those larger cities.
3. As for charges they are set by either BCI Communications or TXA Australia and we assume that 2/9th of the charges is then divided between community broadcasters as per their bit rate (bit/s)/256 used per transmitter.
4. The use of DAB+ channels is an advantage because it gives whole capital city coverage at high power from tall towers and via repeaters. However, DAB+ is a poor choice for country areas because the number of commercial and community broadcasters able to share the transmission costs is greatly reduced.
5. There are only about 8 DAB+ transmission channels available and this has left 54 community broadcasters in capital cities unable to get access to the existing DAB+ transmission channels. High powered DAB+ and TV transmissions on channels 6 -12 must be separated by 336 km.
6. In addition, there are 349 country community broadcasters which are yet to be given the opportunity to convert to any form of digital radio.

The overarching principles as described in the ACMA document seem to be the population overlap, followed by the geographical overlap, with undue importance given to the population overlap. It seems that, the higher the overlap, the better the chances of accessing a multiplex are, though the table included shows that the highest number of community licenses and services are where the overlap is currently lowest, around 25%.

This is not surprising, since the very nature of community stations is to fill in the gaps, to offer that special content in the language required by a community. If anything, it is the very antithesis of commercial radio which wants to reach the maximum number of people for impact and ad sales.

Recommendations

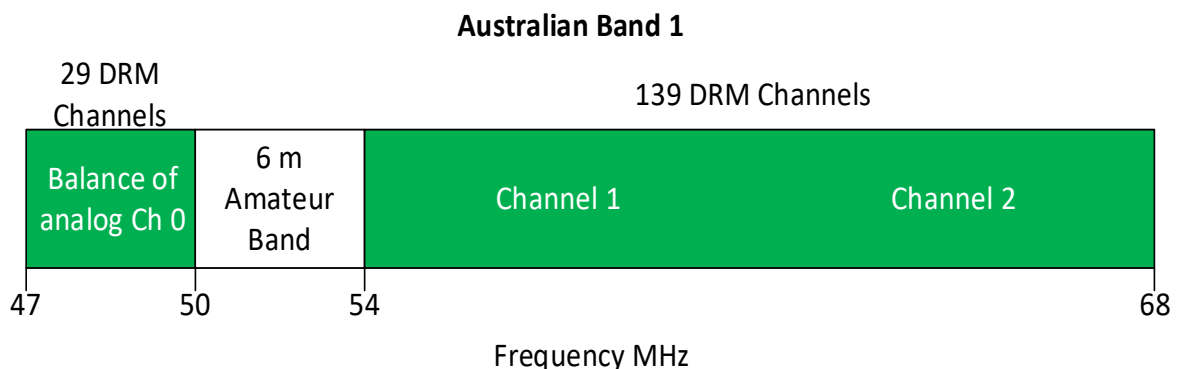
To even out the playing field, between city and country, the 40 community simulcasts on DAB+ in capital cities should cease leaving only DAB+ which has been on air for 11 years. This will reduce those broadcasters' costs.

There are 402 community broadcast transmitters which are yet to see digitisation. These transmitters should be on DRM for the reasons outlined below. Their licence area should be determined by their population distribution and not by interference limitations through the lack of DAB+ channels and the large signal losses through the air.

1. Therefore, the DRM Consortium would like to suggest that ACMA considers DRM as the ideal solution for digitising the community stations, on its own, or in conjunction with the multiplex solution, if so required. DRM has truly clear advantages for local and community stations:

The DRM digital broadcasting standard supports **all VHF bands** including the FM band.

In Australia we understand that all of Band III is used for TV and DAB+. ACMA say that the FM band is already full, which is preventing much of the AM country stations converting to FM. With conversion of TV to digital 40 TV transmitters left 47 – 68 MHz band which was occupied by analogue TV channels 0 – 2. An analysis of two-way radio manufacturers failed to find any transceivers manufactured for this frequency range. As a result, this band is unused and could also be used for DRM.



(An interesting fact is that there are 168 x 100 kHz wide channels available above compared to the 102 x 200 kHz wide FM band 2 channels. This leaves existing FM transmissions untouched and there are no power reductions for adjacent channel interference).

DRM has been developed specifically for allowing broadcasters to serve their individual target audiences in their defined and often unique coverage areas in one or several languages, while co-existing peacefully and without any interference with existing analogue FM services during the transition period. This DRM flexibility cannot be replicated by any other digital radio standard today.

2. DRM is a perfect standard for digitising FM services, keeping broadcasters in full control of their transmission infrastructure and optimised for the broadcaster's individual coverage needs. DRM therefore allows introducing digital radio services while maintaining full compatibility with established business models. DRM's advanced features revolutionise the radio experience for listeners, allowing broadcasters to develop new revenue streams and to intensify listener engagement.

3. DRM offers Value for Money as there are minimum costs for maximum advantages: no spectrum costs, savings on capex and opex, as the existing infrastructure can be upgraded and made to work in efficient multiplex mode. There are energy consumption savings and the flexibility and quality of audio and multimedia services that future-proofs and drives forward the community stations.

Why Consider DRM? A Closer Look

The DRM terrestrial radio broadcasting standard has been specifically designed as a high-quality digital replacement for current analogue radio broadcasting in **all the frequency bands**, from the **AM to the FM/VHF bands**; as such it can be operated with the same channelling and spectrum allocations as the former analogue transmissions. The simulcast option allows for a smooth transition from analogue to an all-digital DRM broadcast.

The DRM standard caters for **all coverage needs**:

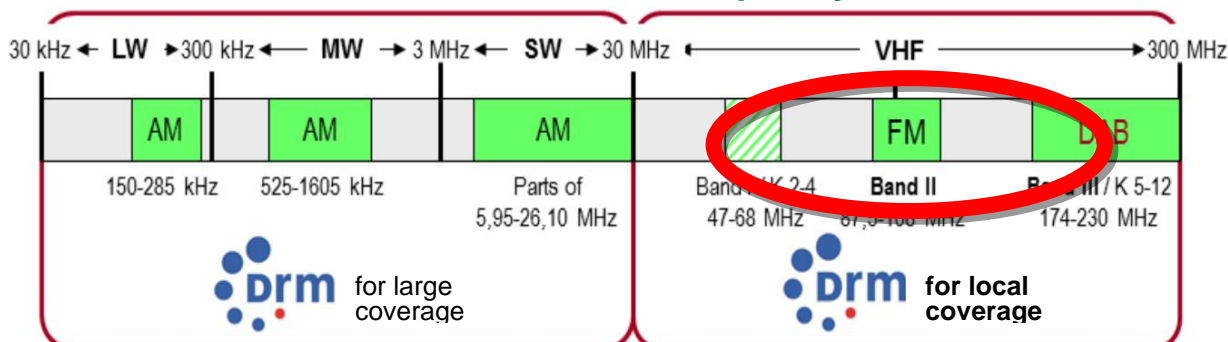
a. DRM for large-area coverage

DRM operates in all the AM bands below 30 MHz, including medium and shortwave support. (Remote community broadcasters would get a larger coverage area by using the 2.3 – 5 MHz high frequency band, which gives better sound than existing medium frequency AM.)

b. DRM for localised and regional services

DRM operates equally well in the VHF bands I, II and III. This enables flexible localised digital-FM services. DRM provides enough capacity for up to 3 stereo programmes plus multimedia components within half the bandwidth formerly required for a single analogue FM service. During a transition period, new DRM digital-FM services can easily co-exist in the FM band, without affecting analogue FM services.

DRM – the standard for all frequency bands



DRM IN THE FM Band

The ITU-endorsed DRM digital radio broadcasting standard supports the FM Band and where applicable the VHF Band III. It offers an exciting opportunity for digitising radio broadcasters like the community stations.

Each DRM transmission signal has a bandwidth of just 96 kHz. Within this bandwidth – which is only half of the bandwidth of an analogue FM service – DRM can provide up to three high quality stereo radio services plus multimedia components, such as Journaline interactive and multilingual text, slideshow services (like news images) and EWF emergency warning functionality (see below). DRM supports Unicode natively and thus is prepared for all international languages and scripts.

It has been positively established that the DRM digital radio transmission signals can be inserted in the guard-bands between two analogue FM radio carriers (each analogue FM slot requiring 200kHz bandwidth able to carry only one single audio programme), without disturbing or impacting operation of the ongoing analogue FM radio services, even in big cities.

It has been clearly established that, even in the existing congested frequency spectrum in the FM band, DRM digital radio services can well be added and operated without any interference. This allows the enhancement of the FM band capacity, even in scenarios where there is currently not enough space for a single additional analogue FM service.

With the addition / insertion of DRM services in the FM band, there will be no additional constraints on the channel allotment. As the white spaces between the currently assigned analogue channels are comparatively wide (with respect to a 96 kHz DRM slot), the DRM transmission signal can be inserted in the FM band with a lot of flexibility.

In addition, in each FM service area, one can make use of the 'prohibited' channels for inserting one or multiple DRM services, while meeting all the co- and adj-channel protection ratios. This will add substantially to the radio services capacity of the service areas and will certainly offer channels to community stations without fear of losing listeners or being in competition with the commercial stations. This solution does not impact on the on-going analogue FM services. On the other hand, this solution provides existing and new broadcasters with the potential for additional digital quality stereo radio channels and value added services, such as the text service Journaline (news, information, weather, financial, social, health, e-learning, etc.); graphics (to enhance the radio content); and emergency warning functionality.

Every broadcaster is responsible for generating and configuring its own DRM content and transmission signal. **This is ideal for community stations wishing to serve listeners in a specific area.**

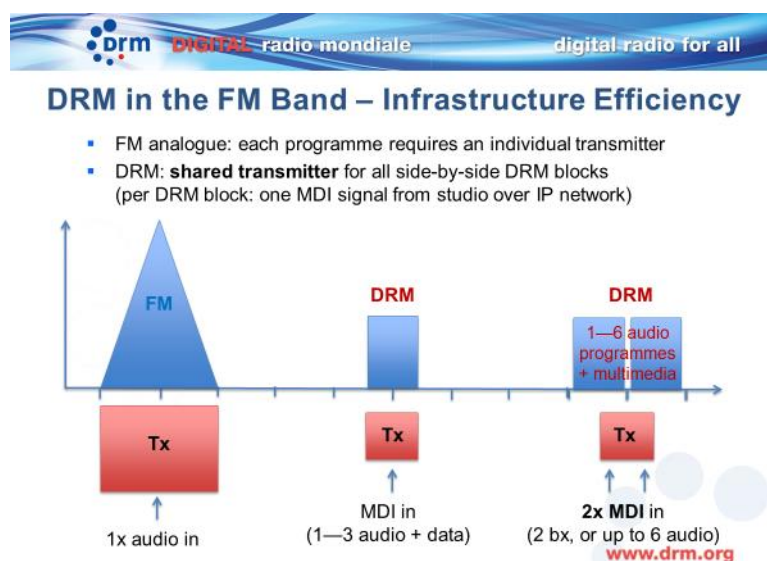
In addition, existing FM transmission sites can be re-purposed, upgraded or enhanced for DRM transmissions, without the need to acquire and establish a whole new transmitter infrastructure and to work out some new network planning.

What should also be noted is that for neighbouring service areas, DRM can operate in SFN configuration ("Single Frequency Networking"), i.e. the same DRM signal being transmitted from several transmitters with overlapping service area on the same frequency. Instead of signal destruction in the overlapping areas – as would be the case for analogue FM services – the DRM signal is enhanced and strengthened in SFN. The SFN technology can be combined with the multiple-DRM-signals-per-transmitter approach, as described earlier.

Furthermore, due to its narrow signal bandwidth, DRM can effectively exploit whitespace between FM allocations while broadcasting at lower power levels to achieve comparable coverage. DRM allows for signal combination on a single transmitter and from one antenna. This in turn allows new channel allocations which are unusable for FM broadcasting or by using traditional channel combiners.

By using a **shared transmission infrastructure**, including a high-power transmitter, many of the benefits of the DAB standard can now be replicated in the FM band when using DRM. Unlike DAB+ however, **broadcasters remain in full control of their own DRM signal**. Since one DRM channel carries two to three audio programmes, a single transmitter could therefore broadcast as many as 18 programmes in pure DRM using 6 consecutive channels which is available in band 1. The ABC/SBS transmitters in country areas could give the same program range as for DAB+ listeners in capital cities. Reception of all DRM sidebands were also demonstrated on a professional DRM modulation monitor which displayed a perfect 16-QAM constellation with better than 40 dB MER.

If bandwidth is available, two DRM signals can be transmitter-combined before injection into a combiner branch. This is illustrated in the next figure.



The ability to freely mix and combine analogue and multiple digital DRM signals with individually varying power levels allows broadcasters, network regulators and frequency

planners a new dimension of planning and operating digital radio networks using established planning parameters for both DRM and FM services. The shared broadcast infrastructure when using DRM leads to important savings. The superior signal propagation characteristics of VHF Band II allows larger geographic coverage using single frequency networks (SFNs) with fewer high-power transmitters compared to other standards' networks.

The new channel allocation described so far can be used to provide (national, regional or **localised** services by SFN (the latter for community stations), grouping individual DRM signals in the extended multiplex. An extended DRM multiplex can be built out with increasing demand, by adding one DRM signal at a time to the same transmitter. Eventually, DRM can provide hundreds of audio and data services in the VHF Band II (FM).



DRM ADVAANTAGES IN DIGITISING COMMUNITY STATIONS

Financial viability in the FM band

DRM FM uses existing analogue FM transmitters, thus reduces Capex drastically

In most cases, the current FM radio operators will be able to use their existing analogue FM transmitter and site for the additional DRM services. This was very well demonstrated in several DRM FM digital radio trials carried out in many countries. This approach reduces the Capex (Capital Expenses) for implementing the DRM FM services to a very small amount.



The table below presents an approximate setup cost.

 DIGITAL radio mondiale digital radio for all			
(a) Typical Setup Cost Scenario – High Power			
	new FM tx on existing FM site	pure DRM tx on existing FM site	DRM upgrade of existing FM tx*
Power level (TX)	10 kW	1 kW	
Transmitter	\$ 40.000	\$ 20.000	\$ 10.000
Mask Filter	\$0	\$ 0	\$ 0
Cooling System	\$ 5.000	\$ 2.000	\$ 0
Antenna & RF Line, Installation	Exists	Exists	Exists
TX Installation	\$ 5.000	\$ 2.000	\$ 2.000
Total site cost (per site)	\$ 50.000	\$ 24.000	\$ 12.000
Studio Head-End (1x for network)	\$ 0	(\$ 20.000)	(\$ 20.000)
No. of programs	1	3	3
Cost per programme & site	\$ 50.000	\$ 8.000	\$ 4.000
 *) Only DRM-capable FM transmitters can be upgraded! www.drm.org			

DRM FM substantially reduces Opex

In addition, DRM allows saving of up to 90% of the transmitted power, as compared to an analogue FM transmission, while still covering the same service area. This,

along with reduced cooling, space and maintenance requirements, results in substantial savings in the Opex (Operational Expenses) for running DRM FM services, particularly if calculated over a full multi-transmitter network and over many years of operation.

 DIGITAL radio mondiale digital radio for all		
(b) Typical Energy Cost – High Power		
<ul style="list-style-type: none"> Energy is stated as largest position of Operational Costs for Broadcaster DRM with significant energy costs savings ! 		
Transmitter	FM	DRM
Power	10 kW	1 kW
Efficiency	72 %	50 %
Energy consumption per Transmitter	13.9 kW	2 kW
Annual Energy Bill per Transmitter	18 250 USD	2 640 USD
Programmes per Transmitter	1	3
Annual Energy Bill per Programme	18 250 USD	880 USD
Assumes 0.15 USD per kWh		
 www.drm.org		

Economic case Analysis: Capex and Opex

As can be understood from the information provided above, the financial aspects of implementing DRM digital radio broadcasting services in the FM band are quite favourable. The main reasons are:

1. The cost of implementation is quite low. As shown in the example given above, cost per programme (channel) is

- USD 4000.00 for an upgraded transmitter (using the existing FM transmitter)
- USD 8000.00 for a new digital transmitter

On top, these transmitters could each be shared by multiple broadcasters transmitting their individual DRM signals side-by-side (without the need for FM band combiners).

2. The typical annual energy costs (as representative of the Opex costs) are also quite low. As shown in the example given above, cost per programme (channel) is

- USD 880.00 as annual energy costs for a DRM digital radio transmitter
- USD 18250.00 as annual energy costs for an analogue FM radio transmitter with the same coverage.

This saving is particularly significant if scaled to a multi-transmitter network, over many years of operation.

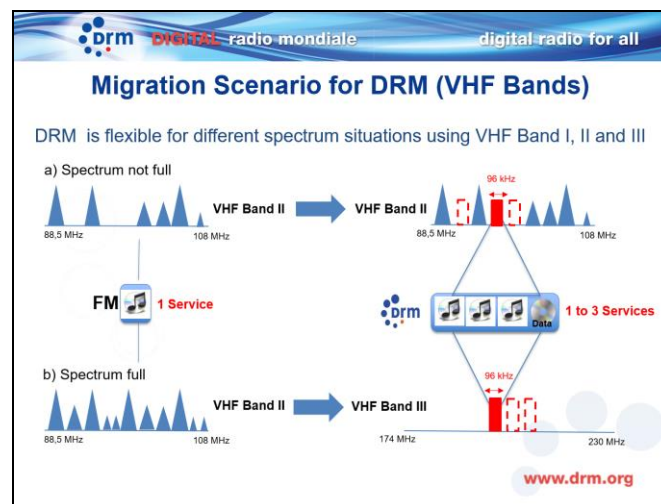
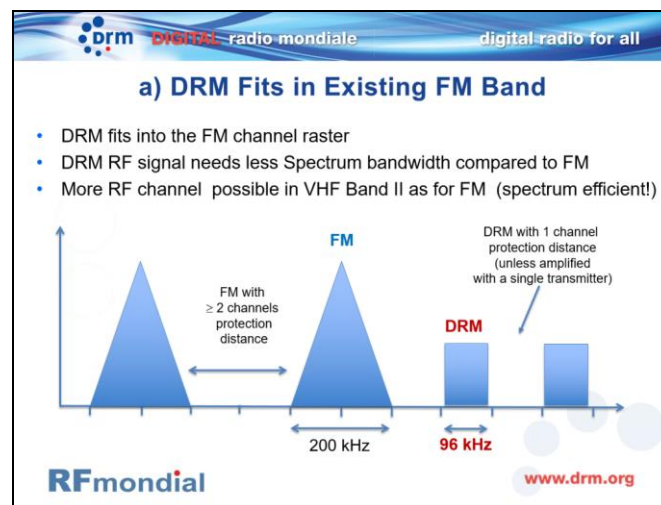
Spectrum Costs

NO Cost: DRM FM band digital radio broadcasting requires NO new spectrum

DRM transmission signal occupies a spectrum bandwidth of 96 KHz

The bandwidth of each DRM transmission signal is only 96 kHz – less than half of the bandwidth required for a single analogue FM service. Since it is a digital carrier and sharp cut-off digital filters are used, the slot has a near rectangular mask.

This 96 kHz wide signal can be adjusted anywhere in the white space between two analogue FM carriers, if a few conditions are met. In practice, many DRM FM carrier slots can be adjusted and fitted in white spaces within the FM band.

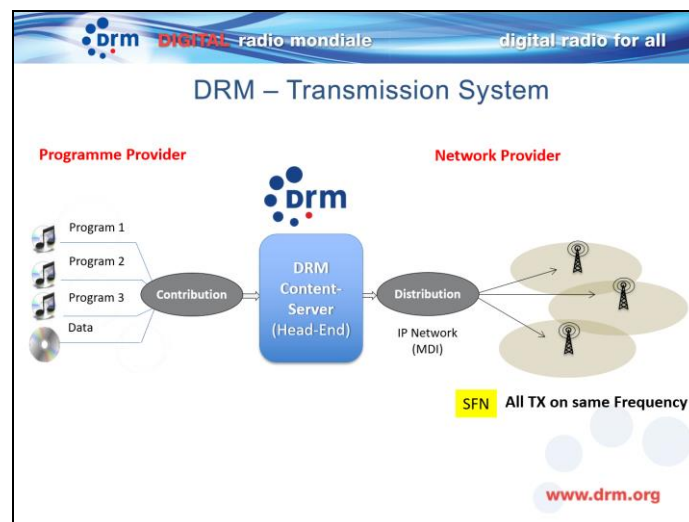


The lower frequency of band 1 is 1/12th of the through the air loss in band 3 used by DAB+ and 1/4th of the FM band when comparing the centre of each band. This allows the radiated power in band 1 to be reduced reducing electricity consumption and possibly capex costs. On the other hand, higher power can be used for bigger coverage areas than for FM.

Services

DRM digital radio standard offers more channels in each transmission

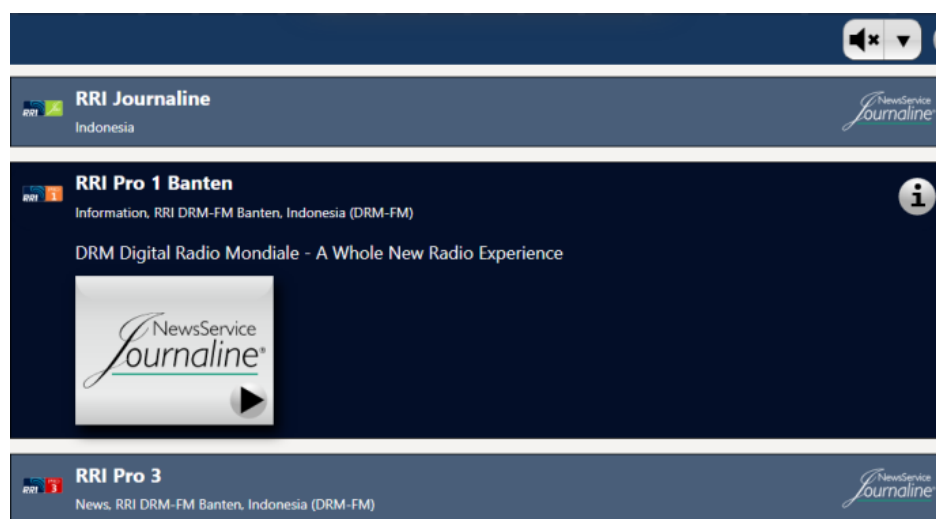
Each of the 96 kHz wide DRM transmission signals has a bit rate capacity for useful content (audio and multimedia) of between 37 and 186 Kbps (depending on the signal robustness level chosen by the broadcaster). This capacity is utilised for up to 3 audio channels (all stereo), Journaline text info service and emergency warning functionality (EWF).



Value Added Services

DRM digital radio provides additional value-added services such as the advanced text service Journaline (news, information, weather, financial, social, health, e-learning, etc.); graphics (to enhance the radio content); and emergency warning functionality.

Example of a real live Journaline service in Indonesia is depicted below (dated 11 May, 2020)





Flexibility

In view of the above, DRM FM digital radio is a flexible solution that permits broadcasters to provide listeners with significant improvements in service reliability, audio quality and, most importantly, usability. DRM allows established broadcasters to follow the existing business models of radio.

Quality

a. DRM offers advanced services, **revolutionising the radio experience for the next generations of listeners**:

- **convenient service selection** by station name – gone is the need to memorise and manually select bands and frequencies
- **better-than-FM audio quality** with optional 5.1 MPEG Surround sound
- a range of standardised data applications such as DRM Text Messages, **Journaline advanced text**, Slideshow, TPEG traffic data, service logos via SPI, etc. All DRM text content (service labels, Text Messages, Journaline) is Unicode based, thus supporting all languages and scripts worldwide

There have been many closures of community newspapers, where Journaline is a way of delivering an electronic newspaper including colour pictures.

Radio for the print handicapped (#RPH), could also transmit transcripts of sound programs for the hearing impaired as a value-added service.

b. DRM is the first global digital radio standard to embrace the **most advanced MPEG audio codec, xHE-AAC**, which is the only codec to combine speech and general-purpose audio coding in a unified system. This allows for high quality delivery of any type of audio content at very low bit rates. xHE-AAC is a superset of HE-AAC v2, which remains part of the DRM standard as well.

c. **DRM provides built-in AFS functionality (Automatic Frequency Signalling & Switching)**, allowing a receiver to stay tuned to the selected service even if the listener

leaves the coverage area of the current transmission. The DRM AFS functionality also integrates services transmitted on analogue AM and FM.

d. **DRM** natively supports **emergency alert signalling for immediate mass-notification in case of impending disasters (EWF – DRM Emergency Warning Functionality)**. AFS can also restrict the area of EWF broadcasts to radios within the affected area as specified by the emergency services.

Spectrum Congestion

The multiple radio services provided by DRM can be used to reduce the FM band congestion in major cities and they can offer new opportunities for existing FM broadcasters.

Interference

There is no interference from a DRM FM carrier into the analogue FM carrier spectrum if the established ITU planning parameters are respected, such as keeping a spacing of 50 Khz between the two band edges

Emergency Warning

The DRM digital radio standard provides a comprehensive built-in emergency warning dissemination service, known as “DRM Emergency Warning Functionality” (EWF). This provides clear emergency alerts in case of pending disasters – both as audio announcement and using the Journaline multi-lingual text component, which reaches hearing-impaired users, serves non-native speakers, and provides detailed instructions in the desired languages. One of the functions is the automatic “waking up” feature of radio receivers in standby mode. This is an important service for both the national regulators and authorities as well as the radio audiences. FM radio operators can also capitalise on carrying this service.

CONCLUSIONS

1. The DRM digital broadcasting standard supports all bands, therefore **all VHF bands** including the FM band. It has been developed specifically for allowing broadcasters to serve their individual target audiences in their defined and often unique coverage areas, while co-existing peacefully and without any interference with existing analogue FM services during the transition period. This DRM flexibility cannot be replicated by any other digital radio standard today.

2. DRM is a perfect standard for digitising FM services, keeping broadcasters in full control of their transmission infrastructure and optimised for the broadcaster’s individual coverage needs. DRM therefore allows introducing digital radio services while maintaining full compatibility with established business models. DRM’s advanced features revolutionise the radio experience for listeners, allowing broadcasters to develop new revenue streams and to intensify listener engagement.

3. Successful DRM in VHF trials and demonstrations have been carried out all over the world during the past few years, such as in Germany, the UK, India, the Vatican, Norway, Sri Lanka, Brazil, Sweden, Russia, Indonesia, South Africa and France (in VHF bands I, II and III).

To make digital broadcasting a success ACMA and community, government and commercial broadcasters need to devise a plan and a timetable for rolling out digital radio. This will give the receiver manufacturers, importers and car manufacturers notice that they need to produce all band DRM and DAB+ receivers. There are already the components (chipsets) available to manufacturers to produce these receivers and the price drops with large orders which will not occur until there are attractive programs to listen to.

With last summer's huge fire areas, DRM can solve the issue of mobile phone, TV and radio transmitter failures at a time of crisis.

Addendum 1

Following several trials and demonstrations of the Digital Radio Mondiale (DRM) digital radio standard in the FM band in several countries in the region and presentations / recommendations to the respective National Regulators, some positive developments are expected towards the official adoption of FM radio digitization policies in these countries.

Countries like Indonesia and India are quite proactive. Indonesia has started DRM digital radio services in the FM band from a transmitter located in one of the regions of the country. These digital radio transmissions are made up of up to 3 stereo audio radio programmes, Journaline text info service and emergency warning functionality from each location. Four more locations will see DRM FM-band transmission in the country soon.

Pakistan has adopted the DRM digital radio standard for the mediumwave band and for the FM band. Recently, transmitters started broadcasting DRM digital radio in the FM band in the capital. All the services are being provided.

In addition, in countries like Nepal and Russia, DRM FM-band radio live demo transmissions have been conducted. (Other countries are South Africa, Sri Lanka, Germany, UK and Vatican City). Nepal is working on long term DRM FM digital radio trials in Kathmandu.

A comprehensive list of detailed trials and reports is contained in the most recent DRM Handbook (v5), which is available as a free PDF download from the drm.org homepage¹.

¹ See <http://handbook.drm.radio>