Digital Radio Mondiale by Simon Gosby, Ex G8OVZ, BBC World Service

Write-up By Dick Brocks, G3WHR.

As a Project Manager for the BBC World Service, Simon is responsible for installing new systems and equipment so he was able to give us a very informative talk on the background to this latest development in MW/SW broadcasting.

Simon began by describing the current methods by which the BBC World Service is delivered to its estimated 150 Million listeners. The main carriers are MW (2000hr/wk) and SW (6500hr/wk) with VHF, Satellite, DAB, SMS, and Internet in support.

The BBC transmits its AM services from 4 sites in the UK owned by VT Merlin Communications and from a further 7 BBC owned rebroadcast sites throughout the world – mostly located on Islands.

In recent years the audience for MW and SW broadcasts has been declining. Listeners in the major cities have been switching to VHF, no doubt encouraged by the better audio quality of FM. The BBC has put considerable investment into VHF transmitters and can now be received on FM in 139 cities. However, the relatively short range of VHF transmitters means that areas beyond the principal cities of a country do not receive the FM service. There is also the problem that transmitters within the borders of a country are under the control of the local government and broadcasting privileges can be withdrawn.

The 'range' advantage, combined with the existing investment in transmitters, ensures that MW/SW broadcasting is going to have a future, however, something has to be done to improve the audio quality. The AM standard, in use since 2MT, has limited bandwidth and is susceptible to selective fading and interference.

Time for a new standard. Digital Radio Mondiale (DRM) has the potential to provide the audio quality required with the bonus of additional services. DRM has been developed by a consortium of broadcasters, manufacturers and others, to bring the benefits of digital modulation to the MW and SW bands. The system has been designed to fit the existing channel bandwidths and to have sufficient flexibility to cope with both ground wave and sky wave propagation. The system is complementary to other digital delivery systems and integrates well with the digital program storage and distribution used by the BBC.

In addition to improved audio quality, the user benefits from additional features like program associated data - such as a cricket scorecard to accompany the match commentary, textual information, and alternative frequencies for reception.

The BBC WS is transmitted in DRM from Rampisham on 7320kHz between 1000 and 1500. All the major AM broadcasters now include regular DRM broadcasts and the number continues to grow. Even Radio Wales International has a 30-minute program in DRM twice a week.

Simon explained how the DRM signal is constructed and then modulated using COFDM techniques similar to DAB and DTV – see later.

VT Merlin has purchased a new MW transmitter for DRM but it is possible to re-engineer their more recent AM SW transmitters to send a DRM signal by installing a phase modulator for the carrier signal. Following conversion to DRM the average power level has to be reduced by 10dB to keep the peak envelope power within the linear operating region of the output stage.

Rather sadly for us radio engineers; Simon said that the BBC has to purchase its high power transmitters from France - there being no UK manufacturer.

DRM receivers should be available later this year. The price and battery life will reflect the additional complexity of decoding a DRM signal. Future development should provide a solar powered receiver for a price around £20. PC software to decode DRM signals is available on CD with a licence fee of 60 Euros - you also have to convert your Rx IF signal to an output frequency of 12kHz and will need a modern sound card. Simon generously donated 4 CDs + licences to the club, which meant that 3 lucky raffle winners went home with a CD. (If you want to experiment then there is some free software from a German university on the Internet – no guarantees and a huge download.)

The BBC participated in the DRM field trials so we were able to hear off air recordings taken 5 minutes apart with the same music passage transmitted using AM and then repeated using DRM. The improvement in audio bandwidth and elimination of interference made DRM a clear winner. (For those who didn't hear the demonstration – our secretary has a copy of Simon's audio presentation on CD.)

Simon is currently managing some antenna improvements in Cyprus and was able to show us photographs of the recent installations plus some photographs of broadcast transmitters he has known, and some really impressive antenna farms. Simon also brought some examples of the components that are fitted to 250kW SW transmitters.

Finally, Simon showed two examples of FM stations that the BBC has installed, a solar powered station in Bamian, Afghanistan, and one in Baghdad, Iraq.

Our thanks to Simon for a professional view of MW/SW broadcasting. We hope that once his work for the BBC is over he will find the time to reactivate G8OVZ.

Simon covered a lot of ground in 90 minutes – so here is a guide to DRM

The AM signal has not changed since the days of 2MT and is something we all study for the licence exam. It consists of a central RF carrier and two sidebands extending either side of the carrier. The upper and lower sidebands contain the information that is to be transmitted to the receiver and are to a certain extent a duplication of information; nevertheless they have both got to be sent to the receiver if the detector output is not to be distorted. If the modulation was changed to SSB then we would be able to send audio signals up to 10kHz with no duplication of information. So how does DRM send near FM quality with up to 15kHz audio in a 10kHz channel – as Simon's presentation said – "It is very complicated".

It starts with state-of-the-art audio processing. For years designers have been finding new ways of converting an analogue waveform into a digital bitstream and back again with the goal of using the minimum number of bits per second for the bitstream. Initial techniques preserved the frequency response by rapid sampling and preserved the noise performance by using lots of bits to code each sample. It worked but the bitstream came out at 1.4Mb/s. Advanced Audio Coding uses the knowledge that the human brain cannot perceive all the sounds that the ear hears. A loud sound at a particular frequency will dominate over weaker sounds on nearby frequencies. AAC analyses the audio spectrum and only encodes those sounds that the brain can perceive. The higher frequencies (>6kHz) are not coded at all, but information on the spectrum shape is sent to the decoder where a technique called Spectral Band Replication is used to replicate the spectrum using harmonics of the frequencies decoded from the AAC data. The combined AAC+SBR signal requires around 20kb/s. Speech can be coded at 4 to 8 kb/s using similar techniques.

DRM is more than an audio bitstream. The system allows the simultaneous transmission of up to 4 different services with associated data called the Main Service Channel. This system information has to be passed to the receiver and adding two extra channels does this. The Fast Service Channel contains data providing information on the number of services and programme type; and the Service Description Channel contains information on decoding the MSC and alternative frequencies for reception. The combined FSC, SDC and MSC are called a DRM Multiplex.

It is perfectly feasible to send digital data by high speed CW using a single carrier frequency. Providing the path is line-of-sight and the signal received is well above noise level, then accurate reception shouldn't be a problem. However, once the propagation path becomes obstructed or non line-of-sight, the results wouldn't be too good. If the signal received from the direct path is interfered with by a time delayed signal caused by a reflection then no amount of increase in transmitter power is going to improve reception. Short bursts of high-level interference from sources local to the receiver will cause errors or maybe complete loss of data. These problems are made much worse if the receiver is mobile or if the propagation path changes.

To overcome the above problems, the COFDM modulation scheme was evolved. The transmitter end works by encoding the input data and then distributing the code words in time and modulating them onto several separate carriers spaced at regular intervals across the permitted channel bandwidth.

By using known code words, the received data can be reconstructed even if the received code word is not entirely correct. Amateurs use a similar technique when they use the phonetic alphabet to spell words. The longer the code word, the greater the chance of correcting an error.

The distribution of code words in time is used to counteract bursts of interference. When the code words are put back in the correct order at the receiver end, any burst of interference appears to be shortened and spread over a number of code words rather than affecting just one codeword. More code words may be in error, but the errors can be corrected.

The distribution of code words to separately modulated carriers allows the modulation rate of each carrier to be reduced. By sending slowly the individual modulation symbols can be made to last much longer than the time by which any reflected or multipath signal is delayed. The direct signal and the delayed signal can then be combined to provide a greater signal to the demodulator.

The amount by which the carriers are spaced in frequency is linked to the modulation rate of each carrier. The sidebands of a regularly modulated carrier are not continuous – they have gaps where there is no transmitted energy; the carrier frequency spacing is designed to fit into these gaps so there is no interference between the separately modulated carriers.

The individual carriers are normally amplitude and phase modulated. Transmitting 1 bit per modulation symbol is extravagant; you can transmit 2 bits per symbol by using four different phase states without needing extra signal to noise power at the demodulator. If the signal to noise level permits, it is usual to transmit up to 6 bits per modulation symbol by using a combination of amplitude and phase modulation.

The DRM system allows the broadcaster to choose from a set of code words, carrier spacing and modulation complexity to optimise the chance of getting an error free data stream at the receiver demodulator output. The choices are encoded with the program and sent to the receiver.

The COFDM modulator is actually a large digital processor with two output bitstreams; these are converted back to analogue using conventional Digital to Analogue converters and then sent to the transmitter. One signal goes to the phase modulator and the other to the amplitude modulator. The transmitter output spectrum appears as a flat-topped signal that fills the radio channel completely. If you listen to DRM with an AM detector you just hear random noise up to the limit of your IF bandwidth.

Our thanks to Dick G3WHR for this comprehensive report and description of DRM.