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Date: 2005-03-17 22:59
Editor: Lars Liljeryd

Digital World Traveller user guide.



Dear Digital World Traveller user!

Coding Technologies' Digital World Traveller offers good sensitivity and selectivity - important factors for reception of DRM. I sincerely believe that the Digital World Traveller will bring you a lot of enjoyment when exploring the world of DRM transmissions, and when listening to the Long- Medium- Shortwave or FM band.

The (ITU) broadcast bands are:

LF/LW (Long Wave band)	153 kHz to 279 kHz
MF/MW (Medium Wave band)	535 kHz to 1.615 MHz
HF/SW (Short Wave band)	5.950 MHz to 26.100 MHz
FM (VHF band)	87.5 MHz to 108 MHz

The Digital World Traveller covers the following bands:

DRM digital (LF/MF/HF bands):	150 kHz to 29.999 MHz
AM analog (LW/MW/SW bands):	150 kHz to 29.999 MHz
FM analog (VHF band):	87.5 MHz to 108 MHz

The Digital World Traveller is delivered with functionality satisfying most listeners. Moreover, there are utilities available on the Internet that increases the usefulness of your Digital World Traveller. These utilities can help you to explore interesting topics in digital communication, broadcasting and radio signal reception and propagation. You do not need to be an experienced broadcasting engineer to enjoy these features. I have prepared some links and explanations for you below.

Happy Listening!

Lars "Stockis" Liljeryd

(DRM and AES member. Inaugurator of Coding Technologies and co-inventor of the MPEG aacPlus audio codec used by DRM and others).

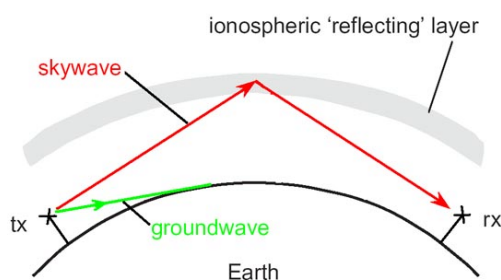
Digital Radio Mondiale



With more than 2 billion AM-radio receivers in use worldwide, AM-radio is one of the most important distribution media. DRM (Digital Radio Mondiale) is a new digital radio standard that revitalizes the traditional AM broadcasting band with high sound quality and interference-free reception. Since the early 20's, broadcasters have used the very efficient AM-band for wide area, intercontinental broadcasting. One single transmitter can cover an entire country, or even an entire continent. However, AM-band reception is plagued by noise and interference as well as limited audio bandwidth (around 2.5 kHz). Although a large part of the world population is listening daily to the AM-band, the number of listeners is slowly declining (most likely due to limited sound quality). The new DRM standard is changing this due to improved sound quality and interference free reception and broadcasters and listeners are thrilled. (Recently the DRM consortium has decided to also cover the FM-band in the upcoming DRM-120 standard, thus digital FM-broadcasts will soon become a reality).

An additional advantage is that digital DRM transmissions are very power efficient and thus environmentally friendly, needing only about half the power for the same coverage area compared to analogue transmissions. Note that a powerful analogue AM transmitter can easily consume 1 Megawatt/hour. Read more about the DRM standard at <http://www.drm.org>

Radio propagation and the DRM broadcast schedule



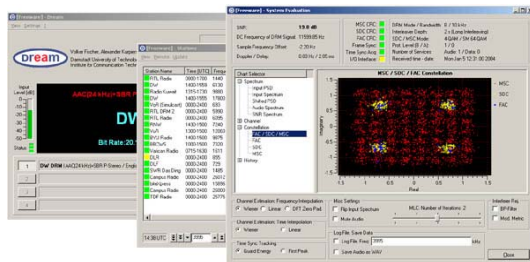
Radio waves propagate very far in the AM-bands due to sky-wave reflections in the ionosphere, and suffer only little attenuation over great distances (contrary to the FM-band that more or less only propagates ground-wave). However, broadcasting in the AM-bands is a complex issue that depends on many variables (like sunspot activity and geomagnetic field variations) and exhibits daily and seasonal variations. The variations can, at a remote area, offer anything from clear reception to silence. In order to optimise coverage, broadcasters are therefore switching broadcast frequencies and transmission time schedules on a perpetual basis that are related to signal propagation conditions and frequency allocation. Consequently, it is imperative to know when a given DRM broadcaster is beaming in your direction, and at what time and frequency, so that you can set your Digital World Traveller to the frequency of interest. See the continuously updated DRM broadcast schedule at <http://www.drm.org/livebroadcast/globlivebroadcast.htm>

“DRM Discoverer” real-time broadcast scheduler



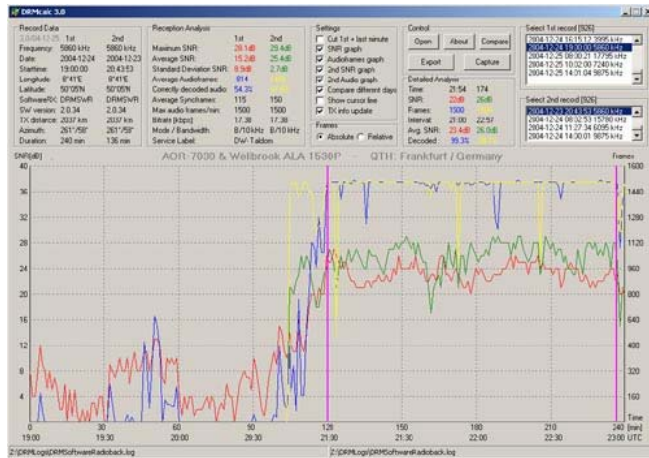
A real-time broadcast scheduler displays who is broadcasting at the moment, at what frequency and power, and to what area etc. The “DRM Discoverer” is a useful freeware product. It will also update new broadcast schedules over the Internet when they become available. The DRM Discoverer freeware can be downloaded at <http://home.arcor.de/carsten.knuetter/drm.htm>

“DREAM” software radio/analyser



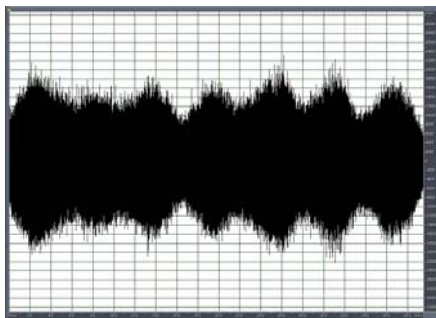
If you are more technically interested, the DREAM freeware receiver/analyser is an excellent tool for checking many technical parameters related to the DRM digital broadcasting format and the reception quality with your Digital World Traveller. Parameters such as signal to noise ratio (S/N) and reception quality versus time, channel impulse response (number of skywave jumps), channel transfer function, and constellation diagram of the FAC/SDC/MSC channels can easily be analysed graphically in real-time. In addition, DREAM includes tuneable sideband (USB/LSB) demodulation for SSB transmissions and variable band pass filtering (for CW/RTTY etc). These features are useful when your Digital World Traveller is used in the alternative analogue AM-mode. The DREAM freeware also includes a real-time broadcast scheduler. For real-time analysis, DREAM needs co-exist with your Digital World Traveller software running on your PC, and needs the Windows-XP operating system. When listening to DRM, we recommend that you to use the headphone output jack on your Digital World Traveller, since the DREAM aacPlus decoder is not quality-certified by Coding Technologies. Download “Compiled DREAM decoder software” from <http://www.sat-schneider.de/DRM/DRM.htm> or <http://pessoal.onda.com.br/rjamorim/dream.zip> If you want to compile and build your own DREAM receiver, download the latest software package from <http://drm.sourceforge.net/>
Although distributing the DREAM software radio freely on the Internet is in the legal grey-zone (me and others are supposed to earn patent licence royalties from DRM radios), but as long as it is available out there, I can do nothing but recommend it.

“DRMcalc” for log-file statistics analysis

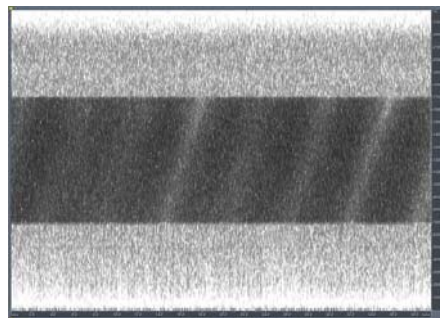


The DREAM software receiver/analyser and the DRM Software Radio can generate a log-file of transmission parameters and reception statistics. Such information is important for the broadcaster in order to assess the performance and coverage of his transmissions, thus his quality of service (QoS). The log files can be analysed and compared to each other using the DRMcalc freeware. Download at <http://home.arcor.de/carsten.knuetter/drm.htm>

Recording and off-line analysing of the IF (OFDM) signal



Time-domain representation of IF signal



Frequency-domain (TFA) representation of IF signal

If you want to record the received IF (OFDM) modem signal from your Digital World Traveller, for example for subsequent offline analysis in the DREAM receiver/analyser, you can do this with any wav-file recording software. Select “Digital World Traveller” as “wave in” device, set recording format to 48 kHz sampling-rate and mono, and start recording the wav-file.

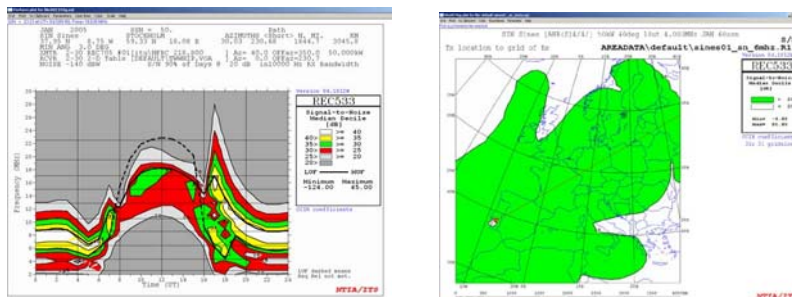
Subsequently you can playback and analyse this IF OFDM file in the DREAM software, by writing a batch file containing the following text:

start Dream.exe -f waveFileName.wav.

You can also download DRM test wav-file examples (IF OFDM) from:

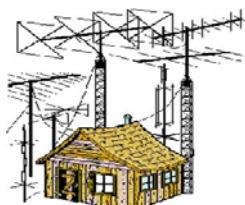
<http://drm.sourceforge.net/drm.html>

DRM shortwave propagation simulation using “REC533”



If you are seriously interested in ionospheric radio signal propagation and coverage in the DRM HF/SW band, an excellent simulation package (freeware) is available. This application calculates the propagation in the transmission channel accounting for ground-wave and sky-wave propagation and takes into account the transmitter and the receiver antenna design, transmitter power, sun spot activity, background noise, interference and more. The algorithms have been developed by the U.S. Army and ITS under more than 50(!) years of use and forms the base of most propagation software programs available today (for example ITU HFBC and FIELDPLOT WIN). The REC533 (single receiver) and RECAREA (multiple receiver grid coverage) versions have been developed for ITU for commercial broadcast propagation simulation and planning, but are also popular by radio amateurs for shortwave propagation analysis. (In the REC533 and RECAREA simulation, use 20 dB Required SNR for DRM signal to noise ratio, RF Bandwidth 10000 Hz and noise -140 dBw/Hz when performing DRM simulations). This tool is highly recommended! Download HFWIN32, HFCC.zip and documentation at <http://www.elbert.its.blrdoc.gov/hf.html> and see a quick guide at <http://www.uwasa.fi/~jpe/voacap/index.html>

Antennas



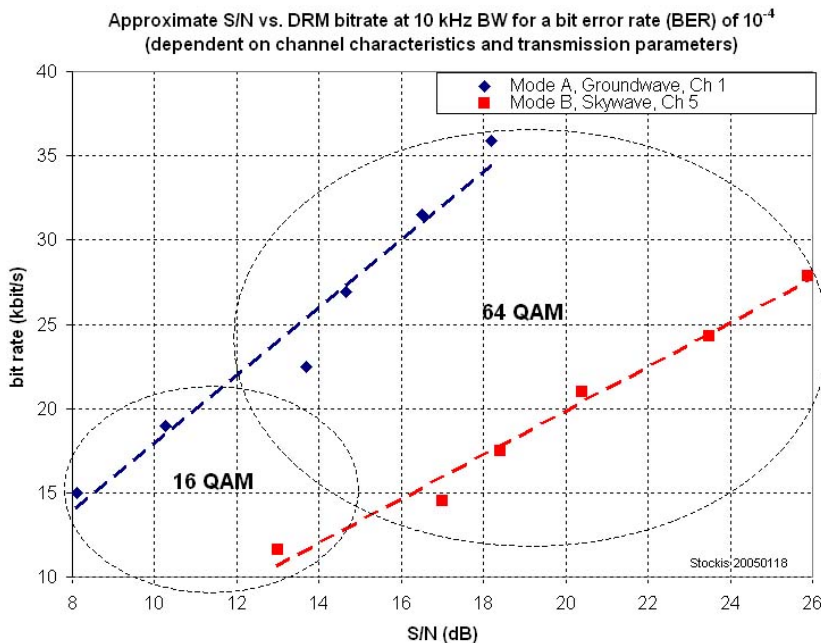
Remember, the easiest way to improve reception results and receiver performance is by improving parameters relating to your antenna! Examples are: placing the antenna higher up, or in a different room, tie its end to a tree in your garden, or moving it away from electromagnetic interfering objects. Changing the antenna location locally can make a difference in signal to noise ratio (S/N) of 10 dB or more! A Longwire (single wire) antenna is easiest and cheapest to deploy. However, it needs some space due to its physical length. A “Longwire” antenna is at least a half wavelength of the broadcast frequency of interest. That is, the Longwire length in meters can be calculated as the constant 142 divided by the frequency in Megahertz. Example: $142 / 15.4$ (MHz) gives an antenna length of approximately 9 meters. If you only are interested in strong and/or local transmissions, you may cut the antenna wire short. Read more at for example <http://www.astrosurf.org/lombry/qs1-antenna.htm>

Typical DRM bitrates

The DRM standard supports a wide range of bitrates, modulation and protection modes. Bitrates from 4.8 kbps (at a RF bandwidth of 4.5 kHz) to 71.96 kbps (at a RF bandwidth of 20 kHz) represents a sound quality span from wideband speech, to CD-quality audio. Typical bitrates for the popular Mode B (Skywave), used for broad coverage international and national broadcasting, is shown below:

RF BW kHz	QAM	MSC Prot	bitrate
10	64	2	24,7
10	64	1	21,0
10	64	0	17,5
10	16	1	14,6
10	16	0	11,6

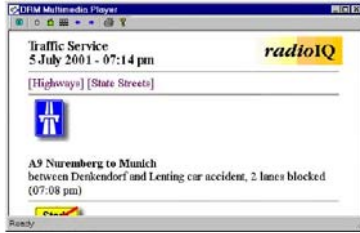
DRM signal to noise ratio (S/N) versus bitrate



The S/N ratio required at the receiver for satisfactory quality of service (QoS) depends on many factors. The transmission channel Doppler spread, impulse response, noise, interference, and last but not least, the modem parameters set at the transmitter such as OFDM constellation (16 or 64 QAM), groundwave or skywave mode, RF bandwidth, protection level. An approximate figure of the needed S/N versus audio coding bitrate (and thus audio quality) may be found from the diagram.

The broadcasters are always facing a difficult trade-off between robustness and sound quality; higher bitrates give higher sound quality but lower robustness and therefore a smaller broadcasting coverage area; lower bitrates give lower sound quality but higher robustness and therefore a larger broadcasting coverage area.

DRM Programme Associated Data (PAD) and text services



The DRM standard (and for example the DRM Software Radio and DREAM software receiver/analyser) supports digital audio broadcasting in combination with low data-rate services that can be displayed at the receiver side, such as text messages, slideshows or as broadcasters web pages. In addition, the DRM standard supports a data-only mode where the above services are transmitted at a higher data rate due to the fact that audio content is excluded.

DRM natural audio and speech coding

The DRM standard includes three audio codecs. One for “natural audio”, and two for “speech”. A natural audio codec is built upon a psychoacoustic model of the listeners hearing system (the receiver). A speech codec is built upon a model of the human vocal tract (the transmitter). Since a speech codec is designed for speech only, it is very efficient (more efficient than a natural audio codec), but cannot reproduce complex program material (music) at any useful quality.

The CT MPEG-4 **aacPlus** “natural audio” codec is designed to reproduce program material at the highest bitrate/quality ratio, currently offering the highest coding efficiency of any audio codec available. Due to Coding Technologies’ Spectral Band Replication (SBR) and Parametric Stereo (PS) tools, the aacPlus offers very good (near FM-like) audio quality in stereo at the very lowest DRM bitrates.

The MPEG-4 **HVXC** speech codec is believed to be the most efficient quality speech codec available, offering good speech quality at ultra-low bitrates of 2.4 kbps. Such an efficient speech codec can be used for simultaneous multilingual transmissions or for background downloading and storage of spoken information in the receiver.

The MPEG-4 **CELP** speech codec is also a very efficient speech codec, offering higher speech quality than the HVXC but at somewhat higher bitrates (filling the gap between aacPlus and HVXC). This codec can also be used for simultaneous multilingual transmissions or for background downloading and storage of spoken information in the receiver.

Coding Technologies’ SBR tool is used in DRM for both HVXC and CELP codec enhancement in order to extend the audio bandwidth to broadcasting standards. All three codecs are supported by the DWT, DRM and FhG software radios, but currently only aacPlus is supported by the DREAM software radio. Read about the Digital World Traveller and Coding Technologies’ exiting products and technologies at <http://www.codingtechnologies.com/products/digtrav.htm>

DRM and FHG software radio

Most utilities and information described in this document also apply for the DRM Software Radio and the professional FhG Software Radio. The DRM Software Radio and the professional FhG Software Radio works well with the Digital World Traveller. As such, the Digital World Traveller forms a very portable, lightweight and cute companion to your laptop for DRM use, substantially more compact than dedicated desktop radios used so far.

DRM Software Radio information: <http://www.drmrx.org/>

The FhG Software Radio: <http://www.iis.fraunhofer.de/dab/products/drmreceiver/>

Rebuilding HF communications receivers for DRM reception

If you are a bit technical it is possible to rebuild most communications receivers for DRM reception and subsequently decode the signal in your PC using a software radio. A simple down-mix of the receivers 455 kHz IF is needed to 12 kHz baseband IF for input to the PC's sound card. A small PCB can be obtained at low cost from <http://www.sat-schneider.de/DRM/DRM.htm> or a drawing on how to build it yourself at <http://www.sat-schneider.de/download/Mixerflyer.pdf> or Google search: DRM modification mixer. General advice on how to rebuild HF radios for DRM are available at http://www.drmrx.org/receiver_mods.html

I have modified my ICOM IC-R75 radio for DRM reception using the Sat-Schneider PCB with excellent results.

DRM documentation

For those of You who want to learn more about the DRM technology and the DRM standard, download "The DRM Broadcasters Manual" at

<http://www.drm.org/BUM/globbum.htm> or the full ETSI DRM standard document "ETSI ES 201 980 V2.1.1" at

http://pda.etsi.org/PDA/home.asp?wki_id=E_Mk8LSXqO56EDEBYqe9j

Many other documents related to DRM are available on the Internet.

DRM software radio forum

If you are interested in reading or taking part of technical discussions relating to DRM and DRM software radios, go to <http://www.drmrx.org/forum/>

The details, opinions and recommendations given in this document reflects the undersigned's personal views and does not necessarily reflect or represent the opinion of Coding Technologies AB/GmbH

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