Digital Radio Mondiale
– revitalising the bands below 30 MHz

J.H. Stott
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Abstract

This document records an invited Keynote Address made on 23 June 2003 as the opening presentation of the 9th International Conference on HF Systems and Techniques, held at Bath University and organised by the IEE.

The presentation was a deliberately light-hearted look at the development and introduction of the DRM (Digital Radio Mondiale) system for digital broadcasting in the bands below 30 MHz. It was timely, as the Official Launch of DRM had taken place the previous week, and also illustrated some very recent results concerning frequency-diversity reception of DRM.
White Papers are distributed freely on request.

Authorisation of the Chief Scientist is required for publication.
Digital Radio Mondiale

– revitalising the bands below 30 MHz

Jonathan Stott
23 June 2003
Ninth International Conference on HF Radio Systems and Techniques
DRM™ – what is it?

- DRM = Digital Radio Mondiale
- A consortium with the mission:
  - “to create a universal, digital system for the AM broadcasting bands below 30MHz”
- The digital broadcasting system they have created
DRM – why?

- LF, MF, and HF broadcasting bands share unique property that *signals go a long way*
  - ground wave
  - sky wave
- but they use AM – ‘Ancient Modulation’!
- AM listening experience doesn’t match modern expectations
Commercial Radio Australia (Australia); Nautel Ltd., Radio Canada International/CBC (Canada); Academy of Broadcasting Science of China (China); RIZ Transmitters (Croatia); HFCC (Czech Republic); ESPOL, HCJB World Radio (Ecuador); Digita Oy, Kymenlaakso Polytechnic (Finland); Atmel ES 2, CCETT, Radio France, Radio France Internationale, TeleDiffusion de France, Thales Broadcast & Multimedia (France); ADDX, APR, Coding Technologies GmbH, Deutsche Welle, Deutschland Radio, DLM, Sender Europa 1, Fraunhofer IIS, Georg-Simon-Ohm – University of Applied Sciences Nuremberg, Innovationszentrum Telekommunikationstechnik GmbH IZT, IRT, Medienanstalt Sachsen-Anhalt/Digitaler Rundfunk Sachsen-Anhalt, Micronas GmbH, Robert Bosch GmbH, Sony International Europe, SWR Südwestrundfunk, TELEFUNKEN SenderSysteme Berlin AG, T-Systems MediaBroadcast, University of Applied Sciences - FH Merseburg, University of Hannover, University of Ulm, VPRT (Germany); Antenna Hungaria, Communications Authority Hungary (Hungary); All India Radio (India); Basamad College, Tehran (Iran); Hitachi Kokusai Electric Ltd., JVC Victor Company of Japan, Ltd., NHK (Japan); Libyan Jamahiriya Broadcasting (Libya); Broadcasting Centre Europe (Luxembourg); Asia Pacific Broadcasting Union (Malaysia); Nozema, Radio Netherlands (Netherlands); Radio New Zealand International (New Zealand); Voice of Nigeria (Nigeria); Telenor/Norkring (Norway); Radiodifusao Portuguesa (Portugal); RTRN/The Voice of Russia (Russia); Arab States Gulf Cooperation Council (Saudi Arabia); Universidad del Pais Vasco, (Spain); Radio Sweden International (Sweden); EBU, International Committee of the Red Cross, ITU (Switzerland); Arab States Broadcasting Union (Tunisia); BBC, Christian Vision, VT Merlin Communications, QinetiQ, RadioScrape Ltd., Roke Manor Research Ltd., WRN (U.K.); Dolby Laboratories Incorporated, Dolby Laboratories Licensing Corporation, Harris Broadcast Corporation, IBB/VOA, IDT Continental Electronics, Kintronic Laboratories, Inc., National Association of Short-wave Broadcasters, Sangean America, Inc., TCI, a Dielectric Company, Via Licensing Corporation (U.S.A.); and Radio Vaticana (Vatican City).
DRM Members

DRM has 81 members from 30 countries
— major international broadcasters
— other broadcasters & network operators
— transmitter manufacturers
— receiver manufacturers
— research institutes

Commercial Radio Australia (Australia); Nautel Ltd., Radio Canada International/CBC (Canada); Academy of Broadcasting Science of China (China); RIZ Transmitters (Croatia); HFCC (Czech Republic); ESPOL, HCJB World Radio (Ecuador); Guangzhou Radio (China); GPR, Coding Technologies GmbH, Deutsche Welle, Deutschlandfunk, DLM, Sonder Europa 1, Fraunhofer IIS, GE, GE, Georg-Schwarz-Strasse 1, 80290 Munich, Germany; TDK; Telekommunikations- und Funkunion HZT, TRT, Mediakomunikat Sachsen-Anhalt, Delft, Netherlands, Telecom Italia; Technische Universität München - FH Mergemburg, University of Hannover, University of Ulm, VPRT (Germany); Antenna Hungaria, Communications Authority Hungary (Hungary); Azadhi, Radio Iran (Iran); Basamad College, Tehran (Iran); Hitachi Kokusai Electric Ltd., JVC Victor Company (Japan); Libyan Jamahiriya Broadcasting (Libya); Broadcasting Centre Europe (Luxembourg); Asia Pacific Broadcasting Union (Malaysia); Nozema, Radio Netherlands (Netherlands); Radio New Zealand (New Zealand); Nippon Hoso Kyokai (Japan); Radio Telefoniya Sri Lanka (Sri Lanka); Telenor/Norkring (Norway); Radiodifusao e Televisao de Angola (Angola); National Press Club, International Arab States Gulf Cooperation Council (Saudi Arabia); Universidad del Pais Vasco, (Spain); Radio Sweden International (Sweden); EBU, International Committee for the Protection of the General Interest of Broadcasting Union (Tunisia); BBC, Christian Vision, VT Media, Swedish National Broadcasting, Radio Nederland, Royal Manor Research Ltd., WRN (U.K.); Dolby Laboratories Incorporated, Dolby Laboratories Licensing Corporation, Harris Broadcast Corporation, IIBB/VOA, IDT Communications, International Association of Short-wave Broadcasters, Sangean America, Inc., TCI, a Dielectric Company, Via Licensing Corporation (U.S.A.); and Radio Vaticana (Vatican City).
DRM very brief history

- 1997 discussions lead to formation
- 1998 Consortium officially founded
- 2001 ETSI Specification published
- 2003 achieved triple recognition
  - IEC Standard 62272-1
  - ETSI Standard ES 201 980, as well as:
  - ITU-R Recommendation BS 1514-1
DRM Launch, 16 June 03

- DRM Launch coincided with World Radio Conference in Geneva
- DRM Chairman Peter Senger makes the official address
DRM Launch, 16 June 03

DRM broadcasts were launched by:

BBC World Service, Christian Vision,
Deutsche Welle, Deutschland Radio,
R Canada Int’l, R France, R France Int’l,
MOI Kuwait, Radio Netherlands, RTL, R Vaticana,
Swedish R Int’l, Voice of America,
Voice of Russia, Wales R Int’l – and
a Hochschule in Nürnberg!
DRM Launch, June 03

- Both MF and 26 MHz transmissions were made from Mont Saleve, nearby in France
Both MF and 26 MHz transmissions were made from Mont Saleve, nearby in France.
DRM Launch, June 03

- BBC World Service engineer takes the opportunity to examine the latest technology at the DRM launch!
DRM – the system

- Designed for all broadcasters, large & small
- Options to match propagation requirements
  - Trade ruggedness against capacity
- Intended as plug-in replacement for AM
- Modulation is COFDM (multi-carrier) with MLC (multi-level coding)
- Modern audio bit-rate reduction
  - AAC+SBR (waveform); HVXC, CELP (speech)
DRM – the system

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Hear how ruggedness can even be adjusted dynamically to match propagation conditions, in the QoSAM paper by QinetiQ later in the conference.
DRM receivers

- Receivers were needed for both system development and field trials
  - Thales put extra cards in industrial PC
    - transportable, used in first field trials
- Subsequent receivers of 2 main types
  - analogue front end, feeding a computer
    - with software demodulation and decoding
  - free-standing hardware
Software receivers

conventional superhet radio

down-converter

1F, say 455kHz

low IF, say 12kHz

computer, with demod/decoding software

sound card
FhG software receiver

- Fraunhofer produce PC software used by many DRM members, often with AOR 7030 receiver
- Cut-down version made available cheaply to radio enthusiasts via website
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Cut-down version made available cheaply to radio enthusiasts via website.

Note that an open-source software receiver project will be presented later in the Conference by Darmstadt University.
BBC R&D ‘pro’ receiver

Inspired by Davies (DERA) paper in 2000 Conference, we made a ‘fully-digital’ design
BBC R&D ‘pro’ receiver

- 27 MHz LPF
- Digital down-converter
- DSP, with demod/decoding software
- 65 Msample/s
First consumer-size rx

BBC R&D DSP card
DSP card fits other rxs

- We couldn’t resist slipping the card into an AOR 7030!
Future receivers

- Future receivers for consumers must be cheap and low-power
  - technically possible
  - huge market (≈2.5 billion AM sets to replace)
- Needs DRM ICs
  - several collaborations are working on this
Future receivers

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- several collaborations are working on this

Note other papers on receiver technology will be presented later in the Conference by Lancaster University and Roke Manor Research
Broadcast chain

- We need broadcast infrastructure
  - many broadcasters have 2 or more transmitters in a network
    - single or multi-frequency (SFN or MFN)
  - DRM-DI Distribution Interface to distribute to transmitters and synchronise them
- First synchronous MFN set up last month by BBC R&D/VT Merlin
  - R&D receiver re-programmed as modulator
We need broadcast infrastructure. Many broadcasters have 2 or more transmitters in a network. Single or multi-frequency (SFN or MFN) DRM-DI Distribution Interface to distribute to transmitters and synchronise them.

First synchronous MFN set up last month by BBC R&D/VT Merlin.

R&D receiver reprogrammed as modulator.

Broadcast chain:
- Studio centre
- Content (audio/data)
- Content server (makes DRM-DI)
- GPS receiver
- GPS satellite network
- Distribution satellite network
- Uplink station
- DVB-S carrying DRM-DI

DRM distribution for widespread transmitter network.

- Transmitter site 1
  - GPS receiver
  - Modulator (accepts DRM-DI)
  - Satellite receiver
  - Transmitter

- Transmitter site 2
  - GPS receiver
  - Modulator (accepts DRM-DI)
  - Satellite receiver
  - Transmitter

Coverage area}: DRM RF signal
Field Trials

- BBC engineers took their field-trial brief seriously!
DRM Field Trials

- Field trials performed throughout
  - both channel-sounding and system-testing
  - short- and long-term, all sorts of paths
    - long-term tests automatically gathered data from widespread receivers on members’ sites
  - some of the work funded by EC as part of the Radiate project
- Ecuador NVIS tests led to extra modes
Latest BBC R&D tests

- Demonstrations at DRM Launch this month
  - included synchronous 2-frequency transmissions
  - had to drive kit there anyway, so…
- Grasped chance to measure frequency-diversity reception
  - mobile measurement on journey
  - static measurement in Geneva
Demonstrations at DRM Launch this month included synchronous 2-frequency transmissions that had to drive kit there anyway, so…

Grasped chance to measure frequency-diversity reception during mobile measurement on journey, and static measurement in Geneva. A pause in France on the way to Geneva.

Latest BBC R&D tests: Three BBC R&D receivers logging MFN and frequency-diversity reception.
Frequency-diversity

Frequency 1
Frequency 2

Single-frequency reception suffers some drop-outs (poor SNR)
Frequency-diversity

Single-frequency reception suffers some drop-outs (poor SNR)

But solid reception using diversity!
Every silver lining...

Interference

... has a cloud!

other HF radio users

Drm

Research & Development
Interference

- Interference remains a worry, especially from systems using the mains wiring
  - PLT/PLC – Power Line (Tele) Communications
- Strong political pressure for PLT
  - ‘Broadband for all’
- EC has issued Mandate to ETSI/Cenelec Joint Working Group (JWG)
**Interference**

**LATEST NEWS:**
Latest JWG emissions-limit proposal for MF/HF is H-field equivalent to 55.5 dBµV/m quasi-peak, measured at 3 m.

Minimum AM HF broadcast protected FS is 40 dBµV/m, implying a *substantially negative* S/(N+I) ratio for indoor reception of AM or DRM.

Does this regulation do anything useful? It’s 60 dB too slack!
Conclusions

- DRM is now ready for introduction
  - so at last we can have good quality audio and the long-distance reach of the ‘AM’ bands
- DRM exemplifies how applying digital techniques revitalises the HF bands
The End

Thanks for listening!

Have a great Conference!
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