



R&D White Paper

WHP 022

February 2002

Digital Radio Mondiale (DRM): compliance testing and specification validation

O.P. Haffenden

Digital Radio Mondiale (DRM): compliance testing and specification validation

O.P.Haffenden

Abstract

Digital Radio Mondiale (<http://www.drm.org>) is a new system for digital broadcasting below 30MHz. The DRM Consortium has now completed work on the technical standard which describes the “Signal on Air”. This is an open standard which has now been published by ETSI as a Technical Specification, and it is currently being input to the ITU/IEC standardisation process. As for any open standard, it is vital that any party implementing the specification should interpret it in the same way.

This document summarises the “Compliance Testing and Specification Validation” exercise conducted within DRM. This has now successfully demonstrated that the DRM specification is clear, complete and unambiguous. The exercise was led by BBC Research and Development, drawing on our experience of validating the DVB-T specification in the successful VALIDATE project.

Key words: digital radio, DRM, compliance testing

White Papers are distributed freely on request.
Authorisation of the Head of Research is required for
publication.

© BBC 2002. All rights reserved. Except as provided below, no part of this document may be reproduced in any material form (including photocopying or storing it in any medium by electronic means) without the prior written permission of BBC Research & Development except in accordance with the provisions of the (UK) Copyright, Designs and Patents Act 1988.

The BBC grants permission to individuals and organisations to make copies of the entire document (including this copyright notice) for their own internal use. No copies of this document may be published, distributed or made available to third parties whether by paper, electronic or other means without the BBC's prior written permission. Where necessary, third parties should be directed to the relevant page on BBC's website at <http://www.bbc.co.uk/rd/pubs/whp> for a copy of this document.

Digital Radio Mondiale (DRM): compliance testing and specification validation

O.P.Haffenden

1 Introduction

The Digital Radio Mondiale Consortium has now completed work on the technical standard which describes the “Signal on Air”. This is an open standard which has now been published by ETSI as a Technical Specification (ETSI TS 101 980 v1.1.1, 2001-09), and it is currently being input to the ITU/IEC standardisation process. As for any open standard, it is vital that any party implementing the specification should interpret it in the same way.

For this reason, a “Compliance Testing and Specification Validation” exercise was conducted within DRM. This has now successfully demonstrated that the DRM specification is clear, complete and unambiguous. The exercise was led by BBC Research and Development, drawing on our experience of validating the DVB-T specification in the successful VALIDATE project.

2 Parties involved

Six independent implementations of the standard were compared. The partners were:

- BBC R&D
- Deutsche Telekom T-Systems
- France Telecom R&D
- Fraunhofer Institute for Integrated Circuits
- Harris/HCJB
- Thales Broadcast Multimedia

For anonymity, the implementations are denoted as A to F (not in that order) in the results given below.

3 Method

The method used to compare the implementations was as follows. Seven different test cases were defined; for each case the parameters of the DRM signal were specified together with the input data streams. The output signals from the various modulator implementations were then compared for each case. In addition, a number of intermediate signals were also compared, to avoid the risk of subtle differences being concealed.

All of the implementations are software-based, so it was straightforward to generate and exchange data files representing the various signals. The same software is used in the real-time implementations, so that if the software comparisons show an agreement, the on-air signals are also likely to match.

4 Modes tested

The DRM specification allows a large number of possible combinations of robustness mode, constellation, code rate etc. The compliance testing exercise had to be limited to a subset of these combinations. The following parameters have been varied:

- Robustness mode (A, B, C and D)
- Spectral occupancy (9 and 10 kHz)
- Interleaver depth (0.4 s and 2.0 s)
- Main Service Channel (MSC) constellation (16-QAM, 64-QAM)
- MSC code rate (0.5, 0.6, 0.71, 0.78 for 64-QAM, 0.62 for 16-QAM)
- Service Description Channel (SDC) constellation (4-QAM, 16-QAM)
- Equal Error Protection (EEP) / Unequal Error Protection (UEP)

5 Results

Table 1 gives error measures for each implementation, relative to implementation F. Two error measures are given. The “RMS error” is the root-mean-square value of the difference between the two signals being compared. The “maximum error” is the magnitude of the difference between the two signals for the sample where this difference is the greatest. Both measures are expressed in dB relative to the RMS value of the signals; the signals are scaled before being compared such that both have the same RMS value.

Implementation	Max. error	RMS error	Comments
A	-64.0 dB	-72.9 dB	
B	-70.6 dB	-78.0 dB	Case 1 only
C	-66.0 dB	-81.0 dB	
D	-61.5 dB	-69.8 dB	
E	-65.4 dB	-75.4 dB	Case 1 only
F	-	-	Reference

Table 1: Error measures for each implementation relative to implementation F

Note that the choice of implementation F as the reference is purely arbitrary. At the time of writing, files for implementations B and E were only available for one of the test cases (case 1).

All of the errors are small enough to be caused by differences in clipping and rounding, together with the use of fixed-point arithmetic. We can therefore conclude that the implementations are identical.

6 Specification Validation

In order to achieve the results presented above, some modifications were needed to the various implementations. However, in all cases it was agreed that the specification itself was unambiguous. In one case an editorial clarification to the specification has been recommended.

7 Real-time interoperation

Following the successful conclusion of the first stage of the compliance testing, the consortium was able to demonstrate over-air interoperation at IBC 2001. Transmissions were generated using two different modulators, and the signals were decoded using three different receivers.

8 Conclusions

The compliance testing exercise has shown that the ETSI specification TS 101 980 is essentially complete and unambiguous. This means that DRM compliant equipment can be constructed by manufacturers whether or not they are members of the DRM consortium.

The exercise made it possible to achieve interoperation between independent implementations within a few months of the specification being finalised.

It can be said with confidence that all DRM signals now being radiated are compliant to the ETSI specification.