DIGITAL SOUND BROADCAST (DSB) TECHNICAL STANDARD

GENERAL REQUIREMENTS

MTSFB 005 : 2005

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Annexes

Committee representation

The Working Group DSB Committee comprises representatives from the following Broadcasters, Manufacturer and Professional Bodies.

Airtime Management & Programming Sdn Bhd
Dimensitek Sdn Bhd
Malaysian Communications and Multimedia Commission
Mercantile & Gentry
Ntl Broadcast Sdn Bhd
PTT Unitrunk
Radio Television Malaysia
Rohde & Schwarz Malaysia Sdn Bhd
Star RFM

FOREWORD

This “Technical Standards Requirements (TSR)” has been produced by the Working Group Digital Sound Broadcasting (DSB) in response to a mandate from the Malaysian Communications and Multimedia Commission (MCMC) under the Communications and Multimedia Act, CMA 1998 (CMA) and the relevant provisions on technical regulation of Part VII of the CMA.

This document specifies the standards to be used for the transmission of Terrestrial Digital Sound Broadcasting (DSB) in Malaysia. This standard will dictate the specifications for transmission and reception equipment manufacturers of all Terrestrial DSB related services in this country.

NOTE:
Compliance with a Technical Standard does not of itself confer immunity from legal obligations.

DIGITAL SOUND BROADCAST (DSB) TECHNICAL STANDARD

1. Scope

The objective of this document is to review the current available DSB systems and make recommendations to the Malaysian Communications and Multimedia Commission for establishment of DSB services in Malaysia.

Previous recommendation (Recommendation to Malaysia Communications and Multimedia Commission For The Establishment Of A Digital Sound Broadcast Trial Project) documentation has been presented to Malaysian Communications and Multimedia Commission in year 2000. The documents recommendation was for the adoption of the Eureka 147 standard.

Broadcasters, manufacturers and the regulators are to be prepared for the market-driven launch of DSB system as a successor/replacement system for FM, MW and SW radio broadcasting.

DAB Eureka 147 and DRM have been identified and determined for use as the most appropriate systems for Malaysia, based on the key features and requirements deemed important to radio broadcasters, radio listeners and advertisers.

With reference to the earlier recommendation for the trial project, the DSB WG is supportive of the proposal and the trial project to be implemented for both DAB Eureka 147 and DRM standards.

2. Introduction

Digital Sound Broadcast opens the opportunities of having more new audio content and data services to listeners, enhancing choice for the consumer and advertiser. It gives listeners interference-free reception of high quality sound and data applications.

The key to the success of the Digital Sound Broadcast launch is making receivers affordable, mobility, portability and easy to use.

There are several standards worldwide for Terrestrial Digital Sound Broadcast (DSB) namely:

1. Europe - Eureka 147 (DAB
2. Korea - DMB Eureka 147 (DAB) Platform
3. Europe - Digital Radio Mondiale (DRM)
4. Japanese - Integrated Service Digital Broadcasting (ISDB-Tn) system
5. American - In Band On Channel (IBOC) known as HD Radio

3. Available DSB Standards

3.1 Eureka 147 (DAB)

Adopted and develop in Europe, with the most widely spread DSB system take up, with commercial and trial services in operation in Europe, Canada, Asia, South Africa and Australia. It is designed to enhance and possibly replace existing FM services. It meets all requirements drawn up by the International Telecommunications Union (ITU), given in ITU-R Recommendations 774 and 789. Eureka 147 (DAB) has been recommended worldwide by the Inter-Union Technical Committee of the World Conference of Broadcasting Unions. The system achieved a worldwide standard as given in ITU-R Recommendation BS.1114 and BO.1130 for terrestrial and satellite sound broadcasting, respectively, to vehicular, portable and fixed receivers in the VHF/UHF frequency range. Adopted by the European Telecommunications Standard Institute (ETSI) as an agreed European Standard (ETS 300401, March 1997)

3.2 DMB system

DMB is a variant of Eureka 147 that supports multimedia applications for a mix of video, sound and data. This format is under consideration by ETSI but countries like Korea, Taiwan and Japan have commenced DMB services since early 2005. The Korean DMB broadcasters have developed a workable system for reception by special DMB receivers and DMB enabled handphones. ETSI have now adopted a standard for DMB (TS 102 427 and TS 102 428).

3.3 Digital Radio Mondiale (DRM)

Adopted and develop in Europe. DRM consortium and World DAB Forum is working together offering a digital radio solutions worldwide. The world's only non-propriety digital radio system for short-wave, medium-wave/AM and long-wave. The system has been endorsed by the ITU, IEC and ETSI, currently covers the broadcasting bands below 30 MHz (short-wave, medium-wave/AM and long-wave) for use worldwide.

3.4 Integrated Service Digital Broadcasting (ISDB-Tn) system

Adopted and developed in Japan. The system can operate a DAB-like transmission infrastructure with multiple transmission sites with overlapping coverage areas for the purposes of nationwide coverage and single frequency networks. However, the system is still under development and trials only have been conducted in Japan.

3.5 In Band On Channel (IBOC)

Adopted and develop in US. The FCC has approved In-Band On-Channel (IBOC) digital radio operation for AM and FM broadcast stations. IBOC digital radio is expected to provide near CD quality reception for stations operating in the FM broadcast band. For AM stations, IBOC digital radio is expected to provide reception approximately equal to today's analog FM reception. Minimal impact is anticipated on reception of existing services. It has some limitations with data services and quality of audio. The system is currently in operation in the US.

4. Characteristics of DSB Standards

The following details are the considered features and elements of the DSB system for the choice of the standards for Malaysia.

4.1. Robustness & Mobility

Digital signals are more robust compared to analogue services. Signals can be well received by portable and mobile receivers under the following conditions:

- complex multi-path signals.
- indoor reception
- error protection

Poor reception areas for existing analogue services especially in built-up urban centres will receive DSB better with the multi-path signals and wide area coverage.

4.2. Multimedia and Data Services

Fixtures of the data services are as follows:

- Programme Associated Data
- Conditional Access
- Service Information
- Traffic and Travel Information

The above features are available in varying degree of sophistication for DAB and DRM. However, DMB system offers more comprehensive possibilities for multimedia and data services.

4.3. Frequency Spectrum Utilization

More spectrum efficiency can be derived from the use of Single Frequency Networks (SFN) over Multi Frequency Network (MFN) with digital transmission.

In addition, more radio channels can be introduced and transmitted within the same allocated spectrum channel. The number of radio channels will be dependent on the bit rate to be adopted. This is particularly applicable for the DAB system.

For DRM, the spectrum for SW, MW will be utilized.

The frequency spectrum for both DAB and DRM are detailed in the MCMC Standard Radio System Plan (SRSP) documents.

4.4. Availability of Transmission Equipment

The components of digital sound broadcast transmission equipment are more complex than the traditional analogue system. For the broadcaster new equipments are required like encoders, multiplexers, network systems and other related equipment.

The availability of these components will influence the readiness for the implementation of Digital Sound Broadcast. To date, transmission equipment is readily already for DAB and IBOC. For DRM, the equipment will be commercially available soon.

4.5. Availability of Digital Receivers

Receivers for DSB should not only receive audio but receive text, pictures and videos (multimedia). DAB receivers are readily available and are capable of receiving multimedia content. Receivers with both DAB and DRM reception will be available soon as dual band chipsets are currently under development.

For DMB, receivers complete with LCD displays and hand phones are already being deployed for use in the DMB service areas in Korea.

5. Recommendations

After applying all criteria and consideration, the Eureka 147 system is recommended for adoption in Malaysia for Terrestrial Digital Sound Broadcast, technical standards information is detailed herein.

The DRM system is also recommended as complementary and non competitive to Eureka147, for use however technical standards are not enclosed therefore should be adopted separately with supporting technical standards.

The Eureka 147 system should be adopted on a Voluntary Code basis.

For clarification, Eureka 147 supports Digital Multimedia Broadcast (DMB), the same standards are applicable, therefore by default DAB and DMB under the Eureka 147 standard is recommended for adoption, as the migratory standards for Terrestrial Digital Sound Broadcast use in Malaysia.

Additional Multiplexing and Migration related recommendations are detailed below under items 8 and 9.

6. Receivers

Type of sets :

1) Car radio
2) Hi-fi of various types
3) Portable radio - which may include a cassette or CD player
4) PCs card

Features of receiver set:

1) Tri-band handles all Band III and L-Band DAB, DRM, FM-RDS, AM, SW
2) Pause and Rewind DAB audio
3) Scrolling of DAB text messages with capabilities of track back phone numbers, track names, web addresses etc
4) Support wide selection of European languages (English, France, German etc), Bahasa Malaysia, Chinese, Indian
5) Easy and quick locates DAB stations and easy to use auto-tune feature
6) Can list stations alphabetically or by most listened to
7) Scrolling text shows additional data such as song titles, artists' names, programme descriptions, news headlines etc
8) Electronic Programme Guide (EPG), Traffic Message Channel (TMC), TPEG etc
9) DMB support
10) Single antenna connection

7. Transmission

DAB:

Details for the minimum requirements for DAB Transmitters as prepared by WorldDAB in September 2001.

7.1 Scope

This document recommends a minimum set of requirements for terrestrial DAB transmitters according to ETS 300 401 [1]. A transmitter comprises all the functions of a chain starting with the input of an ETI signal and ending with the power output of the DAB signal (including power filter if applicable).

It is expected that standard broadcasting transmitter requirements shall apply for features not mentioned here (i.e. features not directly related to DAB).

Re-transmitters receiving RF DAB signals are not under the scope of this document.

The antenna system is not subject to this recommendation, as the local situation may often require individual solutions. However, it is assumed that the deviations of the radiated signal from the power-amplified signal can be derived by taking into account the properties of the antenna system.

In practice a back-up technique may be necessary to ensure a continuous service.
However, within this document only the basic transmitter is considered.

7.2 Minimum Functionality

7.2.1 Digital Signal Processing – COFDM Encoder

7.2.1.1 Input Signal

The CODFM encoder shall be fed with a signal according to [2]. The processing of the network independent layer [ETI(NI)] is the minimum requirement in any defined physical interface (currently G.703 [3] and V11 are defined).

For MFN applications, the time stamp and the Multiplex Network Signaling Channel (MNSC), which may be present in the ETI(LI), need not be processed as a minimum requirement. The signal processing may be synchronized to the clock-rate of the TI(NI) input or an external reference.

For SFN applications, the time stamp from either the ETI(LI) or ETI(NA) must be processed. The MNSC need not be processed as a minimum requirement. It must be possible to utilize an external time and frequency references, e.g. as derived from GPS. The recommended external frequency reference is a 10 MHz sine wave >-10dBm. The recommended external timing reference is a 1pps (1 pulse per second) signal, rising edge significant, between 2V and 5V peak-to-peak.

Remark: The MNSC within the ETI(LI) provides a low data rate channel that can allow the ensemble multiplex operator to control certain transmitter functions. To date, provision has been made for control of Transmitter Offset Delay and Transmitter Identification Information (TII) using the MNSC.

7.2.1.2 Output Signal

The type of the output signal of the COFDM encoder – base band digital, base band analogue, IF or RF – is subject to the choice of the manufacturer. However, if the COFDM encoder delivers digital base band I and Q signals, the interface should follow the specification given in [4].

7.2.1.3 Functionality

The COFDM encoder shall be capable of generating signals compliant with [1] in the desired DAB operating mode. If multiple modes are supported, it shall be possible to select the DAB mode from the ETI(NI) input.

The COFDM encoder shall appropriately follow any allowed multiplex reconfiguration. In particular, those Sub channels of the Main Service Channel that are not subject to the reconfiguration shall not suffer any interruption.

The insertion of TII (Transmitter Identification Information) in the Null symbol shall be possible. Manual setting is minimum requirement.

7.2.1.4 Delay Management

Definition: The overall signal delay of the DAB transmitter is the time difference from the start of the ETI(LI) frame (i.e. the start of B0,n(b0) of ETI(LI) frame n) with frame phase 0 to the start of the Null symbol of the corresponding transmission frame at the RF output.

Manual setting of the adjustable delays is the minimum requirement.

Further information regarding delay types and management is given in Annex B.

7.2.1.4.1Internal Processing Delay

The internal processing delay of a transmitter comprises the delay in the digital and analogue stages when all adjustable delays are set to minimum. The processing delay shall not exceed 200 ms in mode I, 120 ms in modes II/III, and 150 ms in mode IV.

Remark: Larger processing delays are allowed in Modes I and IV because the FIC data of four or two ETI(NI) frames, respectively, must be combined to form a transmission frame.

7.2.1.4.2 Adjustable delay for use in MFN Transmitters

Adjustable delay for use in MFN Transmitters that are operated in MFNs (Multiple Frequency Networks) shall provide additional adjustable delay sufficient to extend the inherent processing delay to match the maximum permissible processing delay as given above, with a maximum step size of 1 µs.

7.2.1.4.3 Adjustable delay for use in SFN Transmitters

Adjustable delay for use in SFN Transmitters that are operated in SFNs (Single Frequency Networks) shall provide additional adjustable delay sufficient to extend the inherent processing delay to at least 500 ms in all modes, with a maximum step of 1 µs.

Remark: Adjustable delay may also be a requirement in particular situations when analogue and digital transmissions have to be synchronized. In such cases delays of up to one second should be expected. This delay is not subject to a minimum requirement.

7.2.1.5 Behaviour in case of erroneous ETI signal

If the input signal is absent, or if frame synchronization is not achieved, the transmitter shall deliver no RF signal.

After the warming-up time of the transmitter the output RF signal shall be valid within two seconds following the application of an error-free input signal.

7.2.1.5.1 CRC errors

If frame synchronization is achieved but CRC violations are detected, the transmitter shall offer at least the following two alternative responses:

a) The output RF signal is not affected by sporadic single CRC violations. The output RF signal is switched off after p CRC violations in q frames, and switched on after m consecutive frames free from CRC violations. Typical values for p, q and m will be p=4, q=40, m=80 (four errors in ~1 second to shut down, ~2 seconds error-free to restore) however the exact values may be configurable and may exceed those given here.

b) The output RF signal is transmitted irrespective of CRC violations.

7.2.1.5.2 Error status field

If frame synchronization is achieved but the ETI(NI) ERR field is set to indicate upstream errors, the transmitter shall offer at least the following two alternative responses:

a) The output RF signal is switched off when the ERR field indicates level 2 or 3

b) The output RF signal is switched off when the ERR field indicates level 3

7.2.2 Analogue Signal Processing

It shall be possible to convert the output from the COFDM generator into an RF DAB signal, which may be broadcast.

Any signal processing delays incurred during this conversion shall be included when complying with the requirements lay out in section 2.1.4.

The resultant signal shall comply with the requirements laid out in section 3.

7.3 Minimum Performance

7.3.1 Power Classes

The output power of the DAB transmitter is measured according to 5.3.

The scheme for output power classes could be based on the quasi-logarithmic system of 1, 2, 5, 10 steps.

If the RF output filter forms part of the transmitter the output power is measured after this filter.

The output power stability shall be better than ±1 dB for all climatic conditions

A reduction of the nominal output power by at least 3 dB should be possible without otherwise affecting the performance.

7.3.2 Unwanted Emission

7.3.2.1 Out-of-band emission

The spectrum of the output DAB signal shall comply with the masks given in [1]. In the case of non-critical L-Band situations (not covered by [1]) the relaxed spectrum mask given in [5] shall apply. The spectrum masks shall be applied up to ±3 MHz and ±5 MHz from centre frequency of the signal in VHF and L-Band respectively. See 5.4 for measurement.

Remark: Other masks may be requested and defined in the future.

Remark: Demands of national licensing authorities may be more stringent.

Remark: It is recommended that the level of a spurious central carrier in the DAB signal should not exceed -30 dB of the total power of the DAB signal.

7.3.2.2 Spurious emission

Spurious emission outside the range of the spectrum mask as defined in 3.2.1 shall be limited according to [6].

Remark: Demands of national licensing authorities may be more stringent.

7.3.3 RF Accuracy and Frequency Synchronization

7.3.3.1 MFN Transmitters

The centre frequency of the RF signal shall not deviate more than 10 % of the relevant carrier spacing from its nominal value. This results in the following allowance for frequency deviation:

Transmission mode I < 100 Hz
Transmission mode IV < 200 Hz
Transmission mode II < 400 Hz
Transmission mode III < 800 Hz

The stability of the centre frequency shall be better than

Transmission mode I ± 10 Hz
Transmission mode IV ± 20 Hz
Transmission mode II ± 40 Hz

Transmission mode III ± 80 Hz

Within a three-month period when measured under identical operating conditions at the start and at the end of the period.

7.3.3.2 SFN Transmitters

For SFN transmitters the same requirement for frequency deviation applies as for MFN transmitters. However, provision has to be made to minimize the differential frequency shift of any two transmitters in an SFN.

Remark: In case of SFN operation the following “differential” frequency accuracy (static and dynamic deviations) shall be maintained between any two transmitters:

Mode I < 10 Hz
Mode IV < 20 Hz
Mode II < 40 Hz
Mode III < 80 Hz

Differential frequency shift of transmitters in an SFN can be minimized by locking all oscillators to an external reference.

The recommended external frequency reference is a 10 MHz sine wave >-10dBm. The recommended external timing reference is a 1pps (1 pulse per second) signal, rising edge significant, between 2V and 5V peak-to-peak.

7.3.4 Deviation of the Output Signal from the Theoretical Form

The distortion of the output signal due to linear and non-linear signal processing inside the DAB transmitter is in general not subject to a minimum requirement.
However, limitation is implicitly given by the BER performance degradation (see 3.6) and by the spectrum mask of the ETS.

Remark: It is expected that a variation of not more than ± 1 dB (in addition to the 3dB variation due to symbol prolongation by the guard interval) of the spectral power density inside the nominal signal bandwidth will not impact the BER performance significantly.
See 5.1 for details of measurement technique.

Remark: Intermodulation up to -25 dB (non-linear products close to the edge of the nominal signal spectrum, often referred to as "shoulder attenuation") will not impact the BER performance significantly.

The group delay distortion across the ensemble bandwidth shall not exceed 2.5 µs in any transmission mode.

Remark: Group delay distortion up to the length of the guard interval may not impact BER performance when measured without multipath propagation; therefore a specific limitation is necessary.

Remark: The contribution of the analogue part of the transmitter to the group delay distortion may be derived from measurements. A complete measurement needs a new definition of procedure and equipment.

7.3.5 Limitation of Peak Power Levels

The peak envelope level of the output RF power signal shall not exceed the mean envelope level by more than 13 dB.

7.3.6 BER-Performance degradation

An operational transmitter shall not degrade the theoretical system BER (with channel coding and decoding) by more than 1 dB, under the conditions set out below:

(See 5.1 for measurement).

Code Rate R for equal convolutional coding	0.5
Transmission modes	all applicable
Theoretical performance	according to Table 1

BER	C/N
$1*10^{-2}$	5.0 dB
$3*10^{-3}$	5.4 dB
$1*10^{-3}$	5.8 dB

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$3*10^{-4}$	6.2 dB
$1*10^{-4}$	6.6 dB
$3*10^{-5}$	6.9 dB
$1*10^{-5}$	7.2 dB
$3*10^{-6}$	7.5 dB
$1*10^{-6}$	7.8 dB

Table 1: Theoretical BER performance in Gaussian channel (equal error protection with R= 0.5)

7.4 Controlling and Monitoring

In this section only DAB related matters are included. Standard broadcasting transmitter techniques for control and monitoring shall apply for features not mentioned here.

7.4.1 Control

The minimum requirement includes the provision of sufficient means for the following operations:

- Delay setting
- TII comb and pattern setting
- Response to CRC violations
- Response to ERR field

All applicable settings shall be stored in non-volatile memory. Stored values shall be used at start-up to ensure continuous operation (e.g. after interruptions of main supply).

It shall be possible to verify the parameters above without interruption of the output.
In addition, it shall be possible to set the value for all the parameters listed above, except the Delay setting, without interruption of the output.

Remark: Turning RF power on and off, adjusting RF-levels and -thresholds as well as adjusting frequency and other transmission characteristics are expected to be implemented according to standard broadcasting transmitter requirements.

Remark: The ETI(NI) MNSC (Multiplex Network Signaling Channel) provides means for remote setting of TII and transmitter offset delay.

7.4.2 Monitoring

The minimum requirement is the provision of the following indications:

- Loss of ETI frame synchronisation
- CRC violation
- RF disabled
- RF disabled by ETI signal error

Remark: Storage for the history of error events, indication of power and return loss, as well as the provision of measurement points with defined signal levels are expected to be implemented according to standard broadcasting transmitter requirements.

7.5 Measurement Technique

The properties of a DAB transmitter are tested while the transmitter is connected to a dummy load.

Remark: In some cases channel output filters may not be integrated into the transmitter unit (particularly on multi transmitter sites) and due regard should be made to this fact when measuring the Spectrum Mask and Output Power parameters.

7.5.1 BER measurement

For this measurement a reference receiver with a performance that is known and is closed to theory is used. In principle only the degradation of the whole chain (transmitter and receiver) can be assessed, but this can provide a useful indication of transmitter degradation.

The receiver is connected to the output of the transmitter (without insertion of a channel simulator). Band limited noise is added to the DAB signal at the receiver input in order to achieve a given value of BER. Adjustable attenuators are used to set both the input power (C) and the noise power (N) to appropriate values at the input of the receiver. BER is the ratio of erroneous bits of the received data to the total bits of the received data during the measurement interval. The power of the added noise, N, is measured within the nominal DAB bandwidth of 1.536 MHz (for power measurement see 5.3).

7.5.2 Delay measurement

A possible means of determining the delay of a transmitter is to insert a specific test pattern into the ETI signal and observe the COFDM signal at IF or RF. Annex A provides details of one implementation of this method.

7.5.3 Power Measurement

The power of the signal of a DAB transmitter is defined as the long-term average of the time-varying short-term signal power. An appropriate instrument for DAB power measurements is a thermal power meter.

Remark: CW power meters are now available, and these should be treated with caution as a measurable error is introduced. Depending on the type of meter used, the error may be as much as 3dB.

Remark: The signal power is constant symbol by symbol. A certain short-term variation is especially given by the Null symbol.

7.5.4 Spectrum Measurement

The spectrum mask in the ETS is defined in relation to spectrum density measured in 4 kHz bandwidth.

The spectral density of a DAB signal shall be defined as the long-term average of the time-varying signal power per unity bandwidth (i.e. 1 Hz). Values for other bandwidths can be achieved by proportional increase of the values for unity bandwidth.

The spectral density of a DAB signal can in principle be determined by the following procedure: The DAB signal is applied to a band filter with rectangular pass band characteristics and a known bandwidth (typically 10 kHz) and with an adjustable centre frequency. The output of the filter is measured by a power meter that delivers real mean values and integrates as long as necessary (typically 2 transmission frames) to get constant readings.

These readings can be interpreted as the average spectral density for the measurement bandwidth used. By moving the centre frequency step by step across the DAB signal and adjacent frequency regions the frequency dependent average of the spectral density can by found. The derivation of the average spectrum density for the unity bandwidth is straightforward. In practice using a spectrum analyzer will often perform such measurements. It has to be analysed to what extend the device follows the principles given above. In particular, equivalent noise bandwidth and RMS measurement need to be carefully checked.

Due to the prolongation of the COFDM symbol by the guard interval the spectral density inside the nominal bandwidth varies by about 3 dB with a periodicity of the carrier distance (see ETS). This variation can only be observed in its entirety if the bandwidth of the spectral density measurement filter is low compared to the carrier distance. (The carrier distance is mode-dependent.)
Remark: Low measurement bandwidth allows detection of small CW components within the COFDM spectrum. Those components that fall outside the nominal DAB frequency block should be treated separately from the COFDM signal, as their impairment effect may be different.

To avoid regular structures in the modulated signal a non-regular, e.g. a PRBS (Pseudo Random Binary Sequence) like or a programme type digital transmitter-input signal is necessary.

Care has to be taken that the input stage of the selective measurement equipment is not overloaded by the main lobe of the signal while assessing the spectral density of the side lobes, i.e. the out-of-band range. Especially in cases with very strong attenuation of the side lobes non-linear distortion in the measurement equipment can produce side lobe signals that mask the original ones. Selective attenuation of the main lobe has proven to be in principal a way to avoid this masking effect. However, as the frequency response of the band-stop filter has to be included in the evaluation the whole measurement procedure may become somewhat complex.

8. Multiplexing

Ownership:
Broadcasters (CASP's) or Consortiums consisting of several CASP's should be allowed NSP/NFP licences in addition to CASP licences, to allow the establishment of a more financially economical technical infrastructure. Without this flexibility, it may not be viable for CASP's to proceed to commercial roll out at all, as transmission infrastructure costs are the highest single operational cost for CASP's in Malaysia

9. Migration

Migration to Eureka 147 will carry an extremely high investment, with no immediate commercial return as it will not generate new listeners. Digital listeners will typically consist of analog listeners migrating to new digital receivers. The ongoing costs to maintain both analog and digital transmission systems for a 10 year simulcast period will be potentially crippling, therefore the following recommendations are requested;

No regulatory/licensing migration costs applicable

No new players for the simulcast period of 10 years, as new entrants will devalue the current market to existing players and will result in casualties.

A simulcast period of 10 years before any consideration to switch off analog.

All available Band III and L-Band spectrum to be reserved to allow initial introduction of Digital, no new analog television to be allowed in Band III

A plan is established for analog television in Band III to migrate out as soon as possible
CASP's allowed to introduce new channels, to help promote the advantage and provide incentive to move to Digital to the consumer.

Loose control over audio to data share of allocated bandwidth, so that CASP's can develop new content services.
CASP's must use a major share of bandwidth for audio services to avoid bandwidth being used for data distribution.

Bandwidth allocated to CASP's proportionate to the existing number of analog channels, to maintain fairness and stability within the industry.

10. Reference documents

The following references are to be used in order to further define the details of the technical standards which has been published and made available for the public. Website for the standard can be found at http://www.worlddab.org

Doc No	Title	Organization
ITU-R Recommendations 774 & 789	Requirements for DAB	ITU
ITU-R Recommendations BS. 1114 and BO. 1130	Standard for terrestrial and satellite sound broadcasting respectively to vehicular, portable and fixed receivers in VHF/UHF frequency range	ITU
ITU-T Recommendations G.703	General Aspects of Digital Transmission Equipment; Terminal Equipment. Physical/electrical Characteristics of Hierarchical Digital Interfaces, Geneva, 1994	ITU
ITU: Radio Regulations, Appendix 8, Geneva, 1994	Minimum Requirements for Terrestrial DAB Transmitter	ITU
EN 300401 V1.3.3 (May 2001)	DAB to mobile, portable and fixed receivers (Third Edition)	ETSI
EN 300797 V1.2.1	DAB, Distribution interfaces, Service Transport Interface (STI)	ETSI
EN 300 798 V1.1.1	DAB, Distribution interfaces; Digital baseband In-phase and Quadrature (DIQ) Interface	ETSI
ETS 300799	DAB; Distribution interfaces; Ensemble Transport	ETSI

	Interface (ETI)	
EN 301234 V1.2.1	DAB ; Multimedia Object Transfer (MOT) protocol	ETSI
EN 301700 V1.1.1	DAB; Service Referencing from FM-RDS; Definition and use of RDS-ODA	ETSI
EN 302077-1 V1.1.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the Terrestrial- Digital Audio Broadcasting (T-DAB) service; Part 1: Technical characteristics and test methods	ETSI
EN 302077-2 V1.1.1	Electromagnetic compatibility and Radio spectrum Matters (ERM); Transmitting equipment for the Terrestrial- Digital Audio Broadcasting (T-DAB) service; Part 2: Harmonized EN under article 3.2 of the R&TTE Directive	ETSI
ES 201735	DAB; Internet Protocol Datagram Tunnelling	ETSI
ES 201736 V1.1.1	DAB; Network Independent Protocols for Interactive Services	ETSI
TS 101736 V1.1.1	DAB; Network Independent Protocols for Interactive Services	ETSI
ES 201737 V1.1.1	DAB Interactive Channel through GSM / PSTN / ISDN / DECT	ETSI
TS 101737 V1.1.1	DAB Interactive Channel through GSM / PSTN / ISDN / DECT	ETSI
TR 101495 V1.1.1	DAB; Guide to DAB Standard; Guidelines and Bibliography	ETSI
TR 101496-1 V1.1.1	DAB; Guidelines and Rules for Implementation and Operation	ETSI
TR 101496-2 V1.1.2	DAB; Guidelines and Rules for Implementation and Operation	ETSI
TR 101496-3 V1.1.2	DAB; Guidelines and Rules for Implementation and Operation	ETSI
TR 101497 V1.1.1	DAB; Rules of Operation for the Multimedia Object Transfer Protocol	ETSI
TS 101498-1 V1.1.1	DAB; Broadcast Web Site Application, Part 1: User Application Specification	ETSI
TS 101498-2 V1.1.1	DAB; Broadcast Web Site Application, Part 2: Basic Profile Specification	ETSI
TS 101499 V1.1.1	DAB; MOT Slide Show; User Application Specification	ETSI

TS 101756 V1.1.1	DAB; Registered Tables	ETSI
TS 101757 V1.1.1	DAB; Conformance Testing for DAB Audio	ETSI
TS 101758 V2.1.1	DAB; DAB Signal Strengths and Receiver Parameters	ETSI
TS 101759 V1.2.1	DAB; DAB Data Broadcasting Transparent Data Channel	ETSI
TS 101860 V1.1.1	DAB; Distribution Interfaces; Service Transport Interface (STI); STI Levels	ETSI
TS 101993 V1.1.1	DAB; A Virtual Machine for DAB: DAB Java Specification	ETSI
TS 102818 V1.2.1	DAB;XML Specification for DAB Electronic Programme Guide (EPG)	ETSI
TS 102371 V1.1.1	DAB; Transportation and Binary Encoding Specification for DAB Electronic Programme Guide (EPG)	ETSI
TS 102367 V1.1.1	DAB; Conditional access	ETSI
TS 102368 V1.1.1	DAB; DAB-TMC (Traffic Message Channel)	ETSI
TS 102 427	DMB	ETSI
TS 102 428	DMB	ETSI
EN 50255	DAB; Specification of the Receiver Data Interface (RDI)	CENELEC
IEC 62105	DAB; Specification of the Receiver Data Interface (RDI)	IEC
EN 50248	Characteristics of DAB receivers	CENELEC
IEC 62104	Characteristics of DAB receivers	IEC
EN 50320	The DAB Command Set for receivers	CENELEC
MCMC SRSP Document	Official document shall be published by MCMC	MCMC

11. Glossary

AIC (Auxiliary Information Channel	A part of the Main Service Channel, used to carry information (e.g. SI) redirected from the Fast Information Channel.
Audio frame	A frame of 24ms duration which contains information of an ISO/IEC 11172-3 (3) Layer II encoded audio signal, corresponding to 1,152 consecutive audio samples at 48 kHz sampling frequency. It is the smallest part of the audio stream which is decodable on its own.
CA (Conditional Access)	A mechanism by which the user access to services can be restricted.
CEPT	European Conference for Posts and Telecommunications
COFDM (Coded Orthogonal Frequency Division Multiplex)	A transmission technique by which the complete ensemble (=multiplex) is transmitted via several hundred (or even several thousand) closely-spaced RF carriers which occupy a total bandwidth of approx. 1.5 MHz, the so-called frequency block. Due to the low data rate of each RF carrier, any delay reflections of the signal (i.e. "passive echoes") will add to the direct signal already received and thus allow interference-free reception under conditions of multipath propagation.
Convolutional coding	the coding procedure which generates redundancy in the transmitted data stream in order to provide ruggedness against transmission distortions
DAB	Digital Audio Broadcasting
DAB audio frame	same as audio frame, but includes all the specific DAB audio related information e.g. PAD
DAB transmission signal	the transmitted radio frequency signal
Doppler effect	an apparent shift in the received frequency of a source due to relative motion between source and receiver
DQPSK (Differential Quadratur Phase Shift Keying)	a modulation principle which consists of encoding the phase rotation of each carrier between consecutive modulation symbols
Dual-channel mode	The audio mode in which two independent programme contents (e.g. bilingual) are encoded within one audio bit stream. The coding process is the same as for the stereo mode
Ensemble	The transmitted signal (i.e. multiplex). The ensemble is the entity which is received and processed. In general, it contains programme and data services
ETI (Ensemble Transport Interface)	the interface between the Ensemble Provider and the Transmission Network to deliver a full DAB ensemble to each

	transmitter
ETS (European Telecommunication Standard)	In late 1994, the EUREKA-147 DAB system was adopted by the ETSI as the European Standard. The ETS 300 401 on DAB describes the technical details of the broadcast on-air signal. It is based on the overall system and service requirements adopted by the ITU-R Recommendations 774 and 789.
ETSI	European Telecommunications Standard Institute
FIC (Fast Information Channel)	a part of the transmission frame which contains the multiplex configuration information together with optional Service Information and data service components
FIDC (Fast Information Data Channel)	The dedicated part of the Fast Information Channel which is available for non-audio related data services, such as paging.
ITTS (Interactive Text Transmission System)	a text transmission system that maintains an exchange with the user, alternately accepting input and then responding
ITU (International Telecommunication Union)	A global organisation to consider new developments in broadcasting technology and agree the technical standards of broadcast systems – for both radio and TV – on a worldwide basis.
ITU-R	International Telecommunication Union – Radiocommunication
Joint stereo mode	the audio mode in which two channels forming a stereo pair (left and right) are encoded within one bit stream and for which stereophonic irrelevance or redundancy is exploited for further bit reduction
JPEG (Joint Picture Expert Group	An ISO/IEC standard to digitally encode and compress still pictures.
MCI (Multiplex Configuration Information)	The information defining the configuration of the multiplex. It contains the current (and in the case of an imminent reconfiguration, the forthcoming) details about the services, service components and sub-channels and the linking between these objects. It is carried in the FIC in order that a receiver may interpret this information in advance to decode the service components carried in the Main Service Channel. It also includes identification of the ensemble itself and a date and time marker.
MOT (Multimedia Object Transfer Protocol)	the protocol used to support the transfer of the useful data and the side-information (= multimedia objects) via DAB using all the transport mechanisms provided (Stream mode, Packet mode and PAD)
MPEG (Moving-Picture Experts Group)	a standard (ISO/IEC 11172-3 (MPEG 1 Audio Layer II) and ISO/IEC 13818-3 (MPEG 2 Audio Layer II)) on source-coding systems/audio-compression formats to digitally encode and represent moving pictures and associated audio making use of the phenomenon of Psycho-acoustic Masking. This system is also known as MUSICAM

MSC (Main Service Channel)	a channel which occupies the major part of the transmission frame and which carries all the digital service components (audio and/ or data
Multiplexing	The process of interweaving two or more lower-speed data streams into a single high-speed radio-frequency channel for simultaneous transmission.
MUSICAM (Masking pattern Universal Sub-band Integrated Coding and Multiplexing):	An MPEG ISO standardised audio-compression technique used in DAB.
Packet mode	The mode of data transmission in which data is carried in addressable blocks called packets.
Null symbol	the first OFDM symbol of the transmission frame
OFDM symbol	The transmitted signal for that portion of time when the modulating phase state is held constant on each of the equi-spaced, equal amplitude carriers in the ensemble. Each carrier is four-phased differentially modulated from one symbol to another, giving a gross bit-rate of two bits per carrier per symbol
PAD (Programme Associated Data):	Information which is transmitted together with the audio data. The PAD field is located at the end of the DAB audio frame
PCM	Pulse Code Modulation
Protection Level	a level specifying the degree of protection, provided by the convolutional coding, against transmission errors
RDI (Receiver Data Interface)	Expected to become the standard interface between DAB receivers and peripheral devices (e.g. computers, printers, dedicated decoders and devices for audio processing and recording). The RDI can carry the full DAB multiplex including information about which transmitters are being received for location-dependant data evaluation; it can also be used for receiver measurements, since it provides access to the decoded bit-streams of the FIC and MSC Subchannels.
RF (Radio Frequency)	A frequency that is useful for radio transmission, usually between 10kHz and 300,000 MHz.
Service label	Alphanumeric characters associated with a particular service and intended for display in a receiver
SFN (Single Frequency Network)	A network of DAB transmitters using the same radio frequency to achieve a large area coverage.
SI (Service Information)	Auxiliary information about services, such as service labels and programme type codes.
Stereo mode	The audio mode, in which two channels forming a stereo pair (left and right) are encoded within one bit stream and for which the coding process is the same as for the Dual channel mode.
Stream mode	The mode of data transmission within the Main Service Channel in which data is carried transparently from source to

	destination
Sub-band	A subdivision of the audio frequency range. In the DAB audio coding system, 32 sub-bands of equal bandwidth are used
TII (Transmitter Identification Information)	The symbol included in every second transmission frame instead of the Null-Symbol in order to indicate the current transmitter
TMC (traffic Message Channel)	An additional service transmitted as a part of the FIC to provide digitally encoded traffic messages.
Transmission frame	The actual transmitted frame, specific to the four transmission modes, conveying the Synchronisation Channel, the Fast Information Channel and the Main Service Channel.
UEP (Unequal Error Protection)	An error protection procedure which allows the bit error characteristics to be matched with the bit error sensitivity of the different parts of the audio frame.
WARC (World Administrative Radio Conference)	at the Torremolinos WARC-92 held in 1992, DAB services were allocated at 1.5 GHz (L-Band) occupying a frequency band of 40MHz
WARC-88	The World Administrative Radio Conference on the use of the Geostationary-Satellite Orbit and the Planning of Space Services Utilising It, Geneva 1988.
WARC-92 bands	The frequency bands located at 1.5, 2.3 and 2.6 Ghz.

Annex A
(normative)

Measurement of the overall delay of a COFDM-Encoder

In an SFN the transmitters have to transmit the symbols synchronous in time and frequency. To set up an SFN the overall delay time of each transmitter including delay compensation has to be known.

According to 2.1.3 the overall delay of a DAB transmitter is defined as the time difference from the start of the first bit of the ETI(LI) frame with phase 0 to the start of the Null symbol of the corresponding transmission frame at the RF output. It comprises the processing delay and the additional adjustable delay.

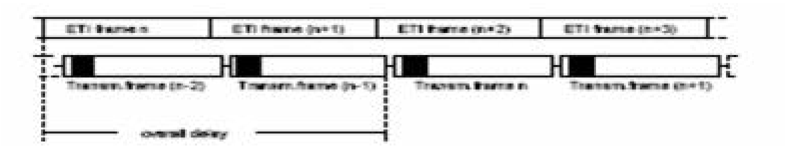

Figure A.1. Overall Transmitter delay, illustrated for the case of transmission mode II and III

The problem is to identify the output frame corresponding to a specific ETI frame.

Detection of a transmission frame in the analogue output signal

It is not possible to observe a specific sub channel because the sub channels are time interleaved. So the solution is to fill the FIC with a specific data pattern and to detect this specific FIC at the analogue output of the COFDM encoder or the whole transmitter.

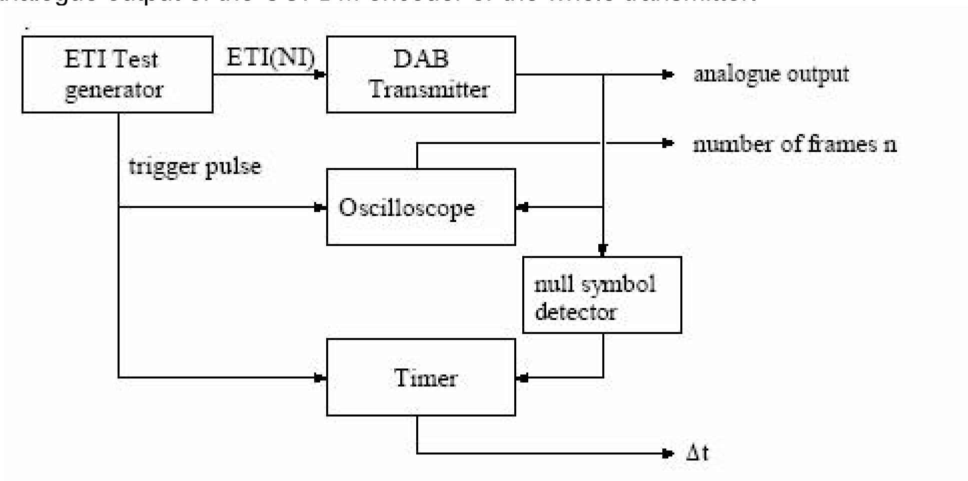

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Figure A.2. Set-up for the measurement of the overall transmitter delay

The ETI test generator periodically inserts Fast Information Blocks (FIB) with a specific data pattern into ETI frames with frame phase 0. A suitable period might be 32 frames. It also generates a trigger pulse synchronous to the start of this ETI frame, which is used to trigger a storage oscilloscope.

In a COFDM encoder the first FIC symbol is calculated by differential encoding the frequency interleaved data with reference to the phase states of the phase reference symbol. For example if the frequency interleaved data of the following symbol would be all zero the envelope of the phase reference symbol would be repeated.

The specific FIBs result in specific FIC symbols. Their waveform can be detected with an oscilloscope suitable for the frequency range of the DAB Signal, e.g. an IF signal. So the user has to count the number of complete transmission frames until the specific FIC appears.

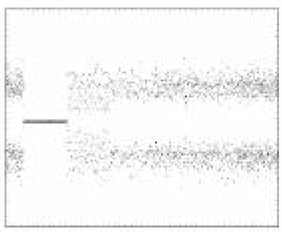
Finally the time difference between the start of the ETI frame and the first displayed transmission frame after the trigger pulse has to be measured. This can be done by detecting the null symbol and generate a synchronous pulse. Then the difference between this pulse and the trigger pulse can be measured with a timer.

Calculating the overall delay

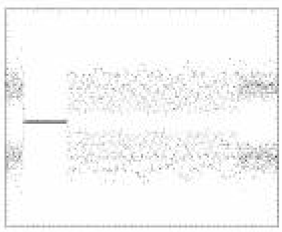
The overall delay is given by the following expression:
delay = n · Tf + .t

with n number of complete transmission frames
Tf duration of a transmission frame
.t difference between trigger pulse and null symbol pulse

The following figures show the difference of a normal FIC waveform and a FIC waveform with a specific data pattern as can be observed at an oscilloscope screen.



FIC with normal data



FIC with specific data pattern

Fig. A3: Difference in FIC waveforms

Annex B
(normative)

Delay Type and delay management

There are a number of types of delay adjustment that may be defined for operational purposes. These are:

Transmitter Trimming Delay

Transmitter Trimming Delay is used to ensure that transmitters from different manufacturers have the same nominal delay. By implication, the adjustment range provided for this compensation, added to the delay to the basic transmitter, must meet the maximum delay specification as given in 2.1.4.1.

Transmitter Offset Delay

Used to adjust the relative timings of transmitters within an SFN, in order to optimise reception. The range needed for this adjustment is in the order of 0 to 2000 µs.

Network Padding Delay

Used to compensate the delays in the distribution systems, to ensure that the network is synchronized. Some introductory networks may require up to several hundred milliseconds of adjustment. Network adaptation would normally be expected to include compensation for delays in the distribution system, removing the need for Network Padding Delay in the basic transmitter.

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Malaysian Technical Standards Forum Bhd

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THE MALAYSIAN TECHNICAL STANDARDS FORUM BHD

23-1B Jalan Bandar 9
Pusat Bandar Puchong
47100 Puchong
Selangor Darul Ehsan
Malaysia

Tel: (+603) 5882 2485
Fax: (+603) 5882 2475

Website: www.mtsfb.org.my