Service Following Test Route
Digital Radio UK

Section 1 – Introduction

Alongside the launch of the Digital Radio Certification Mark; Arqiva, Global Radio and Digital Radio UK have set up a test area to demonstrate the DAB service following system.

The objective of setting up this test is to provide DAB radio receiver manufacturers with an ETSI standard-compliant demonstration of service following use cases, as defined in ETSI 103 176, and to confirm the UK Broadcast Digital Radio Technical Codes and Guidance published by OFCOM.

The test route reaches three specific areas – sections of M4 motorway, the M1 motorway and the Dartford tunnel. In these areas specific test cases can be experienced as shown in the document figures below.

A copy of OFCOM Digital Radio Technical Codes and guidance can be downloaded here. Please be aware, OFCOM is currently consulting to amend the Digital Radio Technical Codes, details of which can be found here.

By setting up this test area we are demonstrating each of the defined service following uses cases as specified in ETSI TS 103 176 Digital Audio Broadcasting (DAB); Rules of implementation; Service information features. A copy of the ETSI standard TS 103 176 can be downloaded here.

To achieve this aim, Arqiva will provide all the necessary service following FIG signalling information to be broadcast from the trial DAB Ensembles listed in Table 1.

DAB Ensemble	Ensemble Operator
London 1	CE Digital
London 2	Switchdigital
Berks N. Hants	NOW Digital
West Wiltshire	NOW Digital
Swindon	NOW Digital
Bristol	NOW Digital
Herts Beds & Bucks &Northants	NOW Digital

Table 1: DAB trial ensembles

This trial will be limited to run until 31st December 2014.

If you use the test route please feedback results confidentially to sam.bonham@digitalradiouk.com. No matter how small the detail, we are keen to learn as much as possible from the test.

If there are questions regarding the "service following" feature and trial setup please email sam.bonham@digitalradiouk.com.

If manufacturers would like Digital Radio UK and Arqiva to sign NDAs please speak directly with sam.bonham@digitalradiouk.com.

Section 2 – Service following use cases

A.1 DAB to DAB link in Multi-Frequency Networks

A.1.1 Problem Description

The same ensemble is transmitted on channel 10C and channel 10D (213 360 kHz and 215 072 kHz) for the Northamptonshire, Hertfordshire, Bedfordshire and Buckingham areas in the United Kingdom. These areas are located adjacent to one another with signals transmitted using DAB mode I which are co-timed and synchronised.

Users may expect almost seamless switching between the different frequencies when the ensembles are identical and synchronized.

Synchronized means that the frame start (Null symbol) is sent at precisely the same moment in time, the interleaving is identical and the guard interval is respected. A synchronized MFN is managed like an SFN, the only difference being that the signal is modulated on more than one frequency.

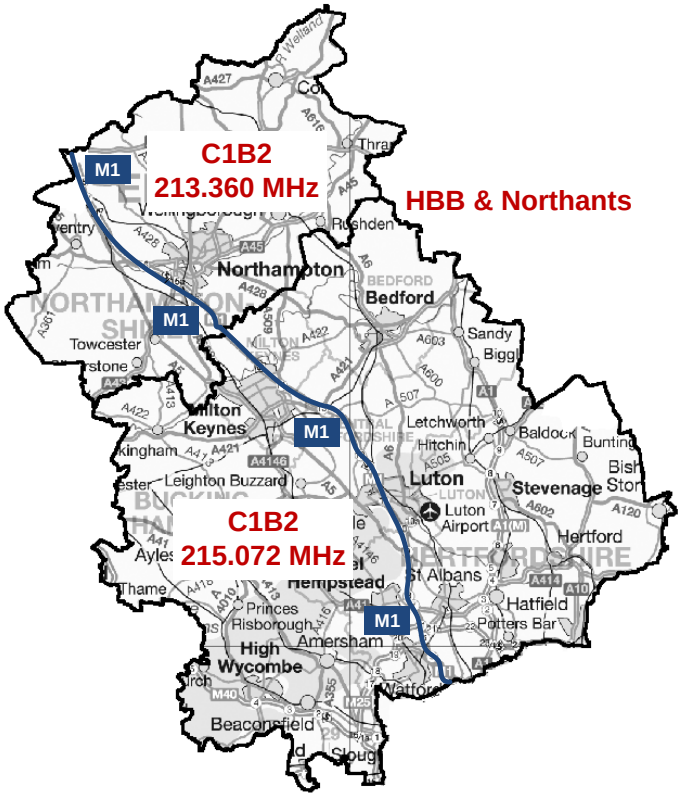

Figure A.1: ensemble configuration showing MFN use case

A.1.2 Concept

A dual tuner device will find the alternative ensemble by scanning in the background.

A single tuner/decoder device should try to monitor the signal strength at all the frequencies indicated by the frequency information in FIG0/21. If a signal is available on another frequency it might try to retune the tuner while keeping the decoder pipeline in operation. Confirming the EId of the chosen frequency before switching reception of the MSC should provide for seamless switching.

A.1.3 Signalling

A.1.3.1 FIG0/6 Service linking information

Not required for this use case.

A.1.3.2 FIG0/24 OE Services

Not required for this use case.

A.1.3.3 FIG0/21 Frequency Information

Field	Value	Description
C/N	0	Start of database
OE	0	Tuned Ensemble
P/D	0	not used for Frequency Information
RegionId	0b000 …0	RegionId set to "0000 0000 000", no area is specified
Length of FI list	9	Length in bytes of the following FI list
Id field (Identifier field)	0xC1B2	EId
R&M	0b0000	Range and Modulation, DAB Ensemble
Continuity flag	1	The ensemble is co-timed and synchronised
Length of Freq. list	6	Length in bytes of the following Freq list
Control field	0b00010	field Adjacent area, transmission mode I
Freq	0x03417	The multiplier of 16 kHz of the centre frequency 213 360 kHz
Control field	0b00010	Adjacent area, transmission mode I
Freq	0x03482	The multiplier of 16 kHz of the centre frequency 215 072 kHz

FIG0/21 Binary Data
0c 15 00 09 c1 b2 0e 10 34 17 10 34 82

A.1.4 Receiver Behaviour

A.1.4.1 Single tuner device

A single tuner decoder device should try to monitor the signal strength of the frequency it is not tuned to; so when tuned to 10C it should monitor the signal strength of 10D and vice-versa. If the receiver can also determine the EId of the signal at the other frequency it can confirm if the correct ensemble is present.

If the signal strength on the other frequency is better it should retune while keeping the decoder pipeline in operation.

If the EId of the newly acquired ensemble does not match the original then the receiver should retune to the original frequency.

A.1.4.2 Dual tuner device

A dual tuner will synchronise the second tuner to the second frequency. In case of signal loss on the first frequency the receiver might switch or retune the foreground tuner keeping the decoder pipeline in operation.

A.2 Linking to the same service on different ensembles

A.2.1 Problem Description

The same programme service (same SId) is available on multiple ensembles (differing EId's), and those ensembles are on a variety of frequencies.

Figure A.2 illustrates the coverage areas of four different adjacent ensembles. The example explains service following for the XFM service that is available in all ensembles. The bold line illustrates a possible travelling route between the different coverage areas.

The ensemble with EId 0xC186 (London 2) is geographically adjacent to ensembles with EId's 0xC1AD (Berks N.Hants) and ensembles 0xC1A9 (Sussex Coast), 0xC19C (Essex), and 0xC1AF (Cambridge) which are not shown, signalling has not been included to these ensembles.

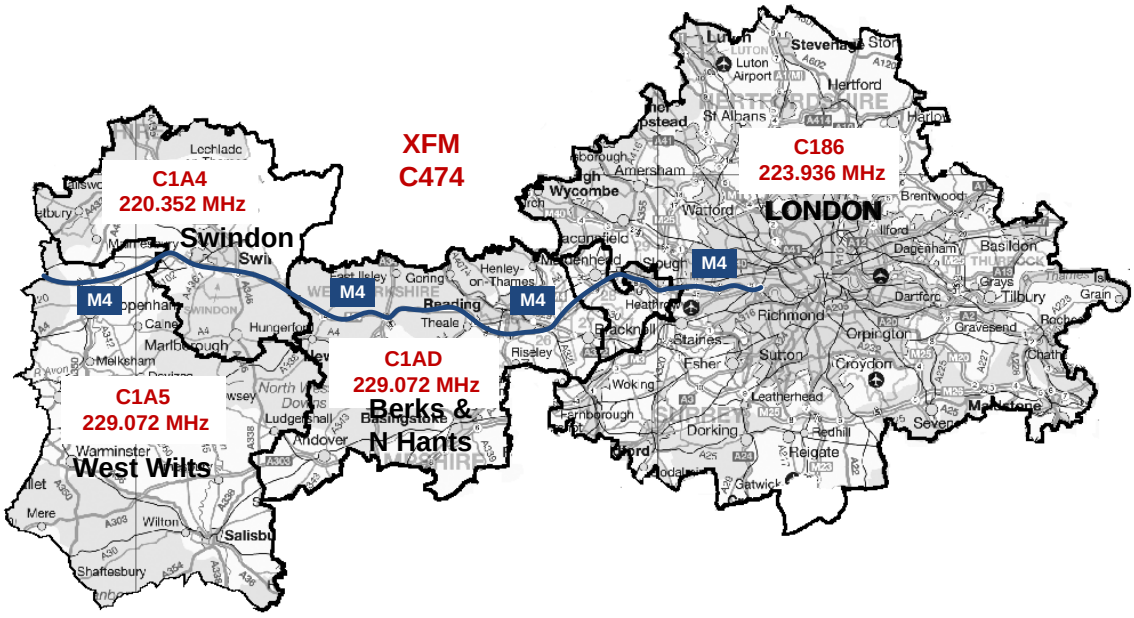

Figure A.2: Ensemble coverage schematic showing XFM service following use case

A.2.2 Concept

Signalling of FIG0/24 will help a single tuner to identify alternative ensembles carrying the same service.

Signalling of FIG0/21 will help a single tuner to find the frequencies of the alternative ensembles.

A dual tuner may detect the same service on a different ensemble and frequency by periodic analysis of received
signals.

A.2.3 Signalling

A.2.3.1 FIG0/6 Service linking information

Not required for this use case.

A.2.3.2 FIG0/24 OE Services

FIG0/24 Signalling in ensemble **0xC186** is shown below.

Field	Value	Description
C/N	0	Start of database
OE	0	Tuned Ensemble (the service exists in the tuned Ensemble)
P/D	0	Programme service
SId	0xC474	Service for which ensemble information is being signalled
Rfa	0	
CAId	0	No Conditional Access applicable
Number of EId's	1	1 Ensemble Ids to follow
Ensemble Identifier	0xC1AD	Ensemble Id of an ensemble carrying the Service

FIG0/24 Binary Data
06 18 c4 74 01 c1 ad

A.2.3.3 FIG0/21 Frequency Information

Signalled *differently* in each ensemble since this is the OE frequency information. FIG0/21 Signalling in ensemble **0xC186** is shown below.

Field	Value	Description
C/N	0	Start of database
OE	1	Other Ensemble(the service is carried in other ensembles)
P/D	0	not used for Frequency Information
RegionId	0b000 …0	RegionId set to "0000 0000 000", no area is specified
Length of FI list	6	Length in bytes of the following FI list
Id field (Identifier field)	0xC1AD	EId
R&M	0b0000	Range and Modulation, DAB Ensemble
Continuity flag	0	The ensemble is not co-timed or synchronised
Length of Freq. list	3	Length in bytes of the following Freq list
Control field	0b00010	field Adjacent area, transmission mode I
Freq	0x037ED	The multiplier of 16 kHz of the centre frequency 229 072 kHz

FIG0/21 Binary Data
09 55 00 06 c1 ad 03 10 37 ed

A.2.4 Receiver Behaviour

A receiver should decide a point at which the currently received signal is inadequate. For a single tuner device this may be through use of a fixed reference point, and for a dual tuner by comparison with the quality of signal being received from other frequencies.

The receiver should attempt to locate the current service on an alternative ensemble. It may use the OE services and frequency information provided by the broadcaster, using Region Information when supplied to reduce the number of alternative ensembles to try to just those in the current Region.

If this fails, or no OE services information is being signalled, the receiver will attempt to locate the current service by scanning all possible frequencies and analysing all the services on the ensembles found.

E.g. While travelling along the route in the picture above. Between ensembles London and Berks N.Hants, both Ensemble coverage areas overlap and are therefore available. In both Ensembles, FIG0/24 and FIG0/21 are signalled. Switching between the Ensembles may occur at any time.

A.3 Linking regional variations of a service on different ensembles

A.3.1 Problem Description

A programme service is broadcast across multiple regions, on different ensembles. At certain times the programme service is identical on all ensembles, and at other times the content is different. As the programme content is not always identical on all ensembles at all times, each regional variation has a different SId code. The periods of non-identical content may be of only a few minutes duration, such as commercial breaks or news bulletins, or may be for the duration of a programme segment.

At times when the programme service is identical, the broadcaster wants the listener to experience continuous coverage, as if the service was transmitted with the same SId code on all ensembles.
At times when the programme service is not identical, the broadcaster does not want the listener to be switched between regions automatically by the receiver between regions carrying different content and will therefore rely on soft linking for the listener to determine the most suitable alternative programme.
The broadcaster can control whether linking is active or inactive, and can do so quickly and often.

There are two occasions on a weekday where Heart transitions into network programming (10am and 7pm) and once at weekends (5pm Saturday, 4pm Sunday). Table 2 below shows a typical example of weekday transitions to the London region of the Heart network.

Heart Service – Network Configurations				
Approximate Time	Description	LSN 197 Hard LA	LSN 1A7 Hard LA	Network Configuration
18:20	Songs and live links. Common on both Heart London and Heart UK. The rest of the Heart network is playing local programming.	False	True	Heart London Regionalised - uses link 1A7
18:40	Commercial break. Different commercials play on Heart London and Heart UK	False	False	Heart Local – No network linkage
18:45	End of break. Common programming on Heart London and Heart UK. Rest of the network still in local programming.	False	True	Heart London Regionalised - uses link 1A7
18:55	Commercial break into news. Again different content on services.	False	False	Heart London only – No network linkage
19:02	End of news. All Heart stations in the network taking common programming	True	False	Heart networked nationally
19:15	First break of the network show. All stations take localised commercials. Different audio on Heart London and Heart UK	False	False	Heart Local – No network linkage
19:20	End of break. All stations take network feed again.	True	False	Heart networked nationally

Table 2: Heart network showing approximate network configuration transitions

In figure A.3 the six related Heart services are carried on five of the trial ensembles.

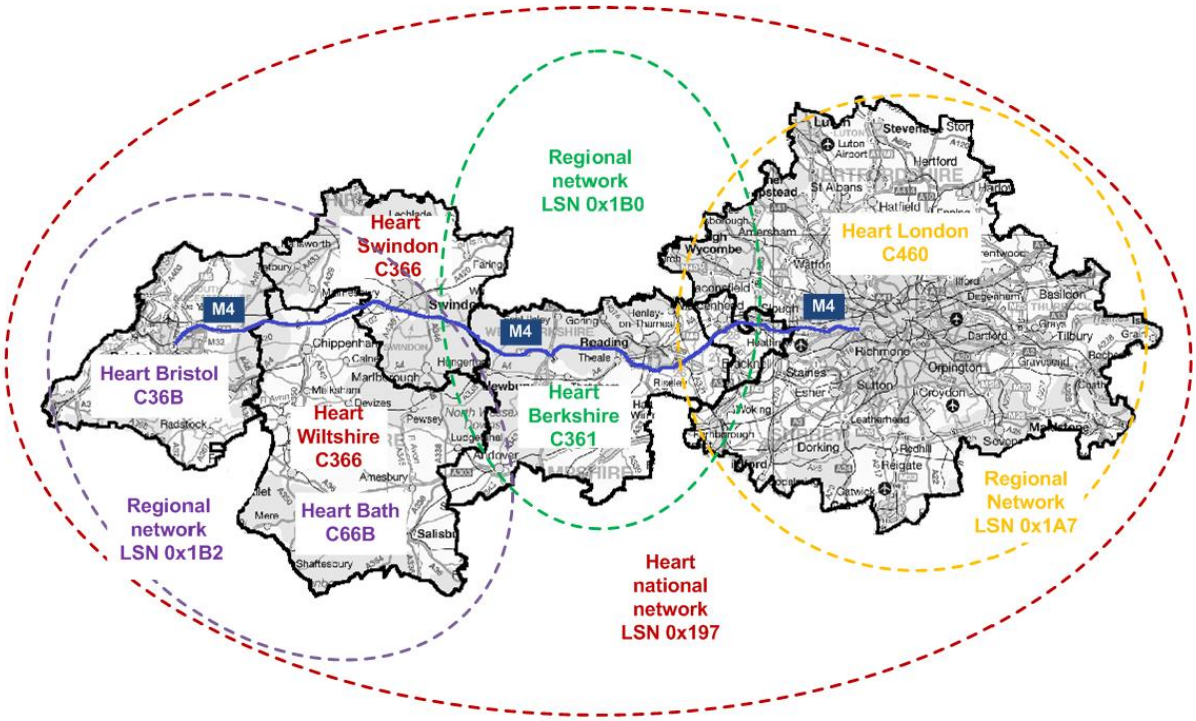

Figure A.3: Ensemble coverage schematic showing Heart service following use case

A.3.2 Concept

There are two network configurations with services that need to be linked and each is represented by a linkage set. The linkage sets are signalled in each ensemble that has a service that is linked, so all ensembles include the linkage set for all six Heart services linked together and the two ensembles, Bristol and West Wilts also have the linkage set for the two services linked during periods when Heart is regionalised. Two further regional networks are demonstrated in the trial using LSN's 0x1B0 and 0x1A7. FIG0/6 in the long form is used to repeat these definitions throughout the day. According to the time of day, the appropriate linkage set is activated or deactivated using FIG0/6 in the short form.

To assist single tuner devices, the OE Services (FIG0/24) and frequency information (FIG0/21) may be signalled. OE Services links the SId and EId and frequency information provides the centre frequency of the ensembles.

A dual tuner may detect the linked services on other ensembles by periodic analysis of received signals.

A.3.3 Signalling

A.3.3.1 FIG0/6 Service linking information

The information describing the linkage set for all services linked together (LSN = 0x197) is signalled on all five
ensembles and the order of the SId list is the same on all five. The information describing the linkage set when the Heart Bristol and Heart Bath services are linked together (LSN = 0x1B2) is signalled on these two ensembles; again the order of the Sid list is the same on both ensembles. Therefore each ensemble will signal the national linkage set and a regional linkage set at all times. The state of the link actuators will always be set in accordance with the linkage schedule both in the slower cyclic repetition of the long form database definition FIGs and the faster cyclic repetition of the short form activation state FIG's. When the activation states changes then a burst of short form FIGs are sent.

The following shows partial FIG0/6 information sent on ensemble 0xC18C; the linkage actuator settings are according to the time of day. This snapshot was when linkage set 0x1B2 is activated.

Field	Value	Description
C/N	0	Start of database
OE	0	Tuned Ensemble (the service exists in the tuned Ensemble)
P/D	0	Programme service
Id List Flag	1	Long form
Linkage Actuator	1	Link is active
Soft/Hard	1	Hard link
ILS	0	National link
LSN	0x1B2	Linkage Set Number
Rfu	0	1 bit reserved for future use
IdLQ	0b00	Each Id represents an DAB SId
Shd	0	Ids in the list represent a single service
Number of Ids	2	Number of Ids in the Id list
Id1	0xC36B	SId of service
Id2	0xC66B	Sid of service
Id List Flag	1	Long form
Linkage Actuator	1	Link is active
Soft/Hard	1	Hard link
ILS	0	National link
LSN	0x1B2	Linkage Set Number
Rfu	0	1 bit reserved for future use
IdLQ	0b01	Each Id represents an FM RDS PI code
Shd	0	Ids in the list represent a single service
Number of Ids	1	Number of Ids in the Id list
Id1	0xC36B	PI code of service

FIG0/6 Binary Data
08 06 e1 b2 02 c3 6b c6 6b 06 06 e1 b2 21 c3 6b

The following short form FIG0/6 signalling information is also sent on ensemble 0xC18C; the linkage actuator settings are according to the time of day. This snapshot was when linkage set 0x1B2 is activated and linkage set 0x197 is deactivated.

Field	Value	Description
C/N	0	Linkage Activation State
OE	0	Tuned Ensemble (the service exists in the tuned Ensemble)
P/D	0	Programme service
Id List Flag	0	Short form
Linkage Actuator	0	Link is deactivated
Soft/Hard	1	Hard link
ILS	0	National link
LSN	0x197	Linkage Set Number
Id List Flag	0	Short form
Linkage Actuator	1	Link is activated
Soft/Hard	1	Hard link
ILS	0	National link
LSN	0x1B2	Linkage Set Number

FIG0/6 Binary Data
05 06 21 97 61 b2

A.3.3.2 FIG0/24 OE Services

The information describing the OE Services is signalled on each of the ensembles for the related services.

The information is different on each ensemble because each has a different set of other ensemble services.

The following information is sent on ensemble 0xC1AD and includes adjacent ensembles where related Heart services are present on participating trial ensembles.

Field	Value	Description
C/N	0	Start of database
OE	1	Other Ensemble (the service is carried in Other Ensembles)
P/D	0	Programme service
SId	0xC460	Service for which ensemble information is being signalled
Rfa	0	
CAId	0	No Conditional Access applicable
Number of EId's	1	1 Ensemble Id to follow
Ensemble Identifier	0xC185	Ensemble Id of an ensemble carrying the Service
SId	0xC366	Service for which ensemble information is being signalled
Rfa	0	
CAId	0	No Conditional Access applicable
Number of EId's	2	1 Ensemble Id to follow
Ensemble Identifier	0xC1A4	Ensemble Id of an ensemble carrying the Service
Ensemble Identifier	0xC1A5	Ensemble Id of an ensemble carrying the Service
SId	0xC66B	Service for which ensemble information is being signalled
Rfa	0	
CAId	0	No Conditional Access applicable
Number of EIds	1	1 Ensemble Id to follow
Ensemble Identifier	0xC1A5	Ensemble Id of an ensemble carrying the Service

FIG0/24 Binary Data
12 58 c4 60 01 c1 85 c3 66 02 c1 a4 c1 a5 c6 6b 01 c1 a5

The following Other Services information is sent on ensemble 0xC1A4 for an adjacent ensemble where the same Heart service is present.

Field	Value	Description
C/N	0	Start of database
OE	0	Tuned Ensemble (the service exists in the tuned Ensemble)
P/D	0	Programme service
SId	0xC366	Service for which ensemble information is being signalled
Rfa	0	
CAId	0	No Conditional Access applicable
Number of EIds	1	1 Ensemble Id to follow
Ensemble Identifier	0xC1A5	Ensemble Id of an ensemble carrying the Service

FIG0/24 Binary Data
06 18 c3 66 01 c1 a5

A.3.3.3 FIG0/21 Frequency Information

The information describing the Frequency information is signalled on each of the ensembles for the related ensembles. The information is different on each ensemble because each has a different set of three other ensembles.

The following information is sent on ensemble 0xC185.

Field	Value	Description
C/N	0	Start of database
OE	1	Other Ensemble (the frequencies belongs to other ensembles)
P/D	0	not used for Frequency Information
RegionId	0b000 …0	RegionId set to "0000 0000 000", no area is specified
Length of FI list	6	Length in bytes of the following FI list
Id field (Identifier field)	0xC1AD	EId
R&M	0b0000	Range and Modulation, DAB Ensemble
Continuity flag	0	The ensemble is not co-timed or synchronised
Length of Freq. list	3	Length in bytes of the following Freq list
Control field	0b00010	field Adjacent area, transmission mode I
Freq	0x037ED	The multiplier of 16 kHz of the centre frequency 229 072 kHz

FIG0/21 Binary Data
09 55 00 06 c1 ad 03 10 37 ed

A.3.4 Receiver Behaviour

If the receiver has determined that it needs to switch to an alternative service, it should refer to the FIG0/6 information.

In each linkage set where the current SId is present in the Id list, and where the linkage set is activated (LA = 1), there is a list of alternative SId codes for the current service.

In conjunction with OE Services (FIG0/24) and Frequency information (FIG0/21) (where provided), the receiver should try the alternative SId codes in any sequence to locate the alternative service on a different ensemble, and with an acceptable signal quality.

The receiver should minimise the time taken to locate the alternative service.

If the receiver has current knowledge of which alternative ensembles and services can be received, for instance by using a dual tuner, then it should switch immediately to the alternative service with the best signal quality.

If ensemble information and frequency information is provided for the alternative services, then this should be used to initially try only frequencies where one or more ensembles carrying the alternative services may be received. In this case, multiple alternative services on multiple alternative ensembles may be checked on a fewer number of frequencies.

If an alternative service cannot be found on the ensembles and frequencies provided in FIG0/24 and FIG0/21, the receiver tries all possible frequencies to locate an alternative service.

On locating an alternative service, and concluding that the signal quality is better than the current service and all other alternatives, the receiver switches automatically and without user intervention. After switching to the alternative service on a different ensemble, the receiver uses service linking information received from the new ensemble for further linking.

A.4 Linking technology variations of a service on different ensembles

A.4.1 Problem Description

The very same audio content may be distributed in different ensembles (different EId) with a different SId because on some ensembles the audio is coded as MPEG layer 2 (DAB), whilst on other ensembles the audio is coded as AAC (DAB+). Those ensembles may or may not have overlapping coverage areas.

This use case will not be trialled in the UK.

Figure A.4: Intentionally not shown

A.4.2 Concept

Signalling of FIG0/6 in all ensembles should be provided to link services together.

Signalling of FIG0/21 will help a single tuner device to find an alternative frequency.

Signalling of FIG0/24 will help a single tuner to identify an ensemble carrying a linked service.

A dual tuner device may find the alternative frequency by scanning all frequencies in the background.

A dual tuner may also detect the linked service in one of the scanned frequencies.

A.5 Soft linking of services

A.5.1 Problem Description

The broadcaster with a number of regional variations of a programme service illustrated in clause A.3 also wishes to indicate to his listeners when a *related* service is available during the times when the services are *not* hard linked together. He may do this by creating a linkage set that includes all his DAB services and his services on other bearers too, like FM-RDS, and signalling this as a *soft* link.

At certain times, some of the regional variations carry identical content, and are linked together using hard links, whilst others are either carrying exclusive content or linked to other regional variants. The regional variants with identical content will be present and active in one of the Heart hard linkage sets, but they may also be active in one soft linkage set at the same time. Therefore, when a receiver cannot find any alternative hard linked services, it may offer the listener a soft linked service that is available.

Figure A.5 illustrates the DAB services available from the example in clause A.3 and also adds the FM-RDS services.

Note that LSN = 0x197 has been chosen to represent the set of all Heart services.

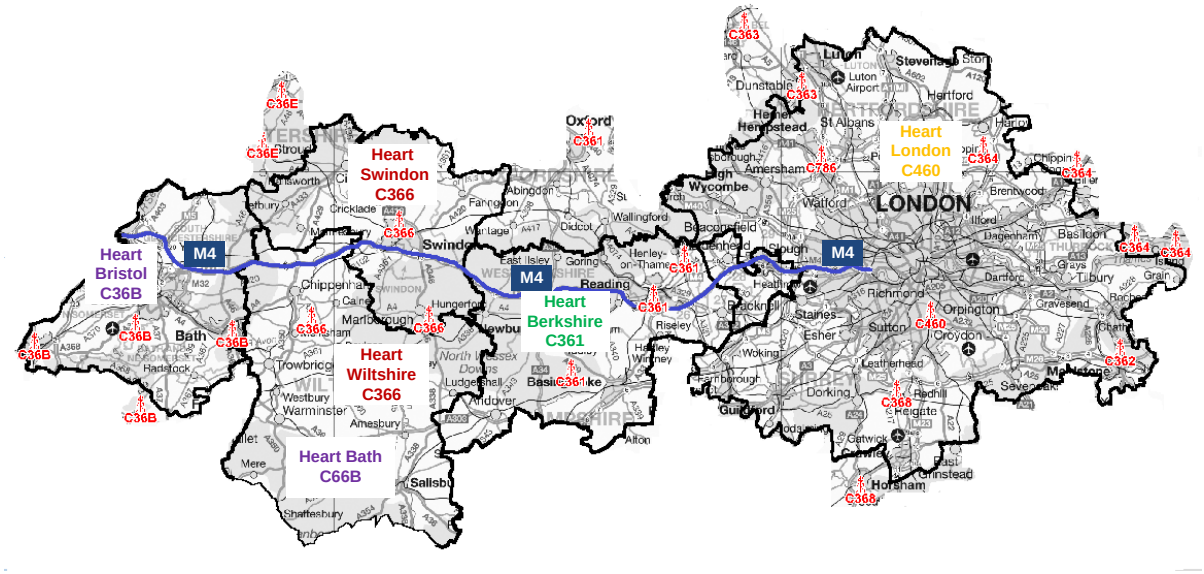

Figure A.5: Ensemble and FM coverage schematic showing Heart service following use case

A.5.2 Concept

All the regional variations of the programme service are contained in a single Linkage Set, with the S/H flag set to 0, indicating a soft linkage set. Some or all of the regional variations may also be in hard linkage sets, which are activated only when the programme content is identical.

The linkage set is transmitted by all the ensembles carrying the regional variations, and the order of the identifiers of the linkage set will be identical on all ensembles. The soft linkage set is always active.

To assist single tuner devices, the OE Services (FIG0/24) and frequency information (FIG0/21) may be signalled. OE Services connects the SId and EId and frequency information provides the centre frequency of the ensembles and the frequency of the FM-RDS services.

A dual tuner may detect the linked services on other ensembles by periodic analysis of received signals.

A.5.3 Signalling

A.5.3.1 FIG0/6 Service linking information

The FIG0/6 information describes all the similar regional variations of the programme service, both carried on DAB and FM-RDS. Each ensemble signals this linkage set at all times. Note that the same LSN is used in this example (0x197) for the soft and hard linkage sets that represent all the services, but that these linkage sets are distinct because the one in clause A.3 is a hard linkage set and the one in this use case is a soft linkage set. However, different LSNs could also have been allocated.

Since the soft linkage set is always active no change FIGs will be sent. However, the linkage information will be sent every two minutes and the state of the linkage actuator will be sent every 10 seconds.

The start of database signalling for soft linkage set 0x197 is shown in the following table. The complete soft linkage set for LSN 0x197, contains 28 DAB SId's and 52 FM PI-codes.

Field	Value	Description
C/N	0	Start of database
OE	0	Tuned Ensemble (the service exists in the tuned Ensemble)
P/D	0	Programme service
Id List Flag	1	Long form
Linkage Actuator	1	Link is active
Soft/Hard	0	Soft link
ILS	0	National link
LSN	0x197	Linkage Set Number
Rfu	0	1 bit reserved for future use
IdLQ	0b00	Each Id represents an DAB SId
Shd	0	Ids in the list represent a single service
Number of Ids	12	Number of Ids in the Id list
Id1	0xC36B	SId of service
Id2	0xC66B	SId of service
Id3	0xC366	SId of service
Id4	0xC361	SId of service
Id5	0xC460	SId of service
Id6	0xC36E	SId of service
Id7	0xC560	SId of service
Id8	0xC661	SId of service
Id9	0xC363	SId of service
Id10	0xC364	SId of service
Id11	0xC362	SId of service
Id12	0xC368	SId of service

FIG0/6 Binary Data
1c 06 C1 97 0c c3 6b c6 6b c3 66 c3 61 c4 60 c3 6e c5 60 c6 61 c3 63 c3 64 c3 62 c3 68

The end of database signalling for soft linkage set 0x197 is shown in the following table.

Field	Value	Description
C/N	1	Continuation of database
OE	0	Tuned Ensemble (the service exists in the tuned Ensemble)
P/D	0	Programme service
Id List Flag	1	Long form
Linkage Actuator	1	Link is active
Soft/Hard	0	Soft link
ILS	0	National link
LSN	0x197	Linkage Set Number
Rfu	0	1 bit reserved for future use
IdLQ	0b01	Each Id represents an FM-RDS PI code
Shd	0	Ids in the list represent a single service
Number of Ids	4	Number of Ids in the Id list
Id1	0xC763	SId of service
Id2	0xC663	SId of service
Id3	0xC563	SId of service
Id4	0xC369	SId of service

FIG0/6 Binary Data
0c 86 c1 97 24 c7 63 c6 63 c5 63 c3 69

A.5.3.2 FIG0/24 OE Services

See clause A.3.

A.5.3.3 FIG0/21 Frequency Information

See clause A.3. Frequency information could also be provided for the RDS services.

A.5.4 Receiver Behaviour

If the receiver has determined that it needs to switch to an alternative service, and has already exhausted all possibilities to link to an identical programme service, it should refer to FIG0/6 information where the S/H flag is set to 0, indicating soft links.

The receiver should use the same strategy for locating alternative services as described in clause A.3.4 for hard links, but make it clear to the listener that they are being offered a similar service as an alternative, and require the listener to confirm the change rather than it happening automatically.

A.6 Linkage of DAB and FM-RDS services

A.6.1 Problem Description

In an area where DAB signal quality is too low, and the listened service is not available on another frequency, a receiver may switch to FM.

In an area where DAB signal quality becomes receivable corresponding to a listened FM service, a receiver may switch to DAB.

The following example represents a case in London while travelling through the Dartford Tunnel.

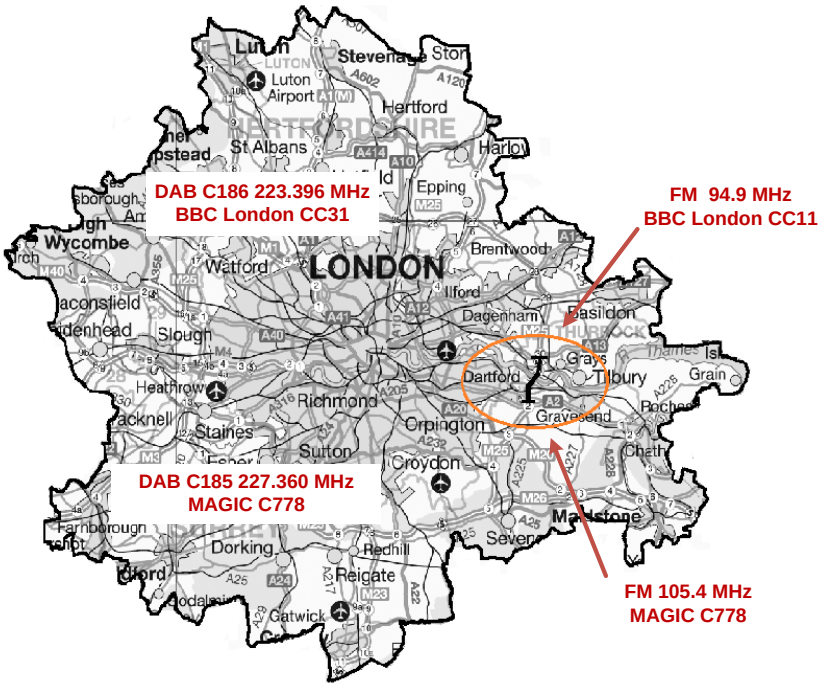

Figure A.6: Ensemble and FM coverage schematic showing BBC London and Magic service following use cases

A.6.2 Concept

In case of direct association PI/SId no additional signalling is needed to be transmitted. FIG0/21 may be used to inform receiver about FM frequencies. Implicit linking is considered to be a hard link.

This example is represented by the service "Magic" carried on Ensemble 0xC185 where SId and PI code are equal.

FIG0/6 may be used to create a link (hard or soft) between a SId and a PI which are not the same.

This use case is represented by BBC London transmitted on Ensemble 0xC186 where Sid Code ≠ FM RDS PI code.

FIG0/21 is used to inform the receiver about FM frequencies.

Only one hard link may be activated at any given time.

A.6.3 Signalling

A.6.3.1 FIG0/6 Service linking information

In Ensemble **0xC186** example above - to demonstrate the case where Sid Code ≠ FM RDS PI code.

Field	Value	Description
C/N	0	Start of database
OE	0	Tuned Ensemble (the service exists in the tuned Ensemble)
P/D	0	Programme service
Id List Flag	1	Long form
Linkage Actuator	1	Link is active
Soft/Hard	1	Hard link
ILS	0	National link
LSN	0x4D	Linkage Set Number
Rfu	0	1 bit reserved for future use
IdLQ	0b01	Each Id represents an RDS PI code
Shd	0	Ids in the list represent a single service
Number of Ids	2	Number of Ids in the Id list
Id1	0xCC31	SId of the service in the current ensemble
Id2	0xCC11	PI code of FM services to link with

FIG0/6 Binary Data
08 06 e0 4d 22 cc 31 cc 11

A.6.3.2 FIG0/24 OE Services

Not required for this use case.

A.6.3.3 FIG0/21 Frequency Information

Frequency Information may be provided but not mandatory for this case. It helps speed up tuning to the FM alternative on a single tuner device. In large FM networks one can end up in a very long list of FM frequencies.
The following list represents the signalling of just one frequency of the example above for the Ensemble 0xC186.

Field	Value	Description
C/N	0	Start of database
OE	0	Tuned Ensemble
P/D	0	not used for Frequency Information
RegionId	0b000 …0	RegionId set to "0000 0000 000", no area is specified
Length of FI list	4	Length in bytes of the following FI list
Id field (Identifier field)	0xCC11	RDS PI code
R&M	0b1000	FM with RDS
Continuity flag	0	Continuous audio output not expected (audio not co-timed)
Length of Freq. list	1	Length in bytes of the following Freq list
Freq	0x4A	FM frequency 94.9 MHz

FIG0/21 Binary Data
07 15 00 04 cc 11 81 4A

A.6.4 Receiver Behaviour

Travelling from point B to D in the example above:

When leaving point C the DAB reception fails and no other DAB Ensemble can be tuned to.
If the receiver has determined that it needs to switch to an alternative service, it should refer to the FIG0/6 information.
In conjunction with Frequency (FIG0/21) information the receiver should try the alternative FM frequency to locate the alternative service, and with an acceptable signal quality.

The receiver should minimise the time taken to locate the alternative service on FM.

The receiver should continue to follow the DAB service linking rules even when it has switched to an alternative on FM.

A.7 Linkage of DAB and FM-RDS services with time varying network relationships

A.7.1 Problem Description

A service "Heart" is provided on FM and DAB. At some times of the day, the same audio programme is provided throughout the UK as a networked service. However, at other times, the programming is split into regional variants.

During the networked service times all FM transmitters share a common PI-code within a “Heart” region.

During the regionalisation times the FM transmitter network is split into several regional variants with different PI-codes. All regional variants are transmitted in parallel on a DAB ensemble as primary audio service components with different SId's.

The service "Heart" is simulcast via DAB and FM. One of the invariant SId’s of the service is 0xC36B. For regional programmes with identical content, the PI-code changes from 0xC36B to 0xC56B as shown for Heart Bath in Table 3.

To enable a receiver to follow the service from DAB to FM during the main and the local times when hard linkage is deactivated, both PI-codes (0xC36B and 0xC56B) are part of the active soft link linkage set.

Event on Heart Bristol and Heart Bath	Heart Bristol				Heart Bath				Heart Wiltshire		
	FM Service	DAB Service - Bristol			FM Service	DAB Service - West Wilts			FM Service	DAB Service - West Wilts	
	PI Code	Service ID	LSN 197/H	LSN 1B2/H	PI Code	Service ID	LSN 197/H	LSN 1B2/H	PI Code	Service ID	LSN 197/H
Regional programme (eg breakfast) with common content, such as a song.	C36B	C36B	Inactive	Active	C36B	C56B	Inactive	Active	C366	C366	Inactive
Regional programme (eg breakfast) with common content, such as a commercial break.	C36B	C36B	Inactive	Inactive	C56B	C56B	Inactive	Inactive	C366	C366	Inactive
Networked program (eg overnight) with common content, such as a song.	C36B	C36B	Active	Inactive	C36B	C56B	Active	Inactive	C366	C366	Active
Networked program (eg overnight) with common content, such as a commercial break	C36B	C36B	Inactive	Inactive	C56B	C56B	Inactive	Inactive	C366	C366	Inactive

Table 3: Heart network showing use of FM PI code switching and DAB LSN linkage of regional variations

Although the PI-code of the FM transmitters change several times throughout the day the linking mechanism can be achieved by a single static linkage set. During the main service times the PI-code 0xC56B is not on air and the receiver will be forced to follow the link indicated by the PI-code 0xC36B. When the regional variant is broadcast there is no service with the PI-code 0xC36B transmitted, as consequence the receiver will choose the service with the PI-code 0xC56B as an alternative service.

The following example represents the regionalised “Heart” FM network within the trial ensemble area. Switched PI-Codes are shown highlighted.

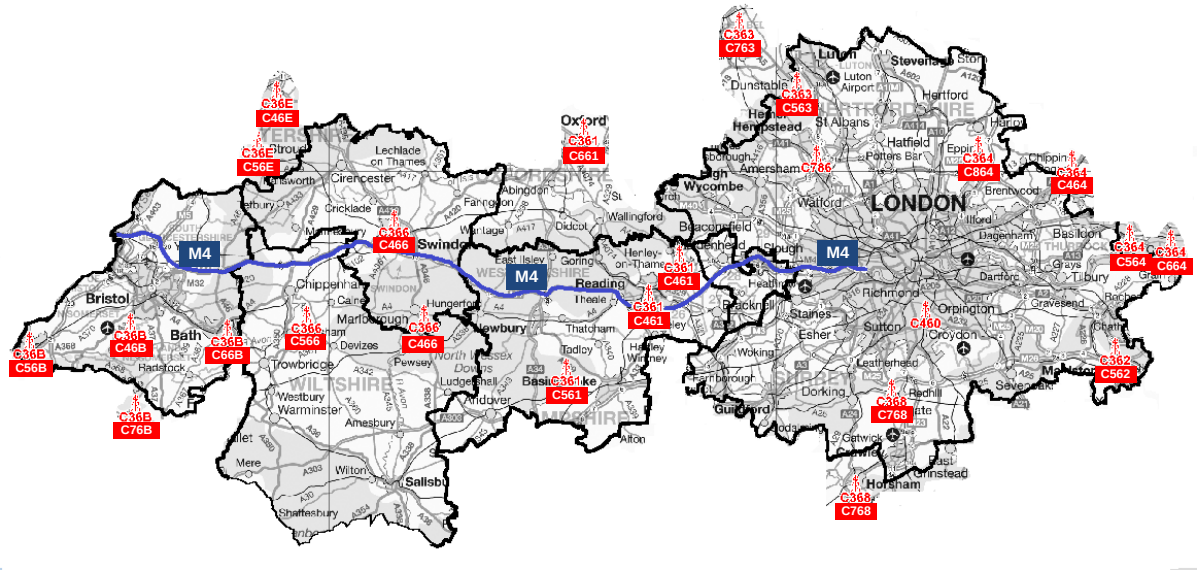

Figure A.7: Heart FM PI-Codes within Ensemble coverage schematic

A.7.2 Concept

FIG0/6 is used to define a set of hard links to FM services and also a set of soft links which a receiver will use to find a suitable alternative during periods when the hard Links are deactivated.

FIG0/21 is provided to give frequency information for those FM services.

A.7.3 Signalling

A.7.3.1 FIG0/6 Service linking information

Field	Value	Description
C/N	0	Start of database
OE	0	Tuned Ensemble (the service exists in the tuned Ensemble)
P/D	0	Programme service
Id List Flag	1	Long form
Linkage Actuator	1	Link is active
Soft/Hard	0	Hard link
ILS	0	National link
LSN	0x1B2	Linkage Set Number
Rfu	0	1 bit reserved for future use
IdLQ	0b00	Each Id represents an DAB SId
Shd	0	Ids in the list represent a single service
Number of Ids	2	Number of Ids in the Id list
Id1	0xC36B	SId of service
Id2	0xC66B	Sid of service
Id List Flag	1	Long form
Linkage Actuator	1	Link is active
Soft/Hard	0	Hard link
ILS	0	National link
LSN	0x1B2	Linkage Set Number
Rfu	0	1 bit reserved for future use
IdLQ	0b01	Each Id represents an FM RDS PI code
Shd	0	Ids in the list represent a single service
Number of Ids	1	Number of Ids in the Id list
Id1	0xC36B	PI code of service

FIG0/6 Binary Data
0d 06 c1 b2 02 c3 6b c6 6b c1 b2 21 c3 6b

A.7.3.2 FIG0/24 OE Services

Not required for this use case.

A.7.3.3 FIG0/21 Frequency Information

Not required for this use case.

A.7.4 Receiver Behaviour

As general hard linking behaviour - receiver will try both the PI which is equal to the SId code and try the other PI code which is not equal.

A.8 preventing implicit linkage to FM-RDS

A.8.1 Problem Description

Normally identifiers for DAB and FM-RDS services are drawn from the same pool of codes and regulatory authorities ensure that DAB and FM-RDS services do not have the same identifier unless they are exactly the same service.

However, there may be occasions when this is not the case and a broadcaster wants to prevent receivers from service following to FM.

A.8.2 Concept

The "dead link" mechanism is used.

A.8.3 Signalling

The “dead link” use case will not be demonstrated as part of this trial.

A.8.4 Receiver Behaviour

Receivers decoding this information disable implicit linking from this service to FM.