NorDig Rules of Operation
Version 2.2

Draft v. 22

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To be updated

1 General

1.1 Scope

The NorDig Rules of Operation contain a set of minimum transmission regulations, which are deemed necessary along with other applicable standards in order to support the basic functionality of the NorDig compliant receiver operating in primary and secondary network environment. In general it is assumed that transmissions targeted for the NorDig digital receiver are fully compliant with the NorDig Unified specifications.
These Rules of Operation therefore only contain specification regarding configuration of transmission parameters and the interpretation of signalling in the NorDig receiver. The Rules of Operation is also a guideline for digital receiver manufacturers as how the IRD is to interpret NorDig compliant transmissions.

1.2 Document History

Version	Date	Comments
0.9	2002-05-30	This is the first approved version pf the NorDig Rules of Operation for NorDig I and II Receiver Networks
1.0	2004-10-28	Updated to reference to NorDig Unified v 1.0.2 receiver specification, which includes following relevant changes/updates: - Reference to NorDig Unified receiver specification (v1.0.2 Nov 2004), instead of NorDig I and II receiver specifications - Includes the new NorDig private descriptor; Logical Channel Descriptor version 2 - Includes the PMT descriptor; Carousel id descriptor, for MHP applications - Removal of the Service Move descriptor, to be in line with the NorDig IRD specification. Updated versions of references to international specifications (ETSI etc)
2.1	2010-01-08	Updated version by Per Tullstedt
2.2	2013-04-DD	Updated version by Deasún Mac Giolla an Chloig
2.2	2016-01-26	Draft version 21 by Deasún Mac Giolla an Chloig and Peter Mølsted

1.3 Abbreviations

AFD	Active Format Descriptor
API	Application Programming Interface
BAT	Bouquet Association Table
BCD	Binary Coded Decimal
BER	Bit Error Ratio
bslbf	bit string, left bit first
C/N	Carrier to Noise ratio
CA	Conditional Access
CAT	Conditional Access Table
CENELEC	Comité Européen de Normalisation Électrotechnique
CI	Common Interface
CID	Content Identifier Descriptor
CRC	Cyclic Redundancy Check
CRID	Content Reference Identifier
CVBS	Composite Video Baseband Signal
DAD	Default Authority Descriptor
dBFS	dB Full Scale
DSM-CC	Digital Storage Media Command and Control
DVB	Digital Video Broadcasting
DVB-C	Digital Video Broadcasting - Cable
DVB-data	Digital Video Broadcasting - Data Broadcasting
DVB-MHP	Digital Video Broadcasting - Multimedia Home Platform
DVB-S	Digital Video Broadcasting - Satellite
DVB-T/T2	DVB-Terrestrial
EBU	European Broadcasting Union
ECCA	European Cable Communications Association
EICTA	European Information & Communications Technology Industry Association
EIT	Event Information Table
EITp/f	Event Information Table, present/following tables
EITsch	Event Information Table, schedule tables
EITp	Event Information Table, present table/section of EITp/f
EITf	Event Information Table, following table/section of EITp/f
EPG	Electronic Program Guide (based on API)
ESG	Event Schedule Guide (without any API)
GOP	Group of Pictures
HDCP	High-bandwidth Digital Content Protection
HDMI	High-Definition Multimedia Interface
HDTV	High Definition Television
HTTP	Hyper Text Transfer Protocol
IDTV	integrated Digital TV
IEC	International Electrotechnical Commission
IEEE	Institute for Electrical and Electronic Engineers
IRD	Integrated Receiver Decoder
ISO	International Organisation for Standardisation

LCD	Logical Channel Descriptor
LCN	Logical Channel Number
MFN	Multiple Frequency Network
MHP	Multi Media Home Platform
MPEG	Moving Pictures Expert Group
NIT	Network Information Table
NVOD	Near Video On Demand
OSD	On Screen Display
PAL	Phase Alternating Line
PAT	Program Association Table
PID	Packet Identifier
PMT	Program Map Table
PSI	Program Specific Information
PCR	Programme Clock Reference
PVR	Personal Video Recorder, (same as PDR, Personal Digital Recorder, or DVR)
QAM	Quadrature Amplitude Modulation
QoS	Quality of Service
QPSK	Quaternary Phase Shift Keying
RF	Radio Frequency
RoO	Rules of Operation
RS	Reed-Solomon
RST	Running Status Table
SDT	Service Description Table
SDTV	Standard Definition Television
SFN	Single Frequency Network
SI	Service Information
SIT	Selection Information Table
ST	Stuffing Table
STB	Set-top box
TDT	Time and Date Table
TOT	Time Offset Table
TS	Transport Stream
TV	Television
UHF	Ultra-High Frequency
uimsbf	unsigned integer most significant bit first
UTC	Universal Time, Co-ordinated
VHF	Very-High Frequency
VHS	Video Home System
VSB	Vestigial Side Band
XML	Extensible Mark-up Language

2 Programme Specific Information and Service information (P)SI

2.1 General

The following sections identify the (P)SI tables transmitted in all transport streams.

DVB (P)SI Tables

Descriptor	Tag value	NIT	BAT	SDT	EIT	TOT	CAT	PMT
Reserved	0x00	-	-	-	-	-	-	-
Reserved	0x01	-	-	-	-	-	-	-
video_stream_descriptor	0x02	-	-	-	-	-	-	Mb
audio_stream_descriptor	0x03	-	-	-	-	-	-	Mb
target_background_grid_descriptor	0x07	-	-	-	-	-	-	Ob
video_window_descriptor	0x08	-	-	-	-	-	-	Ob
CA_descriptor	0x09	-	-	-	-	-	Mb	Mb
ISO_639_language_descriptor	0x0A	-	-	-	-	-	-	Mb
Carousel_id_descriptor	0x13	-	-	-	-	-	-	Mb
network_name_descriptor	0x40	Mb	-	-	-	-	-	-
service_list_descriptor	0x41	Mb	-	-	-	-	-	-
satellite_delivery_system_descriptor	0x43	Mb	-	-	-	-	-	-
cable_delivery_system_descriptor	0x44	Mb	-	-	-	-	-	-
service_descriptor	0x48	-	-	Mb	-	-	-	-
linkage_descriptor	0x4A	Mb	-	Mb	*	-	-	-
NVOD_reference_descriptor	0x4B	-	-	-	-	-	-	-
time_shifted_service_descriptor	0x4C	-	-	-	-	-	-	-
short_event_descriptor	0x4D	-	-	-	Mb	-	-	-
Extended_event_descriptor	0x4E	-	-	-	Mb	-	-	-
Component_descriptor	0x50	-	-	-	Ob	-	-	-
stream_identifier_descriptor	0x52	-	-	-	-	-	-	Ob
CA_identifier_descriptor	0x53	-	-	Ob	Ob	-	-	-
content_descriptor	0x54	-	-	-	Mb	-	-	-
Parental_rating_descriptor	0x55	-	-	-	Ob	-	-	-
teletext_descriptor	0x56	-	-	-	-	-	-	Mb
local_time_offset_descriptor	0x58	-	-	-	-	Mb	-	-
Subtitling_descriptor	0x59	-	-	-	-	-	-	Mb
Terrestrial_delivery_system_descriptor	0x5A	Mb	-	-	-	-	-	-
private_data_specifier_descriptor	0x5F	Mb	-	Mb	Mb	-	-	Mb
service_move_descriptor	0x60	-	-	-	-	-	-	Ob
Frequency_list_descriptor	0x62	Ob	-	-	-	-	-	-
data_broadcast_id_descriptor	0x66	-	-	-	-	-	-	Mb
AC-3_descriptor	0x6A	-	-	-	-	-	-	Mb
Application_signalling_descriptor	0x6F	-	-	-	-	-	-	Mb
service_identifier_descriptor	0x71	-	-	Ob	-	-	-	-
service_availability_descriptor	0x72	-	-	-	-	-	-	Ob
Default_authority_descriptor	0x73	-	-	Mb	-	-	-	-
Content_identifier_descriptor	0x76	-	-	-	Mb	-	-	-
AAC_descriptor	0x7C	-	-	-	-	-	-	Mb
user defined	0x80	-	-	-	-	-	-	-
NorDig private: ssu_service_descrioptor	0x81	-	-	Mb	-	-	-	-
NorDig private: Logic_channel_descriptor, v1	0x83	Mb	-	-	-	-	-	-
NorDig private: Logic_channel_descriptor, v2	0x87	Mb	-	-	-	-	-	-
NorDig private: content_protection_descriptor	0xA0							Ob
user defined	0xFE	-	-	-	-	-	-	-
Forbidden	0xFF	Fb	Fb	Fb	Fb	Fb	Fb	Fb

Table 1: NorDig DVB descriptor list

Mb	Mandatory to Broadcast.
Ob	Optional to broadcast, but recommended (if applicable).
Mr	Mandatory to receive and interpret.
Fb	Forbidden to broadcast (may cause misinterpretation)
-	Descriptor not required

2.2 PAT - Program Association Table

The PAT is mandatory and shall always be transmitted on PID 0x0000. The PAT lists the packet identifier (PID) for all programmes available in the transport stream (PMT), the PAT also provides the location of the Network Information Table (NIT). The PAT shall be transmitted at least every 500ms.

2.3 CAT - Conditional Access Table

The CAT shall be transmitted whenever at least one service component in the transport stream is encrypted. CAT shall be transmitted on PID 0x0001.

CA descriptor:	The *CA_descriptor* identifies the CA_System_Id of the operator as well as the EMM packet identifier (PID) it may also support the insertion of private data.

2.4 PMT - Program Map Table

For each service within a transport stream there shall be a corresponding Program Map Table. The PMT shall be encoded according to ISO/IEC 13818 and there shall be a separate program_map_PIDs for each service. The PMT also indicates the programme clock reference (PCR) for the service. The PMT may be transmitted on PID 0x10 to 0xFFE; within the PMT the following descriptors are mandatory.
The PMT shall be transmitted at least every 500 ms.
The receiver should continually monitor the PMT for change.

Video descriptor:	MPEG 2 Video is signalled by the video_stream_descriptor as per ISO 13818. The descriptor shall be placed in the descriptor loop for the video element of the PMT with a tag value of 0x02
Video descriptor:	MPEG 4 Video is signalled by the AVC_video_descriptor as per ISO 13818. The descriptor shall be placed in the descriptor loop for the video element of the PMT with a tag value of 0x28
Audio descriptor:	MPEG 1 L II Audio is signalled by the audio_descriptor as per ISO 13818. The descriptor shall be placed in the descriptor loop for the audio element of the PMT with a tag value of 0x03.
Audio descriptor:	AC-3 Audio is signalled by the audio_descriptor as per ISO 13818. The descriptor shall be placed in the descriptor loop for the audio element of the PMT with a tag value of 0x6A.

Audio descriptor: MPEG 4 HE-AAC Audio is signalled by the audio_descriptor as per ISO 13818. The descriptor shall be placed in the descriptor loop for the audio element of the PMT with a tag value of 0x7C.

ISO 639-2 language descriptor: This descriptor shall be inserted in the descriptor loop for the audio element of every audio component defined in the PMT with a tag value of 0x0A.
The audio_type may be set to any value defined by ISO 13818 e.g. “normal / undefined”.

Language	ISO 639-2 Code	To Native	Comment
Danish	dan	Dansk	Mandatory
English	eng	English	Mandatory
Finnish	fin	Suomi	Mandatory
Irish	iri	Gaeilge	Mandatory
Norwegian	nor	Norsk	Mandatory
Swedish	swe	Svenska	Mandatory
Audio Description	nar	Narrative	Mandatory
Original Language	qaa	Original Language	Mandatory

Table 2: language descriptor

Teletext descriptor: Mandatory whenever a teletext component is defined and shall be inserted in the descriptor loop for the teletext element of the PMT with tag value 0x56.
The syntax shall be according to ETR 300 468 –[7].
teletext_type 0x01 initial teletext page,
teletext_type 0x02 teletext subtitle page.

Subtitling descriptor: Mandatory whenever DVB bitmap subtitles are transmitted and shall be inserted in the descriptor loop for the subtitling element of the PMT with tag value 0x59.

Stream identifier descriptor: Mandatory whenever the service contains more than one stream of the same type and there are component descriptors for that type of stream within the EIT and shall be inserted in the descriptor loop of the PMT with tag value 0x52.

Service move descriptor: Mandatory whenever a service is moved from one transport stream to another. The syntax shall be according to ETR 300 468. As soon as the service is available in the new transport stream, a service_move_descriptor shall be inserted in the PMT in the original transport stream with tag value 0x60.

Data broadcast descriptor:	Mandatory whenever MHEG 5 applications are transmitted or when System Software Update (SSU) is transmitted. The syntax shall be according to ETR 300 468, a data_broadcast_id_descriptor shall be inserted in the PMT in the original transport stream with tag value 0x66 and a data_broadcast_id 0xA "system software update".

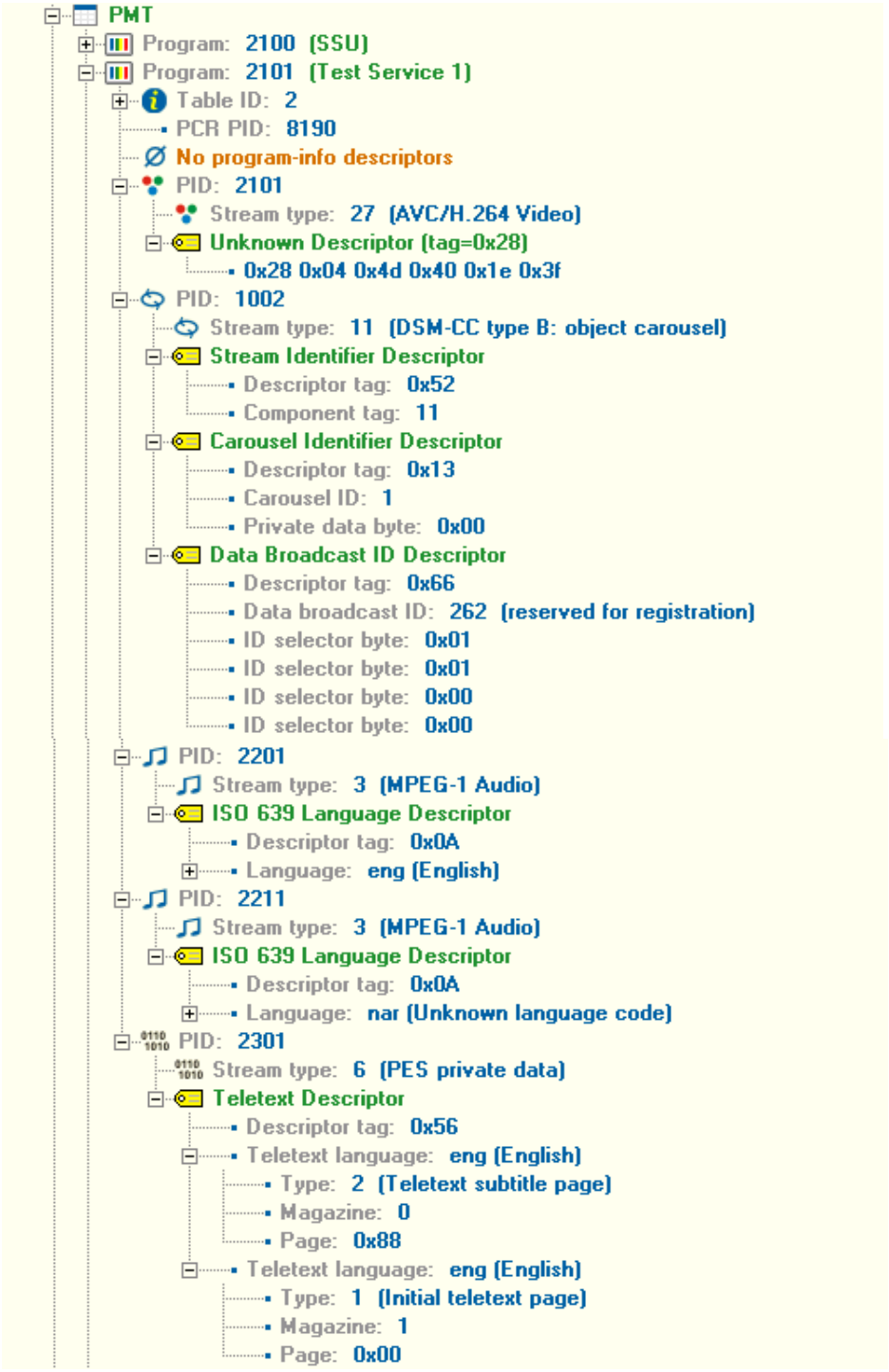


Figure 1: Typical PMT tree with descriptors

2.5 Network Information Table (NIT)

NIT shall be transmitted in each transport stream in the network.
Both NIT_actual _table_id 0x40 (64) and NIT_other table_id 0x41 (65) shall be transmitted.
The NIT shall always be transmitted on PID 0x0010, with a recommended repetition rate of 8000 ms.
A network is defined as a number of transport streams that share the same value of Original Network ID (ONID) and same value of network ID, the NIT actual shall carry details of all transport streams in the current network as defined by the value of the network ID.
A single Frequency List Descriptor shall be carried in each Transport Stream loop of the NIT actual; each instance of the Frequency List Descriptor shall describe all frequencies on which this transport stream may be received.
A single (terrestrial) Delivery Descriptor shall be used in each Transport Stream Loop of the NIT actual, each instance of the (terrestrial) Delivery Descriptor shall describe the properties for this transport stream .
The Frequency List Descriptor defines the frequency on which the Transport Streams are broadcast.
A single logical Channel Number Descriptor shall be carried in each transport Stream loop of the NIT actual, the LCN Descriptor shall be used to describe the LCN and the availability of each service carried within this Transport Stream.
The Private Data Specifier Descriptor shall be carried in the NIT actual to specify private descriptors, such as the LCN.

2.5.1 Mandatory descriptors

Network Name Descriptor:	A *network_name_descriptor* (0x40)shall be inserted for each NIT sub table.
Service list descriptor:	A *service_list_descriptor* (0x41) shall be inserted for each transport stream defined in each NIT section. All services targeted for the network in a transport stream shall be listed in the *service_list_descriptor*, the receiver should use the SDT to build the service list.
Satellite delivery system descriptor:	A *satellite_delivery_system_descriptor* (0x43) shall be inserted for each transport stream in a satellite network. All transport streams in a network shall be defined in the appropriate NIT section.
Cable delivery system descriptor:	A *cable_delivery_system_descriptor* (0x44) shall be inserted for each transport stream in a cable network. All transport streams in a network shall be defined in the appropriate NIT section.
Terrestrial delivery system descriptor:	A *terrestrial_delivery_system_descriptor* (0x5A) shall be inserted for each transport stream in a terrestrial network. All transport streams in a network shall be defined in the appropriate NIT section.

Linkage descriptor:	A *linkage_descriptors* (0x4A) with linkage type 0x09 shall refer to a transport stream carrying a system software update (SSU). The descriptor shall be inserted into the first NIT descriptor loop and shall only be broadcast when the SSU is available. Private Data within the descriptor will indicate originating manufacturer of the software or the generic “DVB SSU”.
Frequency list descriptor:	A *frequency_list_descriptor* (0x62) shall be inserted in the secondary descriptor loop of the NIT. The descriptor shall list all frequencies employed in the network and shall be complete. If there are more than one frequency employed in the network the other_frequency_flag in the terrestrial_system_descriptor shakll be set to “1” indicating that other frequencies are in use.
Private data specifier descriptor:	A private_data_specifier with tag value(0x5F) shall be inserted in the secondary descriptor loop of the NIT. For NorDig Logical Channel Descriptor (LCN) V1 & V2 the private_data_specifier_value shall be 0x00000029.
Logical channel descriptor:	A *logical_channel_descriptor* shall be inserted into the secondary descriptor loop of the NIT. The descriptor shall list all services contained within the transport stream and shall specify the logical channel that is assigned to each of those services, a tag value of 0x83 shall be used for NorDig LCN v1 and a tag value of 0x87 for NorDig LCN v2.
SSU scan linkage descriptor:	A ssu_scan_linkage_descriptor shall be signalled within the NIT when a DVB SSU data broadcast is delivered. If the descriptor is used it will identify the transport_stream_id of the transport stream that contains the system software update, it shall only be broadcast when a SSU update is available (0x41) and employ tag value 0x4A (in conjunction with linkage type 0x09).

2.5.2 Logical_channel_descriptor

The NorDig *logical_channel_descriptor* is a privately defined descriptor intended for use in terrestrial networks, it shall be inserted in the second descriptor loop of the NIT.
All services within the network shall be assigned a logical channel number employing descriptor tag 0x83 for NorDig LCN v1 and descriptor tag 0x87 for NorDig LCN v2.
All services which are defined as unique on the network will be assigned a unique LCN.
Services which differ only in regional interstitials (local programming or advertising) shall be assigned the same LCN, the NorDig IRD shall dynamically update any change in LCN assignment.

Logical Channel Number Syntax:

The syntax of the *logical_channel_descriptor* is defined below:

Syntax	No. Of bits	Identifier
logical_channel_descriptor(){		
descriptor_tag	8	uimsbf
descriptor_length	8	uimsbf
for (i=0;i<N;i++){		
service_id	16	uimsbf
reserved	6	bslbf
logical_channel_number	10	uimsbf
}		
}		

Table 3: Syntax of the logical channel descriptor

descriptor_tag: This shall be assigned to be 0x83 (LCN v1) or 0x87 (LCN v2).

descriptor_length:

service_id: This is a 16-bit field which serves as a label to identify this service from any other service within the Transport Stream. The service_id is the same as the program_number in the corresponding program_map_section. Services shall be included irrespective of their running status.

visible_service_flag: This 1 bit field when set to “1” indicates that the service is visible and selectable via the receiver list. When set to “0” this indicates that the receiver shall not offer the service to the user in normal navigation modes and is “hidden”.

Reserved: All reserved bits shall be set to ”1”.

Logical_channel_number: This is a 10-bit field which indicates the broadcaster preference for ordering services. Its use is defined in table 2 examples are given in table 3 and table 4 below.

LOGICAL_CHANNEL_NUMBER	DESCRIPTION
0x00	Reserved
0x01-0x9F	logical_channel_number
0xA0-0xFF	Reserved for future use

Table 4: Allocation of logical_channel_number

NorDig v1

Descriptor tag	Service_Id	Service_Id	visible_service_flag	Logical Channel Number	Decimal Channel Number
0x83					
	04	4D	C0	01	1
	04	4E	C0	02	2
	04	4F	C0	03	3
	04	50	C0	04	4
	04	52	C0	05	5
	04	51	C0	06	6
	04	53	C0	07	7
	04	54	C0	08	8
	04	CA	C0	C8	200
	04	CE	C0	C9	201
	04	CB	C0	CA	202
	04	CC	C0	CB	203
	04	CD	C0	CC	204
	04	CF	C0	CD	205
	04	D0	C0	CE	206
	04	D1	C0	CF	207
	04	D2	C0	D0	208
	04	D3	C0	D1	209
	04	4C	40	F9	249

Table 5: A detailed example NorDig LCN V1 with service_id, visibility flag and logical channel number.

NorDig v2

Descriptor tag	Channel List Id	Channel List Name length	Name Character	Name Character	Name Character	Name Character	Name Character	Name Character	Country Code	Country Code	Country Code	Service Loop Size	Service Id	Service Id	Service Visibility Flag	Logical Channel Number	Decimal Channel Number
0x87	01	06	52	54	C9	4E	4C	20	49	52	4C	40	04	4D	FC	01	1
													04	4E	FC	02	2
													04	4F	FC	03	3
													04	50	FC	04	4
													04	51	FC	05	5
													04	52	FC	06	6
													04	53	FC	07	7
													04	54	7C	08	
						No Value											
													04	CA	FC	C8	200
													04	CB	FC	C9	201
													04	CC	FC	CA	202
													04	CD	FC	CB	203
													04	CE	FC	CC	204
													04	CF	FC	CD	205
													04	D0	FC	CE	206
													04	D1	FC	CF	207
													04	D2	FC	D0	208
													04	D3	FC	D1	209

Table 6: A detailed example NorDig LCN V2 with service_id, visibility flag and logical channel number.

NorDig LCN V2 contains additional information which may identify the operator and country of operation alongside the standard information of service_id, service visible flag and logical channel numbering as carried in NorDig LCN V1.
In the above example the operator and country code are listed in hexadecimal, therefore:-

- 0x52, 0x54, 0xC9, 0x4E, 0x4C , 0x20, 0x49, 0x52, 0x4C equates to RTÉNL_IRL
- In LCN V1 above service_id 1100 (0x044C) and LCN V2 service_id 1108 (0x0454) are both signalled within LCN as hidden.

The intended use of the *logical_channel_descriptor* is outlined below:

1. The descriptor is used as the default assignment of the service position *viz:* the viewer shall have the possibility to override this function and take command over the assignment of service positions. Once the viewer has taken command this function shall be disabled. The process to re-enable the *logical_channel_descriptor* will be defined by the receiver manufacture.
2. It is not necessary that all service_ids referenced in the *service_list_descriptor* are allocated a logical channel number. The numbers used may start at any value, and need not be sequential.
3. The logical_channel_number shall be unique across the network (as defined by the network_id). In case more than one service is assigned to the same logical channel number, only one service shall have the running status of ”running” at any time (within the same network). In areas where several network intersect and the same logical channel number is used by several services, only the service belonging to the preference network (see below for definition) will be assigned to its logical channel number.

Within the network environment coverage overlaps of different service networks is unavoidable in these instances the home or preferred network may be assigned by the user , this selection is then employed in the assignment of logical channel for the viewer in the overlap area, the assignment algorithm shall follow the below:

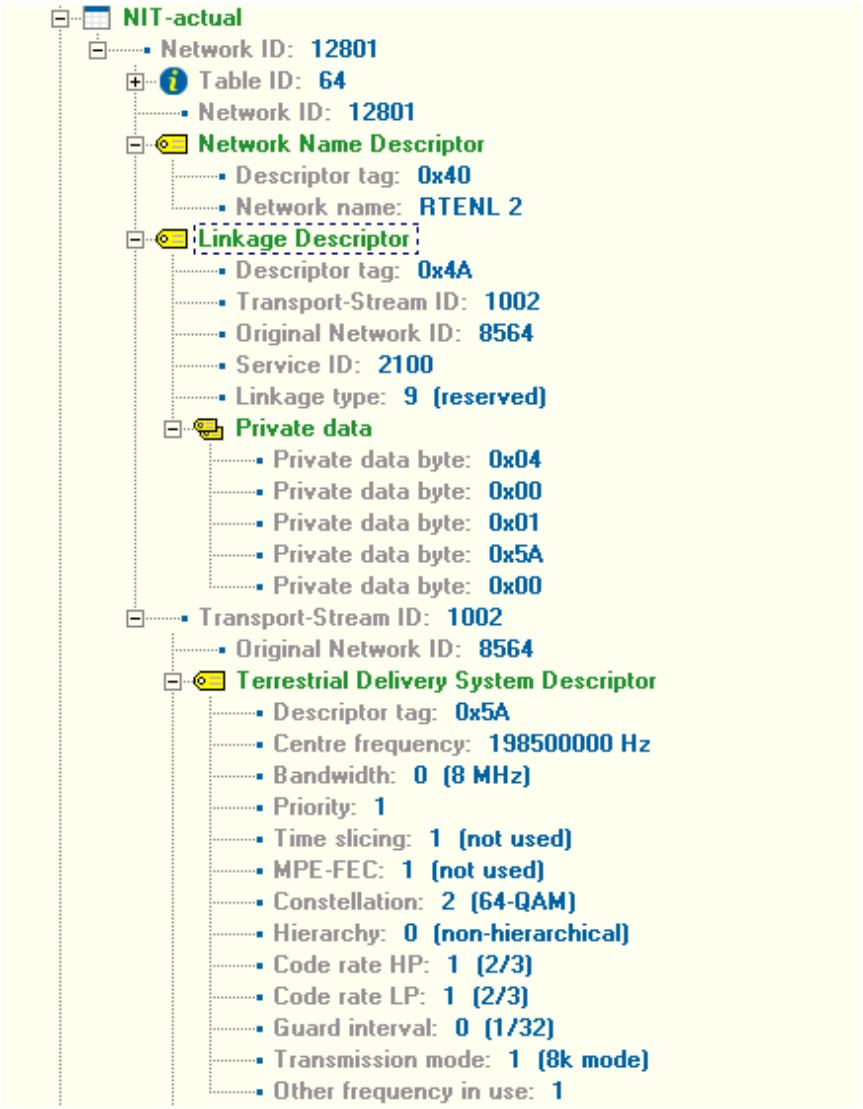
- When during first time installation several networks are available the receiver shall present a network list, with all the available networks displayed from which the viewer is able to choose a preference network. (If only one network is available the receiver shall not display preference network).
- The network id shall be stored in the receiver for future use. The receiver should be prepared to make a default assignment if the user is not confident enough to make a choice. The default assignment algorithm is a receiver manufacture decision. The preference network should be static with two exceptions:

1. The preference network can no longer be received, the receiver may have been moved or other circumstances may have caused this lost of reception. In this case the updated assignment list shall be presented as described above.
2. The user wants to change their preference network. In this case the user shall be able to alter their preferred network from an available network list.

2.5.3 Frequency_list_descriptor

Within a broadcasters service area there will be many transmitters operating on different frequencies and bands, inevitably there will be overlaps between main transmitters and and daughter relay stations. Inclusion of this descriptor is optional, but if it is present, then the list of frequencies shall be complete. Broadcasters shall list additional frequencies for the same service multiplex in the frequency_list_descriptor of the secondary loop of the Network Information Table (NIT). As a consequence, the receiver may discriminate between services and LCN intentionally duplicated. Services which are duplicated but of a lower receive quality may be discarded by the receiver in favour of best quality service by examining the frequency list descriptor of the NIT.

A typical network information table tree is indicated below in Figure 2:



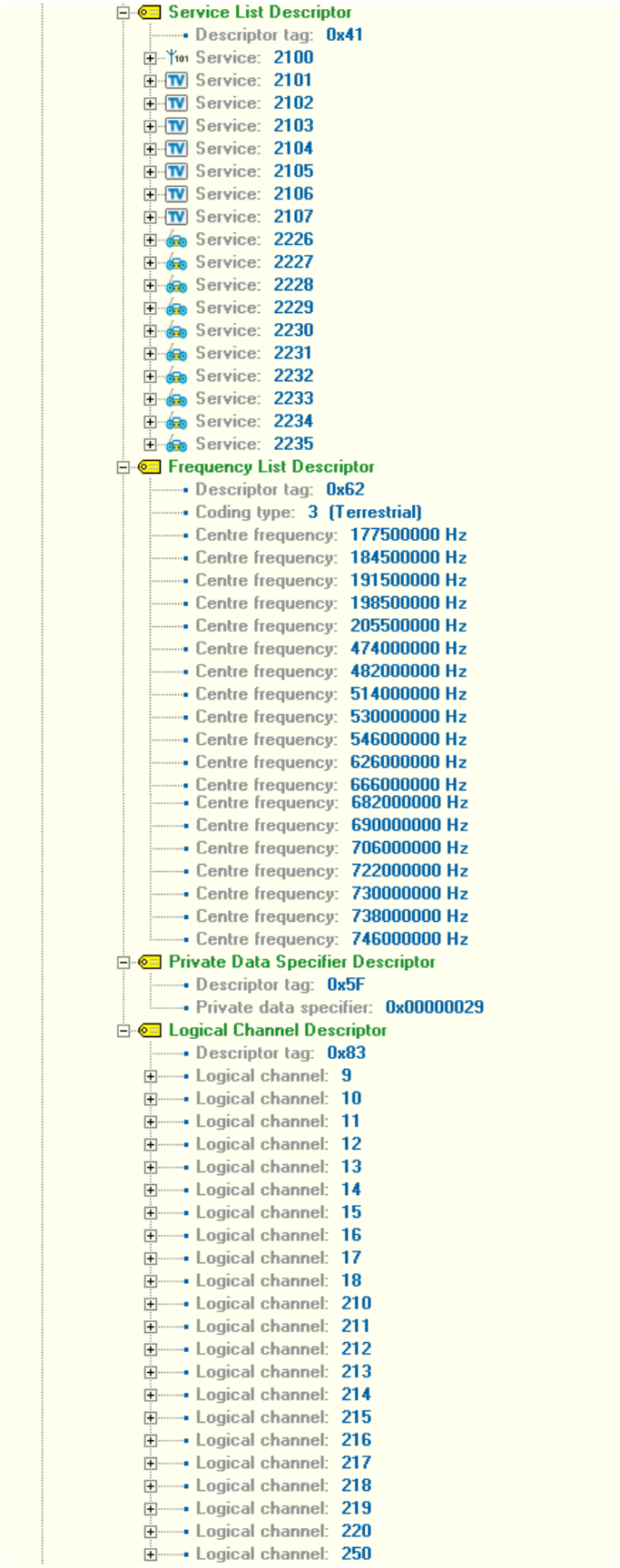


Table 8: Typical Network Information Table structure

2.6 Service Description Table (SDT)

SDT_actual table (0x42) is mandatory for each transport stream in the network. The SDT shall describe all services within the multiplex, it shall change when any of the services within the multiplex change status. It is recommended that receivers use the SDT_actual to determine services that may be included in the channel list rather than the service_list_descriptor in (0x41) the NIT.
All sections within the SDT_actual_table shall be transmitted every 1000 ms.

Transmission of SDT_other is recommended. The SDT_other (0x46) shall describe all other services carried on transport streams across the same network, it is recommended that receivers use the SDT_other to determine services that may be included in the channel list rather than the service_list_descriptor in (0x41) the NIT.
All sections of the SDT_other shall be transmitted every 10000 ms.
For each standard service the running status shall be set to 4 (running) and for each time shifted service (NVOD)the running status shall be set to 0 (undefined) as per ETSI EN 300 468 [6].

2.6.1 Mandatory descriptors SDT Actual /SDT Other

service_descriptor:	A *service_descriptor* (0x48)shall be inserted for each service defined in the SDT. The service_descriptor provides the name of the service and the service provider in text format together with the service_type. *Nordig private: ssu_ service_descriptor 0x81 shall be used for software download service.*
Service_availability_descriptor:	A *service_availability_descriptor* (0x72) shall be inserted when local services are not present on the across the whole network, the descriptor shall reference the service list against the services which are available for the receiver to decode. See ETSI TR 101 211 (4.2.3.12.)
default_authority_descriptor:	A *default_authority_descriptor* (0x73) shall be inserted within the SDT to more efficiently manage the EIT CRID data necessary to support PVR functionality on the network; every service on the network shall be allocated a descriptor.
CA_identifier_descriptor:	A CA_identifier_descriptor shall be inserted within the SDT as mandatory whenever at least one service component is scrambled. The aim of this descriptor is to prevent scrambled services being displayed in service lists by FTA recievers. See ETSI TR 101 211 (4.2.3.3.).

Service types available for use on NorDig DTT networks are listed in Table 2.

Service Type	Description
0x01	Digital Television Service
0x02	Digital Radio Sound Service
0x03	Teletext Service
0x0C	Data Broadcast Service
0x16	AVC SD Digital Television Service
0X19	AVC HD Digital Television Service

Table 7: NorDig service types

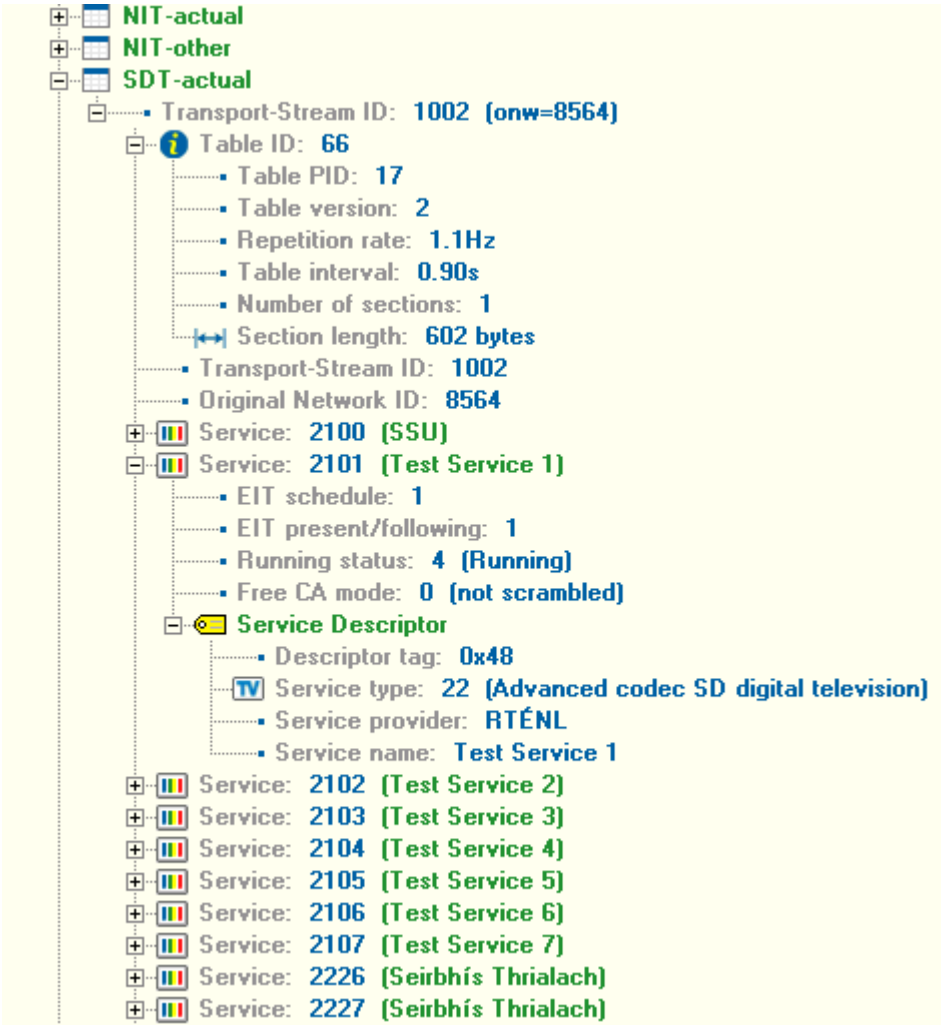


Figure 3: Typical Service Descriptor Table

2.7 Event Information Table (EIT) Actual

It is mandatory to transmit EIT p/f (present/following) Table_id 0x4E sections for all services signalled as visible in the LCN on the actual transport stream and for each service where there is a reference to that service in the SDT (actual or other) and where the EIT_present_following_flag is set.
Visible services are those services which are listed within the Logical Channel Descriptor with the visible_service_flag set to “1”.
EIT p/f Other shall be carried for all services listed within the SDT Other in which the EIT_present_following flag is set.
All transport streams in the network may contain a link to the EIT schedule information, implemented by a *linkage_descriptor* in the NIT. Linkage_type 0x04 is used for the EIT schedule information. The parameter "service_id" in the *linkage_descriptor* is not applicable when linkage_type 0x04 is used.
The EIT_actual_p/f shall be transmitted every 1500 ms to 2000 ms

2.7.1 Mandatory descriptors

short_event_descriptor:	A *short_event_descriptor* (0x4D) shall contain the programme title and possibly a short (less than 256 characters) text information about the event.
extended_event_descriptor:	An *extended_even_descriptor* (0x4E) shall contain extended text information about the event and acts as a supplement to/or instead of the *short_event_descriptor* which would then only contain the programme title.
component_descriptor:	A *component_descriptor* (0x50)identifies all the components associated with the service for the running event, this can indicate whether a current or future event has additional components which may be of interest to the viewer, such as subtitles or audio description.
content_descriptor:	A *content_descriptor* (0x54) classifies the event according to certain content classes (genre) as specified by DVB SI specification EN 300 468 6.2.9. Support for content_nibble_level_1 is mandatory, level 2 is optional.
parental_rating_descriptor:	A *parental_rating_descriptor* (0x55) provides the recommended age rating and identifies the country of the originating broadcaster, as specified by DVB SI specification EN 300 468 6.2.28.

Content_identifier_descriptor:	A *content_identifier_descriptor* (0x76) is transmitted to associate a CRID to a event and is placed in the event loop of the EIT.
FTA_content_managment_descriptor	A *FTA_content_idfentifier_descriptor* (0x7E)may be transmitted to indicate the content management policy for the HD content of the originating broadcaster or platform operator, as specified by DVB SI EN 300 468 6.2.18.

The below extract is a typical example of XML employed to generate EIT data, the section in bold pertains to the event detailed in Figure 4

```
</event>
<event end_time="20130715 08:00:00" event_id="62265" event_seq="A62265" start_time="20130715
06:00:00" title="">
<description extended_synopsis="Cathal MacCoille, Rachael English and Gavin Jennings with news, business
news, sports news, travel and a review of the morning's papers." language="eng" short_synopsis=""
title="Morning Ireland"/>
<content nibble1="0" nibble2="0"/>
</event>
<event end_time="20130715 09:00:00" event_id="64459" event_seq="A64459"
start_time="20130715 08:00:00" title="">
<description extended_synopsis="The latest Irish and international news from RTÃ‰." 
language="eng" short_synopsis="" title="Latest News"/>
<content nibble1="0" nibble2="0"/>
</event>
<event end_time="20130715 10:00:00" event_id="64460" event_seq="A64460" start_time="20130715
09:00:00" title="">
<description extended_synopsis="The latest Irish and international news from RTÃ‰." language="eng"
short_synopsis="" title="Latest News"/>
<content nibble1="0" nibble2="0"/>
</event>
```

Figure 4: Extract from XML used to generate EIT

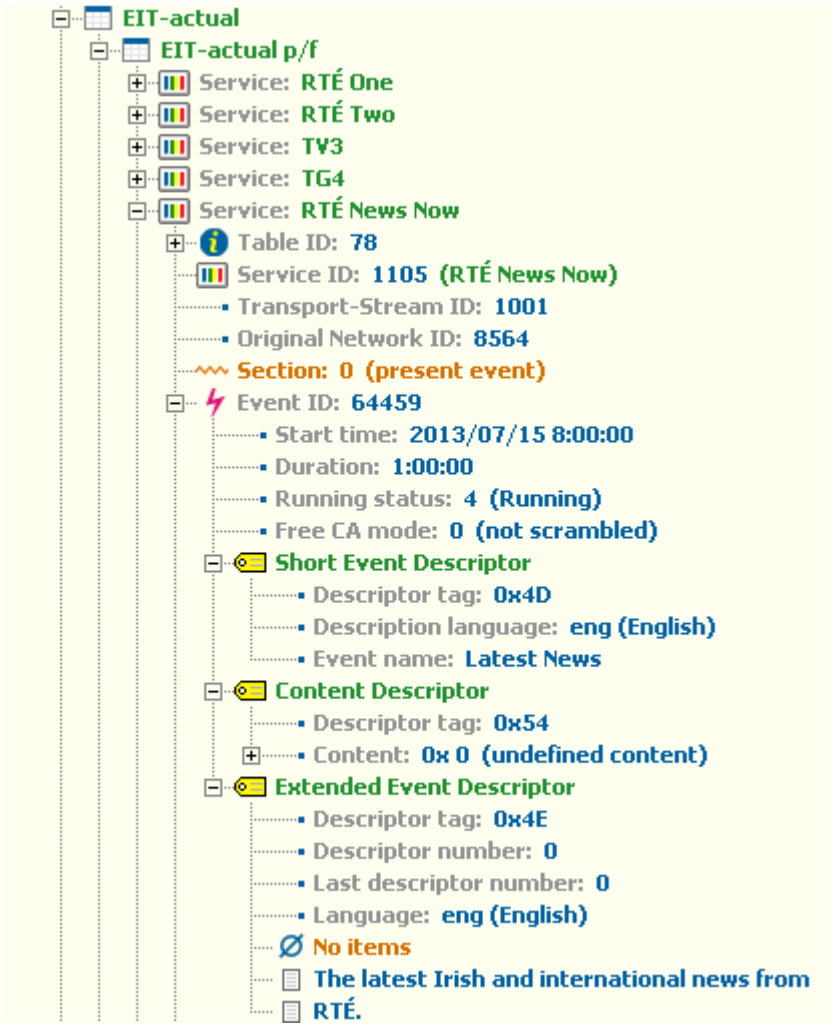


Figure 5: Typical Event Information Table actual p/f structure

2.8 Event Information Table (EIT) Other

It is mandatory to transmit EIT other p/f Table_id 0x4F sections for all services signalled as visible in the LCN on the other transport stream and for each service where there is a reference to that service in the SDT (actual or other) and where the EIT_present_following_flag is set.
Visible services are those services which are listed within the Logical Channel Descriptor with the visible_service_flag set to "1".
EIT p/f Other shall be carried for all services listed within the SDT Other in which the EIT_present_following flag is set.
All transport streams in the network may contain a link to the EIT schedule information, implemented by a *linkage_descriptor* in the NIT. Linkage_type 0x04 is used for the EIT schedule information. The parameter "service_id" in the *linkage_descriptor* is not applicable when linkage_type 0x04 is used.
The EIT_actual_p/f shall be transmitted every 10000 ms.

2.8.1 Mandatory descriptors

short_event_descriptor:	A *short_event_descriptor* (0x4D) shall contain the programme title (less than 40 characters)and possibly a short (less than 256 characters) text information about the event.
extended_event_descriptor:	An *extended_even_descriptor* (0x4E) shall contain extended text information about the event and acts as a supplement to/or instead of the *short_event_descriptor* which would then only contain the programme title.
component_descriptor:	A *component_descriptor* (0x50)identifies all the components associated with the service for the running event, this can indicate whether a current or future event has additional components which may be of interest to the viewer, such as subtitles or audio description.
content_descriptor:	A *content_descriptor* (0x54) classifies the event according to certain content classes (genre) as specified by DVB SI specification EN 300 468 6.2.9. Support for content_nibble_level_1 is mandatory, level 2 is optional.
parental_rating_descriptor:	A *parental_rating_descriptor* (0x55) provides the recommended age rating and identifies the country of the originating broadcaster, as specified by DVB SI specification EN 300 468 6.2.28.

Content_identifier_descriptor: A *content_identifier_descriptor* (0x76) is transmitted to associate a CRID to a event and is placed in the event loop of the EIT.

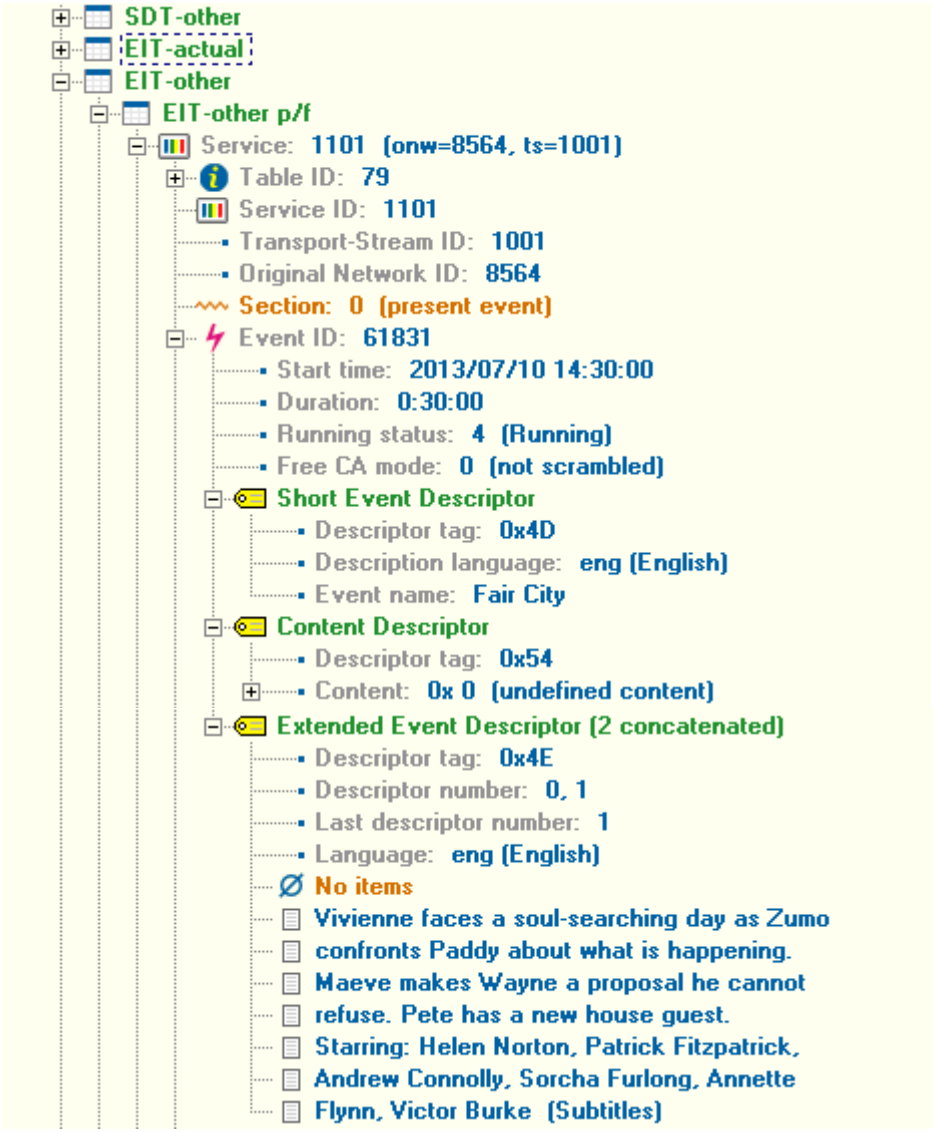


Figure 6: Typical Event Information Table Other structure

2.9 Time Date Table (TDT)

TDT is mandatory in each transport stream in the network , Table_id 0x70 and is used by the receiver to determine the current time. The time accuracy shall be within ±2 seconds from UTC.
Each section of the TDT shall be transmitted every 10000 ms.

2.10 Time Offset Table (TOT)

TOT is mandatory in each transport stream in the network, Table_id 0x73 and is used by the receiver to determine local time offset from UTC referenced within the TDT.
The time accuracy shall be within ±2 seconds from UTC. Each section of the TOT shall be transmitted every 10000 ms. The TOT shall be advanced or retarded to signal daylight savings time commencement or end.

2.10.1 Mandatory descriptors

local_time_offset_descriptor: The local_time_offset_descriptor (0x58) shall be transmitted and will operate within the range UTC +1 or UTC +2 dependent on the time of year.
Currently the following country_codes are defined in this descriptor for the NorDig region:
DEN
FIN
ICE
IRL
NOR
SWE

The parameter "country_region_id" is set to zero for all these countries.

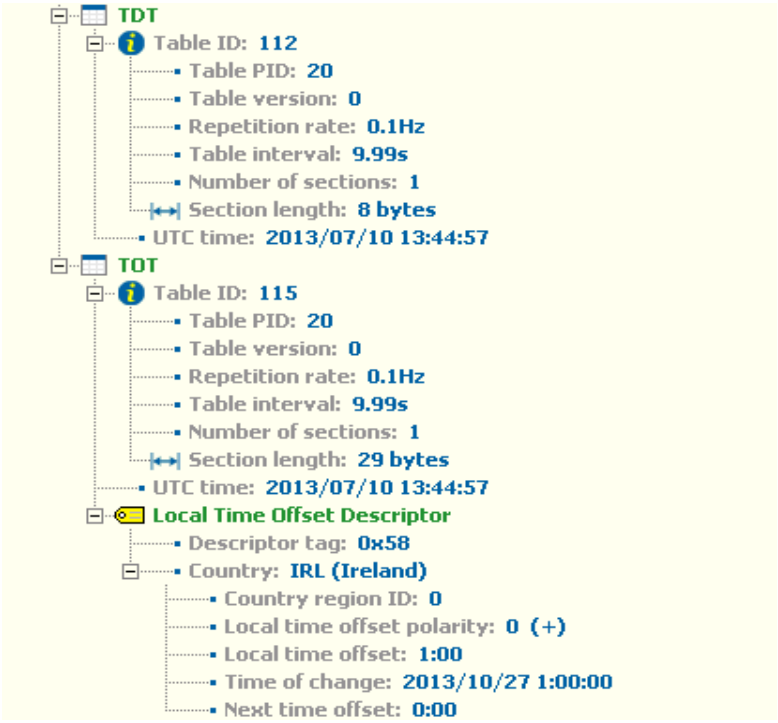


Figure 7: Typical TDT TOT table structure

3 Tuning and Navigation

The tuning of the NorDig set-top box can either be based on Network Information Table (NIT) signalling within SI or on scanning. The receiver shall identify a service uniquely through a combination of original_network_id (ONID) and service_id (SID). Tuning based on NIT information is detailed below.

3.1 DVB specific identifiers

Each service shall be uniquely identified through the combination *original_network_id (ONID) transport_stream_id (TSID) service_id(SID) also* known as the DVB triplet . These, and some other mandatory parameters, are described in the following sections.

3.1.1 Original_network_id

Each network operator originating broadcasting signals shall apply for a 2-byte *original_network_id* according to ETSI TR 101 162.

Country	ONID	Network ID
Denmark	0x20D0	Colour plan C (0x3201 ~ 0x3300)
Finland	0x20F6	Colour plan D (0x3301 ~ 0x3400)
Iceland		
Ireland	0x2174	Colour plan C (0x3201 ~ 0x3300)
Norway	0x2242	Colour plan E (0x3401 ~ 0x3500)
Sweden	0x22F1	Colour plan B (0x3101 ~ 0x3200

Table 8: DVB identifiers

3.1.2 Network_id

Each NorDig network operator broadcasts a number of transport streams, each stream is considered as part of that specific network and shall identify uniquely its self by *network_id*. The allocation of *network_id* is carried out by ETSI, and allocated values are available in the ETSI document TR 101 162 and as detailed in Table 3.
For terrestrial networks a unique *network_id* shall be allocated to each Local Service Network (LSN) in the national network. The allocation shall comply to the ETSI TR 101 162 4-colour-map approach, this gives the possibility to allocate up to 256 *network_ids* within the network.

3.1.3 Transport_stream_id

The *transport_stream_id* shall uniquely define a transport stream within the network comprising of a specific combination of services and components. Each multiplex operator shall allocate a *transport_stream_id* on a individual basis however all transport streams within a network should carry a unique identifier.

3.1.4 Service_id

The *service_id* shall identify all unique services carried by the multiplex operator on the network.
A service is considered unique if its service name, scheduled events and service components are different to any other service components on the network.
The *service_id* is equivalent to the program_number used in PAT and PMT.

3.1.5 Private_data_specifier

A NorDig allocated *private_data_specifier* 0x00000029 shall be inserted within the *private_data_descriptor*

3.1.6 Bouquet_id

One or several *bouquet_ids* shall be allocated to each service provider. The following general rules are applicable:

i) A service provider shall not allocate more *bouquet_ids* than it has services to offer.
ii) Each service should be presented in one and only one bouquet.
iii) A service provider can group several services into one bouquet.
iv) A bouquet (with an associated *bouquet_id*) may contain services from different service providers.
v) The *bouquet_id* is static and cannot change in time.

bouquet_id registration is the responsibility of the service provider.

3.1.7 Event_id

The *event_id* is a 16-bit field which contains the identification number of the described event. Each service provider is free to allocate *event_ids* within their service_id domain, with the restriction that an *event_id* shall be unique within the transmitted schedule. An *event_id* shall be associated with a single event within the schedule, i.e. if an event is rescheduled within the currently transmitted schedule, it shall not change its *event_id*. If the event is removed from the schedule (or rescheduled to outside the transmitted schedule) then its *event_id* shall be removed from the schedule. Any replacement event shall be allocated a new *event_id* unique within the transmitted schedule.
A recommended allocation method for new *event_id* in terrestrial networks is to use odd values for national events and even values for regional events, this to avoid that events that are inserted at different locations will be allocated the same *event_id*.
The *event_id* shall be included in the following EIT tables;

EIT_actual_p/f
EIT_other _p/f
EIT_actual_schedule
EIT_other_schedule

3.1.8 Link to EIT schedule

Generally the linkage to the EIT schedule is implemented by inserting a *linkage_descriptor* in the first descriptor loop in the NIT. Linkage_type 0x04 is used for this purpose.

A problem can occur whenever multiple operators offer services from the same satellite transponder. This is best illustrated by the following example:

One satellite network which we will call *X-sat* consists of 4 transport streams, there are two independent operators managing transport streams on this satellite according to the following rule:

- TS1 - transport_stream_id 0x0001: operated by "Operator A"
- TS2 - transport_stream_id 0x0002: operated by "Operator A"
- TS3 - transport_stream_id 0x0003: operated by "Operator B"
- TS4 - transport_stream_id 0x0004: operated by "Operator B"

The *network_id* of *X-sat* is 0x0040, while the original_network_id of Operator A and Operator B is 0x0041 and 0x0051 respectively. Operator A transmit their EIT schedule information in TS 1, while Operator B transmit their EIT schedule information in TS 3.

TS 5 contains 5 services split between "Operator A" and "Operator B" as indicated in Table 4:

Service	**Service_id**	**Commercial operator**
Service 1	0x0101	"Operator A"
Service 2	0x0102	"Operator A"
Service 3	0x0103	"Operator A"
Service 4	0x0104	"Operator B"
Service 5	0x0105	"Operator B"

Table 9: Services in TS 5

Subscriber A has subscribed for the services from Operator A; they access Service 1 and select the Guide button, with this action subscriber A expects to access the EIT schedule provided by Operator A and transmitted in TS 2.
Subscriber B has subscribed to the services from Operator B, they access Service 4 and select the Guide button, subscriber B expects to access the EIT schedule for Operator B transmitted in TS 3.

Accessing different EIT schedule services on the same transponder cannot be achieved by inserting *linkage_descriptors* within the NIT, this is resolved by employing the *bouquet_ association_ table*. The BAT shall contain a bouquet associations for both for Operator A and for Operator B as indicated in Figure 5

Note each operator has to apply for a unique bouquet_id from ETSI. The document TR 101 162 indicates available values for the bouquet_id. In this example we have for illustrative purposes assumed that the bouquet_id for Operator A and Operator B is 0x0001 and 0x0002, respectively.

```
bouquet_association_section(){
        table_id                                0x4A
        bouquet_id                                      0x0001  ("Operator A")

        #bouquet descriptors{
                bouquet_name_descriptor(){
                        bouquet_name            "Operator A"
                }
                linkage_descriptor(){
                        transport_stream_id     0x0002
                        original_network_id     0x0041
                        service_id
                        linkage_type            0x04
                }
        }
        # transport stream loop{
                transport_stream_id             0x0001
                original_network_id             0x0041
                #transport stream descriptors{
                        service_list_descriptor(){
                                <all services in TS1>
                        }
                transport_stream_id             0x0002
                original_network_id             0x0041
                #transport stream descriptors{
                        service_list_descriptor(){
                                <all services in TS2>
                        }
                transport_stream_id             0x0005
                original_network_id             0x0041
                #transport stream descriptors{
                        service_list_descriptor(){
                                service_id              0x0101
                                service_type    digital television
                                service_id              0x0102
                                service_type    digital television
                                service_id              0x0103
                                service_type    digital television
                        }
                }
        }
}

bouquet_association_section(){
        table_id                                0x4A
        bouquet_id                                      0x0002  ("Operator B")

        #bouquet descriptors{
                bouquet_name_descriptor(){
                        bouquet_name            "Operator B"
                }
                linkage_descriptor(){
                        transport_stream_id     0x0003
                        original_network_id     0x0051
                        service_id
                        linkage_type            0x04
                }
        }
        # transport stream loop{
                transport_stream_id             0x0003
                original_network_id             0x0051
                #transport stream descriptors{
                        service_list_descriptor(){
                                <all services in TS3>
                        }
```

```
                transport_stream_id                 0x0004
                original_network_id                 0x0051
                #transport stream descriptors{
                        service_list_descriptor(){
                                <all services in TS4>
                        }
                transport_stream_id                 0x0005
                original_network_id                 0x0041
                #transport stream descriptors{
                        service_list_descriptor(){
                                service_id                  0x0104
                                service_type        digital television
                                service_id                  0x0105
                                service_type        digital television
                        }
                }
        }
}
```

Figure 8: BAT containing bouquets for both operators

Note that in each bouquet, the *service_list_descriptor* for TS 5 contains only the services from the corresponding commercial operator.
The set-top box is advised to access EIT schedule according to the following algorithm:

```
If linkage_descriptor in first descriptor loop in NIT
{
        If linkage_type = 0x04
        {
                Tune to Barker Channel;
                Read EIT
        }
}
Else
{
        Find the BAT subtable containing the last accessed service;
        Read linkage_descriptor;
        If linkage_type = 0x04
        {
                Tune to Barker Channel;
                Read EIT
        }
}
```

Figure 9: EIT schedule algorithm

It might be the case in secondary distribution networks that only a subset of the services from the primary distribution network will be available. Both PAT and SDT in the secondary distribution network may signal more services than are actually available. The native service navigator, i.e. ESG, shall not display any service that the receiver cannot receive, due to the fact that it is not retransmitted from primary distribution network. A service is available whenever it is included in the *service_list_descriptor* in the NIT for the appropriate network.

The receiver shall decide whether a service shall be presented in the native service navigator by the following algorithm:

```
If service_id is available in any service_list_descriptor in the appropriate NIT
        {
                display the service in the (ESG/EPG )
        else
                do not display the service
        }
```

Figure 10: Native service navigator algorithm

The same algorithm shall be used in terrestrial receivers to “hide” services not accessible due to low RF level.

3.2 Specific tuning for Satellite Networks

3.2.1 Multiple operators in the same physical network

One physical network (orbital satellite position) may be shared between multiple operators, e.g. each operator manages different transponders in the same physical network.

On satellite networks, NIT_actual on each transponder shall describe all transport streams operated by the operator of the actual transport stream as well as all transport streams operated by other operators in the same satellite network. NIT_other may describe transport streams operated by any other operator in another network (i.e. retransmission into secondary networks).

The principle of multiple operators in the same satellite network is best illustrated by an example.

One satellite network *X-sat* consists of 4 transport streams. There are two independent operators managing these transport streams according to the following rule:

- TS1 - transport_stream_id 0x0001: operated by "Operator A"
- TS2 - transport_stream_id 0x0002: operated by "Operator A"
- TS3 - transport_stream_id 0x0003: operated by "Operator B"
- TS4 - transport_stream_id 0x0004: operated by "Operator B"

The *network_id* of *X-sat* is 0x0040, the *original_network_id* of Operator A and Operator B is 0x0041 and 0x0051 respectively. Operator A transmit their EIT schedule information in TS 1, whilst Operator B transmit their EIT schedule information in TS 3.
The network operator ("X-sat") is responsible for NIT generation and all transport streams are signalled in *NIT_actual,* both from Operator A and Operator B……

An example of the NIT transmitted in all transport streams is shown in Figure 11:

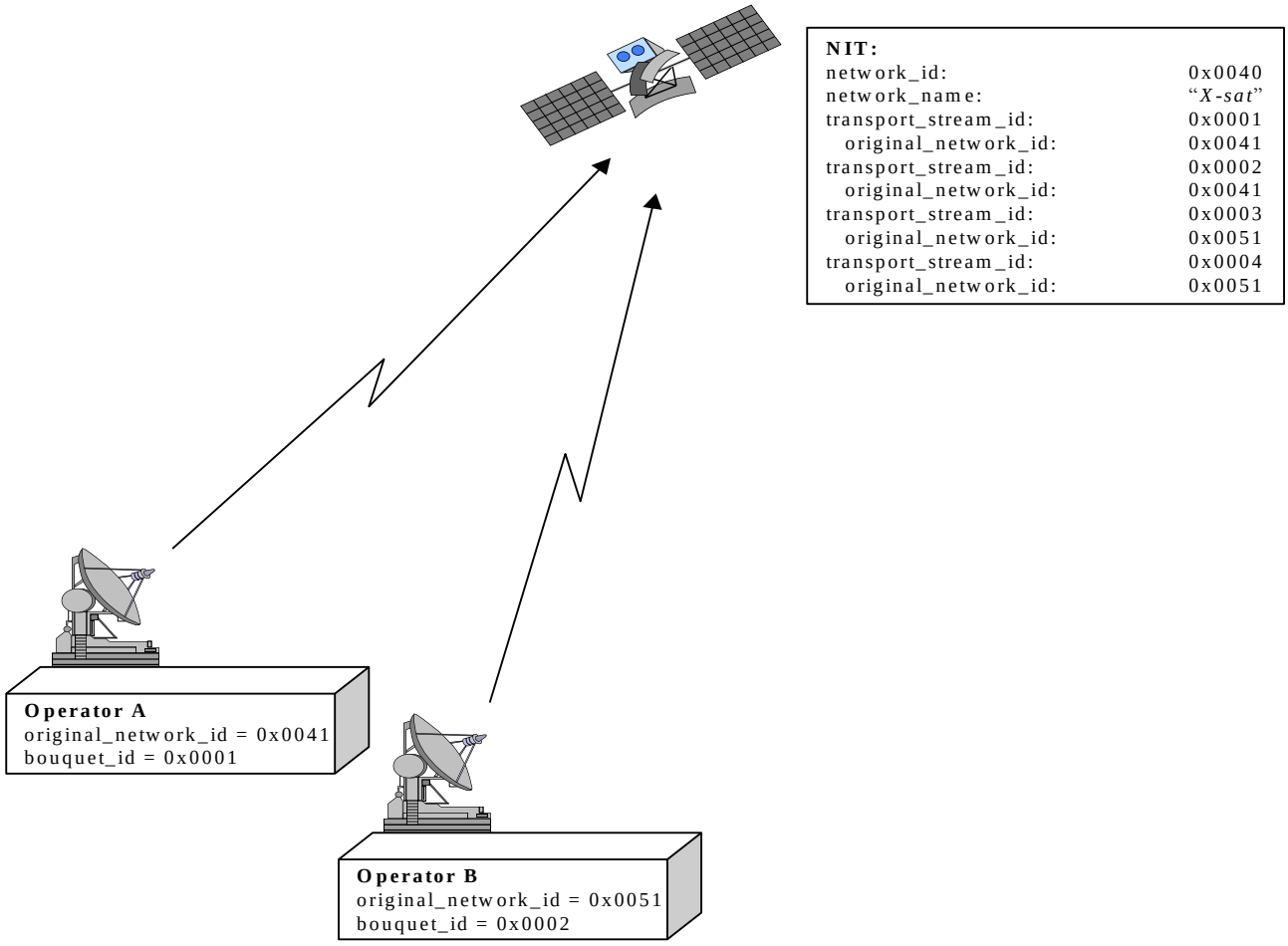


Figure 11: NIT transmission with multiple operators

```
network_information_section(){
        table_id 0x40               (NIT_actual)
        network_id      0x0040  (X-sat)
        #first loop descriptors{
                network_name_descriptor(){
                        network_name    "X-sat"
                }
                linkage_descriptor(){       # link to NorDig software
        download
                        transport_stream_id         0x0001
                        original_network_id         0x0041
                        service_id                          0x000A
                        linkage_type                0x81
                        private_data                <according to NorDig
                        specification>
                }
        }
        #transport stream definitions{
                transport_stream_id             0x0001
                original_network_id             0x0041  (Operator A)
                #second loop descriptors{
                        satellite_delivery_system_descriptor()
                        service_list_descriptor()
                }
                transport_stream_id             0x0002
                original_network_id             0x0041  (Operator A)
                #second loop descriptors{
                        satellite_delivery_system_descriptor()
                        service_list_descriptor()
                }
                transport_stream_id             0x0003
                original_network_id             0x0051  (Operator B)
                #second loop descriptors{
                        satellite_delivery_system_descriptor()
                        service_list_descriptor()
                }
                transport_stream_id             0x0004
                original_network_id             0x0051  (Operator B)
                #second loop descriptors{
                        satellite_delivery_system_descriptor()
                        service_list_descriptor()
                 }
        }
}
```

Figure 12: Example of NIT from "X-sat"

3.2.2 Set-top box interpretation

For satellite transmission a valid *NIT_actual* should always be transmitted. Satellite tuners may ignore *NIT_other* and focus on *NIT_actual*. Parameters of a default transponder have to be entered manually by the subscribers or may be pre-programmed from the set-top box manufacturer.

3.3 Specific tuning for cable networks

Cable operators may use both *NIT_actual* and *NIT_other* for two specific reasons:

1. Cable operators often distribute signals to several subnets located in different geographical areas. The *network_id* is used to distinguish between these subnets.
2. Cable operators retransmitting signals received from satellite may insert the receive network information as *NIT_other* .

3.3.1 Transmission of multiple NIT_other tables

Cable operators must be able to provide multiple NIT tables for different networks. The NorDig receiver should provide a menu for the user to enter the network number of the physical network it is connected to.

The following example has been chosen to illustrate this:

The satellite network *X-sat* transmits *NIT_actual* containing network information for the satellite network. In addition, NIT_other from *X-sat* contains network information for the following SMATV operators:

- SMATV A: network_id = 0x0090
- SMATV B: network_id = 0x0091

The following transport streams are transmitted in SMATV A:

- TS1 – transport_stream_id = 0x0001
- TS2 – transport_stream_id = 0x0002

The following transport streams are transmitted in SMATV B:

- TS3 – transport_stream_id = 0x0001
- TS4 – transport_stream_id = 0x0002

The NIT transmitted via satellite is indicated in Figure 8

```
network_information_section(){
        table_id 0x40           (NIT_actual)
        network_id      0x0040  (X-sat)
        #first loop descriptors{
                network_name_descriptor(){
                        network_name    "X-sat"
                }
                linkage_descriptor(){       # link to NorDig software
                        download
                        transport_stream_id         0x0001
                        original_network_id         0x0041
                        service_id                          0x000A
                        linkage_type                0x81
                        private_data                <according to NorDig
                                                    specification>
                }
        }
        #transport stream definitions{
                <Definition of transport streams in satellite network>
        }
}
network_information_section(){
        table_id 0x41           (NIT_other)
        network_id      0x0090  (SMATV A)
        #first loop descriptors{
                network_name_descriptor(){
                        network_name    "SMATV A"
```

```
                }
                linkage_descriptor(){       # link to NorDig software
                        download
                        transport_stream_id         0x0001
                        original_network_id         0x0040
                        service_id                          0x000A
                        linkage_type                0x81
                        private_data                <according to NorDig
                                                specification>
                }
        }
        #transport stream definitions{
                transport_stream_id             0x0001
                original_network_id             0x0040
                #second loop descriptors{
                        satellite_delivery_system_descriptor()
                        service_list_descriptor()
                }
                transport_stream_id             0x0002
                original_network_id             0x0040
                #second loop descriptors{
                        satellite_delivery_system_descriptor()
                        service_list_descriptor()
                }
        }
}
network_information_section(){
        table_id 0x41           (NIT_other)
        network_id      0x0091  (SMATV B)
        #first loop descriptors{
                network_name_descriptor(){
                        network_name    "SMATV B"
                }
                linkage_descriptor(){       # link to NorDig software
                        download
                        transport_stream_id         0x0001
                        original_network_id         0x0040
                        service_id                          0x000A
                        linkage_type                0x81
                        private_data                <according to NorDig
                                                specification>
                }
        }
        #transport stream definitions{
                transport_stream_id             0x0001
                original_network_id             0x0040
                #second loop descriptors{
                        satellite_delivery_system_descriptor()
                        service_list_descriptor()
                }
                transport_stream_id             0x0002
                original_network_id             0x0040
                #second loop descriptors{
                        satellite_delivery_system_descriptor()
                        service_list_descriptor()
```

Figure 13: Satellite NIT transmission including NIT other

3.3.2 Set-top box interpretation

For cable set-top boxes the parameters of the “barker channel” shall either be entered manually from the subscriber or pre-programmed by the set-top box manufacturer. Along with the “barker channel” parameters, the set-top box shall ask the subscriber to enter the appropriate network number. When the subscriber initiates channel search, the set-top box may perform a search according to the following algorithm:

```
Access the “barker channel” NIT;
For all network_ids in NIT_actual and NIT_other{
        If network_id = network number{
                # Correct NIT section detected
                For all transport streams defined in NIT section{
                        Read cable_delivery_system_descriptor;
                        Read service_list_descriptor,
                        Tune to the transport stream;
                        Read SDT;
                        Present all service names for which service_id is
        included in service_list_descriptor;
                }
        }
}
```

Figure 14: Barker channel algorithm

3.4 Specific tuning for Terrestrial Networks

Terrestrial transmission is somewhat different from both satellite and cable transmission due to several reasons, particularly the following two:

- One network operator may cover the same geographical area from several transmitters, i.e. the same services may be received from different transmitters.
- The network may offer regional signals, i.e. signals receivable only in a part of the total network.

Due to these reasons, some special precautions have to be taken for terrestrial transmission. The following sections identify these precautions.

3.4.1 Definition of terrestrial network concepts

MFN: Multiple Frequency Network is a network that over a specified area transmits with several different frequencies and thereby has the possibility to transmit different transport streams over that area. This property is what we in this document call a **Scalable Network (SN)**.

Preference Network: Can be seen as the main network of a viewer in an intersection area of several networks, this network is usually chosen by the user during installation of the STB.

SFN: Single Frequency Network is a network where one transport stream is feeding several main-transmitters all transmitting on the same frequency. The transport stream has to be identical in all main-transmitters. This property, that the transport stream is identical over a bigger region, is what we have called a **Non Scalable Network (NSN)** in this document. A NSN can be caused by a SFN or that only one multiplexer is feeding several frequencies.

3.4.2 Cross-Carriage of SI

It should always be possible to present all services and events (present and following) to the viewer, which the viewer has the possibility to receive within a Local Service Network (see below). This requires that all SI is cross-distributed over all frequencies in that specific region. The cross-carriage of SI is limited to the finest level of regionality, called a Local Service Network (LSN). The Local Service Network can be defined as the coverage area of a transport stream, i.e. if several transport streams cover exactly the same area they belong to the same Local Service Network. The cross carriage shall be limited within the Local Service Networks with the exception of region who have a mixture of SFN and MFN.
The navigation EPG/ESG, shall not display any service that the receiver can not receive, due to low RF level or status.

The definition that a service is possible to receive is that it is included in the *service_list_descriptor* in a received NIT_actual table. By using this definition the receiver can by a very simple algorithm decide whether or not to present the cross distributed service. Such an algorithm is presented in section 3.1.8, and is repeated here for convenience:

```
If Service_id is available in any received NIT_actual (service_list_descriptor)
                display the service in the (ESG/EPG )
else
                do not display the service
```

- The receiver shall only display a service once, even if the same service is received from multiple transmitters, the receiver shall chose the service belonging to the preferred network.

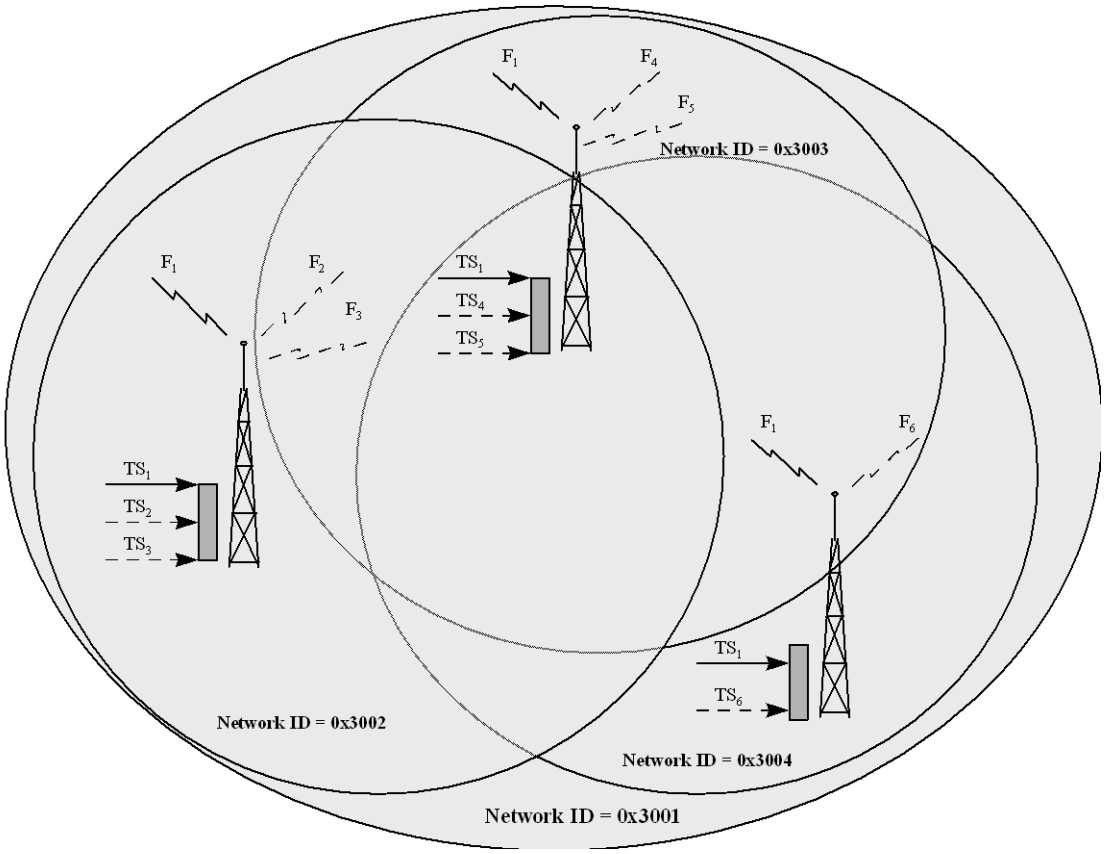


Figure 15: an example of the mixture of Multiple- and Single Frequency Networks

Due to limited bandwidth in the terrestrial network the cross distribution of the SI shall be limited to the following tables:

- All BAT sub tables for the LSN.
- SDT other for all services in the LSN, i.e. listed in the NIT (actual)
- EIT other (present and following) for all services listed within each SDT other. The EIT_present_following_flag shall be set to ”1”, which indicates that the EIT_present_following information for the services is present in the current TS.

The LSN can for the purpose of SI be treated as a single terrestrial network unique within the network.

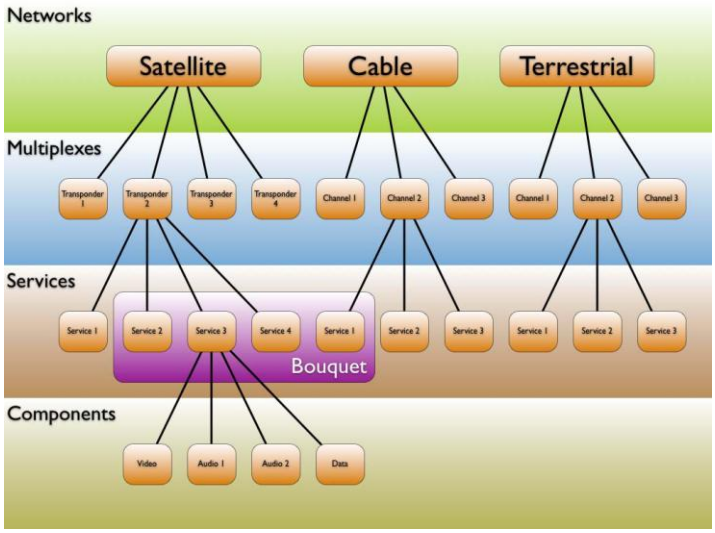


Figure 16: DVB service delivery model

The delivery system model is detailed in Figure 9; this restriction is to optimise the use of the bandwidth within the terrestrial network. Depending on aerial installation and receiver location, a receiver may be able to receive multiplexes from more than one LSN. There is normally no cross-carriage of SI specified between LSN, and the receiver must therefore treat the LSN as independent networks. However, where a receiver finds the same combination of original_network_id / service_id in multiplexes received from different LSN the services may be considered to be identical.

As specified above there is an exception to the rule of no cross-distribution between LSN. The cross-distribution in the case of mixture of SFN and MFN will be limited to the SFN. The best way to explain this is probably by example:

One multiplexer (TS 1) is feeding three main-transmitters all transmitting on the same frequency (F 1) in a regional Single Frequency Network. Each of these transmitter nodes has other transmitters that are transmitting on the frequencies F 2, F 3, F 4, F 5 and F 6. These three local transmitters are fed by their own multiplexer transport streams TS 2, TS 3, TS 4, TS 5 and TS 6 respectively.
All the transport streams covering the same regional network will cross-distribute the SI between them, just as previously discussed. However the SFN that covers several LSN will cross-distribute the SI from all the LSN area that it covers and the SI from the SFN is likewise cross-distributed to the MFN.

An overview of the Network Information Tables for TS 1 and TS 2 in our example is described below:

For TS 1:

```
Network_information_section() {
        table_id                0x40 ( actual )
        network_id              0x3001
        transport_stream_id     0x0001
                {
                        list of services
                }

    network_information_section() {
        table_id                0x41 ( other )
        network_id                  0x3002;   0x3003;   0x0004    (one for each NIT other table) ↓
↓           ↓
        transport_stream_id     0x0002 -3;0x0004-5; 0x0006     (for each NIT other table)
                {
                        list of services
                }
```

For TS 2:

```
        network_information_section() {
                table_id                0x40 ( actual )
                network_id              0x3002
                transport_stream_id     0x0002-3
                        {
                                list of services
                        }

            network_information_section() {
                table_id                0x41 ( other )
                network_id              0x3001
                transport_stream_id     0x0001
                        {
                                list of services
                        }
```

4 Video Transmission

4.1 MPEG 2

The NorDig compliant platform shall support MPEG 2 video encoding for Standard Definition (SD) signals only, each multiplex on the network may consist of MPEG 2 SD services, MPEG 4 SD services, MPEG 4 HD services or a mix of SD and HD services where technically feasible by the encoding platforms.

The video format shall be encoded and decoded as described in ISO/IEC 13818 [2] and EN 300 468 constrained and interpreted as described in TR 101 211 and TS 101 154 and as clarified and extended below.

Table	Description
PMT	May be static or dynamic. Elementary stream_type signalled as described earlier.
SDT	service_type signalled as described earlier.
EIT	stream_type signalled as described earlier.
EIT	component_type signalled as per earlier description

Table 10: MPEG 2 format SI signalling

The following elements must be included for all video services:

Framing
A Group of Pictures (GOP) defines the distance between I frames, the I-frame is the only MPEG-2 frame type which can be fully decompressed without any reference to frames that precede or follow it.
The standard MPEG 2 GOP contains one I-Frame, two B-Frames and one P-frame, the final I-Frame of the GOP contains an IDR

Resolution
The video encoder shall be capable of encoding Standard Definition (SD) at main profile at main level video resolutions. The encoder shall support 544x576, 704x576, and 720 x 576 Standard Definition (SD) in 4:3 or 16:9 Aspect Ratio.

4.2 MPEG 4

Each multiplex on the network may consist of AVC SD services, AVC HD services or a mix of SD and HD services. As NorDig specified and certified receivers decode and display both HD and SD services there is no requirement to simulcast HD and SD versions of the same service.
The following considers the different scenarios for single or mixed format services, dynamic support of format change cannot stably be supported, format changes may only occur with a service (day part) change.

Single format indicates a service which runs 24/7 in either Standard Definition (SD) or High Definition (HD) format.

Table	Description
PMT	May be static or dynamic. Elementary stream_type signalled as described earlier.
SDT	service_type signalled as described earlier.
EIT	stream_type signalled as described earlier.
EIT	component_type signalled as per earlier description

Table 11: Single format SI signalling

Multiple format indicates a part day shared service which changes format for certain hours during the broadcast day.

Table	Description
PMT	Must be dynamic. Elementary stream_type signalled as to current format and as described earlier.
SDT	service_type signalled at the lowest stream type and as described earlier.
EIT	stream_type signalled as described earlier.
EIT	component_type signalled as per earlier description

Table 12: Multiple format SI signalling

The video format shall be encoded and decoded as described in ISO/IEC 14496-10 [4] and EN 300 468 [7] constrained and interpreted as described in TR 101 211 [8] and TS 101 154 [14] and as clarified and extended below.

The following elements must be included for all video services:

Framing
Random Access Point (RAP) in the video stream. The maximum time interval between RAP shall be less than 2 secs. The receiver shall commence decoding and displaying the H264 Advanced Video Coded service from the RAP.
A Group of Pictures (GOP) defines the distance between Instantaneous Decoder Refresh (IDR) key frames.

An IDR frame is a special type of I-frame in H.264, an IDR frame specifies that no frame after the IDR frame can reference any frame before it. Inserted at the beginning of a coded video sequence, the IDR unit contains an *intra* picture, a coded picture that can be decoded without decoding any previous pictures in the stream, the presence of an IDR indicates that no subsequent picture in the stream will require reference to pictures prior to the intra picture it contains in order to be decoded. The IDR also performs the task of flushing the IRD buffer on channel change and splash screen cleardown.

Resolution
The video encoder shall be capable of encoding High Definition (HD) main and high profile level 3 and 4 video resolutions. The encoder shall support 544x576, 704x576, and 720 x 576 Standard Definition (SD) in 4:3 or 16:9 Aspect Ratio (AR) and 1440x1080, 1920x1080 and 1280x720 High Definition (HD) in 16:9 Aspect Ratio. Random Access Point (RAP) parameters describe either a 16:9 or 4:3 aspect ratio coded frame that is either one of the full screen formats or a cropped version of one of those.

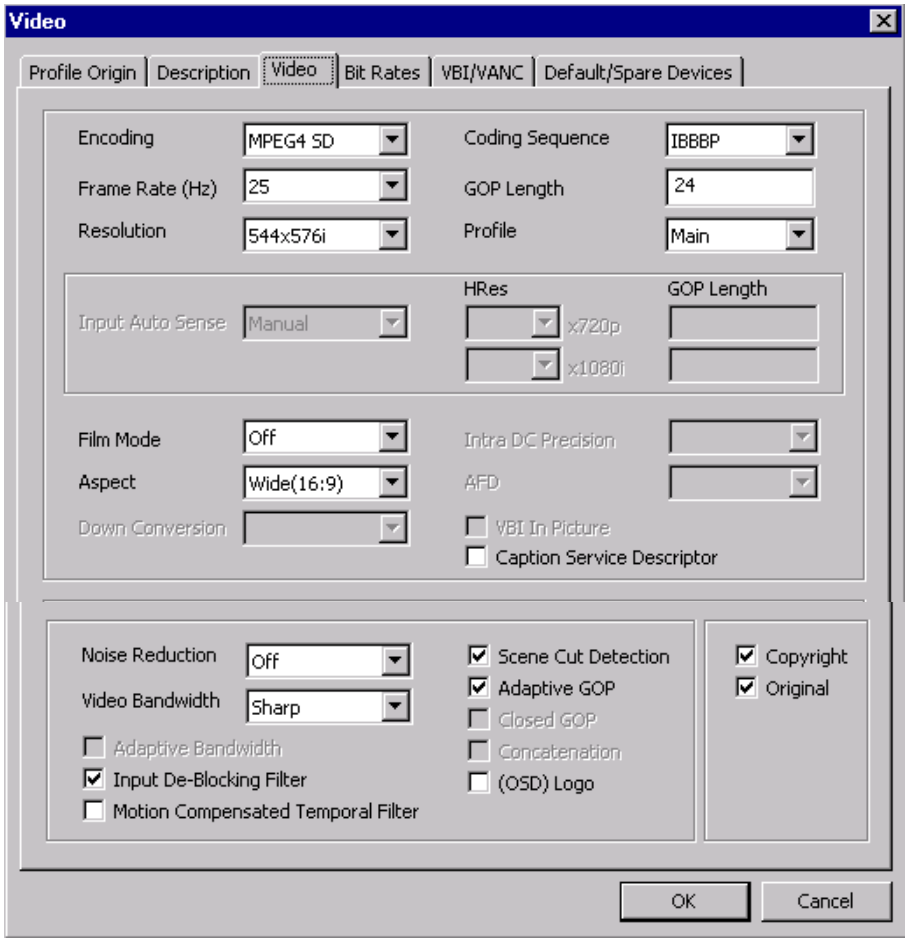


Figure 17: Typical control platform video setting for Standard Definition service

Active format description

The majority of SD broadcast services and all HD broadcast services on the NorDig compliant network are transmitted in a aspect ratio of 16:9, however in order for broadcasters to correctly display archived transmission material an aspect ratio of 4:3 may be necessary from time to time, the NorDig Headend encoder shall be capable of inserting Automatic Format Descriptor (AFD) codes into the Packetised Elementary Stream (PES) header to allow the receiver to determine the correct display, AVC AFD are carried in the Supplemental Enhancement Information (SEI) of the header.

Active Format Descriptors (TS 101 154) may be broadcast by services to describe the portion of the 16:9 or 4:3 coded frame. The format descriptions are provided to assist the receiver in optimising their presentation of video to the viewer.

Figure 18: Full height anamorphic 16:9 picture as displayed on widescreen (16:9) display.

Figure 19: 4:3 Picture correctly displayed on 16:9 display, known as Pillarbox

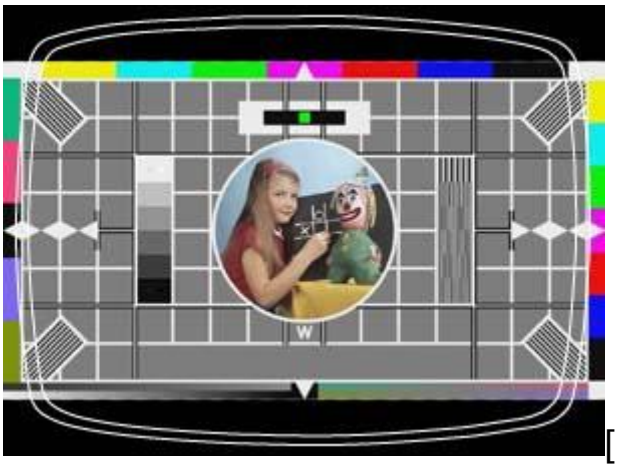


Figure 20: 16:9 Picture correctly displayed on 4:3 display known as Letterbox

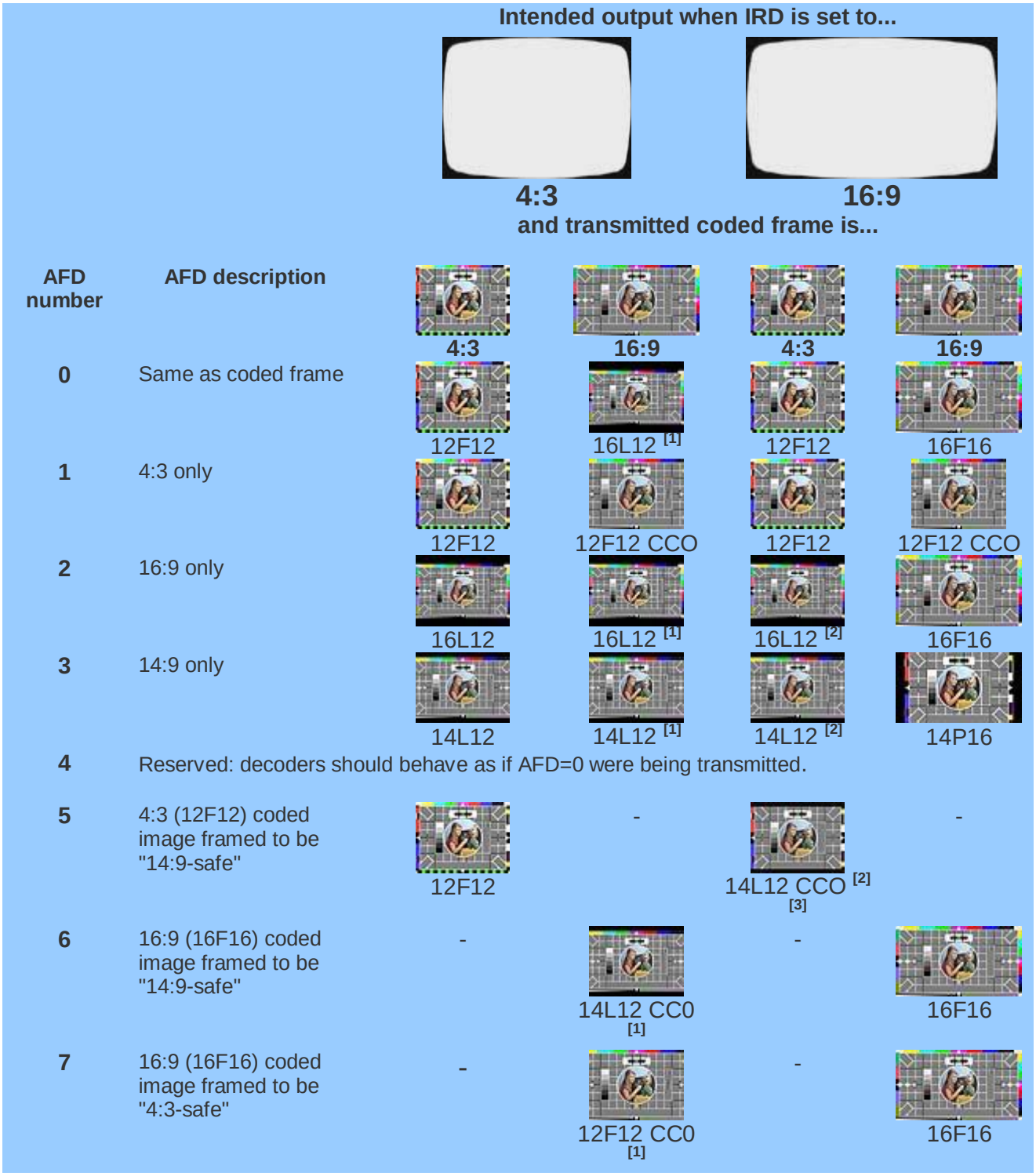


Figure 21: IRD output 16:9 / 4:3

1) In these instances the decoder may often be set to output a different shape of picture, from full height to deep letterbox, under the control of the user.

2) Widescreen displays are often capable of 'zooming' 14L12 and 16L12 pictures to the full screen height, either under the control of the user or a WSS signal from the decoder.

3) In this instance the decoder might not add extra blanking the to 12F12 picture, leaving the widescreen display to mask the picture by zooming it to '14P16'.

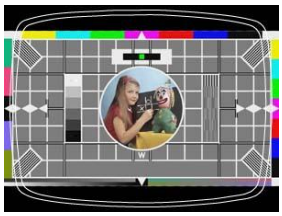
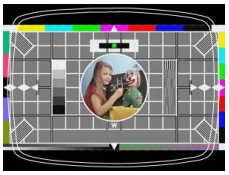
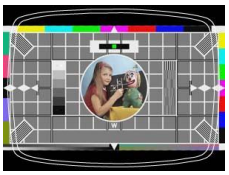
AFD	Display AR	Format conversion	Scart Pin 8	Display
AFD 1000  4:3	4:3	None	High (12v)	
	16:9	None	High (12v)	
AFD 1010  16:9 letterbox 4:3	4:3	None	High (12v)	
	16:9	Scaling to 16:9 frame	Low (6v)	
AFD 1000  16:9	4:3	Scale to Letterbox	High (12v)	
	4:3	Centre cutout	High (12v)	
	16:9	None	Low (6v)	

Table 13: AFD signalling

AFD	Display AR	Format conversion	Scart Pin 8	Display
AFD 1001  4:3 ratio on 16:9 display.	4:3	Centre Cutout	High (12v)	
	16:9	None	Low (6v)	

Table 14: AFD signalling

Aspect ratio switching within the NorDig specification is confined to standard definition (SD) broadcasts only, all High Definition (HD) broadcast within the NorDig region will be in aspect ration 16:9 only.
In Table 8 above the SCART status is employed to also indicate the status of the HDMI Info-Frame signalling.

4.3 Still picture - MPEG 4 AVC

If still pictures are transmitted this shall be indicated by setting the "still_picture_flag" in the *video_stream_descriptor* of the PMT to "1" or “on”.
The *video_stream_descriptor* is mandatory in the PMT whenever still pictures are transmitted.

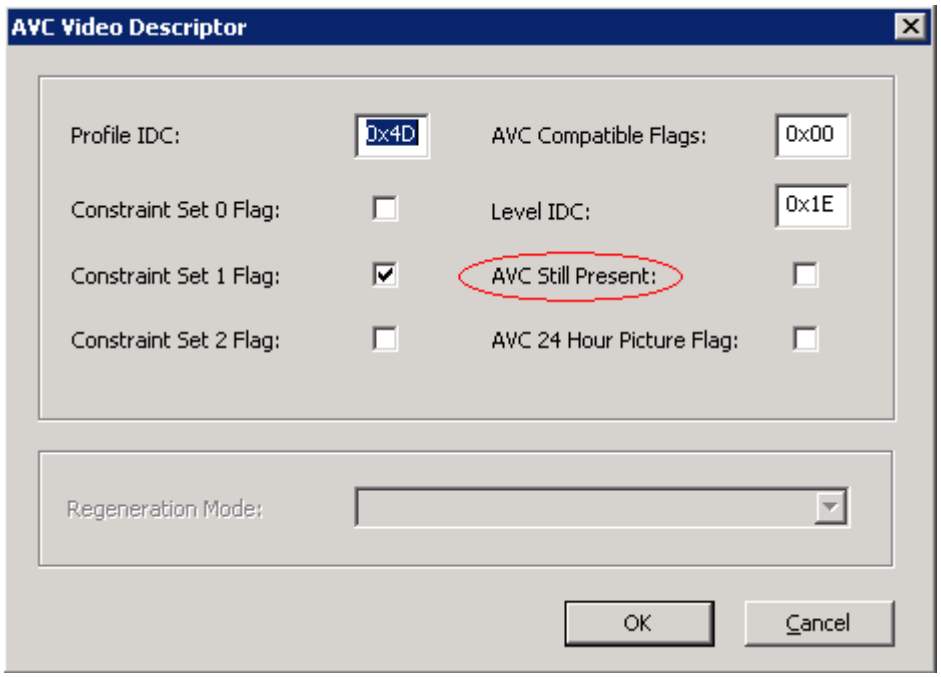


Figure 22: AVC Video Descriptor

5 Audio Transmission

5.1 General

This section includes several aspects regarding the set-up up of the audio parameters within the broadcast television and radio services like such as:

- The quality of audio at different encoding bit rates and some indications on selection of that bitrate for different audio quality classes.
- A brief description of the different subjective test methods for audio quality.
- A recommended set-up of audio parameters at the encoding headend.
- Recommendations regarding the handling of multichannel audio in the production, encoding and decoding domains.
- Commentary to assist the understanding of employing the correct audio metadata for loudness and down-mixing.
- Detail regarding the coding artefacts of audio which may occur when re-encoding audio for on ward distribution.

5.1.1 Method of subjective audio quality assessment

When encoding linear PCM audio into compressed audio, using psychoacoustical encoding schemes encoding artefacts may be added to the original audio. These encoding artefacts may be audible to normal human hearing, to evaluate this there are several scientific methods employed to subjectively assess the fidelity of the decoded audio when compared to the original baseband PCM audio. With these methods, the resulting figures obtained indicate the subjective qualities of the audio encoding, decoding process.

One of the primary methods employed in subjective audio quality assessment is International Telecommunication Union Recommendation BS.1116-3. This method is primarily intended for the evaluation of audio content where the audio artefact is judged to be minor or slightly impaired and are set out below in Table 12.

There is also the closely related International Telecommunication Union Recommendation BS.1284-1 which is intended for listening tests that are not as stringent as BS.1116-1, and the grading scales are accompanied with a perceived description.

Impairment	Grade	Quality (only in ITU-R BS.1284-1)
Imperceptible	5.0	5 Excellent
Perceptible, but not annoying	4.0	4 Good
Slightly annoying	3.0	3 Fair
Annoying	2.0	2 Poor
Very annoying	1.0	1 Bad

Table 15: Grading scale employed by ITU-R BS.1116-1 (originally ITU-R BS.1284-1)

The methodology employed in the subjective listening process is based on the ABX method, in this method, the listener is presented with three audio excerpt signals in sequence. Excerpt A is always the reference signal, excerpt B is a secondary reference and excerpt X is the excerpt under evaluation. The listener then has to decide if X sounds the same as either A or B, and grade the audio quality of X according to the grading scale.
Typically therefore signal A may be uncompressed baseband audio, signal B may be of poor or over compressed quality and signal X a proposed sampling and encoding bitrate to be assessed prior to use.

A secondary method employed in audio quality assessment is the MUltiple Stimuli with Hidden Reference and Anchor method (MUSHRA)or International Telecommunications Recommendation BS.1534-2, this method of assessment was originally developed and employed for audio content perceived as intermediate in quality and typically employed when the impairment to be measured is quite obvious to human hearing. Recently (c. 2005 onwards), the MUSHRA method has tended to have been employed even for audio content that is very close to the category of ”slight impairment”, this is due mainly to the relatively ease of listening and evaluating the audio content under test by the method.

Although the grading scales in both methods share some resemblance, they are not directly comparable due to the differences in test methodologies.

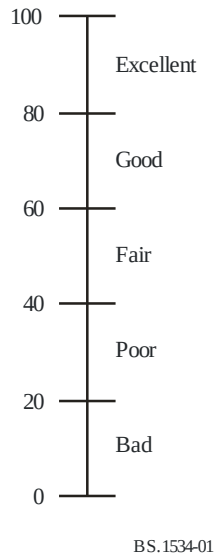


Figure 23. Grading scale employed for the MUSHRA method ITU-R BS.1534-2 (originally ITU-R BS.1284-1)

The MUSHRA method has a layout of approximately five or more audio excerpts presented to the listener in sequence to each other.
Again (and as with the ABX method) one of the excerpts presented is the un-encoded reference signal, and one signal is that of an anchor signal that is designed to give a quality rating close to “Poor” or “Bad” that is say of a quality impairment worse than the audio excerpt under test.

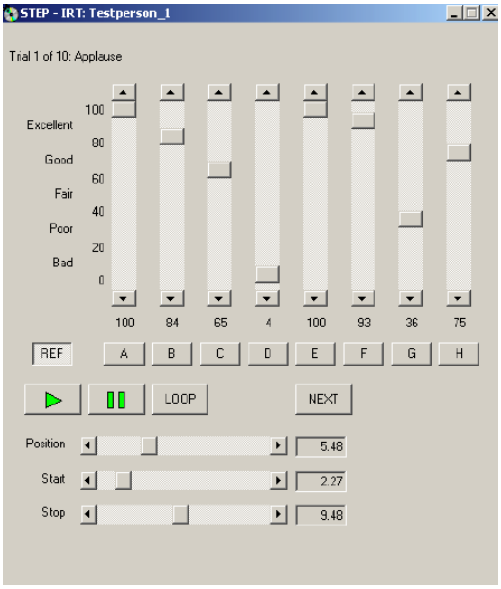


Figure 23: Example of a computer display used for a MUSHRA test.

Significant effort has to be made to ensure that the audio content employed for the evaluation of encoder and decoder chains is relevant and sensitive.
Typical audio content that has historically been employed are certain specific music and speech excerpts along with that of audience applause, it is also important and necessary to include audio content that has been recorded with different microphone set-up techniques and/or the use of special audio imagery.

With the increasing use of modern low bit rate encoders (which may use synthetically generated high frequency range), audio content which intrinsically employs material that is based around high frequencies is of particular interest within the evaluation process.
Encoder buffer clearance rates may also be revealed by the use of audio content with repeated transients which occur at higher frequency rates.

Equally important within the evaluation process is the employment of expert listeners or so called “golden ears” rather than amateur or inexpert listeners, research has found that the results obtained from inexpert listeners may be skewed and show much larger differences among the answers than those obtained from expert listeners.
Viz. Non-expert listeners do not know what to listen for and therefore tend to allocate higher points than expert listeners do; they do not appear to hear as much difference between audio content excerpts as the expert listeners can and therefore can not differentiate with the same ease and confidence.

5.2 Audio Encoding

NorDig has defined three audio encoding formats:

- MPEG 1 Layer II, which refers to MPEG-1 Layer II up to stereo (2.0) channel encoding.
- E-AC-3, which refers to E-AC-3 streams (including AC-3) up to 5.1 multi-channel encoding
- HE-AAC, which refers to MPEG-4 HE-AAC Level 4 (incl AAC-LC) up to 5.1 multi-channel encoding.

Informative: Some NorDig broadcasters have aligned the delivery of their MPEG-4 based services to include HE-AAC, E-AC-3 or AC3 audio formats only, this is optional within Nordig and MPEG 4 services may legally be transmitted with MPEG 1 Layer II encoding format.

5.2.1 Audio Decoding

Within the NorDig network, where there is no single operator responsible for the acceptance of the Integrated Reciever Decoder, the NorDig IRD shall support as a minimum:

- MPEG-1 Layer II
- E-AC-3 (AC-3)
- HE-AAC.

Within the NorDig network, where there is a single operator or regulator responsible for specifying and accepting the functionality of the IRD and for ensuring that the minimum requirements are met. The operator or regulator may specify one of following minimum audio decoding format alternatives for the NorDig IRD to support (as a minimum) for that specific network:

- MPEG-1 Layer II, E-AC-3 and HE-AAC audio decoding, or
- MPEG-1 Layer II, E-AC-3 audio decoding, or
- MPEG-1 Layer II, HE-AAC audio decoding.

The Audio decoders shall fully comply with the DVB Implementation Guidelines for the use of MPEG-2 Systems, Video and Audio in satellite, cable and terrestrial Broadcasting Applications ETSI TS 101 154

5.2.2 Audio Terminology

The term “Normal” within this specification refers to audio streams that are:

- Intended for the majority of broadcasters or broadcasters that are not interested in any supplementary audio.

- Audio signalled in the supplementary descriptor as mix_type ‘1’ and editorial description ‘0’ also within the ISO 639 language descriptor as audio type ‘Normal/Undefined’ and language not set to ‘nar’ (or equivalent broadcaster supplementary language code).

A Supplementary Audio (SA) service may be either:

- Audio Description (AD): audio that includes narration describing the action of the scene and is targeted at users with visual or cognitive impairments (see 6.11 for more information).
- Spoken subtitling (SS): audio that includes a spoken rendition of the broadcast subtitle and is targeted at users with visual or cognitive impairments (see 6.11 for more information).
- Clean Audio (CA): functionality that provides improved intelligibility and is targeted at users with hearing impairments, but can also serve as improvement for listening in noisy environments (see 6.10 for more information).

The following audio modes may be employed in the NorDig region.

5.2.3 MPEG-1 Layer II

MPEG-1 layer II audio stream shall be signalled by the audio_stream_descriptor (tag 0x03) in the PMT for the service.
It shall be encoded according to ISO 13818-3 and constrained according to ETSI TS 101 154.
The reference level for transmission shall be -18 dBFS, in accordance with EBU recommendation R68 "Alignment level in digital audio production equipment and in digital audio recorders" and as recommended by ETSI TS 101 154.

Table	Description
PMT	May be static or dynamic. MPEG-1 Layer II Audio is signalled by the audio_descriptor as per ISO 13818. The descriptor shall be placed in the descriptor loop for the audio element of the PMT with a tag value of 0x03.
SDT	service_type signalled as described earlier .
EIT	stream_type signalled as described earlier.
EIT	component_type signalled as per earlier description.

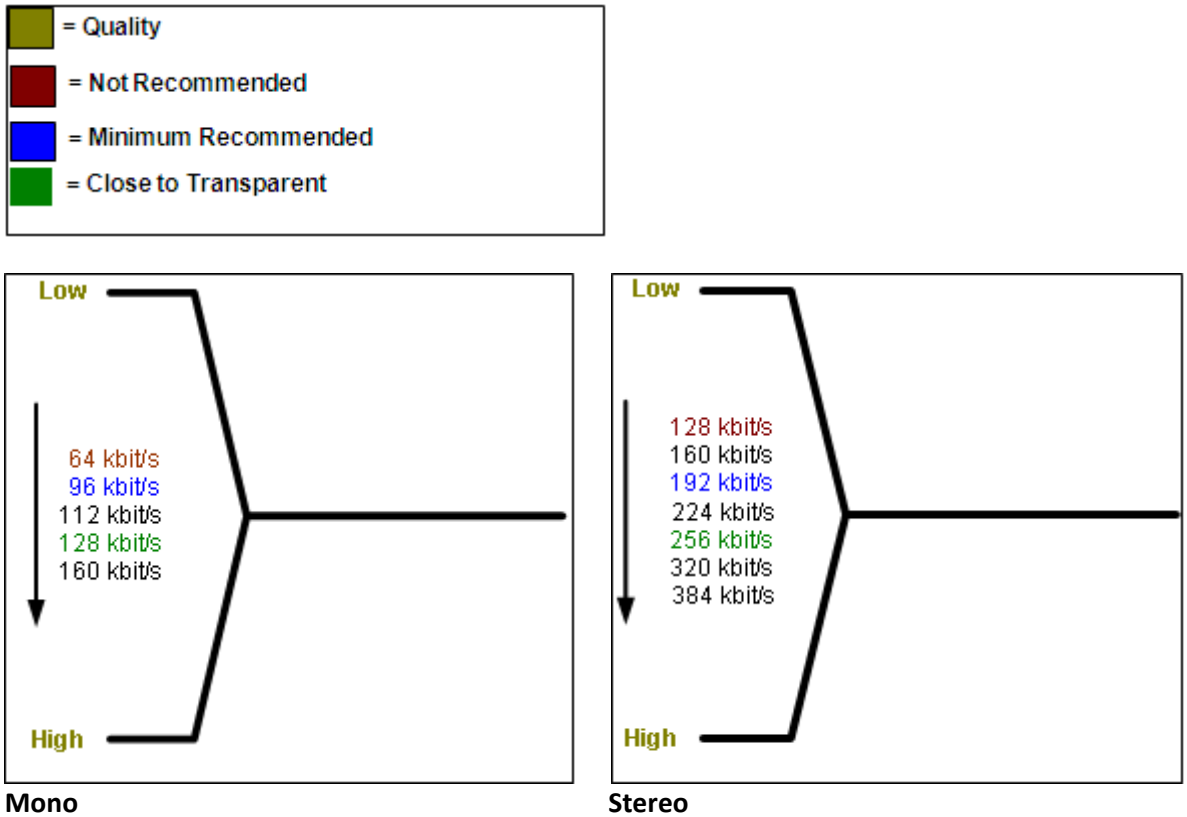
Table 16: MPEG 1 layer II format SI signalling

Figure 24: MPEG-1 layer II PMT format signalling

MPEG-1 Layer II: Recommendations/Requirements on Audio Handling

The following MPEG-1 Layer II modes may be employed:

Modes:	**Bit rates:**
Monaural :	64 kbit/s
Joint Stereo:	96 kbit/s
Stereo :	128 kbit/s
	160 kbit/s
Sampling Frequency:-	192 kbit/s
33 kHz	224 kbit/s
44.1 kHz	256 kbit/s
48 kHz	320 kbit/s
	384 kbit/s



Mono **Stereo**

Figure 25: Recommended Audio Bitrates

5.2.3 E-AC-3 and AC-3

AC-3 audio stream shall be signalled by the AC-3_descriptor (tag 0x6A) in the PMT for the service. It shall be encoded according to ETSI TS 102 366 and constrained according to TS 101 154, Annex C "Guidelines for the implementation of AC-3 audio in DVB compliant Transport Streams"

E-AC-3 and AC-3 is based on a constant bitrate (CBR) encoding scheme.

Table	Description
PMT	May be static or dynamic. AC-3 Audio is signalled by the audio_descriptor as per ISO 13818. The descriptor shall be placed in the descriptor loop for the audio element of the PMT with a tag value of 0x6A.
SDT	service_type signalled as described earlier.
EIT	stream_type signalled as described earlier.
EIT	component_type signalled as per earlier description

Table 17: AC – 3 format SI signalling

5.2.4 MPEG 4 HE AAC

MPEG 4 HE AAC audio stream shall be signalled by the AAC_descriptor (tag 0x7C) in the PMT for the service.

It shall be encoded as described in ISO 14496-10 and constrained according to TS 101 154,

Table	Description
PMT	May be static or dynamic. MPEG 4 HE-AAC Audio is signalled by the audio_descriptor as per ISO 13818. The descriptor shall be placed in the descriptor loop for the audio element of the PMT with a tag value of 0x7C.
SDT	service_type signalled as described earlier .
EIT	stream_type signalled as described earlier .
EIT	component_type signalled as per earlier description

Table 18: HE AAC format SI signalling

5.3 Signalling for Supplementary Audio

It is highly recommended that all Supplementary Audio streams (both Broadcast mixed and Receiver mixed) are signalled by the broadcaster in the stream by means of the Supplementary Audio Descriptor.

5.3.1 Informative for Supplementary Audio

A supplementary audio service (as defined in ETSI TS 101 154 [28]) is specified below for the “in-service delivery”, and applies when “normal” audio streams and the supplementary audio streams are available within the same service (i.e. listed within same PMT).

A Supplementary Audio (SA) service may be broadcasted as either:

- "Broadcast mixed" : pre-mixed audio by the broadcaster where the Supplementary Audio stream is a complete self-standing audio which contains both the programme audio mixed together with the supplementary audio content.

- "Reciever mixed": audio containing only the supplementary audio content which is not a complete self-standing audio and is not intended to be presented on its own. The receiver mixed supplementary audio and programme audio are typically mixed together in the IRD, under some control of the broadcaster via broadcast of supplementary data.

NB: Some IRDs currently in the market handle supplementary audio in a variety of ways, and there are some legacy receivers which are unable to elegantly support the presence of Supplementary Audio. To mitigate this and avoid unwanted behaviour, some Networks use special signalling for the Supplementary Audio. This means for example that in some networks a broadcast pre-mixed supplementary audio may be signalled in the ISO639 descriptor as "normal/undefined" audio type but with language 'nar' (or other language code), or a receiver mix supplementary audio may be signalled in the ISO639 descriptor as 'visual impaired' audio type but with a different language to that of the associated standard programme audio or national audio. Modern receivers support the Supplementary Audio Descriptor however, and hence avoid the problems associated with legacy signalling.

5.3.2 Implementation of Supplementary Audio

Within NorDig, the most common way of using Supplementary Audio is to use the facility to broadcast spoken subtitles, audio description as broadcast mix is also in use as a Supplementary Audio service. Since audio dubbing of content is very rarely employed within NorDig, the original spoken audio language content is broadcast together with subtitling and an accompanying supplementary audio track which may either be i) a spoken version of the subtitle or ii) an original language version track with narrative description (in the same language) . The viewer is then at liberty then to select their preference accordingly dependent upon their personal preference or needs.

Within NorDig, there are several different methods employed to broadcast Supplementary Audio for the viewer. In general, the following methods are employed:

- Broadcast mixed, Supplementary Audio signalled (in test in Sweden).
- Broadcast mixed, a separate TV service (in use in Denmark and Norway)
- Receiver mixed without metadata, Supplementary Audio signalled (in use in Sweden HD).
- Receiver mixed with metadata, Supplementary Audio signalled.
- Supplementary Audio only, on a separate TV service (in use Sweden SD).
- Supplementary Audio only with video, on separate TV service (in use Sweden cable).
- Broadcast mix Audio Descriptive service with a narrative voice that describes the scene portrayed during natural gaps in dialogue, allowing viewers with visual impairment to follow on screen action. This functionality is presented to the viewer as an alternate language track and selected by the viewer via the language/audio function on the remote control. (in use in Ireland, Sweden, Norway & Denmark).

When Supplementary Audio is signalled via SI within the DVB stream, the user may configure the IRD to use "Audio Description ON/Yes" in the set-up menu to select the supplementary audio track.

The broadcaster sources the appropriate type of supplementary audio, (broadcast mixed or receiver mixed). The standard method of broadcasting receiver mixed audio is together with metadata instruction to “duck” or reduce the audio level of the main programme stream during periods of descriptive narrative, this metadata is typically carried within supplementary audio stream and follows operational practice set out BBC WHP 198.

An alternate method for the broadcaster in supplying supplementary audio is to employ “broadcast mixed” supplementary audio.
In some NorDig countries a separate duplicate TV service is employed for the supplementary audio, with only the audio track differing in content from that of the “main” service.
This can simplify selection of the accessibility service for the viewer, however it is an inefficient use of bandwidth and can complicate service selection.

5.3.3 Spoken Subtitle supplementary audio

The receiver mixing between supplementary audio and programme audio can be done in various ways. Generally, when the supplementary audio is active, the programme audio is attenuated or “ducked”. When supplementary audio is inactive, the programme audio returns to its original level.
The timing, attenuation speed, release speed, attenuation level, and delay of the supplementary audio in relation to when the subtitle is presented on screen, can be adjusted at the play-out chain. It is generally deemed preferable for the viewer if the programme audio that is not reduced too much but also maintains a good speech intelligibility of the spoken subtitle. The attenuation of the programme audio with the range of -6 to -12 dB is considered to adequate in order to achieve this. Too fast a change of programme audio level might give the impression of “pumping” audio and is undesirable.
It has been found through subjective observation that some slight delay of the spoken subtitles compared to when the subtitle is displayed on screen can be advantageous to the eye and assist comprehension.

Example:

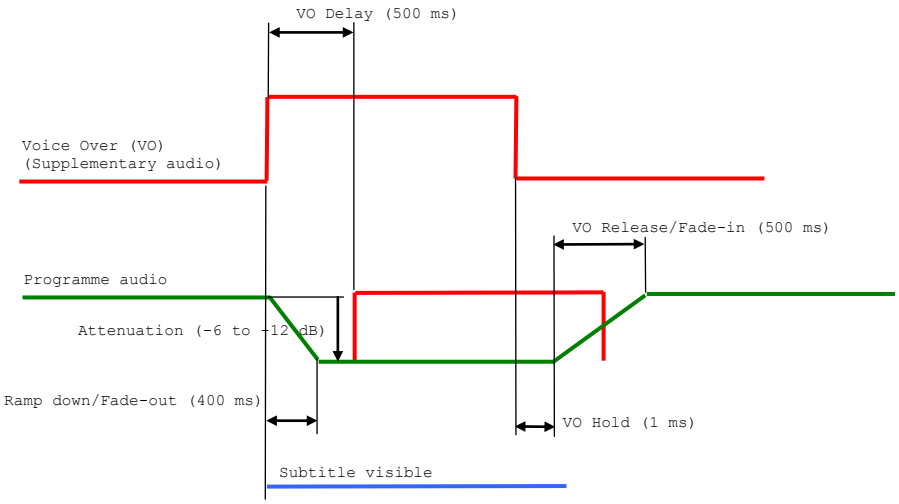


Figure 26: Spoken Subtitle supplementary audio

5.3.4 ISO 639-2 language descriptor

Supplementary audio (Audio Description , AD) may be carried as a separate broadcast pre-mixed audio track; described, signalled and selected as Narrative or 'nar' in ISO 639-2 language code with audio type 0x00 (as "normal/undefined"). The NorDig IRD may recognise the ISO 639-2 language code (nar) and display the word "Narrative" in the appropriate OSD and menu, this functionality is in an identical manner to the display of the ISO 639-2 language codes 'eng' or 'fre' as "English or "French".
Ideally when a separate language descriptor is broadcast within the PMT of the supplementary audio track the receiver will support simple rotation of language source via a single button press (e.g. Language or Audio) and as indicated via an on-screen navigational aid.
As a navigational aid for the user the onscreen display (OSD) should clearly indicate the audio language(s) available to the viewer on the channel selected via the (Language or Audio) button and the selection process available to the viewer should be via the appropriate navigation arrows. The presence of an alternative or dual language track shall be indicated to the viewer via icon on the OSD search and scan banner displayed during a channel change.
The ISO 639-2 language descriptor shall be inserted in the descriptor loop for the audio element of every audio component defined in the PMT with a tag value of 0x0A.
The audio type may be set to any value defined by ISO 13818 e.g. "normal / undefined".

5.4 Audio Prioritisation witin the NorDig IRD

The NorDig IRD is required to always decode and output audio if the selected service has an audio stream (irrespective of type, language, format or codec used). For television services with more than one audio stream, the NorDig IRD is required to prioritise and select the preferred audio stream to decode and present an output according to IRD's user preference settings, see Table 17 below.

IRD settings →		**" Normal" audio mode**		**Supplementary audio mode**	
		stereo mode (factory default)	**multichannel mode**	**stereo mode**	**multichannel mode**
IRD behavoir depending on above IRD settings					
Property of priority for audio	**Priority**	**Order of priority**			
Audio type	1 (highest)	1.1 " normal" 1.2 supplementary audio	1.1 " normal" 1.2 Supplementary audio	1.1 supplementary audio 1.2 " normal"	1.1 supplementary audio 1.2 " normal"
Language	2	2.1 audio match primay audio language settings 2.2 audio match secondary audio language settings 2.3 (if no match) " normal" audio 2.4 (if no " normal" audio) any audio	2.1 audio match primay audio language settings 2.2 audio match secondary audio language settings 2.3 (if no match) " normal" audio 2.4 (if no " normal" audio) any audio	2.1 supplementary audio match primay audio language settings 2.2 supplementary audio match secondary audio language settings 2.3 (if no match) " normal" audio 2.4 (if no " normal" audio) any audio	2.1 supplementary audio match primay audio language settings 2.2 supplementary audio match secondary audio language settings 2.3 (if no match) " normal" audio 2.4 (if no " normal" audio) any audio
Audio format	3	3.1 stereo 3.2 Multichannel 3.3 mono	3.1 Multichannel 3.2 stereo 3.3 mono	3.1 stereo 3.2 Multichannel 3.3 mono	3.1 Multichannel 3.2 stereo 3.3 mono
Stream type	4 (lowest)	4.1 MPEG-1 Layer II 4.2 HE-AAC 4.3 E-AC-3 4.4 AC-3	4.1 HE-AAC 4.2 E-AC-3 4.3 AC-3 4.4 MPEG-1 Layer II	4.1 MPEG-1 Layer II 4.2 HE-AAC 4.3 E-AC-3 4.4 AC-3	4.1 HE-AAC 4.2 E-AC-3 4.3 AC-3 4.4 MPEG-1 Layer II

Table 19: Audio Priority between incoming audio streams where a lower number refers to higher priority

Note:	NorDig IRD released before 1 July 2015 may still use old priority order with Lanugue higher priority than Audio type.

The IRD uses information from the PMT in order to select the appropriate audio stream or PID according to the user receiver preferences (Audio type, Language, Audio format, Stream type) if several audio streams or PID's are available. After selecting audio PID to be decoded, the IRD uses the audio metadata (PES/ES header or bitstream) within the audio stream for the decoding process. And this audio metadata (PES/ES header or bitstream) is normally more dynamic, (such as changing audio format between stereo and multichannel, downmix parameters, etc.). This means that the IRD does not use the EPG/EIT data for selecting the audio stream or PID, nor for the actual decoding. The information within the EIT/(EPG) regarding the audio is only intended for presentation to the viewer, e.g. EPG information. The values in the PMT should be more quasi static and describing the maximum use case (e.g. multichannel if the audio stream is dynamically changing between stereo and multichannel).

5.4.1 Internal Reference Level

Within NorDig the level for reference or lineup tone for transmission will be -18 dB FS below clipping level, in accordance with EBU Recommendation R.68 "Alignment level in digital audio production equipment and in digital recorders" as recommended by ETSI TS 101 154 [23].

5.4.2 Audio Prioritising, Format (multichannel or stereo)

The intention for the setting "Stereo" and "Multichannel" is to enable the user to set up the IRD to select the appropriate audio stream to suit their preference. Some broadcasters employ only stereo audio, others use stereo and multichannel and some use stereo audio and multichannel audio that rotates between the two dependent upon the content (*viz.* from stereo up to 5.1). More combinations with Audio Description (AD) or Spoken Subtitle audio stream content may also be present.

It is deemed importance that the receiver behaves in a elegant manner that it does not change audio stream type dependent up on how the content itself may have been produced. T
The intention is that the receiver adheres to an audio stream type in a semi-constant way, after the receiver has selected which audio stream type to decode and the receiver begins to decode the audio stream, only then does the audio decoder read and apply the *Channel Mode* audio metadata (e.g. for AC-3) to the appropriate outputs (can be stereo output to the TV-loudspeakers and multichannel bitstream to the digital audio output). It is therefore defined that the IRD must read the *AAC_type* field in the AAC_descriptor for AAC audio, and the *number of channels flags* in the AC-3 descriptor and Enhanced AC-3 descriptor for AC-3 and E-AC—3.

5.5 Loudness levels

It is strongly recommended to use the loudness levels defined in EBU Tech 3344.
In general, it should be assumed that each content provider that supplies programs content to the platform head-end will follow the rules set in EBU Tech 3344. These guidelines state that program loudness for each program should be -23 LUFS.
A television service may consists of a sequence of programming content in successive order., including commercials and interstitials and all are interpreted as individual programming. The overall long term integrated loudness for a complete service is therefore also meant to equate to -23 LUFS (service loudness). In order for this to successfully work as intended all the way to the domestic receiver, the audio level itself must be under control, but also, it is of utmost importance that the audio metadata for loudness carries the correct values when employing receiver mix of supplementary audio of spoken subtitle, specifically the values for dialogue normalisation for AC-3 audio, and Program Reference Level for HE-AAC and LC-AAC audio. Occasionally, the platform head-end may take their own loudness measurements in order to verify that each content provider has aligned the loudness levels in a correct way according to EBU Tech 3344 and is legal.

E.g. If the integrated loudness level for a content provider is measured to be -23 LUFS service loudness, then depending on the stream type being used, check that these Target reference levels are applied:

- Dialogue normalisation, dialnorm, normally set to -23 dBFS for AC-3 and E-AC-3.
- Program Reference Level, prog_ref_level, normally set to -23 dBFS for HE-AAC.
- MPEG-1 Layer II has no additional audio metadata, and the audio therefore has to be measured and checked that the service loudness is –23 LUFS.

Caveat: Only set static values when the content provider does not supply dialnorm/prog_ref_level. Some content providers may supply dynamically changing dialnorm/prog_ref_level metadata.

If the Target reference values do not match with the measured service loudness, unnecessary Dynamic Range Control processing might be applied in the IRD which therefore can be seen as being fed out of range .
It is of utmost importance that the operator of the encoder (typically network operator) has good control over all of the content providers signals in their distribution MPEG platform, so that the user experience a consistent loudness when zapping between different services. It is a very good practice if the operator of the encoder and the content providers has an on-going communication so that the audio levels and audio metadata values match. In some cases the audio metadata is set by the content provider, or is set at the operator of the encoder, and these values follow the emission all the way to the IRD, so the control of this metadata is very important. There are some suggestions in the EBU Tech 3344 on how to automatically correct the service loudness with audio metadata, however these kind of systems may not be able to find on the market yet. Therefore, use measurements to verify the loudness levels and correct if you discover discrepancy.

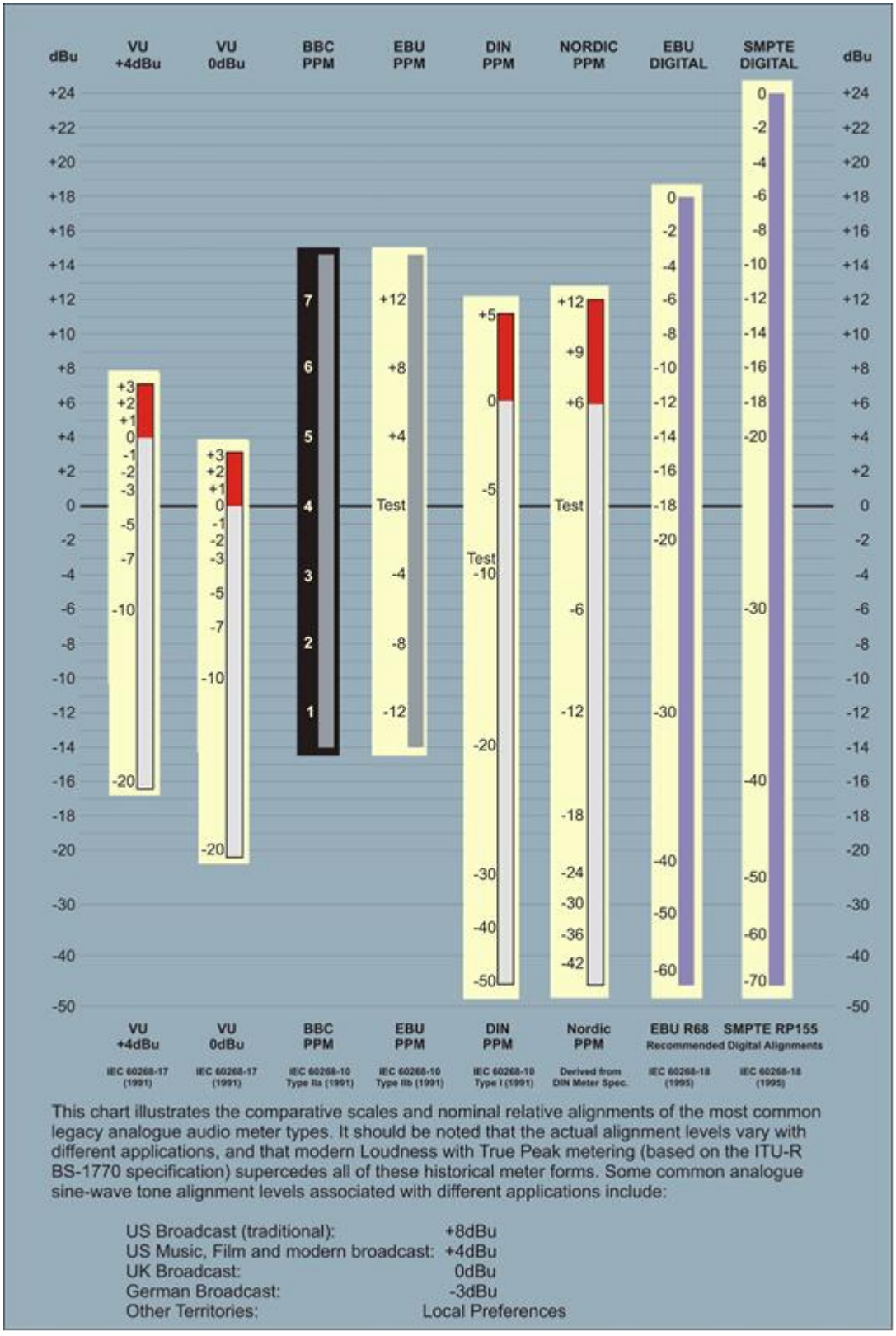


Figure 27: Comparative Scales and nominal alignment

6 System Software Update (SSU)

6.1 System software

The updating of receivers software by over air download (OAD) is as described in ETSI EN 102 006 DVB SSU with “simple profile” being the minimum level of functionality required.
Simple profile based SSU utilise signalling in the Network Information Table (NIT) and Programme Map Table (PMT), the NIT shall carry the linkage_descriptor (tag 0x4A) with linkage type 0x09 and user defined private data to indicate Organisation Unique Identifier (OUI) or signal generic DVB (0x00015A) again as per EN 102 006 [6].
A data_broadcast_id_descriptor (tag 0x66) will be included within the PMT of the planned system software update service, a value of 10 or 0xA “system software update” shall apply.

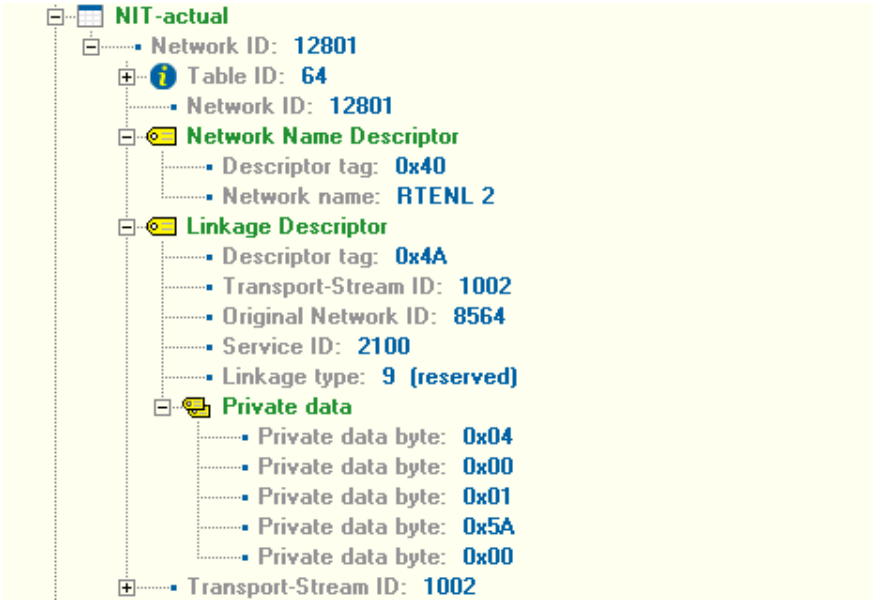


Figure 28: Example of linkage descriptor carried within the NIT

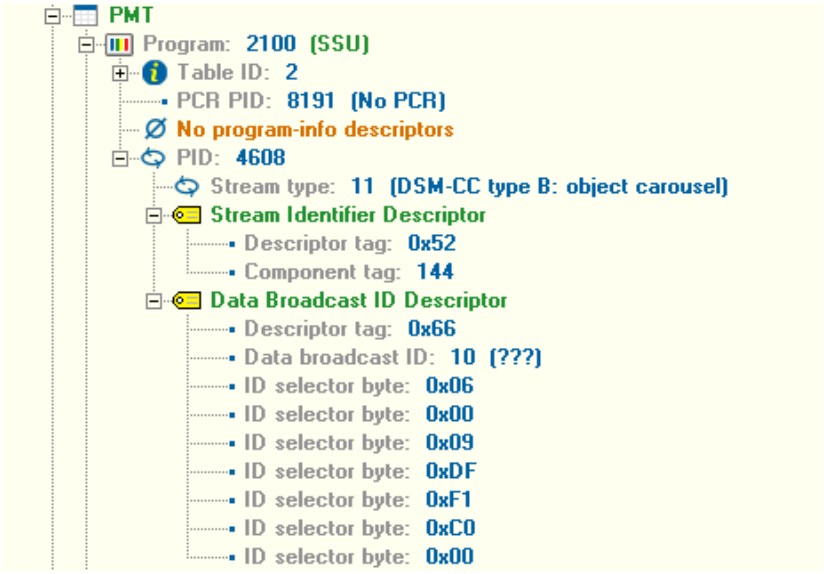


Figure 29: SSU stream_identifier and data_broadcast_id descriptors within the PMT

It is recommended that system software updates take place overnight where there is minimum prospect of interfering with normal viewing.
The NorDig platform operator shall not broadcast an over air download without Organisation Unique Identifier (OUI) if the Generic DVB OUI is not used in the NIT the manufacture shall supply the relevant NIT information, likewise for the data_broadcast_id_descriptor within the PMT.

Until a common API is defined for the NorDig set-top box, the legacy system software implementations are regarded as specific for the different network operators. It shall therefore not be possible for the user to download system software which is targeted for the set-top boxes in another network. To obtain this, the download signalling should contain a reference to a specific hardware version of the relevant manufacturer The general procedures of the bootloading are described in the NorDig I specification.

7 Teletext and Subtitling

7.1 Teletext

If EBU teletext is employed by the NorDig service it shall conform to the standard defined in ITU-R System B Teletext in DVB Bitstreams, teletext data shall be inserted on lines 6 to 20 and 318 to 334 only.

Two restrictions apply when considering transmission of teletext for on-screen display:

- The size of the text «packet» that can be handled correctly in the IRD.
- The time delay for presentation of text in real time.

For services intended for transcoding to PAL teletext must be inserted such that allowable lines in the recoded PAL signal are utilised. The exact line numbers to be used must be established in each particular case.

7.1.1 PES Packet Length

PES packets containing the teletext pages shall not exceed 1504 bytes in length. A maximum of two fields per PES packet shall be transmitted.

7.2 Subtitling

Subtitling may be provided through ITU-R system B Teletext [8] or through the DVB Subtitling System [9]. Subtitling shall not be supplied or transmitted on line 21 of the VBI by the broadcaster on the NorDig compliant network, subtitling shall be supplied and broadcast on line 335 of the VBI only.

7.2.1 ITU-R System B Teletext Subtitling

Subtitling on line 335 shall be signalled within in the Programme Map Table (PMT) of the service using stream type 0x06 (S) indicating PES packet private data with a subtitling_descriptor associated with the subtitle stream component.
In order to ensure acceptable delay in the presentation of the subtitles the following rules must be observed:

- For a teletext service carrying a mix of text and subtitles no restriction other than that given in section 7.1 applies.
- In a subtitles-only teletext service the PES packets must be limited to contain those text pages that shall be displayed simultaneously (multiple language subtitling). Moreover those text pages must fill an entire PES packet, with the aid of stuffing bytes if necessary.

7.2.2 DVB Subtitling System

The use of DVB subtitling is supported by the NorDig I set-top boxes according to EN 300 743 Digital Video Broadcast (DVB) subtitling systems.

8 PVR

8.1 General

The PVR is defined as an IRD with two RF tuners, with which the user is able to view one channel whilst recording another, it possesses a integral hard drive (HDD) and has the ability to pause the live broadcast, the PVR can record all components of the desired service i.e. video, main programme audio, supplementary programme audio (AD), subtitling etc.

Programming a recording (or booking) refers to the user action of making a booking to record a live event, series and/or other broadcast content, either to be scheduled in the future or for immediately recording from the EPG grid or whilst viewing the service or receiving an on screen prompt (green button) whilst viewing a programme.

The PVR shall be capable (at factory default) that all recordings shall include all supported components or PID's listed within the PMT of the recorded service *Viz.* Video, Audio 1, Audio 2, Subtitle, Audio Description, Original Language, PCR etc).

If the (HbbTV/MHEG) application in the transmission is signalled as not to be recorded, the NorDig Enhanced or Interactive PVR should not record these application streams.

The NorDig PVR specification is based solely upon broadcast signalling via DVB-SI, which is independent of Video and Audio formats of Application Interface (API), Conditional Access (CA) and Digital Rights Management (DRM)systems and is capable of operating in free-to-air and Pay TV modes. The NorDig PVR specification follows closely the DTG specification (D-Book 6.2.1) this is to encourage harmonisation of standards and encourage the use of a standard PVR within NorDig.
Both the NorDig and DTG specifications are based upon the TV-Anytime standard signalling.

8.2 Implementation overview

8.2.1 Broadcaster

The broadcaster is responsible for the description of the programme content via standardised DVB signalling and the distribution of that signalling transparently across their network to the PVR receiver.

Broadcaster schedule providers will generally generate and deliver content information via XML format. This XML schedule information is typically translated into DVB EIT (Event Information) tables prior to its inclusion within the transmitted DVB transport stream, the data typically comprises of EIT present/following (p/f) and EIT schedule, other extended DVB SI signalling to support the PVR is also required.

It is a basic requirement that content providers (broadcast stations) ensure that their broadcast content (Video/Audio) run concurrent with the programme information supplied via EIT p/f and EIT schedule this is to avoid clipped recordings and poor PVR viewer / user experience.

8.2.2 Signalling

Basically there are three types of program information or signalling distributed in the DVB SI stream:

- Static Data (channel name, broadcaster id, etc)
- Programme Content data (EIT p/f, EIT Schedule, EIT + 8 days)
- Live Programme Content update data (EIT p / f, i.e. updates to broadcast duration.

The support of EIT p/f live updating is mandatory for the NorDig PVR.

The NorDig PVR specification is based on the TV Anytime standard for programme description and content, this specification employs the standard Content Reference Identifier (CRID) system for an advanced cross-platform handling of programme and content.
As mandatory, the broadcaster will support NorDig PVR signalling by employing a unique programme identifier for each programme event in order to distinguish individual programmes, identify a series of programmes or accommodate the split recording of programmes.

8.1.3 Network operator

DVB signalling to support the NorDig PVR shall be implemented on all Multiplex's within in the NorDig broadcast network as mandatory, this includes NIT, SDT, EIT p/f, EIT Schedule and extensions, this inclusion ensures that all broadcasters on the network who wish PVR functionality may support this by supplying the necessary data within their respective programme schedule(s).

Support of NorDig PVR signalling necessitates a slight increase in data payload and hence the bitrate required for transmission of EIT p/f, EIT schedule. Operators may choose to handle broadcaster and channel id CRID with abbreviations to save bandwidth capacity across the network.

In order to ensure that Live Programme Content updates are conveyed to the PVR via EIT p/f within 10 seconds of the live update occurring, it is necessary to ensure that the data path from the content provider/ broadcaster to the PVR is as transparent as possible, it is necessary therefore that a direct data connection from Content Provider / Broadcaster scheduling system to the EIT generation system on the network head-end in order to accommodate this.

8.1.4 The Re-transmission of DTT to Cable or Satellite networks

For the support of NorDig PVR when employed on a cable or satellite network the broadcaster may choose to re-broadcast the DTT sourced transmission.

In such circumstances the broadcaster my choose to pass the complete PVR signalling requirement within EIT p/f and schedule along with programme content (Video, Audio, Teletext, Subtitling, Etc.), with the appropriate modifications to NIT (ONID, LCN), PMT, SDT etc.

Or re-generate EIT p/f and EIT schedule from the original programme content provider XML for separate broadcast, this latter action may be necessary where certain programme rights issues are in place preventing the transmission of programme on the Cable or Satellite Network.

8.2 CRID Types

A content identifier descriptor can indicate the type of CRID that is carried therein.
There are 3 types of CRID employed on the NorDig DVB Network:-
A Programme CRID – to identify a specific piece of content (e.g. programme)
A Series CRID – to group together an arbitrary selection of content (e.g. a series)
A Recommendation CRID – may point to a single event (in programme or series)

user private CRID types are to be used:
crid_type :-
0x01 Programme CRID
0x02 Series CRID
0x03 Recommendation CRID (currently unused within NorDig).

The NorDig PVR should ignore all other CRID types.

8.2.1 Programme CRID

CRID Type 0x1

Programme CRIDs are used to identify two or more EIT events as being the same programme and may not be used to represent other content defined by the same broadcast authority, this prevents duplicate programmes or repeats being recorded from within the same series and also allows alternative programme instances to be recorded (or offered for recording) if a booking clash occurs.
An EIT event can only be associated with a single programme CRID.
Programme CRID employed on time delay services (+1 hr) must be different and unique from that employed on the live service.

8.2.2 Series CRID

CRID TYPE 0x2

Series CRIDs define groups of programmes linked by the series concept. A CID that describes a Series may contain multiple CRIDs; therefore a Programme may be part of more than one Series. Where an event is associated with more than one series, an invitation to record programmes in the same series as this event would book to record all events in all series associated with the selected event. A PVR shall store and track series CRIDs for up to 13 weeks between occurrences in EIT schedule. To allow broadcasters to reuse a series CRID for a different editorial concept, receivers shall discard any series CRIDs not seen in EIT for 13 weeks.

8.2.3 Recomendation CRID

CRID TYPE 0x3

A recommendation may point to a single event (Programme CRID 0x01) or a series (Series CRID 0x02).
A CRID in the CID shall be marked as CRID type 0x03 (Recommendation) and be a programme or series CRID. It is unnecessary for a recommendation CRID be continually carried within the EIT, if the event being referenced by the recommendation CRID is not present within the current live EIT, the recommendation may be presented to the user when it eventually appears within the EIT.
If a recommendation CRID does not appear within the EIT within 91 days of the referencing event it shall be discarded.
A recommendation may reference an event earlier in the EIT schedule than the linked-from event, e.g. to link to a preview programme.

8.2.4 Use of the Instance Metadata Identifier

A CRID in the CID shall be a programme CRID (crid type 0x1) with an IMI extension. Where two events have the same CRID and IMI value and the gap between each event is less than 3 hours (measured from the end of the preceding event to the start of the next event) then they shall be considered to be segments of a single item of content.
An item of content may be split across more than two events as long as the gap between each event remains less than 3 hours.

8.3 CID Carriage

Each Programme described within the EIT p/f and EIT Schedule shall carry in the Event Loop at least one CID that shall contain one CRID of type Programme. Additional CIDs may also be carried in the same Event Loop to describe Groups. A CID that describes a Series may contain multiple CRIDs; therefore a Programme may be part of more than one Series.

8.4 CRID Encoding

A CRID contained within a Content Identifier Descriptor shall be encoded according to the following rules:-
The CRID must be a compliant URI as defined in ETSI TS 102 822-4 section 8.
The CRID is further restricted to only contain characters encoded over the range from ISO 6937 0x20 to 0x7F.
The length of the CRID plus IMI (if any) shall not exceed 64 characters. The maximum lengths of the separate parts of the CRID are as follows: -
authority 32 characters (excluding leading „crid://„)
data 29 characters (including leading „/„)
instance metadata id 3 characters (including „#„ separator)
The CRIDs are not intended to be human readable and shall not be displayed on-screen.
The CRID is split into a number of separate parts:-

Given the CRID, **crid://rtenl.ie/0123ABF#A1**

Scheme:	crid://	The Scheme describes the format of the rest of the CRID and shall always be “crid://”.
Authority	rtenl.ie	The Authority is a registered domain used to represent the source of the content and may be taken from the producer of the content, the broadcaster or other body.
Content	/0123ABF	The Content Identifier uniquely identifies the content within the scope of the current Authority
Instance Identifier	#A1	The Instance Identifier is an optional part that shall be used when a single piece of content has been split into

8.5 Default Authority Descriptor

A *default_authority_descriptor* (0x73) may be placed within the SDT to more efficiently manage the EIT CRID data necessary to support PVR functionality on the network; every service on the network shall be allocated a descriptor. Should the Default Authority Descriptor be carried within the SDT, it is unnecessary for the broadcaster to include the default authority within the CRID.

As described in ETSI TS 102 323, where an event within the EIT does not have a complete URL, the Content Identifier Descriptor (CID) (i.e. a CRID starting with '/'), the NorDig PVR IRD shall:

- Use the default authority (DA) defined for this service within the SDT.
- If no default authority is defined within in the SDT, the PVR shall use the default authority defined within the second TS loop of the NIT.
- If no default authority is defined for the actual transport stream in second loop of the NIT, the receiver shall use default authority in the first loop in NIT for the network that the service belongs to.

For further information see 12.2.8 of NorDig Unified

8.6 Complete recording

See Appendix A for information

8.7 Optional Trailer booking/Promotional Linking

The trailer booking (or promotional linking) is typically used during a promotion trailer to give the viewer the opportunity to easy and directly program/book their PVR to record the event the trailer is referring to. The PVR supporting Trailer Booking shall have the ability to decode and process Related Content Signalling as defined in section 12.8 of NorDig unified v2.5.1 (related content descriptor) in order to drive broadcast-triggered native or API based applications typical example Trailer Booking
See Appendix no. xx for more information

8.8 Series recording or Series link

All events that have the same series CRID belongs to the same Series. An individual event inside a Series is referenced here as an Episode. (For definition of CRID, see section 12.4.6. of NorDig unified v2.5.1).

See Appendix A for more information

9 Conditional Access

Chapter to be inserted here

10 API - HbbTV

10.1 General

The NorDig Hybrid IRD shall support all mandatory features and requirements of HbbTV v1.5 as specified in ETSI TS 102 796 v1.2.1 specification [30].
The NorDig Hybrid IRD shall support all the DVB SI additions as defined in the HbbTV v. 1.5 ETSI TS 102 796 v.1.2.1 specification [29].
The NorDig Hybrid IRD shall have a broadband interface in accordance with NorDig Section 8.3 (two-way interface).
The NorDig Hybrid IRD shall have HbbTV feature as enabled by default. It shall have a menu option to allow user to enable / disable the HbbTV feature as a whole and it should have a menu option to allow user to enable / disable the HbbTV feature service by service.

10.2 HbbTV applications

Applications shall be either compliant with ETSI TS 102 796 v1.1.1 (“HbbTV1.0”) or with ETSI TS 102 796 v1.2.1 (“HbbTV1.5”).
Applications using DRM shall follow guidelines defined in ETSI TS 102 796 v1.2.1 Annex D – DRM Integration, [see also 10.4 Communication between CAM and application].

10.3 Signalling of HbbTV application

The application signalling shall be fully compliant with ETSI TS102 796 v1.2.1.

- The AIT may signal two versions of the application (one for HbbTV1.5 and one for HbbTV1.0)
- Hbbtv services without broadcast audio or video components will be signalled according to ETSI 102 796 v1.2.1
- HbbTV services may be present on scrambled services and are expected to be received / detected by all receivers compliant with HbbTV

When retransmitting broadcast signal between different networks (i.e. DVB-T to DVB-C), HbbTV signalling shall be considered as an essential part of the service and its signalling including the AIT and DSMCC carousels format must be retained as-is. (PID re-mapping is permitted).
If the operator is signalling its own HbbTV applications, the original applications from the broadcaster shall be included in the transmission as well.

10.3.1 HbbTV and EBU Teletext

Operator may transmit an application in the AIT with the usage type in the application_usage_descriptor set to 0x1 together with EBU Teletext magazine. In this case the IRD shall provide a method for toggling between EBU teletext and HbbTV Digital Teletext. The method should work as specified in HbbTV spec version 1.2.1 chapter 5.3.4, cases A to F.

10.3.2 Simultaneous EBU Teletext and HbbTV Digital Teletext

For services that have both an EBU Teletext service and an HbbTV Digital Teletext application signaled and available, the IRD shall be able to start and display the HbbTV Digital Teletext application as well as being able to start and display the EBU Teletext service (one at a time).
The IRD shall start teletext and be able to toggle between any HbbTV Digital Teletext and any EBU Teletext service as described in clause 5.3.4 of HbbTV specification ETSI TS 102 796 [30].
Informative: Remote Control Interface /Digital TV Functions: Text [Text] – This function launches the HbbTV Digital Teletext application and/or the EBU Teletext.

10.4 Detecting capabilities

No application shall start a video object without prior checking the capabilities or the IRD to avoid conflict and ensuing errors (e.g. if the IRD support MPEG *dash*).
For this purpose, the application shall make use of xml Capabilities as defined in in ETSI TS 102 796 V1.2.1, chapter 10.3, to detect the capabilities of the IRD for media delivery and decryption (e.g: MPEG DASH and DRM).

10.5 Communication between CAM and application

The communication between the CI+CAM and the application may be used.
Possible non exhaustive list of use cases may be:

- Identification of the user via the smart card (if present)
- Communication from the CAM module for any specific information. This may be retrieved any information from the LSC or generated information in the CAM

For this purpose, the DRM Agent API as defined in ETSI TS 102 796 V1.2.1, Annex D, chapter D.3 are used.

10.5.1 Content via the CEA-2014 A/V Object

If DRM is used to protect content presented via the CEA-2014 A/V object then it have to be signalled as defined in ETSI TS 102 796 V1.2.1, Annex D, chapter D.4
A DRM System ID for the DRM system needs to be registered in as described in OIPF Volume 5 [6], Section 9.3.10. [ETSI TS 102 796 V1.2.1, Annex D, chapter D.2]

10.6 MPEG DASH

Transition between framerates may be used, although HbbTV Specification 1.5 does not mandate support for it. (See TS102796 1.2.1 chapter E.4.2.1).
Operators will be using DASH configurations which involve a changing framerate, at least from 25 fps to 50 fps (1280x720p50). Therefore it is highly recommended that the HbbTV terminal supports framerate transitions in DASH.

11 References

[1] ISO/IEC 13818-1: "Information Technology – Generic coding of moving pictures and associated audio information – Part 1: Systems".

[2] ISO/IEC 13818-2: "Information Technology – Generic coding of moving pictures and associated audio information – Part 2: Video".

[3] ISO/IEC 13818-3: "Information Technology – Generic coding of moving pictures and associated audio information – Part 3: Audio".

[4] ETS 300 421: "Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for 11/12 GHz satellite services".

[5] ETS 300 429: "Digital broadcasting systems for television, sound and data services; Framing structure, channel coding and modulation for cable systems".

[6] ETS 300 468: "Digital broadcasting systems for television, sound and data services; Specification for Service Information (SI) in Digital Video Broadcasting (DVB) systems".

[7] ETR 211: "Digital broadcasting systems for television, sound and data services; Guidelines on implementation and usage of service information (SI)".

[8] ETS 300 472: "Digital broadcasting systems for television, sound and data services; Specification for conveying ITU-R Teletext in Digital Video Broadcasting (DVB) bitstreams".

[9] ETS 300 743: "DVB subtitling system".

[10] ETR 162: Digital broadcasting systems for television, sound and data services;
Allocation of Service Information (SI) codes for Digital Video Broadcasting (DVB) systems

Appendix A: NorDig PVR

1 Complete recording

The PVR shall be capable (at factory default) for all recordings to include all supported components/PID's listed within the PMT of the recorded service *Viz.* Video, Audio 1, Audio 2, Subtitle, Audio Description, Original Language, PCR etc).
If the (HbbTV/MHEG) application in the transmission is signalled as not to be recorded, the NorDig Enhanced and/or Interactive PVR should not record these application streams.

NB: For a NorDig PVR using removable media formats (such as DVD or Blu-ray) for recordings, such devices shall include all supported components/PIDs for that format and any subtitling shall (according to the user preference settings) be burnt in to the video or converted into a supported subtitling format.

2 Optional Trailer booking/Promotional Linking

The event name shall be displayed together with any promotional text at time of booking (when displaying the Trailer booking menu on screen). At the time of booking, the PVR shall not include any event description text from the short event descriptor.
The short event descriptor's event name (from the RCT) shall be used to provide information about the event in the PVR list of booked recordings. The extended event descriptor's event description text from EIT may also be used in the PVR list of booked recordings to provide information.

3 Series recording or Series link

The PVR shall be able to record a complete Series via the CRID.
The PVR shall store and track series CRIDs that are programmed for recording for up to 91 days between occurrences in EIT schedule. To allow broadcasters to reuse a series CRID for a different editorial concept, the NorDig PVR shall discard any series CRIDs not seen in EIT for 91 days.
The display of programmes selected for recording shall include an indication if the programme is included as a consequence of being one of a series.
The IRD should be aware that the default authority may be changed over time (for example a service might have default authority added in SDT); the NorDig PVR should automatically update its stored default authorities (not only during installation) within fifteen minutes from reception.

3.1 Series record for all episodes

The PVR shall support recording of all episodes of a specific series via series CRID in the broadcast transport stream.
It shall be possible for the viewer from EPG to program the PVR to record a series of events. The PVR shall indicate in the EPG that an event is part of a series and the PVR shall, if the user selects to record the event that belongs to a series, request the user to confirm what to record:

1. Only the single event selected.
2. Several or All events (episodes) of the series

3.2 Series record limited to a number of episodes for a series

The PVR should support recording of a (limited) number of episodes of a specific series via series tagging in the broadcast. The limitation should either be a period of time or a specific number of episodes.

3.4 Series, only one instance/copy of each episode

The PVR should support the feature to only record one instance/copy of each episode in a series for series recording, in order to more efficiently handle to handle repeat programming.

3.5 Split recording

A programme may consist of multiple EIT events within the same service or over several services. i.e. a film might be divided into two parts/blocks interrupted by a news programme in the middle (see fig 1 -A) or a longer sport event might be split into several parts/blocks over several services, (see fig 1-B).
Signalling carried in the SI allows the PVR to identify and record all the events containing the parts of a single programme. A “split programme” is a single piece of content, which comprises of two or more EIT events having the same CRID and IMI value with the gap from the scheduled end time (start_time plus duration) to the scheduled start time of any two of those events is less than 3 hours.
The PVR shall consider a split programme to be segments of a single item of content. When selecting a split programme for recording, the PVR shall select and record all constituent events so that the complete programme content is recorded.

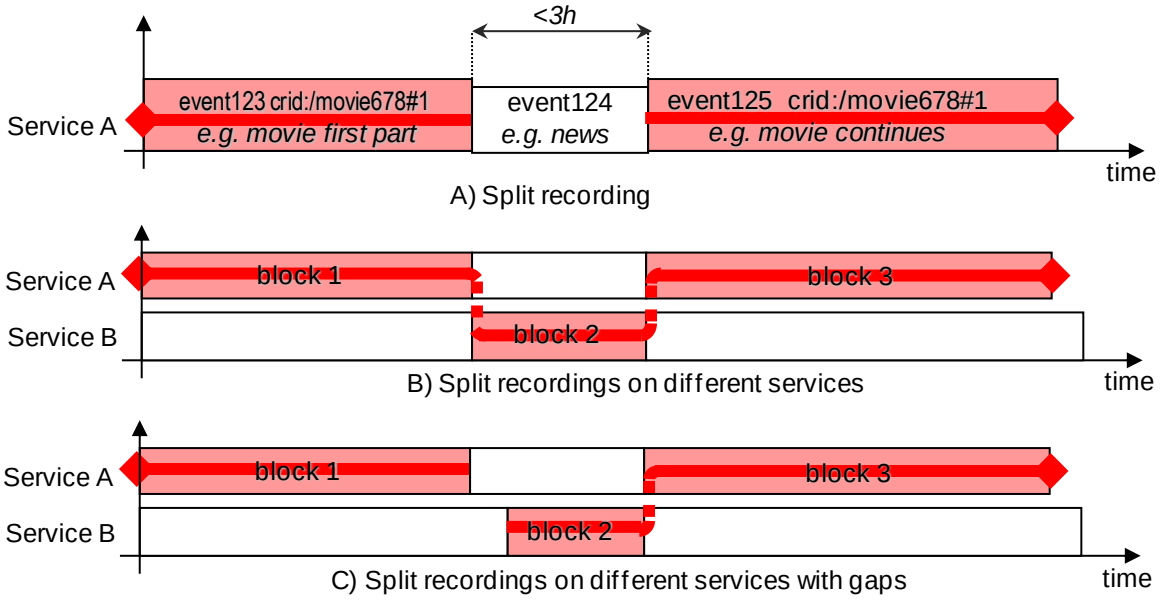


Table 1: Handling of split recordings by the PVR. Split programme events (events with the same CRID value that are broadcast close in time to each other) shall be recorded with one and the same programming by the PVR.

A) The maximum gap time between events with the same programme CRID value that shall still be treated as belonging to the same programme for recording.

B) Split programme over several services.

C) Split programme with gap and over separate services

There are cases where a PVR may during the time of programming a recording only see a single event with the booked CRID and IMI combination (for example initially only the first part/block of the split programme has so far been included in the EIT). The PVR shall continue to monitor the EIT for additional events with the same CRID and IMI combination and include them to the selected recording.

In case of overlap between the split events and if the PVR has limitation in recording capacity when back-to-back recording, then the PVR shall first finalise recording of the first part or event of the split programme (according to the events start time and duration) before starting recording the next part of the split programme, this is the same behaviour as back-to-back recordings.
During the lifecycle of the EIT schedule, broadcasters may change programmes from split to single or vice versa.
In the PVR split recordings shall clearly be marked in the list of recordings as constituent parts belonging to the same programme, for example as one and the same entity or similar. It shall be enough to select only one entity from the file list of recording to get a playback of the complete programme, including all constituent events.

4 Safe margins

The PVR shall have a factory default safe margin setting of one minute before the events start time and five minutes after the event is no longer present. The margin before the event start time shall be based on the latest possible EIT update. For safe margin, recording the PVR should insert index markers into the recording when the event status changes to running and another when the event becomes not running. It shall be possible via the set-up or configuration menu to deactivate safe margin settings.
As a default, setting safe margins shall have a lower priority than any back to back recording (NorDig v2.5.1 14.3.11)

5 Presentation and management of scheduled recordings

The PVR at all times keep track of future scheduled recordings, the PVR shall present to the user all scheduled recordings on one screen (manual single, manual repeated and series).
For scheduled series recordings, the PVR shall present to the user all future scheduled instances of the series that can be detected from the broadcast EIT data.
The user shall be able to delete any future scheduled recording. The user shall be able to delete one individual scheduled recording belonging to a series without deleting the series.

6 Presentation and management of acquired recordings

In addition to NorDig v2.5.1 14.2.1, the user shall be able to view a list of acquired recordings where all episodes of a series are grouped into the same item on the list and displayed as such. Series items should be marked for the user that the item includes several episodes or events. Each such item representing a group of recorded series shall be expandable on request by the user so that all recorded episodes are displayed.

7 Cache in background

The PVR shall support during normal viewing mode monitor and cache all EIT section data including EIT present/following, EIT schedule and EIT other as a background function. The PVR shall update its cached EIT data for any dynamic changes in the EIT broadcast data. To improve presentation of EPG data after start up, the PVR should store the most up to date cache of EIT data to the PVR persistent memory (HDD).

For more information, see Appendix 1. : “NorDig PVR metadata Whitepaper”