



VF TD 0050

Broadcast Signal Delivery Requirements

Service Engineering

Version 1.8.0

2024-08-23

This document contains information that is proprietary to
Vodafone Deutschland GmbH
Any use is subject to a Non Disclosure Agreement.

All rights reserved.

No part of this document may be reproduced or published without written permission of Vodafone Deutschland GmbH.

© Copyright 2021 Vodafone Deutschland GmbH.

**IMPORTANT NOTE: This document is subject to change.
This document replaces documents with lower version numbers.**

Contents

1.	Introduction.....	3
1.1.	Scope of this document.....	3
1.2.	Disclaimer	3
1.3.	Revision History	3
1.4.	Verbal Forms for the Expression of Provisions.....	3
1.5.	References	3
1.6.	Abbreviations	6
2.	Playout Center - National services delivery	8
3.	Network Node – Regional services delivery.....	9
4.	Signal Interfaces.....	10
4.1.	SDI	10
4.2.	HD-SDI	12
4.3.	IP Transport for SD-SDI and HD-SDI	13
4.4.	Satellite Downlink.....	14
4.5.	IP Multicast.....	15
4.6.	IP Data Connection for SDI/HD-SDI	16
4.7.	Transport via Public Internet, SRT	17
5.	Encoding profiles.....	18
5.1.	Regional services – SD.....	18
5.2.	Regional services – HD.....	21
5.3.	National services – SD.....	23
5.4.	National services – HD.....	25
5.5.	Radio Services	27
5.5.1.	Digital Radio (DVB TS)	27
5.5.2.	Digital Radio (Internet Stream)	28
6.	EPG and Service Information delivery	29
6.1.	National services	29
6.2.	Regional services.....	29
6.3.	EPG data for PVRs (gracenote).....	29
7.	DRM information	30

1. Introduction

1.1. Scope of this document

This document describes audio and video interfaces for the handover of linear broadcast signals from a third party into the Vodafone TV broadcast infrastructure.

1.2. Disclaimer

The technical data contained in this documentation has been researched and compiled with due diligence. However, no guarantee is made as to the currency, accuracy, completeness or quality of the documentation.

1.3. Revision History

Version	Date	Editor	Description
1.5.1	2012-10-10	Andreas Lautner	Complete Rework
1.5.2	2013-10-07	Andreas Lautner	Added Radio Signal Delivery
1.6.1	2014-08-08	Andreas Lautner	Added Regional HD Delivery
1.6.2	2016-02-22	Andreas Lautner	CI Adaption
1.6.3	2016-03-04	Andreas Lautner	CI Adaption
1.6.4	2017-10-04	Manuel Mann	Added Analog Radio
1.6.5	2017-11-20	Manuel Mann	Table rep., Add. Input Formats, EBU R128
1.6.6	2018-04-24	Manuel Mann	Added Digital Radio (Internet Stream)
1.7.0	2021-03-04	Ralf Laue	Playout Center Consolidation, analog removed
1.7.1	2021-05-19	Ralf Laue	Added AAC Audio Coding (Internet Stream)
1.8.0	2024-08-23	Ralf Laue	SD in H.264, Digital Radio in AAC

1.4. Verbal Forms for the Expression of Provisions

Verbal form	Indication	Equivalent expression
shall	Requirement	must
shall not	Requirement	must not
<i>should</i>	Recommendation	it is recommended that
<i>should not</i>	Recommendation	it is not recommended that
<i>may</i>	Permission	is allowed
<i>need not</i>	Permission	it is not required that
<i>can</i>	Possibility/Capability	be able to
<i>cannot</i>	Possibility/Capability	be unable to

1.5. References

- [1] ITU-R BT.656 "Interfaces for digital component video signals in 525-line and 625-line television systems operating at the 4:2:2 level of Recommendation ITU-R BT.601 (Part A)"

- [2] SMPTE 259M "Television – SDTV Digital Signal/Data – Serial Digital Interface"
- [3] SMPTE 291M "Ancillary Data Packet and Space Formatting"
- [4] SMPTE 272M "Television – Formatting AES/EBU Audio and Auxiliary Data into Digital Video Ancillary Data Space"
- [5] IEC 60958-4 "Digital audio interface – Part 4: Professional applications"
- [6] ETSI TS 102 366 "Digital Audio Compression (AC-3, Enhanced AC-3) Standard"
- [7] ETSI EN 300 706 "Enhanced Teletext specification"
- [8] ETSI EN 300 294 "Television Systems; 625-line television Wide Screen Signaling (WSS)"
- [9] ITU-R BT.709 "Parameter values for the HDTV standards for production and international programme exchange"
- [10] SMPTE 292M "1.5 Gb/s Signal / Data Serial Interface"
- [11] SMPTE 299M "24-Bit Digital Audio Format for SMPTE Bit-Serial Interfaces at 1.5 Gb/s and 3 Gb/s"
- [12] ETSI EN 300 421 "Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for 11/12 GHz satellite services"
- [13] ETSI EN 302 307 "Digital Video Broadcasting (DVB); Second generation framing structure, channel coding and modulation systems for Broadcasting, Interactive Services, News Gathering and other broadband satellite applications"
- [14] ISO/IEC 13818-1 | ITU-T H.222.0 "Information technology - Generic coding of moving pictures and associated audio information: Systems"
- [15] ETSI EN 300 468 "DVB; Specification for Service Information (SI) and DVB systems"
- [16] ETSI EN 101 154 "DVB; Implementation guidelines for the use of MPEG-2 Systems, Video and Audio in satellite, cable and terrestrial broadcasting applications"
- [17] ETSI TR 101 211 "DVB; Guidelines on implementation and usage of Service Information (SI)"
- [18] ETSI TR 101 290 "DVB; Measurement guidelines for DVB systems"
- [19] EN 50093-9 Appendix B "Asynchronous Serial Interface"
- [20] ISO/IEC 13818-2 | ITU-T H.262 "Information technology - Generic coding of moving pictures and associated audio information: Video"
- [21] ISO/IEC 11172-3 "Information technology - Coding of moving pictures and associated audio for digital storage media at up to about 1,5 MBit/s - Part 3: Audio"
- [22] ETSI EN 300 472 "DVB; Specification for conveying ITU-R System B Teletext in DVB bit streams"
- [23] ETSI EN 301 775 "DVB; Specification for the carriage of Vertical Blanking Information (VBI) data in DVB bit streams"
- [24] ETSI TS 102 809 "Digital Video Broadcasting (DVB); Signalling and carriage of interactive applications and services in Hybrid broadcast/broadband environments"
- [25] ISO/IEC 14496-10 „Information technology -Coding of audio-visual objects - Part 10: Advanced video coding“

- [26] Vodafone Deutschland document "Broadcast Signal Handover Interface Points at VF/VFKD Network Nodes (BPOPs)"
- [27] Vodafone Deutschland specification TS T14 0023 "Übergabeparameter für digitale regionale Programme"
- [28] Vodafone Deutschland document "Broadcast Signal Handover – Available Satellite Positions at VF/VFKD Satellite Downlinks"
- [29] Thales document "JADE - High Level XML Format description for Service Information Import / Export"
- [30] RFC 4607 "Source-Specific Multicast for IP"
- [31] ETSI EN 300 743 "Digital Video Broadcasting (DVB); Subtitling Systems"
- [32] SMPTE RP 186:2008 "Video Index Information Coding For 525- And 625-line Television Systems"
- [33] SMPTE ST 2031:2007 "Carriage of DVB/SCTE VBI Data in VANC"
- [34] ISO/IEC 13818-3 | Generic coding of moving pictures and associated audio information -- Part 3: Audio
- [35] SMPTE ST 2022-6:2012 "Transport of High Bit Rate Media Signals over IP Networks (HBRMT)"
- [36] ISO/IEC 14496-3 "Information technology -Coding of audio-visual objects – Part 3: Audio"

1.6. Abbreviations

AIT	Application Information Table
ASI	Asynchronous Serial Interface
CBR	Constant Bit Rate
DVB	Digital Video Broadcasting
EIRP	Equivalent Isotropically Radiated Power
EIT	Event Information Table
FLP	Foreign Language Program
GbE	Gigabit Ethernet
HD	High Definition
IGMP	Internet Group Management Protocol
IP	Internet Protocol
MPEG	Moving Pictures Experts Group
MPTS	Multi Program Transport Stream
NIT	Network Information Table
ÖR	Öffentlich Rechtliche (Services of ARD, ZDF)
PAT	Program Association Table
PID	Packet Identifier
PMT	Program Map Table
POC	Playout Center
PSI	Program Specific Information
RDS	Radio Data System
SD	Standard Definition
SDI	Serial Digital Interface
SDT	Service Description Table
SI	Service Information
SPTS	Single Program Transport Stream
SRT	Secure Reliable Transport
SSM	Source Specific Multicast
STB	Set-top box
TCP	Transmission Control Protocol
TDT	Time and Date Table
TOT	Time Offset Table
TS	Transport Stream
UDP	User Datagram Protocol
VBR	Variable Bit Rate

VFDE	Vodafone Deutschland
VFKD	Vodafone Kabel Deutschland
VFUM	Vodafone Unitymedia
WSS	Wide Screen Signaling

2. Playout Center - National services delivery

This chapter describes the possible types of delivery for the handover of national linear broadcast audio and video signals at the Vodafone Deutschland Playout Center Frankfurt-Rödelheim “POC Rödelheim” and Vodafone Deutschland Playout Center Kerpen “POC Kerpen”.

National signals **shall** be handed over in the POC Rödelheim at the following location and address (unless otherwise stated in contract referencing this specification):

Vodafone Deutschland GmbH

Breitlacher Str.96

60489 Frankfurt / Main

Germany

National signals **shall** be handed over in the POC Kerpen at the following location and address (unless otherwise stated in contract referencing this specification):

Vodafone Deutschland GmbH

Michael-Schumacher-Str. 1

50170 Kerpen

Germany

The following general rules **shall** apply for signal delivery to POC Rödelheim and POC Kerpen:

- The handover of signals **shall** always take place for redundancy reasons at both Playout Center locations simultaneously.
- IP Data connection (TS over IP) or SDI and HD-SDI (SMPTE 2022-6) **shall** be the main signal interface at the Playout Center locations.
- In case of SD- or HD-SDI delivery: the transport of SDI and HD-SDI signals from signal origin to POC Rödelheim and POC Kerpen **shall** be bit-transparent and mathematical lossless. SDI and HD-SDI signals will be picked up by Vodafone at the program provider site.

The delivered signals **shall** be signals for national distribution - regional signal handover **may** take place at Vodafone POC or Backbone Network nodes.

The following signal interfaces *can* be used for signal delivery to POC Rödelheim and POC Kerpen:

- IP data connection according to “4.6 IP Data Connection for SDI/HD-SDI”
- IP data connection according to “4.5 IP-Multicast”
- SDI for SD services as specified in chapter “4.1 SDI”
- HD-SDI for HD services as specified in chapter “4.2 HD-SDI”
- Satellite reception and encoding for SD services as specified in “4.4 Satellite Downlink” and “5.1 National services – SD”
- Satellite reception and encoding for HD services as specified in “4.4 Satellite Downlink” and “5.2 National services – HD”

3. Network Node – Regional services delivery

The Vodafone Deutschland backbone network consists of several large network nodes across Germany. As the new Vodafone Deutschland cable headend architecture is based purely on IP Multicast delivery via the Vodafone Deutschland backbone network, it is possible to handover regional signals directly at the network nodes.

To allow comfortable and easy access for content providers the network nodes available for the handover of signals are chosen by the following criteria:

- Presence of a variety of line carriers
- Availability of rack space offered by third parties

As the list of network nodes available for signal handover is constantly progressing, an up-to-date list including addresses and more detailed information for the single locations is available from Vodafone Deutschland on request [26].

The delivered signals **shall** only be signals for regional distribution - national signal handover **shall** take place at the Vodafone Deutschland Playout Centers.

The following combinations of signal interfaces and encoding profiles *can* be used for signal delivery to Vodafone Deutschland backbone network nodes:

- IP multicast and encoding for SD services as specified in “4.5 IP Multicast” and “5.1 Regional services – SD”
- IP multicast and encoding for HD services as specified in “4.5 IP Multicast” and “5.2 Regional services – HD”

4. Signal Interfaces

4.1. SDI

Uncompressed SD signals **shall** be handed over as SDI signals. The following technical parameters **shall** apply (Pre-Encoding at program provider site):

Physical connection / Redundancy:

- The physical connection **shall** be BNC connectors.
- The used cable impedance **shall** be 75 Ohm.
- If not otherwise stated in the delivery contract the signal **shall** be handed over redundant at two BNC connectors.

Transport parameters:

- The SDI signal transport **shall** be according to ITU-R BT.656 [1] / SMPTE 259M [2].
- Ancillary data inside the SDI **shall** be according to SMPTE 291M [3].
- The bit rate **shall** be 270 Mbit/s.

Video parameters:

- The video parameters **shall** be according to ITU-R BT.601 [1] / SMPTE 259M [2].
- The video **shall** be delivered in 576i50 with a horizontal resolution of 720 pixels (720 x 576 pixels, interlaced, 50 fields per second).
- The chroma subsampling **shall** be YCrCb 4:2:2 at 10bit per channel.
- Other video formats possible over SDI **shall not** be used.
- The video signal **shall not** contain illegal or invalid levels which would avoid a standard compliant PAL conversion.
- The video signal **shall** carry "16:9 full screen" content in an anamorphic way while signaling 16:9 (see also "Additional parameters").

Aspect Ratio:

Signalization of aspect ratio *can* be done in following three ways:

- Applying a fixed aspect ratio (i.e. no alteration of aspect ratio).
- Video Index according to SMPTE RP 186:2008 [32] in video line 11.
- WSS aspect ratio information according to ETSI EN 300 294 [8] in video line 23.

Audio parameters:

- Audio **shall** be embedded into ancillary data space according to SMPTE 272M [4].
- Separate audio delivery outside the SDI signal **shall not** be used.
- The audio payload **shall** be AES3 (Stereo) according to IEC 60958-4 [5], AES3 (Dual Mono) according to IEC 60958-4 [5] or AC-3 (2.0 or 5.1) according to ETSI TS 102 366 [6].
- Each single audio payload (AES3 / AC-3) **shall** be permanently available.
- The parameters for **AES3** **shall** be 48 kHz sampling rate and 20 or 24 bit quantization.
- The maximum audio level for AES3 **shall** be according to EBU R128.

Additional parameters:

Teletext *may* be used as additional component.

Teletext **shall** be EBU Teletext Level 1.5 according to ETSI EN 300 706 [7].

In case of DVB subtitling:

- DVB subtitling **shall** comply with ETSI EN 300 743 [31].
- DVB subtitling components **shall** be signaled with ISO stream_type '0x06' [PES private data].
- DVB subtitling components **shall** be signaled with a DVB subtitling_descriptor.

4.2. HD-SDI

Uncompressed HD signals **shall** be handed over as HD-SDI signals. The following technical parameters **shall** apply (Pre-Encoding at program provider site):

Physical connection / Redundancy:

- The physical connection **shall** be BNC connectors.
- The used cable impedance **shall** be 75 Ohm.
- If not otherwise stated in the delivery contract the signal **shall** be handed over redundant at two BNC connectors.

Transport parameters:

- The HD-SDI signal transport **shall** be according to ITU-R BT.709 [9] / SMPTE 292M [10].
- Ancillary data inside the HD-SDI **shall** be according to SMPTE 291M [3] and SMPTE ST 2031 [33].

Video parameters:

- The video parameters **shall** be according to ITU-R BT.709 [9] / SMPTE 292M [10].
- The video **shall** be delivered exclusively in 720p50, 1080i25 or 1080p50.
- The chroma subsampling **shall** be YCrCb 4:2:2 at 10bit per channel.
- Other video formats possible over HD-SDI **shall not** be used.

Audio parameters:

- Audio **shall** be embedded into ancillary data space according to SMPTE 299M [11].
- Separate audio delivery outside the HD-SDI signal **shall not** be used.
- The audio payload **should** be AC-3 (2.0 or 5.1) according to ETSI TS 102 366 [6].
- Each single audio payload **shall** be permanently available.

HD-SDI to SDI conversion:

- On request HD-SDI signals *may* be converted by Vodafone Deutschland to SDI signals to create an SD service carrying the same content.

Additional parameters:

Teletext *may* be used as additional component.

Teletext **shall** be EBU Teletext Level 1.5 according to ETSI EN 300 706 [7].

In case of DVB subtitling:

- DVB subtitling **shall** comply with ETSI EN 300 743 [31].
- DVB subtitling components **shall** be signaled with ISO stream_type '0x06' [PES private data].
- DVB subtitling components **shall** be signaled with a DVB subtitling_descriptor.

4.3. IP Transport for SD-SDI and HD-SDI

Uncompressed SD-SDI and HD-SDI **shall** be handed over via IP connection. The following technical parameters **shall** apply:

Physical connection / Redundancy:

- The physical connection interface at Vodafone Deutschland network nodes **shall** be optical 10Gigabit Ethernet, Single Mode (SM) 1310 nm.
- If not otherwise contractually stated the signal **shall** be handed over redundant using two connectors.

Transport parameters:

- The SD-/HD-SDI signal transport **shall** be according to SMPTE 2022-6 [35].
- Other parameters: see 4.1 SDI, 4.2 HD-SDI, 4.5 IP Multicast

4.4. Satellite Downlink

The Vodafone Deutschland TV infrastructure includes two satellite downlinks which allow redundant reception of satellite signals. The first downlink is located at POC Rödelheim, the second downlink is located at POC Kerpen.

There is a variety of already established and receivable satellite positions. A full list of currently available positions *can* be requested from Vodafone Deutschland [28].

The following technical parameters and rules **shall** apply:

- The satellite position **shall** be present in the Vodafone Deutschland's list of available positions.
- The transmission channel coding **shall** be DVB according to ETSI EN 300 421 [12] or DVB-S2 according to ETSI EN 302 307 [13].
- The satellite downlink transmission **shall** be only in the Ku-Band (10.7 – 12.75 GHz).
- The satellite downlink transmission **shall** be only linear vertical or horizontal polarization.
- The satellite downlink transmission **shall not** be via a satellite (spot) beam not intended for reception across Germany.
- The EIRP level of the used satellite beam at POC Rödelheim and POC Kerpen location **shall** be equal or greater than 44dBW.
- The signal transport **shall** be MPEG-2 Transport Stream according to ISO 13818-1 [14], ETSI EN 300 468 [15], ETSI TS 101 154 [16] and ETSI TR 101 211 [17].
- The transport stream **shall** produce no errors when measured according to ETSI TR 101 290 [18].

4.5. IP Multicast

The following technical parameters and rules **shall** apply:

- The physical connection interface at Vodafone Deutschland network nodes **shall** be optical Gigabit Ethernet, Single Mode (SM) 1310 nm.
- If not otherwise contractually stated the signal **shall** be handed over redundant to two different network node locations.
- All IP multicast signals of one delivering party (carrier, technical service provider or institution) **shall** be bundled on one line.
- The IP transport **shall** be offered as Source Specific Multicast (SSM) according to RFC 4607 [30]. All IP multicast streams **shall** be handed over without any needs for IGMP joins (flooding multicast streams on the interface).
- The Group IP address, Source IP addresses and port numbers *may* be chosen freely by the content signal provider.
- The transport **shall** be encapsulated as IP/UDP/MPEG-2 TS.
- Each UDP frame **shall** consist of a maximum of seven MPEG-2 TS packets.
- The signal transport **shall** be MPEG-2 Transport Stream according to ISO 13818-1 [14], ETSI EN 300 468 [15], ETSI TS 101 154 [16] and ETSI TR 101 211 [17].
- The transport stream **shall** produce no errors when measured according to ETSI TR 101 290 [18].

4.6. IP Data Connection for SDI/HD-SDI

For the delivery of additional service components and/or other data which *cannot* be transported embedded in SDI/HD-SDI signals an IP data connection *can* be added.

The following technical parameters and rules **shall** apply:

- The physical connection interface for IP data connection at Vodafone Deutschland **shall** be optical Gigabit Ethernet, Multi Mode (MM) 850 nm, LC/PC connectors. Other type of GbE interfaces on request.
- If not otherwise contractually stated the signal **shall** be handed over redundant using two connectors.
- The connection **shall** be able to transport IP Multicast signals according to “4.5 IP Multicast”.
- The connection **shall** be able to transport standard IP Unicast traffic.
- Security and firewall rules for the connection **shall** be agreed between all involved parties.
- Used IP addresses and port for the connection **shall** be agreed between all involved parties.
- The maximum data rate for the data connection **shall** be agreed between all involved parties.
- Additional service components (e.g. DVB subtitles, AIT) **shall** be conveyed as MPEG programs and referenced in PAT/PMT. Each program **shall** contain a PCR that **shall** be identified by the pcr_pid value in the corresponding PMT. For convenience the usage of an SDT is recommended. Other data or tables (e.g. EIT) **shall** be conveyed on reserved DVB PIDs or unique unreferenced PIDs (Ghost PIDs) as agreed between all involved parties.

4.7. Transport via Public Internet, SRT

The Vodafone Deutschland TV infrastructure allows reception of services via public internet by using the SRT (secure reliable transport) protocol. Transport via public Internet may be used for FLP content or regional services. SRT shall not be used for national premium services like ÖR, Sky, other national services.

The following technical parameters and rules **shall** apply:

- If not otherwise contractually stated, the redundant signal **shall** be handed over via independent lines.
- The connection **shall** be able to transport IP Multicast signals according to “4.5 IP Multicast”.
- The connection **shall** be able to transport standard IP Unicast traffic.
- The connection **shall** be able to transport standard IP TCP/IP traffic.
- Security and firewall rules for the connection **shall** be agreed between all involved parties.
- Used IP addresses and ports for the connection **shall** be agreed between all involved parties.
- The maximum data rate for the data connection **shall** be agreed between all involved parties.
- The transport protocol **shall** be according to the actual version of the SRT Alliance (as at time of writing: v1.4.2). Updates of the transport protocol version **shall** be agreed between all involved parties.
- The service provider is responsible for a failure-free signal delivery to the Vodafone POC. This includes bandwidth management and selection of appropriate transport parameters. The transport parameter settings shall be agreed between all involved parties.

5. Encoding profiles

5.1. Regional services – SD

Regional SD services *can* be delivered as pre-encoded signals intended for direct insertion into digital signals at the cable headends. Furthermore the same signal can be multiplexed in the POCs and redistributed to regional Hubs and TV-Pops. By using pre-encoded signals it is not necessary to do a second re-encoding by Vodafone Deutschland, which would imply additional signal delays and degradation of video quality.

As the signals may directly be transferred to the cable headend edge devices it is crucial to follow the specified parameters exactly and to perform interoperability testing in collaboration with Vodafone Deutschland before the signal is used productive or if there are later changes (e.g. usage of a different encoder).

The specified technical parameters apply for SD services only.

The following technical parameters **shall** apply:

Transport parameters:

- The signal transport **shall** be MPEG-2 Transport Stream according to ISO 13818-1 [14], ETSI EN 300 468 [15], ETSI TS 101 154 [16] and ETSI TR 101 211 [17].
- The transport stream **shall** produce no errors when measured according to ETSI TR 101 290 [18].
- The MPEG-2 TS packet size **shall** be 188 bytes.
- The transport stream **shall** be a Single Program Transport Stream (SPTS) carrying only one service.
- The overall bit rate of the delivered MPEG-2 TS **shall** be constant (CBR).
- The overall bit rate of the carried MPEG-2 TS **shall** be 3 Mbit/s

Video parameters:

- The video codec **shall** be H.264 Main Profile Level 3 according to ISO/IEC 14496-10 [25].
- The video bit rate **shall** be chosen as high as possible within the limits given by the overall MPEG-2 TS bit rate.
- The video bit rate **shall** be constant (CBR).
- The video **shall** be delivered in 576i25 with a horizontal resolution of 720 pixels (720 x 576 pixels, interlaced, 50 fields per second, 25 frames per second).
- The chroma subsampling **shall** be 4:2:0.
- 16:9 video **shall** be encoded anamorphic.
- The aspect ratio information **shall** be correctly signaled in the video elementary stream sequence header.

Audio parameters:

- The audio codec **shall** be AAC-LC according to ISO 13818-7 [34] / ISO/IEC 14496-3 [36].
- The audio sampling rate **shall** be 48 kHz.
- The audio bit rate **shall** be constant.
- The audio bit rate for stereo (L/R) **shall** be 128 kbit/s.
- AAC-LC components **shall** be signaled with Audio Stream Type: LATM: 0x11 or ADTS: 0xF

- The maximum audio level **shall** be according to EBU R128.
- The audio/video delay **shall** be in the range of +/- 10 ms.

Alternative Audio parameters:

- The audio codec **shall** be AC-3 (2.0 or 5.1) according to ETSI TS 102 366 [6].
- The maximum bit rate for AC-3 **should** be 384 kbit/s.
- AC-3 components **shall** be signalized with ISO stream_type '0x06' [PES private data].
- AC-3 components **shall** be signalized with a DVB AC-3_descriptor.
- The audio/video delay **shall** be in the range of +/- 10 ms.

Teletext parameters:

- Teletext *may* be used as additional component.
- Teletext **shall** be EBU Teletext Level 1.5 according to ETSI EN 300 706 [7].
- Teletext **shall** be delivered according to ETSI EN 300 472 [22].
- Teletext components **shall** be signalized with ISO stream_type '0x06' [PES private data].
- Teletext components **shall** be signalized with a DVB teletext_descriptor.

PSI/SI parameters:

- PSI data **shall** be used according to ISO 13818-1 [14]
- DVB SI data **shall** be used according to ETSI EN 300 468 [15], ETSI EN 101 154 [16] and ETSI TR 101 211 [17].
- The following tables **shall** be present: PAT, PMT, SDT.
- The following tables *may* be present: TDT, TOT
- EIT p/f (actual transport stream) **shall** be present.
- EIT schedule (actual transport stream) *may* be present.
- EIT_present_following_flag and EIT_schedule_flag **shall** be signalized correctly in SDT.
- TransportStreamID (TSID), OriginalNetworkID (ONID), ServiceID (SID) and PacketIdentifier (PID) for PMT and elementary streams **shall** be requested by the content provider from Vodafone Deutschland for each stream to be delivered.
- PAT, PMT and SDT repetition interval **shall** be within ETSI TR 101 290 specification.
- Service names *should not* be longer than 16 characters (including spaces).
- Other PSI/SI tables as the mentioned above **shall not** be present as long as not otherwise agreed with Vodafone Deutschland.

Other parameters:

- Other service components (e.g. DVB AIT for HbbTV) **shall** be chosen and tested in close collaboration with Vodafone Deutschland to secure interoperability.

In case of DVB subtitling:

- DVB subtitling **shall** comply with ETSI EN 300 743 [31].
- DVB subtitling components **shall** be signalized with ISO stream_type '0x06' [PES private data].
- DVB subtitling components **shall** be signalized with a DVB subtitling_descriptor.

In case of DVB HbbTV, DSM-CC carousels and Stream Events:

- DVB HbbTV, DVB AIT, DSM-CC carousels and Stream Events shall comply with ETSI TS 102 809 [24].
- DVB AIT components **shall** be signaled with ISO stream_type '0x05' [private sections].
- DVB AIT components **shall** be signaled with a DVB application_signalling_descriptor and application_type set to DVB registered MHP_Application_Type_ID '0x10' (decimal value '16') [HBBTV]. See also https://www.dvbservices.com/identifiers/mhp_app_type_id

5.2. Regional services – HD

Regional HD services **shall** be delivered as pre-encoded signals intended for direct insertion into digital signals at the cable headends.

As the signals may directly be transferred to the cable headend edge devices it is crucial to follow the specified parameters exactly and to perform interoperability testing in collaboration with Vodafone Deutschland before the signal is used productive or if there are later changes (e.g. usage of a different encoder).

The specified technical parameters apply for HD services only.

Transport parameters:

- The signal transport **shall** be MPEG-2 Transport Stream according to ISO 13818-1 [14], ETSI EN 300 468 [15], ETSI TS 101 154 [16] and ETSI TR 101 211 [17].
- The transport stream **shall** produce no errors when measured according to ETSI TR 101 290 [18].
- The MPEG-2 TS packet size **shall** be 188 bytes.
- The transport stream **shall** be a Single Program Transport Stream (SPTS) carrying only one service.
- The overall bit rate of the delivered MPEG-2 TS **shall** be constant (CBR).
- The overall bit rate of the carried MPEG-2 TS **shall** be 7 Mbit/s

Video parameters:

- The video codec **shall** be H.264 High Profile Level 4 according to ISO/IEC 14496-10 [25].
- The video bit rate **shall** be chosen as high as possible within the limits given by the overall MPEG-2 TS bit rate.
- The video **shall** be delivered in 1080i25 with a horizontal resolution of 1920 pixels (1920x1080 pixels, interlaced, 50 fields per second, 25 frames per second).
- The video bit rate **shall** be constant (CBR).
- The chroma subsampling **shall** be 4:2:0.
- The video **shall** be encoded anamorphic.

Audio parameters:

- The audio codec **shall** be AAC-LC (2.0) according to ISO 13818-7 [34] / ISO/IEC 14496-3 [36].
- The maximum bit rate for AAC **should** be 128 kbit/s.
- AAC-LC components **shall** be signaled with Audio Stream Type: LATM: 0x11 or ADTS: 0xF

Alternative Audio parameters:

- The audio codec **shall** be AC-3 (2.0 or 5.1) according to ETSI TS 102 366 [6].
- The maximum bit rate for AC-3 **should** be 384 kbit/s.
- AC-3 components **shall** be signaled with ISO stream_type '0x06' [PES private data].
- AC-3 components **shall** be signaled with a DVB AC-3_descriptor.
- The audio/video delay **shall** be in the range of +/- 10 ms.

Teletext parameters:

- Teletext *may* be used as additional component.

- Teletext **shall** be EBU Teletext Level 1.5 according to ETSI EN 300 706 [7].
- Teletext **shall** be delivered according to ETSI EN 300 472 [22].
- Teletext components **shall** be signaled with ISO stream_type '0x06' [PES private data].
- Teletext **shall** be signaled with a DVB teletext_descriptor.

PSI/SI parameters:

- PSI data **shall** be used according to ISO 13818-1 [14].
- DVB SI data **shall** be used according to ETSI EN 300 468 [15], ETSI EN 101 154 [16] and ETSI TR 101 211 [17].
- The following tables **shall** be present: PAT, PMT, SDT
- The following tables *may* be present: TDT, TOT
- EIT p/f (actual transport stream) **shall** be present.
- EIT schedule (actual transport stream) *may* be present.
- EIT_present_following_flag and EIT_schedule_flag **shall** be signaled correctly in SDT.
- PAT, PMT and SDT repetition interval **shall** be within ETSI TR 101 290 specification.
- Service names **shall not** be longer than 16 characters (including spaces).
- Other PSI/SI tables as the mentioned above **shall not** be present as long as not otherwise agreed with Vodafone Deutschland.

Other parameters:

- Other service components (e.g. DVB subtitles, DVB AIT for HbbTV, private data delivery) or other PSI/SI tables **shall** be chosen and tested in close collaboration with Vodafone Deutschland to secure interoperability.

In case of DVB subtitling:

- DVB subtitling **shall** comply with ETSI EN 300 743 [31].
- DVB subtitling components **shall** be signaled with ISO stream_type '0x06' [PES private data].
- DVB subtitling components **shall** be signaled with a DVB subtitling_descriptor.

In case of DVB HbbTV, DSM-CC carousels and Stream Events:

- DVB HbbTV, DVB AIT, DSM-CC carousels and Stream Events shall comply with ETSI TS 102 809 [24].
- DVB AIT components **shall** be signaled with ISO stream_type '0x05' [private sections].
- DVB AIT components **shall** be signaled with a DVB application_signalling_descriptor and application_type set to DVB registered MHP_Application_Type_ID '0x10' (decimal value '16') [HBBTV]. See also https://www.dvbservices.com/identifiers/mhp_app_type_id

5.3. National services – SD

All national services will passthrough Vodafone's Transcoding Platform. Therefore it is preferred to deliver national services in a Mezzanine format. If the delivery of services in a Mezzanine format is not possible, delivery in a standard distribution format is accepted.

In general, the delivery of national services in SD format shall be avoided, preferred format is HD.

The following technical parameters **shall** apply:

Transport parameters:

- The signal transport **shall** be MPEG-2 Transport Stream according to ISO 13818-1 [14], ETSI EN 300 468 [15], ETSI TS 101 154 [16] and ETSI TR 101 211 [17].
- The transport stream **shall** produce no errors when measured according to ETSI TR 101 290 [18].

Video parameters format:

- The video codec **shall** be H.264 Main Profile Level 3 according to ISO/IEC 14496-10 [25].
- The video **shall** be delivered in 576i25 with a horizontal resolution of 720 pixels (720 x 576 pixels, interlaced, 50 fields per second, 25 frames per second).
- The chroma subsampling **shall** be 4:2:0 (4:2:2 on request).
- The video **shall** have a minimum bit rate of 7.0 Mbit/s CBR or equivalent statistical multiplexing rate. Preferred is a Mezzanine format at a higher data rate.

Audio parameters:

- The audio codec **shall** be MPEG-1 audio Layer 2 according to ISO/IEC 11172-3 [21].
- The minimum audio bit rate for stereo (L/R) **shall** be 192 kbit/s.
- The maximum audio level **shall** be according to EBU R128.
- An additionally audio codec *may* be AC-3 (5.1) according to ETSI TS 102 366 [6].
- AC-3 components **shall** be signalized with ISO stream_type '0x06' [PES private data].
- AC-3 components **shall** be signalized with a DVB AC-3_descriptor.
- The audio/video delay **shall** be in the range of +/- 10 ms.

Alternative Audio parameters:

- The audio codec **shall be** AAC-LC (2.0) according to ISO 13818-7 [34] / ISO/IEC 14496-3 [36].
- The minimum audio bit rate for AAC stereo (L/R) **should** be 128 kbit/s.
- The audio sample rate **shall** be 48 kHz.
- AAC-LC components **shall** be signalized with Audio Stream Type: LATM: 0x11 or ADTS: 0xF
- The maximum audio level **shall** be according to EBU R128

Teletext parameters:

- Teletext *may* be used as additional component.
- Teletext **shall** be EBU Teletext Level 1.5 according to ETSI EN 300 706 [7].
- Teletext **shall** be delivered according to ETSI EN 300 472 [22].
- Teletext components **shall** be signalized with ISO stream_type '0x06' [PES private data].
- Teletext components **shall** be signalized with a DVB teletext_descriptor.

PSI/SI parameters:

- PSI data **shall** be used according to ISO 13818-1 [14].
- DVB SI data **shall** be used according to ETSI EN 300 468 [15], ETSI EN 101 154 [16] and ETSI TR 101 211 [17].
- The following tables **shall** be present: PAT, PMT, SDT.
- The following tables *may* be present: NIT, TDT, TOT, EIT.
- PAT, PMT and SDT repetition interval **shall** be within ETSI TR 101 290 specification.
- Other PSI/SI tables as the mentioned above **shall not** be present as long as not otherwise agreed with Vodafone Deutschland.

Other parameters:

- Other service components (e.g. DVB subtitles, DVB AIT for HbbTV, private data delivery) or other PSI/SI tables **shall** be chosen and tested in close collaboration with Vodafone Deutschland to secure interoperability.

In case of DVB subtitling:

- DVB subtitling **shall** comply with ETSI EN 300 743 [31].
- DVB subtitling components **shall** be signaled with ISO stream_type '0x06' [PES private data].
- DVB subtitling components **shall** be signaled with a DVB subtitling_descriptor.

In case of DVB HbbTV, DSM-CC carousels and Stream Events:

- DVB HbbTV, DVB AIT, DSM-CC carousels and Stream Events shall comply with ETSI TS 102 809 [24].
- DVB AIT components **shall** be signaled with ISO stream_type '0x05' [private sections].
- DVB AIT components **shall** be signaled with a DVB application_signalling_descriptor and application_type set to DVB registered MHP_Application_Type_ID '0x10' (decimal value '16') [HBBTV]. See also https://www.dvbservices.com/identifiers/mhp_app_type_id

Encrypted signal delivery:

- In case the signal is encrypted on the satellite delivery path, the content provider **shall** deliver a minimum of 4 Professional CAMs including smartcards suitable for use in professional IRDs.

5.4. National services – HD

All national services will passthrough Vodafone's Transcoding Platform. Therefore it is preferred to deliver national services in a Mezzanine format. If the delivery of services in a Mezzanine format is not possible, delivery in a standard distribution format is accepted.

The following technical parameters **shall** apply:

Transport parameters:

- The signal transport **shall** be MPEG-2 Transport Stream according to ISO 13818-1 [14], ETSI EN 300 468 [15], ETSI TS 101 154 [16] and ETSI TR 101 211 [17].
- The transport stream **shall** produce no errors when measured according to ETSI TR 101 290 [18].

Video parameters format:

- The video codec **shall** be H.264 High Profile Level 4 according to ISO/IEC 14496-10 [25].
- The video **shall** be delivered exclusively in 720p50, 1080i25 or 1080p50.
- The chroma subsampling **shall** be 4:2:0 (4:2:2 on request).
- The video **shall** have a minimum bit rate of 15.0 Mbit/s CBR or equivalent statistical multiplexing rate. Preferred is a Mezzanine format at a higher data rate.

Audio parameters:

- The audio codec **shall** be AC-3 (2.0. or 5.1) according to ETSI TS 102 366 [6].
- Dolby E and AES3 **should not** be used.
- The minimum bit rate for AC-3 **should** be 384 kbit/s.
- The audio sample rate **shall** be 48 kHz.
- AC-3 components **shall** be signaled with ISO stream_type '06' [PES private data].
- AC-3 components **shall** be signaled with a DVB AC-3_descriptor.
- The maximum audio level **shall** be according to EBU R128
- The audio/video delay **shall** be in the range of +/- 10 ms

Alternative Audio parameters:

- The audio codec **shall** be AAC-LC (2.0) according to ISO 13818-7 [34] / ISO/IEC 14496-3 [36].
- The minimum audio bit rate for AAC stereo (L/R) **should** be 128 kbit/s.
- The audio sample rate **shall** be 48 kHz.
- AAC-LC components **shall** be signaled with Audio Stream Type: LATM: 0x11 or ADTS: 0xF
- The maximum audio level **shall** be according to EBU R128
- The audio/video delay **shall** be in the range of +/- 10 ms

Teletext parameters:

- Teletext *may* be used as additional component.
- Teletext **shall** be EBU Teletext Level 1.5 according to ETSI EN 300 706 [7].
- Teletext **shall** be delivered according to ETSI EN 300 472 [22].
- Teletext components **shall** be signaled with ISO stream_type '0x06' [PES private data].
- Teletext **shall** be signaled with a DVB teletext_descriptor.

PSI/SI parameters:

- PSI data **shall** be used according to ISO 13818-1 [14].
- DVB SI data **shall** be used according to ETSI EN 300 468 [15], ETSI EN 101 154 [16] and ETSI TR 101 211 [17].
- The following tables **shall** be present: PAT, PMT, SDT.
- The following tables *may* be present: NIT, TDT, TOT, EIT
- PAT, PMT and SDT repetition interval **shall** be within ETSI TR 101 290 specification.
- Other PSI/SI tables as the mentioned above **shall not** be present as long as not otherwise agreed with Vodafone Deutschland.

Other parameters:

- Other service components (e.g. DVB subtitles, DVB AIT for HbbTV, private data delivery) or other PSI/SI tables **shall** be chosen and tested in close collaboration with Vodafone Deutschland to secure interoperability.

In case of DVB subtitling:

- DVB subtitling **shall** comply with ETSI EN 300 743 [31].
- DVB subtitling components **shall** be signaled with ISO stream_type '0x06' [PES private data].
- DVB subtitling components **shall** be signaled with a DVB subtitling_descriptor.

In case of DVB HbbTV, DSM-CC carousels and Stream Events:

- DVB HbbTV, DVB AIT, DSM-CC carousels and Stream Events shall comply with ETSI TS 102 809 [24].
- DVB AIT components **shall** be signaled with ISO stream_type '0x05' [private sections].
- DVB AIT components **shall** be signaled with a DVB application_signalling_descriptor and application_type set to DVB registered MHP_Application_Type_ID '0x10' (decimal value '16') [HBBTV]. See also https://www.dvbservices.com/identifiers/mhp_app_type_id

Encrypted signal delivery:

- In case the signal is encrypted on the satellite delivery path, the content provider **shall** deliver a minimum of 4 Professional CAMs including smartcards suitable for use in professional IRDs.

5.5. Radio Services

5.5.1. Digital Radio (DVB TS)

The following technical parameters **shall** apply:

Transport parameters:

- The signal transport **shall** be MPEG-2 Transport Stream according to ISO 13818-1 [14], ETSI EN 300 468 [15], ETSI TS 101 154 [16] and ETSI TR 101 211 [17].
- The transport stream **shall** produce no errors when measured according to ETSI TR 101 290 [18].

Audio parameters:

- The audio codec shall be AAC-LC audio according to ISO 13818-7 [34] / ISO/IEC 14496-3 [36].
- The audio bit rate for stereo (L/R) **shall** be 128 kbit/s.
- The audio sample rate **shall** be 48 kHz.
- AAC-LC components **shall** be signaled with Audio Stream Type: LATM: 0x11 or ADTS: 0xF
- The maximum audio level **shall** be according to EBU R128.
- AC-3 **should not** be used.

PSI/SI parameters:

- PSI data **shall** be used according to ISO 13818-1 [14].
- DVB SI data **shall** be used according to ETSI EN 300 468 [15], ETSI EN 101 154 [16] and ETSI TR 101 211 [17].
- The service type **shall** be 0x11 (LATM).
- The following tables **shall** be present: PAT, PMT, SDT.
- The following tables *may* be present: NIT, TDT, TOT, EIT.
- PAT, PMT and SDT repetition interval **shall** be within ETSI TR 101 290 specification.
- Other PSI/SI tables as the mentioned above **shall not** be present as long as not otherwise agreed with Vodafone Deutschland.

In case of DVB HbbTV, DSM-CC carousels and Stream Events:

- DVB HbbTV, DVB AIT, DSM-CC carousels and Stream Events shall comply with ETSI TS 102 809 [24].

5.5.2. Digital Radio (Internet Stream)

The following technical parameters **shall** apply:

Access parameters:

- The network control protocol **shall** be RTSP, Shoutcast or IceCast.

Transport parameters:

- The signal transport **shall** be Real, ADTS, or HTTP

Audio parameters:

- The audio codec **should** be either
 - MPEG-1 audio Layer 2 according to ISO/IEC 11172-3 [21], or
 - MPEG-2 according to ISO/IEC 13818-3 [34], or
 - MPEG-1 audio Layer 3 according to ISO/IEC 11172-3 [21], or
 - AAC audio according to ISO 13818-7 [34] / ISO/IEC 14496-3 [36].
- The minimum audio bit rate for stereo (L/R) **shall** be 192 kbit/s for MPEG1/MPEG2-streams.
- The minimum audio bit rate for stereo (L/R) **shall** be 96 kbit/s for AAC-streams.
- The maximum audio level **shall** be according to EBU R128.

6. EPG and Service Information delivery

6.1. National services

EPG and Service Information data for national services *can* be delivered using one of the following ways:

- Delivery of DVB EIT data within the delivered signal (in case of SDI or HD-SDI signals, delivery within a separate signal via satellite or ASI line is also possible)
- via mediapress /pps
- via Gracenote

Only the delivery via DVB EIT within the signal, allows an immediate reflection of EPG data changes within the Vodafone Deutschland network.

All EPG TV-data are fed automatically into Vodafone Deutschland EPG barker which is used by Vodafone Deutschland set-top-boxes for displaying a comprehensive EPG.

6.2. Regional services

EPG and Service Information data for regional services *can* be delivered using one of the following ways:

- EIT p/f (actual transport stream) **shall** be present within the delivered signal and will be displayed on all set-top-boxes.
- EIT schedule (actual transport stream) *may* be present within the signal. However EIT schedule information will only be available on few set-top-boxes because Vodafone Deutschland set-top-boxes are using the Vodafone Deutschland EPG Barker. Therefore it is not suggested to use this method.

6.3. EPG data for PVRs (gracenote)

Vodafone Deutschland set-top-boxes having recording capabilities (Personal Video Recorder PVR) using a different mechanism for EPG data delivery in order to allow a schedule reaching further into the future and to provide more detailed program information. The underlying service for this functionality is the gracenote EPG service. To deliver also EPG data to PVRs the service provider has to setup the service together with gracenote. More information regarding gracenote delivery *can* be requested from Vodafone Deutschland.

7. DRM information

For specific information on metadata or controlling data related to DRM delivered typically via Conditional Access Systems please contact Vodafone Deutschland for more information.