

**Consumer Device Platform
for Connected Television**

**Draft A
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Note: the present version of this document describes requirements for a Canvas-enabled DTT HD DTR product only. This document will evolve over time to reflect different devices, including non-DTR and Freesat variants.

1 Device Platform Summary

The following table summarises the main features of the device platform. *The subsequent sections provide more detailed specification of these items.*

	Function	Required ¹	Commentary
1	Consumer device platform		
1.1	Core hardware		
	CPU: 700 DMIPS+	Y	Specific silicon products currently being evaluated by the BBC.
	RAM: 512 Mbyte min Minimum DDR bandwidth: 3 Gbyte/sec.	Y	Higher bandwidth may improve performance.
	Flash memory	Y	Partitions for: - device software image - JV System Provisioning information - resident JV Applications - device configuration settings - application persistent data (e.g. cookies) Note: some of this information may be stored on hard disk subject to the power management requirements in section 2.4.
1.2	Internal hard disk		
	300 GB min.	Y	
	Support for on disk encryption using AES128 or Triple DES.	Y	Required for HD broadcast content.
1.3	Input / output		
	USB 2.0	Y	Minimum of two: At least one on front panel and one on rear.
	Ethernet port supporting 10BASE-T and 100BASE-TX	Y	For Internet connectivity and Home Networking. May be used in conjunction with fixed wire, power line adapter or wireless adapter as convenient in home.
	Integrated wireless Ethernet: 802.11n.	N	Integrated wireless Ethernet is optional. If not provided, the device must support the use of USB Wifi adapters.
	Unique MAC address for Ethernet, programmed at Manufacture	Y	
	2x dual-mode DVB-T/T2 tuners	Y	RF characteristics as specified by DTG D-Book version 6.2. DVB-T2 is used for HD services on digital terrestrial.
	1x HDMI v1.3	Y	Including support for HDCP, auto lipsync, CEC "One-Touch Play" and "System Standby", Multi-channel linear PCM audio, bitstream audio, YcbCr 4:2:2 12-bit, BT709 colorimetry.
	1x SCART	Y	
	Analogue HD outputs	E	Excluded as part of rights management strategy.
	Modulated UHF output	N	Strongly desired but not required.
	RF loop-through	Y	Remains powered in standby.
	Separate stereo audio	N	Stereo audio may be provided on RCA sockets if present
	Digital audio (DTS or AC-3 bitstream or linear stereo PCM)	Y	Optical or coaxial SPDIF connection.
	Adjustable delay on audio output	Y	Accommodate display video delay (pref. Automatically)
	Serial I/O	N	Connection to BARB panel meter will be accommodated via USB.
	Common Interface Slot	C	May be present if necessary to meet other requirements (e.g. IDTV requires slot under EC regulations). Where provided, CI+ recommended.
	CA card slot	N	Could be added in pay operator specific variant of the device

¹ Y = yes; N=no/optional; E=excluded/not permitted; C=conditional (see commentary)

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	Function	Required ¹	Commentary
1.4	Peripheral devices		
	Support for USB mass storage devices	Y	For presentation of content from USB drives. No requirement to export content.
	Support for USB wireless Ethernet adapter	C	Required for domestic connectivity if IEEE 802.11n not supported internally.
	Support for USB human interface devices	Y	Required for accessibility applications
	Support for USB Bluetooth adapter	N	
	Support for USB serial adapter	Y	Required for BARB panel meter (audience measurement) interface
	Support for SD card reader	N	
1.5	Graphics		
	1280x720 32bpp ARGB8888 graphics plane	Y	
	Support for simultaneous display of subtitles, MHEG engine and top level navigation	Y	Note: may be implemented using multiple hardware graphics layers or by hardware-assisted composition onto a single layer.
	2D graphics hardware acceleration	Y	Detailed specification in section 2.7.
	3D graphics hardware acceleration	N	Not required. However, support for OpenGL ES 2.0 and/or OpenVG may allow for higher performance rendering for presentation environments that make use of vector shapes or non-rectangular bitmap transformations.
1.6	AV codecs		
	SD video: MPEG-2 MP@ML 25Hz	Y	As specified by DTG D-Book v6.2.
	SD video: MPEG-4 part 10 (H.264/AVC) Main and High Profile Level 3.0	Y	As specified by DTG D-Book v6.2. High profile included as will already be supported for HD services.
	HD video: MPEG-4 part 10 (H.264/AVC) Main and High Profile Level 4.0	Y	As specified by DTG D-Book v6.2.
	Audio: MPEG-1 Layer II	Y	As specified by DTG D-Book v6.2. Decode of existing SD FTA terrestrial services.
	Audio: Dolby AC-3	N	Not required by D-Book 6.2.
	Audio: Dolby E-AC-3 (inc. transcode to AC-3 or DTS)	Y	Up to 5.1 channel surround sound.
	Audio: Multi-channel HE-AAC (inc. transcode to AC-3 or DTS)	Y	Up to 5.1 channel surround sound.
	Audio: Down-mix of E-AC-3 and multi-channel HE-AAC to stereo	Y	As specified by DTG D-Book v6.2.
	Audio: HE-AAC and LC-AAC	Y	As specified by DTG D-Book v6.2. In stereo mode, good for low bitrate services.
	Audio description: Receiver mix	Y	As specified by DTG D-Book v6.2 section 4.5. Requires dual decode and mix. Devices shall provide an option to enable AD on all outputs or only on SPDIF output.
	Audio: MPEG-1 Layer III	Y	Elementary streams
	Content decryption	Y	
1.7	Remote control		
	Minimum set of remote control buttons	Y	Standard text-based labelling. Detailed specification is included in section 3.2.
	Basic functions available from the device front panel	N	Standby button required, other buttons optional. See section 2.14.
	Remote control design to observe requirements for accessibility	Y	Includes: - layout of keys - contrast between labelling and background - presence of dedicated subtitle (and where relevant) audio description keys.
	Single/common remote control design	N	
	Remote control protocol and codes made available by manufacturers	Y	For providers of alternative remotes.
	Free-field remote control	N	
1.8	Operating system & standard libraries		
	Embedded Linux 2.6.18 or later	Y	
	DirectFB graphics environment with multi-application core	Y	
1.9	Misc		
	Fan-less operation	Y	Rely on passive cooling.

2 Core Consumer Device Platform

2.1 Silicon

All consumer devices will need to be based on SoCs for which the ability to support the necessary functionality has been established.

Editors note: It is the intention of the proposed Canvas joint venture to publish a list of approved SoCs.

2.2 Connectivity

2.2.1 Network

The device shall provide an auto-negotiating Ethernet port for connection to a TCP/IP network. The port shall support at least 10BASE-T and 100BASE-TX physical layers via an RJ-45/8P8C socket with MDI wiring as specified by IEEE 802.3. 1000BASE-T may also be supported. Multicast capability is required. Devices shall support half duplex mode, full duplex mode and full duplex with flow control. The default shall be to auto negotiate but devices must also support manual selection of a specific mode.

It is recommended that the Ethernet port have link and traffic indicator lights to simplify the diagnosis of connection problems. The Ethernet MAC address shall be available to the configuration user interface for diagnostic purposes. Note: MAC address shall not be used as a device unique identifier for any other purpose.

Devices shall support wireless networking, either using a built-in IEEE 802.11n adapter, or by supporting the configuration and use of optional USB IEEE 802.11g and IEEE 802.11n adapters. Devices may restrict the range of adapters that are supported, for example to limit the number of drivers required. There may be a minimum set of drivers defined to be supported in all devices.

Use of WiFi Protected Setup (WPS) is recommended, to simplify configuration. Devices shall also provide options to configure the wireless interface manually by selecting from a list of SSIDs. Devices shall support WEP, WPA/PSK and WPA2/PSK encryption.

PowerLine Telecommunications (PLT) is an option for network connectivity, either built in to the device or via an external adapter. However, only solutions supporting ETSI TS 102 578 may be provided or recommended for use with connected television devices.

2.2.2 UHF input

The device shall have a combination of tuners and demodulators that permits:

- reception of two DVB-T multiplexes simultaneously
- reception of one DVB-T multiplex and one DVB-T2 multiplex
- reception of two DVB-T2 multiplexes simultaneously

For DVB-T and DVB-T2, the RF characteristics from DTG D-Book version 6.2 shall apply.

2.2.3 A/V outputs

Devices shall provide A/V connections as specified in section 22.3.4.4.1 of D-Book 6.2 with the following changes:

- HDMI "Auto Lipsync Correction", CEC "One-Touch Play" and "System Standby" are mandatory. Note that the "Auto Lipsync" feature implies HDMI version 1.3.
- A manual audio delay adjustment affecting analogue and SPDIF outputs (both PCM and non-PCM) shall also be provided, as required by D-Book 6.2. When used, this manual adjustment shall override the automatic adjustment. These adjustments shall not affect the timing of HDMI audio.
- The HDMI output shall use BT709 colorimetry.

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- SD output modes shall not be used over HDMI; the device shall up-scale SD video to the configured HD output resolution. HDMI outputs are not required to support resolutions below 720p.
- The HDMI connection shall be monitored to detect when a display is connected or removed.

As required by D-Book 6.2, devices shall not have analogue component HD outputs.

Devices shall have the hardware capability to output CGMS-A signalling on analogue SD outputs. However, by default, no CGMS-A restrictions shall be signalled. CGMS-A restrictions shall be signalled only when presenting protected IP-delivered content and only where specifically mandated by the Connected Television specifications.

Devices shall have at least one SCART connector supporting RGB and composite video. This shall become the primary output if no display is connected to the HDMI connector. Where a display is connected to the HDMI connector, the SCART output becomes a secondary output.

Devices may have an additional AUX SCART connector but this is not required. If present, loop-through of composite video, RGB video and audio inputs from this SCART to the primary SCART shall be provided whilst in standby and under pin 8 control.

The table below specifies the requirements for the A/V outputs. Specific outputs may have additional requirements for rights management reasons.

Mode	Connector	Graphics (Flash, HTML, MHEG)	Subtitles	Video	Volume controls
HDMI connected	HDMI	Required	Required	Required	Enabled
	SCART 1	Not recommended	Required	Required	Disabled
	SCART 2 (if present)	Not recommended	Required	Required	Disabled
HDMI not connected	HDMI	N/A	N/A	N/A	N/A
	SCART 1	Required	Required	Required	Enabled
	SCART 2 (if present)	Not recommended	Required	Required	Disabled if possible

Additional analogue and digital audio outputs are optional.

Volume controls shall not affect the SPDIF audio level.

Audio output requirements are specified further in sections 2.10.3 and 2.10.4.

2.2.4 USB devices

Devices shall provide at least two high speed, high power, USB 2.0 host ports. There shall be at least one connector on the front of the device and at least one on the back. The USB standard 'A' socket shall be used.

2.2.5 Audience Measurement interface

The device shall provide a mechanism for connection to an audience-monitoring unit provided by BARB.

The mechanism for connection of this unit is currently work in progress. It is expected that the unit will interface via a USB serial port adapter.

2.3 Internal storage

Devices shall have internal non-volatile storage to hold the device software image and to store A/V content.

The internal storage may utilise either Flash memory or a hard disc or both. However, devices must adhere to the power management requirements specified in section 2.4. This means that all the information that the device needs to access whilst in standby mode must be stored in solid state memory or temporarily held in RAM.

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The device is not required to continue to function in the event of a hard disc failure. However, where possible, the device should be able to report such a failure to the user.

2.3.1 Media storage

HD DVR devices shall have storage for at least 300 Gbytes of A/V content. Storage requirements for other classes of devices will be defined in a future revision of this specification.

Storage for broadcast recordings and IP downloads shall be managed as a single storage area.

Devices shall support reservation of part of the media storage area for background 'pushed' content. The size of this area will be defined in a subsequent revision of this specification but is expected to be around 30 Gbytes.

HD broadcast content stored on disk shall be encrypted with AES128 or 3DES. Content obtained in encrypted form over IP shall be stored on disk as is. If decryption keys for stored content are themselves held on the hard disk, they shall be encrypted with a key linked to a device identifier such that the keys cannot be extracted if the hard disk is transplanted into a different device.

2.3.2 Swap space

Devices may use internal storage as swap space if this improves performance. However, consideration should be given to locking the main user interface processes in RAM. Also, no swap space residing on a hard disc may be used whilst the device is in any standby mode.

2.4 Power management

Devices shall comply with all applicable legislation on standby power consumption.

Devices shall power down hard discs when in standby, except when making a recording. This requirement means that any background monitoring of broadcast and/or IP signalling while in standby (for example to maintain a schedule cache) cannot read from or write to the hard drive.

Device manufacturers shall take all reasonable steps to minimise power consumption in active standby mode. Typical steps will be: reduce CPU clock speed, power down A/V outputs, power down system components not in use, switch SDRAM to self-refresh, use hardware timers to wake up device from low power state.

Support for the following power states is required:

State	Name	Description
1	ON	Device in use by the user. Device is fully powered, UI is running.
2A	STANDBY_RECORDING	A recording, download or software update is occurring. Device is fully powered but outputs disabled and UI not running.
2B	STANDBY_NOT_RECORDING	A configuration update, broadcast schedule update, or similar task is being performed. CPU is powered but disk powered down, outputs disabled and UI not running.
2C	STANDBY_IDLE	Low power state to meet code of conduct and legal requirements. Timer and IR being monitored but everything else could be off.

2.5 Operating system

Devices shall be built using the Linux operating system with either glibc or uClibc. The following version requirements apply:

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Component	Min version	Notes
Linux kernel	2.6.19.2 ¹	SMP support required for devices where SoC has a multi-core application CPU.
Glibc	2.5	
uClibc	0.9.29 + NPTL	This version has known shared library dynamic linking restrictions.
Toolchain (GCC)	4.1	

The linux kernel shall be suitably configured for use on a platform with limited resources.

Device drivers for the following functions are required:

- SATA
- USB 2.0 (including hot plug support)
- Powered and non-powered USB hubs
- USB mass storage
- USB human interface devices (USB keyboard, gamepad and mouse buttons, for accessibility input devices)
- USB 802.11g and 802.11n adapters with WPA and WPA2 support (may be restricted to adapters requiring specific drivers). Note: support for USB Wifi adapters is not required if the device has built-in 802.11n support.
- USB serial port adapter (specific driver TBD) for interface with BARB panel meter (audience monitoring) device. BARB device is expected to have a unique USB ID.
- Ethernet, TCP/IP, multicast (both SSM and ASM)
- IR remote control
- DirectFB fusion shm/ipc module (version 8.1.1 or later)
- Watchdog (if supported by SoC)
- ALSA PCM sound²
- Set top box functions (typically using silicon-vendor provided drivers)

The following filesystems shall be supported:

- vfat filesystem (for USB devices)
- Filesystem suitable for large media files (e.g. xfs. Note: ext3 is unlikely to be suitable due to the excessively long time taken to delete large files)
- Filesystem suitable for general purpose use (e.g. ext3)
- Filesystem suitable for Flash memory (e.g. jffs2)
- Filesystem for unpacking platform software images (cramfs)

Filesystems used within the device shall be recoverable in the event of a power failure while the device is in use.

2.6 Standard libraries

The following table lists software libraries that are required or recommended.

¹ Required for reliable support of madvise(MADV_REMOVE) to allow for better freeing of DirectFB shared memory. If the relevant bug fix from <http://lkml.org/lkml/2006/12/13/302> is back-ported, version 2.6.18 may be used.

² Where this is not available, it can be omitted but additional porting work will be required for some software components.

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Library	Status	Min version	Notes
C libraries	Required	See section 2.2	libc, libm, libpthread, librt, libdl, libresolv
C++ libraries	Required	See section 2.2	As supplied with compiler
DirectFB	Required	1.4.3	Full requirements are detailed below
SaWMan	Required	1.4.3	Shared application window manager for DirectFB
DBus	Required	1.2.16	IPC library
libpng	Required	1.2.37	PNG image decoder. Older versions unsuitable due to security concerns.
Libjpeg	Required	6b	JPEG image decoder
libz	Required	1.2.3	Zlib compression library. Older versions unsuitable due to security concerns.
CURL	Required	Latest available	HTTP client library. For security reasons, the most recent possible version should be used.
libxml2	Required	2.6.30	XML parser
OpenSSL	Required	Latest available	Encryption library for TLS, MHEG security etc. For security reasons, the most recent possible version should always be used.
SQLite	Required	3.6.3	Lightweight database for configuration information
log4cplus	Required	1.0.4	Logging library
Libasound	Recommended	1.0.15	ALSA sound API for presentation engines
Freetype	Recommended	2.3.1	Text rendering for MHEG

Additional libraries may be required to support specific presentation engines, uPnP/DLNA and for device setup and configuration. These are not yet included in this list.

For efficiency, shared libraries shall be used in all cases.

2.7 DirectFB requirements

2.7.1 Version

DirectFB 1.4 version 1.4.3 or later is required.

2.7.2 Multi-application core

DirectFB shall support the multi-application core using the Fusion kernel module and support libraries. The DirectFB 'system' and 'gfxdriver' plugins for the hardware being used must support use in a multi-application environment.

DirectFB shall support applications running as different linux users.

2.7.3 Presentation engine integration

Presentation engines requiring graphics display shall do so through a DirectFB Window. Presentation engines may not directly manipulate DirectFB layer surfaces.

2.7.4 Layers

The DirectFB implementation shall provide at least the capabilities to manage a single primary graphics layer. This layer will be used to compose the graphics from various presentation engines. This composition process may use alpha blending and as a result, the graphics layer will always contain alpha-premultiplied pixel data. Consequently, the layer shall support the option to blend with the video layer in manner that takes into account this premultiplication.

The graphics layer shall support the following capabilities:

- DLCAPS_SURFACE
- DLCAPS_OPACITY

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- DLCAPS_ALPHACHANNEL
- DLCAPS_PREMULTIPLIED¹

2.7.5 2D acceleration

The graphics performance of the device depends on the presentation engines having access to the 2D hardware acceleration functions provided by the SoC. Devices shall provide acceleration through a suitable DirectFB graphics driver for at least the following set of operations:

Operation	Blending flags	Blending functions	Notes
FillRectangle FillRectangles	DSDRAW_NOFX	N/A	
	DSDRAW_BLEND	SRC (1, 0) SRC_OVER (1, 1-A _{src})	
Blit StretchBlit BatchBlit	DSBLIT_NOFX	N/A	
	DSBLIT_BLEND_ALPHACHANNEL	SRC (1, 0) SRC_OVER (1, 1-A _{src})	Used to blend images that have an alpha channel and premultiplied pixel data.
	DSBLIT_BLEND_ALPHACHANNEL DSBLIT_SRC_PREMULTIPLY	SRC (1, 0) SRC_OVER (1, 1-A _{src})	Used to blend images that have an alpha channel and non-premultiplied pixel data.
	DSBLIT_BLEND_ALPHACHANNEL DSBLIT_BLEND_COLORALPHA DSBLIT_SRC_PREMULTICOLOR	SRC (1, 0) SRC_OVER (1, 1-A _{src})	Used to apply a constant alpha value to an image that has an alpha channel and premultiplied pixel data.
	DSBLIT_BLEND_ALPHACHANNEL DSBLIT_BLEND_COLORALPHA DSBLIT_SRC_PREMULTIPLY	SRC (1, 0) SRC_OVER (1, 1-A _{src})	Used to apply a constant alpha value to an image that has an alpha channel and non-premultiplied pixel data.
	DSBLIT_COLORIZE		Required to be supported in combination with all blending flag combinations listed above.
	DSBLIT_SRC_COLORKEY	None	Required only if colour keying is more efficient than blending and then only if subtitles must be rendered on the same graphics plane as the UI. Otherwise not required.

The performance of these hardware accelerated functions shall be at least as specified in the following table for all pixel formats that are required to be accelerated (see below):

Operation	Performance required
Rectangle fill	200 Mpixel/sec
Rectangle fill (blended)	120 Mpixel/sec
Blit	120 Mpixel/sec
Blit (blended)	100 Mpixel/sec
StretchBlit upscale (with and without blending)	At least the same as a straight Blit of the destination size

¹ The DirectFB implementation must accept a configuration with this option. The platform must either act on this flag directly or must provide an alternative means for the graphics layer to be configured to handle premultiplied pixel data.

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Operation	Performance required
StretchBlit downscale (with and without blending)	At least the same as a straight Blit of the source size

These figures shall be achievable when the device is showing broadcast SD video. Graphics performance may degrade during HD video playback, or playback of content from IP.

Accelerated blitting operations shall be supported for at least the following pixel formats: ARGB and ARGB4444 (as source and destination formats) and A8 (as a source format and for A8 to A8 copy). If subtitles must be rendered on the same graphics plane as the UI, LUT8 is also required as a source format.

The results of hardware accelerated operations shall agree with the DirectFB software renderer to within the following tolerances:

Operation	Destination pixel format	Source pixel format	Colour max RMS error	Alpha max error
Simple blit with no blending	Any	Same as destination	Zero	Zero
All other operations	ARGB	ARGB	2%	1%
	ARGB	Not ARGB	2%	7%
	Not ARGB	Any	10%	7%

2.7.6 Plug-ins

DirectFB image providers shall be provided for at least the following formats: PNG, JPEG and GIF. Where hardware image decoding is available, this should be supported through DirectFB. Presentation engines are recommended to use DirectFB for image decoding wherever possible in order to take advantage of any hardware acceleration that is available.

DirectFB font rendering support is optional but may be required in a future revision of this specification.

DirectFB input drivers shall be provided for the device's IR remote control and for USB keyboard, gamepad and mouse devices (mouse drivers need only support button press events). Support for USB input devices allows for custom user input devices to meet accessibility requirements. All input devices shall support auto-repeating keys, generating multiple DirectFB KEYPRESS events while the key is held down and a single RELEASE event when the key is released.

2.8 Graphics layers

Graphics from the various presentation engines shall be rendered through DirectFB. Presentation of DVB subtitles may also be rendered in this way. However, it is recommended that DVB subtitles be rendered into a separate hardware graphics plane if one is available that can support 8bpp pixel data. Subtitles are always positioned directly in front of the video plane, *below* the main graphics.

The graphics layer managed by the screen manager shall have a resolution of 1280x720. The device shall be responsible for managing the output of this graphics plane on the different output resolutions that the device is required to support. Implementations shall take into account filtering requirements for interlaced displays. The graphics system is performance critical. Devices shall optimise the graphics path appropriately for the particular SoC used.

2.9 HTTP client library (libcurl)

Presentation engines and the metadata subsystem require an HTTP client library. To minimise code duplication, porting efforts and for interoperability, devices shall use the CURL library for this function, with cryptographic functions provided by OpenSSL.

CURL shall be compiled with the following protocols and features enabled:

- Protocols: HTTP, HTTPS, FILE

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- Features: SSL, IPv6¹, libz, cookies, proxy

The following features are not required and should be disabled:

- FTP, ldap, ldaps, dict, telnet, tftp, sspi, gnutls, nss, libidn

2.10 A/V handling

2.10.1 Video codecs

Hardware support for the following video codecs is required:

Codec	Notes
SD: MPEG-2 MP@ML 25Hz	As specified by DTG D-Book v6.2.
SD: MPEG-4 part 10 (H.264/AVC) Main and High Profile Level 3.0	As specified by DTG D-Book v6.2. High profile included as will already be supported for HD services.
HD: MPEG-4 part 10 (H.264/AVC) Main and High Profile Level 4.0	As specified by DTG D-Book v6.2.

The H.264/AVC video decoder shall support dynamic changes of bitrate and decoded frame sizes that occur at IDR points.

2.10.2 Audio codecs

Support for the following audio codecs is required:

Codec	Notes
MPEG-1 Layer II	As specified by DTG D-Book v6.2. Decode of existing SD FTA terrestrial services.
Dolby E-AC-3	Up to 5.1 channel surround sound. See 2.10.3.
Multi-channel HE-AAC	Up to 5.1 channel surround sound. See 2.10.3.
Stereo HE-AAC and LC-AAC	As specified by DTG D-Book v6.2.
Receiver-mix audio description	As specified by DTG D-Book v6.2. See 2.10.4.
MPEG-1 Layer III	Elementary streams, with or without ID3 tags.

Audio decoders shall support dynamic changes of encoded bitrate between access units. The AAC decoder shall support seamless transitions between access units that use SBR and those that do not.

2.10.3 Audio mixing and transcoding

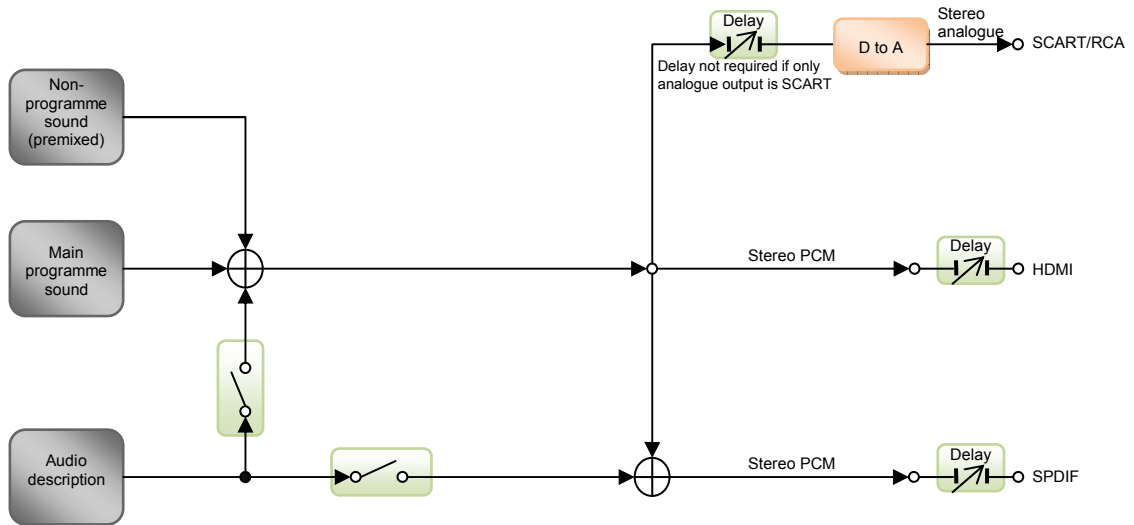
Devices shall support the audio output and transcoding requirements specified in D-Book 6.2.1.

The following figures show a logical model for audio flow within the device:

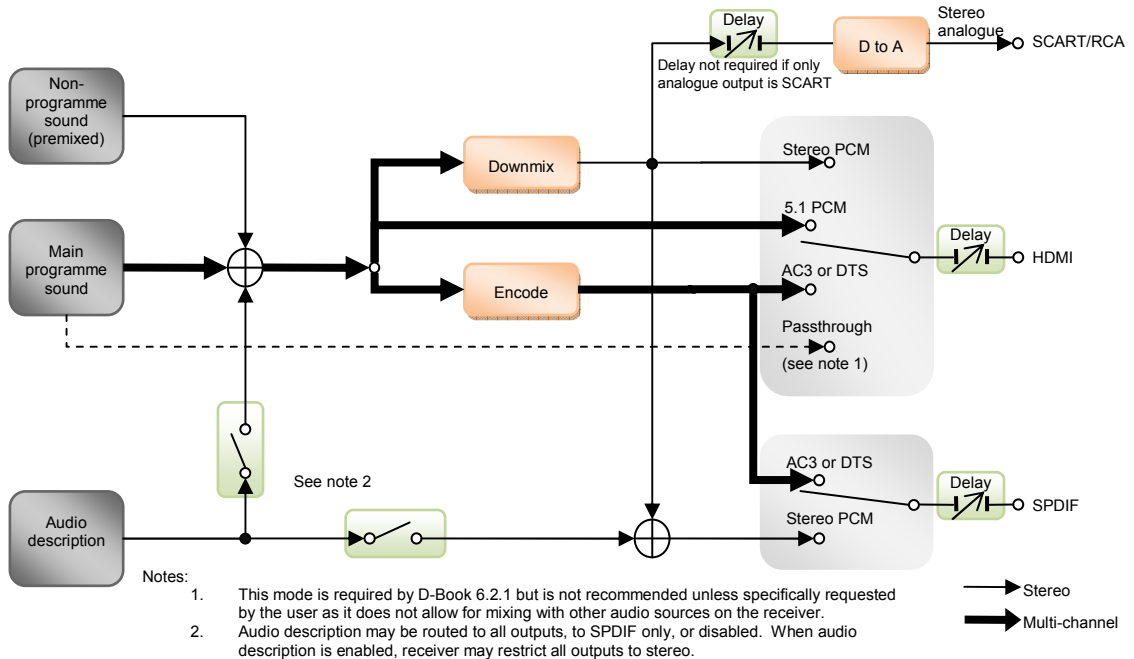
¹ IPv6 is not required for launch
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Where the main programme sound is stereo:



Where the main programme sound is multi-channel:



Audio delay for HDMI is controlled by the HDMI Auto Lipsync Correction feature. Audio delay for analogue and SPDIF outputs is controlled by a user configuration setting.

The reference level post normalisation shall be -31 dB FS for SPDIF and for HDMI where the sink supports bitstream audio. The reference level post normalisation shall be -23 dB FS for HDMI where the sink does not support bitstream audio. Audio level adjustments required to meet these requirements are not shown on the diagram.

The diagrams do not show any sample rate conversion but this may be required where different audio sources have a different sample rate.

Non-programme sound may originate from any presentation engine and there may be multiple sources active at any time. For the purposes of these diagrams, all non-programme sound is assumed to have been premixed to stereo PCM.

Devices may support additional audio output options to those shown.

2.10.4 Audio description

Devices shall support receiver-mix audio description services, as specified in D-Book 6.2 section 4.5.

Devices shall provide the following user configuration settings for the output of audio description:

- Audio description disabled
- Audio description mixed with all audio outputs
- Audio description mixed with audio on SPDIF output; main programme sound sent to all other audio outputs. Note: in this mode, the SPDIF output is only required to provide a stereo mix.

2.10.5 Content decryption

Devices shall support decryption of content encrypted using the following schemes:

For MPEG-2 transport streams:

- AES with a 128-bit key using the Cipher Block Chaining (CBC) encryption mode with the residual termination block process from ANSI/SCTE 52 2008, as specified in IEC 62455 section 6.4.6.

For MP4:

- TBD, expected to be AES-based. Current recommendation is that hardware should support at least general-purpose decryption of AES-128-CTR and AES-128-CBC.

2.10.6 A/V recordings and accurate playback

Devices shall support frame accurate playback of content recorded from a linear broadcast stream. Driver support shall be provided to allow for accurate playback between specified start and end positions.

To achieve this, devices shall generate sufficient indexing metadata during recording so that playback can be requested from any PTS value. Generally, this will require the creation of an index file that contains PTS values and corresponding byte offsets for each frame within the stream file. Only the PTS values of frames from which clean decoding of the stream can commence need be stored in the index file.

The low-level media playback subsystem shall accept any valid PTS value to begin playback. The playback subsystem shall seek to the nearest previous frame from which decoding can begin and begin presenting A/V media once the requested start PTS has been reached in the file. Media between the seek point and the start point shall not be presented.

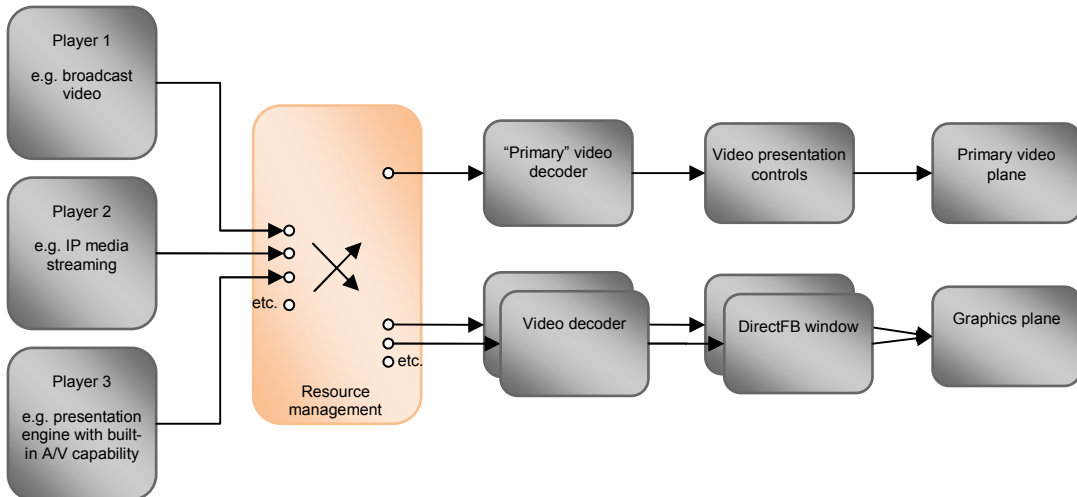
Where a subtitles stream is present in a broadcast service, this shall be included in recordings made from that service.

2.10.7 Video decoding and resource management

Devices shall support one HD video decode and presentation path to the specifications of D-Book 6.2.1. Devices shall support the decoding of additional low resolution video streams for presentation on the graphics plane up to a maximum combined source pixel area of 720x576 pixels.

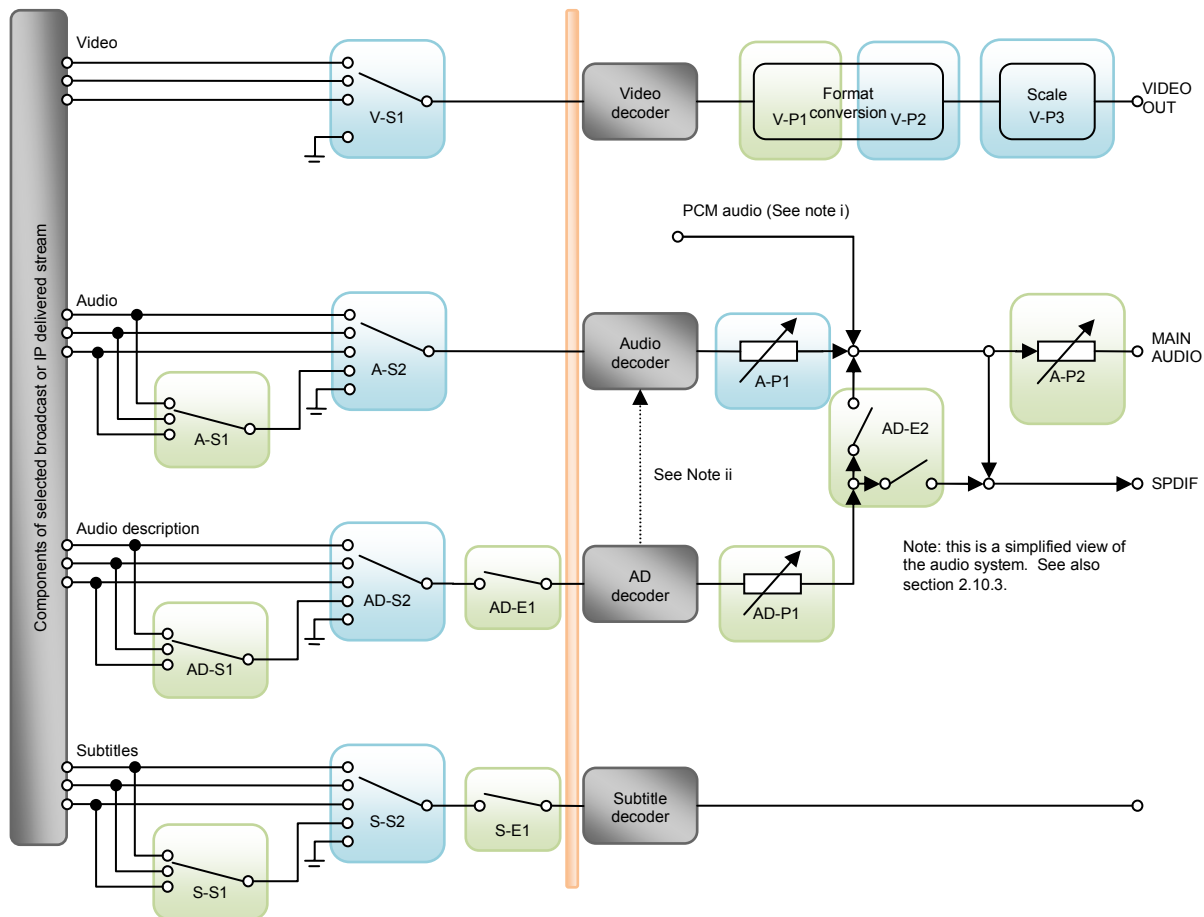
Editors note: Further constraints on the number of additional video decodes will be added in a future revision of this specification.

It is acceptable for there to be occasional dropped frames in the rendering of video onto the graphics plane and performance may degrade further if the video is subject to blending or up-scaling or has a source resolution greater than 360x288. The primary A/V decode path shall not drop frames. The following figure illustrates the primary and additional video paths.



2.10.8 A/V component selection and presentation controls

The figure below shows the various component selection and presentation controls required. The case shown best reflects the situation where broadcast video is being presented. The orange line indicates the resource management function from the previous diagram. The controls shaded green are controls that are expected to be adjusted by the viewer; those shaded blue are expected to be adjusted by application software.



Notes:

- i. Presentation engines may output stereo PCM audio samples to be *combined* with audio from the media pipeline. Please refer to the appropriate presentation engine integration specification for details.
- ii. The audio description decoder (marked “AD decoder”) is able to adjust the volume of the audio coming out of the main audio decoder as part of its built-in behaviour. This is depicted by the dotted arrow. The audio volume control A-P1 affects the audio level after this has happened.

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The table below describes the function of the various controls:

Control	Function
V-S1	This is the application-controlled video component selector. It can select between any of the video components from the selected source or can select nothing.
V-P1	This is the viewer's aspect ratio control. It combines with V-P2 to influence the composition of the video picture and the display formatting.
V-P2	This is an application control for aspect ratio conversion. It combines with V-P1 to influence the composition of the video picture and the display formatting.
V-P3	This is an application control of video scaling and positioning.
A-S1	This is the viewer's audio language preference and forwards a default audio component to control A-S2.
A-S2	This is an application-controlled audio component selector. It can select between any of the audio components from the selected source, the default component from A-S1 or nothing.
A-P1	This is the application-controlled audio volume control. It is specific to the audio coming from the audio decoder and does not affect other audio sources on the device.
A-P2	This is the viewer's master volume control and controls all audio outputs that are controllable.
AD-S1	This is the viewer's audio description language preference (which may be set automatically to match A-S1).
AD-S2	This is an application-controlled audio description component selector. It can select between any of the audio description components from the selected source, the default component from AD-S1 or nothing.
AD-E1	This is the viewer's audio description enabling control.
AD-P1	This is the viewer's audio description volume control. It adjusts the audio description volume independently of the main audio volume. The control defaults to following A-P2. The viewer controls the offset that makes the audio description quieter or louder relative to the main audio.
AD-E2	This control determines whether audio description appears on all outputs or only on the SPDIF output.
S-S1	This is the viewer's subtitle language preference (which may be set automatically to match A-S1).
S-S2	This is the application-controlled subtitle component selector. It can select between any of the audio components from the selected source, the default component from S-S1 or nothing.
S-E1	This is the viewer's subtitle enabling control.

2.11 Device software upgrade

Devices need to store several different types of information in non-volatile storage:

- Core device software image (Linux kernel and root filesystem)
- Platform policy information and user interface
- User configuration information
- Persistent data associated with third party services and applications, e.g. cookies
- Cached metadata and data relating to third party services

The core device software image is managed by the device manufacturer. Devices must be able to update their software image both over broadcast and over IP because for any particular device, one of these might not be connected. The broadcast update mechanism is specified in the DTG D-Book. The mechanism for core software image upgrade over IP is implementation dependent.

The complete software image for a device may be large. The capacity of the broadcast engineering channel is very limited (c. 20 Mbytes/hour). If appropriate, manufacturers may split the core device software upgrade into two parts, the first containing the software necessary for all broadcast-related functions to operate normally as well as the functionality needed to upgrade the device over IP, and the second containing the software required for all other IP functions. If this is done, it is acceptable for software upgrades made available over the broadcast path to cover only the broadcast part of the

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software image, provided that the device can automatically download a complete upgrade when next connected to an IP network.

The user interface is a separate software-upgradable module. The IP upgrade mechanism for this will be managed by the platform and is described in the Consumer Device Software Management specification.

Devices shall be tolerant of power interruption at any time.

More detailed specification of the device upgrade requirements can be found in the Consumer Device Software Management specification.

2.12 Security

The device shall use a secure boot mechanism to ensure that only manufacturer-signed software images can be run on the device.

JTAG shall be disabled or password protected in production devices.

The device shall have a unique encryption key known to the manufacturer held securely and not available directly to the application CPU.

The device shall have a unique immutable ID available to software running on the box and known to the manufacturer. This ID shall not be the device's MAC address. The device shall have a unique RSA private key and corresponding X.509 certificate signed by the manufacturer. The RSA private key shall not be stored unencrypted in Flash memory or on the hard disk.

No key described above shall be present unencrypted in the device software image, nor in any device upgrade file or over-air download carousel.

The device shall be capable of supporting DTCP-IP.

Content protection mechanisms for broadcast-delivered content shall be as specified in D-Book 6.2.

Content protection mechanisms for IP-delivered content are still under consideration. Additional security features may be required once the content protection mechanisms have been defined.

2.13 Automatic reset

It is recommended that devices incorporate a hardware watchdog timer that will automatically reset the device in the event that the device software stops functioning.

2.14 Front panel buttons, indicators and displays

This specification does not specify any requirements for status indicator lights or information displays.

Where front panel indicator lights or displays are present, they shall not display information that is inconsistent with the standby state of the device (as perceived by the user) or with information shown in the UI.

Devices shall have a front panel standby button. Holding down the standby button shall force a reboot of the device.

Additional front panel buttons are optional. If front panel buttons are provided to duplicate the functions of remote control keys, the following set of keys will allow the operation of many device functions: standby, up, down, left, right, OK, back and the menu button (label TBD).

3 User Input Device

3.1 Technology

Devices shall support a conventional IR remote control. Other remote control technologies may also be supported.

3.2 Set of keys

The remote control shall have the following keys:

Function	Description	Status	Key labelling (mandatory)	DirectFB key symbol
On/Standby	To toggle between active and stand-by mode.	Mandatory	As D-Book 6.2 Section 25.3.1	DIKS_POWER when transitioning from ON to STANDBY mode. DIKS_POWER2 when transitioning from STANDBY to ON mode. Note: this event may not be generated if the device is in a low power mode when the key is pressed.
Return to sound and vision	Allow the user to immediately exit an interactive application, EPG or other user interaction function.	Mandatory	"close"	DIKS_TV
Menu	Display the top level user interface menu.	Mandatory	[TBC]	DIKS_MENU
Guide	Show the main programme guide.	Mandatory	"guide"	DIKS_EPG
Mute sound	Mute the audio output.	Mandatory	As D-Book 6.2 Section 25.3.	DIKS_MUTE
Help	Access contextual help	Mandatory	"help"	DIKS_HELP
Cursor control keys (Up, Down, Left, Right) ¹	Keys used to provide user interaction to a variety of device functions.	Mandatory	As D-Book 6.2 25.3.4.	DIKS_CURSOR_UP, DIKS_CURSOR_DOWN, DIKS_CURSOR_LEFT, DIKS_CURSOR_RIGHT
OK ¹	Allow the user to confirm or select a particular screen choice or action.	Mandatory	"OK"	DIKS_OK
Back	Allow the user to move back one step in an interactive application, EPG or other user interaction function.	Mandatory	"back"	DIKS_BACK
Volume up/down	Increase or decrease the audio level.	Mandatory	As D-Book 6.2 Section 25.3.12.	DIKS_VOLUME_UP, DIKS_VOLUME_DOWN
Channel up/down	Step up or down to the next service available to the user, normally ordered by number.	Mandatory	"ch+", "ch-"	DIKS_CHANNEL_UP, DIKS_CHANNEL_DOWN

¹ A combined control may be used, replacing the separate up, down, left, right and OK buttons. Such a control must generate the same key events as the individual buttons it replaces.

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Function	Description	Status	Key labelling (mandatory)	DirectFB key symbol
Text	Enter an interactive application while viewing a channel.	Mandatory	"text"	DIKS_TEXT
Info	Display programme information.	Mandatory	"i"	DIKS_INFO
Zoom	Accessibility and web view management	Mandatory	"zoom"	DIKS_ZOOM
DVR controls	Keys to control playback of recorded or streamed content.	Mandatory	Standard symbols for stop, play, rewind, fast forward, pause and record. As D-Book 6.2 Section 25.4.	DIKS_REWIND, DIKS_PLAY, DIKS_FASTFORWARD, DIKS_STOP, DIKS_PAUSE, DIKS_RECORD
DVR skip controls	Keys to skip forward and back by 30 seconds	Recommended	Standard symbols for skip forward and back.	DIKS_NEXT, DIKS_PREVIOUS
Red, Green, Yellow, Blue	Buttons available to device functions to aid user interaction. May also be used to enter an interactive application while viewing a channel.	Mandatory	As D-Book 6.2 Section 25.3.11.	DIKS_RED, DIKS_GREEN, DIKS_YELLOW, DIKS_BLUE
Numeric entry	Primarily for numeric entry but also labelled so as to support text entry.	Mandatory	"0", "1", "2", "3", "4", "5", "6", "7", "8", "9" plus secondary labelling to support text entry: " _", "@ [TBC], "abc", "def", "ghi", "jkl", "mno", "pqrs", "tuv", "wxyz"	DIKS_0 ... DIKS_9 with key <i>identifiers</i> set to the values DIKI_KP_0 through DIKI_KP_9
Dual function: Shift (during text entry) Audio Description (toggle)	Toggle upper and lower case text entry Enable/disable audio description	Mandatory	Dual label: Shift arrow symbol, and "AD"	DIKS_AUDIO
Dual function: Delete (during text entry) Subtitles (toggle)	Delete a character from a text field Enable/disable subtitles	Mandatory	Dual label: "del", and "subtitle" or "sub"	DIKS_SUBTITLE
Web Apps	Short cut to the Web Apps section of the UI	Recommended	"Web Apps" or "apps"	DIKS_F1
On Demand	Short cut to on demand section of the UI	Optional ¹	"on demand"	DIKS_F2
Provider On Demand	Short cut to a provider's portal	Optional ¹	[Provider name]	DIKS_F3
My Stuff	Short cut to the My Stuff section of the UI	Optional ¹	"My Stuff"	DIKS_F4

Any additional manufacturer-specific keys shall use DirectFB key symbols in the range DIKS_CUSTOM0 to DIKS_CUSTOM9.

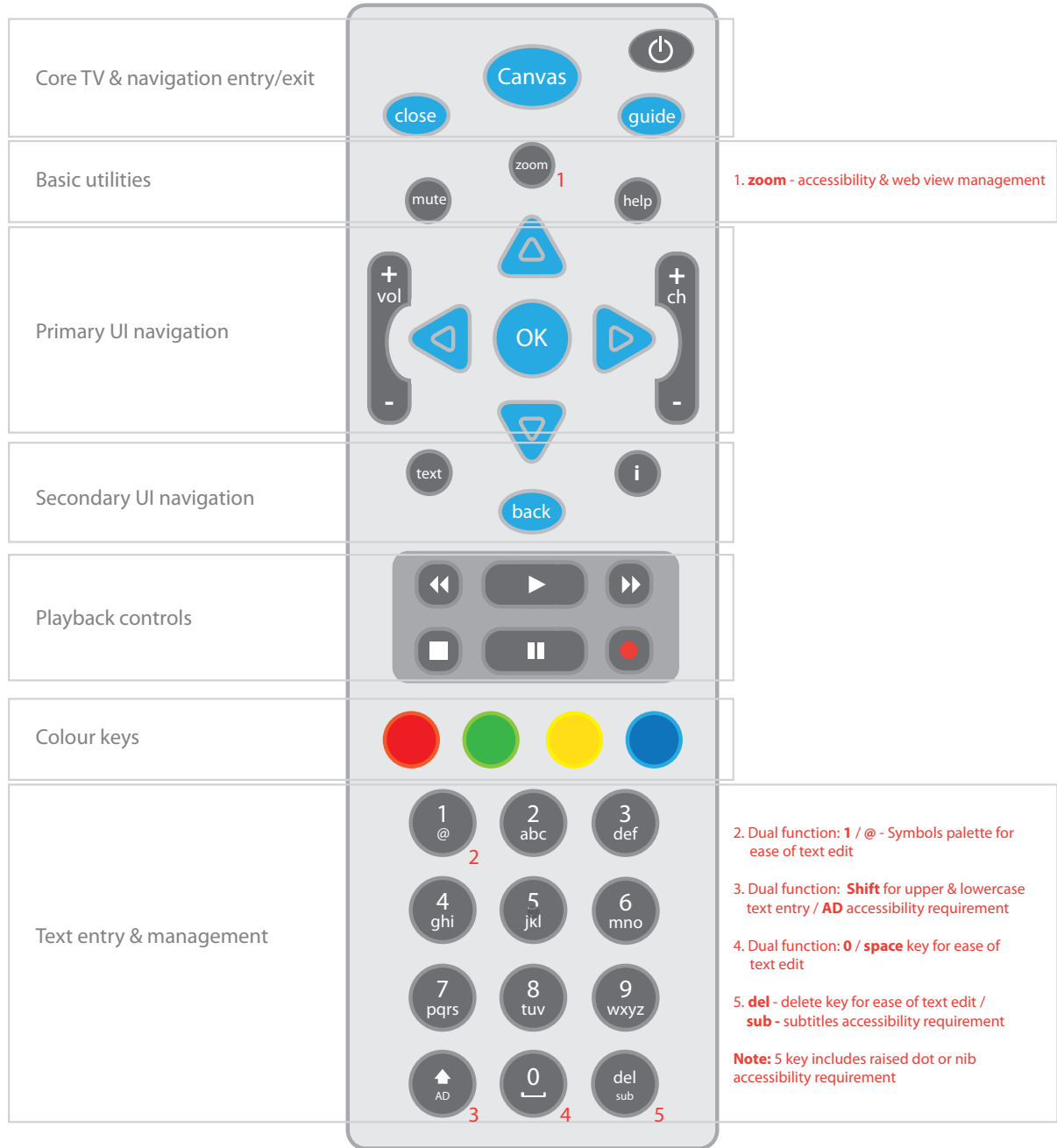
3.3 Key groupings

The illustration below shows an example remote control layout highlighting the groups of keys that will typically be used together. The layout shown here is not mandatory but keeping related keys together

¹ It is recommended that optional buttons are avoided where possible to reduce clutter and increase remote device usability
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will improve the usability of the remote control. In this illustration, the “Menu” function listed in section 3.2 has been labelled “Canvas”.



3.4 Additional control codes

In addition to the standby toggle function, the remote control code set shall include independent power on and power off control codes. This is to support the use of programmable remote controls.

These additional key codes shall generate the DIKS_POWER and DIKS_POWER2 DirectFB key events in the same manner as the ‘standby’ remote control key.

3.5 Physical requirements

The following physical requirements apply. (In some cases, example approaches to meeting the requirement are given; these are indications of best practice but are not mandatory, and the manufacturer may choose to meet the requirement in other appropriate ways.)

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- Keys shall be large and well separated (for example separated by 50% or more of button width).
- Adjacent keys shall be tactilely distinguishable (for example be raised or have raised edges).
- There shall be a raised dot or “nib” on the figure 5 key of the numeric pad.
- Keys shall be logically grouped by function and those functional groups should be separated by more than the distance between keys within each group. Different functions should also be distinguished by distinct shapes or texture.
- The remote should have no redundant keys
- The remote control shall have clear legible legends (in a sans serif font and as large as possible) and contrast with the keys and/or background.
- All labelling shall be durable and long-lasting (for example moulded into casing).
- Access to the remote’s battery compartment should be straightforward but child-proof.
- The remote shall be capable of single-handed operation by either hand, easy to grip and stable if placed on a flat surface. It should be non-slippery, for example by means of a textured finish.
- Care should be taken to ensure that the directional properties of the communications link from the remote control to the device are as wide-angle as possible.
- If batteries are supplied, they should provide a minimum lifetime of 12 months with typical remote control use.

3.6 Keyboard input

Key input events from any connected USB keyboard shall be mapped to DirectFB user input events in the same manner as for the standard DirectFB ‘keyboard’ and ‘linux_input’ drivers. The effect of this is that the key events for the numeric keypad keys will duplicate the number functions of the remote control whilst the ‘standard’ number keys will generate key identifiers that can be distinguished. This allows user interaction with the remote control to use a multi-tap text entry method whilst allowing a keyboard to generate both alphabetic and numeric key input directly.

Any other input device capable of generating alphanumeric input (such as a remote control providing a full alphanumeric keyboard) shall map alphanumeric keys in the same way. Input devices may use any *other* key symbols for text input purposes provided that they represent ASCII characters and do not correspond to any of the key symbols listed in section 3.2. Input events for such symbols may use any DirectFB key identifier and modifier values.

3.7 Key mapping for presentation engines

The present document does not specify the mapping of DirectFB key events to particular presentation engines.