Multicore Software Development Kit for Video and Analytics

Functional Specification

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Preface

About this Document

This document is part of a document set prepared in support of the Texas Instruments Software Customer Documentation A product release.

About the Document Set

Various books in the document set will be of interest to developers of voice-over-packet products according to their role:

- Project Managers
- Hardware Engineers
- Software Engineers
- Test Engineers
- Application Developers

The document set contains two kinds of documents:

- *Texas Instruments Software-Produced Documents*
- *Supporting Documents*

Texas Instruments Software-Produced Documents

The following Texas Instruments Software-produced documents are provided with this release:

Note—TI Software documentation may describe features and capabilities that are not supported in all product configurations or releases. See the Functional Specification for the complete list of features, capabilities, and configurations supported in this release.

- *Multicore Software Development Kit for Video and Analytics Functional Specification*

Supporting Documents

Supporting documents by Texas Instruments and third-party vendors are included in the documentation set for hardware and software that is integral to the release.

Supporting documents can include the following:

- Hardware data manuals, user guides, and schematics
- Software user guides, programming guides, and reference manuals
- Application notes and release notes

If supporting documents are provided with this release, a **Supporting Documents** category appears on the PDF menu.

How the Document Set is Distributed

Customer documentation for each release is normally contained in the **docs** folder of the software distribution. Open the file **main_menuTOC.pdf** to view the Main Menu and to access the documents in the set. The **_README.txt** file describes how to set up the documentation set as a standalone, searchable library.

Note—To do a global search on the PDF document set (which is enabled by the **SEARCH the Document Set** command in the navigation pane), you must have Adobe Reader 7.x or later installed on your computer.

Document Conventions

This document uses the following conventions:

- Commands and keywords are in **boldface** font.
- Arguments for which you supply values are in *italic* font.
- Terminal sessions and information the system displays are in `screen font`.
- Information you must enter is in **`boldface screen font`**.
- Elements in square brackets ([ ]) are optional.

Notes use the following conventions:

Note—Means reader take note. Notes contain helpful suggestions or references to material not covered in the publication.

The information in a caution or a warning is provided for your protection. Please read each caution and warning carefully.

CAUTION—Indicates the possibility of service interruption if precautions are not taken.

WARNING—Indicates the possibility of damage to equipment if precautions are not taken.

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List of Tables

Chapter 1

Video Codecs

Description A video codec is used to compress and decompress digitally sampled raw video mainly for the purpose of saving bandwidth. Video codecs are the prominent part of the Multicore Software Development Kit for Video and Analytics release. Release 2.2 leverages codec features as supported in the baseline release and focuses on creating pure C66x video codecs with platform software abstracted.

A list of supported Encoders is as follows:

- AVC1U Encoder
- H.264 High Profile Encoder
- JPEG2K Encoder
- JPEG Image Encoder
- MPEG-4/H.263 Simple Profile Encoder
- MPEG-2 Main Profile Encoder
- HEVC Encoder

A list of supported Decoders is as follows:

- H.264 Base Profile and Main Profile Decoder
- MPEG-4/H.263 Simple Profile Decoder
- MPEG-2 Main Profile Decoder
- H.264 High Profile Decoder
- JPEG2K Decoder
- JPEG Image Decoder
- HEVC Decoder

See the individual codec's data sheet and user guide to learn about supported features, memory foot print, performance, and static and dynamic configuration parameters.

Chapter 2

Packet Processing

2.1 Packetization

Description The Packetization unit is the front end of the packet network interface. Packetization is classified in different sub-functions, such as:

- Network encapsulation - To provide network termination and to support IP based encapsulation. Network encapsulation is the front end of packet processing from the network.
- Video packetization - To provide encapsulation and processing support for video payload with RTP protocol.
- Timed Text packetization - To provide encapsulation and processing support for to receive timed text and graphics for overlay

Performance Performance is measured through various protocol compliances

Standards Compliance

- RFC 3550
- RFC 3016
- RFC 3984
- RFC 2429
- RFC 2250
- RFC 4175
- RFC 4396

Limitations Provided in following subsections

Configuration Options Provided in following subsections

2.1.1 RTP Support

Description If the channel is configured for RTP operation, the data is encapsulated in accordance with the RFC 1889/3550 specification. The Multicore Software Development Kit for Video and Analytics software leverages RTP Support from Voice. Refer to TI MAS Spec.

2.1.2 RFC 3016 Support

Description RFC 3016 describes the RTP payload format for carrying each of MPEG-4 Audio and MPEG-4 Visual bit streams without using MPEG-4 systems. For the purpose of directly mapping MPEG-4 Audio/Visual bitstreams onto RTP packets, it provides specifications for the use of RTP header fields and also specifies fragmentation rules. It

also provides specifications for Multipurpose Internet Mail Extensions (MIME) type registrations and the use of Session Description Protocol (SDP). The TI software provides support for the capabilities defined by RFC 3016 as outlined in the Standard Compliance section below.

Performance Not applicable.

Standards Compliance

Table 2-1 RFC 3016 - RTP Payload Format for MPEG-4 Audio/Visual streams

Features/Sections	Capability Exists
MPEG-4 Audio RTP Payload Format, Section 1.2	No
Use of RTP header fields for MPEG4 Visual, Section 3.1	Yes
Fragmentation of MPEG-4 Visual bit stream, Section 3.2	Yes
RTP Packetization of MPEG-4 Audio bit stream, Section 4 and sub sections	No
MIME type Registration for MPEG-4 Audio/Visual streams, Section 5 and sub sections	No
Security Considerations, Section 6: Supported via RFC1889	Yes

Limitations Only MPEG-4 Visual is supported (Audio not supported) - as it is not needed in the MCSDK_Video DSP Application

Configuration Options Size of MTU

2.1.3 RFC 2429 Support

Description This document specifies an RTP payload header format applicable to the transmission of video streams generated based on the 1998 version of ITU-T Recommendation H.263. Because the 1998 version of H.263 is a superset of the 1996 syntax, this format can also be used with the 1996 version of H.263, and is recommended for this use by new implementations. The TI software provides support for the capabilities defined by RFC 2429 as outlined in the Standard Compliance section below.

Performance Not applicable.

Standards Compliance

Table 2-2 RFC 2429 - RTP Payload Format for 1998 Version of ITU-T Rec. H.263 Video (H.263+)

Features/Sections	Capability Exists
RTP Header Usage, Section 2.1	Yes
Video Packet Structure, Section 2.2	Yes
General H.263+ payload header, Section 4.1	Yes
Video Redundancy Coding Header Extension, Section 4.2	No
Picture Segment Packets and Sequence Ending Packets, Section 5.1	No
Packets that begin with a Picture Start Code, Section 5.1.1	No
Packets that begin with GBSC or SSC, Section 5.1.2	No
Packets that Begin with an EOS or EOSBS Code, Section 5.1.3	No
Encapsulating Follow-On Packet, Section 5.2	No
Use of this payload specification, Section 6	Yes
Security Considerations, Section 7: Supported via RFC1889	Yes

Limitations None

Configuration Options Size of MTU

2.1.4 RFC 3984 Support

Description This document specifies an RTP payload header format applicable to the ITU-T Recommendation H.264 video codec and the technically identical ISO/IEC International Standard 14496-10 video codec. The RTP payload format allows for packetization of one or more Network Abstraction Layer Units (NALUs), produced by an H.264 video encoder, in each RTP payload. The payload format has wide applicability, as it supports applications from simple low bit-rate conversational usage, to Internet video streaming with interleaved transmission, to high bit-rate video-on-demand. The TI software provides support for the capabilities defined by RFC 3984 as outlined in the Standard Compliance section below.

Performance Not applicable.

Standards Compliance

Table 2-3 RFC 3984 - RTP Payload Format for H.264 Video

Features/Sections	Capability Exists
Network Abstraction Layer Unit Types, Section 1.3	Yes
RTP Header Usage, Section 5.1	Yes
Common Structure of the RTP Payload Format, Section 5.2	Yes
NAL Unit Octet Usage, Section 5.3	Yes
Packetization Modes: Single NAL unit mode, Section 5.4	Yes/No
Decoding Order Number (DON), Section 5.5	No
Single NAL Unit Packet, Section 5.6	Yes
Aggregation Packets, Section 5.7	No
Single-Time Aggregation Packet, Section 5.7.1	No
Multi-Time Aggregation Packets (MTAPs), Section 5.7.2	No
Fragmentation Units (FUs), Section 5.8	Yes
Common Packetization Rules, Section 6.1	Yes
Single NAL Unit Mode, Section 6.2	Yes
Non-Interleaved Mode, Section 6.3	No
Interleaved Mode, Section 6.4	No
Single NAL Unit and Non-Interleaved Mode, Section 7.1	Yes
Interleaved Mode, Section 7.2	No
Size of the Deinterleaving Buffer, Section 7.2.1	No
Deinterleaving Process, Section 7.2.2	No
Additional De-Packetization Guidelines, Section 7.3	No
MIME Registration, Section 8.1	No
SDP Parameters, Section 8.2	No
Security Considerations, Section 9, Supported via RFC 1889	Yes
Congestion Control, Section 10	No

Limitations None

Configuration Options Size of MTU

2.1.5 RFC 2250 Support

Description This document specifies an RTP payload header format applicable for MPEG1/MPEG2 Video. The TI software provides support for the capabilities defined by RFC 2250 as outlined in the Standard Compliance section below.

Performance Not applicable.

Standards Compliance

Table 2-4 RFC 2250 - RTP Payload Format for MPEG-2 Video

Features/Sections	Capability Exists
RTP header usage, Section 2.1	Yes
MPEG Video elementary streams, Section 3.1	Yes
MPEG Audio elementary streams, Section 3.2	No
RTP Fixed Header for MPEG ES encapsulation, Section 3.3	Yes
MPEG Video-specific header, Section 3.4	Yes
MPEG-2 Video-specific header extension, Section 3.4.1	No
MPEG Audio-specific header, Section 3.5	No
Security Considerations, Section 4, Supported via RFC 1889	Yes

Limitations RFC2250 is supported only in from network direction.

Configuration Options Size of MTU

2.1.6 RFC 4175 Support

Description This document specifies an RTP payload header format for Uncompressed Video. The TI software provides support for the capabilities defined by RFC 4175 as outlined in the Standard Compliance section below.

Performance Not applicable.

Standards Compliance

Table 2-5 RFC 4175 - RTP Payload Format for Uncompressed Video

Features/Sections	Capability Exists
RTP Packetization, Section 4	Yes
The RTP Header, Section 4.1	Yes
Payload Header, Section 4.2	Yes
Payload Data, Section 4.3, Only 4:2:0 is supported	Yes/No
RTCP Considerations, Section 5: via RFC 3550	Yes
MIME type registration, Section 6.1	No
Parameter Registration, Section 6.2	No
Mapping MIME Parameters into SDP, Section 7	No
Security Considerations, Section 8	No

Limitations RFC4175 supports only YUV 4:2:0. Other formats are not supported

Configuration Options Size of MTU

2.1.7 RFC 4396 Support

Description This document specifies an RTP payload header format for 3rd Generation Partnership Project (3GPP) Timed Text. The TI software provides support for the capabilities defined by RFC 4396 as outlined in the Standard Compliance section below.

Performance Not applicable.

Standards Compliance

Table 2-6 RFC 4396 - RTP Payload Format for 3GPP Timed Text

Features/Sections	Capability Exists
Basic Components of the 3GPP Timed Text Media Format, Section 2.2	Yes
RTP Payload Format for 3GPP Timed Text, Section 4	Yes
Payload Header Definitions, Section 4.1	Yes
Common Payload Header Fields, Section 4.1.1	Yes
TYPE 1 Header, Section 4.1.2	Yes
TYPE 2 Header, Section 4.1.3	No
TYPE 3 Header, Section 4.1.4	No
TYPE 4 Header, Section 4.1.5	No
TYPE 5 Header, Section 4.1.6	No
Buffering of Sample Descriptions, Section 4.2	No
Dynamic SIDX Wraparound Mechanism, Section 4.2.1	No
Finding Payload Header Values in 3GP Files, Section 4.3	No
Fragmentation of Timed Text Samples, Section 4.4	No
Reassembling Text Samples at the Receiver, Section 4.5	No
On Aggregate Payloads, Section 4.6	No
Resilient Transport, Section 5	No
Congestion Control, Section 6	No
Text Rendering Position and Composition, Section 7.1	No
SMIL Usage, Section 7.2	No
Finding Layout Values in a 3GP File, Section 7.3	No
3GPP Timed Text Media Type, Section 8	No
SDP Usage, Section 9	No
Security Considerations, Section 11, Yes via RFC 3550	No

Limitations Sample descriptions are currently not supported.

2.2 Video Playout and Packetization Unit (VPPU)

Description Video Playout and Packetization Unit encapsulate all the RFCs needed by various Codecs and provide a unified interface to the application. VPPU is designed in a way to plug/play additional RFCs without changing the public interface. In addition to the support for RFCs, VPPU provides the following features:

- Accumulate multiple RTP packets arriving on the network, process the RFC headers and construct a Video Frame/NAL unit to feed to the decoder
- Fragment the Video Frame produced by the encoder based on the rules specified in the RFC and the MTU size and hand it over to the RTP protocol Unit for shipping the packet to the network
- RTP packet re-ordering
- Seamless switchover to a new stream (with a different sequence number)
- Delayed packet detection and purge frame(s)
- Detect packet loss
- Extensive statistics on network behavior

Performance Not applicable.

Standards Compliance Not applicable.

Limitations Not applicable.

Configuration Options Ability to select RFC

2.3 Multimedia Container Unit (MMCU)

Description Media is rarely stored as a single elementary audio or video stream. Instead, multiple elementary streams are muxed into a container stream with information for presenting the streams. This information includes details on the format of the elementary streams along with timing information for synchronizing the streams. There are also a variety of container formats that define how the elementary streams are muxed and demuxed to and from a media container. A list of the supported container formats is provided below.

Performance TBD

Supported Container Formats MPEG Transport Stream (MPEGTS)

Configuration Options For each container, it is configurable to select which elementary streams to demux from the container and which streams to discard.

Limitations None

2.4 TFTP Client Support

Description Trivial File Transfer Protocol (TFTP) is a simple protocol to transfer files. It has been implemented on top of the User Datagram Protocol (UDP) using port number 69. TFTP is designed to be small and easy to implement, therefore, lacks most of the features of a regular FTP. TFTP only reads and writes files (or mail) from/to a remote server. It cannot list directories, and currently has no provisions for user authentication.

Performance Not applicable.

Standards Compliance

- RFC 1350 - TFTP Protocol (revision 2)
- RFC 2347 - TFTP Option Extension
- RFC 2348 - TFTP Blocksize Option

Limitation None

Configuration Options TFTP blocksize (based on MTU size) and timeout interval.

Chapter 3

Image Resizing/Trans-sizing

Description The feature involves spatial resizing for video gateways. Video stream consists of multiple images so, video stream resizing is equivalent to resizing of individual images. Resolution change is necessary to allow video sharing between different varieties of video devices. Image size modification occurs for each plane, before stream encoding. Further color image resizing can be split into 3 resizing operations perhaps with different resolutions for each plane. Image resizing algorithms is from group of interpolation / decimation algorithms, Interpolation (up scaling, zooming-in) is equivalent to up-sampling coupled with low-pass filtering and Decimation (downscaling, zooming-out) is equivalent to low-pass filtering coupled with down-sampling.

Performance Refer to following subsections

Standards Compliance Not applicable.

Configuration Options Input width/height and output/desired width height and type of algorithm to be used to do resizing

Limitations Not applicable.

3.1 Bi-Cubic Resizing

Description Bi-cubic resizing algorithm is designed for general scaling operation without constraints.

Performance C version of implementation is available. The algorithm is not yet optimized for performance. 352x288 176x144, takes 3.5 MCPS/frame.

Standards Compliance Not applicable.

Configuration Options Not applicable.

Limitations Not applicable.

3.2 Polyphase Resizing

Description Polyphase resizing algorithm is designed for general scaling operation. It uses poly-phase FIR filters with 32 phases and 4 taps, based on Lanczos2 kernel. Increased number of phases allows better approximation of requested output dimension (only number of filter coefficients is increased - no MIPS penalty for real-time execution).

Performance

- 1280x720 1920x1080, takes 26.4 MCPS/frame (Filter (32 phase, 4 taps) design (once per input-output resolution pair) takes 0.71 MCPS)
- 1920x1080 1280x720, takes 18.8 MCPS/frame (Filter (32 phase, 4 taps) design (once per input-output resolution pair) takes 0.62 MCPS)
- 352x288 176x144, takes 0.65 MCPS/frame

Standards Compliance Not applicable.

Configuration Options Not applicable.

Limitations Not applicable

Chapter 4

Frame Rate Conversion

Description This feature allows conversion of one rate to another for video gateways. Frame rate conversion (FRC) is accomplished by frame repetition or frame dropping. RTP timestamp is used to determine the frame rate of incoming stream. The actual frame rate on wire (wire FPS) can be higher than the RTP time stamp indicated frame rate. While doing frame rate conversion, actual wire fps is ignored. What is considered is the RTP timestamp indicated playout frame rate. If this frame rate is different from the target frame rate specified on the encoder leg of transcoding, then the YUV frames are either repeated or dropped to meet the desired frame rate.

Performance Not applicable.

Standards Compliance Not applicable.

Configuration Options Input frame rate and output/desired frame rate

Limitations Not applicable.

Chapter 5

Video Transcoding

Description The Video Gateway supports transcoding, i.e., converting the coding format received as input to a different format before being sent out. Transcoding among all integrated codecs mentioned in Video Codecs is supported. Transcoding is expected to be done by chaining an encoder with a decoder. Encoder and decoder are loosely coupled.

There is no Motion Vector or any other auxiliary information passed between the decoder and encoder. Only YUV 4:2:0 data is exchanged between decoder and encoder and hence the term: loosely coupled encoder. Video resolutions of up to 1080p are supported. Number of channels on a given core is dependent on the codec combination and channel property chosen.

Performance Not applicable.

Standards Compliance Not applicable.

Configuration Options Not applicable

Limitations Not applicable

Chapter 6

Graphics/Text Overlay

Description Graphics/Text Overlay over a video stream is a feature where Images/Text can be overlaid on top of YUV (after decoder and before encoding) during the transcoding operation. The data to be overlaid can either be pre-downloaded to DSP or can be sent to DSP via an overlay server. The feature will support receiving both text and raw image/graphics data being received at the DSP from external server. Conversion of text content received from external source to YUV format will be done within the DSP. However in the case of raw graphics, media payload received at the DSP is expected to be in YUV format. The network encapsulation details will be based on the configuration provided to overlay channel by the application. The received data can then be alpha-blended on the Video Image.

Performance Not applicable.

Standards Compliance RFC 4396 will be used to receive basic text content from the overlay server. The first phase of the implementation will be limited to receiving Type-1 unit of the RFC which will allow receipt of text content. Additionally the text will be expected to be in UTF-8 format. Implementation does not have the text modifier support

RFC 4175 will be used to receive raw graphics YUV image from the external server.

Configuration Options For Raw Graphics, x and y location of the graphics to be overlaid can be configured. For Text overlay, text string can be configured.

Limitations The raw overlay image support will be limited to 4:2:0 YCbCr video format. Fragmented text content through RFC 4396 will not be supported. Maximum text length will be limited to 1400 bytes (MTU limit). Fragmented text content support will not be available.The functionality is supported only with in a core. In other words core to core overlay is not supported.

Chapter 7

Core to Core Transport for High Resolution

Description The processing power of one core is not enough to run complete transcode at higher resolutions. Hence, in BIOS MCSDK VIDEO, more than one core is employed to complete the transcode. Decoder runs on one core and Encoder runs on another core. YUV data is exchanged via DDR shared memory. Core to core communication is handled through BIOS message queues over IPC (Inter-Process Communication).

Performance Not applicable.

Standards Compliance Not applicable.

Configuration Options Connect request API takes care of connecting two legs even when they are in the same core of in different cores.

Limitations Not applicable

Chapter 8

Multicore Encoders and Decoders

Description The processing power of one core is not enough to run complete Encode or Decode operations at high resolutions in real time. Hence, in Multicore Software Development Kit for Video and Analytics more than one core can be employed to complete the Encode/Decode. Codec partitioning uses Master-Slave(s) strategy and could be a slice-based approach (e.g., H.264 HP Encoder) or pipeline-based approach (e.g., H.264 HP Decoder) or any other intermediate method. All Multicore Codecs adhere to ividMC or IVIDMC3 API. The functions necessary for multicore synchronization, memory allocation, and semaphores are supplied to the codec and the implementation of these functions is done in the framework/application.

Performance Not applicable.

Standards Compliance Not applicable.

Configuration Options Video mode API takes care of configuring Master/Slave when codec is partitioned across multiple cores.

Limitations Not applicable

Chapter 9

Multi-Device Encoders and Decoders

Description The processing power of one device may not be enough to perform real-time encoder and decoder operations. In such cases, multiple devices can be used to achieve real-time performance.

There are DSPC-8681 and DSPC-8682 cards that have four and eight devices respectively that can be plugged into PCIe and encode/decode operations can be offloaded to the DSP.

For more information, see the Developer Wiki on the product download page for MCSDK_Video_2.2.

Chapter 10

Video Analytics

Description The Digital Media Video Analytics Library (DMVAL) is an application-level library developed by TI that leverages the targeted processor architecture to analyze video and generate events in real-time. DMVAL features five video analytics solutions designed to be simple, useful, and reliable. Following algorithms are supported in the MCSDK Video release.

- Camera Tamper Detect (CTD)
- Object Counting (OC)
- Trip Zone (TZ)
- Intelligent Motion Detect (IMD)

Appendix A

Build Summary

The build summary lists the features supported by the SV04, SV05, VPPU, OVLY, TSU, or MMCU builds for the 2.2.0 release of Multicore Software Development Kit for Video and Analytics. An x in a column indicates if the feature is supported and the module where it is implemented. See Table A-1.

Table A-1 BIOS_MCSDK_VIDEO Functional Product Matrix

	Function	SV04	SV05	VPPU	OVLY	TSU	MMCU
1	Video Codecs	x					
2	Packet Processing	x	x	x			
2.1	Packetization			x			
2.1.1	RTP Support			x			
2.1.2	RFC 3016 Support			x			
2.1.3	RFC 2429 Support			x			
2.1.4	RFC 3984 Support			x			
2.1.5	RFC 2250 Support			x			
2.1.6	RFC 4175 Support			x			
2.1.7	RFC 4396 Support			x			
2.2	Video Playout and Packetization Unit (VPPU)			x			
2.3	Multimedia Container Unit (MMCU)						x
2.4	TFTP Client Support	x	x				
3	Image Resizing/Trans-sizing	x				x	
3.1	Bi-Cubic Resizing	x				x	
3.2	Polyphase Resizing	x				x	
4	Frame Rate Conversion						
5	Video Transcoding	x					
6	Graphics/Text Overlay	x			x		
7	Core to Core Transport for high resolution	x					
8	Multicore Encoders and Decoders	x			x		
9	Multi-Device Encoders and Decoders	x					
10	Video Analytics		x				