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Application Programmers Interface for WMV789 Decoder

ABSTRACT:

Application Programmers Interface WMV789 Decoder

KEYWORDS:

Multimedia codecs, WMV9, Windows Media Video

Revision History

VERSION	DATE	AUTHOR	CHANGE DESCRIPTION
0.1	04-Nov-2004	Debashis Sarkar	Initial Draft
0.2	13-Dec-2004	Debashis Sarkar	Updated after internal discussions
0.3	16-Dec-2004	Debashis Sarkar	Updated after review comments
0.4	29-Jan-2005	Debashis Sarkar	Updated after PCS review comments
0.5	06-May-2005	Anurag Goel	Updated performance numbers
1.0	26-May-2005	Prachi Bhatkar	Updated performance numbers
2.0	06-Feb-2006	Lauren Post	Using new format
2.1	31-Mar-2006	Prachi	Updated
2.2	11-Jan-2007	Abhishek	Updated the APIs to provide Padded or Non-Padded data to the application
2.3	20-June-2008	Eagle Zhou	Add API version information

Table of Contents

Introduction

This document describes the application programmer's interface of WMV9.0 video decoder library and its usage. The interface assumes that the input is not a bare WMV9 video bit stream, and relevant information from ASF format is available with the application.

1.1 Purpose

This document gives the application programmer's interface to WMV9 decoder library. End of the document contains an example application written using these APIs.

1.2 Scope

This document does not detail the implementation of this decoder. It only explains the functions and data structures exposed for the application developer to use the decoder library.

1.3 Audience Description

The reader is expected to have basic understanding of video processing and windows media video coding standard.

1.4 References

1.4.1 Standards

- WMV Version 9.0, Windows Media Video V9 Decoding Specification, revision 87
- WMT Version 9.0, Functional Specification, Recommended Media Decoding – rev 8.1.

1.4.2 References

- Arm codec coding guidelines
- Advanced System format (ASF) Specification, Revision 01.20.02, Microsoft Corporation, June 2004

1.4.3 Freescale Multimedia References

- WMV789 Decoder Requirements Book – wmv789_dec_reqb.doc
- WMV789 Decoder Test Plan – wmv789_dec_test_plan.doc
- WMV789 Decoder Release notes – wmv789_dec_release_notes.doc
- WMV789 Decoder Test Results – wmv789_dec_test_results.doc
- WMV789 Decoder Interface Header – wmv789_dec_api.h
- WMV789 Decoder Application Code – wmv789_testapp.c

1.5 Definitions, Acronyms, and Abbreviations

TERM/ACRONYM	DEFINITION
AVC	Advanced Video Coding
API	Application Programming Interface
ARM	Advanced RISC Machine
ASF	Advanced System Format,
FSL	Freescale
ISO	International Standards Organization
ITU	International Telecommunication Union
MPEG	Moving Pictures Expert Group
NAL	Network Abstraction Layer
RVDS	RealView Development Suite
SP	Simple Profile
RVDS	RealView Development Suite
TBD	To Be Determined
UNIX	Linux PC x/86 C-reference binaries
WMV	Windows Media Video

1.6 Document Location

docs/wmv789_dec

2 API Description

This section describes the data structures, enumerations and macros used in the WMV9 decoder library interface.

2.1 Data structures

This section describes the data structures used in the decoder interface. The basic data type definitions are given in section .

2.1.1 Basic data types

These are the typedefs for the basic data types.

```
typedef void      WMV9D_Void ;
typedef int       WMV9D_S32 ;
typedef unsigned int    WMV9D_U32 ;
typedef short int WMV9D_S16 ;
typedef short unsigned int    WMV9D_U16 ;
typedef char      WMV9D_S8 ;
typedef unsigned char   WMV9D_U8 ;
```

sWmv9DecObjectType

This is the main data structure which should be passed to all the decoder functions. The definition of the structure is given below.

```
typedef struct
{
   sWmv9DecMemAllocInfoType     sMemInfo;
   sWmv9DecParamsType           sDecParam;
   WMV9D_Void                   *pvWmv9Obj;
   WMV9D_Void                   *pvBitBuffer;
   WMV9D_Void                   *pvAppContext;
   FpWmv9DecReadCbkType         pfCbkBuffRead;
 } sWmv9DecObjectType;
```

Description of structure *sWmv9DecObjectType*

sMemInfo

This is memory information structure. This is further described later.

sDecParam

The output of the decoder is encapsulated in this structure. This is further described later.

pvWmv9Obj

This is an internal video object context for the decoder and application should not change this.

pvBitBuffer

This buffer is used for holding the bit stream data inside the library.

pvAppContext

This space is provided for the application to keep its context and the decoder does not

modify it. It is passed in the call back function to get the bit stream data.

pfCbkBuffRead

Function to be used for reading the bit stream data. For more information see section 2.3.6.

sWmv9DecMemAllocInfoType

This structure holds the memory block allocation information for decoder library. The decoder memory requirements are given to the application when *eWMV9DQuerymem* is called. The decoder specifies number of memory blocks needed by filling *s32NumReqs* in this structure. For each memory block, all parameters are set in asMemBlks array based on decoder requirement. Application shall allocate the memory required by looking at this structure before initializing the decoder.

```
typedef struct
{
       WMV9D_S32               s32NumReqs;
       sWmv9DecMemBlockType    asMemBlks[WMV9D_MAX_NUM_MEM_REQS];
} sWmv9DecMemAllocInfoType;
```

Description of the structure *sWmv9DecMemAllocInfoType*

s32NumReqs

Number of memory blocks required. Decoder will set this to required value when e*Wmv9DQuerymem* function is called.

asMemBlks

Array of memory block structure. For each request defined in *s32NumReqs* application should allocate the memory. To see how this information can be used, please see (Example library usage).

WMV9D_MAX_NUM_MEM_REQS is the maximum number of memory block requests the decoder can make. WMV9D_MAX_NUM_MEM_REQS has been set to 256.

sWmv9DecMemBlockType

This describes the memory block requirement details such as size, type etc. The application shall allocate memory depending on the requirement and set the pointer in the space provided. The library uses the memory given by the application.

```
typedef struct
{
     WMV9D_S32                 s32Size;
     WMV9D_S32                 s32MemType;
     WMV9D_S32                 s32Priority;
     eWmv9DecMemAlignType      eMemAlign;
     WMV9D_S32                 s32OldSize;
     WMV9D_S32                 s32MaxSize;
     WMV9D_Void                *pvUnalignedBuffer;
     WMV9D_Void                *pvBuffer;
} sWmv9DecMemBlockType;
```

Description of the structure *sWmv9DecMemBlockType*

s32Size

The actual size of the memory required (populated by the decoder).

s32MemType
: The type of memory needed. It can be one of slow/fast along with scratch/static memory. Please see the section Memory types to get the possible type of values (populated by the decoder).

s32Priority
: It suggests the importance of this memory block. Higher the impact of the speed of this memory on the decoder performance, lower will be the value (>0). Priorities are neither unique nor continuous (populated by the decoder).

eMemAlign
: Required alignment of the memory block. The values are defined in the Memory alignment section.(populated by the decoder).

s32OldSize
: Size of the block in the last allocation. It is useful only if the block is resized.

s32MaxSize
: This gives the maximum size that can be requested for this type. This is fixed on compile time, based on the maximum size supported. It is only useful if the application does not want to reallocate memory.

pvUnalignedBuffer
: This storage is provided to keep track of the unaligned buffer address (by the application). This is not used by the decoder.

pvBuffer
: This will be updated by the application based on the memory requirement. The decoder assumes that it contains a valid value of a buffer for the required size, type and alignment.

sWmv9DecParamsType

This defines the data structure for the decoder parameters. This structure is used to exchange multiple parameters between application and decoder.

```
typedef struct
{
    sWmv9DecYCbCrBufferType   sOutputBuffer;
    eWmv9DecCompFmtType       eCompressionFormat;
    WMV9D_S32                 s32FrameRate;
    WMV9D_S32                 s32BitRate;
    WMV9D_U16                 u16FrameWidth;
    WMV9D_U16                 u16FrameHeight;
    WMV9D_U32                 u32PrevFrameNum;
    WMV9D_U32                 u32CurrFrameNum;
    eWmv9DecVOPType           eVopType;
} sWmv9DecParamsType;
```

Description of the structure *sWmv9DecParamsType*

sOutputBuffer
: Decoded output is stored in this structure.

eCompressionFormat
: Compression format used to encode the sequence. This is set by the application.

s32FrameRate
: Frame rate of the bit stream to be decoded (if not known, set it to 0)

s32BitRate
: Bit rate of the bit stream to be decoded (if not known, set to 0).

u16FrameWidth
Width of the frame.
u16FrameHeight
Height of the frame.
u32PrevFrameNum
Assumed frame number of the previous frame. This is used to calculate the current frame number. For proper usage of this field, please see the Example library usage. This is set to u32CurFrameNum after decoding a frame, so that the application need not set it, unless there is a skip.
u32CurrFrameNum
Frame number of the current decoded frame, calculated from the u32PrevFrameNum, and number of frames skipped in the encoder. For proper usage of this field, please see the Example library usage.
eVopType
Type of the VOP of the last decoded frame.

sWmv9DecYCbCrBuferType

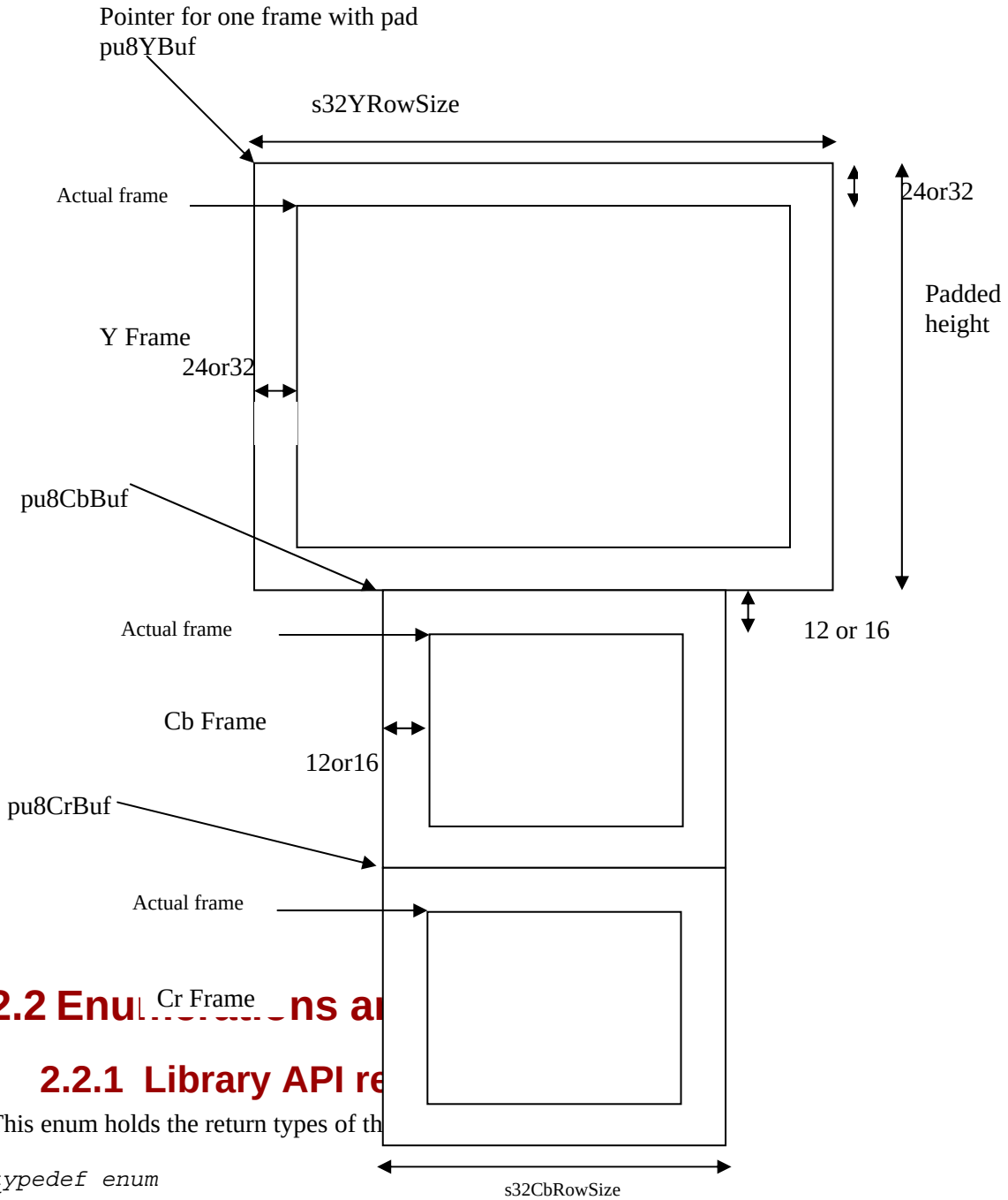
This structure encapsulates the YCbCr buffer, which stores the decoded frame in YUV 4:2:0 format, non-interleaved. The buffer addresses and row sizes shall be set by the decoder in *eWMV9DDecode* function. The values can be changed after each call of *eWMV9DDecode* function. As the pointers point inside the decoder data structure, application shall not modify the pointers or the content.

```
typedef struct
{
    const WMV9D_U8      *pu8YBuf;
    const WMV9D_U8      *pu8CbBuf;
    const WMV9D_U8      *pu8CrBuf;
    WMV9D_S32           s32YRowSize;
    WMV9D_S32           s32CbRowSize;
    WMV9D_S32           s32CrRowSize;
    tVideoFormat_WMC    tOutputFormat;
} sWmv9DecYCbCrBufferType;
```

Description of the structure *sWmv9DecYCbCrBufferType*
pu8YBuf
Buffer pointer to decoded frames Y data.
pu8CbBuf
Buffer pointer to decoded frames Cb data.
pu8CrBuf
Buffer pointer to decoded frames Cr data.
s32YRowSize
Offset in bytes between start pixels of two consecutive rows of Y.
s32CbRowSize
Offset in bytes between start pixels of two consecutive rows of Cb.
s32CrRowSize
Offset in bytes between start pixels of two consecutive rows of Cr.
tOutputFormat

Specifies the format of output data (YUV_420/ YUV_420_PADDED / UYVY_WMV)

Figure 1: Storage format and pointers for one padded output frame



2.2 Enu[illegible]ns ar

2.2.1 Library API re

This enum holds the return types of th

```
typedef enum
{
      /* Successfull return values */
      E_WMV9D_SUCCESS = 0,                    /* Successful completion
                                                 */
```

```
        /* Successful return with a warning, no action needs to be taken */
        E_ WMV9D _ERROR_CONCEALED = 11,       /* Error in the bit stream,
        but concealed */
        E_ WMV9D _ENDOF_BITSTREAM,            /* End of Bit Stream
                                              */

        /* Successful return with a warning, correct the situation and
        continue */
        E_WMV9D _NOT_ENOUGH_BITS=31,          /* Not enough bits are
        provided                              */
        E_WMV9D_BAD_MEMORY,                   /* Out of memory
                                              */
        E_WMV9D _WRONG_ALIGNMENT,             /* Incorrect memory alignment
                                              */
        E_WMV9D _SIZE_CHANGED,                /* Image size changed
                                              */
        E_WMV9D_NO_OUTPUT,                    /* No output frame is
        available                             */
        E_WMV9D_BROKEN_FRAME,                 /* Should have more data in
        this frame*/

        /* irrecoverable error type, may need re-initialization to continue
        */
        E_WMV9D_CORRUPTED_BITS=51,            /* Error bit stream
                                              */
        E_WMV9D_FAILED,                       /* Failure
                                              */
        E_WMV9D _UNSUPPORTED,                 /* Unsupported format
                                              */
        E_WMV9D_NO_KEYFRAME_DECODED,          /* first frame is not an I
        frame                                 */
        E_WMV9D _SIZE_NOT_FOUND,               /* Frame size not found in
        bit stream*/
        E_WMV9D _NOT_INITIALIZED,             /* Decoder is not initialized
                                              */
        E_WMV9D_INVALID_ARGUMENTS             /* Argument to the API is
        invalid                               */
} eWmv9DecRetType;
```

2.2.2 Memory alignment

This enumeration defines the memory alignment type.

```
typedef enum
{
   E_WMV9D_ALIGN_NONE = 0,                /* buffer can start at any place */
   E_ WMV9D_ALIGN_HALF_WORD,              /* start address's last bit has
   to be 0                                */
   E_ WMV9D_ALIGN_WORD,                   /* start address's last 2 bits
   has to be 0                            */
   E_WMV9D_ALIGN_DWORD,                  /* address's last 3 bits has to
   be 0             */
   E_WMV9D_ALIGN_QWORD,                  /* address's last 4 bits has to
   be 0             */
   E_WMV9D_ALIGN_OCTAWORD          /* address's last 5 bits has to be 0
   */
} eWmv9DecMemAlignType;
```

2.2.3 VOP types

This enumeration describes the encoding type of the VOP last decoded.

```
typedef enum
{
   E_WMV9D_INTRA_VOP,                    /* Intra VOP or I-VOP            */
   E_WMV9D_INTER_VOP,                    /* Inter VOP or P-VOP            */
   E_WMV9D_BIDIR_VOP,                          /* Bidirectional VOP or B-
   VOP               */
   E_WMV9D_UNKNOWN_VOP,                  /* Unknown, should not happen    */
} eWmv9DecVOPType;
```

2.2.4 Compression types

The following enumeration is used to specify the compression type that is supported by the decoder.

```
typedef enum
{
   E_WMV9D_COMP_FMT_WMV9,
   E_WMV9D_COMP_FMT_WMV8,
   E_WMV9D_COMP_FMT_WMV7,
   E_WMV9D_COMP_FMT_UNSUPPORTED
} eWmv9DecCompFmtType;
```

To facilitate the conversion of ASF file compression type to the required enumeration, library also provides a utility function to convert a string to the compression type.

*eWmv9DecCompFmtType eWMV9DCompFormat (**const WMV9D_U8*** *format);*

It returns the compression format enumeration from the string used in the ASF file format.

2.2.5 Output Format

```
typedef enum
{
   YUV_420=0,

   #ifdef OUTPUT_BUFFER_CHANGES
   YUV_420_PADDED,
   #endif


   #ifndef WMV9_SIMPLE_ONLY
   UYVY_WMV
   #endif

} tVideoFormat_WMC;
```

Specifies the format of the output data.

2.2.6 Memory types

The following defines specifies the memory types of the memory blocks requested by the decoder. As various properties are combined in single variable, please use the macros provided to extract the required value.

Speed of memory block
WMV9D_SLOW_MEMORY, WMV9D_FAST_MEMORY

Usage of memory block over API calls
WMV9D_STATIC_MEMORY,WMV9D_SCRATCH_MEMORY

Whether there is any size dependency, and if it is, whether we need to copy old data on resizing.
WMV9D_SIZE_DEPENDENT, WMV9D_SIZE_CHANGED, WMV9D_COPY_AT_RESIZE

To specify whether it contains ouput data
WMV9D_OUTPUT_MEMORY

The memory type will be a combination of these properties. Do not check the value directly, use the macros defined bellow instead.

WMV9D_IS_FAST_MEMORY(memType) Returns non zero, if memory type is fast.
WMV9D_IS_SLOW_MEMORY(memType) Returns non-zero, if memory type is slow.

WMV9D_IS_STATIC_MEMORY(memType) Returns non-zero, if memory type is static.
WMV9D_IS_SCRATCH_MEMORY(memType) Returns non-zero, if memory type is scratch.

WMV9D_IS_SIZE_DEPENDENT_MEMORY(memType)
Returns non-zero, if buffer is frame size dependent.

WMV9D_IS_SIZE_CHANGED(memType) Returns non-zero, if buffer size needs to be changed, since the last allocation happened.

WMV9D_COPY_AT_RESIZE(memType) Returns non-zero, if memory content has to be copied when the buffer is resized.

WMV9D_IS_OUTPUT_MEMORY(memType) Returns non-zero, if memory content is output data.

2.3 Application programmer interface functions

2.3.1 Query memory

This is the first function to be called by the application. This function returns the memory requirement for the decoder. The decoder will populate *psWmv9Obj->sMemInfo* structure based on width and height of the frame. The application shall use this information to allocate the requested memory blocks and set the pointers of *asMemBlks* in *psWmv9Obj->sMemInfo* structure to the memory block of required size, type & alignment.

C prototype:

```
eWmv9DecRetType  eWMV9DQuerymem (  sWmv9DecObjectType *psWmv9Obj,
                                   WMV9D_S32  s32Height,
                                   WMV9D_S32 s32Width);
```

Arguments:

- psWmv9Obj - Decoder object pointer
- s32Height - Height of the frame size of the sequence to be decoded
- s32Width - Width of the frame size of the sequence to be decoded

Return value:

eWmv9DecRetType Tells whether the decoder was successful to set the parameters needed for memory allocation.

Return values are -

E_WMV9D_SUCCESS - Function successful.
Other values - Error

2.3.2 Initialization

All initializations required for the decoder are done in e*WMV9DInit*. This function must be called before main decoder functions are invoked. This function also parses the sequence header, and uses the call back function to get the required data.

C prototype:

```
eWmv9DecRetType eWMV9DInit (sWmv9DecObjectType *psWmv9Obj);
```

Arguments:

- psWmv9Obj - Decoder object pointer.

Return value:

eWmv9DecRetType Tells whether decoder has been successfully initialized or not.

Return values are -

E_WMV9D_SUCCESS - Function successful.
Other values - Error

2.3.3 Decode a frame

This is the frame decoding function. It decodes the WMV bit stream to generate one frame of decoder output in every call.

C prototype:

```
eWmv9DecRetType eWMV9DDecode (sWmv9DecObjectType *psWmv9Obj,0
                              WMV9D_U32 u32FrameDataSize);
```

Arguments:

- psWmv9Obj - Decoder object pointer.
- u32FrameDataSize - Bit stream data size in bytes for this frame (or sequence header)

Return value:

eWmv9DecRetType Tells whether frames were decoded successfully or not.

Return values are:

E_WMV9D_SUCCESS - Function successful.
Other values - Error

2.3.4 Get output frame

This API gives the recently decoded frame output. In case of YUV_420 output format,

- It copies decoded video frame (after removing padded data) into a buffer allocated by the application.
- The pointers to the buffer allocated by the application must be populated on the structure members of *sWmv9DecYCbCrBufferType* (pu8YBuf, pu8CbBuf and pu8CrBuf).

In case of YUV_420_PADDED output format, this API sets the pointers pu8YBuf, pu8CbBuf and pu8CrBuf to point to the padded video frame buffers. This will be helpful if the application can handle removal of padded data using hardware.

C Prototype:

```
eWmv9DecRetType eWMV9DecGetOutputFrame (sWmv9DecObjectType *psWmv9Obj);
```

Arguments:

- psWmv9Obj - Decoder object pointer.

Return value:

eWmv9DecRetType Tells whether the output data is available.

Return values are -

E_WMV9D_SUCCESS - Function successful.
Other values - Error

2.3.5 Free decoder

This is the decoder function to release any resources used by the decoder. It doesn't free memory that has been allocated by the application on behalf of the decoder.

Prototype:

```
eWmv9DecRetType eWMV9DFree (sWmv9DecObjectType *psWmv9Obj);
```

Arguments:

- *psWmv9Obj* - Decoder object pointer.

Return value:

eWmv9DecRetType - Tells whether memory was freed successfully or not.

Return values are -
E_WMV9D_SUCCESS - Function successful.
Other values - Error

2.3.6 Input buffer callback interface

Input buffer callback function should be a synchronous function used by the decoder to read the portion of bit stream from the application. This function is called by the decoder in *eWMV9DInit* and *eWMV9DDecode* functions, when it needs the bit stream data. The decoder assumes that the application knows the end of the bit stream data for the current frame, and data returned is for current frame only. While initializing, only sequence header data should be returned.

This function is not a part of the library and has to be implemented by the application, user of the decoder library. Application developer has complete control on implementing this function based on his/her system requirements. The name of the function given is only for illustration purpose, and the application developer can name the function as he/she likes. The decoder cannot continue till this function returns with the required data. For example usage, see section Example library usage.

C prototype:

```
int  cbkWMV9BuffRead (int s32BufLen, unsigned char *pu8Buf,  int
                      *bEndOfFrame, void * pvAppContext);
```

Arguments:

- *s32BufLen* Length of the buffer provided.
- *pu8Buf* Pointer to the buffer.
- *bEndOfFrame* Set to 1, if no more data for the current frame (or sequence header) is available.
- *pvAppContext* Caller context, as set while initializing the decoder. It can be used to distinguish between calls from different decoding threads in multi-threaded environment.

Return value:

Returns the size of the buffer copied else return -1.

Note:
The function cbkWMV9BuffRead is in application space and can have any name. The function pointer in the sWmv9DecObject structure has to be initialized to this function.
sWmv9DecObjectType.pfCbkBuffRead = cbkWMV9BuffRead

2.3.7 Debug logging

Debug logs for the decoder can be enabled by setting the debug levels appropriately. They are described in debug.h file. The logs can be extracted with various debug level enabled depending on the need. Here are the list of levels and its meaning. These settings are compilation time options.

Table 1 Different debug levels

DEBUG_1	Data that occurs once per bitstream
DEBUG_2	Data that occurs once per VOP
DEBUG_3	Data that occurs once per MB
DEBUG_4	Data that occurs once per block

The debug log interface functions are defined in the log_api.h file, which is supplied with the library. The application should implement the specific logging functionality required, according to the interface.

2.3.7.1 Initializing debug log module

Prototype

```
int   DebugLogInit (void/* any parameter defined by the application*/);
```

2.3.7.2 Logging a data value

This function is used by the decoder to log a data value. Return value is ignored.

C prototype

```
int DebugLogData (short int msgid, void *ptr, int size);
```

Arguments

- *msgid* Message id for the particular codec/data type.
- *ptr* Memory where the data is present.
- *size* Data size in bytes.

2.3.7.3 Logging a text message

This function is used to log a text message, similar to printf format. Return value is ignored.

C prototype

```
int DebugLogText (short int msgid, char *fmt, ...);
```

Arguments

- *msgid* Message id for the particular codec/message type.
- *fmt* Format of the message, similar to *printf* function.
- … Any other arguments (possibly none) that the format specifies.

2.3.7.4 Closing debug logs

This function closes the debug logs. The function shall be called by the application after closing the decoder.

C prototype

```
int DebugLogClose();
```

2.3.8 API Version

This is the decoder function to get the API version information.

Prototype:

```
const char * WMV9DecCodecVersionInfo();
```

Arguments:

- *None*

Return value:

const char * The pointer to the constant char string of the version information string.

3 Example library usage

This example shows how to use the WMV9 decoder library. Here are the steps involved in a typical usage.

1. Get the memory requirement
2. Allocate the memory as required by the decoder.
3. Initialize the decoder
4. Allocate memory as per the requirements.
5. While there are more frames, decode and display the decoded frames.
6. Close the decoder.
7. Free any memory allocated for the decoder and application.

The encoded bit stream is fed through *cbkWMV9DBufRead* function. Please note that the error handling is not shown properly and the code may not compile as it is. Also, at few places only one field of a structure is set, while the application needs to set all the fields.

```
/********************** portion of the application code
************************/

sWmv9DecObject       sWmv9DecObj;   /* instance of a decoder */

/* Call QueryMem to get the size and the type of the memory needed by
the decoder */
error = eWMV9DQuerymem (&sWmv9DecObj, frameHeight, frameWidth);

/* Give memory to the decoder for the size, type and alignment
returned */
AllocateMemory (&sWmv9DecObj);

/* Set the call back function and app context, as Init uses these */
sWmv9DecObj.pfCbkWMV9BuffRead = cbkWMV9DBufRead;
sWmv9DecObj.pvAppContext = (void*)(&sWmv9DecObj);  /* or anything you
need */

/* Initialize the decoder. */
error = eWMV9DInit (&sWmv9DecObj);

/* Decode the bit stream and produce the outputs */
while (1) {

   /* Set the prevFrameNum, if required (FF/RW) */

   /* Decode one frame.*/
   error = eWMV9DDecode (psWmv9DecObj, s32NumBytes);

   error = eWMV9DecGetOutputFrame(&sWmv9DecObj);
   if (error != E_WMV9D_SUCCESS) {
      /* take care of abnormal return value. */
      break;
   }

   /* the current frame number is available at currFrameNum */
```

```
        /* The output frame is available on the YCbCr buffer. Application
          can access the buffer for post-processing (filtering / colour
          conversion / rotation / resizing). Make sure that the buffer is
          not corrupted as this will probably be used by the next decode
          call.
        */
        const unsigned char* pu8RowPtr =
          sWmv9DecObj.sDecParam.sOutputBuffer.pu8YBuf;
        s32RowSize = sWmv9DecObj.sDecParam.sOutputBuffer.s32YRowSize;

        for (row = 0; row < height; row++)
        {
            /* one row data from pu8RowPtr to pu8RowPtr + width */
            pu8RowPtr += s32RowSize;
        }
    }

    /* free the decoder */
    error = eWMV9DFree(&sWmv9DecObj);

    FreeMemory (&sWmv9DecObj);

/*************************************************************************
******
********************** End of the decoding a video bit stream
************************
*************************************************************************
*****/



/* function called by the decoder for reading the bitstream */
int cbkWMV9DBufRead (int s32BufLen, unsigned char *pu8Buf, int
                     *bEndOfFrame, void *pvAppContext)
{
    // Copy bit stream data to the buffer from the bit stream buffer to
decoder space
    // Set the bEndOfFrame to be 1, if there is no more data for this
frame or sequence header.
    // return the amount of data copied.
}

/* couple of helper function used in memory allocation */
void* AllocateFastMem (int s32NumBytes);
void* AllocateSlowMem (int s32NumBytes);
void* MemAllign(void* pvUnallignedBuf, eWmv9DecMemAlignType ememAlign);
void   MemCopy(const void* pvSrc, void* pvDst, s32NumBytes);
void   MemFree(void* pvBuffer);

/* Give memory to the decoder for the size, type and alignment returned
*/
void AllocateMemory (sWmv9DecObject  *psObj)
{
    sMemAllocInfo *psMemInfo = &psObj->sMemInfo;

    for (i = 0; i < psMemInfo->s32NumReqs ; i++) {

        sWmv9DecMemBlock* curBlk = psMemInfo->asMemBlks + i;

        memType = curBlk->type;
```

```
      if (WMV9D_IS_SIZE_CHANGED(memType)) {

         /* See if we need to allocate new memory buffer */
         if (curBlk->size > 0)
         {
            /* allocate the memory fast */
            if (WMV9D_IS_FAST_MEMORY(memType))
               tempBuf = AllocateFastMem (curBlk->size);
            else
               tempBuf = AllocateSlowMem (curBlk->size);

            /* Now align the memory for the requested alignment */
            alignBuf = MemAlign (tempBuf, curBlk->eMemAlign);
         } else
            alignBuf = tempBuf = NULL;

         /* if required copy the data from the old place */
         if (curBlk->pvBuffer != NULL)
         {
            if (WMV9D_COPY_AT_RESIZE(memType))
               MemCopy (curBlk->pvBuffer, alignBuf, smaller of two
sizes);

            /* free the old buffer */
            MemFree (currBlk->pvUnalignedBuffer);
         }

         /* Set the new buffer */
         currBlk->pvUnalignedBuffer = tempBuf;
         curBlk->pvBuffer = alignBuf;

      }  /* if current blocks size has been changed */
   }  /* for each valid entry in the array */
}

/* function to free the memory allocated for the decoder */
void FreeMemeory (sWmv9DecObject  *psObj)
{
   sMemAllocInfo *psMemInfo = &psObj->sMemInfo;

   for (i = 0; i < psMemInfo->s32NumReqs ; i++) {
      sWmv9DecMemBlock* curBlk = psMemInfo->asMemBlks + i;
      if (curBlk->size > 0)
         free (curBlk->pvUnalignedBuffer);
   }
}
```

4 Performance and resource usage

In this section the cycle consumption and the resource usage by the decoder is described. Simulation was done using ARM1136J-S processor, the configuration is as follows.

Table 2 Configuration for performance measurement

ARMulator Specifications for ARM 1136J-S	
Processor Type	ARMv6
Processor Speed	266MHz
I-Cache Size	16KB
D-Cache Size	16KB
External Memory Access Speed (First/ Subsequent)	1/1cycle

The performance recorded in the simulations is listed below. The performance numbers include the test application overhead. All the streams are taken from the Microsoft provided test set.

Table 3 Performance numbers for WMV9, QCIF sequences, at 96 kbps, 15fps

Sequence	RVDS 2.1	CCM[1]
kelsyville_96Kbps_QCIF_15fps.rcv	14.59 MHz (Actual)	

Table 4 Performance numbers for WMV8, QCIF sequences at 56kbps, 30,fps

Sequence	RVDS 2.1	CCM
medley_qcif_56.rcv	21.73 MHz (Actual)	

Table 5 Performance numbers for WMV9, CIF sequence, at 384 kbps 15fps

Test case	RVDS 2.1	CCM
kelsyville_384Kbps_CIF_15fps.rcv	67.07 MHz (Actual)	

Table 6 Memory usage by the decoder library (Program and static memory)

Program ROM	ROM tables	Data RAM	Peak stack
168 Kb	35 Kb		1060

[1] Currently CCM is not working properly with the given application.

Table 7 Dynamic memory requirements (WMV9 only)[2]

Image Size	Without frames	Decoder frame memory	Total Dynamic memory
QCIF	125 KB	147 KB	278 KB
CIF	280 KB	440 KB	720 KB

[1] It does not include the frame buffer managed by the application and input bit stream buffer

[2] It does not include the frame buffer managed by the application and input bit stream buffer