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Overview
Intel® Media Software Development Kit – SDK is a software development library that exposes the media acceleration capabilities of Intel platforms for decoding, encoding and video processing. The API library covers a wide range of Intel platforms.

This document describes SDK extension to support Multi-view Video Coding (MVC).

Document Conventions
The SDK API uses the Verdana typeface for normal prose. With the exception of section headings and the table of contents, all code-related items appear in the Courier New typeface.

Acronyms and Abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDK</td>
<td>Intel® Media Software Development Kit – SDK</td>
</tr>
<tr>
<td>API</td>
<td>Application Programming Interface</td>
</tr>
<tr>
<td>MVC</td>
<td>Multi-view Video Coding</td>
</tr>
<tr>
<td>H.264</td>
<td>ITU*-T H.264, Advanced Video Coding</td>
</tr>
</tbody>
</table>

Related Documents
ITU*-T H.264: The ITU-T H.264 specification: “Advanced video coding for generic audiovisual services”

Architecture & Programming Guide
SDK extension for multiple view video coding requires the application to use an additional include file mfxmvc.h, in addition to the regular SDK include files. No additional library is needed at the link time.

Include these files:
```
#include "mfxvideo.h" /* SDK functions in C */
#include "mfxvideo++.h" /* Optional for C++ development */
#include "mfxmvc.h" /* Multiview Video Coding development */
```

Link to this library:
```
libmfx.lib /* The SDK dispatcher library */
```

The SDK supports MVC as a natural extension of the H.264 codec. The application can identify MVC encoding and decoding by the codec identifier **MFX_CODEC_AVC** and one of the profiles below:

- **MFX_PROFILE_AVC_MULTIVIEW_HIGH** Multi-view high profile
- **MFX_PROFILE_AVC_STEREO_HIGH** Stereo high profile

The SDK considers each view (or temporal representation) of a frame picture a separate processing unit. The SDK decoder outputs one view at a time. The video processor and the encoder process one view at a time. The SDK maintains state within the library so that the SDK decoding, video processing and encoding functions process/generate all views of the current picture in sequence, before process/generate the next picture.

Decoding Procedure
The SDK MVC decoder operates on complete MVC streams that contain all view/temporal configurations. The application can configure the SDK decoder to generate a subset at the decoding output. To do this, the application needs to understand the stream structure and based on such information configure the SDK decoder for target views.

The decoder initialization procedure is as follows:

- The application calls the **MFXVideoDECODE_DecodeHeader** function to obtain the stream structural information. This is actually done in two sub-steps:
  - The application calls the **MFXVideoDECODE_DecodeHeader** function with the **mfxExtMVCSeqDesc** structure attached to the **mfxVideoParam** structure. Do not allocate memory for the arrays in the **mfxExtMVCSeqDesc** structure just yet. Set the **View**, **ViewId** and **OP** pointers to **NULL** and set **NumViewAlloc**, **NumViewIdAlloc** and **NumOPAlloc** to **zero**. The function parses the bitstream and returns **MFX_ERR_NOT_ENOUGH_BUFFER** with the correct values **NumView**, **NumViewId** and **NumOP**.
  - The step can be skipped if the application is able to obtain the **NumView**, **NumViewId** and **NumOP** values from other sources.
- The application allocates memory for the **View**, **ViewId** and **OP** arrays and calls the **MFXVideoDECODE_DecodeHeader** function again. The function returns the MVC structural information in the allocated arrays.
- The application initializes the SDK decoder using the **MFXVideoDECODE_Init** function. The application must attach both the **mfxExtMVCSeqDesc** structure and the **mfxExtMvcTargetViews** structure to the **mfxVideoParam** structure.

In the above steps, do not modify the values of the **mfxExtMVCSeqDesc** structure after the **MFXVideoDECODE_DecodeHeader** function, as the SDK decoder uses the values in the structure for internal memory allocation.

Once the application configures the SDK decoder, the rest decoding procedure remains unchanged. As illustrated in Example 1, the application calls the **MFXVideoDECODE_DecodeFrameAsync** function multiple times to obtain all target views of the current frame picture, one target view at a time. The target view is identified by the **FrameID** field of the **mfxFrameInfo** structure. See the **SDK Developer Reference** for additional details of the decoding procedure.

Example 1: Pseudo Code of the Decoding Procedure
Video Processing Procedure

The SDK video processing supports processing multiple views. For video processing initialization, the application needs to attach the `mfxExtMVCSeqDesc` structure to the `mfxVideoParam` structure and call the `MFXVideoVPP_Init` function. The function saves the view identifiers.

During video processing, the SDK processes each view independently, one view at a time. The SDK refers to the `FrameID` field of the `mfxFrameInfo` structure to configure each view according to its processing pipeline. The application needs to fill the `FrameID` field before calling the `MFXVideoVPP_RunFrameVPPAsync` function, if the video processing source frame is not the output from the SDK MVC decoder.

Example 2 shows the video processing procedure pseudo code. See the SDK Developer Reference for additional details of the video processing procedure.

Example 2: Pseudo Code of the Video Processing Procedure

```c
/* create sequence description */
mfxExtBuffer *eb;
mfxExtMVCSeqDesc  seq_desc;
mfxVideoParam init_param;

init_param.ExtParam = &eb;
init_param.NumExtParam = 1;
eb = &seq_desc;

/* init VPP */
MFXVideoVPP_Init(session, &init_param);

/* perform processing */
for (;;) {
    MFXVideoVPP_RunFrameVPPAsync(session, in, out, aux, &syncp);
    MFXVideoCORE_SyncOperation(session, &syncp, INFINITE);
}

/* close VPP */
MFXVideoVPP_Close(session);
```

Encoding Procedure

Similar to the decoding and video processing initialization procedures, the application attaches the `mfxExtMVCSeqDesc` structure to the `mfxVideoParam` structure for encoding initialization. The `mfxExtMVCSeqDesc` structure configures the SDK MVC encoder to work in three modes:

- **Default dependency mode:** The application specifies `NumView` and all other fields zero. The SDK encoder creates a single operation point with all views (view identifier `0…NumView-1`) as target views. The first view (view identifier `0`) is the base view. Other views depend on the base view.
- **Explicit dependency mode:** The application specifies `NumView` and the `View` dependency array, and sets all other fields to zero. The SDK encoder creates a single operation point with all views (view identifier `View[0…NumView-1].ViewId`) as target views. The first view (view identifier `View[0].ViewId`) is the base view. The view dependencies follow the `View` dependency structures.
- **Complete mode:** The application specifies the views and their dependencies. The SDK encoder generates a bitstream with corresponding stream structures.

The SDK MVC encoder does not support importing sequence and picture headers via the `mfxExtCodingOptionSPSPPS` structure, or configuring reference frame list via the `mfxExtRefListCtrl` structure.
During encoding, the SDK encoding function `MFXVideoENCODE_EncodeFrameAsync` accumulates input frames until encoding of a picture is possible. The function returns `MFX_ERR_MORE_DATA` for more data at input or `MFX_ERR_NONE` if having successfully accumulated enough data for encoding of a picture. The generated bitstream contains the complete picture (multiple views).

The application can change this behavior and instruct encoder to output each view in a separate bitstream buffer. To do so the application has to turn on the `ViewOutput` flag in the `mfxExtCodingOption` structure. In this case, encoder returns `MFX_ERR_MORE_BITSTREAM` if it needs more bitstream buffers at output and `MFX_ERR_NONE` when processing of picture (multiple views) has been finished. It is recommended that the application provides a new input frame each time the SDK encoder requests new bitstream buffer.

The application must submit views data for encoding in the order they are described in the `mfxExtMVCSeqDesc` structure. Particular view data can be submitted for encoding only when all views that it depends upon have already been submitted.

Example 3 shows the encoding procedure pseudo code. See the **SDK Developer Reference** for additional details of the encoding procedure.

**Example 3: Pseudo Code of the Encoding Procedure**
```c
/* create sequence description */
mfxExtBuffer *eb;
mfxExtMVCSeqDesc seq_desc;
mfxVideoParam init_param;
init_param.ExtParam=&eb;
init_param.NumExtParam=1;
eb=&seq_desc;

/* init encoder */
MFXVideoENCODE_Init(session, &init_param);

/* perform encoding */
for (;;) {
    MFXVideoENCODE_EncodeFrameAsync(session, NULL, surface2, bits, &syncp);
    MFXVideoCORE_SyncOperation(session,syncp,INFINITE);
}

/* close encoder */
MFXVideoENCODE_Close();
```

**Structure Reference**

### mfxFrameId

**Definition**

```c
typedef struct {
    mfxU16    TemporalID;
    mfxU16    PriorityID;
    union {
        mfxU16    reserved[2];
        mfxU16    ViewID;
    };
} mfxFrameId;
```

**Description**

The `mfxFrameId` describes the view and layer of a frame picture.

**Members**

- **TemporalID**: The temporal identifier as defined in the annex H of the ITU-T H.264 specification.
- **PriorityID**: Reserved and must be zero.
- **ViewID**: The view identifier as defined in the annex H of the ITU-T H.264 specification.

**Change History**

This structure is available since SDK API 1.3.

### mfxFrameInfo

**Definition**

```c
typedef struct {
    mfxU32      reserved[6];
    mfxFrameId  FrameID;
    mfxU32      FourCC;
    ...;
} mfxFrameInfo;
```

**Description**

The `mfxFrameInfo` structure is extended to describe additionally the frame view information. Other fields remain unchanged. See the **SDK Developer Reference** for additional structure descriptions.

**Members**
The **mfxFrameId** structure to describe the frame view information. **FrameID** is ignored when used in the **mfxVideoParam** structure.

**Change History**

This structure is available since SDK API 1.0. SDK 1.3 extended the structure to include the frame view description.

### mfxMVCViewDependency

**Definition**

```c
typedef struct {
    mfxU16    ViewId;
    mfxU16    NumAnchorRefsL0;
    mfxU16    NumAnchorRefsL1;
    mfxU16    AnchorRefL0[16];
    mfxU16    AnchorRefL1[16];
    mfxU16    NumNonAnchorRefsL0;
    mfxU16    NumNonAnchorRefsL1;
    mfxU16    NonAnchorRefL0[16];
    mfxU16    NonAnchorRefL1[16];
} mfxMVCViewDependency;
```

**Description**

This **mfxMVCViewDependency** structure describes MVC view dependencies.

**Members**

- **ViewId**: View identifier of this dependency structure
- **NumAnchorRefsL0**: Number of view components for inter-view prediction in the initial reference picture list RefPicList0 for anchor view components
- **NumAnchorRefsL1**: Number of view components for inter-view prediction in the initial reference picture list RefPicList1 for anchor view components
- **AnchorRefL0**: View identifiers of the view components for inter-view prediction in the initial reference picture list RefPicList0 for anchor view components
- **AnchorRefL1**: View identifiers of the view components for inter-view prediction in the initial reference picture list RefPicList1 for anchor view components
- **NumNonAnchorRefsL0**: Number of view components for inter-view prediction in the initial reference picture list RefPicList0 for non-anchor view components
- **NumNonAnchorRefsL1**: Number of view components for inter-view prediction in the initial reference picture list RefPicList1 for non-anchor view components
- **NonAnchorRefL0**: View identifiers of the view components for inter-view prediction in the initial reference picture list RefPicList0 for non-anchor view components
- **NonAnchorRefL1**: View identifiers of the view components for inter-view prediction in the initial reference picture list RefPicList1 for non-anchor view components

**Change History**

This structure is available since SDK API 1.3.

### mfxMVCOperationPoint

**Definition**

```c
typedef struct {
    mfxU16    TemporalId;
    mfxU16    LevelIdc;
    mfxU16    NumViews;
    mfxU16    NumTargetViews;
    mfxU16    *TargetViewId;
} mfxMVCOperationPoint;
```

**Description**

The **mfxMVCOperationPoint** structure describes the MVC operation point.

**Members**

- **TemporalId**: Temporal identifier of the operation point
- **LevelIdc**: Level value signaled for the operation point
- **NumViews**: Number of views required for decoding the target output views corresponding to the operation point
- **NumTargetViews**: Number of target output views for the operation point
- **TargetViewId**: View identifiers of the target output views for operation point

**Change History**

This structure is available since SDK API 1.3.

### mfxExtMVCSeqDesc

**Definition**
typedef struct {
    mfxExtBuffer Header;
    mfxU32   NumView;
    mfxU32   NumViewAlloc;
    mfxMVCViewDependency *View;
    mfxU32   NumViewId;
    mfxU32   NumViewIdAlloc;
    mfxU16   *ViewId;
    mfxU32   NumOP;
    mfxU32   NumOPAlloc;
    mfxMVCOperationPoint *OP;
    mfxU16   NumRefsTotal;
    mfxU32   Reserved[16];
} mfxExtMVCSeqDesc;

Description
The mfxExtMVCSeqDesc structure describes the MVC stream information of view dependencies, view identifiers, and operation points. See the ITU-T H.264 specification chapter H.7.3.2.1.4 for details.

Members
- Header.BufferId: Must be set to MFX_EXTBUFF_MVC_SEQUENCE_DESCRIPTION
- NumView: Number of views
- NumViewAlloc: The allocated view dependency array size
- View: Pointer to a list of the mfxMVCViewDependency structure
- NumViewId: Number of view identifiers
- NumViewIdAlloc: The allocated view identifier array size
- ViewId: Pointer to a list of view identifier
- NumOP: Number of operation points
- NumOPAlloc: The allocated operation point array size
- OP: Pointer to a list of the mfxMVCOperationPoint structure
- NumRefsTotal: Total number of reference frames in all views required to decode the stream. This value is returned from the MFXVideoDECODE_Decodeheader function. Do not modify this value.

Change History
This structure is available since SDK API 1.3.

mfxExtMvcTargetViews
Definition
typedef struct {
    mfxExtBuffer    Header;
    mfxU16        TemporalID;
    mfxU32        NumView;
    mfxU16        ViewID[1024];
} mfxExtMvcTargetViews;

Description
The mfxExtMvcTargetViews structure configures views for the decoding output.

Members
- Header.BufferId: Must be MFX_EXTBUFF_MVC_TARGET_VIEWS
- TemporalID: The temporal identifier to be decoded
- NumView: The number of views to be decoded
- ViewID: List of view identifiers to be decoded

Change History
This structure is available since SDK API 1.3.

Enumerator Reference
CodecProfile
Description
The CodecProfile enumerator is extended to support MVC profiles. See the SDK Developer Reference for additional profile definitions.

Name/Description
MFX_PROFILE_AVC_MULTIVIEW_HIGH, MFX_PROFILE_AVC_STEREO_HIGH MVC profiles

Change History
This enumerator is available since SDK API 1.0. SDK API 1.3 added MVC profiles.
**ExtendedBufferID**

**Description**

The `ExtendedBufferID` enumerator is extended to add MVC support. See the *SDK Developer Reference* for additional definitions.

**Name/Description**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFX_EXTBUFF_MVC_SEQUENCE_DESCRIPTION</td>
<td>This extended buffer describes stream structures. See the <code>mfxExtMVCSeqDesc</code> structure for details. The application can attach this buffer to the <code>mfxVideoParam</code> structure for encoding, decoding and video processing initialization.</td>
</tr>
<tr>
<td>MFX_EXTBUFF_MVC_TARGET_VIEWS</td>
<td>This extended buffer defines target views at the decoder output. See the <code>mfxExtMVCTargetViews</code> structure for details. The application can attach this buffer to the <code>mfxVideoParam</code> structure for decoding initialization.</td>
</tr>
</tbody>
</table>

**Change History**

This enumerator is available since SDK API 1.0. See additional change history in the structure definitions.