REALTEK

AN0301

Multimedia Framework v2

Abstract

Purpose of AN0301 document is to describes Multimedia Framework of AmebaPro SDK. This framework integrates multiple units such as Video, Audio, Network, Storage, and media streams which are passed or stored between these units.

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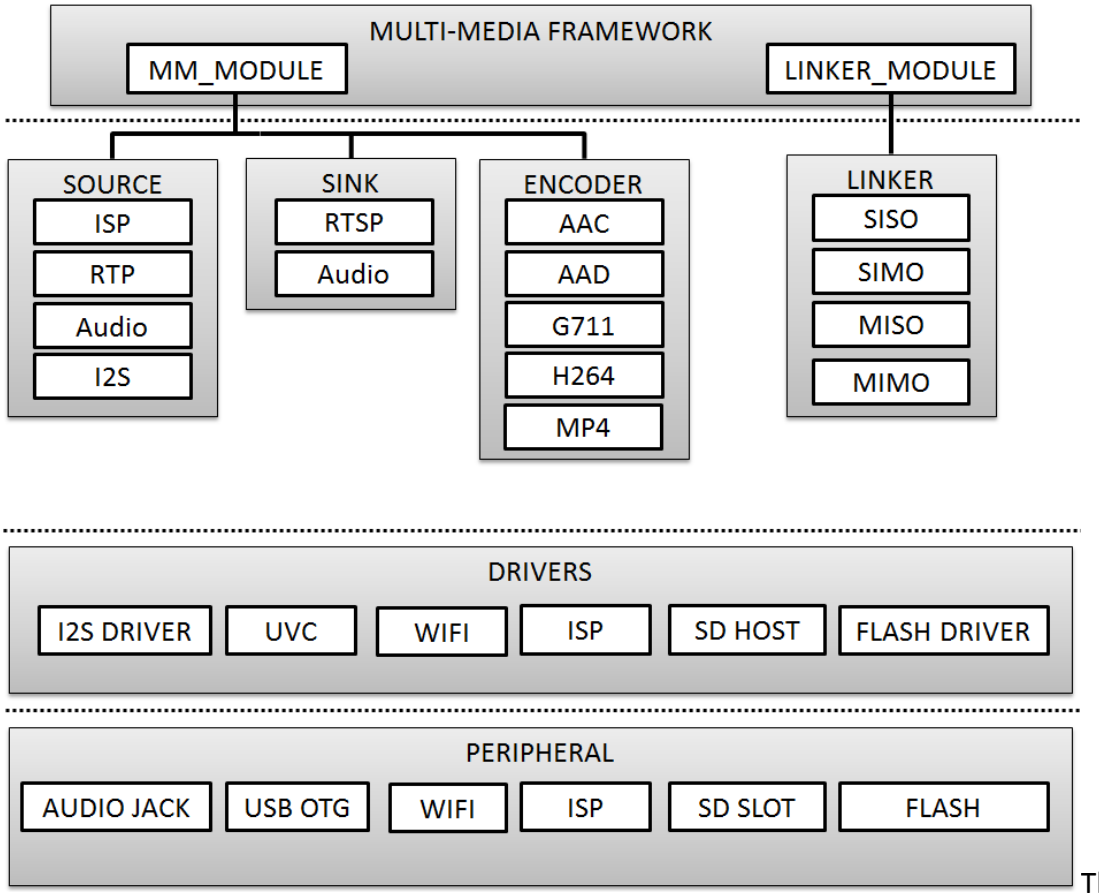
1 Multimedia Framework Architecture

The Multimedia Framework Architecture version 2(MMFv2) is responsible for handling the connection and management of different media resources on AmebaPro.

1.1 Architecture



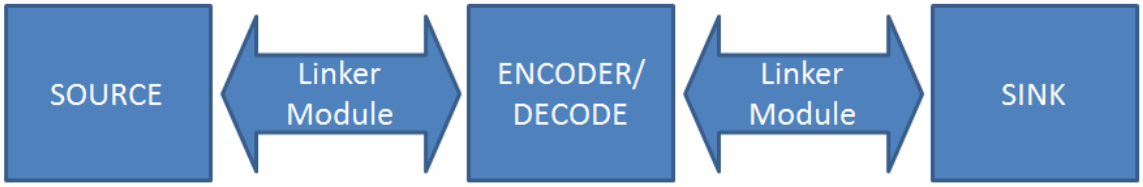
The structure of MMFv2 is as shown in the following chart :

There are two important entities in the MMFv2. One is MM_MODULE(the source, sink and decode/encode module are one of MM_MODULE), which source produces resource and the sink consumes the resource produce by source module. The source can be the file input, microphone, camera, and or storage, and the sink can be RTSP or other stream. The other is LINKER_MODULE which connect different type of module and deal with inter module communication.

In order to use the MMFv2, the following aspects must be followed.

- Define a valid source.
- Define a valid sink.
- Define a valid encoder/decoder if needed.
- Define a valid link module.

The main usage flow is to initialize different MM_MODULE, and connect different MM_MODULE through LINKER_MODULE.



1.1.1 Module

MMFv2 allows users to define customized source, sink and encoder/decoder modules depending on the application. Although implementation details may be different, however basic rules of thefor MMF structure should be a little bit similar.

MMF module

MMFv2 requires users to predefine both source and sink modules through implement create, destroy, control, handle, new_item, del_item and rsz_item function callbacks. mmf_module_t provides the interface for communication between mmf modules. In order to maintain the flexibility and convenience between modules, modules only retain the interface of each type to provide module to access. Function's constant of each module is defined by module itself.

```
typedef struct mm_module_s{
        void*       (*create)(void*);
        void*       (*destroy)(void*);
        int         (*control)(void*, int, int);
        int         (*handle)(void*, void*, void*);
        void*       (*new_item)(void*);
        void*       (*del_item)(void*, void*);
        void*       (*rsz_item)(void*, void*, int);
        uint32_t    output_type;
        uint32_t    module_type;
        char*       name;
}mm_module_t;
```

Function description

create

Pointer to the function that loads and initializes the module that you wish to add. For example, for ISP source, it points to the function in which the ISP driver is initialized and the corresponding context is returned.

destroy

Pointer to the function that de-initializes module instance and releases resource. For example, for ISP source, it points to function in which ISP driver is de-initialized and the corresponding context is released.

control

Pointer to function that sends the control command to the MMF module layer or a specific module. For example, for ISP source, it points to function that controls ISP parameters (“frame height”, “frame width”, “framerate”, etc.) and MMFv2 service task on or off.

handle

Pointer to the function that manipulates media data (how to produce data in source or how to consume data in sink). Data is transferred from source to sink and vice versa by means of OS message queue. Please note that MMF service task reacts differently based on message exchange buffer status.

new_item

Pointer to the function that create queue item that will be send to input and output queue, only will be used when setting MM_CMD_INIT_QUEUE_ITEMS to MMQI_FLAG_STATIC.

del_item

Pointer to the function that destroy queue item, only will be used when setting MM_CMD_INIT_QUEUE_ITEMS to MMQI_FLAG_STATIC.

rsz_item

Pointer to the function decrease memory pool size, only will be used when h264 and aac module is created.

output_type and module_type

Output_type indicates output mode. There are MM_TYPE_NONE, MM_TYPE_VSRC, MM_TYPE_ASRC, MM_TYPE_VDSP, MM_TYPE_ADSP, MM_TYPE_VSINK, MM_TYPE_ASINK, and MM_TYPE_AVSINK can be used, corresponding to different module usage scenarios, let application know which mode the output is. module_type represents the identity of the module, and there are three option can be used MM_MASK_SRC, MM_MASK_DSP and MM_MASK_SINK.

name

Pointer to the module name.

1.1.2 Context

MMFv2 context supply message transfer between different modules. It contains mm_module_t, and queue that used to pass data. There are 6 types of status that mm_context support(MM_STAT_INIT, MM_STAT_READY, MM_STAT_ERROR, MM_STAT_ERR_MALLOC,MM_STAT_ERR_QUEUE, MM_STAT_ERR_NEWITEM),these status are responsible for maintaining the module state to ensure the program runs smoothly.

```
typedef struct mm_contex_s{
    xQueueHandle    output_ready;
    xQueueHandle    output_recycle;
    mm_module_t*    module;
    void*           priv;     // private data structure for created instance
    uint32_t        state;    // module state
}mm_context_t;
```

mm_contex is responsible for maintaining each module entity. MMFv2 default support these module (isp, h264, jpeg, aac_encoder, aac_decoder, amebapro_audio, g711, mp4, rtp, rtsp). Each module is independent and corresponding to the individual input/ output queue, state and in the mm_context of the module to update parameters and delivery entities.

1.1.3 Module Inter Connection

This section introduces mm_siso_t, mm_simo_t, mm_miso_t, mm_mimo_t and its corresponding create, delete, ctrl, start, stop, pause, resume function, which is responsible for connection and control between modules in mmfv2.

SISO module (Single Input Single Output)

```
typedef struct mm_siso_s{
    mm_context_t      *input;
    mm_context_t      *output;
    uint32_t          status;
    uint32_t          stack_size;
    xTaskHandle       task;
}mm_siso_t;
```

The SISO module is a unidirectional interface between modules. Input and output are independent. The state of the SISO module is responsible for determining the correct process. The stack_size is used to determine the size of the handler, and xTaskHandle task is reserved to control the use of the task.

There are several functions in the SISO module that are responsible for the module inter-connection. These functions are mostly used to update the status of the task and are handed over to the task handler for the main processing:

siso_create

Pointer to the function that siso_create declares the space of mm_siso_t and returns mm_siso_t entity after initialization.

siso_delete

Pointer to the function stops SISO execution and free space of mm_siso_t entity.

siso_ctrl

Pointer to the function sends the control command to siso module.
There are three types of operations MMIC_CMD_ADD_INPUT, MIC_CMD_ADD_OUTPUT, MMIC_CMD_SET_STACKSIZE.
MMIC_CMD_ADD_INPUT link the input module to the input of the siso module, MMIC_CMD_ADD_OUTPUT link the output module to the output of the siso module, and MMIC_CMD_SET_STACKSIZE add size to the stack_size of siso.

siso_start

Pointer to the function checks whether there is anything in the input and output module before siso start. If the answer is yes, siso task will create a task handler to send data from input module to the output module.

siso_stop

Pointer to the function updates status to MMIC_STAT_SET_EXIT and wait for task handler to switch status to MMIC_STAT_EXIT.

siso_pause

Pointer to the function updates status to MMIC_STAT_SET_PAUSE and wait for task handler to switch status to MMIC_STAT_PAUSE.

siso_resume

Pointer to the function updates status to MMIC_STAT_SET_RUN and wait for the task handler to switch status to MMIC_STAT_RUN.

SIMO module (Single Input Multiple Output)

```
typedef struct mm_simo_s{
    mm_context_t      *input;
    int               output_cnt;
    mm_context_t      *output[4];

    // internal queue to handle reference count and usage log
    mm_simo_queue_t   queue;
    uint32_t          status[4];
    uint32_t          stack_size;
    xTaskHandle       task[4];
}mm_simo_t;
```

The SIMO module is a unidirectional interface between modules. Input and output are independent, and output_cnt represents the number of simultaneous output modules. status[4] maintains the state of the SIMO module to confer the process is correct in the middle of the transfer, stack_size is used to determine the size of the handler task for intermediate transfers, and the xTaskHandle task of xTaskCreate is reserved to control the use of the task.

There are several functions in the SIMO module that are responsible for the module inter-connection. These functions are mostly used to update the state of the task and are handed over to the task handler for the main processing:

simo_create

Pointer to the function that simo_create declares the space of mm_simo_t entity and returns mm_siso_t after initialization, and simo_create crate a queue head and queue.lock to protect the results of multiple outputs.

simo_delete

Pointer to the function calls simo_stop() to stop SIMO execution and free space.

simo_ctrl

Pointer to the function sends the control command to simo module.
There are six types of operations, MMIC_CMD_ADD_INPUT link the input module to the input of the simo module. MMIC_CMD_ADD_OUTPUT0, MMIC_CMD_ADD_OUTPUT1, MMIC_CMD_ADD_OUTPUT2, MMIC_CMD_ADD_OUTPUT3 link output module to the corresponding output and increase the output_cnt to record number of output modules.
MMIC_CMD_SET_STACKSIZE add size to simo stack_size.

simo_start

Pointer to the function that simo_start will create corresponding number of task handlers based on simo -> output_cnt, and each task handler will be used to send the received data.

simo_stop

Pointer to the function that simo_stop sets each simo status to MMIC_STAT_SET_EXIT,and waits for the task handler to switch each status to MMIC_STAT_EXIT.

simo_pause

Pointer to the function that simo_pause will set each simo -> status to MMIC_STAT_SET_PAUSE according to pause_mask, and wait for the task handler to switch each status to MMIC_STAT_PAUSE.

simo_resume

Pointer to the function that simo_resume will set each simo -> status to MMIC_STAT_SET_RUN, and wait for the task handler to switch each status to MMIC_STAT_RUN.

MISO module (Multiple Input Single Output)

```
typedef struct mm_miso_s{
    int             input_cnt;
    mm_context_t    *input[4];  // max 4 input
    mm_context_t    *output;
    uint32_t        status;
    uint32_t        stack_size;
    xTaskHandle     task;
}mm_miso_t;
```

The MISO module is a unidirectional interface between modules. Input and output are independent, and input_cnt represents the number of simultaneous input modules. status[4] maintains the state of the MISO module to confer the process is correct in the middle of the transfer, stack_size is used to determine the size of the handler task for intermediate transfers, and the xTaskHandle task of xTaskCreate is reserved to control the use of the task.

There are several functions in the MISO module that are responsible for the module inter-connection. Most of these functions update the state of the task and hand over to the task handler for the main processing:

miso_create

Pointer to the function that space of mm_miso_t is declared in miso_create and initialized to return mm_miso_t entity.

miso_delete

Pointer to the function that calls miso_stop() to stop MISO and free space.

miso_ctrl

Pointer to the function sends the control command to miso module. There are six operating can be use. MMIC_CMD_ADD_INPUT0, MMIC_CMD_ADD_INPUT1, MMIC_CMD_ADD_INPUT2, MMIC_CMD_ADD_INPUT3 link input module to the corresponding miso input and increase the value of input_cnt for number of input module. MMIC_CMD_ADD_OUTPUT links the output module to the output of the miso module.

the input module coupled to the input miso module and to increase the value of the number of recording input_cnt input module, MMIC_CMD_ADD_OUTPUT the output The module is linked to the output of the miso module, and MMIC_CMD_SET_STACKSIZE adds the size to the stack_size of the miso. MMIC_CMD_SET_STACKSIZE adds size to the stack_size of miso.

miso_start

Pointer to the function checks whether there is anything in the input and output module before starting. If the answer is yes, a task handler will be created, and the data of the input module will be sent to the output module.

miso_stop

Pointer to the function sets the miso status to MMIC_STAT_SET_EXIT and wait for the task handler to switch the status to MMIC_STAT_EXIT.

miso_pause

Pointer to the function that miso_pause will set miso -> status to MMIC_STAT_SET_PAUSE according to pause_mask, waiting for the task handler to switch status to MMIC_STAT_PAUSE.

miso _resume

Pointer to the function that miso_resume will set miso -> status to MMIC_STAT_SET_RUN, waiting for the task handler to switch each status to MMIC_STAT_RUN.

MIMO module (Multiple Input Multiple Output)

```
typedef struct mm_mimo_s{
    int               input_cnt;          // depend on intput count
    mm_context_t      *input[4];
    mm_mimo_queue_t   queue[4];
    int               output_cnt;         // depend on output count
    mm_context_t      *output[4];         // output module context
    uint32_t          output_dep[4];      // output depend on which input, bit mask
    uint32_t          input_mask[4];      // convert from output_dep, input
                                             referenced by which output, bit mask
    uint32_t          status[4];
    uint32_t          stack_size;
    xTaskHandle       task[4];
}mm_mimo_t;
```

The MIMO module is a unidirectional interface between modules, Input[4] and output[4] represent input and output modules respectively, and input_cnt represents the number of simultaneous input modules. Input and output support up to 4 outputs at the same time, MIMO module also needs mm_mimo_queue_t queue[4] to maintain the synchronization problem of each input queue. Each mm_mimo_queue_t has a lock and head to record the beginning of each queue and whether a program is already in use. status[4] maintains the state of the MIMO module to determine the correct process in the middle of the transfer, stack_size is used to determine the size of the handler task for the intermediate transfer, and the xTaskHandle task of xTaskCreate is reserved to control the use of the task.

mimo_create

Pointer to the function mimo_create declares the space of mm_mimo_t entity and returns mm_mimo_t after initialization.

miso_delete

Pointer to the function calls mimo_stop() to stop the mimo module and free space.

mimo_ctrl

Pointer to the function sends the control command to miso module. There are nine available operations (MMIC_CMD_ADD_INPUT0, MMIC_CMD_ADD_INPUT1, MMIC_CMD_ADD_INPUT2, MMIC_CMD_ADD_INPUT3, MMIC_CMD_ADD_OUTPUT0, MMIC_CMD_ADD_OUTPUT1, MMIC_CMD_ADD_OUTPUT2, MMIC_CMD_ADD_OUTPUT3, MMIC_CMD_SET_STACKSIZE) in mimo_ctrl function. MMIC_CMD_ADD_INPUT0, MMIC_CMD_ADD_INPUT1, MMIC_CMD_ADD_INPUT2, and

MMIC_CMD_ADD_INPUT3 link input module to the input corresponding to the mimo module and increase the value of input_cnt to record the number of input modules. MMIC_CMD_ADD_OUTPUT0, MMIC_CMD_ADD_OUTPUT1, MMIC_CMD_ADD_OUTPUT2, and MMIC_CMD_ADD_OUTPUT3 link the output module to the output of the mimo module and increase the value of output_cnt to record the number of output modules. MMIC_CMD_SET_STACKSIZE adds size to the stack_size of mimo.

mimo_start

Pointer to the function that mimo_start will generate corresponding task handler according to output_cnt to transfer the received data.

mimo_stop

Pointer to the function that mimo_stop will set the mimo status to MMIC_STAT_SET_EXIT according to output_cnt, and waiting for the task handler switch the status to MMIC_STAT_EXIT.

mimo_pause

Pointer to the function that miso_pause will set each mimo -> status to MMIC_STAT_SET_PAUSE according to pause_mask, and waiting for the task handler to switch status to MMIC_STAT_PAUSE.

mimo _resume

Pointer to the function that mimo_resume will set mimo -> status in the task of MMIC_STAT_PAUSE for each status to MMIC_STAT_SET_RUN, and waiting for the task handler to switch each status to MMIC_STAT_RUN.

1.2 Module Type and Module Parameter

MMFv2 Example supports many application scenarios, and the module parameter also supports manual adjustment. The reader will be able to understand the meaning and setting of different module parameters through this chapter.

1.2.1 ISP

```
isp_params_t isp_v1_params = {
        .width    = V1_WIDTH,
        .height   = V1_HEIGHT,
        .fps      = V1_FPS,
        .slot_num = V1_HW_SLOT,
        .buff_num = V1_SW_SLOT,
        .format   = ISP_FORMAT_YUV420_SEMIPLANAR,
        .boot_mode = ISP_NORMAL_BOOT
};
```

- Resolution ： Supports settings up to 1080P
- FPS ： DROP FRAME mechanism settings, detailed description as below
- HW_SLOT ： Maximum support 4
- SW_SLOT ： Which contains the number of HW_SLOT, the rest will be used as a buffer
- Format ： Currently only support YUV420
- Boot mode ： Which divided into ISP_FAST_BOOT and ISP_NORMAL_BOOT, the former can support the ISP to initialize the speed in BOOT TIME, the latter initializes the ISP settings after the BOOT CODE is completed. If you want FAST BOOT, you need to set the ISP parameters first, but only support one to set one way isp.

```
CINIT_DATA_SECTION isp_boot_stream_t isp_boot_stream = {
        .width = V1_WIDTH,
        .height = V1_HEIGHT,
        .isp_id = 0,
        .hw_slot_num = V1_HW_SLOT,
        .fps = V1_FPS,
        .format = ISP_FORMAT_YUV420_SEMIPLANAR,
        .pin_idx = ISP_PIN_SEL_S0,
        .mode = ISP_FAST_BOOT,
        .interface = ISP_INTERFACE_MIPI
        .clk = SENSOR_CLK_USE
        .sensor_fps = SENSOR_FPS,
};
```

- PIN_IDX : Default set PIN_IDX to ISP_PIN_SEL_S0
- MODE : If isp_boot_stream_t.mode is ISP_FAST_BOOT, the MODE here must also be set to ISP_FAST_BOOT. The two parameters must be set the same.
- INTERFACE : Currently preset MIPI, also supports DVP interface
- CLK: Use the SENSOR.H header to choose the sensor.
- SENSOR_FPS : Select the preset SENSOR FRAME according to SENSOR.H

> *Video/ Audio/ ISP parameters are not arbitrarily adjustable. On RTOS systems, resource configuration requires actuarial. Please adjust within the recommended range.*

About file size calculation, current default ISP output format is YUV420. Assuming current resolution is 1080P, FRAME size is 1920*1080*1.5 = 3110400 bytes. If HW_SLOT = 2, SW_SLOT=4, then the memory size that be consumed is 3110400*4 = 12441600 bytes. Regarding the SLOT number setting, it is currently recommended that HW_SLOT be set to 2, and SW_SLOT will be determined according to the FPS size. If it is set to 4 for 30FPS, it is set to 3 if 15FPS is recommended.

There are two types of FRAME RATE settings here. The first one is to set the FRAME RATE of SENSOR itself. The second one is to set the required FRAME RATE through DROP FRAME mode, but it can't exceed the FRAME RATE of SENSOR itself. If the SENSOR FPS is 30, you can lose one at a time, that is, 30, you can lose one for two, it is 15, you can lose one for three, four because you can't divide it, so it can't support to set, and so on. You can get support frame rate is set to 30, 15, 10, 5, 1

Note on the simultaneous operation of ISP CHANNEL:
1. Do not initialize ISP CHANNEL at the same time. You need to wait for one of CHANNEL settings to continue setting other ISP CHANNEL.
2. Do not switch ISP CHANNEL at the same time. You need to wait for one of CHANNEL settings to continue setting other ISP CHANNEL.

To use ISP FAST BOOT, initialize the ISP_BOOT_STREAM parameter is needed, set the variable SECTION to CINIT, and change the mode of the two parameters to ISP_FAST_BOOT_MODE.ISP FAST BOOT will set up ISP parameters before BOOT CODE, than enter main program. The main purpose is to mount the ISP IRQ CALLBACK, which can be received before the first frame. Other program initialization steps need to be executed later. For related settings, please refer to the example to enable ISP_BOOT_MODE_ENABLE Flag. We can choose the path from mp4 , rtsp or mux to see the result. The follow is set from mp4.

```
#define CONFIG_EXAMPLE_MEDIA_FRAMEWORK
1
#if CONFIG_EXAMPLE_MEDIA_FRAMEWORK
#define FATFS_DISK_SD                                                    1
#define ISP_BOOT_MODE_ENABLE                                                1
#if ISP_BOOT_MODE_ENABLE
#define ISP_BOOT_MP4                                                        0
#define ISP_BOOT_RTSP                                                       0
#define ISP_BOOT_MUX                                                        1
#if (ISP_BOOT_MP4 == 1 && ISP_BOOT_RTSP == 1 && ISP_BOOT_MUX == 1) ||
(ISP_BOOT_MP4 == 0 && ISP_BOOT_RTSP == 0 && ISP_BOOT_MUX == 0)
#error "It only can select the mp4 or rtsp"
#endif
```

1.2.2 H264

```
h264_params_t h264_v1_params = {
        .width          = V1_WIDTH,
        .height         = V1_HEIGHT,
        .bps            = V1_BITRATE,
        .fps            = V1_FPS,
        .gop            = V1_FPS,
        .rc_mode        = V1_H264_RCMODE,
        .mem_total_size = V1_BUFFER_SIZE,
        .mem_block_size = V1_BLOCK_SIZE,
        .mem_frame_size = V1_FRAME_SIZE
};
```

- Width : video width
- Height : video length
- BPS : Bit per second(Bit data transmitted per second)
- FPS : Frame per second(Number of frames transmitted per second)
- GOP : Grout of picture(How many frames are updated per I Frame)
- RC MODE : Rate control mode(currently available CBR, VBR, FIXQP and Rate Adaptive)
- Mem_total_size : H264 encoder memory size capacity
- Mem_block_size ： Block size used by Memory pool
- Men_frame_size : Set a maximum FRAME SIZE capacity

Rate Control Adjustment.

CBR:

- Fixed bit rate, bit rate is controlled by V1_BITRATE.
- QP range default value is [10, 10, 51].
- If there is an adjustment requirement in the [minQp, minIQp, maxQp] control of h264_rc_parm_t in module_h264.h, use API h264_control, the example is as follows (minIQp is I frame QP.)

VBR:

- The bit rate is changed by V1_BITRATE. When the screen is still, it will automatically adjust to 1/2 bit rate. When the screen changes, it will exceed V1_BITRATE. The excess amplitude is controlled by maxQp. The larger the maxQp, the smaller the bit rate is.
- QP range default value is [24, 24, 36]

ABR:

- ABR is a long-term average, and the principle is similar to CBR, which allows the bit rate to be significantly exceeded by the preset V1_BITRATE when the picture is changed. The excess amplitude is controlled by maxQp. The difference with CBR is that it does not force the bit rate immediately when the picture changes, but takes a long time average. The difference with VBR is that the picture is not automatically adjusted to 1/2 bit rate when the picture is still.
- QP range default value is [24, 24, 36]

1.2.3 JPEG

```
jpeg_params_t jpeg_v3_params = {
        .width          = V3_WIDTH,
        .height         = V3_HEIGHT,
        .level          = V3_JPEG_LEVEL,
        .fps            = V3_FPS,
        .mem_total_size = V3_BUFFER_SIZE,
        .mem_block_size = V3_BLOCK_SIZE,
        .mem_frame_size = V3_FRAME_SIZE
};
```

- Width : Image width
- Height : Image length
- LEVEL : Image quality 0-9, The higher the value, the better the picture quality.
- FPS: How many FRAMEs per second
- Mem_total_size ： JPEG encoder memory size capacity
- Mem_block_size ： Block size used by Memory pool
- Men_frame_size : Set a maximum FRAME SIZE capacity

1.2.4 AAC Encoder

```
aac_params_t aac_params = {
        .sample_rate = 8000,
        .channel = 1,
        .bit_length = 16,
        .mem_total_size = 10*1024,
        .mem_block_size = 128,
        .mem_frame_size = 1024
};
```

- sample_rate ：Must be the same as the Audio codec setting. For example, when the Audio codec is set to ASR_8KHZ, it must be set to 8000 here.

- .channel ：Mono is set to 1, and stereo is set to 2. This setting is related to Audio codec. Amebapro built-in codec is mono, so set it to 1.
- bit_length : Must be the same as the word_length of the audio codec, such as audio codec word_length = WL_16BIT, which must be set to 16.
- Mem_total_size : AAC encoder output memory size.
- Mem_block_size ： Block size used by Memory pool.
- Men_frame_size : Set maximum FRAME SIZE capacity

1.2.5 AAC Decoder

```
aad_params_t aad_params = {
        .sample_rate = 8000,
        .channel = 1,
        .type = TYPE_ADTS
};
```

- sample_rate ： Need to be the same source to decode correctly.
- channel : Need to be the same source to decode correctly.
- type ：TYPE_ADTS is used when the source is AAC encoder, TYPE_RTP_RAW is used when source is RTP, and TYPE_TS is not currently supported.

1.2.6 Audio Codec

AEC (Acoustic Echo Cancellation) is included in this module.

```
audio_params_t audio_params = {
        .sample_rate = ASR_8KHZ,
        .word_length = WL_16BIT,
        .mic_gain    = MIC_40DB,
        .channel     = 1,
        .enable_aec  = 1
};
```

- Sample rate currently supports： 8K, 16K, 32K, 44.1K, 48K, 88.2K, 96K HZ
- word_length currently supports: 16, 24 bit
- Microphone gain value support： 0, 20, 30, 40 DB
- Channel currently supports mono, set to 1
- If enable_aec set to 1, echo cancellation will be enabled. If not set or 0, the echo cancellation will be disabled.

1.2.7 RTP Input

```
rtp_params_t rtp_aad_params = {
        .valid_pt = 0xFFFFFFFF,
        .port = 16384,
        .frame_size = 1500,
        .cache_depth = 6
};
```

- valid_pt : Processable RTP Payload types, set 0x FFFFFFFF to handle PCMU(0), PCMA(8), DYNAMIC (96)
- port : The port that receives the RTP packet
- frame_size: Maximum RTP packet size
- cache_depth : The number of caches for RTP packets. The cache handler will send the RTP packet in the cache to the output of the module when the number of packets in the cache >= 50% cache_depth

1.2.8 G711 Codec

G711 Encode

```
g711_params_t g711e_params = {
        .codec_id = AV_CODEC_ID_PCMU,
        .buf_len = 2048,
        .mode     = G711_ENCODE
};
```

G711 Decode

```
g711_params_t g711d_params = {
        .codec_id = AV_CODEC_ID_PCMU,
        .buf_len = 2048,
        .mode     = G711_DECODE
};
```

codec_id： G711 currently supports PCMU and PCMA codec modes.

buf_len： Determine the length of the encode buffer (byte)

mode： Determine whether the G711 codec module is encode or decode

1.2.9 MP4

```
mp4_params_t mp4_params = {
        .width          = V2_WIDTH,
        .height         = V2_HEIGHT,
        .fps            = V2_FPS,
        .gop            = V2_FPS,

        .sample_rate = 8000,
        .channel = 1,

        .record_length = 30, //seconds
        .record_type = STORAGE_ALL,
        .record_file_num = 3,
        .record_file_name = "AmebaPro_recording",
        .fatfs_buf_size = 224*1024, /* 32kb multiple */
};
```

- Width : Video length
- Height : Video height
- FPS : Frame number per second
- GOP : Update I frame cycle
- SAMPLE RATE : Audio sample rate
- CHANNEL: Audio channel number.
- RECORD LENGTH : Video length in seconds
- Record type: Select STORAGE_ALL (with video), STORAGE_VIDEO (video only), STORAGE_AUDIO (sound only)
- REOCRD FILE NUM: Number of videos
- RECORD FILE NAME: Video name
- FATFS BUF SIZE: FATFS cache BUFFER

1.2.10 I2S

```
typedef struct i2s_param_s{
        i2s_sr                  sample_rate;        // SR_32KHZ
        i2s_sr                  out_sample_rate;    // SR_8KHZ
        i2s_wl                  word_length;        // WL_24b
        i2s_wl                  out_word_length;    // WL_16b
        int                     channel;            // 2
        int                     out_channel;        // 1
        int                     enable_aec;         // 0
        int                     mix_mode;           // 0
}i2s_params_t;
```

- sample_rate currently supports：8K、12K、16K、24K、32K、48K、64K、96K、192K、384K、7.35K、11.025K、14.7K、22.05K、44.1K、58.8K、88.2K、176.4K HZ.
- out_sample_rate : currently supported sampling rate is the same as the sample rate, but less than or equal to sample_rate.
- word_length currently supports：16、24、32 bit.
- out_word_length currently supported bit depth is the same as the word_length, but less than or equal to word_length.
- channel : Currently supports stereo or mono, please set to 2 or 1, and also supports 5.1 channels (but only support tx)

1.3 Using the MMF v2 example

Describe how to use the sample program to construct the data stream required by the terminal application.

1.3.1 Sample Program

- The sample program is located at: component\common\example\media_frameworkexample_media_framework.c
- Must set platform_opts.h before use.
- Open project\realtek_amebapro_v0_example\inc\platform_opts.h

```
#define CONFIG_EXAMPLE_MEDIA_FRAMEWORK                  0
#if CONFIG_EXAMPLE_MEDIA_FRAMEWORK
        .........
#endif
```

- Modify CONFIG_EXAMPLE_MEDIA_FRAMEWORK from 0 to 1, compile and execute

```
#define CONFIG_EXAMPLE_MEDIA_FRAMEWORK                    1
#if CONFIG_EXAMPLE_MEDIA_FRAMEWORK
.........
#endif
```

1.4 Selecting and setting up the sample program

Steps:

- Choose the appropriate sample program
- How to adjust the Audio/Video parameters

> *Note: IAR version requires 8.30*

1.4.1 Choose the proper sample program

The main sample program name is example_mmf2_signal_stream_main, and all examples are comment out in default. Pick the example want to open before using it, remove the comment, and recompile. Opening more than two examples at the same time will result in unpredictable program execution results.

```
void example_mmf2_signal_stream_main(void *param)
{
        //int ret;
#if ISP_BOOT_MODE_ENABLE == 0
        common_init();
#endif

        // CH1 Video -> H264 -> RTSP
        //mmf2_example_v1_init();

        // CH2 Video -> H264 -> RTSP
        //mmf2_example_v2_init();

        // CH3 Video -> JPEG -> RTSP
#if ENABLE_V3_JPEG == V3_JPEG_STREAMING
        mmf2_example_v3_init();
#endif

        // 1 Video (H264) -> 2 RTSP (V1, V2)
        //mmf2_example_simo_init();

        // 1 Audio (AAC) -> RTSP (A)
        //mmf2_example_a_init();
```

For example, to open the first example in the sample program

```
        // CH1 Video -> H264 -> RTSP
        mmf2_example_v1_init();
        // CH2 Video -> H264 -> RTSP
        //mmf2_example_v2_init();
```

Currently supported example

Example	Description	Result
mmf2_example_v1_init	CH1 Video -> H264 -> RTSP	Transfer AmebaPro's H264 video stream over the network
mmf2_example_v2_init	CH2 Video -> H264 -> RTSP	Transfer AmebaPro's H264 video stream over the network

mmf2_example_v3_init	CH3 Video -> JPEG -> RTSP	Transfer AmebaPro's JPEG video stream over the network
mmf2_example_simo_init	1Video (H264) -> 2 RTSP(V2)	Transmitting two H264 video streams from AmebaPro over the network, the source of the video is the same ISP stream
mmf2_example_a_init	1 Audio (AAC) -> RTSP (A)	AmebaPro's AAC sound stream over the network
mmf2_example_av_init	1 Video (H264) 1 Audio -> RTSP	Transfer AmebaPro's H264 video and AAC sound stream over the network
mmf2_example_av2_init	2 Video (H264) 1 Audio -> 2 RTSP (V1+A, V2+A)	Transmitting two H264 videos and AAC audio streams from AmebaPro over the network. The source of the videos is different ISP streams.
mmf2_example_av21_init	1 Video (H264) 1 Audio -> 2 RTSP (V+A)	Transfer two copies of AmebaPro's H264 video and AAC sound stream through the network, the video source is the same ISP stream
mmf2_example_audioloop_init	PCM audio -> PCM audio , audio loopback	The sound received by AmebaPro can be broadcast from the 3.5 audio channel of AmebaPro , and the PCM transmission is directly used in the procedure .
mmf2_example_g711loop_init	audio -> G711E -> G711D -> audio	The sound received by AmebaPro can be broadcast from the 3.5 audio channel of AmebaPro
mmf2_example_aacloop_init	audio -> AAC -> AAD -> audio	The sound received by AmebaPro can be broadcast from the 3.5 audio channel of AmebaPro
mmf2_example_i2s_audio_init	I2s -> PCM audio, audio loop back	Sound received by i2s can be played from the 3.5 audio channel of AmebaPro , and the PCM transmission is directly used in the procedure .
mmf2_example_rtp_aad_init	RTP -> AAD -> audio	Stream AAC sound over the network to AmebaPro for playback
mmf2_example_2way_audio_init	AUDIO -> AAC -> RTSP RTP -> AAD -> AUDIO	Stream AAC sound to AmebaPro via the network and transmit the sound received by AmebaPro over the network
mmf2_example_joint_test_init	ISP -> H264 -> RTSP (with AUDIO) ISP -> H264 -> RTSP (with AUDIO) AUDIO -> AAC -> RTSP RTP -> AAD -> AUDIO	(1) Transmitting two H264 video and AAC audio streams from AmebaPro over the network. The source of the video is different ISP streams. (2) Stream AAC sounds to AmebaPro for playback over the network
mmf2_example_av_mp4_init	1 Video (H264) 1 Audio -> MP4 (SD card)	AmebaPro will record three videos to the SD card for 30 seconds each The default storage name is : AmebaPro_recording_0.mp4 AmebaPro_recording_1.mp4 AmebaPro_recording_2.mp4

mmf2_example_joint_test_rtsp_mp4_init	ISP -> H264 -> RTSP (V1) ISP -> H264 -> MP4 (V2) AUDIO -> AAC -> RTSP and mp4 RTP -> AAD -> AUDIO	(1) Transfer AmebaPro's H264 video and AAC sound stream over the network (2) AmebaPro will record three videos to the SD card for 30 seconds each. The default storage name is : AmebaPro_recording_0.mp4 AmebaPro_recording_1.mp4 AmebaPro_recording_2.mp4 (3) Streaming AAC sounds to AmebaPro via the network (1) video source of (2) is different from the ISP stream
mmf2_example_h264_2way_audio_pcmu_doorbell_init	ISP -> H264 -> RTSP (V1) AUDIO -> G711E -> RTSP RTP -> G711D -> AUDIO ARRAY (PCMU) -> G711D -> AUDIO (doorbell)	(1) Transmitting AmebaPro's H264 stream and PCMU sound stream over the network (2) AAC sound can be streamed to AmebaPro via the Internet (3) Play PCMU sound array in AmebaPro (default is the doorbell)
mmf2_example_pcmu_array_rtsp_init	ARRAY (PCMU) -> RTSP (A)	Transmitting PCMU sound arrays within AmebaPro over the network
mmf2_example_aac_array_rtsp_init	ARRAY (AAC) -> RTSP (A)	Transfer AAC sound arrays in AmebaPro over the network
mmf2_example_h264_array_rtsp_init	ARRAY (H264) -> RTSP (V)	Transfer H264 stream array in AmebaPro over the network
mmf2_example_v1_param_change_init	H264/ISP parameter change	Transfer AmebaPro's H264 video over the network and support dynamic adjustment of video parameters

Please refer to the steps below to learn how to use the MMFv2 example.

Pre-requisites

- AmebaPro board * 1
- Camera sensor board* 1
- USB cable * 1
- Wifi used to transfer rtsp stream
- MicroSD * 1

Hardware setup

- Connect the Camera sensor board to the AmebaPro CON1 port
- Connect the USB cable to the AmebaPro CON8 port and the other end to the PC

- Connect the MicroSD card to the MicroSD card slot.

Softer setup

Please refer to the compilation and execution chapter in AN0300 Realtek AmebaPro user_manual_en.

- Open SDK\project\realtek_amebapro_v0_example\inc\platform_opts.h
- Open example_media_framework, set CONFIG_EXAMPLE_MEDIA_FRAMEWORK to 1

```
#define CONFIG_EXAMPLE_MEDIA_FRAMEWORK                    1
#if CONFIG_EXAMPLE_MEDIA_FRAMEWORK
      #define FATFS_DISK_SD                               1
#endif
```

- Open SDK\common\example\media_framework\example_media_framework.c, and select the sample program which locate near the bottom of example_mmf2_signal_stream_main. To test the full function sample program, it is recommended to uncommon and compile mmf2_example_joint_test_rtsp_mp4_init();.

```
// Joint test RTSP MP4
// ISP   -> H264 -> RTSP (V1)
// ISP   -> H264 -> MP4 (V2)
// AUDIO -> AAC  -> RTSP and mp4
// RTP   -> AAD  -> AUDIO

mmf2_example_joint_test_rtsp_mp4_init();
```

- Compile and execute firmware

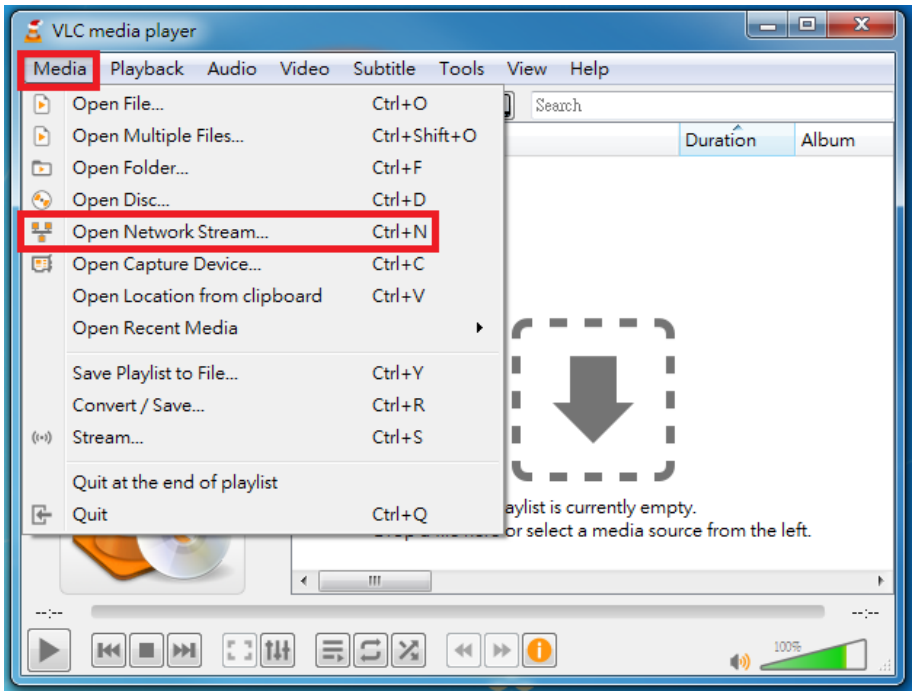
Execution and testing

Before executing example, must set Tera Term or try PuTTY first and set the serial port to COMX/115200: Port number. Once the setting is completed, AmebaPro is also connected with the PC and booted to get the Log message output by AmebaPro.

- In order to execute rtsp stream, you must set up AmebaPro first to connect to the network. Please refer to the steps below.

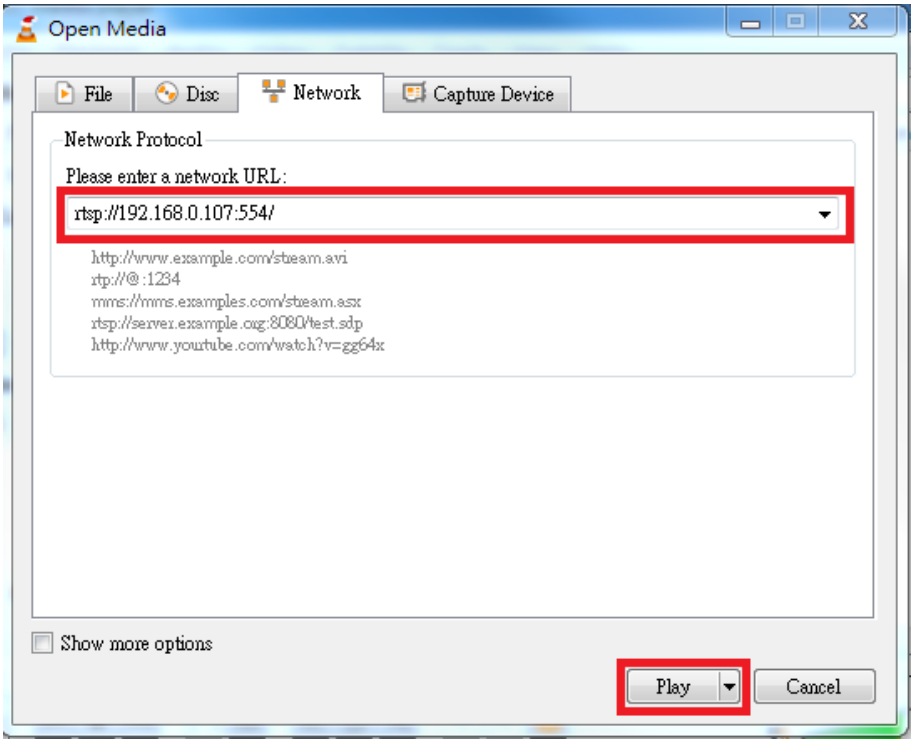
  ATW0 = <Name of WiFi SSID> : Set the WiFi AP to be connected
  ATW1 = <Password> : Set the WiFi AP password
  ATWC : Initiate the connection

- When the “RTSP stream enabled” message shown on console, it indicates that the RSTP server is already running. To stream audio/video from AmebaPro to VLC player, please open the VLC media player



Click “Media” -> “Open Network Stream”.

1. Enter “rtsp://xxx.xxx.xxx.xxx:yyy/”, and click “Play”.

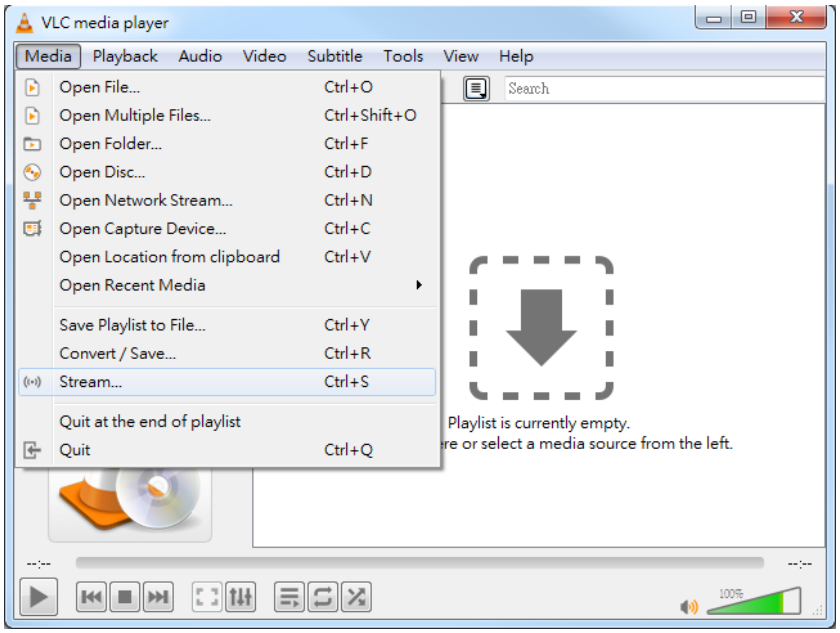


xxx.xxx.xxx.xxx: the Ameba IP address.

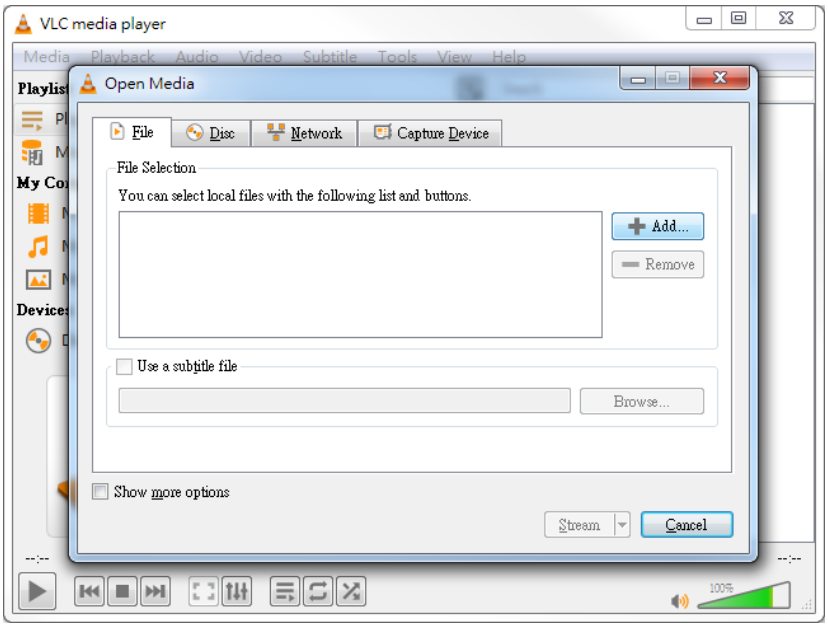
yyy: RTSP server port (default is 554).

> *Note: For latency related settings, please refer to section 1.4.5 VLC media player settings*

- To stream audio from VLC player to AmebaPro, please open the VLC media player.
  1. click “Media” -> “Stream”.



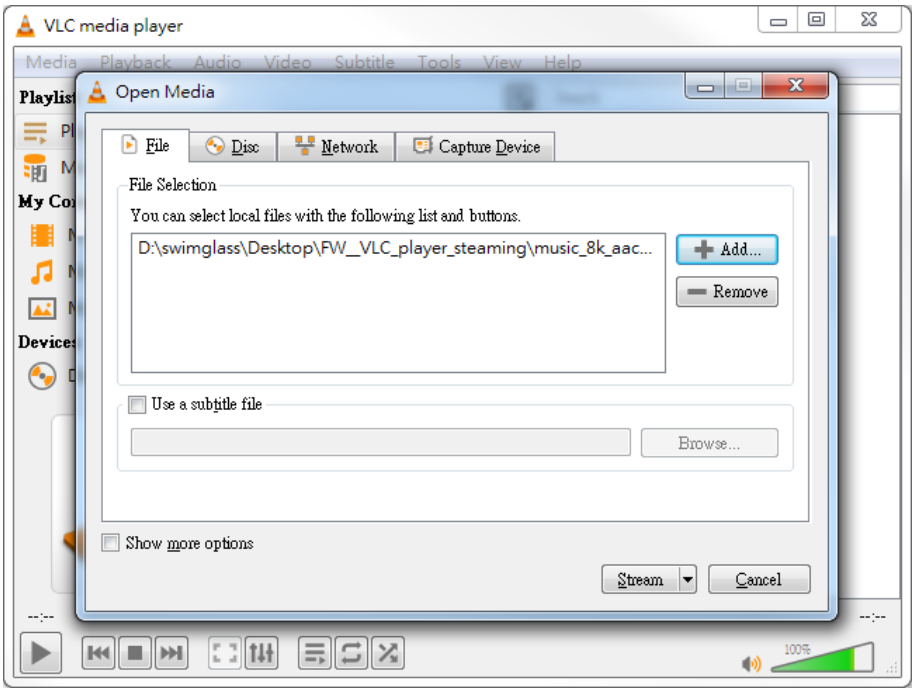
  2. Select “File” and click “Add”.

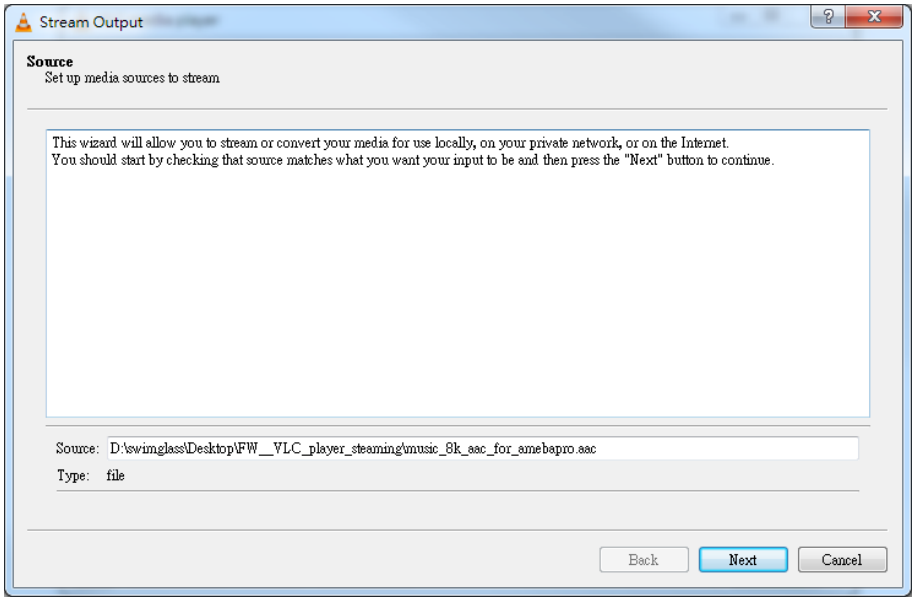


(If the startup example is RTP -> AAD -> AUDIO please select the audio file with the file name .aac. If the startup example is RTP -> G711D -> AUDIO, please select the audio file with the file name .wav)

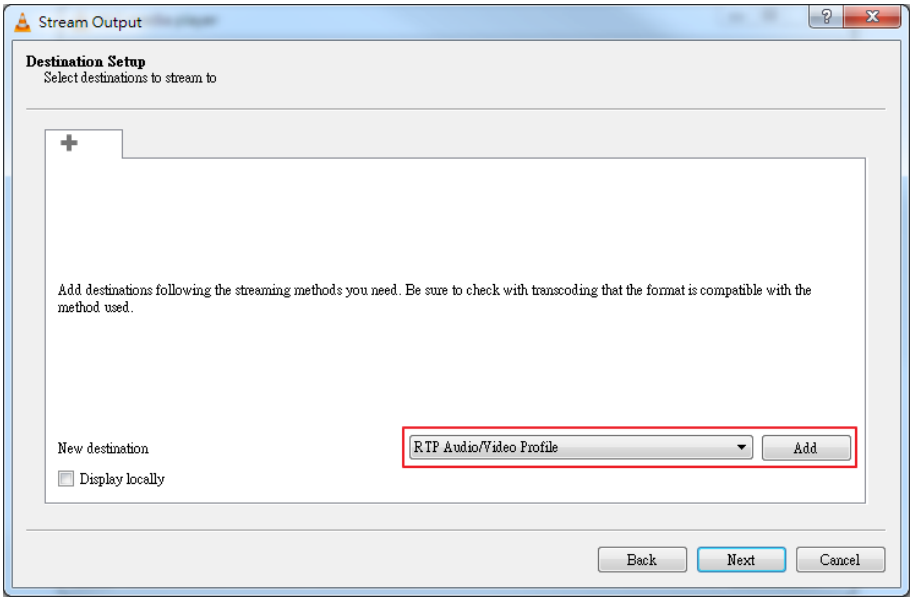
> *Note: Download and use ffmpeg to generate a compatible WAV file with following command:*
> ***ffmpeg -i input.wav -acodec pcm_mulaw -ac 1 -ar 8000 -ab 64k output.wav***

3. Select the audio file to be added, and click “Stream” -> “Next”.

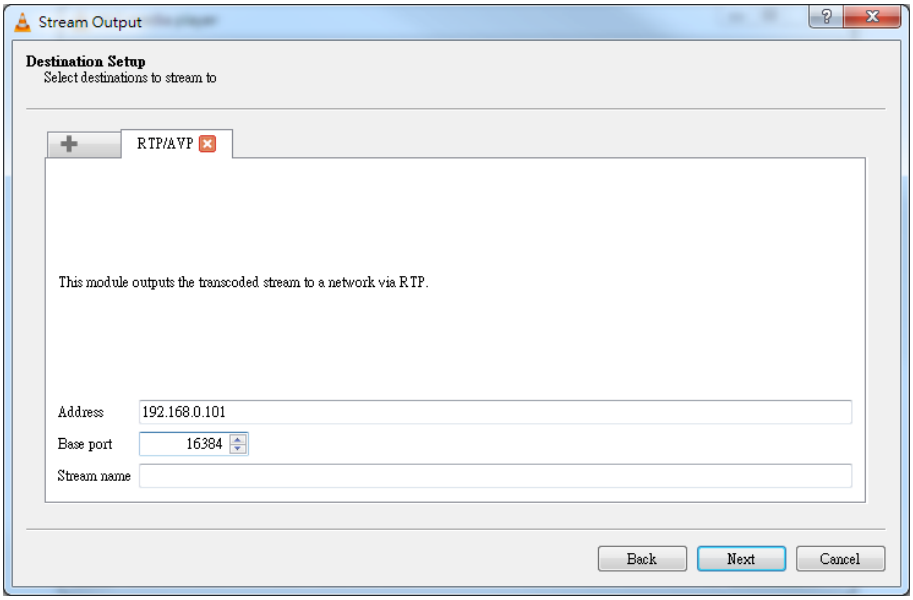




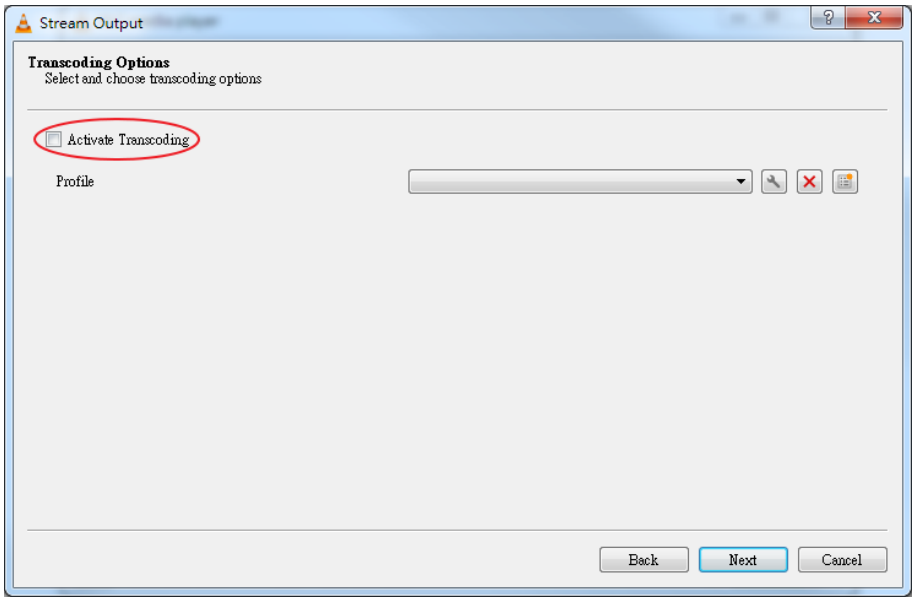
4. Select “RTP Audio/Video Profile”, and click “Add”

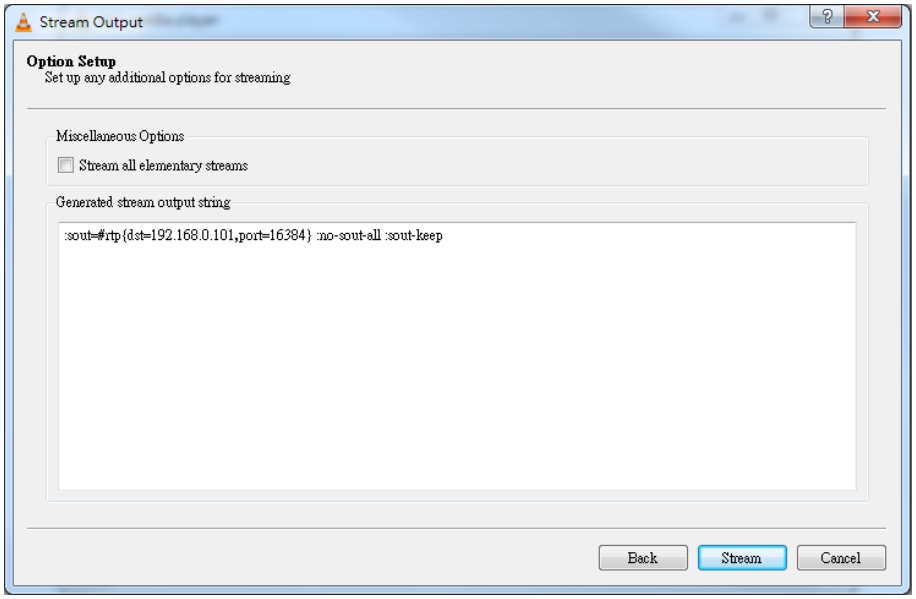


5. Enter AmebaPro's IP Address in “Address” field, with “Base port” set to 16384, and click “Next”.



6. Confirm “Activate Transcoding” is unchecked, and click “Next” -> “Stream”. Then the sound can be heard on AmebaPro 3.5mm audio jack.





Individual instructions and compilation options

If there are more than the above instructions, add the following

- mmf2_example_v1_init(Source AmebaPro Camera, Sink RTSP Stream) ：

  To modify the image quality parameter, please modify the V1 parameter in example_media_framework.h. For the ISP related parameter settings, please refer to chapter 1.2.1. For H264 related parameter, please refer to chapter 1.2.2.

- mmf2_example_v2_init(Source AmebaPro Camera, Sink RTSP Stream) :

  To modify the image quality parameter, please modify the V2 parameter in example_media_framework.h. For the ISP related parameter settings, please refer to chapter 1.2.1. For H264 related parameter, please refer to chapter 1.2.2. If you want to enable ISP BOOT MODE, please enable ISP_BOOT_MODE_ENABLE and ISP_BOOT_RTSP, and VLC will not be an instant image, but the BOOT TIME image at the time.

- mmf2_example_v3_init(Source AmebaPro Camera, Sink RTSP Stream) :

  To modify the image quality parameter, please modify the V1 parameter in example_media_framework.h.
  Also set #define ENABLE_V3_JPEG V3_JPEG_STREAMING in example_media_framework.h
  For the ISP related parameter settings, please refer to chapter 1.2.1. For JPEG related parameter, please refer to chapter 1.2.3.

- mmf2_example_simo_init(Source AmebaPro Camera, 2 Sink RTSP Stream) :

  Two VLC video players must be open at the same time, the other RTSP port is 555.
  To modify the image quality parameter, you can modify the V2 parameter in example_media_framework.h.
  For the ISP related parameter settings, please refer to chapter 1.2.1.
  For H264 related parameter, please refer to chapter 1.2.2.

- mmf2_example_a_init(Source AmebaPro Microphone, Sink RTSP Stream) :

  For audio related parameters, please refer to chapter 1.2.4~1.2.6

- mmf2_example_av_init(Source AmebaPro Camera/Mic, Sink RTSP Stream) :

  To modify the image quality parameter, please modify the V1 parameter in example_media_framework.h.
  For the ISP related parameter settings, please refer to chapter 1.2.1. For H264 related parameter, please refer to chapter 1.2.2.
  For audio related parameters, please refer to chapter 1.2.4~1.2.6

- mmf2_example_av2_init(Source AmebaPro Camera/Mic, Sink RTSP Stream) :

  Two VLC video players must be open at the same time. The other RTSP port is 555.
  If image quality parameters modification is needed, modify the V1 and V2 parameters in example_media_framework.h.
  For the ISP related parameter settings, please refer to chapter 1.2.1. For H264 related parameter, please refer to chapter 1.2.2.
  For audio related parameters, please refer to chapter 1.2.4~1.2.6

- mmf2_example_av21_init(Source AmebaPro Camera/Mic, Sink RTSP Stream) ：

  Two VLC video players must be open at the same time. The other RTSP port is 555.
  To modify the image quality parameter, please modify the V1 parameter in example_media_framework.h.
  For the ISP related parameter settings, please refer to chapter 1.2.1. For H264 related parameter, please refer to chapter 1.2.2.
  For audio related parameters, please refer to chapter 1.2.4~1.2.6

- mmf2_example_audioloop_init(Source AmebaPro Microphone, Sink audio jack) ：

  For audio related parameters, please refer to chapter 1.2.4~1.2.6

- mmf2_example_g711loop_init(Source AmebaPro Microphone, Sink audio jack)：

  For audio related parameters, please refer to chapter 1.2.4~1.2.6

- mmf2_example_aacloop_init(Source AmebaPro Microphone, Sink audio jack)：

  For audio related parameters, please refer to chapter 1.2.4~1.2.6

- mmf2_example_2way_audio_init(Source AmebaPro Microphone, Sink audio jack and Source RTP, Sink audio jack)：

  For audio related parameters, please refer to chapter 1.2.4~1.2.6

- mmf2_example_joint_test_init(Source AmebaPro Camera/Mic, Sink RTSP Stream and and Source RTP, Sink audio jack)：

  Two VLC video players must be open at the same time. The other RTSP port is 555.
  If image quality parameters modification is needed, please modify the V1 and V2 parameters in example_media_framework.h.
  For the ISP related parameter settings, please refer to chapter 1.2.1. For H264 related parameter, please refer to chapter 1.2.2.
  For audio related parameters, please refer to chapter 1.2.4~1.2.6

- mmf2_example_av_mp4_init(Source AmebaPro Camera/Mic, Sink SD card) ：

  To modify the image quality parameter, please modify the V2 parameter in example_media_framework.h.
  For the ISP related parameter settings, please refer to chapter 1.2.1. For H264 related parameter, please refer to chapter 1.2.2.
  For audio related parameters, please refer to chapter 1.2.4~1.2.6.
  If you want to turn on ISP BOOT MODE, enable ISP_BOOT_MODE_ENABLE and ISP_BOOT_MP4

- mmf2_example_joint_test_rtsp_mp4_init(Source AmebaPro Camera/Mic, Sink RTSP Stream and Source AmebaPro Camera/Mic, Sink SD card and and Source RTP, Sink audio jack) ：

If image quality parameters modification is needed, please modify the V1 and V2 parameters in example_media_framework.h.
For the ISP related parameter settings, please refer to chapter 1.2.1. For H264 related parameter, please refer to chapter 1.2.2.
For audio related parameters, please refer to chapter 1.2.4~1.2.6

- mmf2_example_h264_2way_audio_pcmu_doorbell_init(Source AmebaPro Camera/Mic, Sink RTSP Stream and and Source RTP, Sink audio jack) ：

  If image quality parameters modification is needed, please modify the V1 and V2 parameters in example_media_framework.h.
  For the ISP related parameter settings, please refer to chapter 1.2.1. For H264 related parameter, please refer to chapter 1.2.2.
  For audio related parameters, please refer to chapter 1.2.4~1.2.6
  Please use the .wav audio file for the music extension file played from the PC.
- mmf2_example_pcmu_array_rtsp_init(Source Music file in memory, Sink RTSP)
- mmf2_example_aac_array_rtsp_init(Source Music file in memory, Sink RTSP)
- mmf2_example_h264_array_rtsp_init(Source video file in memory, Sink RTSP)

1.4.2 Adjusting the Video/Audio Parameters of MMFv2 Example

- ISP

```
isp_params_t isp_v1_params = {
        .width    = V1_WIDTH,
        .height   = V1_HEIGHT,
        .fps      = V1_FPS,
        .slot_num = V1_HW_SLOT,
        .buff_num = V1_SW_SLOT
};
```

- Resolution: Supports up to 1080P.
- FPS: Currently open for 30, 15, 10, 5 and 1.
- HW_SLOT: Currently supports up to 4.
- SW_SLOT: contains the number of HW_SLOT, the rest will be used as a cache

Regarding file size calculation, current default ISP output format is YUV420 Format. Assuming the current resolution is 1080P, a FRAME size will be 1920*1080*1.5 = 3110400 bytes. If HW_SLOT = 2, SW_SLOT=4, then the memory consumed size is

> *Video/Aduio/ISP parameters are not arbitrarily adjustable. On RTOS systems, resource configuration requires actuarial. Please adjust within the recommended range.*

3110400*4 = 12441600 bytes. Regarding the SLOT number setting, it is currently recommended that HW_SLOT be set to 2, and SW_SLOT will be determined according to the FPS size. If it is set to 4 for 30FPS, it is set to 3 if 15FPS is recommended.

1.4.3 Adjusting LWIP Parameters

For video streaming application, it requires stable and higher performance for network transmission. To meet this requirement, there are some modifications for LWIP parameters within the standard SDK, by enlarging some LWIP buffers to improve the network transmission efficiency. These modifications reside in component\common\api\network\include\lwipopts.h:

```
#if CONFIG_VIDEO_APPLICATION
#undef MEM_SIZE
#define MEM_SIZE (20*1024)

#undef MEMP_NUM_TCP_SEG
#define MEMP_NUM_TCP_SEG 60

#undef PBUF_POOL_SIZE
#define PBUF_POOL_SIZE 60

#undef MEMP_NUM_NETBUF
#define MEMP_NUM_NETBUF 60

#undef DEFAULT_UDP_RECVMBOX_SIZE
#define DEFAULT_UDP_RECVMBOX_SIZE 60

#undef IP_REASS_MAX_PBUFS
#define IP_REASS_MAX_PBUFS 40

#undef TCP_SND_BUF
#define TCP_SND_BUF (10*TCP_MSS)

#undef TCP_SND_QUEUELEN
#define TCP_SND_QUEUELEN (6*TCP_SND_BUF/TCP_MSS)

#undef TCP_WND
#define TCP_WND (4*TCP_MSS)
#endif
```

CONFIG_VIDEO_APPLICATION is defined as 1 in project\realtek_amebapro_v0_example\inc\platform_opts.h as default.

If user has some other requirements for their applications, you can change the LWIP parameters based on current memory usage. Take TCP streaming as example, if the RTT(Round Trip Time) is quite long, e.g. TCP server locates at foreign network, user can try to enlarge the TCP_SND_BUF parameter to make it send more data each time, so that the overall transmission performance would not be low due to the long RTT. As standard SDK, user can adjust some LWIP parameters as below to make the TCP_SND_BUF set to maximum value:

```
#define MEM_SIZE  (55*1024)
#define MEMP_NUM_TCP_SEG  300
```

```
#define PBUF_POOL_SIZE  220
#define TCP_SND_BUF  (44*TCP_MSS)
```

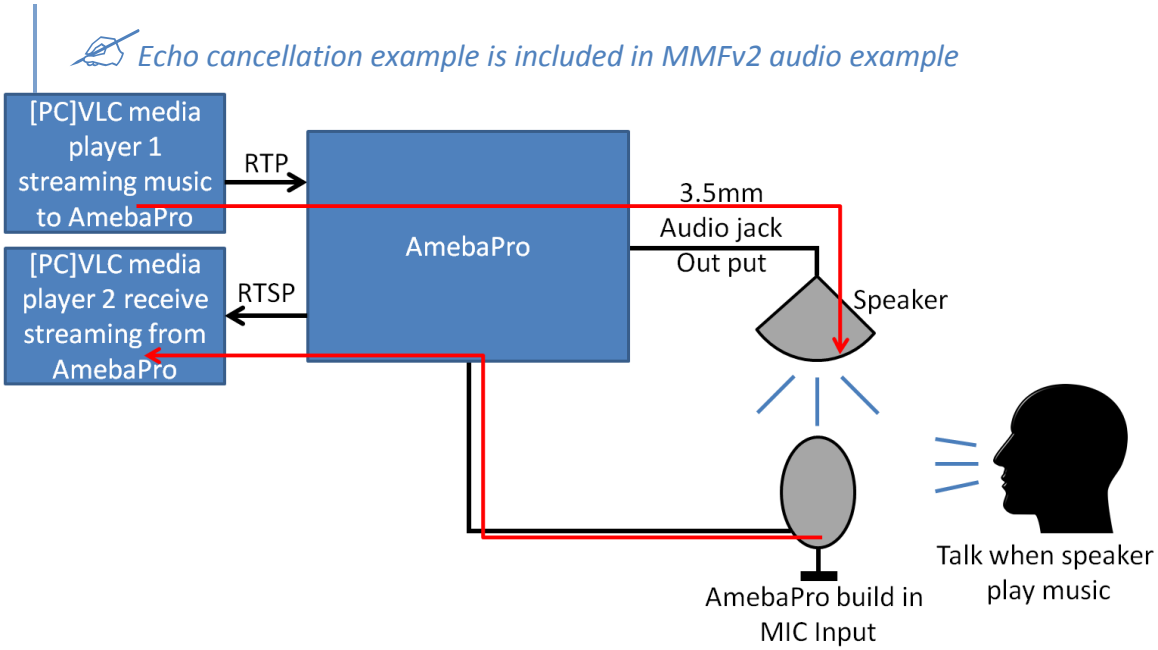
For above configuration, we need to relocate some LWIP buffer to external RAM, by modifying project\realtek_amebapro_v0_example\EWARM-RELEASE\application_is.icf and move the "*section *.itcm.bss object memp.o*" from DTCM_RAM_region to ERAM_BSS. For this configuration, the external RAM would get extra cost about 120KB, but the transmission performance should be improved for long RTT case.

1.4.4 Echo Cancellation

Echo cancellation is default provided in the audio part of MMFv2. To test whether the echo cancellation function is correct, use VLC media player to verify it on the computer.

The verification method is as follows:

1. Use VLC media player on the PC to stream music to AmebaPro.
2. Put AmebaPro speaker next to AmebaPro build in Mic and speak at the same time.
3. Then pass the received sound to the VLC media player on the PC via AmebaPro to see if the sound in step 1 is small or not (the sound of the speech and the sound of the music, but the sound of the music is relatively small)



Parameter adjustment

Speex echo cancellation provides three parameters that can be adjusted, sampling rate, frame size and filter length. Sampling rate is recommended to use 8kHz, and the corresponding frame size is 20ms. Frame size is the amount of data (in samples) you want to process at once and filter length is the length (in samples) of the echo cancelling filter you want to use (also known as tail length). It is recommended to use a frame size in the order of 20 ms (or equal to the codec frame size) and make sure it is easy to perform an FFT of that size (powers of two are better than prime sizes). The recommended tail length is approximately the third of the room reverberation time. For example, in a small room, reverberation time is in the order of 300 ms, so a tail length of 100ms is a good choice (800 samples at 8000 Hz sampling rate).

> *Note : Please use VLC media player version 2.2.4 or greater.*

1.4.5 Capture the first frame and related notes

The purpose of this function can speed up the appearance of ISP Frame. The current measurement time is about 188ms from boot to frame done. The main method is to start ISP initialization in the bootloader. At this time, you can wait for the frame to appear in main. For details, please refer to ISP 1.2.1.

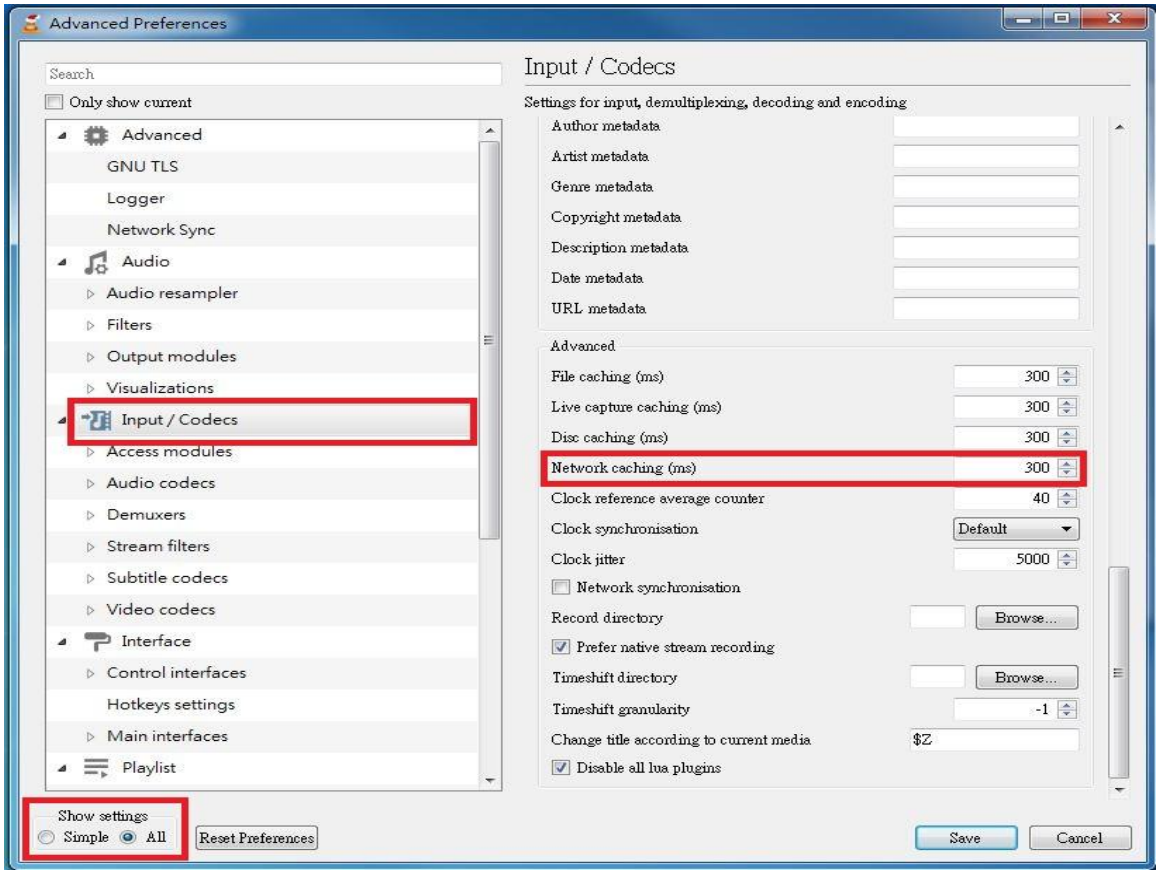
Note: When opening two channels at the same time, you need to execute the First boot all the way. You can refer to the ISP_BOOT_MUX example.

In addition, if you need to change the Frame rate later, please change Flag back to Normal boot after the setting is completed.

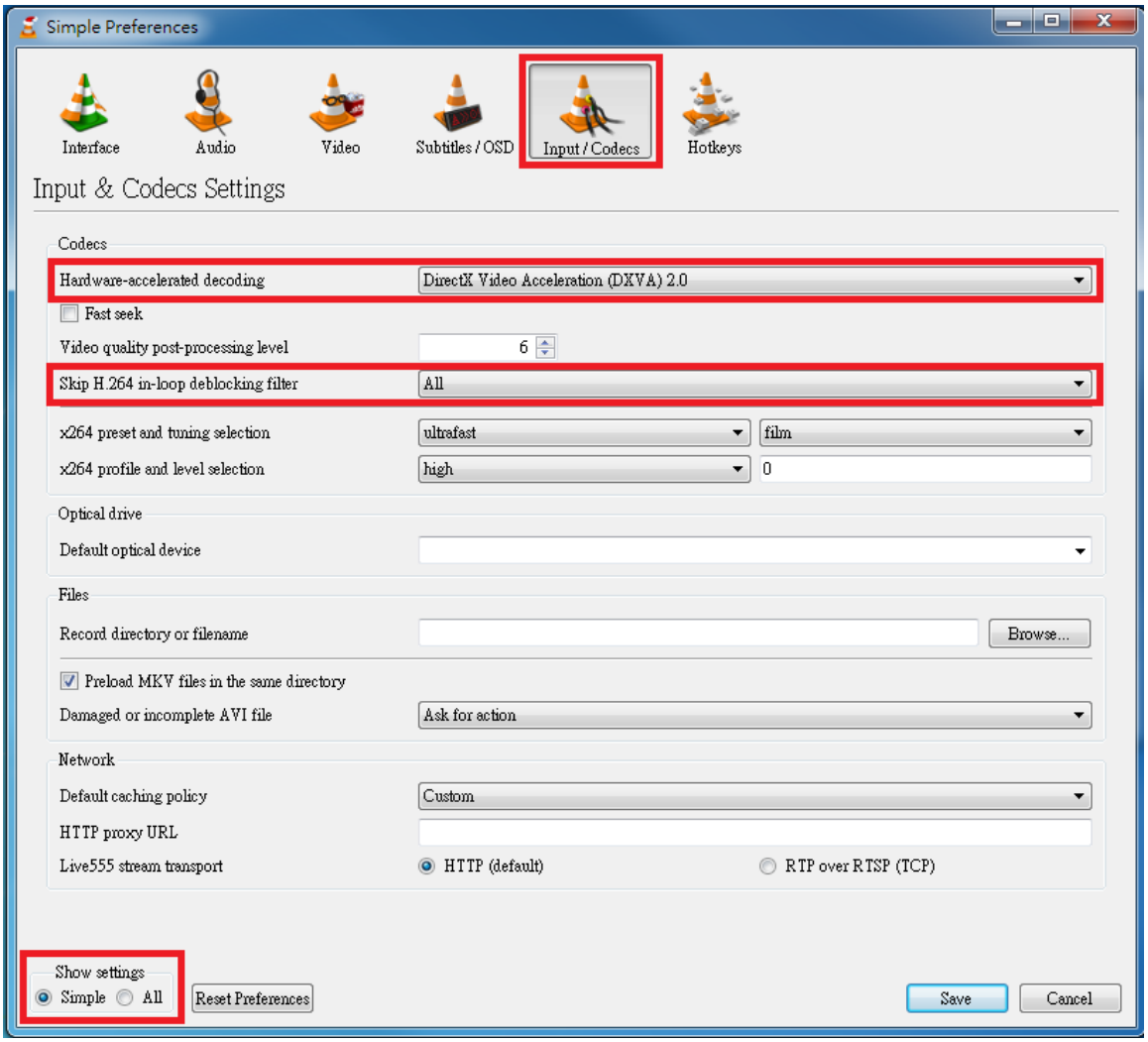
1.4.6 VLC media player settings

- Download VLC media player from website https://www.videolan.org/
- Adjust latency (buffer) related settings

1. Click “Tools” -> “Preferences” -> “Show settings: All” (lower left corner) -> “Input/ Codecs”, and set “Network caching” to 300ms (recommended).



2. Click “Tools” -> “Preferences” -> “Show settings: Simple” (lower left corner) -> “Input/ Codecs”. Enable “Hardware-accelerated decoding” if available, and set “Skip H.264 in-loop deblocking filter” to “All”.



- Playing live streaming from AmebaPro to VLC player
  Please refer to section "1.4.1 Choose the proper sample program" -> Execution and testing.

- Streaming Audio from VLC player to AmebaPro
  Please refer to section "1.4.1 Choose the proper sample program" -> Execution and testing.

2 Video API

Currently includes H264 and JPEG API.

2.1 H264 API

2.1.1 h264_open

Purpose

Create H264 encoder instance.

Function

void *h264_open();

Parameter

None

Return

If the return value is not NULL, it means that the correct Encoder pointer is returned.

2.1.2 h264_initial

Purpose

Set H264 parameter.

Function

int h264_initial(void *ctx,struct h264_parameter *h264_parm);

Parameter

void *ctx :

Encoder pointer.

h264_parameter *h264_parm :

It is necessary to set the width, length, GOP (Group of picture), BPS (Bit per second), FPS (Frame per second), and Rate Control mode.

Rate Control：

Currently supports CBR (Constant bit rate), VBR (Variable bit rate) and FIXQP (Fixed QP). The VBR mode can currently support setting the maximum and minimum QP. The FIXQP mode indicates that the minimum and maximum QP values are the same.

Return

0 : Success ; -1 : Failure

2.1.3 h264_encode

Purpose

Compress a Frame

Function

int h264_encode(void *ctx);

Parameter

Need to set the Input buffer address data, including Y and UV from the ISP buffer. In addition, need to set the Output buffer address data, including the destination address and the buffer length.

Return

0 ： successful
The length of the compression success and the destination address can be obtained.
Non-zero ： Image compression failed.

2.1.4 h264_release

Purpose

Release compressed resources.

Function

int h264_release(void *ctx);

Parameter

void *ctx points to the Encoder pointer

Return

0 ： Success.
Non-zero ： failed to release resources

2.2 JPEG API

2.2.1 jpeg_open

Purpose

Create a JPEG encoder instance.

Function

void *jpeg_open();

Parameter

None

Return

If the return value is not NULL, it means that the correct Encoder pointer is returned.

2.2.2 jpeg_initial

Purpose

Set up JPEG parameters.

Function

int jpeg_initial(void *ctx, struct jpeg_parameter *jpeg_parm);

Parameter

void *ctx :
enocder pointer
struct jpeg_parameter *jpeg_parm:
Need to set the width, length and level (0~9). The higher the level, the better the picture quality.

Return

0 : Success
-1 : Failed

2.2.3 jpeg_encode

Purpose

Compress a Frame

Function

int jpeg_encode(void *ctx);

Parameter

Need to set the Input buffer address data, including Y and UV from the ISP buffer. In addition, need to set the Output buffer address data, including destination address and buffer length.

Return

0: successful
The length of the compression success and the destination address can be obtained.
Non-zero: Image compression failed.

2.2.4 jpeg_release

Purpose

Free compressed resources.

Function

int jpeg_release(void *ctx);

Parameter

void *ctx points to the Encoder pointer

Return

0 : Success.
Non-zero : Failed to release resources

3 ISP API

3.1 video_subsys_init

Purpose

Initialize the setting of video environment.

Function

Int video_subsys_init(isp_init_cfg_t *ctx);

Parameter

isp_cfg_t *cfg pointer

Return

0 : Success
-1 : Failed

3.2 isp_stream_create

Purpose

Create isp stream

Function

isp_stream_t* isp_stream_create(isp_cfg_t *cfg);

Parameter

isp_cfg_t *cfg pointer
Isp_id specifies stream ID (0~2). Format currently only supports YUV420 SEMI PLANAR, length, width, FPS (30, 15, 10, 5, 1) and HW_SLOT (hard compression BUFFER)

Return

Null failed, successfully return isp_stream_t pointer

3.3 isp_stream_destroy

Purpose

Destroy isp stream

Function

isp_stream_t* isp_stream_destroy(isp_stream_t* stream);

Parameter

isp_stream_t* stream pointer

Return

Return NULL

3.4 isp_stream_set_complete_callback

Purpose

CALLBACK FUNCTION when ISP FRAME is registered.

Function

isp_stream_t* isp_stream_destroy(isp_stream_t* stream);

Parameter

void (*cb) (void*) User registered function
void* arg the parameters required by the user

Return

Return NULL

3.5 isp_stream_apply

Purpose

Fill in the settings to the ISP

Function

void isp_stream_apply(isp_stream_t* stream);

Parameter

isp_stream_t* stream pointer

Return

None

3.6 isp_stream_start

Purpose

Start ISP to get FRAME

Function

void isp_stream_start(isp_stream_t* stream);

Parameter

isp_stream_t* stream pointer

Return

None

3.7 isp_stream_stop

Purpose

Stop ISP

Function

void isp_stream_stop(isp_stream_t* stream);

Parameter

isp_stream_t* stream pointer

Return

None

3.8 isp_stream_poll

Purpose

Query if FRAME is completed

Function

Int isp_stream_poll(isp_stream_t* stream)

Parameter

isp_stream_t* stream pointer

Return

0 : Success
-1 : Failed

3.9 isp_handle_buffer

Purpose

Manage ISP BUFFER

Function

void isp_handle_buffer(isp_stream_t* stream, isp_buf_t* buf, int mode);

Parameter

Isp_stream_t* stream pointer
Isp_buf_t* buf can get ISP BUFFER ADDRESS
Mode is divided into the following ways :

MODE_EXCHANGE

Brings in the next ISP BUFFER data and brings the information obtained by the current ISP

MODE_SNAPSHOT

Will raise a FRAME, but will not continue the next FRAME generation

MODE_SKIP

This FRAME skip

MODE_SETUP

Set ISP HARDWARE BUFFER

Return

None

3.10 isp_set_flip

Purpose

Set the image to flip left and right, and flip it upside down

Function

void isp_set_flip(int a_dValue);

Parameter

int a_dValue: Flip the set value, the range is 0~3, each value is as follows
0 : Original output image 1 : Flip left and right
2 : Flip up and down 3 : Left and right and flipped up and down

Return

None

3.11 isp_get_flip

Purpose

Get value of the isp flip

Function

Void isp_get_flip(int *a_pdValue);

Parameter

int *a_pdValue: Retrieves the set value of the flip, the range is 0 ~ 3, each value is as follows
0: original output image 1: flip left and right
2: flip up and down 3: Left and right and flipped up and down

Return

None

3.12 isp_set_brightness

Purpose

Set isp brightness

Function

void isp_set_brightness(int a_dValue);

Parameter

int va_dValue: The brightness value of the image
Rang: -64 to 64,
Adjustable precision: +-1

Return

None

3.13 isp_get_brightness

Purpose

Get the current brightness of the image

Function

void isp_get_brightness(int *a_pdValue);

Parameter

int *a_pdValue: Retrieves the current brightness value.
Range: -64 to 64

Return

None

3.14 isp_set_contrast

Purpose

Set image contrast value

Function

Void isp_set_contrast(int a_dValue);

Parameter

Int a_dValue: image contrast value.
Range: 0~100.

Adjustable precision is +-1

Return

None

3.15 isp_get_contrast

Purpose

Get the current contrast value of isp

Function

Void isp_get_contrast(int *a_pdValue);

Parameter

int *a_pdValue: Get the current contrast value
Range: 0~100

Return

None

3.16 isp_set_saturation

Purpose

Set isp saturation

Function

void isp_set_saturation(int a_dValue);

Parameter

int a_dValue: ISP saturation.
Range: 0 to 100.
Adjustable accuracy: +-1

Return

None

3.17 isp_get_saturation

Purpose

Get the current saturation of isp

Function

void isp_get_saturation(int *a_pdValue);

Parameter

int *a_pdValue: Get the current saturation
Range: 0 to 100

Return

None

3.18 isp_set_sharpness

Purpose

Set isp sharpness

Function

void isp_set_sharpness(int a_dValue);

Parameter

int a_dValue: Sharpness of isp
Range: 0~100.
Adjustable precision: +-1

Return

None

3.19 isp_get_sharpness

Purpose

Get the current sharpness of isp

Function

void isp_get_sharpness(int *a_pdValue);

Parameter

int *a_pdValue: Retrieve the current sharp value from 0 to 100

Return

None

3.20 isp_set_gamma

Purpose

Set the Gamma coefficient

Function

void isp_set_gamma(int a_dValue);

Parameter

int a_dValue: Gamma coefficient.
Range: 100~500.
Adjustable precision: +-1

Return

None

3.21 isp_get_gamma

Purpose

Get the Gamma coefficient

Function

void isp_get_gamma(int *a_pdValue);

Parameter

int *a_pdValue: Retrieve the current Gamma coefficient from 100~500

Return

None

3.22 isp_set_gray_mode

Purpose

Set the gray/color mode

Function

void isp_set_gray_mode(int a_dValue);

Parameter

int a_dValue: The value of gray/color mode. 0: color mode, 1: gray mode

Return

None

3.23 isp_get_gray_mode

Purpose

Get the gray/color mode

Function

void isp_get_gray_mode(int *a_pdValue);

Parameter

int *a_pdValue:
Retrieve the value of gray/color mode, 0: color mode , 1: gray mode

Return

None

3.24 isp_set_exposure_mode

Purpose

Set the mode of auto/manual exposure

Function

void isp_set_exposure_mode(int a_dValue);

Parameter

int a_dValue:
The mode of exposure, value is 1 or 8. (1: manual, 8: Auto)

Return

None

3.25 isp_get_exposure_mode

Purpose

Get the mode of auto/manual exposure

Function

void isp_get_exposure_mode(int *a_pdValue);

Parameter

int *a_pdValue:
Retrieve the mode of exposure, value is 1 or 8, (1: manual, 8: auto)

Return

None

3.26 isp_set_exposure_time

Purpose

Based on manual exposure mode, set the exposure time.

Function

void isp_set_exposure_time(int a_dValue);

Parameter

int a_dValue: The exposure time, unit is us, range is 1~1,000,000, the adjustable precision is +-1

Return

None

3.27 isp_get_exposure_time

Purpose

Get the exposure time

Function

void isp_get_exposure_time(int *a_pdValue);

Parameter

int *a_pdValue:
Retrieve the exposure time, unit is us, the range is 1~1,000,000

Return

None

3.28 isp_set_zoom

Purpose

Set zoom index.

Function

void isp_set_zoom(int a_dValue);

Parameter

int a_dValue: The zoom index.
Range: 0~3 (0: 1.0x, 1: 1.28X, 2: 1.6X, 3: 2.0X)
Adjustable precision: +-1
Note: Since width is limited between 64~640 (exclude 640), the resolution larger than 640X480 is not supported.

Return

None

3.29 isp_get_zoom

Purpose

Get zoom index

Function

void isp_get_zoom(int *a_pdValue);

Parameter

int *a_pdValue: Retrieve the zoom index, range is 0~3

Return

None

3.30 isp_set_pan_tilt

Purpose

Set the shift distance of pan-direction and tilt-direction

Function

void isp_set_pan_tilt(int a_dValuePan, int a_dValueTilt);

Parameter

int a_dValuePan: The shift distance of pan-direction.
Range: -576000~57600.
Adjustable precision: +-3600
int a_dValueTilt: (Tilt is not supported)

Note: Only resolution smaller than 640X480 is supported. (include 640x480)

Return

None

3.31 isp_get_pan_tilt

Purpose

Get the shift distance of pan-direction and tilt-direction

Function

void isp_get_pan_tilt(int *a_pdValuePan, int *a_pdValueTilt);

Parameter

int *a_pdValuePan: Retrieve shift distance of pan-direction
Range: -576000~57600
int *a_pdValueTilt: (Tilt is not supported)

Return

None

3.32 isp_set_AWB_ctrl

Purpose

Set AWB mode

Function

void isp_set_AWB_ctrl(int a_dValue);

Parameter

int a_dValue: Mode of white balance
0: Manual temperature, 1: Auto
Note: The API of manual temperature is not supported.

Return

None

3.33 isp_get_AWB_ctrl

Purpose

Get AWB mode

Function

void isp_get_AWB_ctrl(int *a_pdValue);

Parameter

int *a_pdValue: Retrieve the mode of white balance
0: Manual, 1: Auto

Return

None

3.34 isp_set_power_line_freq

Purpose

Set the mode of Anti-flicker.

Function

void isp_set_power_line_freq(int a_dValue);

Parameter

int a_dValue: Anti-flicker mode.
Range: 0 ~ 3
0: Disable, 1: 50Hz, 2: 60Hz, 3: Auto

Return

None

3.35 isp_get_power_line_freq

Purpose

Get the mode of Anti-flicker.

Function

void isp_get_power_line_freq(int *a_pdValue);

Parameter

int *a_pdValue: Retrieve the mode of Anti-flicker.
Range: 0 ~ 3

Return

None

3.36 isp_set_AE_gain

Purpose

Set gain value.

Function

void isp_set_AE_gain(int a_dValueAnalogGain, int a_dValueDigitalGain, int a_dValueISPDigitalGain);

Parameter

int a_dValueAnalogGain: Gain value in sensor. Range: 256~4080. Adjustable precision: +-16
int a_dValueDigitalGain: Default is 256 and cannot be adjustable
int a_dValueISPDigitalGain: Gain value in ISP. Range: 0~4095. Adjustable precision: +-1

Note: Analog gain is the gain inside sensor; ISPDigitalGain is the gain inside ISP

Return

None

3.37 isp_get_AE_gain

Purpose

Get gain value

Function

void isp_get_AE_gain(int *a_pdValueAnalogGain, int *a_pdValueDigitalGain, int *a_pdValueISPDigitalGain);

Parameter

int a_dValueAnalogGain: Retrieve gain value in sensor. Range: 256~4080
int a_dValueDigitalGain: Default value: 256
int a_dValueISPDigitalGain: Retrieve gain value in ISP: 0~4095

Return

None

3.38 isp_set_WDR_mode

Purpose

Set WDR mode

Function

void isp_set_WDR_mode(int a_dValue);

Parameter

int a_dValue: WDR mode.
Range: 0 ~ 4
0: Disable, 1: Manual, 2: Auto(weak), 3: Auto(medium), 4: Auto(strong)

Return

None

3.39 isp_get_WDR_mode

Purpose

Get WDR mode

Function

void isp_get_WDR_mode(int *a_pdValue);

Parameter

int *a_pdValue: Retrieve the value of WDR mode.
Range: 0 ~ 4

Return

None

3.40 isp_set_WDR_level

Purpose

Based on WDR manual mode, set WDR level

Function

void isp_set_WDR_level(int a_dValue);

Parameter

int a_dValue: WDR level.
Range: 0~100.
Adjustable precision: +-1

Return

None

3.41 isp_get_WDR_level

Purpose

Get WDR level

Function

void isp_get_WDR_level(int *a_pdValue);

Parameter

int *a_pdValue: Retrieve WDR level.
Range: 0~100

Return

None

4 OSD

4.1 OSD introduction

rtstream provides a set of API functions to set the OSD configuration of the data flow stream, etc. Note that when calling this set of APIs, you need to create a data flow before calling. The group interface is as follows:

rts_video_query_osd_attr interface gets the video osd attribute;

rts_video_set_osd_attr interface sets the video osd attribute;

rts_video_release_osd_attr interface releases the attributes obtained by rts_video_query_osd_attr;

In addition, a set of simple interfaces for setting up a video OSD is provided. This set of interfaces does not require the user to create an additional data flow. The group interface is as follows:

rts_query_isp_osd_attr interface gets the video osd attribute;

rts_set_isp_osd_attr interface sets the video osd attribute;

rts_release_isp_osd_attr interface releases the attributes obtained by rts_query_isp_osd_attr;

4.2 OSD example

The sample program is located at:

component\common\example\isp\example_isp_osd_multi.c

Must set platform_opts.h before use.

Open project\realtek_amebapro_v0_example\inc\platform_opts.h

```
#define CONFIG_EXAMPLE_MEDIA_UVCD                                   0
……
#define CONFIG_EXAMPLE_ISP_OSD_MULTI                                0
```

Modify CONFIG_EXAMPLE_MEDIA_UVCD from 0 to 1.

Modify CONFIG_EXAMPLE_ISP_OSD_MULTI from 0 to 1, compile and execute

```
#define CONFIG_EXAMPLE_MEDIA_UVCD                                   1
……
#define CONFIG_EXAMPLE_ISP_OSD_MULTI                                1
```

Execution and testing

- Connect the USB cable to the AmebaPro CON6 port and the other end to the PC.
- Open potplayer, amebaPro atcmd enter “ATIO” will show result.

4.3 OSD Show Time information

The time displayed by the OSD is based on SNTP. The time is obtained by the "sntp_gen_system_time" function. Therefore, the timezone needs to be set by the global variable rtsTimezone.

```
extern int rtsTimezone;
rtsTimezone = 8;
```

4.4 OSD API

4.4.1 rts_video_query_osd_attr

Purpose

Get video stream osd attribute.

Function

int rts_video_query_osd_attr(RtStream stream, struct rts_video_osd_attr **attr);

Parameter

stream Input parameters, RtStream pointer.

attr The output parameter, which points to the address of the variable storing osd attr, needs to be called rts_video_release_osd_attr to release.

Retrun

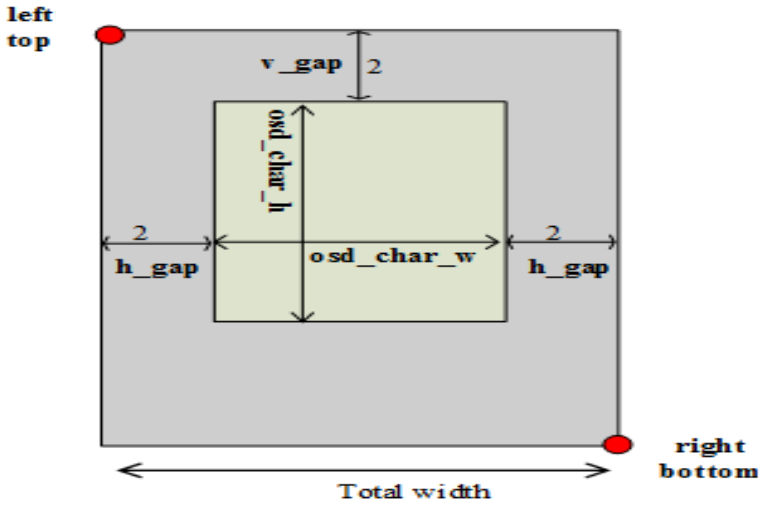
Return 0 means success, returning negative means failure。

Description

Each video stream has a separate osd module, and each osd module is represented by the structure rts_video_osd_attr. Each osd module supports up to 6 blocks, which is an area in the video for displaying characters or images, represented by the structure rts_video_osd_block. The width of a word is inconsistent between English and Chinese in digital display. The English and array are single-wide, and the font file is stored in the single-wide font file. The Chinese display takes up double width and the font file is stored in the double-width font file.
The single_lib_name and double_lib_name in rts_video_osd_attr are used to save the file names of each glyph file. The picture in osd is represented by a pbitmap in the block which is a pointer to the BITMAP_S structure.

```
struct rts_video_osd_attr {
    int number; // the number of blocks in osd
    struct rts_video_osd_block *blocks;
    enum rts_osd_time_fmt time_fmt; // displayed time format
    uint8_t time_blkidx; // displayed time block index
    int time_pos; // Time display position
    enum rts_osd_date_fmt date_fmt; // displayed date format
    uint8_t date_blkidx; // date of the block of the date displayed
    int date_pos; // date display position
    char *single_lib_name; // single font file name
    char *double_lib_name; // double font file name
    uint8_t osd_char_w; // osd character width
    uint8_t osd_char_h; // osd character height
};
```

```
struct rts_video_osd_block {
    struct rts_video_rect rect; // block coordinates
    uint8_t bg_enable; // background enable
    uint32_t bg_color; // background color
    uint32_t ch_color; // character color
    uint8_t h_gap:4,v_gap:4;// Interval between characters and
                               characters
    uint8_t flick_enable; // character flick enable
    uint32_t flick_speed; //flick speed,  flick every 2^flick_speed
    uint8_t char_color_alpha; // character semi-transparent
    uint8_t stroke_enable; // character stroke switch
    uint8_t stroke_direct; // the direction of the character stroke,
                              0: minus the increment, 1: plus the
                              increment
    uint8_t stroke_delta; // character stroke increment
    struct rts_osd_text_t *pshowtext; // Text content to be displayed
    BITMAP_S *pbitmap;
};
```



The meaning of the field in the osd structure is shown in the figure. The value of the interval between the OSD character and the character is configured by the user. The minimum value is 2 and the maximum value is 15. Interval between the character level directions is h_gap. , the vertical interval is v_gap.

rts osd time fmt	顯示樣式	例子
osd_time_fmt_no	Not display time	Not display time
osd_time_fmt_24	hh:mm:ss	14:32:58
osd_time_fmt_12	hh:mm:ss	02:32:58
osd_time_fmt_12_1	Phh:mm:ss	P02:32:58
osd_time_fmt_12_2	PMhh:mm:ss	PM02:32:58
osd_time_fmt_12_3	PM~hh:mm:ss	PM~02:32:58
osd_time_fmt_12_4	hh:mm:ssPM	02:32:58PM
osd_time_fmt_12_5	hh:mm:ss~PM	02:32:58~PM
osd_time_fmt_12_6	hh:mm:ss~~PM	02:32:58~~PM
osd_time_fmt_12_7	hh:mm:ss~~~PM	02:32:58~~~PM

rts osd date fmt	樣式	例子
osd_date_fmt_no	Not display date	Not display date
osd_date_fmt_0	dd/MM/yyyy	26/05/2015
osd_date_fmt_1	dd/MM/yy	26/05/15
osd_date_fmt_2	d/M/yy	26/5/15
osd_date_fmt_3	M/d/yyyy	5/26/2015
osd_date_fmt_4	M/d/yy	5/26/15
osd_date_fmt_5	MM/dd/yy	05/26/15
osd_date_fmt_6	MM/dd/yyyy	05/26/2015

osd_date_fmt_7	yyyy/M/d	2015/5/26
osd_date_fmt_8	yyyy-M-d	2015-5-26
osd_date_fmt_9	yyyy-MM-dd	2015-05-26
osd_date_fmt_10	yyyy/MM/dd	2015/05/26
osd_date_fmt_11	yy-MM-dd	15-05-26
osd_date_fmt_12	yy/M/d	15/5/26
osd_date_fmt_13	yy-M-d	15-5-26
osd_date_fmt_14	yy/MM/dd	15/05/26

4.4.2 rts_video_set_osd_attr

Purpose

Set the osd property of the video stream.

Function

int rts_video_set_osd_attr(RtStream stream, struct rts_video_osd_attr *attr);

Parameter

stream

Input parameters, RtStream pointer.

attr

Input parameters, points to the osd attribute, obtained by rts_video_query_osd_attr. Structure rts_video_osd_attr is defined in rts_video_query_osd_attr

Retrun

Return 0 indicates success and a negative error code indicates failure.

None

4.4.3 rts_video_release_osd_attr

Purpose

Release the osd attribute of the video stream.

Function

void rts_video_release_osd_attr(RtStream stream, struct rts_video_osd_attr *attr);

Parameter

stream

Input parameters, RtStream pointer.

attr

Input parameter which point to the osd attribute is obtained by rts_video_query_osd_attr. The structure rts_video_osd_attr is defined in rts_video_query_osd_attr

Retrun

None

Description

This function is used to release the osd attr obtained by rts_video_query_osd_attr, otherwise a memory leak will occur.

4.4.4 rts_query_isp_osd_attr

Purpose

Get the video osd attribute.

Function

int rts_query_isp_osd_attr(int isp_id, struct rts_video_osd_attr **attr);

Parameter

isp_id

Input parameters, isp supports simultaneous output of multiple channels, each channel can create an isp stream, where id is the index of a certain path isp, starting from 0.

attr

The output parameter, which points to the address of the variable storing osd attr, needs to be called rts_release_isp_osd_attr to release.

Retrun

Return 0 indicates success ,return a negative value indicates failure.

Description

Each video stream has a separate osd module, and each osd module is represented by the structure rts_video_osd_attr. Each osd module supports up to 6 blocks, a block is an area in the image for displaying characters or images, which represented by the structure rts_video_osd_block. English and digital width of a word are inconsistent with Chinese in display. English and array use a single, the width and font files are saved in the single font file. The Chinese display takes up double width, and the font file is saved in the double wide font file.
If you want to display image information such as logo or QR code, you can save the image in the image file, like a glyph file. The single_lib_name, double_lib_name, and picture_lib_name in rts_video_osd_attr are used to save the file names of each glyph file.

4.4.5 rts_set_isp_osd_attr

Purpose

Set the video osd property.

Function

int rts_set_isp_osd_attr(struct rts_video_osd_attr *attr);

Parameter

attr

Input parameter which points to the osd attribute is obtained by rts_query_isp_osd_attr. The structure rts_video_osd_attr is defined in rts_video_query_osd_attr

Retrun

Return 0 indicates success and a negative value indicates failure.

Description

None

4.4.6 rts_release_isp_osd_attr

Purpose

Release the video osd attribute.

Function

void rts_release_isp_osd_attr(struct rts_video_osd_attr *attr);

Parameter

attr

Input parameter which points to the osd attribute is obtained by rts_query_isp_osd_attr. The structure rts_video_osd_attr is defined in rts_video_query_osd_attr

Retrun

None

Description

This function is used to release the osd attr obtained by rts_query_isp_osd_attr, otherwise a memory leak will occur.

5 Motion Detect

5.1 Motion Detect introduction

rtstream provides a set of API functions to set the configuration of the motion detection of the data flow stream. Note that when calling this set of APIs, you need to create a data flow before calling.

The group interface is as follows:

rts_video_query_md_attr interface gets the motion detect attribute supported by the isp;

rts_video_set_md_attr interface setting update motion detect;

rts_video_release_md_attr interface releases the attributes obtained by rts_video_query_md_attr;

rts_video_check_md_status interface checks if a motion detect is detected.

In addition, a set of simple interfaces for setting motion detection is provided. This set of interfaces does not require the user to additionally create a corresponding data flow.

The group interface is as follows:

rts_query_isp_md_attr interface gets the motion detect attribute supported by the isp;

rts_set_isp_md_attr interface setting update motion detect;

rts_release_isp_md_attr interface releases the attributes obtained by rts_query_isp_md_attr;

rts_check_isp_md_status interface checks if a motion detect is detected.

5.2 Motion Detect example

The sample program is located at: component\common\example\isp\example_md.c

Must set platform_opts.h before use.

Open project\realtek_amebapro_v0_example\inc\platform_opts.h

```
#define CONFIG_EXAMPLE_MOTION_DETECT                    0
```

Modify CONFIG_EXAMPLE_MOTION_DETECT from 0 to 1, compile and execute

```
#define CONFIG_EXAMPLE_MOTION_DETECT                    1
```

Execution and testing

- Connect the USB cable to the AmebaPro CON6 port and the other end to the PC.
- Open Tera Term show log, amebaPro atcmd enter “ATID” will show result.

5.3 Motion Detect API

5.3.1 rts_video_query_md_attr

Purpose

Get video stream motion detect attribute.

Function

int rts_video_query_md_attr(RtStream stream, struct rts_video_md_attr **attr);

Parameter

stream Input parameters, RtStream pointer.

attr The output parameter, which points to the address of the variable storing motion detect attr, needs to be called rts_video_release_md_attr to release.

Retrun

Return 0 means success, returning negative means failure。

Description

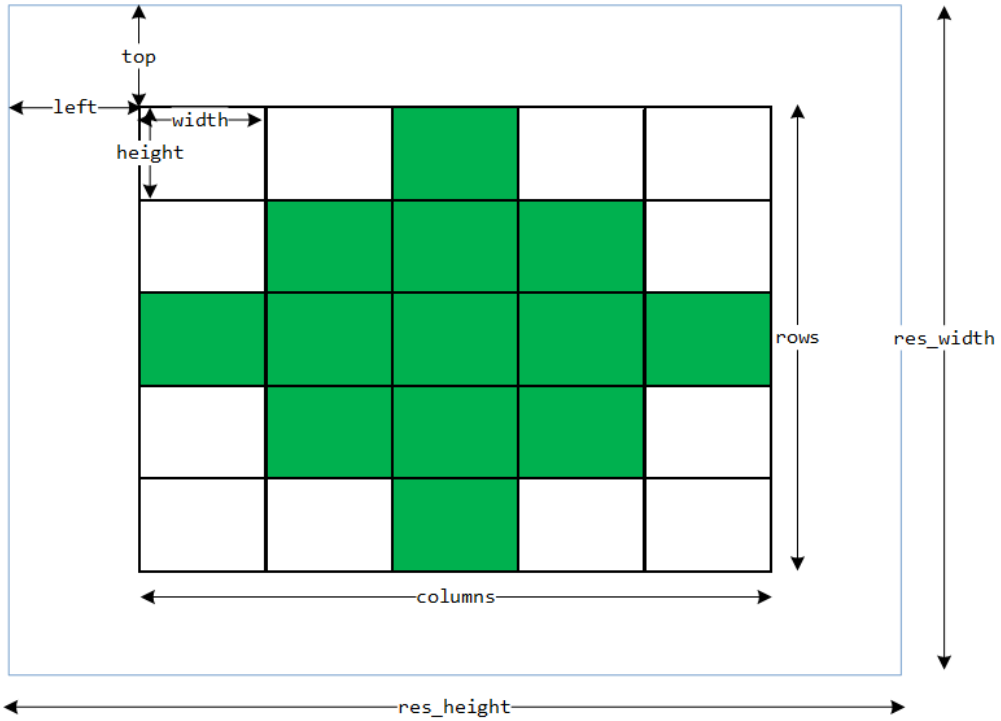
```
Struct rts_video_md_attr {
Int number; //the number of blocks of motion detect
Struct rts_video_md_block *blocks; //index pointing to blocks
Uint32_t reserved[4];
};

Struct rts_video_md_block {
Int enable; //Enable switch
Struct rts_video_grid area;
Uint32_t sensitivity; //sensitivity, 0~100
Uint32_t percentage; //%, 0~100
Uint32_t frame_interval; //trigger interval, 0~7
};
```

When doing motion detect analysis, it can be analyzed frame by frame or interval analysis. The number of separated frames can be configured by frame_interval. If the number of interval frames is small, md is easier to detect high-speed motion, and it is not easy to detect low-speed motion; and if the number of interval frames is large, more differences can be accumulated, which makes it easier to detect slow motion. Depending on the application scenario, you can change the threshold for detecting motion by configuring the sensitivity and percentage. The greater the sensitivity, the more sensitive, the lower the threshold, the easier it is to detect motion. The smaller the percentage, the lower the threshold and the easier it is to detect motion.

```
struct rts_video_grid_unit {
uint32_t width;
uint32_t height;
};
struct rts_video_grid {
int32_t left;
int32_t top;
struct rts_video_grid_unit cell;
uint32_t rows;
uint32_t columns;
int length;
uint8_t bitmap[(RTS_ISP_GRID_MAX_NUM + 7) / 8];
/* Reference resolution, generally the current resolution */
uint32_t res_width;
uint32_t res_height;
};
```

The variables in the rts_video_grid structure are shown in rts_video_grid. Each bit of the bitmap represents a cell of the grid, with 0 being disabled and 1 being able to be enabled. In the picture
rows = 5
columns = 5
length = columns * rows = 5 * 5 = 25
bitmap = {0b00100011, 0b10111110, 0b11100010, 0b00000000};



5.3.2 rts_video_set_md_attr

Purpose

Set the motion detect property of the video stream.

Function

Int rts_video_set_md_attr(RtStream stream, struct rts_video_md_attr *attr);

Parameter

stream Input parameters, RtStream pointer.

attr The input parameter, the indicator pointing to md attr, is obtained by rts_video_query_md_attr and needs to be called by rts_video_release_md_attr. The structure rts_video_md_attr is defined in rts_video_md_attr.

Retrun

Return 0 means success, returning negative means failure。

Description

None

5.3.3 rts_video_release_md_attr

Purpose

Release the motion detect attribute of the video stream.

Function

void rts_video_release_md_attr(RtStream stream, struct rts_video_md_attr *attr);

Parameter

stream Input parameters, RtStream pointer.

attr Input parameters, metrics pointing to md attr, obtained by rts_video_query_md_attr. The structure rts_video_md_attr is defined in rts_video_md_attr

Retrun

None

Description

This function is used to release the md attr obtained by rts_video_query_md_attr, otherwise a memory leak will occur.

5.3.4 rts_video_check_md_status

Purpose

Check the motion detect status of the video stream to see if motion is detected.

Function

Int rts_video_check_md_status(RtStream stream, int mdidx);

Parameter

stream Input parameter, RtStream pointer.

mdidx Input parameter, index of motion detect block

Retrun

Return 1 means motion is detected and a return of 0 means no detected.

Description

None

5.3.5 rts_video_get_md_result

Purpose

Obtain a bitmap of motion detection.

Function

Int rts_video_get_md_result(RtStream stream, int mdidx,struct rts_video_grid_bitmap *result);

Parameter

stream Input parameters, RtStream pointer.

mdidx Input parameter, the index of the motion detect block, currently supports the number of MD blocks for RTS3901 & RTS3902, so set

it to 0 for RTS3901&RTS3902.

result Output parameter, pointing to the metric of rts_video_grid_bitmap, which contains information about the MD grid bitmap.

Retrun

Return 0 means success, returning negative means failure。

Description

A return of 1 means motion is detected and a return of 0 means no detection.

```
Struct rts_video_grid_bitmap {
Uint16_t number; //the number of grids uint8_t
Bitmap[RTS_GRID_BITMAP_SIZE]; // bitmap of all grids
};
```

5.3.6 rts_query_isp_md_attr

Purpose

Get the motion detect property of the video stream.

Function

int rts_query_isp_md_attr(struct rts_video_md_attr **attr, uint32_t res_width, uint32_t res_height);

Parameter

attr output parameter, which points to md attr, needs to be called by rts_video_release_md_attr. See rts_video_md_attr for the definition of the structure rts_video_md_attr.

Res_width Input parameter, the resolution width, and the position in rts_video_md_attr are relative to the resolution.

Res_height Input parameter, the resolution height, and the position in rts_video_md_attr are relative to the resolution.

Retrun

Return 0 means success, returning negative means failure。

Description

The difference with rts_video_query_md_attr is that rts_query_isp_md_attr is independent of stream and does not need to provide Rt-Stream metric parameters.

5.3.7 rts_set_isp_md_attr

Purpose

Set the motion detect property of the video stream.

Function

Int rts_set_isp_md_attr(struct rts_video_md_attr **attr);

Parameter

attr input parameter, the indicator pointing to md attr, is obtained by rts_query_isp_md_attr and needs to be called by rts_release_isp_md_attr. The structure rts_video_md_attr is defined in rts_video_md_attr.

Retrun

Return 0 means success, returning negative means failure。

Description

The difference with rts_video_set_md_attr is that rts_set_isp_md_attr is independent of stream and does not need to provide RtStream indicator parameters.

5.3.8 rts_check_isp_md_status

Purpose

Check the motion detect status of the video stream to see if motion is detected.

Function

Int rts_check_isp_md_status(int mdidx);

Parameter

mdidx input parameter, the index of the motion detect block, the number of MD blocks supported by RTS3901&RTS3902 is 1, so the fixed setting is 0 for RTS3901&RTS3902.

Retrun

Return 1 means motion is detected and a return of 0 means no detected.

Description

The difference with rts_video_check_md_status is that rts_check_isp_md_status is independent of stream and does not need to provide RtStream metric parameters.

5.3.9 rts_get_isp_md_result

Purpose

Obtain a bitmap of motion detection.

Function

Int rts_get_isp_md_result(int mdidx, struct rts_video_grid_bitmap *result);

Parameter

mdidx input parameter, the index of the motion detect block, the number of MD blocks supported by RTS3901&RTS3902 is 1, so the fixed setting is 0 for RTS3901&RTS3902.

result output parameter, which points to the rts_video_grid_bitmap metric, which contains information about the MD grid bitmap.

Retrun

Description	Return 0 means success, returning negative means failure。 The difference with rts_video_check_md_status is that rts_check_isp_md_status is independent of stream and does not need to provide RtStream metric parameters.