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FA92 H.264

Nuvoton Technology Corp.

Example of Hierarchy of a Video Sequence

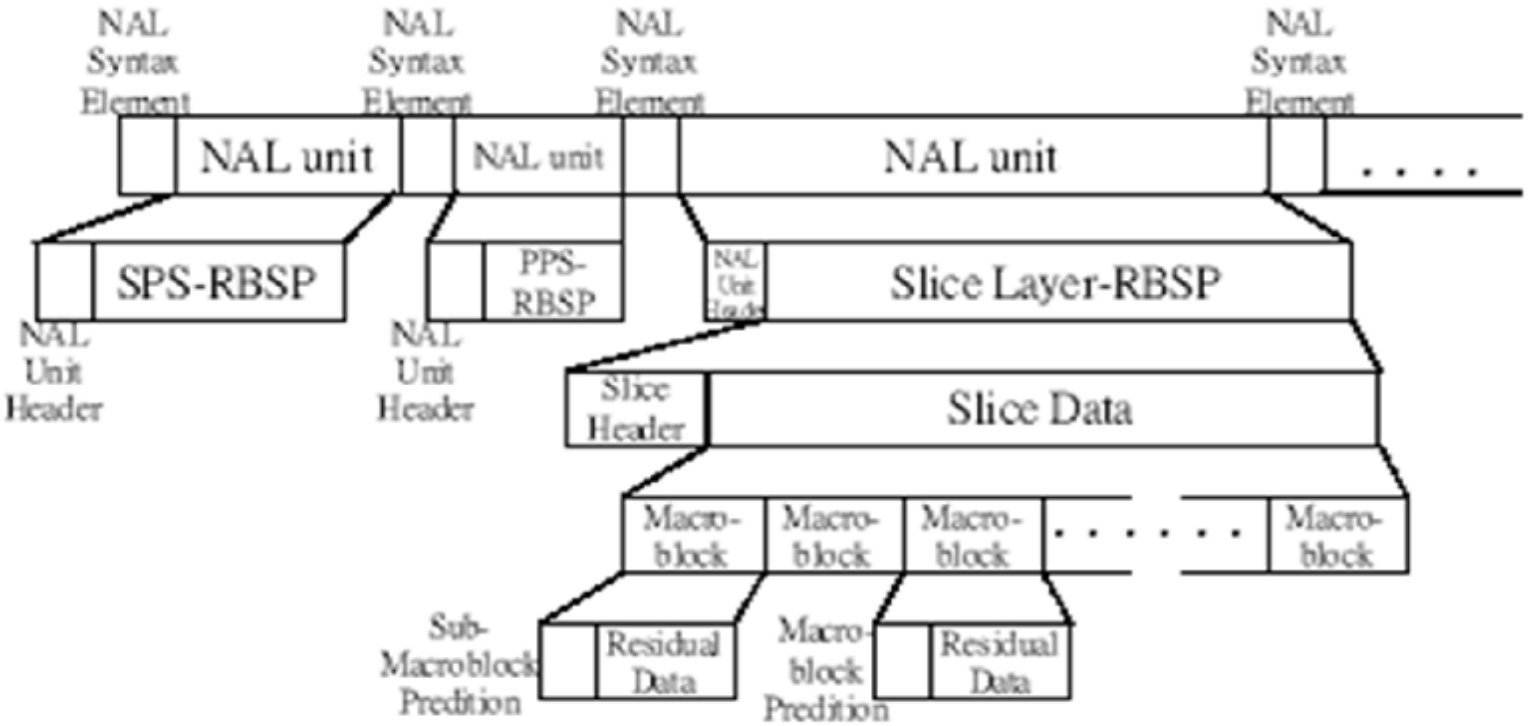


FIGURE4. HIERARCHICAL STRUCTURE OF H.264 BIT STREAM

Sequence(pictures(slices(macroblocks(macroblock partitions(sub-macroblock partitions(blocks(samples)))))))

nal_unit(NumBytesInNALunit) {	C	Descriptor
forbidden_zero_bit 0	All	f(1)
nal_ref_idc 01, 10, 11	All	u(2)
nal_unit_type 0 1000	All	u(5)
NumBytesInRBSP = 0		

byte_stream_nal_unit(NumBytesInNALunit) {	C	Descriptor
while(next_bits(24) != 0x000001)		
zero_byte /* equal to 0x00 */		f(8)
if(more_data_in_byte_stream( )) {		
start_code_prefix_one_3bytes /* equal to 0x000001 */		f(24)
nal_unit(NumBytesInNALunit)		
}		
}		

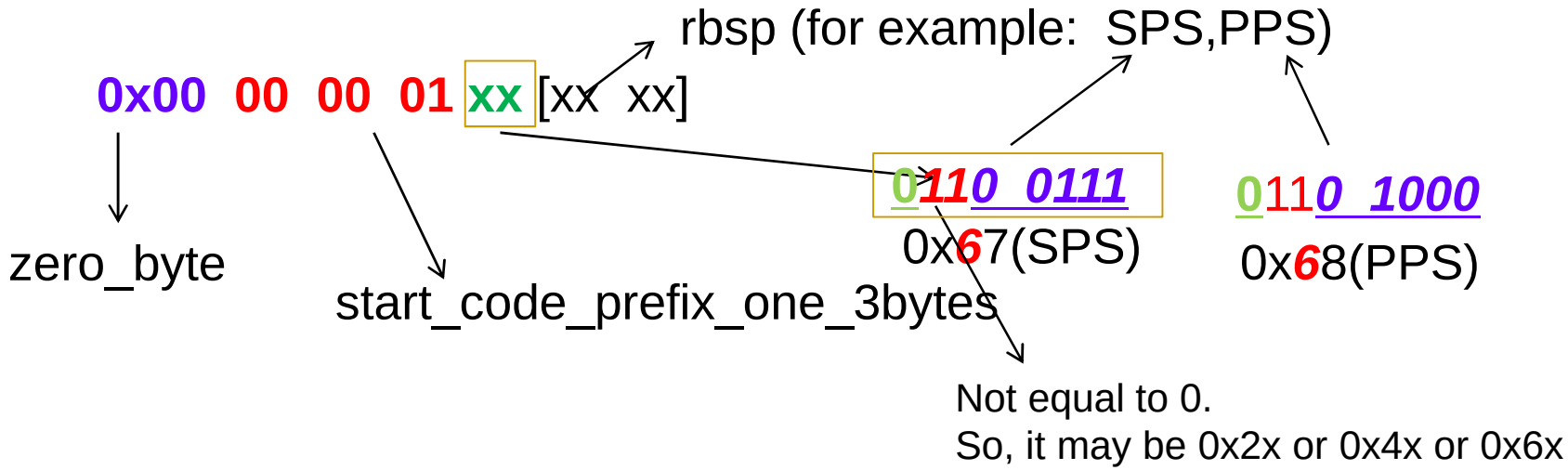


Table 7-1 – NAL unit type codes

nal_unit_type	Content of NAL unit and RBSP syntax structure	C
0	Unspecified	
1	Coded slice of a non-IDR picture slice_layer_without_partitioning_rbsp( )	2, 3, 4
2	Coded slice data partition A slice_data_partition_a_layer_rbsp( )	2
3	Coded slice data partition B slice_data_partition_b_layer_rbsp( )	3
4	Coded slice data partition C slice_data_partition_c_layer_rbsp( )	4
5	Coded slice of an IDR picture slice_layer_without_partitioning_rbsp( )	2, 3
6	Supplemental enhancement information (SEI) sei_rbsp( )	5
7	Sequence parameter set seq_parameter_set_rbsp( )	0
8	Picture parameter set pic_parameter_set_rbsp( )	1
9	Access unit delimiter access_unit_delimiter_rbsp( )	6
10	End of sequence end_of_seq_rbsp( )	7
11	End of stream end_of_stream_rbsp( )	8
12	Filler data filler_data_rbsp( )	9
13..23	Reserved	
24..31	Unspecified	

P

I

An IDR frame is a special type of I-frame in H.264. An IDR frame specifies that no frame after the IDR frame can reference any frame before it. This makes seeking the H.264 file easier and more responsive in the player

SPS (Sequence Parameter Set)

```
seq_parameter_set_rbs() {
profile_idc
…
level_idc
seq_parameter_set_id        //0~31
…
pic_width_in_mbs_minus1
pic_height_in_map_units_minus1
…
}
```

PPS (Picture Parameter Set)

```
pic_parameter_set_rbsp() {
pic_parameter_set_id // 0~255
seq_parameter_set_id // 0~31
…
pic_init_qp_minus26          // -26 to +25
pic_init_qs_minus26
…
}
```

Encoder	Decoder
Baseline profile 3.1	Baseline profile 3.1
144x80 to 1920x1088 in step of 16 **720P @25fps**	144x64 to 1920x1088 **720P @30fps**

Table A-1 – Level limits

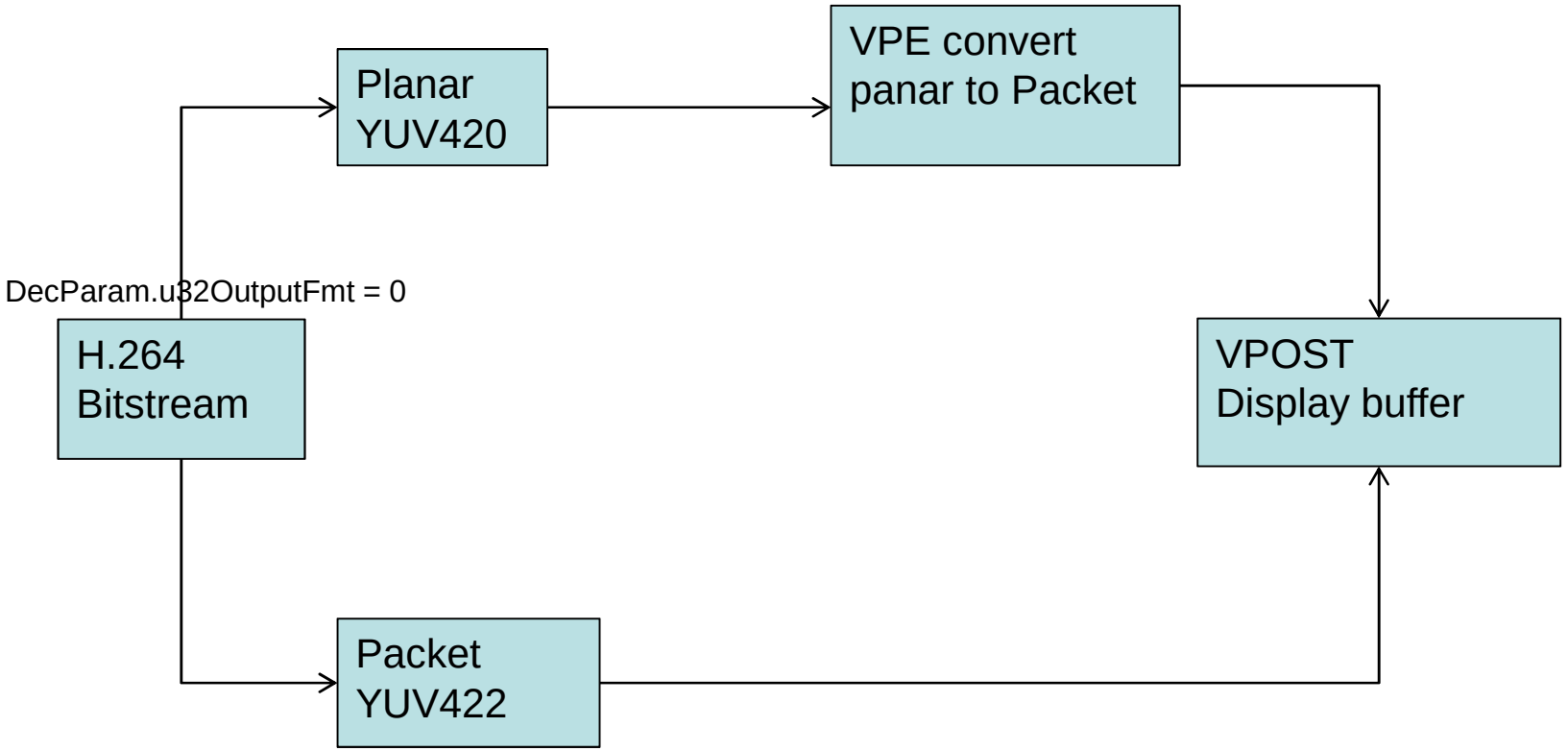
Level number	Max macroblock processing rate MaxMBPS (MB/s)	Max frame size MaxFS (MBs)	Max decoded picture buffer size MaxDPB (1024 bytes)	Max video bit rate MaxBR (1000 bits/s or 1200 bits/s)	Max CPB size MaxCPB (1000 bits or 1200 bits)	Vertical MV component range MaxVmvR (luma frame samples)	Min compression ratio MinCR	Max number of motion vectors per two consecutive MBs MaxMvsPer2Mb
3	40 500	1 620	3 037.5	10 000	10 000	[-256,+255.75]	2	32
3.1	108 000	3 600	6 750.0	14 000	14 000	[-512,+511.75]	4	16

H.264 DECODER

Limitation

- Decoder does not support
  - disable_deblocking_filter_idc=2 (range : 0 ~ 2, slice_header)
  - frame_cropping_flag (SPS level)
  - I_PCM (mb_type at macroblock_layer)
  - ASO (arbitrary slice order) or FMO (flexible macroblock ordering)(PPS)

Decode to display



VideoIn MB data for H.264 enc

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MB n, Y

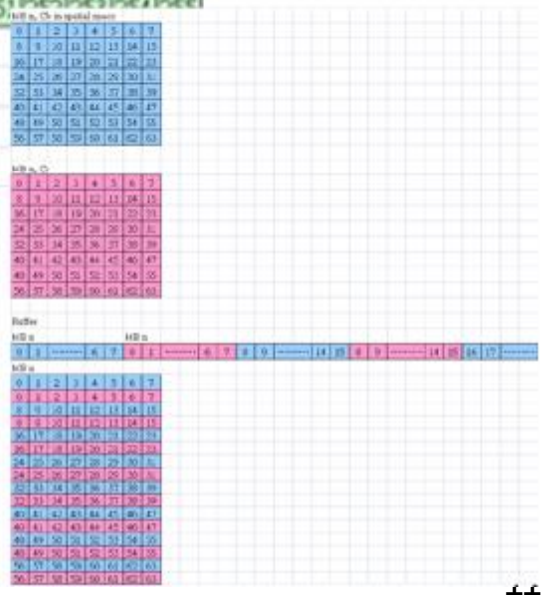
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111
112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143
144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207
208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223
224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239
240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255

MB n+1, Y

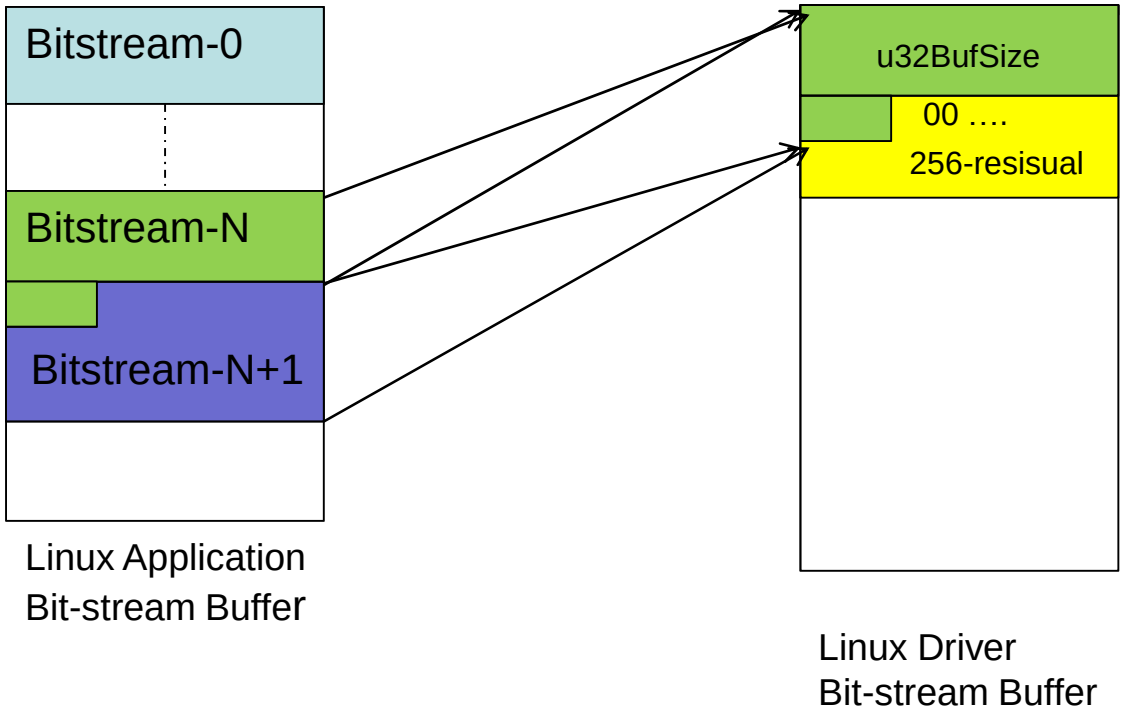
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111
112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143
144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207
208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223
224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239
240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255

Buffer

MB n							MB n+1							MB n+2						
0	1	2	.....	253	254	255	0	1	2	.....	253	254	255	0	1	2	.....			

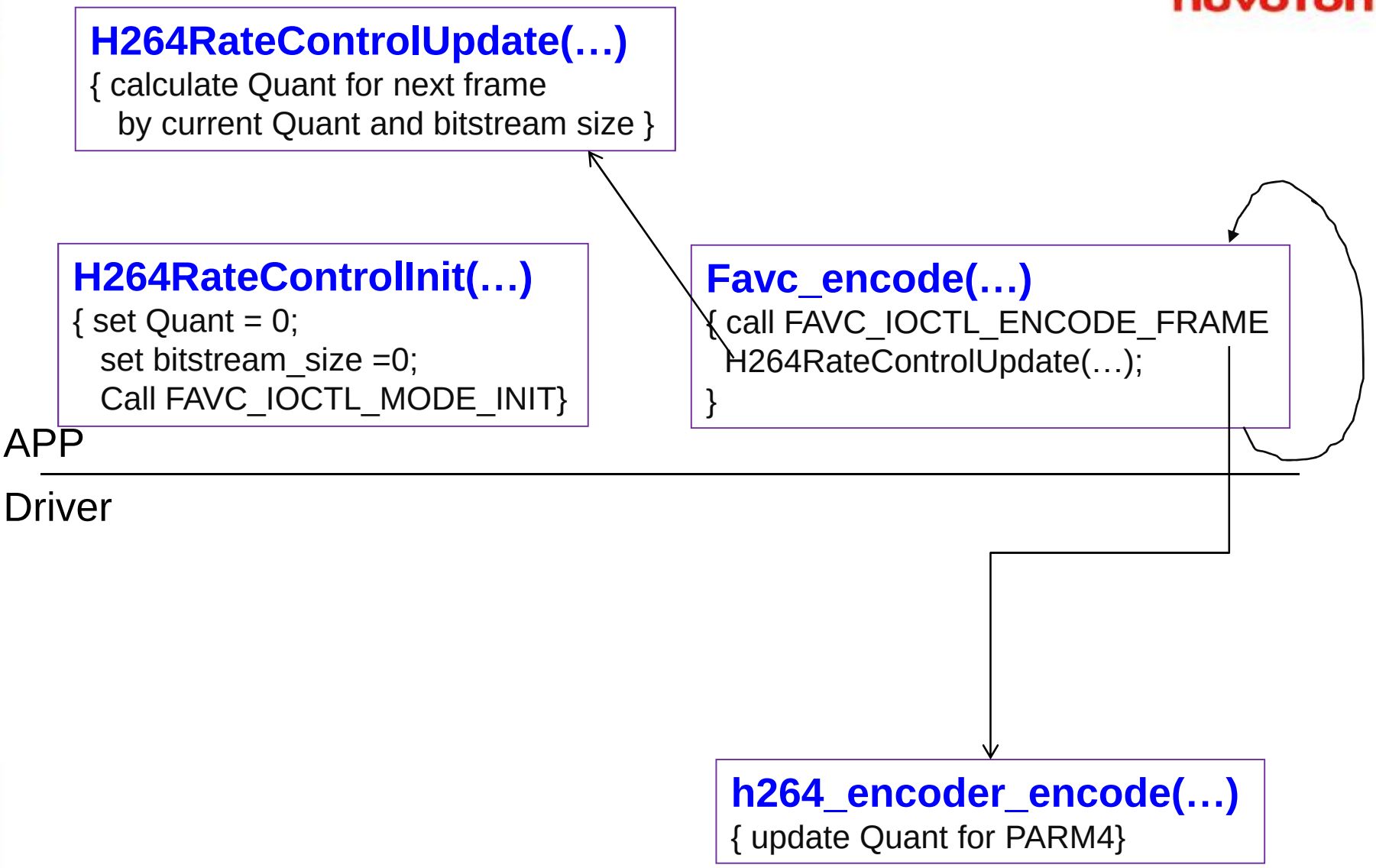


Linux Decoder Bitstram maintain

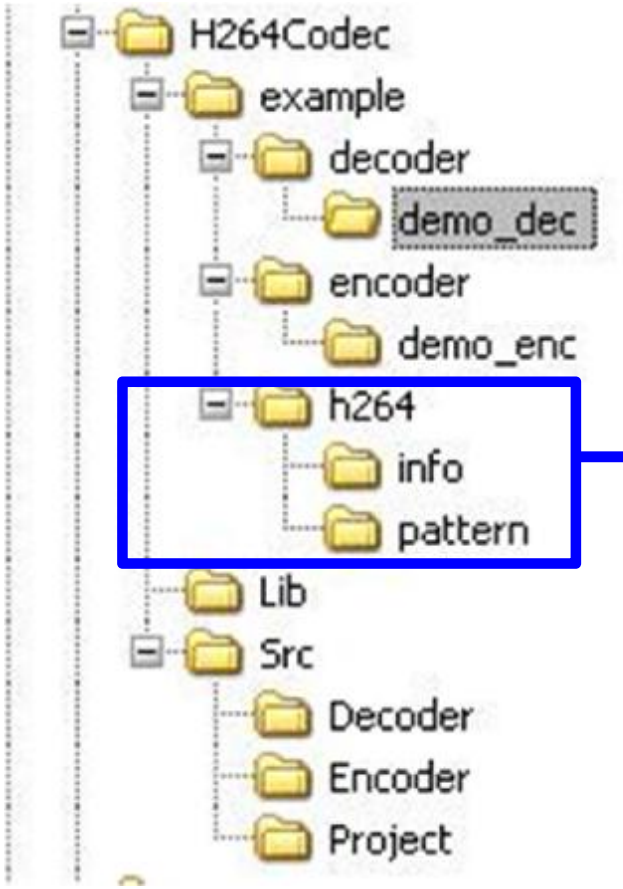


Rate Control

- Rate control is controlled by application
  - H264RateControlInit(…,initq,) function initialize the related parameter **à** if initq=0, all the quant of rate control is “0”. It means fixed quant=0.
  - H264RateControUpdate(h264_ratec, …) calculate next Quant value based on current Quant value and bitstream size
  - Next Bitstream use h264_ratec.rtn_quant as Quant value for current bitstream encoding.


H264RateControlUpdate(…)
{ calculate Quant for next frame
by current Quant and bitstream size }
H264RateControlInit(…)
{ set Quant = 0;
set bitstream_size =0;
Call FAVC_IOCTL_MODE_INIT}
Favc_encode(…)
{ call FAVC_IOCTL_ENCODE_FRAME
H264RateControlUpdate(…);
}
APP
Driver
h264_encoder_encode(…)
{ update Quant for PARM4}

non-OS Library



Copy h264 folder to SD card as the test source pattern

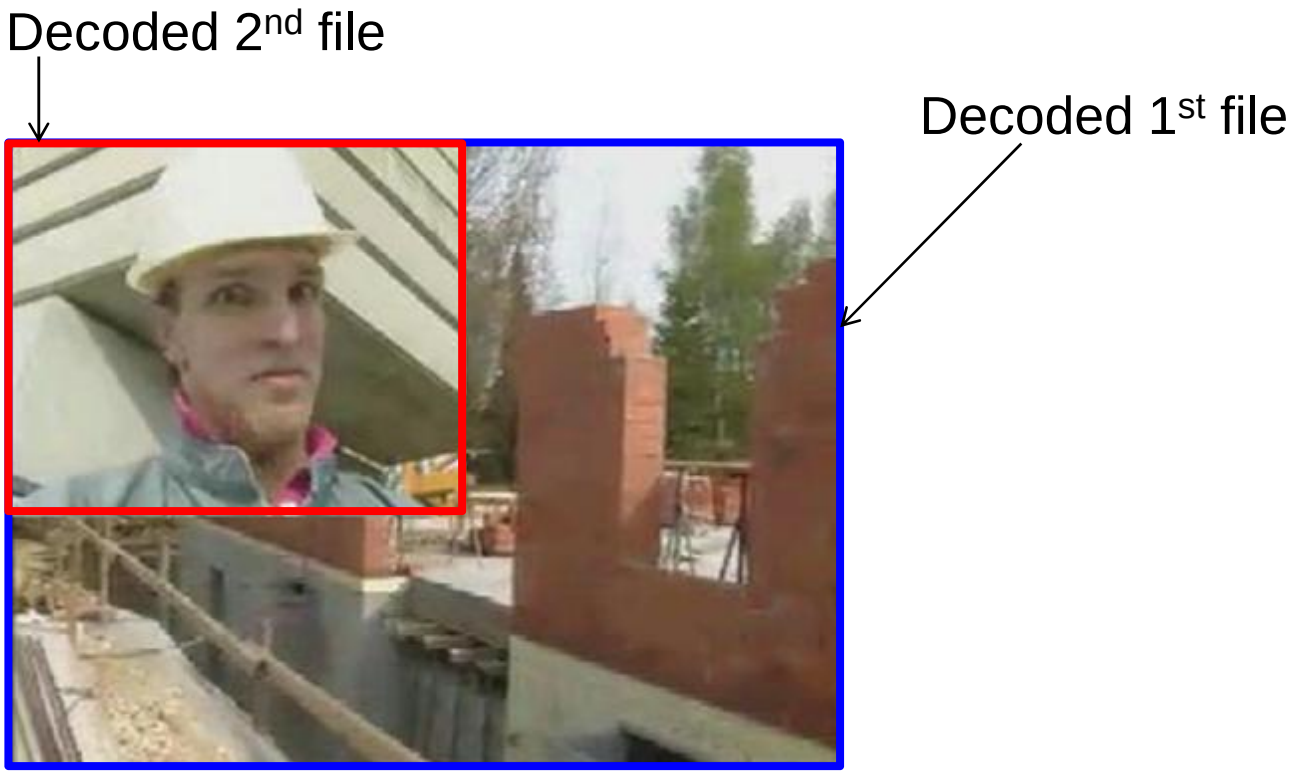
Non-OS Example

- Decode Sample
  - Source pattern :
    - H.264 bitstream are in **SDCard\h264\pattern** folder
    - H.264 bitstream length are in **SDCard\h264\info** folder
      - **p** The file name of H264 bitstream length is same as bitstream, but extension is .txt
      - **p** For example, bitstream.264 in h264\pattern, and bitstream.txt in h264\info folder
    - all *.264 or *.jsv bitstream in C:\h264\pattern folder will be decoded
  - Decoded image is converted by VPE to show on panel (located at the right-upper coner)
  - **Change Linked VPOST library if it is different panel.**

Non-OS Sample ..

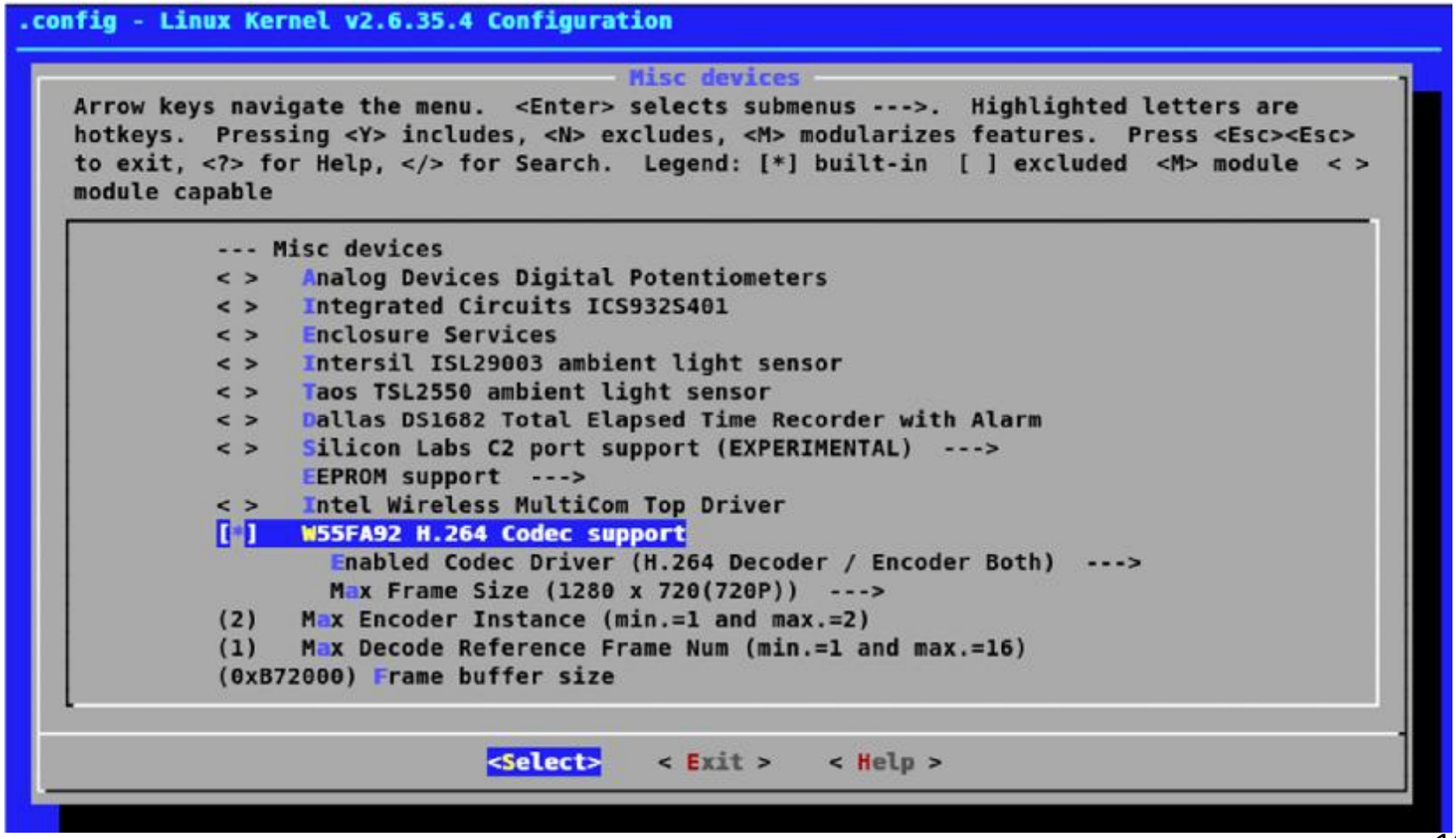
- Encode Sample
  - Source pattern :
    - H.264 bitstream are in **SDCard\h264\pattern\foreman_qcif_2d.yuv** folder
  - Output :
    - Encoded bitstream **encQcif.264** at SDCard\h264
    - Encoded bitstream length for each frame **Qcifframe_info.txt**

Decode example



Linux configure

- Menuconfig
  - Device Drivers **à** Misc devices



Linux application

→Decoder source pattern

- Linux Driver source code is at

  W55FA92\Tags\Linux-2.6.35.4_fa92\drivers\misc\codec264 folder
- Linux application
  - decoder
    - Decode all
    - H.264 bitstream are in ..**\pattern** folder
    - H.264 bitstream length are in ..**\info** folder
  - encoder_vin :
    - Encode QVGA bitstream from VideoIn
    - Encoded encQVGA.264 bitstream is at application\h264codec folder
    - Encode bitsteam length file encQVGA.txt is at application\h264codec folder

Tool

- FA92 Linux H264 Buf Calculate.xls :
  - Calculate the H.264 Encoder & Decoder Buffer requirement for each resolution.
- Find264Length.exe
  - Find each frame bitstream length in H.264 bitstream
- N2F_H2642D.exe
  - Convert the Planar YUV420 format to Planar YUV420 MB format.
- YUVviewer.exe
  - View the Planar YUV420 format Video

FA92 Linux H264 Buf Calculate

Encoder	Decimal	hexadecimal
Image Width	1280	500
Image Height	720	2D0
Driver Instance	2	
Bitstream Buffer	1384448	152000
Reconstruct Buffer	2768896	2A4000
SysInfo Buffer	230400	38400
DMA buffer	624	270
Encoder Only Total Buffer :	8773632	85E000

Decoder		
Image Width	1280	500
ImageHeight	720	2D0
Reference Number	1	
Decoded Bitstream Buffer	1384448	152000
Decoded Buffer	2764800	2A3000
INTRA predict size	2560	A00
MB inform size	2560	A00
Output buffer	3686400	384000
Decoder Only Total Buffer	7843840	77B000

Linux Configure File	Decimal	Hexadecimal
Encoder + Decoder total Buffer size in Linux Config file	16617472	FD9000

Note : Input B2, B3, B4 and B15 for calculation

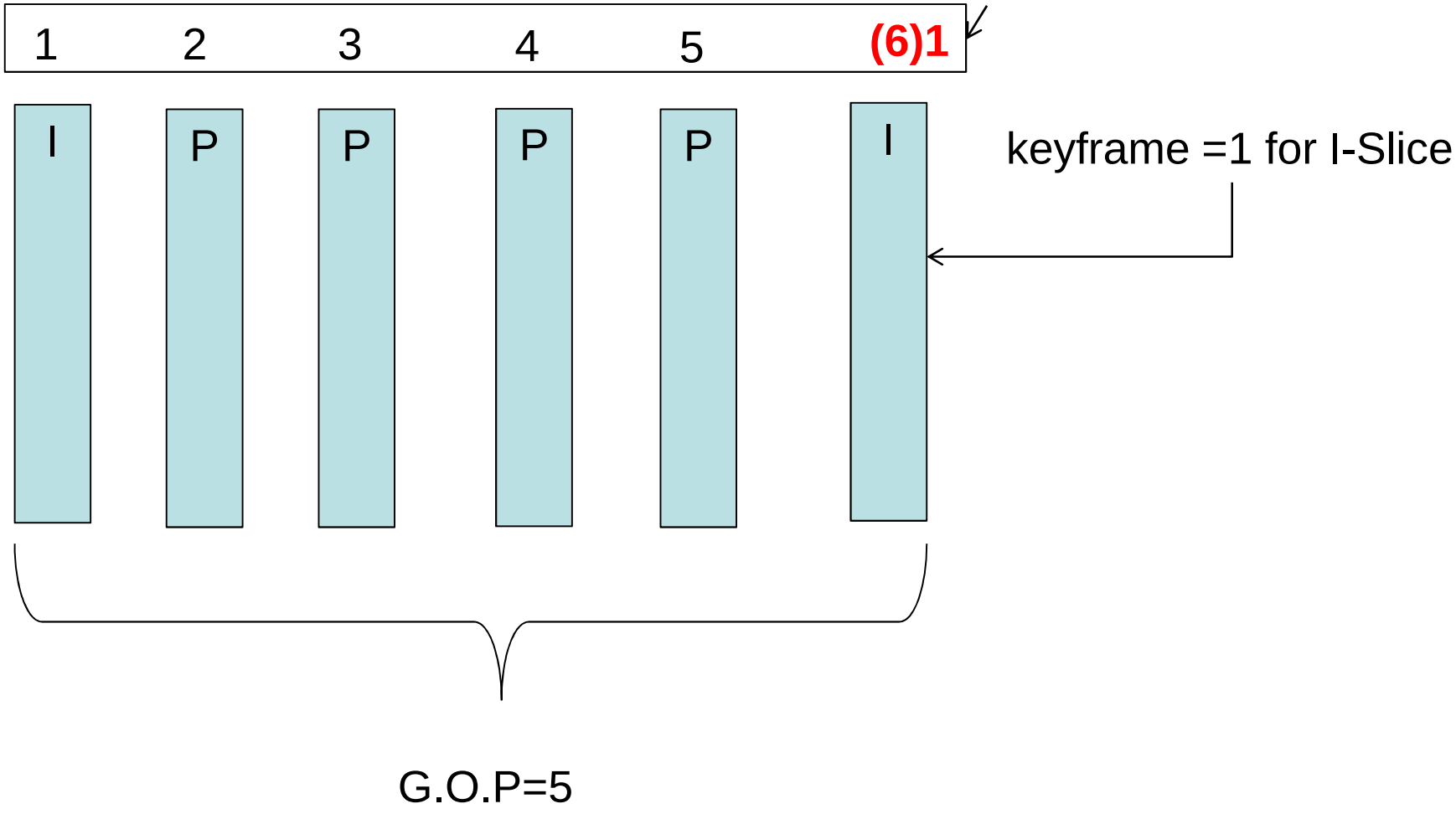
Encoder Init

```
            // 1 : force the encoder to create all I Frame
           // 0 : forces the encoder to crate a P frame
            // -1 : let the encoder decode (based on the u3IPIntervale)
enc_param.intra = -1;
enc_param.u32IPInterval =30;                    // G.O.P.
enc_param.u32BitRate = 64*1000;  // unit : bps
enc_param.fFrameRate = 30;          // vui.num_nuits_in_tick
            // 1: force encoder to output sps+pps
            // 0: force the encoder to output sps+pps on any I frmae
            // -1 : (default) only output sps+pps on first IDR frame
enc_param.ssp_output = -1;
```

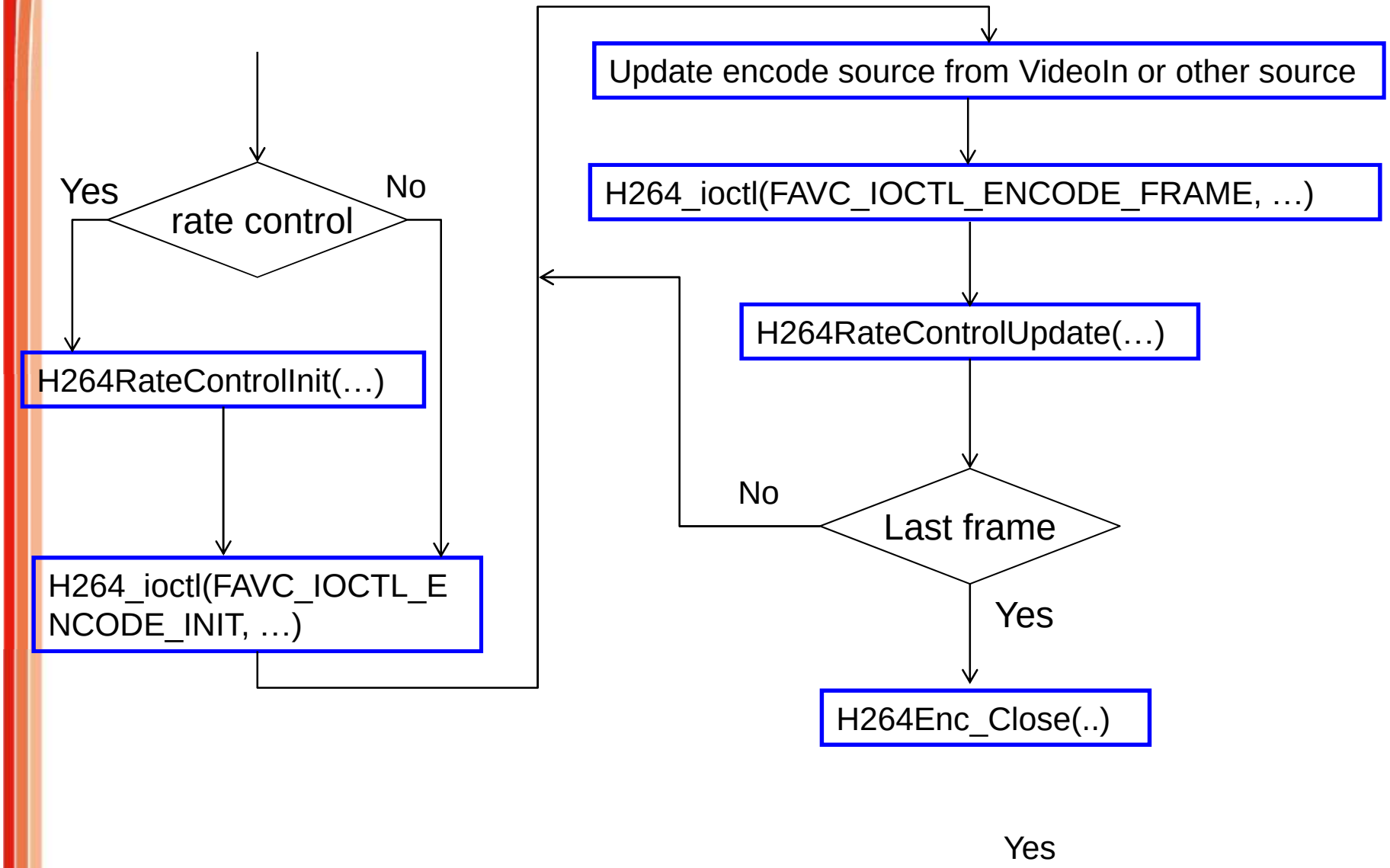
H264_ioctl(FAVC_IOCTL_ENCODE_INIT, & enc_param) //non_OS

or

Ioctl(favc_enc_fd,FAVC_IOCTL_ENCODE_INIT, &enc_param) // Linux


1
2
3
4
5
(6)1
I
P
P
P
P
I
keyframe =1 for I-Slice
G.O.P=5

Encode Flow


Update encode source from VideoIn or other source
H264_ioctl(FAVC_IOCTL_ENCODE_FRAME, …)
H264RateControlUpdate(…)
No
Last frame
Yes
H264Enc_Close(..)
Yes
rate control
Yes
No
H264RateControlInit(…)
H264_ioctl(FAVC_IOCTL_E
NCODE_INIT, …)

Decoder Init

Defined in favc-avcodec.h

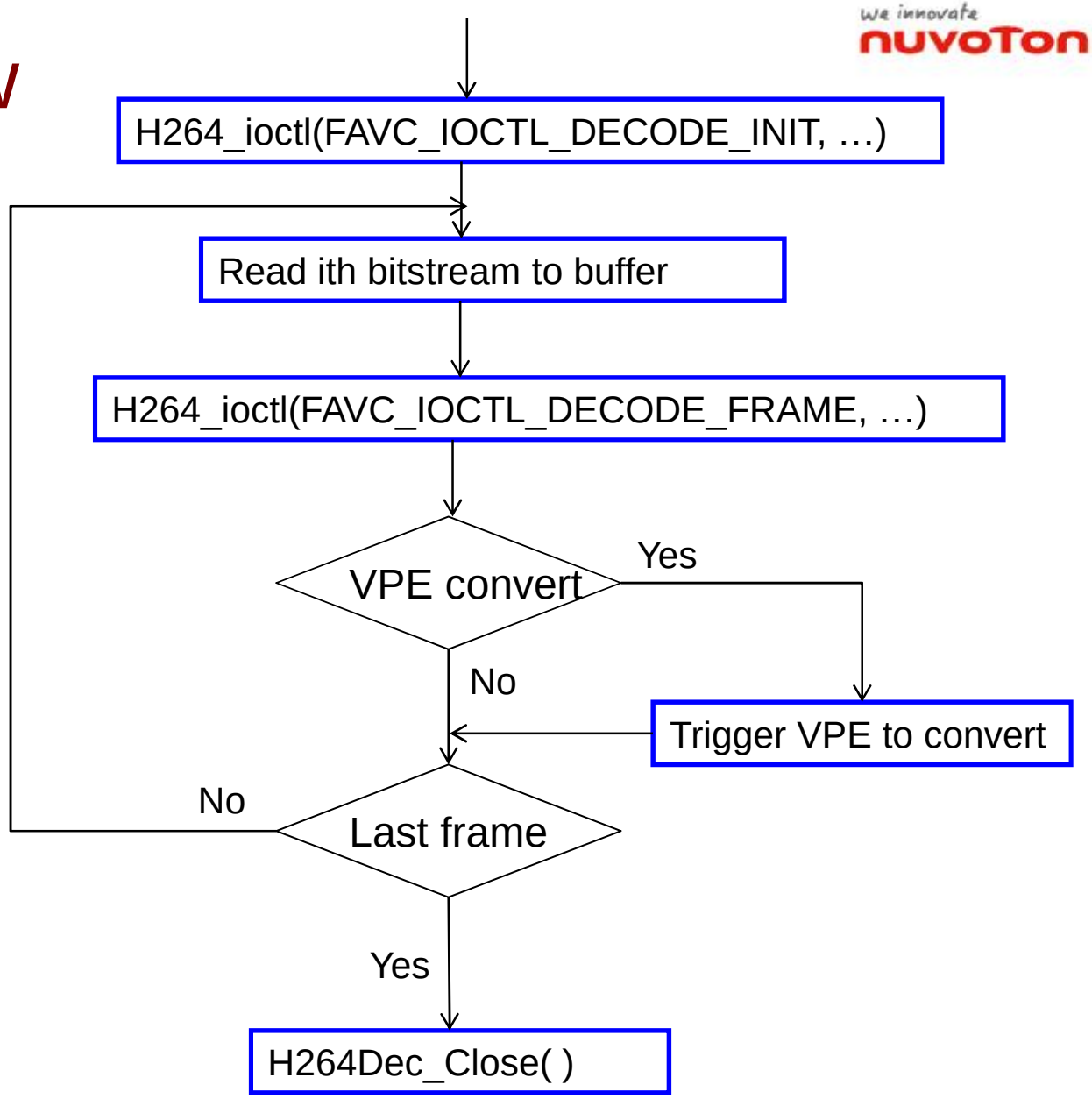
```
typedef struct
{
    UINT32 u32API_version;                  // API version (0x00010000)
   UINT32 u32MaxWidth;                      // Not used now
   UINT32 u32MaxHeight;                     // Not used now
   UINT32 u32FrameBufferWidth;      // if (u32FrameBufferWidth != -1), decoded image width is cropped with u32FrameBufferWidth
                                    // if (u32FrameBufferWidth == -1), decoded image width is continued on memory
    UINT32 u32FrameBufferHeight;    // if (u32FrameBufferHeight != -1), decoded image height is cropped with u32FrameBufferHeight
                                    // if (u32FrameBufferHeight == -1), decoded image height is continued on memory
   UINT32 u32Pkt_size;              // Current decoding bitstream length ( the exact bitstream length for one frame)
    UINT8  *pu8Pkt_buf;             // Current decoding bitstream buffer address (application ready bitstream here)
    UINT32 pu8Display_addr[3];      // Buffer address for decoded data
    UINT32 got_picture;             // 0 -> Decoding has someting error. 1 -> decoding is OK in current bitstream
    UINT8  *pu8BitStream_phy;       // physical address. buffer for bitstream (allocated and used by library only)
    UINT32 u32OutputFmt;            // Decoded output format, 0-> Planar YUV420 format, 1-> Packet YUV422 foramt
    UINT32 crop_x;                  // pixel unit: crop x start point at decoded-frame (not supported now)
    UINT32 crop_y;                  // pixel unit: crop y start point at decoded-frame (not supported now)

    FAVC_DEC_RESULT tResult;   // Return decoding result by library


} FAVC_DEC_PARAM;
```

H264_ioctl(FAVC_IOCTL_DECODE_INIT, & dec_param)

Decode Flow


H264_ioctl(FAVC_IOCTL_DECODE_INIT, …)
Read ith bitstream to buffer
H264_ioctl(FAVC_IOCTL_DECODE_FRAME, …)
VPE convert
Yes
No
Trigger VPE to convert
Last frame
No
Yes
H264Dec_Close( )