

# JCTVC-M0146

## VUI extension and SEI for chroma sampling filter

Takeshi Chujoh      TOSHIBA Corporation,

Kimihiko Kazui      FUJITSU LABORATORIES LTD.

Pankaj Topiwala      FastVDO LLC.

Wei Dai

Madhu Krishnan

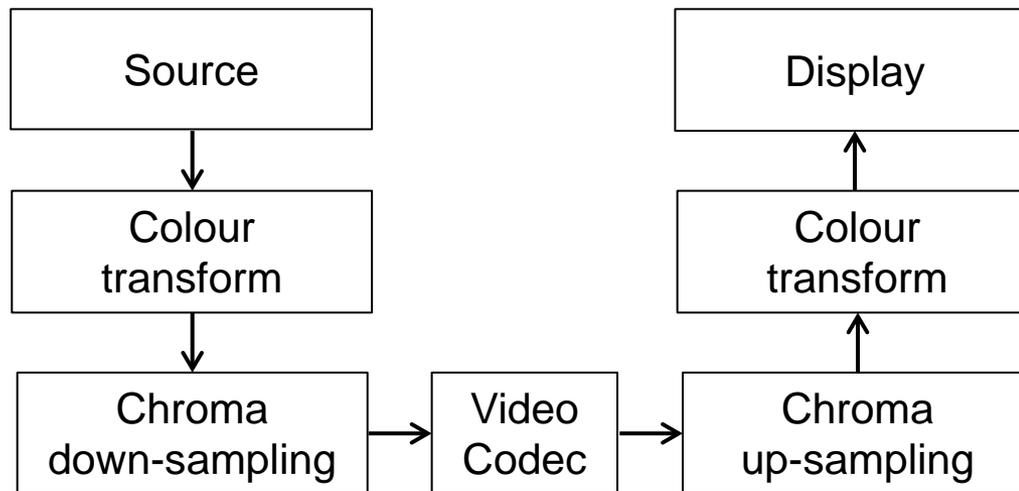
Marta Mrak

BBC

# Background 1

---

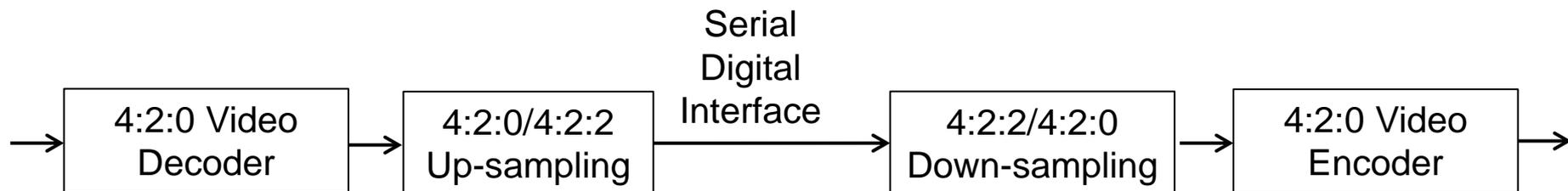
- In VUI, video signal specifies only chroma sample locations.
  - Consistency of chroma sampling filters is needed..



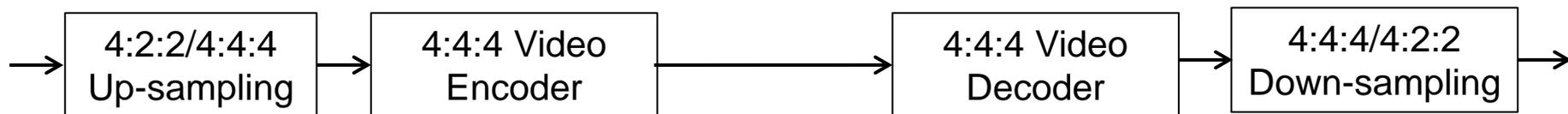
- JCTVC-K0211(FastVDO) discusses several filters which are designed to minimize loss in a single 4:2:2/4:2:0/4:2:2 (or 4:4:4/4:2:0/4:4:4) conversion.

# Background 2

- A problem of chroma shift when two or more codecs are concatenated is known.



- SMPTE RP2050-1:2012 defines perfect reconstruction filter set.
  - Filter coefficients for 4:2:0/4:2:2 and 4:2:2/4:2:0 conversions.



- JCTVC-L0162 and JCTVC-K0302 (BBC) discuss this case.
  - JPEG2000 5/3 filter is used.

# Examples

---

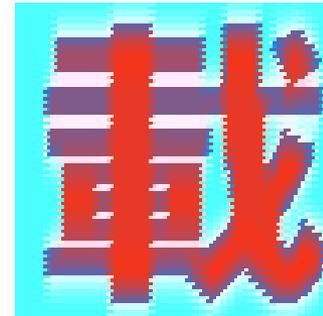
- Degradation of repeat between down and up sampling process.



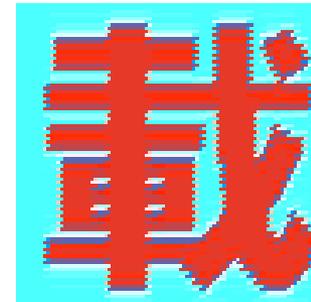
1 time



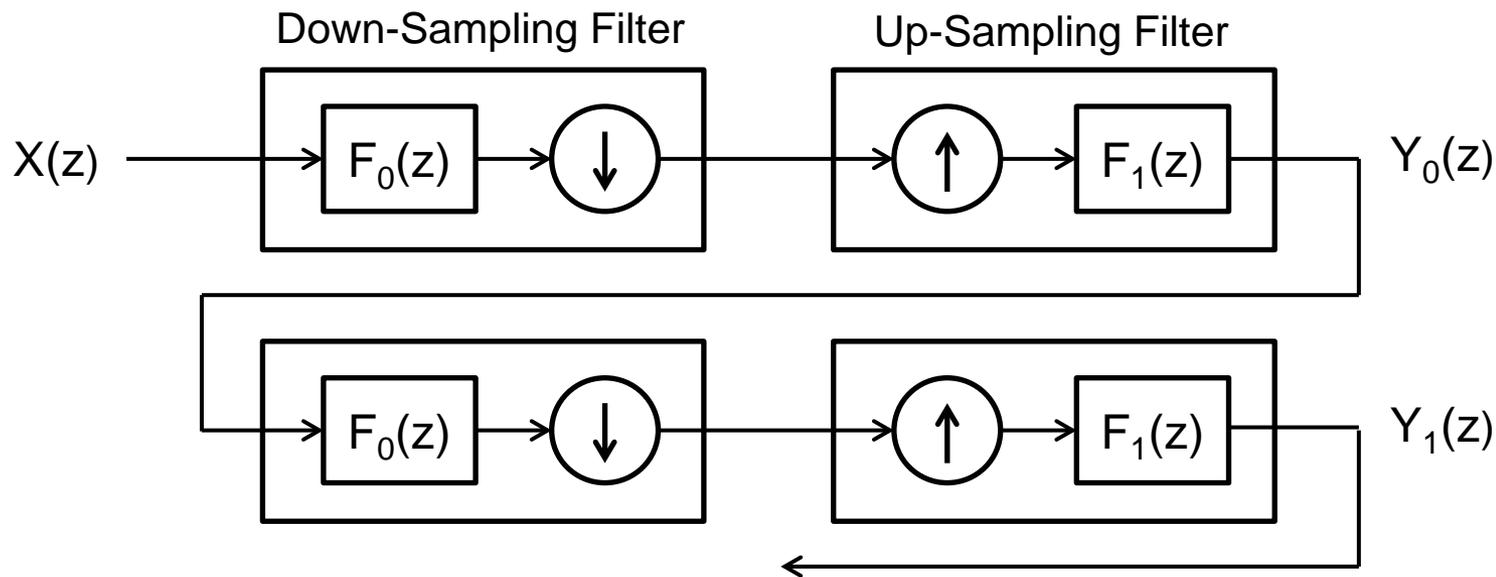
4 times



16 times



# Perfect reconstruction filter



If  $F_0(z) F_1(z) + F_0(z) F_1(z) = 2$  then  $Y_0(z) = Y_1(z)$

- **SMPTE RP 2050-1 and JPEG2000 5/3 filter are satisfied this condition.**
- **There is no degradation of repeat between down and up sampling process.**

# Proposal

---

- **A framework of extended VUI and SEI is introduced.**
- **VUI indicates predefined chroma sampling filter set information**
  - Vertical and horizontal filter indicators
  - Vertical filtering process flag for field picture
- **Chroma sampling filtering hint SEI can specify explicit filter set information**

# Extension of VUI

---

sps_parameter_set_rbsp() {	Descriptor
...	
if( sps_extension_flag ) {	
if ( vui_parameters_present_flag )	
vui_extension_parameters_present_flag	u(1)
if ( vui_extension_parameters_present_flag )	
vui_extension_parameters( )	
while( more_rbsp_data( ) )	
sps_extension_data_flag	u(1)
rbsp_trailing_bits( )	
}	

# Proposed VUI syntax

---

vui_extension_parameters( ) {	Descriptor
if( chroma_loc_info_present_flag ) {	
chroma_filter_info_present_flag	u(1)
if( chroma_filter_info_present_flag ) {	
ver_chroma_filter_idc	u(8)
hor_chroma_filter_idc	u(8)
ver_filtering_process_flag	u(1)
}	
}	
}	

# Chroma filter index in vertical direction

Value	Vertical chroma sampling filter	Informative Remark
0	Unspecified	Chroma filter is unknown or is determined by the application.
1	User-defined	Filter coefficients are specified in the chroma sampling filter hint SEI message
2	$F_V[0][0] = \{-3, -19, 34, 500, 500, 34, -19, 3\}$ $F_V[0][1] = \{19, 103, 1037, -135\}$ $F_V[1][0] = \{-8, -26, 115, 586, 409, -48, -4, 0\}$ $F_V[1][1] = \{24, -41, 1169, -128\}$ $F_V[1][2] = \{-76, 783, 330, -13\}$	SMPTE RP 2050-1:2012 Chroma sample type should be 0.
3	$F_V[0][0] = \{1, 0, -3, 0, 10, 16, 10, 0, -1, 0, 1\}$ $F_V[0][1] = \{1\}$ $F_V[0][2] = \{-1, 5, 5, -1\}$	Chroma sample type should be 2,3,4 or 5 and DistinctParityFlag should be equal to 0.
4 ... 255	Reserved	For future use by ITU-T   ISO/IEC

# Chroma filter index in Horizontal direction

Value	Horizontal chroma sampling filter	Informative Remark
0	Unspecified	Chroma filter is unknown or is determined by the application.
1	User-defined	Filter coefficients are specified in the chroma sampling filter hint SEI message
2	$F_H[0][0] = \{-1, 2, 6, 2, -1\}$ $F_H[0][1] = \{1\}$ $F_H[0][2] = \{1, 1\}$	ITU-T Rec. T.800   ISO/IEC15444-1, 5/3 filter
3	$F_H[0][0] = \{1, 0, -3, 0, 10, 16, 10, 0, -3, 0, 1\}$ $F_H[0][1] = \{1\}$ $F_H[0][2] = \{-1, 5, 5, -1\}$	Chroma sample type should be 0, 2 or 4.
4 ... 255	Reserved	For future use by ITU-T   ISO/IEC

# Proposed SEI syntax

	Descriptor
chroma_sampling_filter_hint( payloadSize ) {	
<b>target_format_idc</b>	ue(v)
<b>perfect_reconstruction_flag</b>	u(1)
if( ver_chroma_filter_idc == 1 ) {	
<b>num_vertical_filters</b>	ue(v)
NumVerFilters = num_vertical_filters	
if( NumVerFilters > 0 )	
for( i=0; i < NumVerFilters; i++ ) {	
<b>ver_tap_length_minus1[ i ]</b>	ue(v)
for( j=0; j <= ver_tap_length_minus1[ i ]; j++ ) {	
<b>ver_filter_coeff[ i ][ j ]</b>	se(v)
}	
}	
}	
if( hor_chroma_filter_idc == 1 ) {	
<b>num_horizontal_filters</b>	ue(v)
NumHorFilters = num_horizontal_filters	
if( NumHorFilters > 0 )	
for( i=0; i < NumHorFilters; i++ ) {	
<b>hor_tap_length_minus1[ i ]</b>	ue(v)
for( j=0; j <= hor_tap_length_minus1[ i ]; j++ ) {	
<b>hor_filter_coeff[ i ][ j ]</b>	se(v)
}	
}	
}	
}	
}	

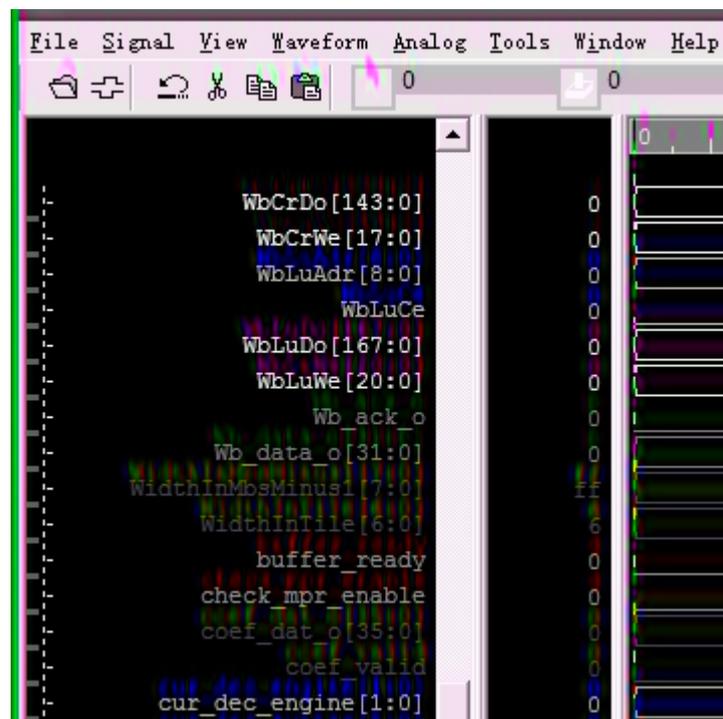
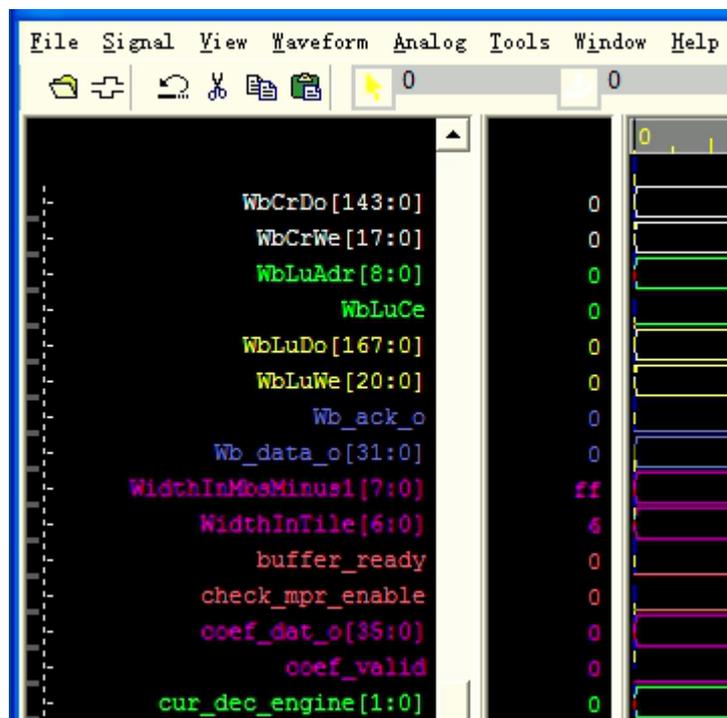
# Demo

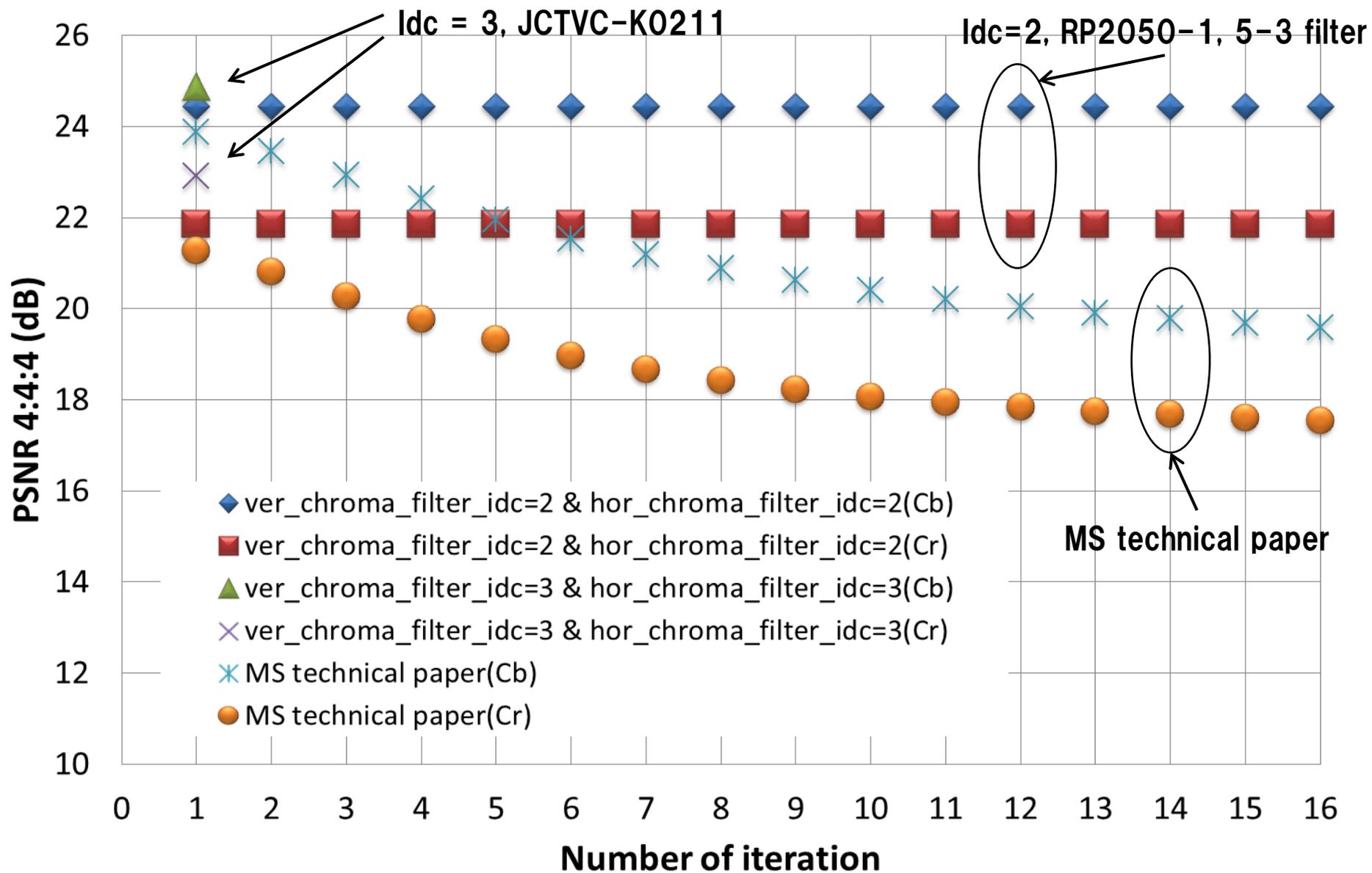
---

- **First frame of**  
“sc\_cad\_waveform\_1920x1080\_20\_200\_8bit\_444.yuv”
- **Down sampling**
  - 4:4:4 to 4:2:2 (ver\_chroma\_filter\_idc=2, JPEG2000 5-3 filter)
  - 4:2:2 to 4:2:0 (hor\_chroma\_filter\_idc=2, SMPTE RP2050-1)
- **Up sampling**
  - Left side
    - 4:2:0 to 4:2:2 (hor\_chroma\_filter\_idc=2, SMPTE RP2050)
    - 4:2:2 to 4:4:4 (ver\_chroma\_filter\_idc=2, JPEG200 5-3 filter)
  - Right side
    - 4:2:0 to 4:2:2 (MS technical paper)
    - 4:2:2 to 4:4:4 (MS technical paper)

[http://technet.microsoft.com/en-us/subscriptions/dd206750\(v=vs.85\).aspx](http://technet.microsoft.com/en-us/subscriptions/dd206750(v=vs.85).aspx)
- **16 times iteration between down and up samplings**

# After 16 times iteration of down and up samplings





# Conclusion

---

- **Additional VUI and SEI message for chroma sampling filter has been proposed.**
  - Any conversion of 4:4:4, 4:2:2 and 4:2:0
- **Reduction of conversion losses of chroma format**
- **Joint four companies proposal.**
  - Toshiba, Fujitsu Lab., FastVDO and BBC

**TOSHIBA**

Leading Innovation >>>

**FUJITSU**

**FastVDO**

**B B C**