

**JCTVC-L0049**  
**SEI MESSAGE: INDEPENDENTLY DECODABLE**  
**REGIONS BASED ON TILES**

InterDigital Communications, LLC

Huawei Technologies Co., Ltd.,

eBrisk Video

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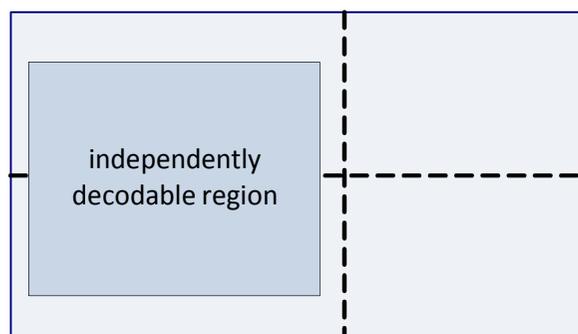
# Motivation

- Independently decodable region is a useful feature for many video applications, especially on mobile
  - Frame compatible 3D video to 2D-only display
  - Multi-point video conference system
  - ClassX Mobile, an e-learning system from Stanford, allows users to pan/zoom into a portion of the video
- Goal: to provide better coding feature support in HEVC
  - **reduced complexity and power consumption on mobile devices**



## Independently decodable region and tiles

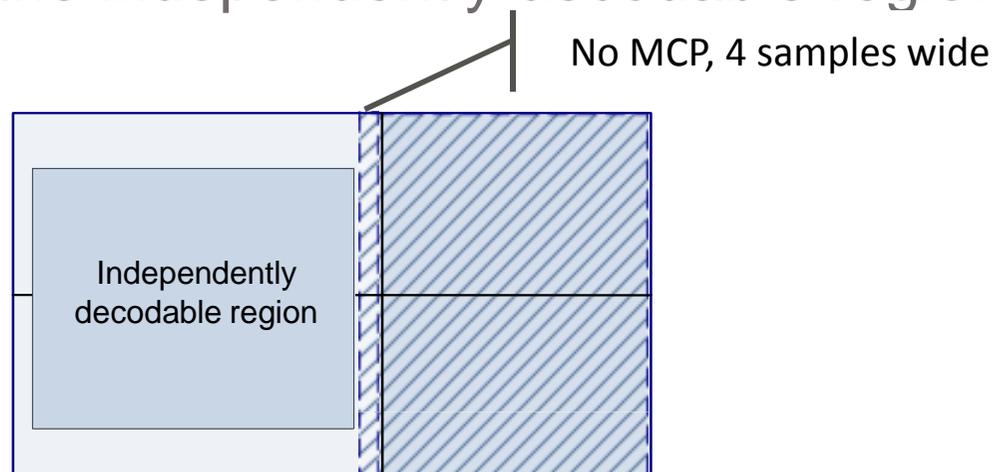
- Tile is a natural choice for independently decodable region support
  - Tiles are independently decodable units
  - Tiles are similarly shaped as independently decodable region



- Only two tiles on the left needed to display the region
- But, in the current HEVC spec, all tiles must be decoded for decoding of future pictures
- Proposal: to constrain the range of MCP and to signal such constraint in the bitstream to enable independently decodable region

## MCP range constraints

- MCP cannot be based on samples outside of the tiles containing the independently decodable region



- Additionally, MCP cannot be based on samples within a 4-pixel-wide band on the boundary between independently-decodable-region tiles and non-independently-decodable-region tiles
  - If `loop_filter_across_tiles_enabled_flag = 1`
- Any deviation of sample values from correctly decoded values is contained within the 4-sample-wide band

## Proposed SEI message

	<b>Descriptor</b>
tile_section () {	
<b>num_tile_sections</b>	ue(v)
for( i = 0; i < num_tile_sections; i++ ) {	
<b>num_tiles_in_section_minus1[ i ]</b>	ue(v)
for( j = 0; j <= num_tiles_in_section_minus1[ i ]; j++ )	
<b>tile_index[ i ][ j ]</b>	ue(v)
<b>tile_section_exact_match_flag[i]</b>	u(1)
}	
}	

## Proposed semantics

- **num\_tile\_sections** specifies the number of tile sections in the picture. **num\_tile\_sections** shall be in the range of 0 to  $(\text{num\_tile\_columns\_minus1} + 1) * (\text{num\_tile\_rows\_minus1} + 1)$ , inclusive. If **num\_tile\_sections** is not present, it is inferred to be 0.
- **num\_tiles\_in\_section\_minus1**[ i ] plus 1 specifies the number of tiles in the i-th tile section. **num\_tiles\_in\_section\_minus1**[ i ] shall be in the range of 0 to  $(\text{num\_tile\_columns\_minus1} + 1) * (\text{num\_tile\_rows\_minus1} + 1) - 1$ , inclusive.
- **tile\_index**[ i ] [ j ] specifies the index of the j-th tile in the i-th tile section in the picture. **tile\_index**[ i ] [ j ] shall be in the range of 0 to  $(\text{num\_tile\_columns\_minus1} + 1) * (\text{num\_tile\_rows\_minus1} + 1) - 1$ , inclusive. The index values of the tiles in a picture are assigned by starting from 0 in the top left corner, and incrementing by 1 following the raster scan order.
- **tile\_section\_exact\_match\_flag**[ i ] indicates whether decoding only the i-th tile section produces reconstructed samples that are exactly the same as decoding the entire picture.

## Performance impact

- Average rate increase 1.4% with MCP restriction, LFCrossTileBoundaryFlag = 0

		HM8.1				HM8.1+MCP restriction				% rate increase	Y PSNR drop
		kbps	Y psnr	U psnr	V psnr	kbps	Y psnr	U psnr	V psnr		
Class A RA	Traffic	13157.84	41.66	41.54	44.22	13328.33	41.65	41.54	44.21	1.3%	-0.01
	PeopleOnStreet	32763.69	40.18	44.89	44.67	33036.22	40.17	44.87	44.66	0.8%	-0.01
	Nebuta	216482.93	39.04	39.14	37.71	217066.48	39.04	39.13	37.70	0.3%	-0.01
	SteamLocomotive	23610.19	41.37	46.22	45.89	23795.98	41.37	46.21	45.89	0.8%	-0.01
Class B RA	Kimono	4792.63	41.61	43.47	45.26	4855.91	41.59	43.46	45.25	1.3%	-0.01
	ParkScene	7663.60	40.07	42.38	43.79	7769.78	40.06	42.38	43.78	1.4%	-0.01
	Cactus	18278.54	38.48	40.04	43.60	18506.47	38.47	40.04	43.59	1.2%	-0.01
	BasketballDrive	17362.12	39.16	43.77	44.99	17624.34	39.15	43.77	44.97	1.5%	-0.01
	BOTerrace	39673.70	37.42	42.11	44.29	40139.15	37.41	42.11	44.29	1.2%	-0.01
Class B LDB	Kimono	5209.49	41.68	43.26	44.75	5324.40	41.66	43.26	44.75	2.2%	-0.02
	ParkScene	7947.19	39.91	41.93	43.07	8112.59	39.89	41.92	43.06	2.1%	-0.01
	Cactus	19903.27	38.69	40.11	43.36	20184.61	38.68	40.10	43.35	1.4%	-0.01
	BasketballDrive	19815.99	39.42	43.64	44.84	20252.70	39.40	43.62	44.82	2.2%	-0.01
	BOTerrace	52655.31	38.23	41.95	44.08	53390.23	38.23	41.93	44.07	1.4%	-0.01

## Performance impact

- Average rate increase 2.5% with MCP restriction, LFCrossTileBoundaryFlag = 1

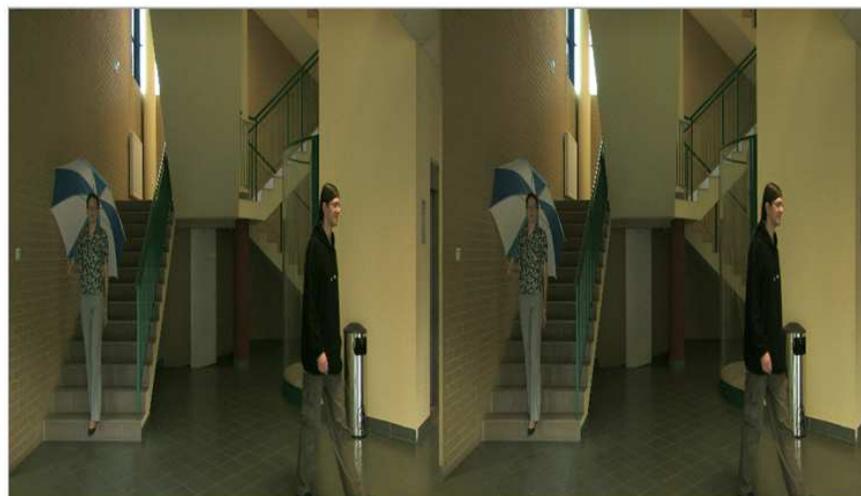
		HM8.1				HM8.1+MCP restriction				% rate increase	Y PSNR drop
		kbps	Y psnr	U psnr	V psnr	kbps	Y psnr	U psnr	V psnr		
Class A RA	Traffic	13155.03	41.66	41.54	44.21	13513.16	41.64	41.53	44.20	2.7%	-0.02
	PeopleOnStreet	32765.69	40.17	44.88	44.66	33267.28	40.17	44.85	44.64	1.5%	-0.01
	Nebuta	216469.62	39.04	39.13	37.70	217172.29	39.04	39.13	37.69	0.3%	-0.01
	SteamLocomotive	23626.29	41.37	46.21	45.89	23836.37	41.36	46.21	45.89	0.9%	-0.01
Class B RA	Kimono	4791.76	41.60	43.46	45.26	4900.66	41.59	43.45	45.24	2.3%	-0.02
	ParkScene	7659.24	40.07	42.38	43.78	7881.50	40.04	42.36	43.77	2.9%	-0.03
	Cactus	18274.74	38.48	40.03	43.59	19104.61	38.46	40.02	43.56	4.5%	-0.02
	BasketballDrive	17364.11	39.16	43.77	44.98	17687.30	39.14	43.75	44.96	1.9%	-0.01
	BOTerrace	39673.09	37.42	42.10	44.28	40411.13	37.41	42.10	44.28	1.9%	-0.01
Class B LDB	Kimono	5207.92	41.68	43.25	44.75	5374.80	41.66	43.25	44.74	3.2%	-0.02
	ParkScene	7948.53	39.90	41.92	43.07	8222.70	39.89	41.91	43.06	3.4%	-0.02
	Cactus	19918.55	38.69	40.09	43.35	20919.17	38.68	40.08	43.33	5.0%	-0.01
	BasketballDrive	19815.24	39.41	43.63	44.83	20339.15	39.40	43.61	44.81	2.6%	-0.01
	BOTerrace	52660.01	38.23	41.94	44.08	53641.76	38.22	41.93	44.06	1.9%	-0.01

## Performance impact

- Rate increase 1.02% with MCP restriction for frame compatible sequence Poznan\_Hall2.

	HM8.1				HM8.1+MCP restriction				% rate increase	Y PSNR drop
	kbps	Y psnr	U psnr	V psnr	kbps	Y psnr	U psnr	V psnr		
Poznan Hall2	341.3350	39.7070	45.3518	45.1736	344.8160	39.7057	45.3417	45.1803	1.02%	0

- No visual coding artifacts observed.



Original MFC Poznan\_Hall2



Reconstruction w/ MCP restriction

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## Conclusion

- Proposed to add independently decodable region coding support in HEVC
  - Independently decodable region has many use cases
  - Especially useful for mobile devices
- Discussed appropriate MCP range constraint at encoder that can limit the decoding error
- Proposed to use **tile section SEI** to signal the MCP range constraint
- Recommend to adopt tile section as a new SEI message