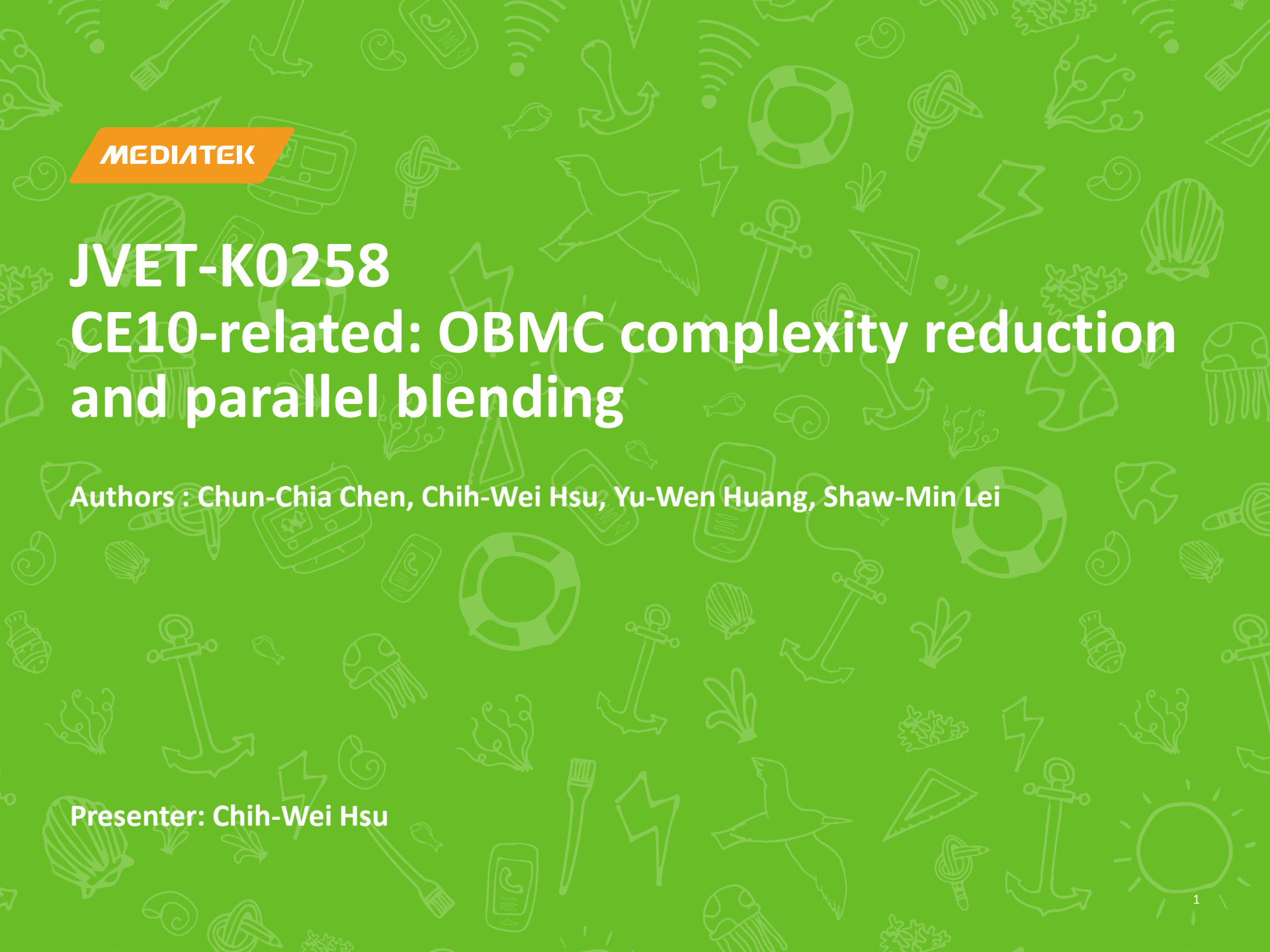


The background is a solid green color with a repeating pattern of white line-art icons. These icons include various nautical items like anchors, lifebuoys, and seashells, as well as outdoor and travel-related items like a compass, a map, a camera, and a bird in flight. The icons are scattered across the entire slide, creating a textured, thematic background.

MEDIATEK

JVET-K0258

CE10-related: OBMC complexity reduction and parallel blending

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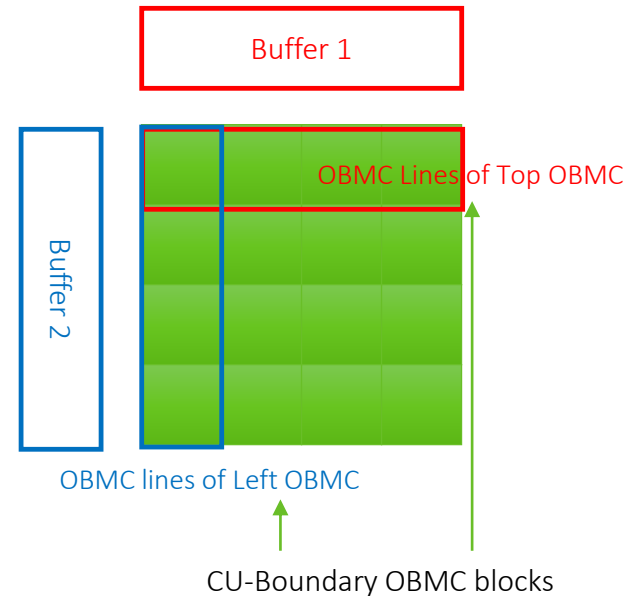
Overall Summary

- Proposed methods
 - Lossless runtime reduction
 - CU-boundary-only OBMC
 - Parallel sample blending process
- Combined results of proposed methods :

	Over VTM 1.0					Over BMS 1.0				
	Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
RA	-1.04%	-2.05%	-2.09%	105%	111%	-0.89%	-2.02%	-2.14%	101%	106%
LB	-1.41%	-1.81%	-1.95%	107%	113%	-1.38%	-2.38%	-2.26%	103%	107%

Proposed Method: Lossless Runtime Reduction

- L-buffer OBMC block reuse
 - Pre-store L-shape of OBMC results
 - Shared for different RDO processes of CU mode candidates
- MC merging
 - Merging OBMC blocks for MC
 - if adjacent OBMC blocks have the same motion information
- Applied for CU-boundary OBMC blocks



Proposed Method: Parallel OBMC Sample Blending Process

- Sequential OBMC sample blending process (conventional, JEM-based)

CU Boundary Mode

Directions loop
OBMC line loop

```
for (top->left) {
    for(k=0, 1, 2, 3) {
        C[] = (C[] *s_w(k) + OBMC[] + r(k)) >> s(k)
    }
}
```

Sub-CU Mode

```
for (top->left->bottom->right) {
    for(k= 0, 1 ) {
        C[] = (C[] *s_w(k) + OBMC[] + r(k)) >> s(k)
    }
}
```

Note :C[]:Current Block. OBMC[]: OBMC block(= L[] or R[] or T[] or B[]
for luma, s_w(i) = 3 7 15 31, r(i) = 2 4 8 16, s(i) = 2 3 4 5

- Parallel OBMC sample blending process (proposed)

$$F(x, y) = (L(x,y)*w(x) + R(x,y)*w(\text{width}-1-x) + T(x,y)*w(y) + B(x,y)*w(\text{height}-1-y) + C(x,y)*\text{rem_w}(x,y) + 16) \gg 5$$

L/R/T/B can be replaced to C if unavailable or same MV

Note : For Luma case:

w(i) = 8 4 2 1 (normal blending) or 8 4 0 0 (simplified blending)

Proposed Method: Parallel OBMC Sample Blending Process

- 3 examples
- CU-boundary mode, left-top 4x4 (having top, left OBMC)

$$F(x, y) = (L(x, y) * w(x) + R(x, y) * w(\text{width} - 1 - x) + T(x, y) * w(y) + B(x, y) * w(\text{height} - 1 - y) + C(x, y) * \text{rem_w}(x, y) + 16) \gg 5$$

$$= (L(x, y) * w(x) + C(x, y) * w(\text{width} - 1 - x) + T(x, y) * w(y) + C(x, y) * w(\text{height} - 1 - y) + C(x, y) * \text{rem_w}(x, y) + 16) \gg 5$$

$$= (L(x, y) * w(x) + T(x, y) * w(y) + C(x, y) * (32 - w(x) - w(y)) + 16) \gg 5$$

- CU-boundary mode, other top 4x4 (having only top OBMC)

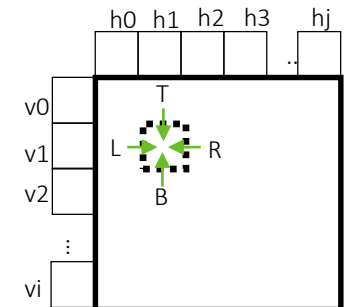
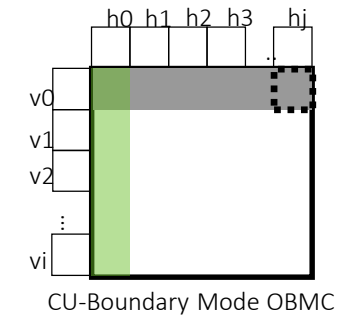
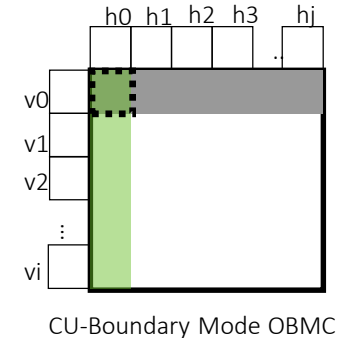
$$F(x, y) = (L(x, y) * w(x) + R(x, y) * w(\text{width} - 1 - x) + T(x, y) * w(y) + B(x, y) * w(\text{height} - 1 - y) + C(x, y) * \text{rem_w}(x, y) + 16) \gg 5$$

$$= (C(x, y) * w(x) + C(x, y) * w(\text{width} - 1 - x) + T(x, y) * w(y) + C(x, y) * w(\text{height} - 1 - y) + C(x, y) * \text{rem_w}(x, y) + 16) \gg 5$$

$$= (T(x, y) * w(y) + C(x, y) * (32 - w(y)) + 16) \gg 5$$

- Sub-CU mode, (having 4-direction OBMC)

$$F(x, y) = (L(x, y) * w(x) + R(x, y) * w(\text{width} - 1 - x) + T(x, y) * w(y) + B(x, y) * w(\text{height} - 1 - y) + C(x, y) * \text{rem_w}(x, y) + 16) \gg 5$$



(also simplified blending)

Simulation Results

Over BMS-1.0 and VTM-1.0

			VTM					BMS				
			Y (%)	U (%)	V (%)	EncT (%)	DecT (%)	Y (%)	U (%)	V (%)	EncT (%)	DecT (%)
1	JEM OBMC	RA	-1.03	-2.03	-2.08	113	123	-1.22	-2.18	-2.28	105	128
		LB	-1.36	-1.80	-1.90	116	124	-1.87	-3.03	-2.73	108	136
2	1 + L reuse + L merge	RA	-1.03	-2.03	-2.08	104	111	-1.22	-2.18	-2.28	103	123
		LB	-1.36	-1.80	-1.90	106	112	-1.87	-3.03	-2.73	105	131
3	CU boundary only OBMC	RA	-1.03	-2.03	-2.08	113	123	-0.88	-1.99	-2.06	104	111
		LB	-1.36	-1.80	-1.90	116	124	-1.37	-2.40	-2.18	106	112
4	3 + L reuse + L merge	RA	-1.03	-2.03	-2.08	104	111	-0.88	-1.99	-2.06	101	105
		LB	-1.36	-1.80	-1.90	106	112	-1.37	-2.40	-2.18	103	106
5	2 + parallel blending	RA	-1.04	-2.05	-2.09	105	111	-1.26	-2.29	-2.37	103	125
		LB	-1.41	-1.81	-1.95	107	113	-1.93	-3.16	-2.86	105	133
6	4 + parallel blending	RA	-1.04	-2.05	-2.09	105	111	-0.89	-2.02	-2.14	101	106
		LB	-1.41	-1.81	-1.95	107	113	-1.38	-2.38	-2.26	103	107

Conclusions

- 3 proposed methods
 - lossless reduction
 - L-reuse for encoder
 - L-merge for encoder/decoder
 - CU-boundary only OBMC
 - Parallel OBMC sample blending process
- Recommend for adoption
 - [A]: JEM OBMC + lossless reduction
 - [B]: CU-boundary only OBMC + lossless reduction
 - Better tradeoff compared to JEM-based OBMC
 - With sub-mode of CU (e.g. ATMVP, PMVD, affine) not fully decided, it's reasonable to exclude sub-type OBMC and re-explore the trade-off after the fully decision of sub-mode of CU
 - [C]: [B] + parallel OBMC sample blending process
 - Enable parallel design

Comparison with CE 10.2

#	Cond.	VTM-1.0					BMS-1.0				
		Y	U	V	EncT	DecT	Y	U	V	EncT	DecT
Proposed	RA	-1.04%	-2.05%	-2.09%	105%	111%	-0.89%	-2.02%	-2.14%	101%	106%
	LB	-1.41%	-1.81%	-1.95%	107%	113%	-1.38%	-2.38%	-2.26%	103%	107%
CE10.2.2	RA	-0.96%	-1.91%	-1.98%	107%	111%	-1.14%	-2.14%	-2.24%	102%	108%
	LB	-1.37%	-1.80%	-1.90%	110%	112%	-1.80%	-2.92%	-2.60%	105%	115%
CE10.2.3	RA	-1.01%	-2.03%	-2.09%	114%	125%	-1.24%	-2.22%	-2.37%	107%	131%
	LB	-1.40%	-1.93%	-2.07%	117%	120%	-1.94%	-2.98%	-2.77%	109%	136%
JEM OBMC	RA	-1.03%	-2.03%	-2.08%	113%	123%	-1.22%	-2.18%	-2.28%	105%	128%
	LB	-1.36%	-1.80%	-1.90%	116%	124%	-1.87%	-3.03%	-2.73%	108%	136%

Comparison with CE 10.2

	Proposal	# of blending lines	Blending order	Blending order	Runtime reduction technique
Proposed	JVET-K0258	2: CU area <64 or 4x4 sub CU 4: otherwise	Don't care	Parallel	L-shape reuse MV merge
CE10.2.2	JVET-J0015	2: CU area <64 or 4x4 sub CU 4: otherwise	Phase 1 : T->L (CU boundary) Phase 2 : T->L->B->R (other sub CU boundaries)	Sequential	MV merge skip similar MVs
CE10.2.3	JVET-J0022	2: CU width or height < 8 4 for one side or 2 for both sides: otherwise	(T,B)->(L,R)	Sequential	
JEM OBMC	JVET-K0258	2: CU area <64 or 4x4 sub CU 4: otherwise	T->L->B->R	Sequential	N/A