

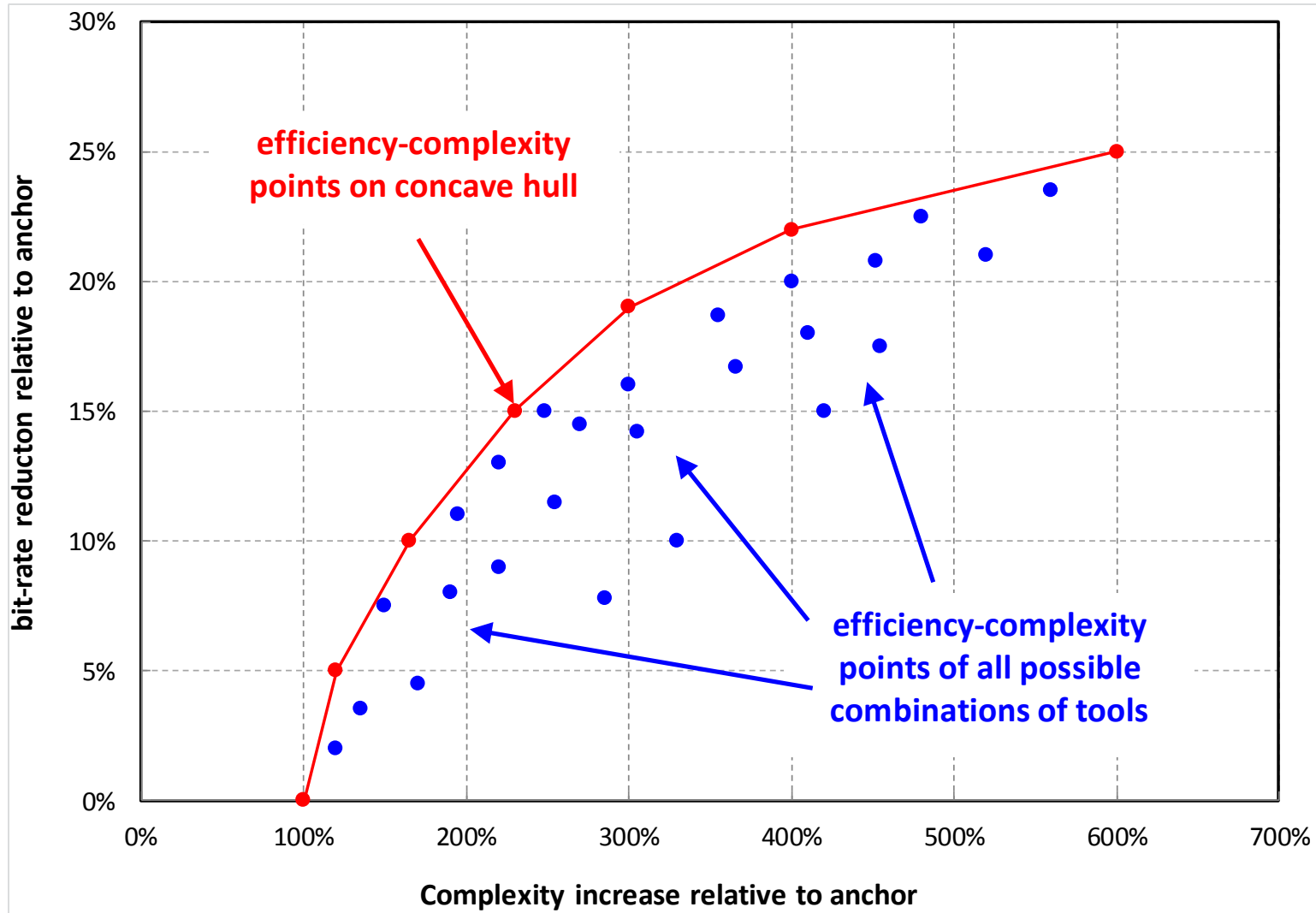
# Coding Efficiency / Complexity Analysis of JEM 1.0 coding tools for the Random Access Configuration

JVET-B0044

2nd Meeting: San Diego, CA, USA, 20–26 February 2016

H. Schwarz, C. Rudat, M. Siekmann, B. Bross, D. Marpe, T. Wiegand

# Basic Idea



Full evaluation  
would require

$$2^N = \underline{2^{22}} \text{ simulations!}$$

# Simplified Algorithm

1. Start with all tools off anchor
2. Include all tools in set of remaining coding tools
3. While the set of remaining coding tools is not empty do:
  - a. Determine coding efficiency and complexity for all tools included in the set of remaining coding tools relative to the anchor.
  - b. Choose coding tool with the steepest slope range
  - c. Enable the selected tool in the anchor
  - d. Remove it from the set of remaining tools.

->  $(N+1) N / 2 = \underline{253 \text{ simulations!}^3}$

## Even More Simplified Algorithm

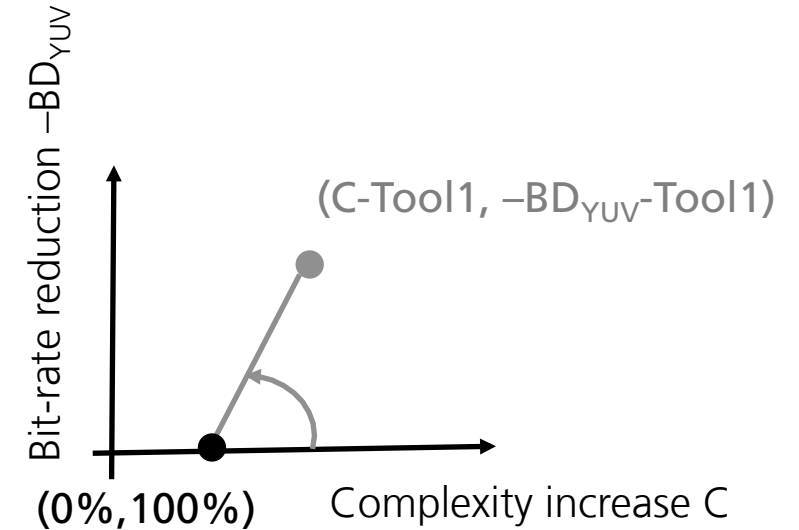
1. Each tool separately tested
2. Coding tools ordered by slope
3. Independent Evaluation:

$C$  and  $BD_{YUV}$  are simply added with decreasing slope

4. Successive Tool combination:

Tools are enabled successively with decreasing slope and gains measured relative to the anchor

->  $N+1+N = \underline{45 \text{ simulations}}$

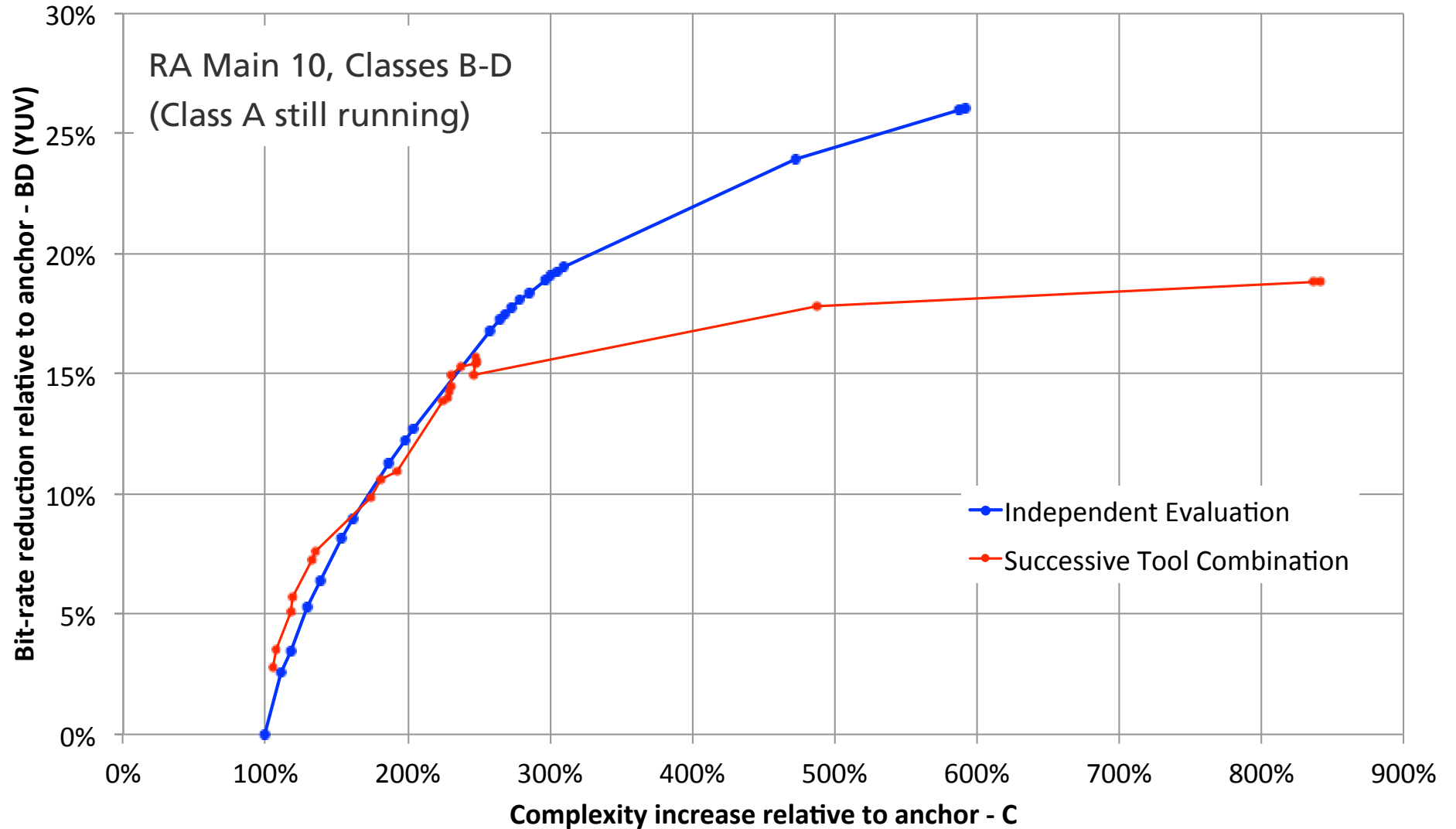


# Measurements

- **Anchor:** JEM 1.0 with all tools turned off (SIMD on)
- **Complexity:** 
$$C = ((C_{\text{enc}} - 1) + w * (C_{\text{dec}} - 1)) / (1 + w) + 1$$
$$w = 5$$
- **Coding efficiency:** 
$$BD_{YUV} = -(6 * BD_Y + BD_{Cb} + BD_{Cr}) / 8$$

# Results

NSST
IMV
EMT
LARGE_CTU
SUB_PU_TMVP
PDPC_INTRA
OBMC
AFFINE
RSAF
ALF
CTX_RESIDUALCODING
INTRA_4TAP_FILTER
INIT_PREVFRAME
MULTI_PARAM_CABAC
IC
T64
INTRA_BOUNDARY_FILTER
INTRA_65ANG_MODES
LMCHROMA
FRUC_MERGE
BIO
BAC_ADAPT_WDOW



Independent Evaluation	BD-Rate (YUV)		Runtime Increase			Slope Angle
	Independent	Cummulativ	Enc	Dec	C	
Anchor	0.00%	0.00%	100%	100%	100%	0
NSST	2.57%	2.57%	134.13%	106.13%	110.80%	13.37
IMV	0.92%	3.48%	151.61%	110.39%	117.26%	8.08
EMT	1.78%	5.26%	187.27%	118.32%	129.81%	8.07
LARGE_CTU	1.13%	6.39%	182.18%	129.23%	138.05%	7.78
SUB_PU_TMVP	1.79%	8.17%	202.97%	144.11%	153.92%	6.42
PDPC_INTRA	0.78%	8.96%	217.00%	150.15%	161.29%	6.05
OBMC	2.30%	11.25%	232.95%	177.15%	186.45%	5.22
AFFINE	0.97%	12.22%	253.98%	186.37%	197.64%	4.95
RSAP	0.51%	12.74%	265.00%	191.63%	203.86%	4.70
ALF	4.06%	16.79%	284.82%	253.11%	258.39%	4.26
CTX_RESIDUALCODING	0.45%	17.24%	293.82%	259.15%	264.93%	3.95
INTRA_4TAP_FILTER	0.25%	17.50%	296.31%	263.05%	268.59%	3.92
INIT_PREVFRAME	0.25%	17.74%	299.60%	267.59%	272.93%	3.28
MULTI_PARAM_CABAC	0.34%	18.09%	306.65%	273.41%	278.95%	3.24
IC	0.29%	18.38%	320.55%	278.08%	285.16%	2.70
T64	0.54%	18.91%	328.05%	290.66%	296.89%	2.62
INTRA_BOUNDARY_FILTER	0.17%	19.08%	330.34%	294.91%	300.81%	2.42
INTRA_65ANG_MODES	0.18%	19.26%	333.41%	299.34%	305.02%	2.40
LMCHROMA	0.19%	19.44%	337.07%	304.09%	309.59%	2.34
FRUC_MERGE	4.50%	23.94%	403.43%	486.93%	473.01%	1.58
BIO	2.02%	25.96%	438.89%	616.63%	587.01%	1.01
BAC_ADAPT_WDOW	0.06%	26.02%	443.56%	622.22%	592.44%	0.59

Successive Tool Combination		BD-Rate (Class B-D)				Runtime Increase		
		Y	U	V	YUV	Enc	Dec	C
Anchor		0.00%	0.00%	0%	0%	100%	100%	100%
Test 1	NSST	-1.91%	-5.15%	-5.47%	2.76%	126%	100%	104.66%
Test 2	IMV	-2.58%	-6.09%	-6.44%	3.50%	140%	101%	107.41%
Test 3	EMT	-4.61%	-6.18%	-6.65%	5.06%	191%	103%	117.86%
Test 4	LARGE_CTU	-5.04%	-7.50%	-7.86%	5.70%	178%	107%	118.94%
Test 5	SUB_PU_TMVP	-6.64%	-8.90%	-9.31%	7.26%	196%	120%	132.79%
Test 6	PDPC_INTRA	-7.09%	-8.81%	-9.26%	7.58%	209%	121%	135.36%
Test 7	OBMC	-9.20%	-11.50%	-11.89%	9.83%	229%	163%	174.09%
Test 8	AFFINE	-9.94%	-12.25%	-12.64%	10.57%	255%	167%	181.35%
Test 9	RSAF	-10.22%	-12.79%	-13.27%	10.92%	324%	166%	192.76%
Test 10	ALF	-13.66%	-14.35%	-14.49%	13.85%	333%	203%	224.37%
Test 11	CTX_RESIDUALCODING	-13.88%	-14.31%	-14.35%	13.99%	354%	203%	228.29%
Test 12	INTRA_4TAP_FILTER	-14.09%	-14.70%	-14.73%	14.24%	356%	204%	229.51%
Test 13	INIT_PREVFRAME	-14.26%	-15.20%	-15.25%	14.50%	355%	205%	229.85%
Test 14	MULTI_PARAM_CABAC	-14.82%	-15.44%	-15.38%	14.97%	368%	203%	230.08%
Test 15	IC	-15.16%	-15.62%	-15.60%	15.27%	396%	205%	237.22%
Test 16	T64	-15.27%	-15.92%	-15.68%	15.40%	408%	216%	247.72%
Test 17	INTRA_BOUNDARY_FILTER	-15.39%	-16.04%	-15.87%	15.53%	409%	216%	248.44%
Test 18	INTRA_65ANG_MODES	-15.57%	-16.02%	-15.94%	15.67%	398%	217%	247.05%
Test 19	LMCHROMA	-16.83%	-9.22%	-9.42%	14.95%	401%	215%	245.98%
Test 20	FRUC_MERGE	-19.76%	-11.78%	-12.06%	17.80%	524%	481%	487.99%
Test 21	BIO	-20.97%	-12.31%	-12.53%	18.84%	689%	872%	841.11%
Test 22	BAC_ADAPT_WDOW	-20.97%	-12.31%	-12.53%	18.83%	686%	867%	837.15%