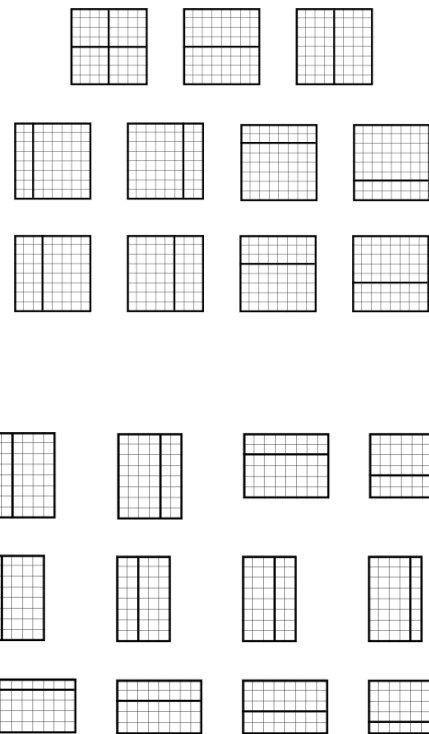

QUADTREE PLUS BINARY TREE WITH SHIFTING

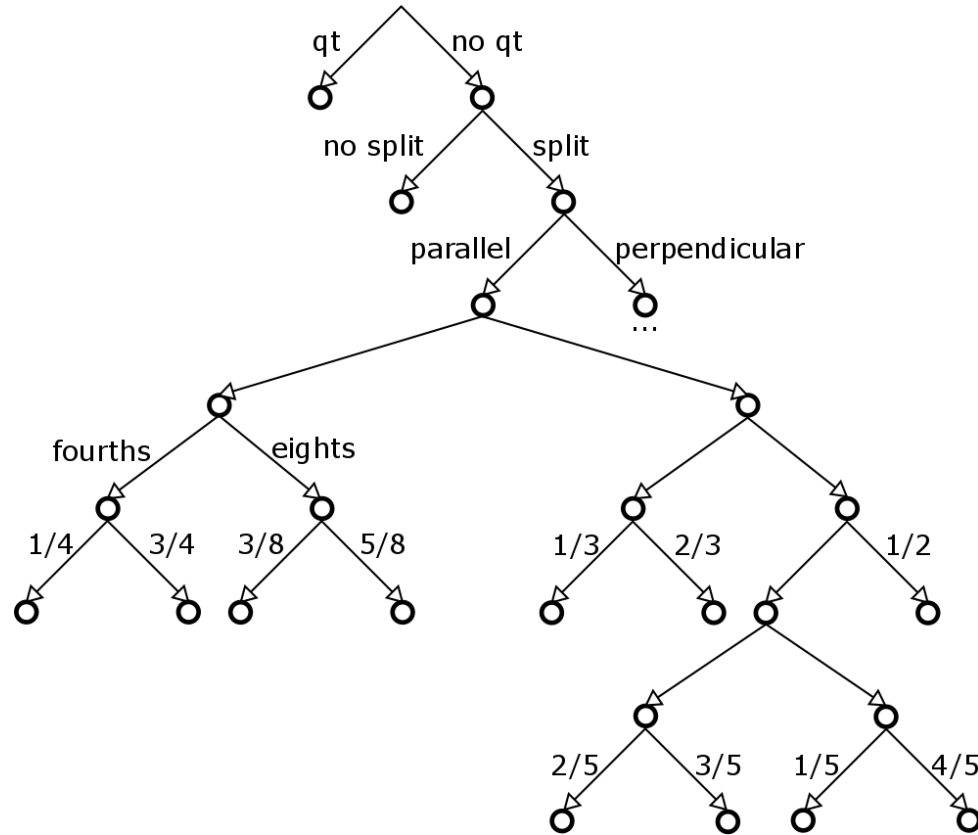
JVET-J0035

Split modes: QT+BTS

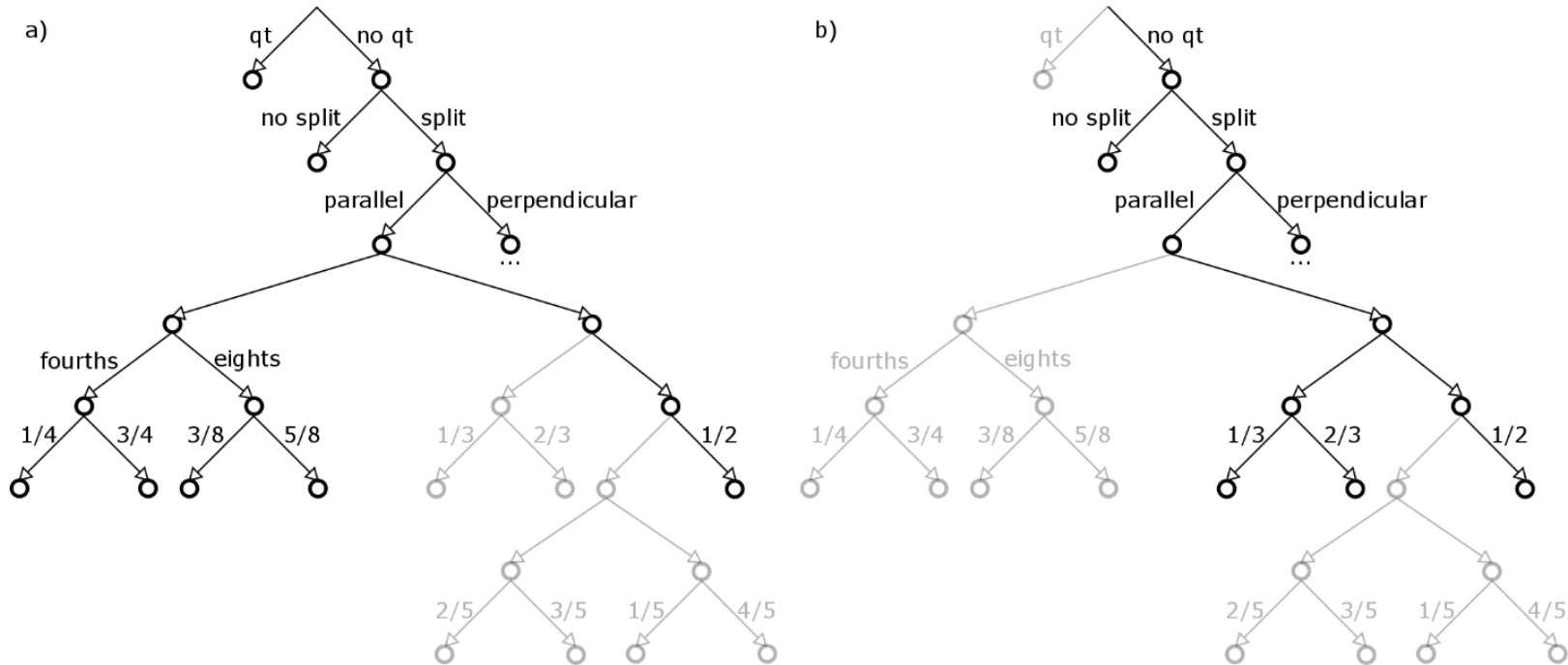
- In addition to QTBT splits the following splits are allowed for split sides of size 2^n
 - 1/4 and 3/4 if $n \geq 4$
 - 3/8 and 5/8 if $n \geq 5$
- If the split side is of size $3 \cdot 2^n$
 - 1/3 and 2/3 if $n \geq 2$.
- If the split side is of size $5 \cdot 2^n$
 - 1/5, 2/5, 3/5, 4/3 if $n \geq 2$.
- If $n \geq 3$, then 1/2 is also available.



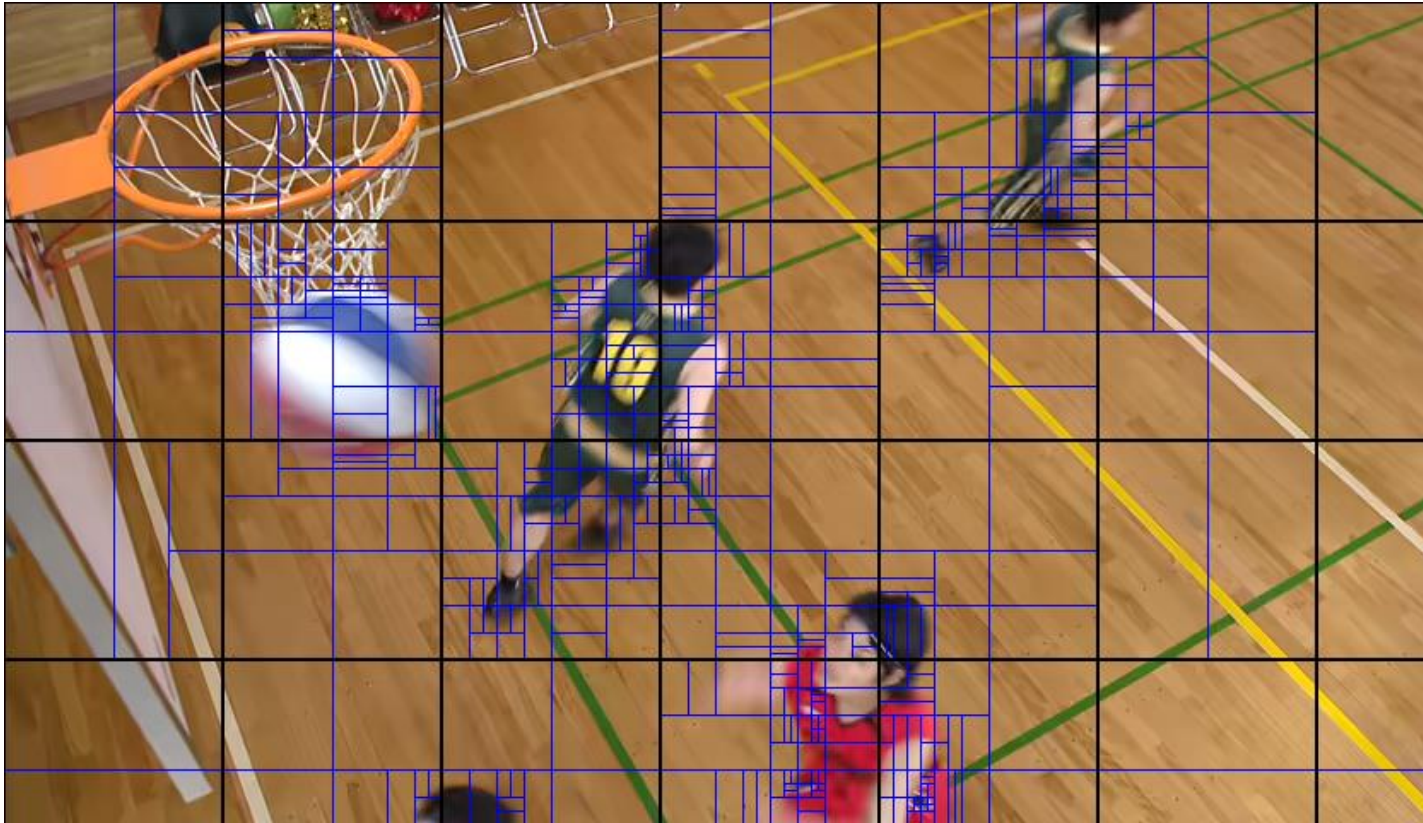
Signaling



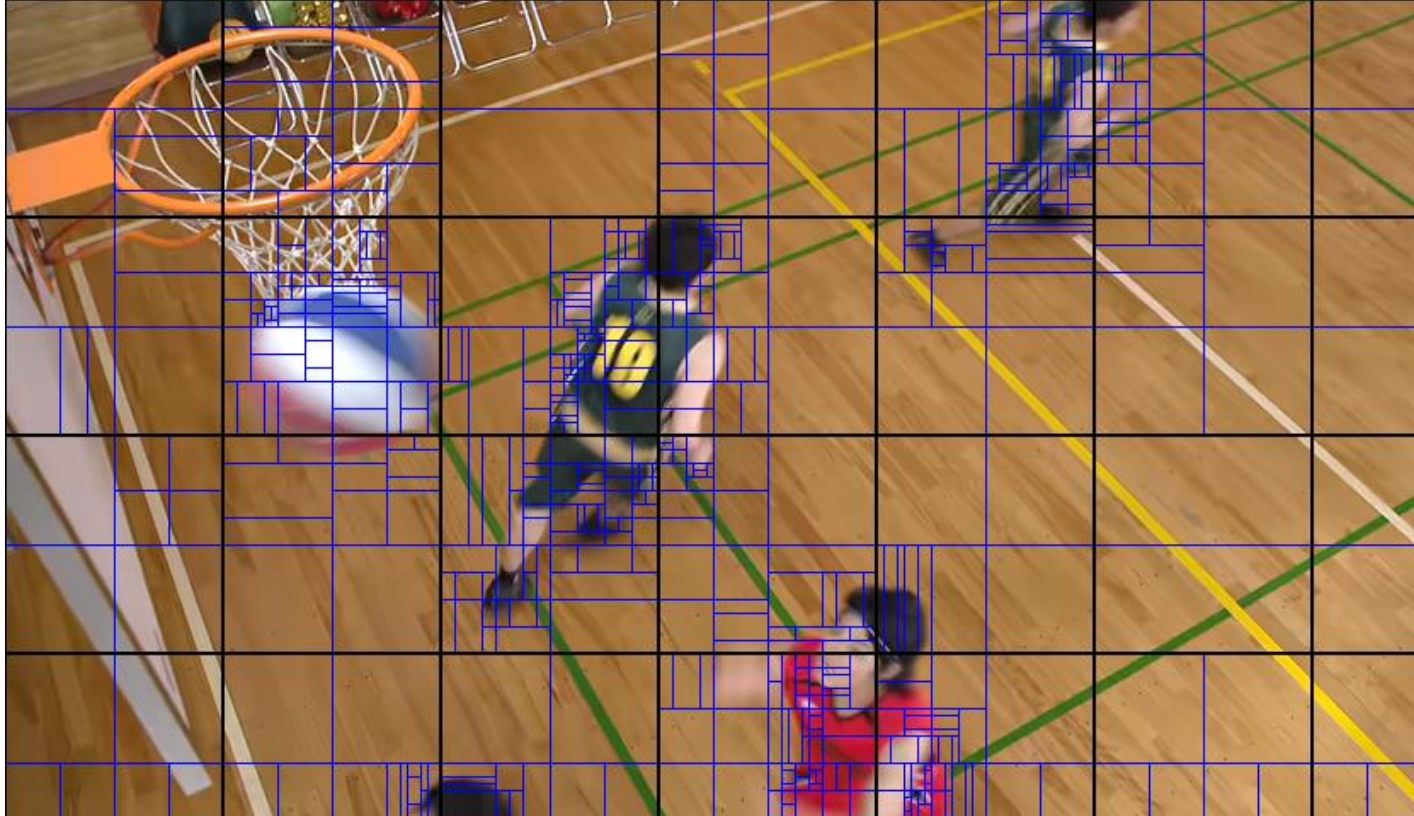
Sub trees for different availability cases



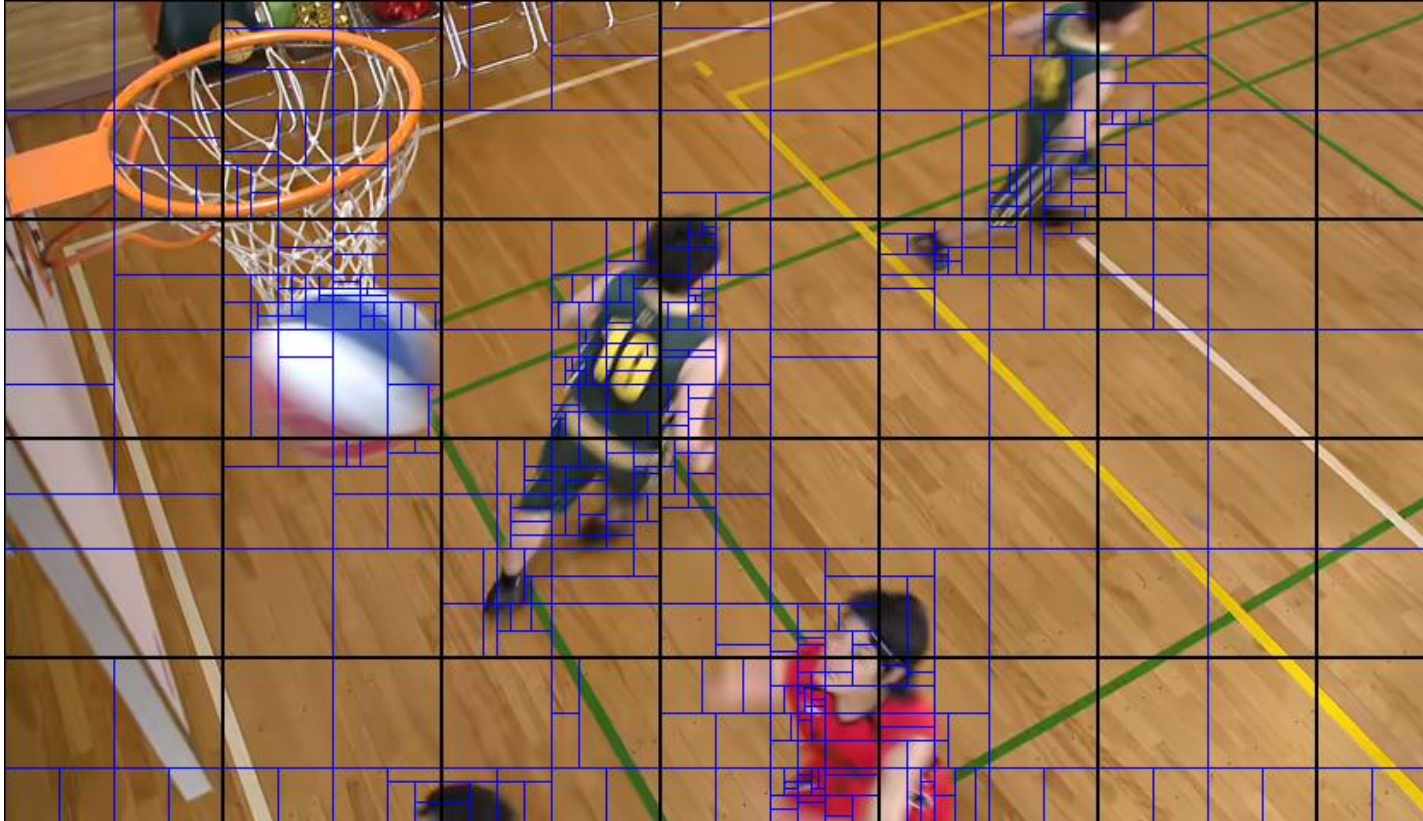
QTBT



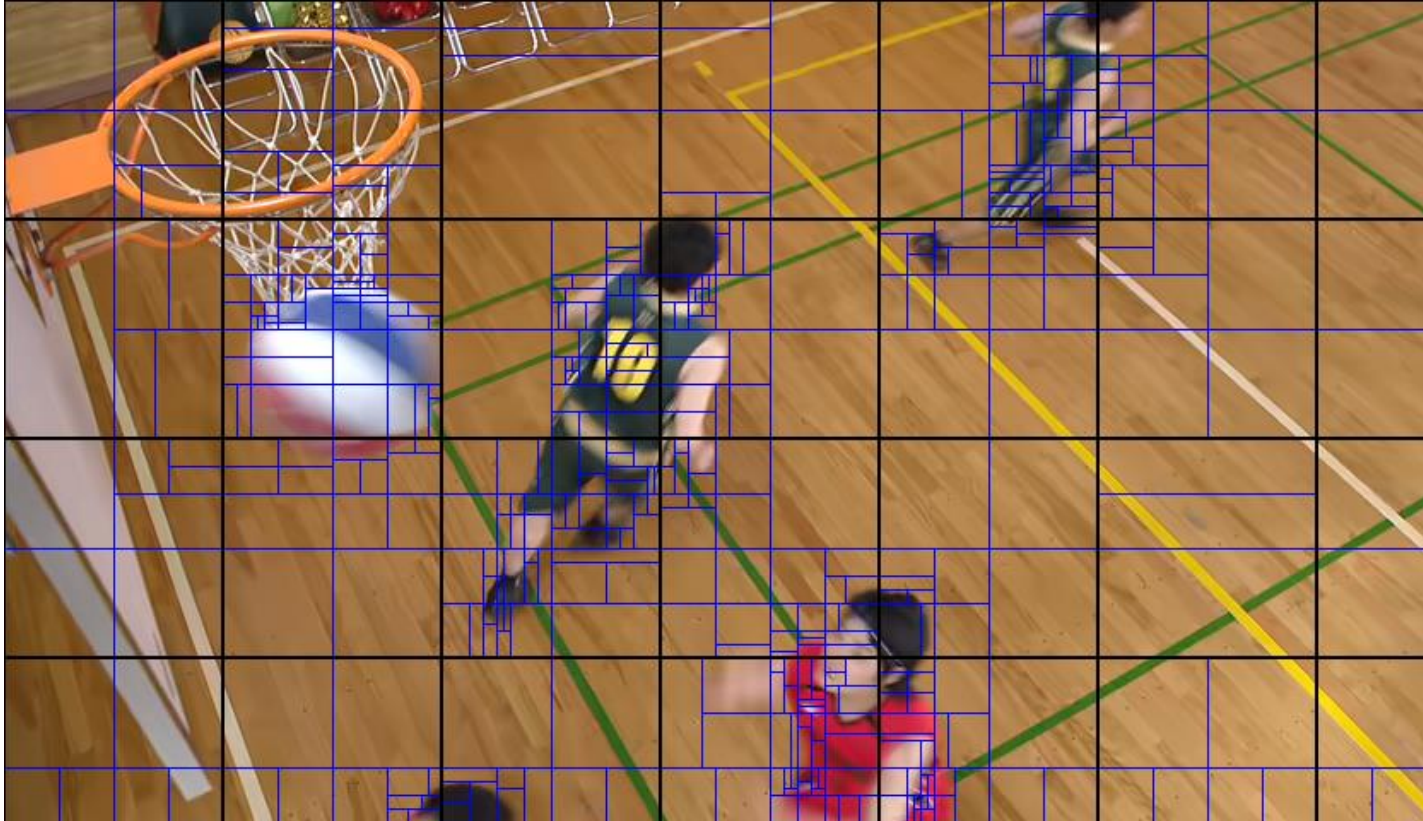
QT+BTS-2-3



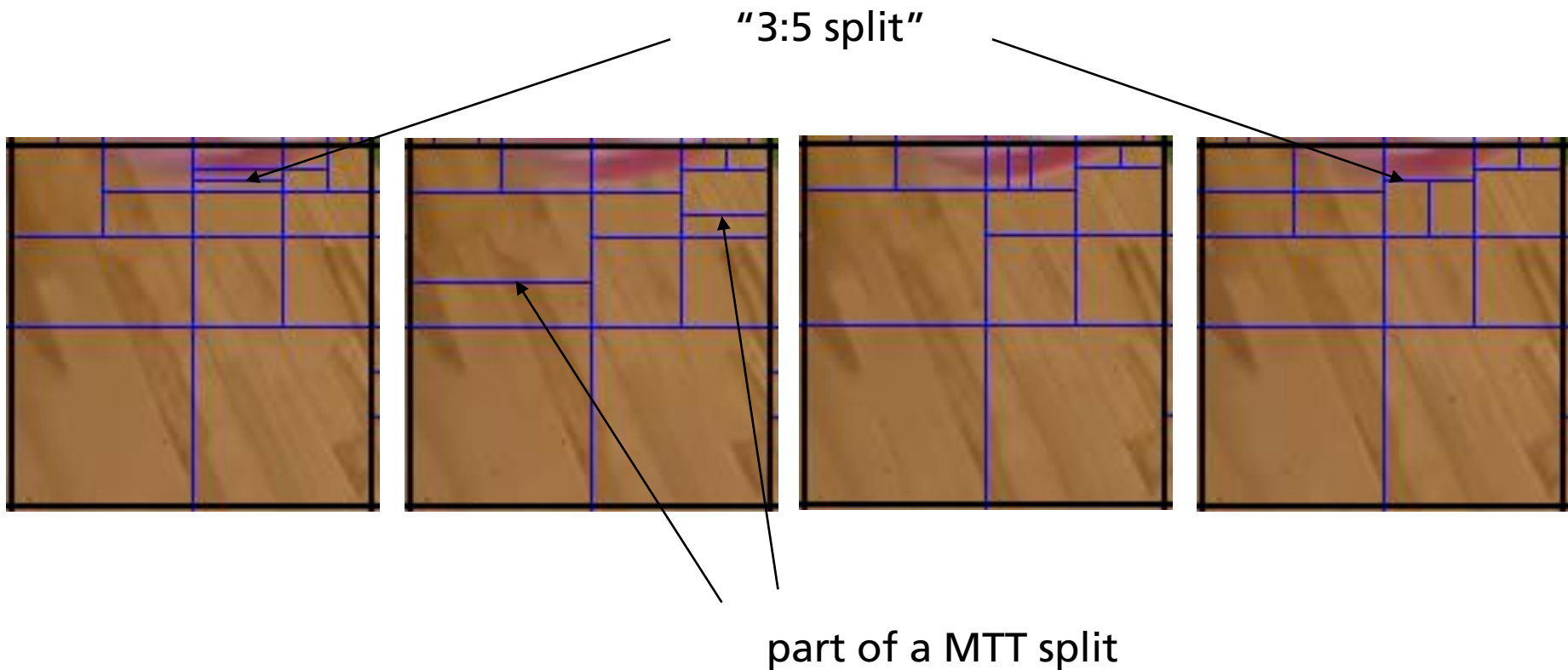
QT+BTS-3-3



QT+BTS-5-3



Comparison inside a CTU

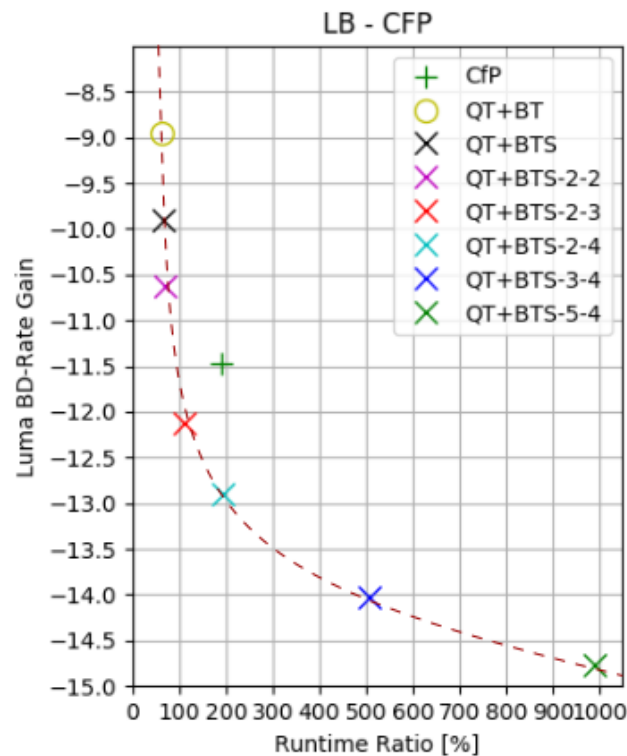
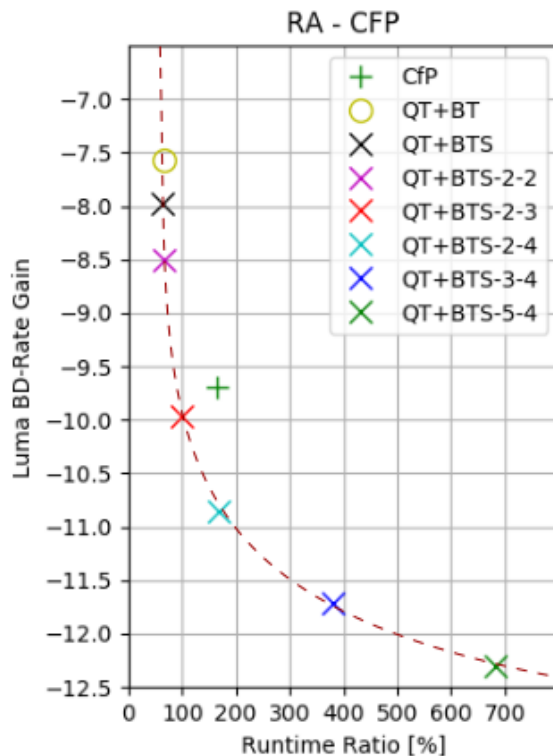
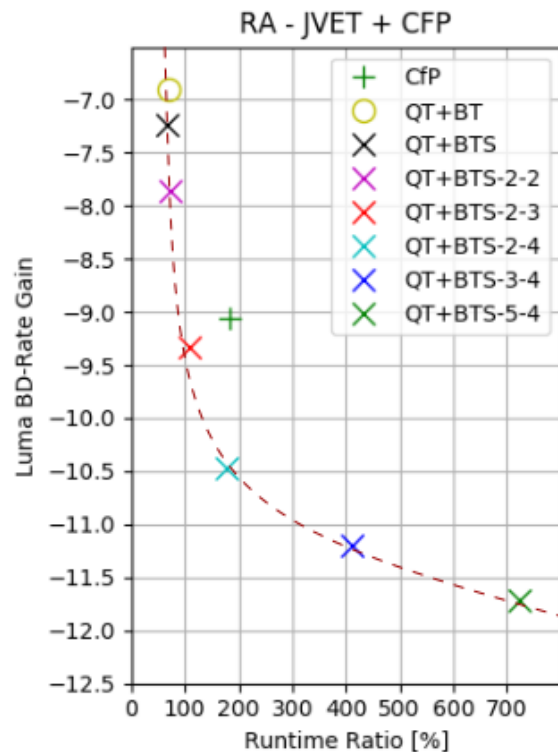


Specific properties

Using high-level parameters QT+BTS can be

- configured to QTBT, MTT, and ABT.
- restricted to power of 2 block sizes.
- Shifts are designed to find more general block partitions and hence, potentially lead to improved localizations of objects with one split.
- Parallel redundancies are prohibited as well as repetitions of the same perpendicular split on neighboured sub-CUs.
- QT+BTS is also implemented for picture boundaries.

Results compared to HM



Low complexity configuration

Random Access										
	QP values 22, 27, 32, 37					QP values 27, 32, 37, 42				
	Y	Cb	Cr	EncT	DecT	Y	Cb	Cr	EncT	DecT
JVET A1	-9.37%	-17.81%	-16.12%	208%	103%	-11.36%	-24.78%	-22.06%	172%	92%
JVET A2	-11.87%	-22.69%	-21.07%	128%	91%	-13.44%	-26.64%	-25.00%	100%	81%
JVET B	-7.69%	-18.59%	-19.54%	153%	112%	-8.99%	-22.62%	-24.16%	123%	102%
JVET C	-7.19%	-16.70%	-17.98%	194%	152%	-8.01%	-21.95%	-23.11%	169%	139%
JVET D	-5.97%	-16.26%	-17.75%	178%	216%	-6.24%	-20.97%	-21.96%	152%	211%
JVET E	-9.40%	-23.87%	-24.65%	78%	102%	-10.17%	-27.94%	-29.07%	60%	96%
JVET F	-6.17%	-16.28%	-17.35%	117%	128%	-7.17%	-21.52%	-22.18%	105%	121%
CfP 360	-6.26%	-21.62%	-27.24%	89%	92%	-7.69%	-31.02%	-39.11%	70%	83%
CfP SDR-A	-11.56%	-17.76%	-17.39%	162%	98%	-13.10%	-21.27%	-20.95%	134%	88%
CfP SDR-B	-9.34%	-22.74%	-24.15%	162%	109%	-11.03%	-28.24%	-29.54%	130%	98%
CfP HDR-A	-8.74%	-19.45%	-26.80%	117%	88%	-9.84%	-26.43%	-37.15%	91%	80%
CfP HDR-B	-6.68%	-31.41%	-41.33%	106%	105%	-8.15%	-31.32%	-28.30%	87%	95%
JVET all	-8.18%	-18.70%	-19.03%	148%	124%	-9.30%	-23.58%	-23.76%	122%	115%
CfP all	-8.50%	-22.87%	-27.43%	124%	99%	-9.97%	-27.76%	-30.48%	100%	89%
JVET + CfP	-8.10%	-20.29%	-22.82%	133%	113%	-9.33%	-25.28%	-26.75%	109%	103%

Medium complexity configuration

Random Access										
	QP values 22, 27, 32, 37					QP values 27, 32, 37, 42				
	Y	Cb	Cr	EncT	DecT	Y	Cb	Cr	EncT	DecT
JVET A1	-10.23%	-18.95%	-17.48%	388%	101%	-12.22%	-26.35%	-23.73%	304%	90%
JVET A2	-12.95%	-24.57%	-22.55%	213%	87%	-14.38%	-28.28%	-26.51%	153%	78%
JVET B	-8.57%	-19.96%	-20.66%	267%	104%	-9.80%	-23.87%	-24.83%	192%	91%
JVET C	-8.38%	-18.17%	-19.39%	366%	138%	-9.26%	-23.82%	-24.85%	306%	126%
JVET D	-7.04%	-18.19%	-19.52%	328%	200%	-7.24%	-22.63%	-23.44%	268%	201%
JVET E	-10.49%	-24.92%	-26.10%	123%	93%	-11.32%	-29.55%	-30.37%	88%	89%
JVET F	-8.53%	-18.51%	-19.23%	221%	118%	-9.39%	-23.43%	-24.02%	190%	112%
CfP 360	-7.16%	-22.52%	-28.05%	166%	88%	-8.60%	-31.99%	-39.60%	122%	77%
CfP SDR-A	-12.41%	-19.10%	-18.64%	288%	95%	-13.91%	-22.55%	-22.20%	227%	86%
CfP SDR-B	-10.35%	-24.23%	-25.69%	276%	103%	-12.01%	-29.70%	-30.91%	203%	90%
CfP HDR-A	-9.58%	-20.63%	-28.23%	203%	84%	-10.58%	-27.49%	-38.52%	146%	76%
CfP HDR-B	-7.65%	-33.94%	-44.69%	193%	102%	-9.06%	-33.42%	-30.25%	148%	91%
JVET all	-9.39%	-20.29%	-20.51%	263%	116%	-10.46%	-25.22%	-25.20%	204%	107%
CfP all	-9.42%	-24.38%	-29.13%	222%	95%	-10.85%	-29.17%	-31.75%	167%	84%
JVET + CfP	-9.19%	-21.84%	-24.40%	238%	107%	-10.37%	-26.81%	-28.12%	183%	97%

Chroma QP Adaptation

For low complexity the proposed method shows BD rate savings of

- 9.97% (Y) 27.76% (U) 30.48(V)

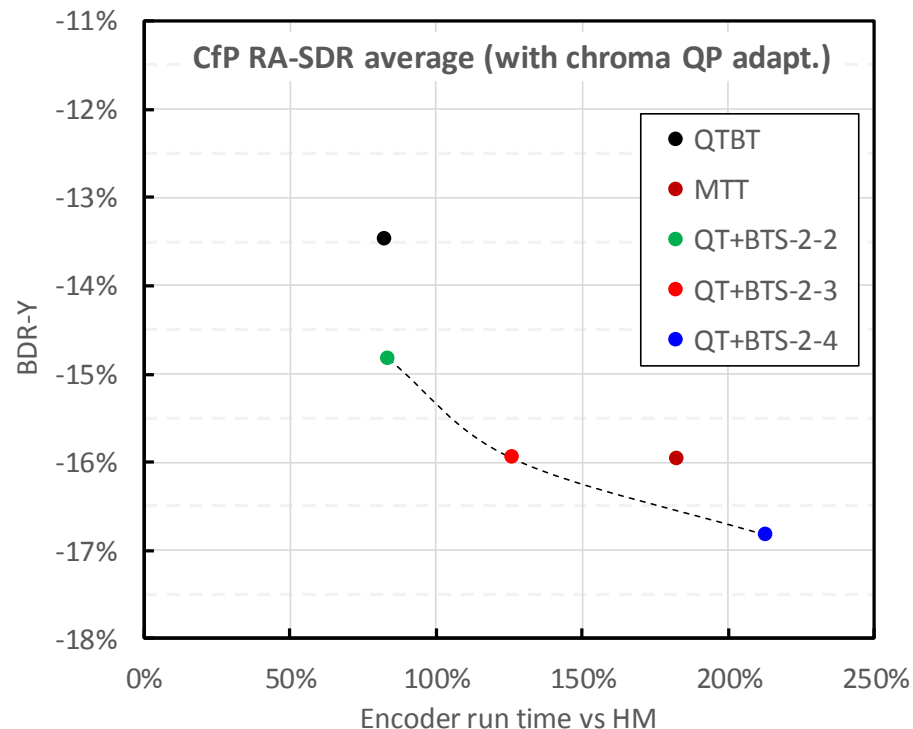
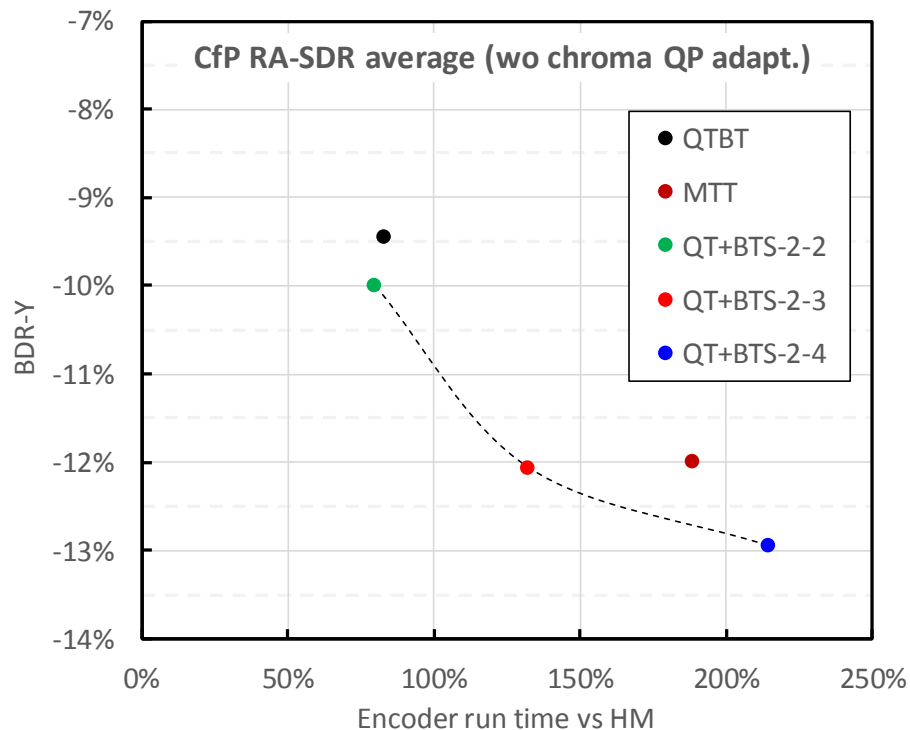
For medium complexity the proposed method shows BD rate savings of

- 10.85% (Y) 29.17% (U) 31.75(V)

Chroma QP adaptation by using table from Mediathek (JVET-J0018)

qPi	< 30	30	31	32	33	34	> 34
Qp _C	= qPi	29	30	31	32	33	= qPi - 2

CfP sequences with chroma QP adaptation

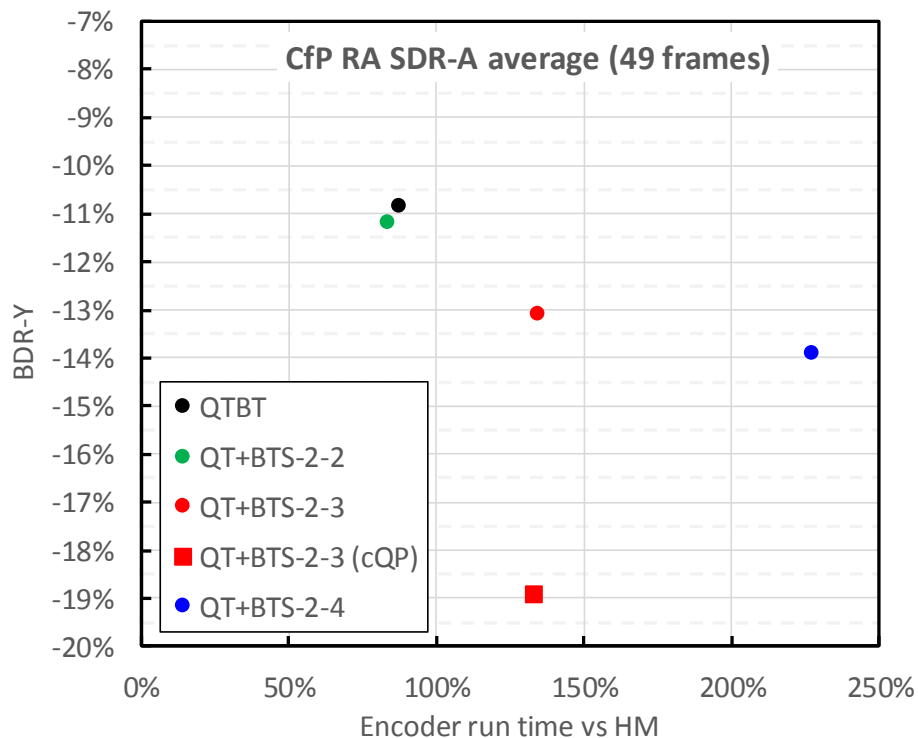
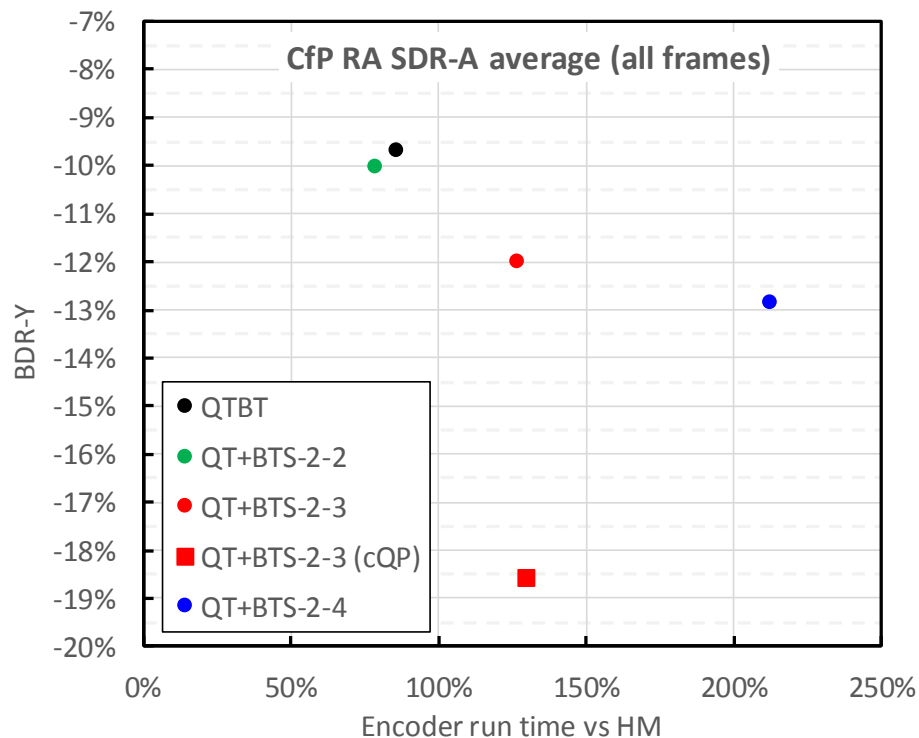


Chroma QP adaptation

Random Access - SDR-A										
	without modified chroma QP					with modified chroma QP				
	Y	Cb	Cr	EncT	DecT	Y	Cb	Cr	EncT	DecT
QTBT	-10.87%	-18.58%	-17.68%	88%	86%	-16.85%	-5.83%	-6.55%	87%	84%
MTT	-13.45%	-21.86%	-21.50%	196%	99%	-19.23%	-9.32%	-10.55%	196%	83%
QT+BTS-2-2	-11.20%	-18.87%	-18.23%	84%	90%	-17.80%	-7.08%	-8.15%	87%	86%
QT+BTS-2-3	-13.10%	-21.27%	-20.95%	134%	88%	-18.90%	-8.75%	-9.94%	133%	87%
QT+BTS-2-4	-13.91%	-22.55%	-22.20%	227%	86%	-19.62%	-10.05%	-11.29%	222%	87%

Random Access - SDR-B										
	without modified chroma QP					with modified chroma QP				
	Y	Cb	Cr	EncT	DecT	Y	Cb	Cr	EncT	DecT
QTBT	-8.04%	-24.45%	-25.62%	79%	92%	-10.12%	-5.55%	-5.28%	78%	88%
MTT	-10.56%	-27.78%	-29.13%	181%	114%	-12.72%	-9.52%	-9.60%	170%	89%
QT+BTS-2-2	-8.81%	-25.30%	-26.27%	76%	93%	-11.86%	-7.91%	-7.61%	81%	91%
QT+BTS-2-3	-11.03%	-28.24%	-29.54%	130%	98%	-13.02%	-9.35%	-9.32%	120%	90%
QT+BTS-2-4	-12.01%	-29.70%	-30.91%	203%	90%	-14.04%	-11.13%	-11.30%	204%	93%

SDR sequences with chroma QP adaptation and full frames



Full Tables

Random Access - SDR-A										
	all frames					49 frames				
	Y	Cb	Cr	EncT	DecT	Y	Cb	Cr	EncT	DecT
QTBT	-9.71%	-17.09%	-17.34%	86%	81%	-10.87%	-18.58%	-17.68%	88%	86%
QT+BTS-2-2	-10.05%	-17.41%	-17.87%	79%	83%	-11.20%	-18.87%	-18.23%	84%	90%
QT+BTS-2-3	-12.02%	-19.95%	-20.63%	127%	83%	-13.10%	-21.27%	-20.95%	134%	88%
QT+BTS-2-4	-12.87%	-21.32%	-22.14%	212%	84%	-13.91%	-22.55%	-22.20%	227%	86%
QT+BTS-2-3 (cQP)	-18.57%	-9.35%	-12.49%	130%	80%	-18.90%	-8.75%	-9.94%	133%	87%

Random Access - SDR-B										
	all frames					49 frames				
	Y	Cb	Cr	EncT	DecT	Y	Cb	Cr	EncT	DecT
QTBT	-7.57%	-22.50%	-24.64%	81%	86%	-8.04%	-24.45%	-25.62%	79%	92%
QT+BTS-2-2	-8.51%	-23.62%	-25.49%	74%	86%	-8.81%	-25.30%	-26.27%	76%	93%
QT+BTS-2-3	-10.77%	-26.44%	-28.25%	120%	87%	-11.03%	-28.24%	-29.54%	130%	98%
QT+BTS-2-4	-11.74%	-28.14%	-30.06%	199%	85%	-12.01%	-29.70%	-30.91%	203%	90%
QT+BTS-2-3 (cQP)	-12.68%	-7.63%	-8.87%	125%	84%	-13.02%	-9.35%	-9.32%	120%	90%

Full Tables

Random Access - SDR-A										
	all frames					49 frames				
	Y	Cb	Cr	EncT	DecT	Y	Cb	Cr	EncT	DecT
QTBT	-9.71%	-17.09%	-17.34%	86%	81%	-10.87%	-18.58%	-17.68%	88%	86%
QT+BTS-2-2	-10.05%	-17.41%	-17.87%	79%	83%	-11.20%	-18.87%	-18.23%	84%	90%
QT+BTS-2-3	-12.02%	-19.95%	-20.63%	127%	83%	-13.10%	-21.27%	-20.95%	134%	88%
QT+BTS-2-4	-12.87%	-21.32%	-22.14%	212%	84%	-13.91%	-22.55%	-22.20%	227%	86%
QT+BTS-2-3 (cQP)	-18.57%	-9.35%	-12.49%	130%	80%	-18.90%	-8.75%	-9.94%	133%	87%

Random Access - SDR-B										
	all frames					49 frames				
	Y	Cb	Cr	EncT	DecT	Y	Cb	Cr	EncT	DecT
QTBT	-7.57%	-22.50%	-24.64%	81%	86%	-8.04%	-24.45%	-25.62%	79%	92%
QT+BTS-2-2	-8.51%	-23.62%	-25.49%	74%	86%	-8.81%	-25.30%	-26.27%	76%	93%
QT+BTS-2-3	-10.77%	-26.44%	-28.25%	120%	87%	-11.03%	-28.24%	-29.54%	130%	98%
QT+BTS-2-4	-11.74%	-28.14%	-30.06%	199%	85%	-12.01%	-29.70%	-30.91%	203%	90%
QT+BTS-2-3 (cQP)	-12.68%	-7.63%	-8.87%	125%	84%	-13.02%	-9.35%	-9.32%	120%	90%

Software

Software repo partitioners only:

https://ipbt.hhi.fraunhofer.de/svn/svn_hhi-next-software/tags/NextSoftware-JVET-J0035

Memory usage:

	Encoder	Decoder
Random access UHD	2450 MB	750 MB
Random access HD	750 MB	250 MB
Low delay HD	450 MB	220 MB

Further version with JEM tools available:

https://ipbt.hhi.fraunhofer.de/svn/svn_hhi-next-software/tags/NextSoftware-JVET-J0035_plus_JEMTools

Summary

- QT+BTS is a quadtree plus binary tree with shifted binary splits.
- Shifting pattern can be restricted to known partitioners such as QTBT, MTT, and ABT.
- Shifts can be configured to only lead to power of 2 subblocks.

SDR-A:

- 13.10% bit rate savings in luma can be achieved for 134% encoder runtime.

SDR-B:

- 11.03% bit rate savings in luma can be achieved for 130% of encoder time.