GOP bit-allocation tuning sheet

Fora Soft Learn

Frame-type ratios, temporal layers, lookahead, MB-tree / CU-tree / TPL

Companion to article 4.14 of Block 4. Print on A4.

1. Frame-type quantizer ratios (x264 defaults)

Knob	Default	Meaning	Effect at QP 22 base
--ipratio	1.40	I-frame quantizer = 1.40 x P-frame quantizer	I-frame QP ~19 (-3 vs P)
--pbratio	1.30	B-frame quantizer = 1.30 x P-frame quantizer	B-frame QP ~24 (+2 vs P)
--qcomp	0.60	complexity^0.60 = relative per-frame bit weight	hard scenes get less than proportional

2. Temporal-layer QP cascade (8-frame mini-GOP, HEVC default)

Layer	Frame role	QP offset	Why
0	anchors (I, P)	QP + 0	referenced by every other frame in the mini-GOP
1	mid-GOP anchor B	QP + 1	anchor for layer 2 and 3 frames
2	referenced B	QP + 2	referenced once, by a layer-3 frame
3	leaf B (disposable)	QP + 3	not referenced; distortion stops here

3. Lookahead window per use case

Use case	Latency budget	Lookahead (frames)	Propagation tracker
WebRTC, conferencing	< 1 s	0 to 8	off (no time for it)
LL-HLS, live ingest	1 to 3 s	16 to 40	MB-tree / CU-tree on
HLS, DASH live	3 to 10 s	40 to 60	MB-tree / CU-tree on
VOD, archive (1-pass)	unbounded	60 to 120	MB-tree / CU-tree / TPL on
VOD, archive (2-pass)	unbounded	first-pass stats	MB-tree / CU-tree / TPL on

4. Encoder knob map

Encoder	Lookahead flag	Propagation flag	Disable (for low latency)
x264	--rc-lookahead N	(MB-tree on by default)	--no-mbtree
x265	--rc-lookahead N	(CU-tree on by default)	--no-cutree
libaom-AV1	--lag-in-frames N	--enable-tpl-model=1	--enable-tpl-model=0
SVT-AV1	--lookahead N	(TPL on by default)	--enable-tpl-la 0
VVenC (H.266)	preset-driven	per-layer Lagrangian	use 'faster' preset

5. Sanity check: per-frame log targets

- Average I-frame QP should sit ~3 QP below the average P-frame QP (ipratio 1.40).
- Average B-frame QP should sit ~2 QP above the average P-frame QP (pbratio 1.30).
- Average frame size ratio I : P : B should be roughly 5 : 2 : 1 at the same perceived quality.
- If the I-to-P size ratio exceeds ~15 : 1, the allocator is starving P/B frames; expect keyframe pulsing.
- If MB-tree / CU-tree / TPL is enabled, hand-tuning ipratio / pbratio is mostly ignored.

6. Common pitfalls

- GOP length not a power of two: hierarchical-B cannot use its full pyramid depth.
- Lookahead 0 in live: MB-tree / CU-tree / TPL effectively off; you lose 5 to 15% bitrate at same quality.
- Mixing two-pass stats from a different preset: complexity numbers drift; rerun pass 1.
- Keyframe interval too short for ABR segment size: every segment starts with a costly I-frame.