Intra-Frame Coding - Cheat Sheet

How one video frame is compressed - the five stages, the mode zoo, the bit budget

Companion to article 4.2 of Block 4. Print on A4 or US Letter.

The five stages, in order

1. Partition	Split frame into variable-size blocks (4x4 to 128x128 depending on codec).
2. Predict	Build a guess from already-coded top and left neighbour pixels.
3. Residual	Original block minus prediction. Mostly small numbers and zeros.
4. Transform	DCT (or ADST). Re-shuffles spatial residual into frequency coefficients.
5. Quantize + Entropy	*** **Only lossy stage.** *** Then pack with CABAC / multi-symbol arithmetic.

Intra prediction modes by codec

Codec	Year	Modes (luma)	Special tools
JPEG	1992	0 (DC predictor on DC coeff only)	—
H.264 / AVC	2003	9 (DC + Planar + 7 angular)	—
VP9	2013	10 (DC + TM + 8 angular)	TM predictor
H.265 / HEVC	2013	35 (DC + Planar + 33 angular)	Tx 4x4 to 32x32
AV1	2018	~95 (56 angular + Smooth x3 + Paeth)	CfL, Palette, IBC, recursive
H.266 / VVC	2020	67 (DC + Planar + 65 angular)	MIP, MRL, ISP, CCLM, PDPC
AV2 (AVM, in progress)	2025	AV1 set + learned modes	Data-driven intra, improved CfL

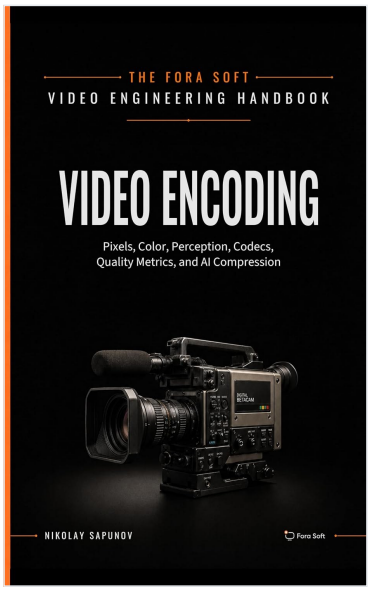
Keyframe interval - what to set when

VOD / Netflix-style	10-15 seconds. Smallest files. No live audience to keep startup short.
HLS / DASH ABR	2-6 seconds. Must align to segment boundaries for clean bitrate switching.
Low-latency / live	1-2 seconds or sub-second. Trade compression for fast tune-in.
WebRTC	On-demand keyframe via PLI / FIR. Tune for packet-loss recovery.
All-intra production	Every frame. ProRes, Avid DNx, Sony XAVC-I. Frame-accurate editing.

Common gotchas

Quant is the only lossy step	Predict / Transform / Entropy are all invertible. Tune QP, not the rest.
More modes != more compression	Mode signalling costs bits. Diminishing returns past ~30-40 modes.
Scene cuts need forced I-frames	Or the first P-frame after the cut becomes nearly as big as an I-frame.
Screen content is different	Palette + IBC win where angular modes lose. Enable for desktop sharing.
HLS demands aligned keyframes	Segment boundary without a keyframe = stalled bitrate switch.
Production codecs are all-intra	Files are ~270x bigger than H.264 VOD. The price of frame-accurate editing.

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This sheet lists the five intra stages, the prediction modes per codec and keyframe interval rules. Volume 1 goes through each stage in depth: pixels and color, block partitioning, prediction and transforms in H.264, HEVC and AV1, quantization and entropy coding, and the quality metrics that tell you what quantization cost.

WHAT YOU WILL FIND INSIDE

- Pixels, color and chroma subsampling
- Partitioning, intra prediction and transforms by codec
- Quantization and entropy coding: CABAC and beyond
- Keyframes and GOP choices for VOD, ABR and live

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