Intra-Prediction Cheat Sheet

Every intra-prediction mode in every major codec, on one page.

Modes by codec

Codec	Year	Max block	Modes	Special	Notes
MPEG-2	1995	16x16 MB	1 (DC)	—	Intra blocks coded JPEG-like
H.264 / AVC	2003	16x16 MB	9 (4x4), 4 (16x16)	I-PCM	Vertical, horizontal, DC, planar
H.265 / HEVC	2013	64x64 CTU	35 (33 ang + planar + DC)	MPM	Constrained intra prediction
VP9	2013	64x64 SB	10 (8 dir + DC + TM)	TM_PRED	Frame-level adaptive transform
AV1	2018	128x128 SB	~62 (56 dir + DC/Pl/3xSm/Paeth/CfL)	Chroma-from-Luma	3-deg angle steps, Smooth modes
H.266 / VVC	2020	128x128 CTU	67 + MIP	MIP / CCLM / MRL / ISP	Matrix-based intra (NN-trained)

When each mode wins

DC:	Single value fill. Wins on flat patches: sky, walls, uniform backgrounds.
Planar / Smooth:	Smooth gradient. Wins on soft lighting, skin tones, large bokeh.
Vertical / Horizontal:	Copy ref row / column. Wins on vertical posts, horizontal floors, scoreboards.
Diagonal (45 deg, 135 deg):	Wins on sharp diagonal edges: rooflines, escalators, bishop-shaped textures.
Fine angular (HEVC/AV1/VVC):	Wins on real-world edges that are 'almost-but-not-quite' on a 45-deg axis.
Paeth (AV1):	Uses top, left, top-left jointly. Wins where two edges meet at a corner.
Chroma-from-Luma (AV1) / CCLM (VVC):	Predicts chroma from already-decoded luma. Big wins on coloured edges.
Matrix-based Intra (VVC):	NN-trained matrix maps boundary samples to block. Wins on natural textures.

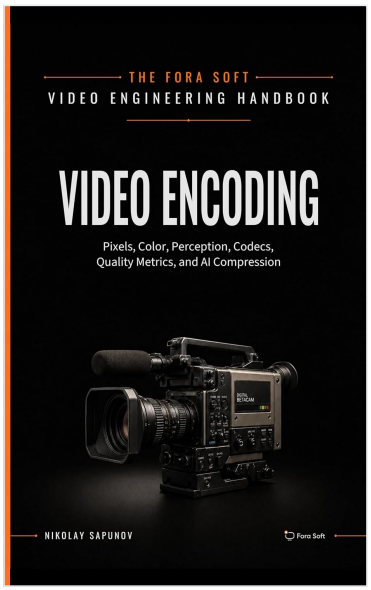
Where the I-frame bits go (rough split)

Intra prediction (mode + residual)	**50-65%**	
Transform + quantisation	**25-35%**	
Entropy coding (CABAC etc.)	**8-15%**	
Block partition signalling	**5-10%**	

Pitfalls

- More modes do not always mean more savings. Modes past ~35 add <0.2% BD-rate each.
- Slower presets test more modes; cost is encoder CPU, gain is small at high quality settings.
- Mode signalling itself eats 8-12% of intra-frame bits in HEVC. MPM lists shrink this.
- Large blocks need fine angular grids. AV1's 56 directions exist because 128x128 needs them.

Companion to: 'Spatial Pixel Redundancy: What's Inside a Single Frame'
www.forasoft.com/learn/video-encoding/articles/spatial-pixel-redundancy



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This sheet maps every intra-prediction mode from MPEG-2 to VVC and when each one wins. Volume 1 explains the coding tools around those modes: block structures in H.264, HEVC and AV1, transforms and quantization, how encoders search modes against CPU cost, and how to measure the gain with quality metrics.

WHAT YOU WILL FIND INSIDE

- Block structures and intra modes from H.264 to AV1
- Transforms and quantization after prediction
- Mode decision, presets and encoder CPU cost
- Measuring BD-rate gains with PSNR and VMAF

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