

Video Pipeline Quality-Loss Audit

Walk your pipeline stage by stage. Mark where quality leaks, whether it's recoverable, and how you'd catch it.

1 • The seven stages — what leaks at each

- CAPTURE — sensor noise + in-camera compression; the 'source' is rarely pristine. Catch: inspect source, no-reference metric.
- PRE-PROCESS — downscaling drops high-frequency detail; 4:2:0 cuts 75% of color; denoise can smear. Catch: compare to source.
- ENCODE — quantization (the QP knob) rounds away coefficients → blocking, banding, ringing. Catch: PSNR / SSIM / VMAF vs source.
- PACKAGE — low ABR-ladder rungs are low quality by design; generation loss stacks on each re-encode. Catch: per-rung metric vs master.
- DELIVER — bitrate down-switches and rebuffering stalls; picture metrics are blind to both. Catch: QoE metrics (rebuffer ratio, startup).
- DECODE — lossless over reliable transport; lost packets trigger error concealment (smear / freeze). Catch: packet-loss monitoring.
- DISPLAY — panel resolution / brightness / gamut limits; HDR→SDR tone-mapping; display upscaling. Catch: real-device testing.

2 • Three questions at every stage

- What information does this stage remove — on purpose, or by accident?
- Is the loss recoverable downstream? (Almost always: no.)
- Which metric can even see it: full-reference, no-reference, or QoE?

3 • Find the leak (triage)

- Soft / blurry everywhere → downscale or a low ladder rung, not the encoder.
- Blocky in motion or dark scenes → encoder QP too high; raise bitrate or change preset.
- Color bleeding on edges or text → chroma subsampling (4:2:0); use 4:2:2 / 4:4:4 if it matters.
- Banding in skies / gradients → bit depth + quantization; try 10-bit and more bitrate.
- Spinner / freeze / stall → delivery (network, ABR, buffer), not the picture.
- Fine on a monitor, bad on a TV → display upscaling or HDR→SDR tone-mapping.

4 • Rules to keep

- Loss is cumulative and one-directional — prevent it, don't try to repair it.
- Always re-encode from the highest-quality source, never a previous output.
- Measure at more than one stage: full-reference where a master exists, QoE across delivery.
- Before tuning the codec, prove the loss actually happened at the codec.

Audit run

Pick one bad clip. Walk it backward from the screen: was it the display, the network, the ladder, the encode, the pre-process, or the capture? Name the single stage that set the ceiling — then fix that stage, not the one after it.