

## Step 1 - 3DoF or 6DoF? (this decides everything)

- 3DoF** Tracks head rotation only: yaw, pitch, roll. System rotates a fixed sound field. Cheap. Fits 360 video, seated VR, fixed AR overlays.
- 6DoF** Adds body position: x, y, z. Must recompute distance, direction, occlusion as you walk. A physics sim. Needed for room-scale VR and walk-around AR.
- Rule** Match audio DoF to video DoF. 6DoF video + 3DoF audio = sound from the wrong place = scene breaks.

## Step 2 - pick the SDK by platform

- Browser / cross-platform: Web Audio API (PannerNode, panningModel HRTF) or Google Resonance Audio.
- Meta Quest: Meta XR Audio SDK (HRTF + ambisonics + room acoustics; feature-frozen v85.0, 2025).
- Apple Vision Pro / iOS: Apple PHASE (direct path, early reflections, late reverb; visionOS ReverbComponent).
- Physically-accurate VR game: Valve Steam Audio (modeled reflections, TOA, optional GPU).
- Real-time spatial voice call: 3GPP IVAS (Release 18), once devices support it.

## The two standards that just landed

- MPEG-I Immersive Audio (ISO/IEC 23090-4:2025, published Nov 2025): 6DoF streaming. Reverb, reflections, occlusion, diffraction, Doppler.
- 3GPP IVAS (Release 18): spatial audio in calls, 13.2-512 kbit/s; 3-4 placed objects at 24.4 / 32 kbit/s.

## Step 3 - bitrate math (channels = (N+1) squared)

- FOA (order 1) = 4 channels. At 64 kbps/ch = ~256 kbps. The floor for 'sound from any direction'.
- TOA (order 3) = 16 channels. At 64 kbps/ch = ~1 Mbps. 4x the bits for sharper localization.
- Stream FOA unless content needs higher-order precision. (Real encoders use joint coding - totals run lower.)

## Pre-ship checklist

Audio degrees of freedom match the video (both 3DoF or both 6DoF).

- Room acoustics ON for any move experience - early reflections + reverb, not just HRTF.
- Head-tracking verified end to end on real hardware; motion-to-sound latency low.
- SDK chosen by target platform, not by reflex.
- Ambisonic order matched to the product; head-locked stereo routed for non-rotating narration.
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