



- 3GPP-VRIF Workshop on VR Ecosystem & Standards
- 4th - 6th Dec, 2017 @Santa Clara

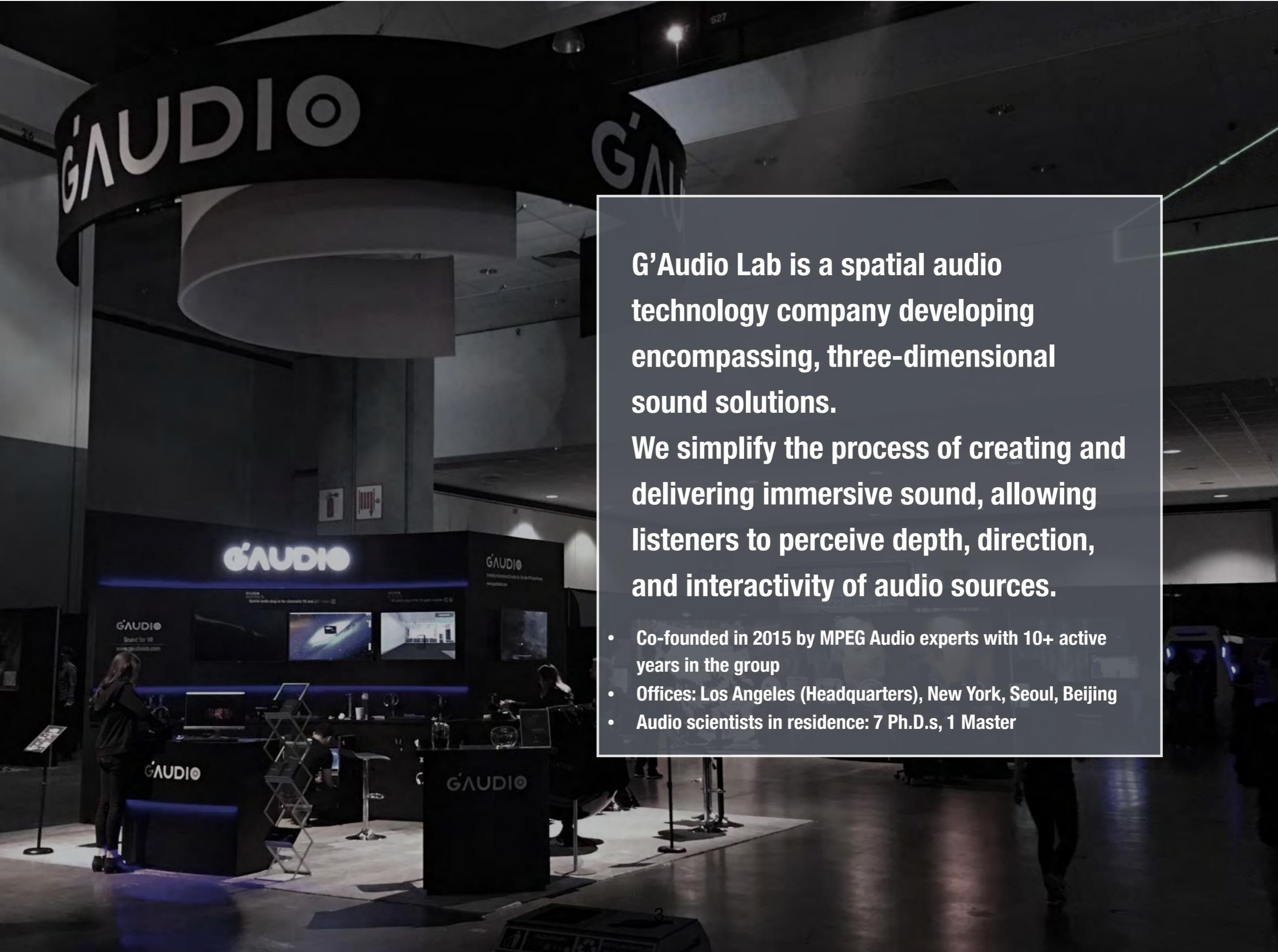
VR/360 Audio Production & Workflow

Glenn Forsythe
GAUDIO

Agenda

- The meaning of VR specific audio
- Audio **Format** and **Workflow**
 - Possible options, ideal scenarios
 - Case studies
 - Challenges





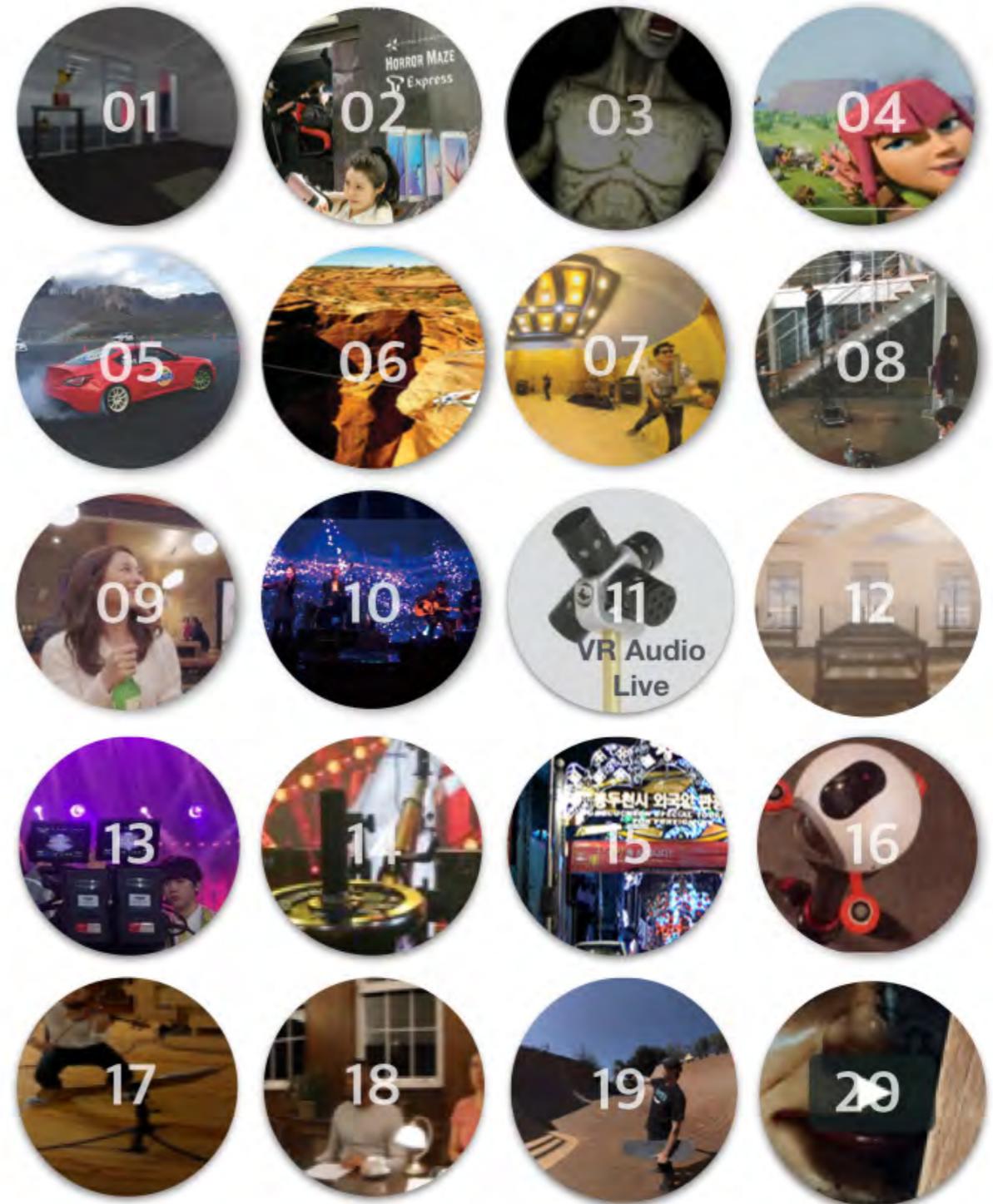
G'Audio Lab is a spatial audio technology company developing encompassing, three-dimensional sound solutions.

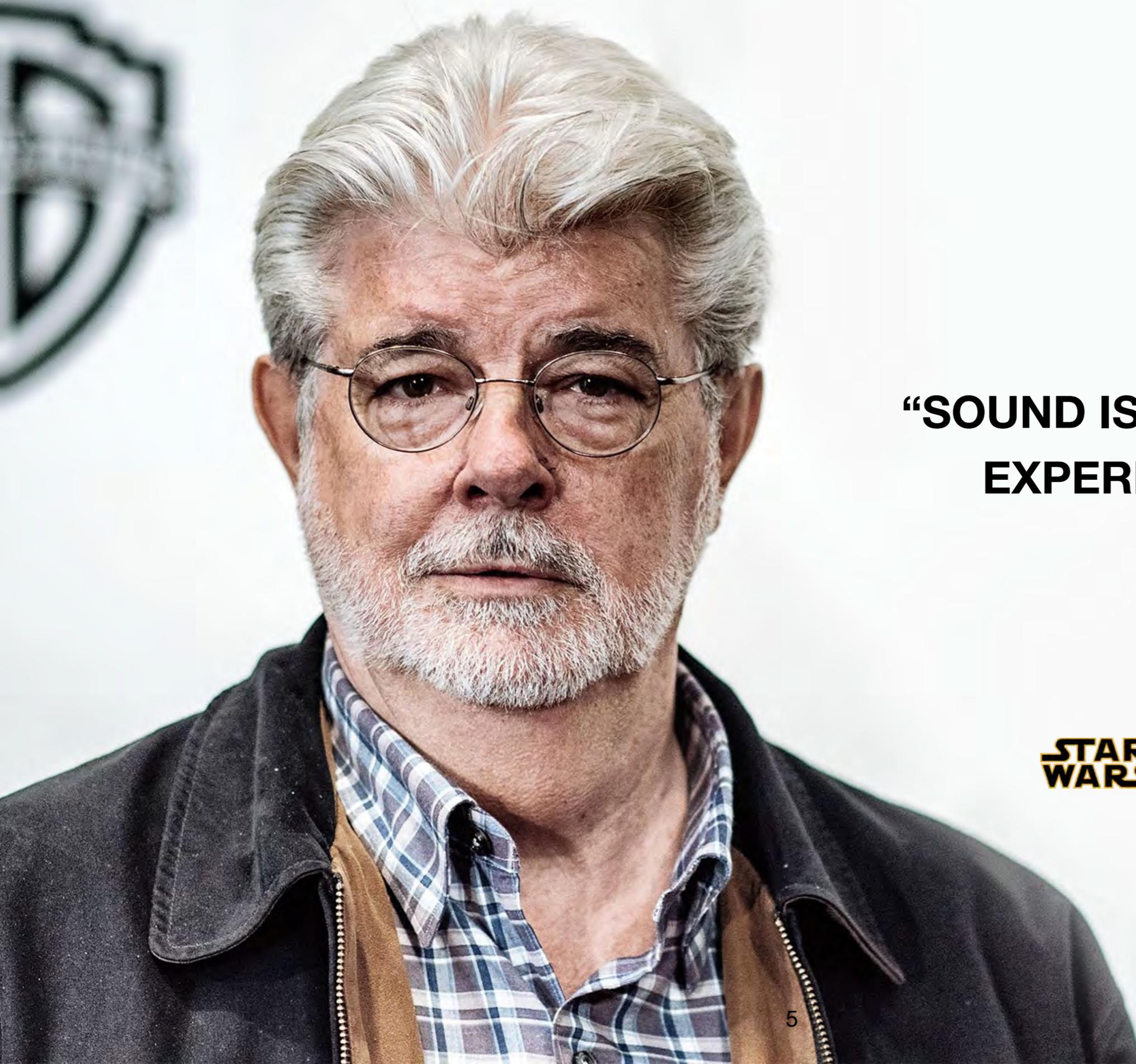
We simplify the process of creating and delivering immersive sound, allowing listeners to perceive depth, direction, and interactivity of audio sources.

- **Co-founded in 2015 by MPEG Audio experts with 10+ active years in the group**
- **Offices: Los Angeles (Headquarters), New York, Seoul, Beijing**
- **Audio scientists in residence: 7 Ph.D.s, 1 Master**

Seasoned Audio Professionals with Experience

01. **Tower GAUDI**
Unity 3D plugin performance demo ('15.7)
High-Definition 3D Positional Sound with Interaction
02. **Horror Maze (Launching Work for GearVR)**
Main 360 video demo for Gear VR 2 launching ('15.11)
Built with 1 Sound Object + Stereo ambient track
03. **CF Zombie (Mini VR Game, GDC 2016)**
High-definition 3D positional sound ('16.3)
All Objects rendered with GAUDIO Unity 3D plugin
04. **Project CoC (Stereo to VR)**
G'AUDIO specialty for legacy 360 video ('16.1)
Convert legacy stereo to interactive
05. **Fanta Promo - Drift**
360 live recording for immersive ('16.2)
Compare Ambisonics v. omni-binaural
06. **Fanta Promo - Rope-swing, Wing-suit**
First-person view 360 live recording ('16.3)
Binaural recording for extreme sport-enthusiast
07. **Downhell Studio (interactive 360 Music)**
Immersive 360 Spatial Audio for 360 Video
HOA + Objects rendering | also for TV speaker demo
08. **Blue Dress (PV demo & Sample PT session)**
Immersive 360 Spatial Audio for 360 Video
HOA + 3 Moving Objects rendering for Immersive
09. **Goodday (360 Commercial)**
Immersive 360 Spatial Audio for 360 Video
Remaster with extracted objects after post-production
10. **Jambinai (interactive 360 Music)**
Interactive Audio for 360 Video
Loud speaker demo for concert & same via Gear VR
11. **World 1st VR Audio Livestreaming**
Collaboration with SK Telecom
Interactive with FOA, Sol Livestreaming
12. **Bo Hwa Gwak (Virtual Museum)**
Virtual experience of famous Museum
Featured in Busan Film Festival 2017
13. **SBS -Astro1&2**
Episodes for K-pop star 360 Drama
Ambisonics shoot, post-production with Works
14. **SBS-TV Live Music Show**
Take from On-air live TV Music Show
for 360 Video, Produced by Works
15. **Bloodless (Award in Venice Film Fest.)**
Based on real story of brutally murdered sex worker,
the Best VR Story award in Venice Film Festival 2017
16. **G'Mic Take #1**
Proprietary consumer FOA Mic Tech Demo
1st shooting on street, in room
17. **HKQ (String Quartet) (i360Music)**
Live String Quartet Recording by Petr Soupa
Object with shotgun + FOA
18. **The Committee (Drama)**
British Comedy by 360 mixed by Petr Soupa
Object with Lav + FOA
19. **Elliot S. (Skateboarding)**
Skateboarding by Olympic Gold Medalist
Reality with extreme elevation
20. **Annabelle (Blockbuster Film)**
Teaser for Hollywood horror movie
Positional sound extremely important for scare facto.





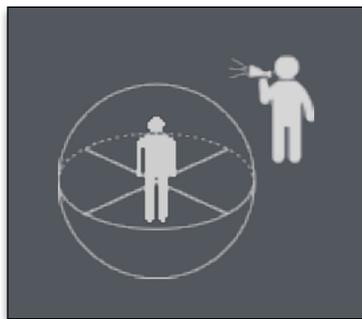
**“SOUND IS HALF THE
EXPERIENCE”**

**STAR
WARS**

Filmmaker
George Lucas

Why Is Audio More Important Than Ever in VR?

01. Positional audio as the storytelling cue



The VR user's **freedom of viewpoint** makes **sound an important signal** to direct his or her attention and lead the story as the content producer intended.

“...I think we're moving into a dangerous medium with virtual reality... The only reason I say it is dangerous is because it gives **the viewer a lot of latitude not to take direction from the storytellers but make their own choices of where to look...**”

- Steven Spielberg

“...**Affordance can be led by sound in VR.** If you hear 'hey!' from the back, you look back without hesitation...**Audio signal can trigger user's action, or can get user's attention...**”

- Clay Bavor (VP, Virtual Reality at Google)

02. Feeling present cannot be achieved without audio



Content is bounded by the TV screen.
You are an observer.

Audio exists solely in the content world



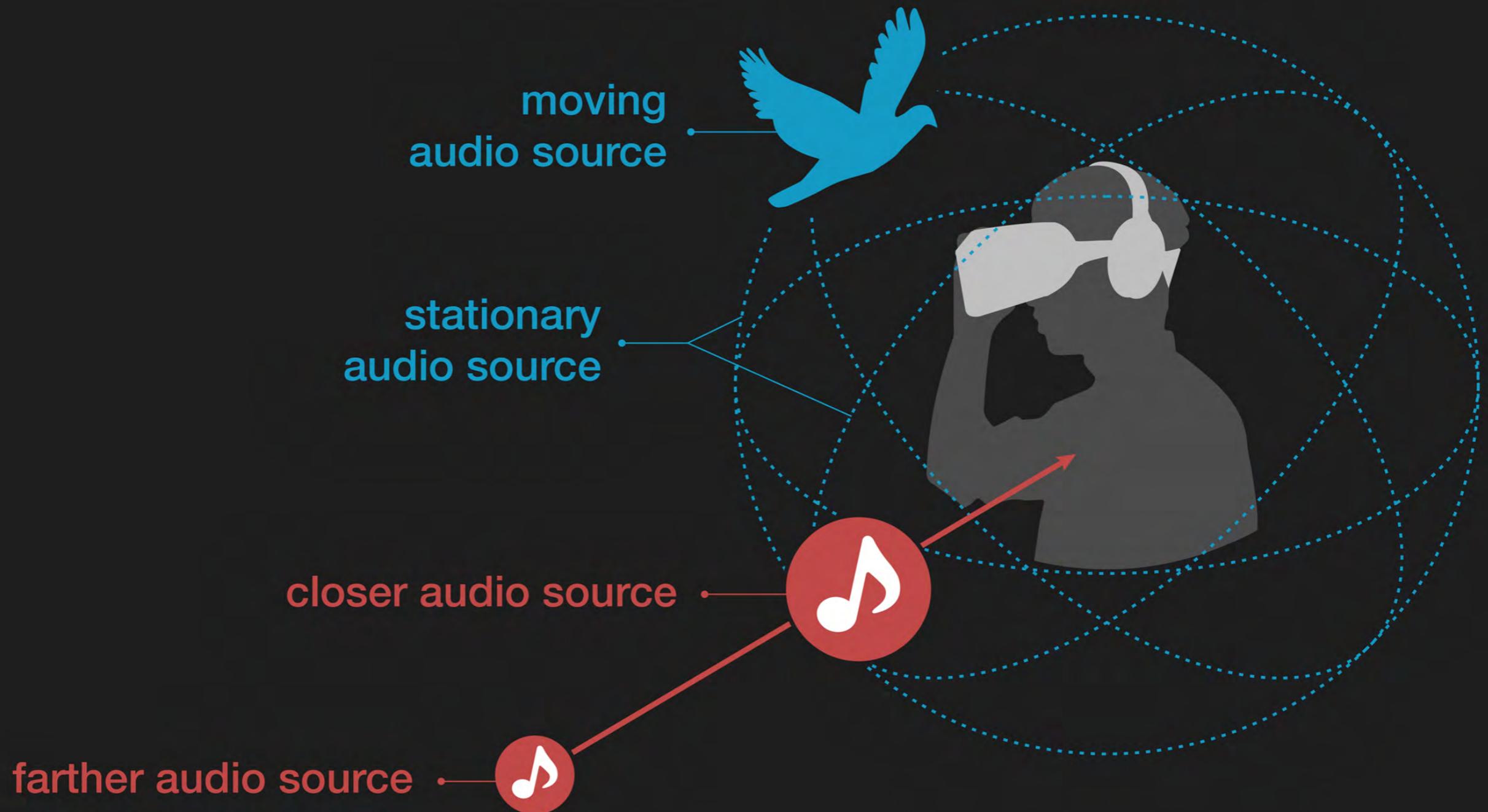
You are immersed in the content.
You are present.

Audio becomes your world

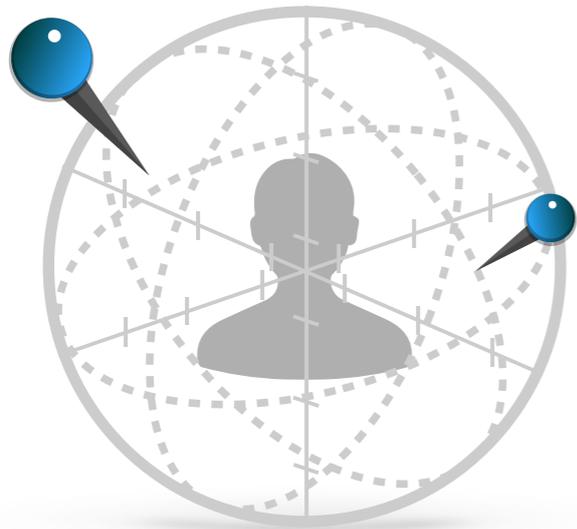
What audio technology is specifically needed for VR?



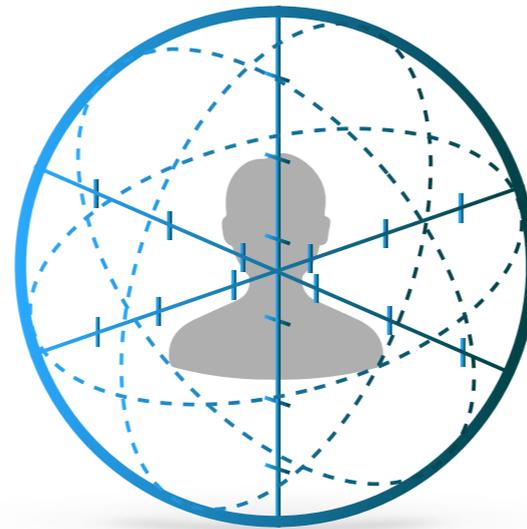
What Does it mean to have VR specific audio?



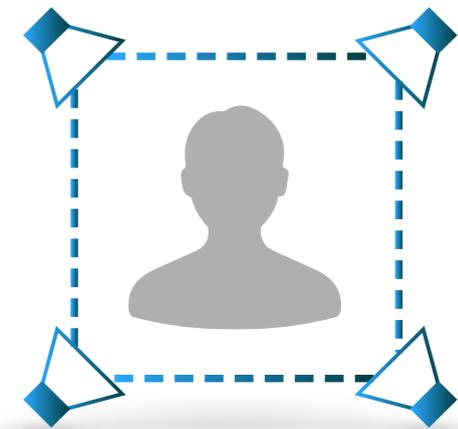
Replicating Lifelike Audio: Different Formats In Use



Object

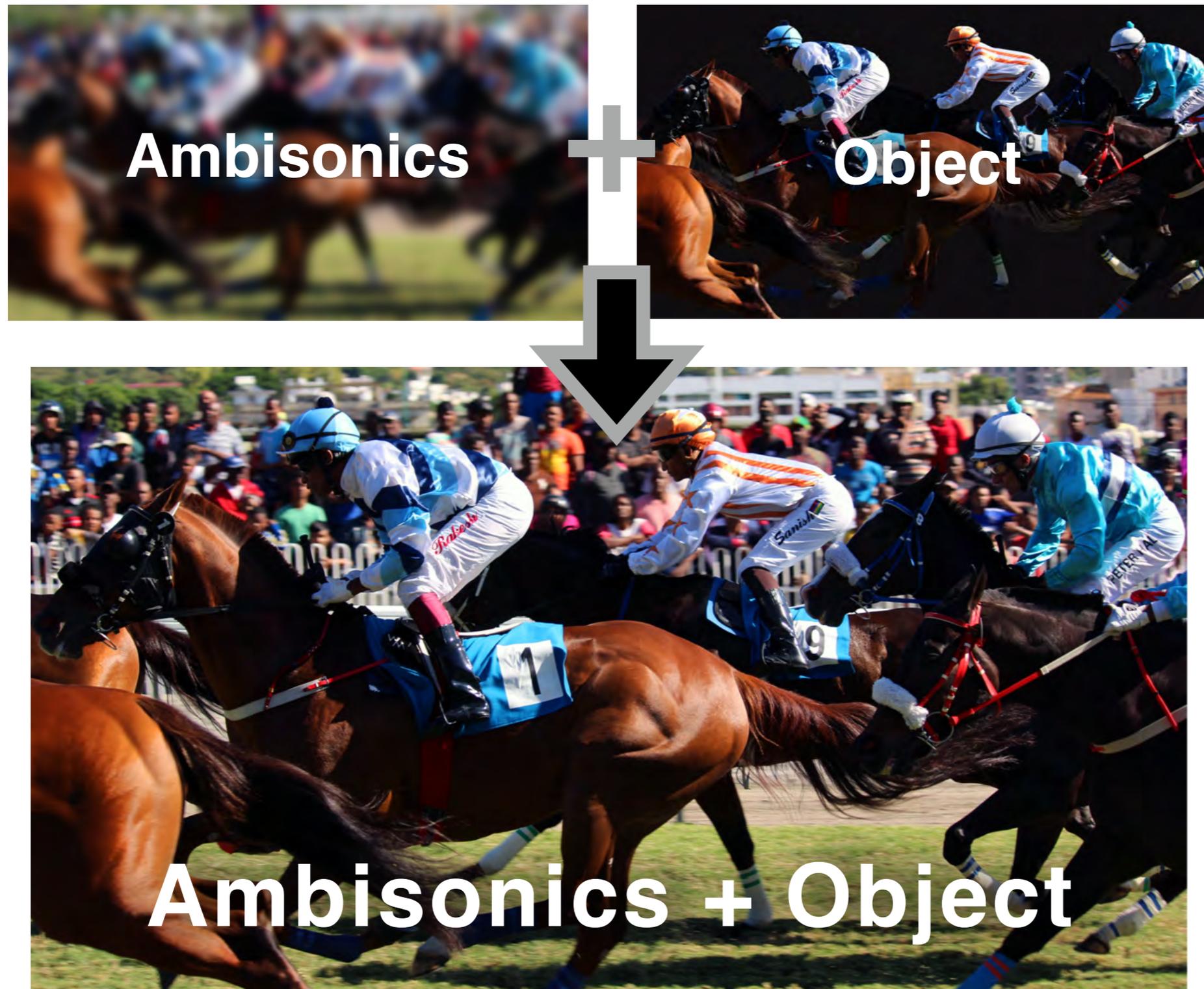


Ambisonics

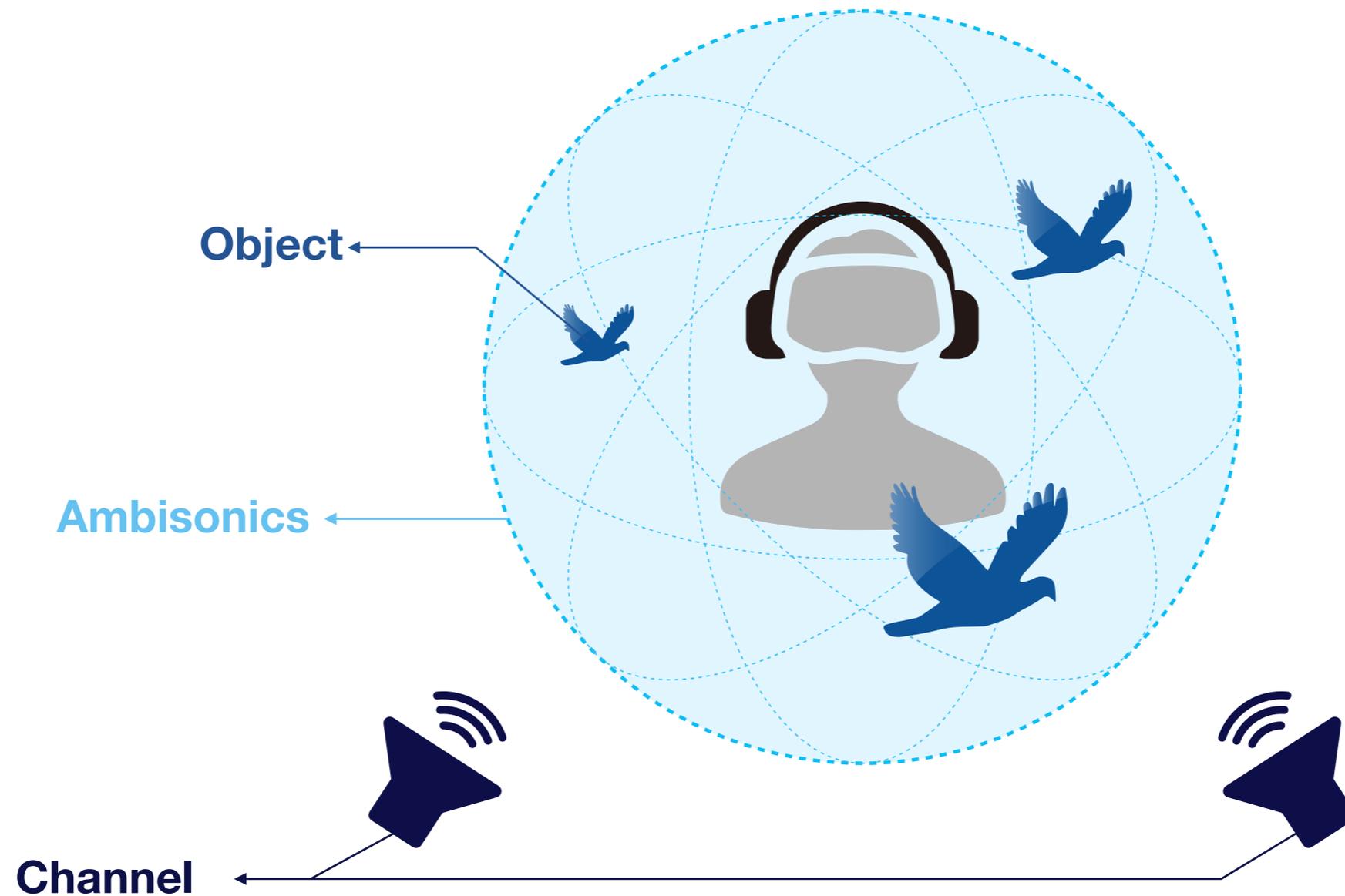


Channel

Let's visualize...



Most Ideal Audio Representation: Mixed Formats

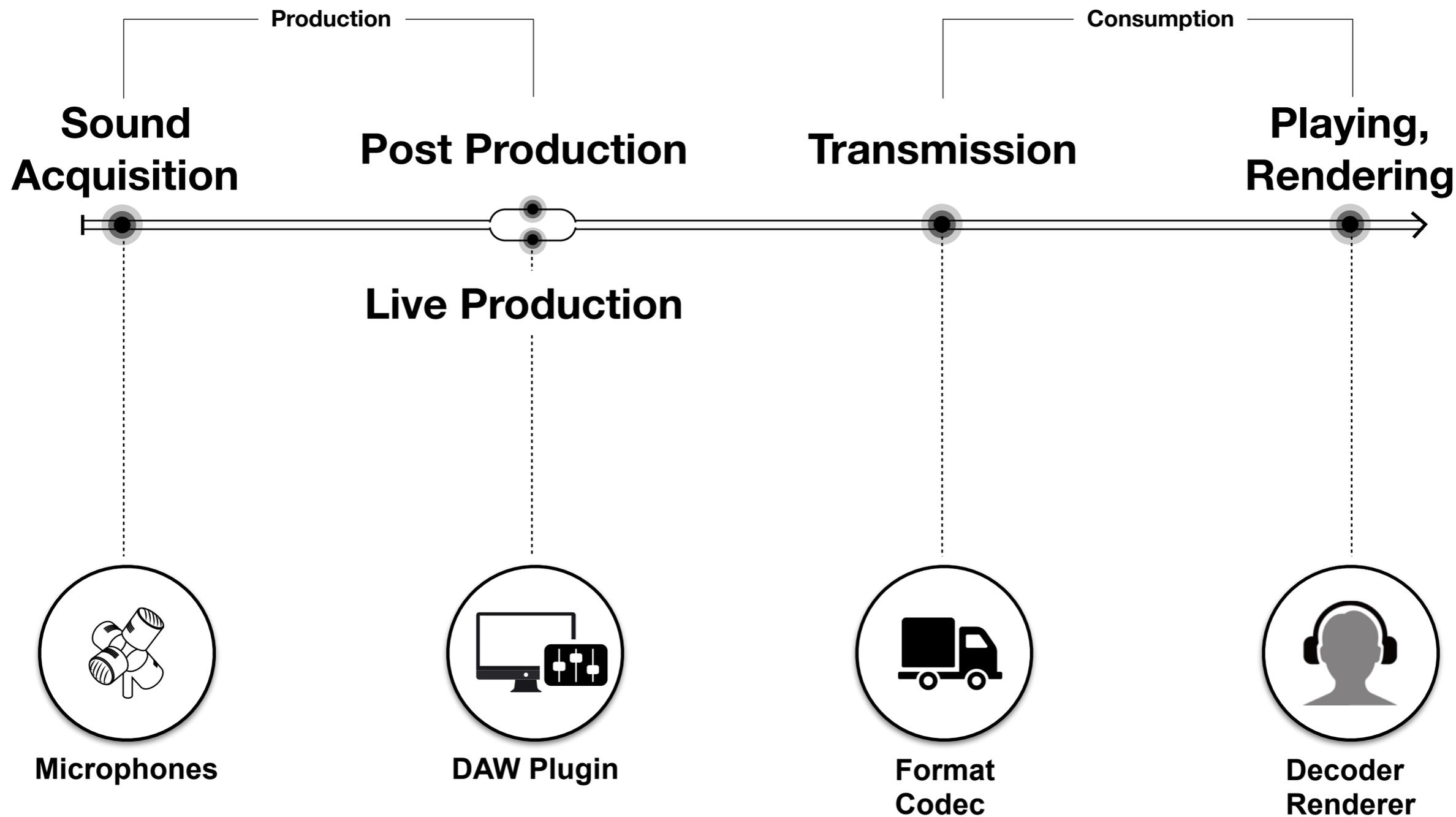


What Does End-to-End Audio Workflow Mean?

“Same High Quality Sound
From Production to Consumption”



Ideal End-to-End VR Audio Workflow



Sound Acquisition



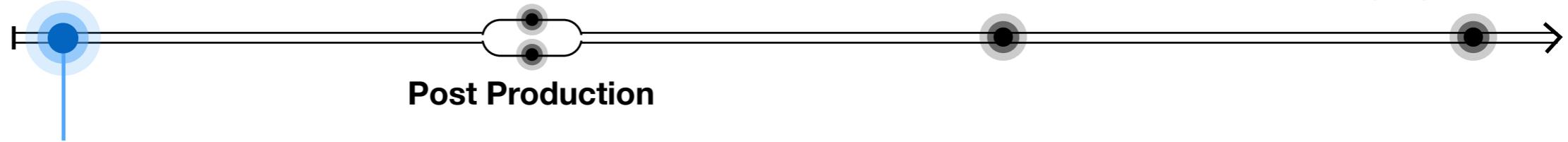
Sound Is Captured in Different Audio Formats

Sound Acquisition

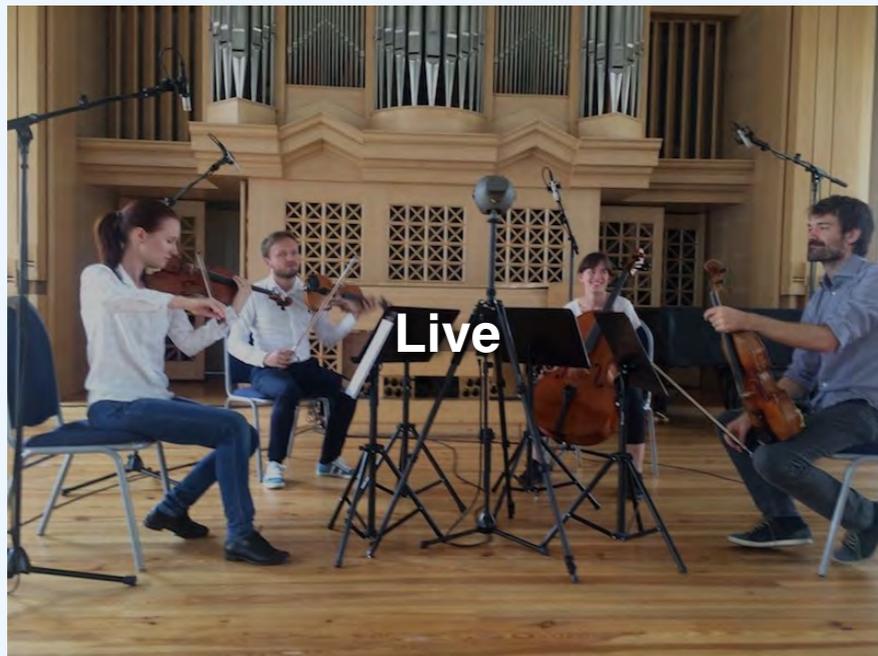
Live Production

Transmission

Playing / Rendering



Post Production



Ambisonics



Object



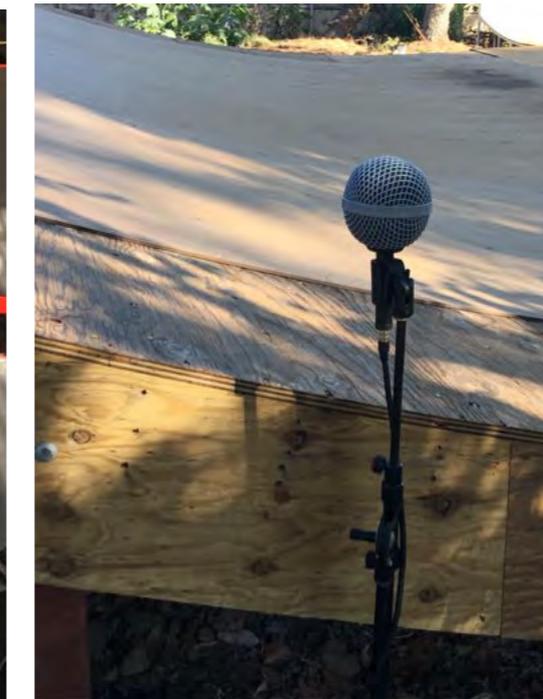
Live Production



Channel

Post Production

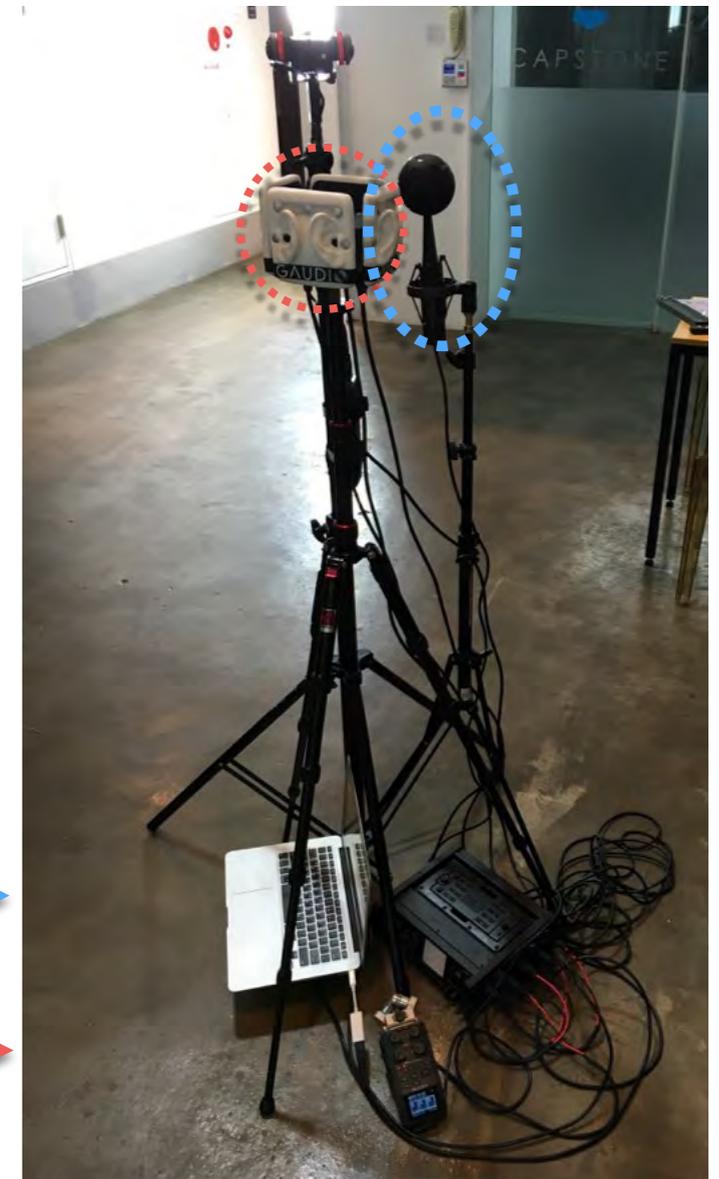
Live Shooting Scene (1)



◀ First Order Ambisonics Mic to get the 3D sound

◀ Typical live capture set (cart)

Third Order ▶
Ambisonics Mic
Omni-binaural mic ▶
(for experiment)



Live Shooting Scene (2)



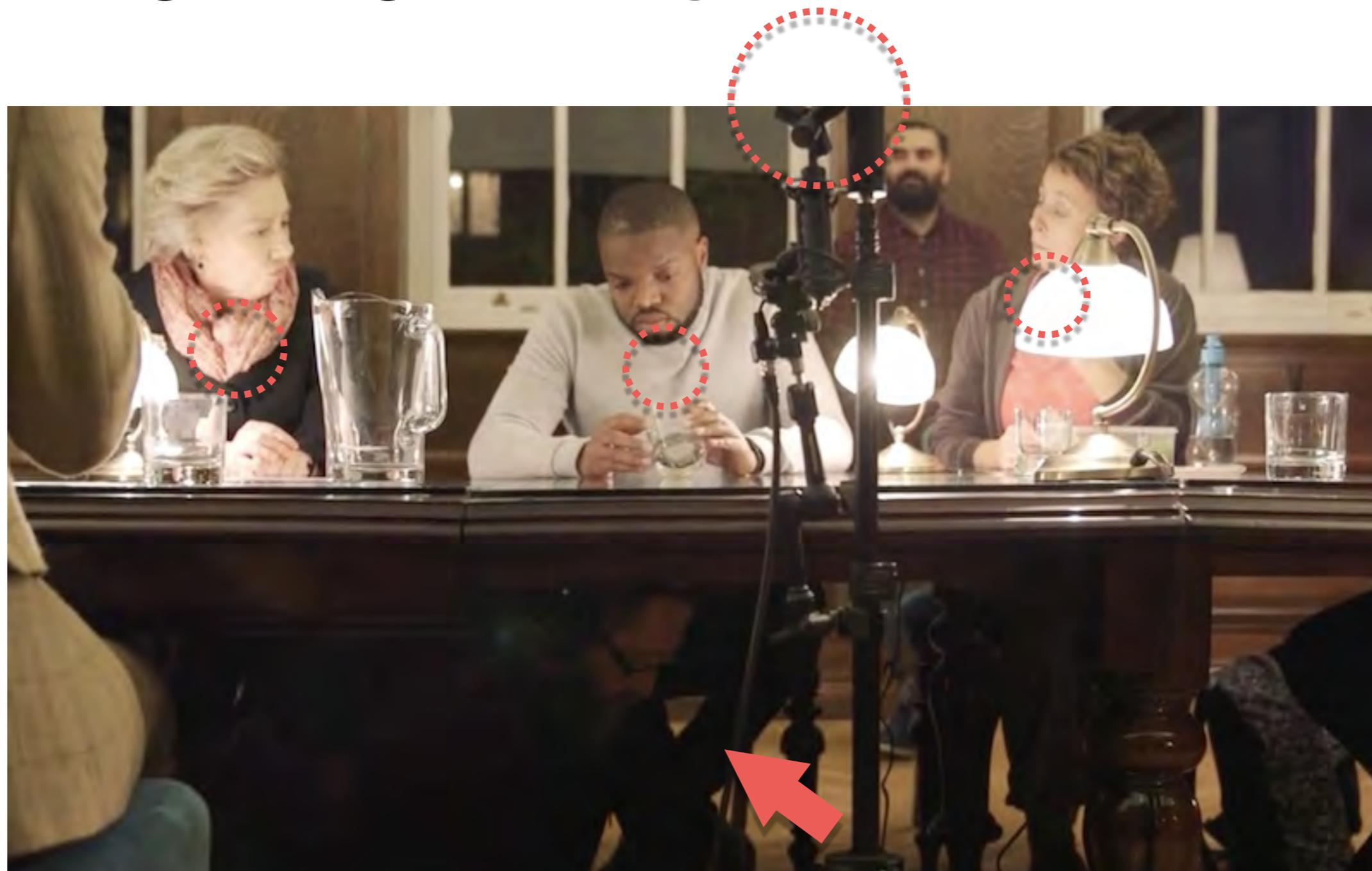
▲ In conventional 2D camera ages, boom mic was for object in live recording.

◀ Lavaliers are widely adopted for human object in 360

Capturing Static Sound Objects: Ambisonics + Shotguns



Capturing Moving Sound Objects: Ambisonics + Lavaliers



Capturing Ambience with Ambisonics Separately



Drone Noise

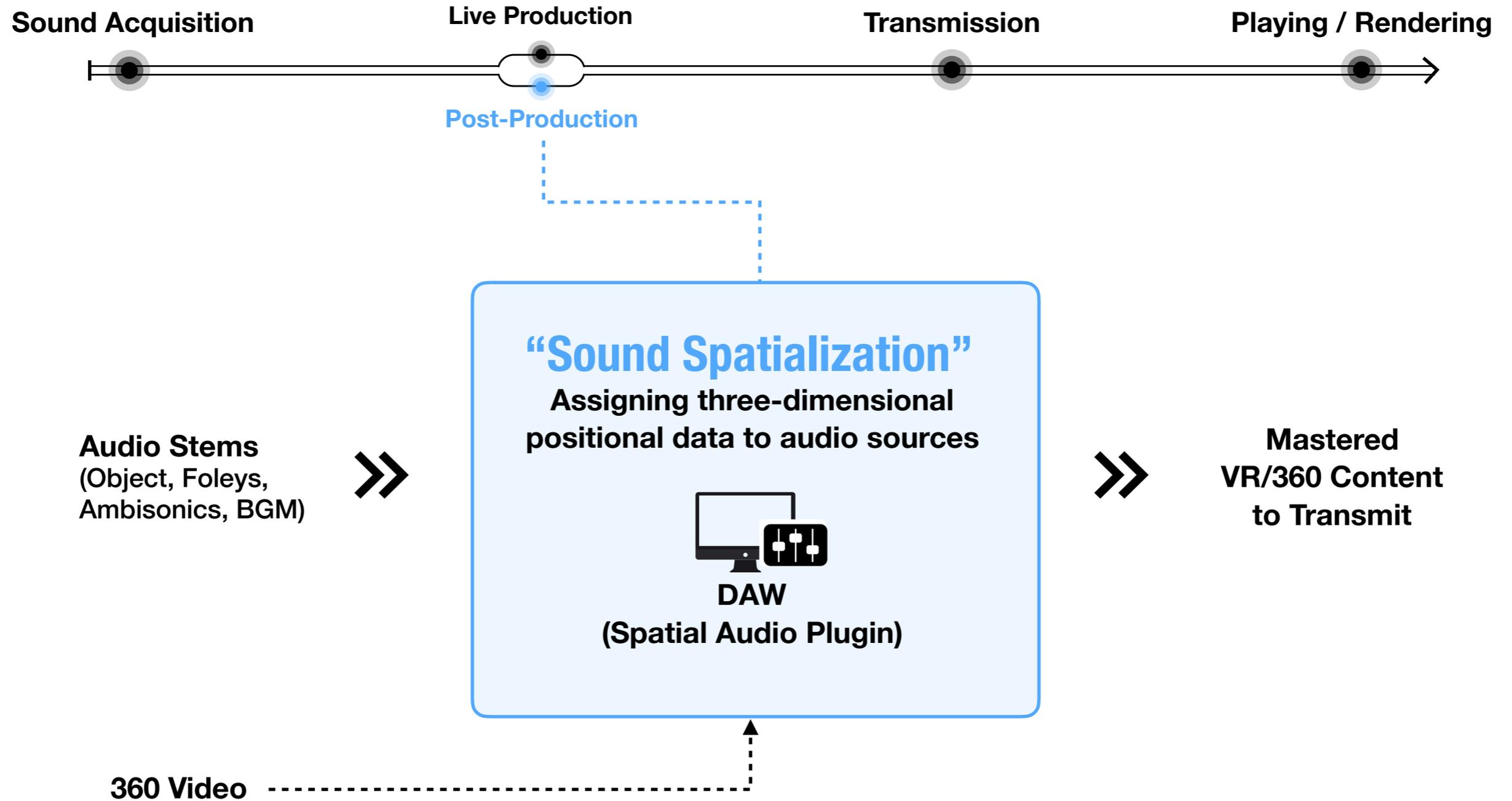


Rover Noise

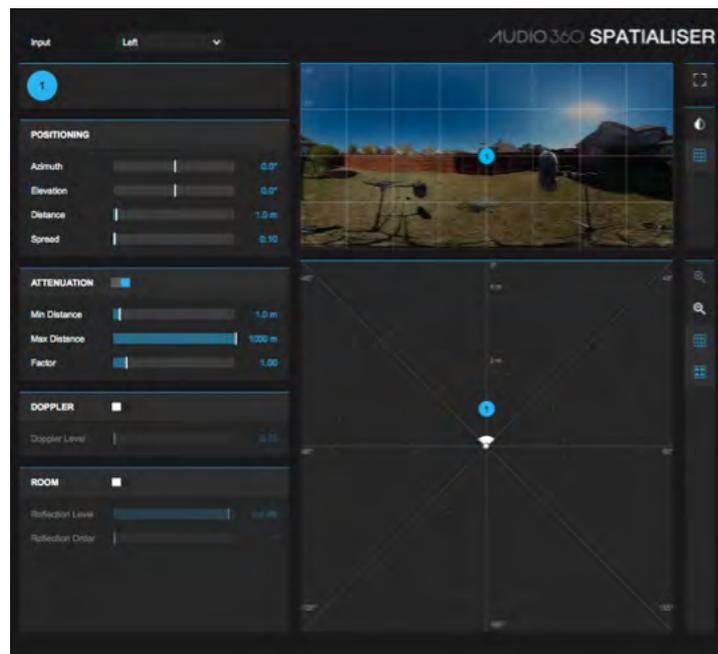
Live Production or Post-Production



During Post-Production, Audio Can Be Spatialized



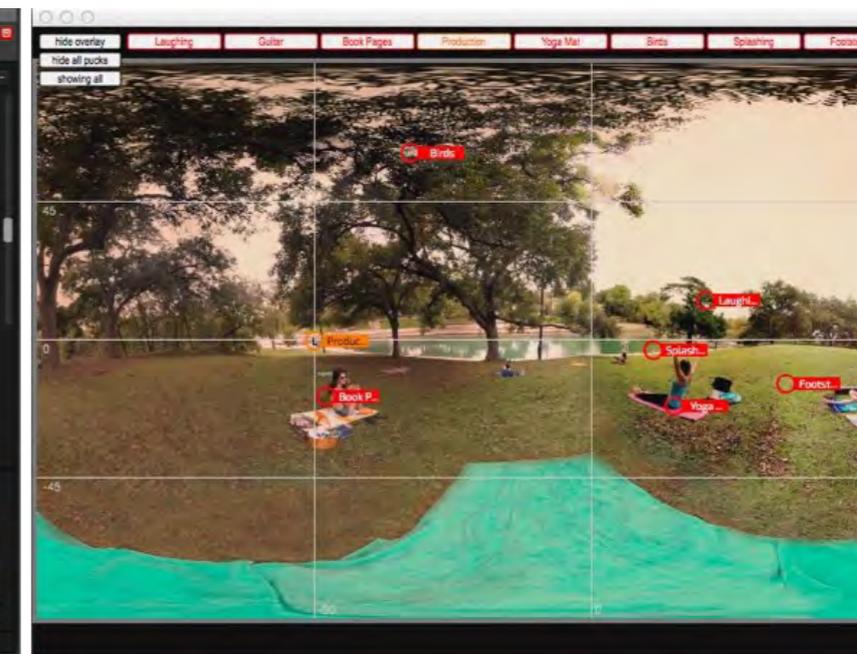
Spatial Audio Tools in Marketplace



Facebook Spatial Workstation



G'Audio Works



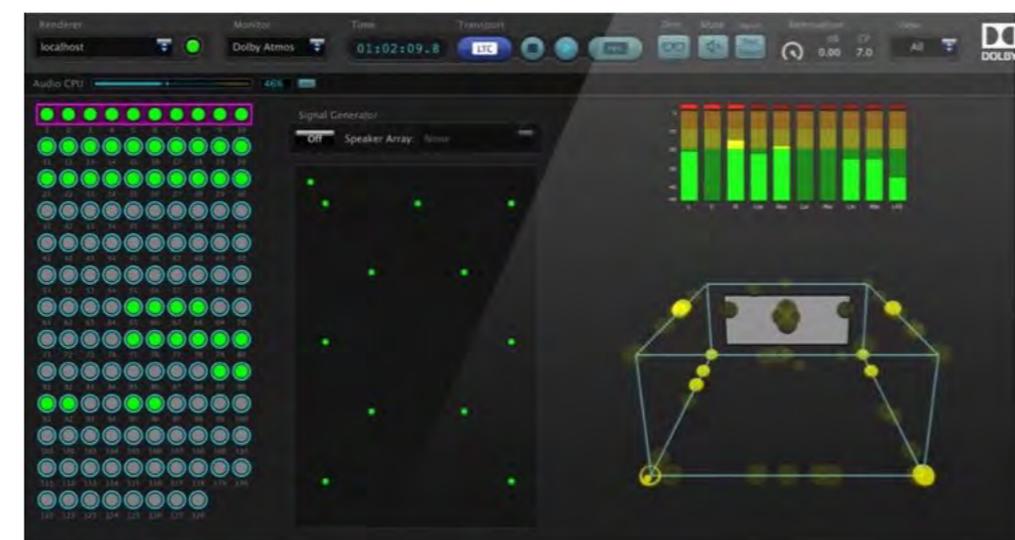
Audio Ease 360pan Suite



Noisemaker Ambi Head



Waves



Dolby Atmos VR

Spatializing Sound with DAW Plugin

The screenshot displays the G'Audio Works Master DAW plugin interface. At the top, the 'Track' section shows 'Master 1' and 'G'Audio Works Master'. The main area is a 3D spatialization environment with a grid and labels for 'BACK', 'LEFT', 'FRONT', 'RIGHT', and 'BELOW'. A dinosaur head is visible in the background. The interface includes a list of tracks on the left: Stereo Bed, Dino Steps, Branches, DinoHowl, Raptors, Raptor L., T Rex, and Woman. The 'Dino Steps' track is selected, showing its spatial positioning controls: Azimuth (-75), Elevation (-14), Distance (6.3), and Gain (0.0). The 'HEAD ORIENTATION' section shows YAW (-180) and PITCH (14). The 'MONITORING FORMAT' section shows GA5 and FOA options, with a timer at 00:00:30:08. The G'Audio Works logo and version (Works v2.0.2) are at the bottom right.

Track: Master 1, G'Audio Works Master

Preset: <factory default> | Auto | COMPARE | SAFE | BYPASS | Native

Tracks: Stereo Bed, Dino Steps, Branches, DinoHowl, Raptors, Raptor L., T Rex, Woman

3D Environment: DinoHowl, Stereo Bed, Dino Steps, Branches

SPATIAL POSITIONING (Dino Steps):

- TRACK: Dino Steps
- TYPE: Mono (Object)
- COLOR: Green
- OPTIONS: BYPASS SPATIAL RENDERING (BACKGROUND), TIMBRE PRESERVATION, LOCK POSITIONING

SPATIAL POSITIONING CONTROLS:

- AZIMUTH: -75
- ELEVATION: -14
- DISTANCE: 6.3
- GAIN: 0.0

HEAD ORIENTATION:

- YAW: -180
- PITCH: 14

MONITORING FORMAT:

- GA5
- FOA
- 00:00:30:08

G'AUDIO WORKS Works v2.0.2

← SETTINGS

Spatialization for Livestreaming?

Live Production

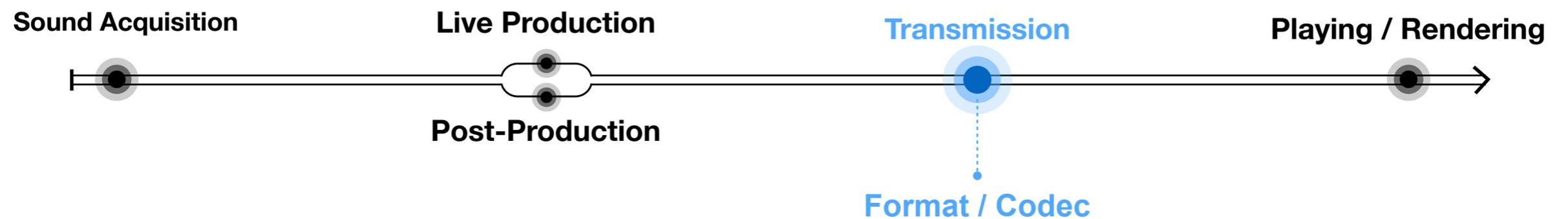


Post Production

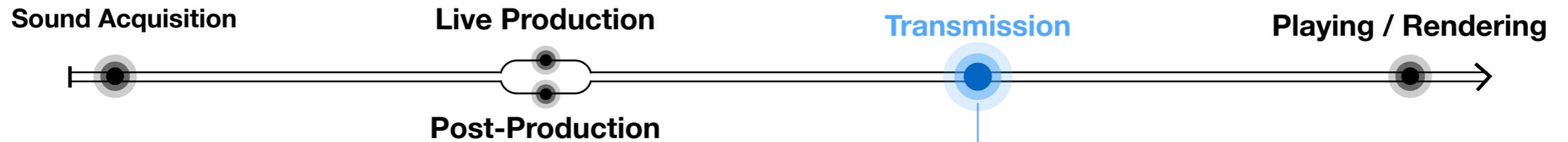


VS

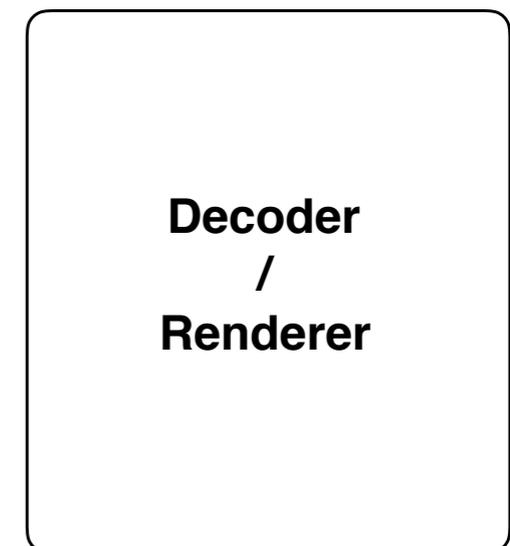
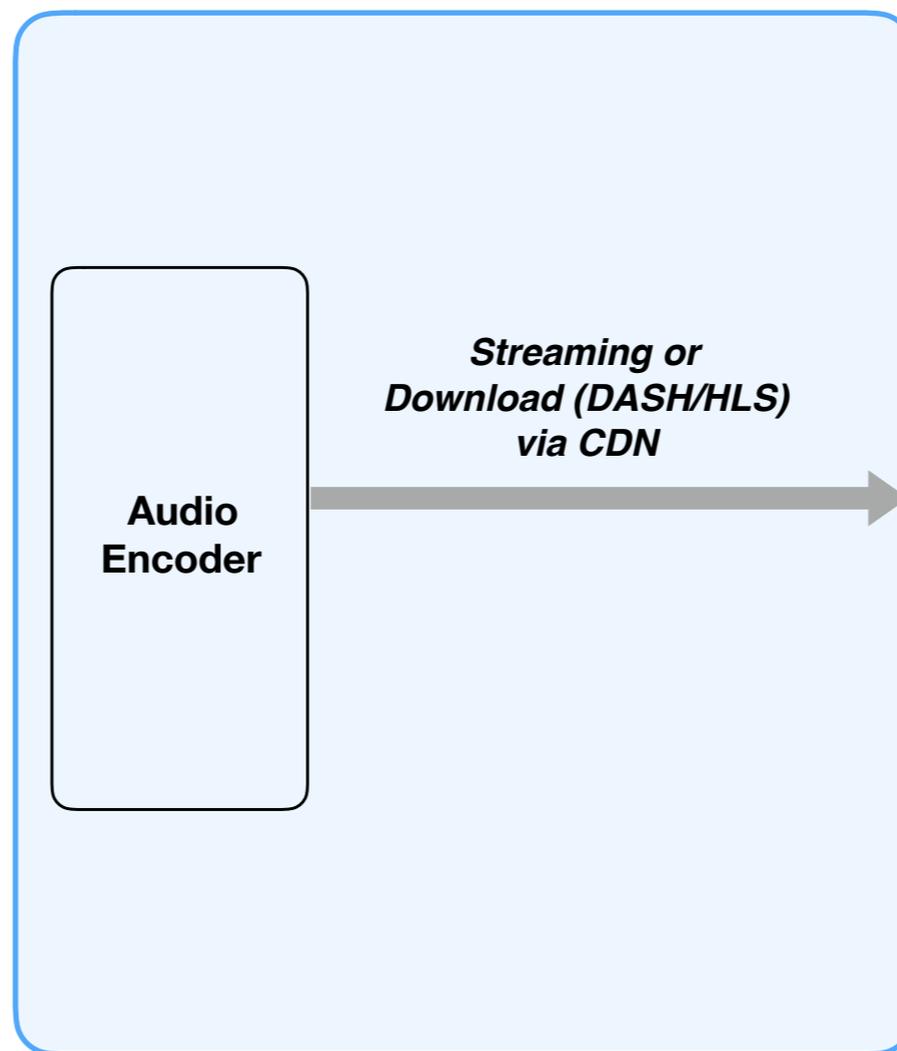
Transmission



VR/360 Audio Streaming & Reception



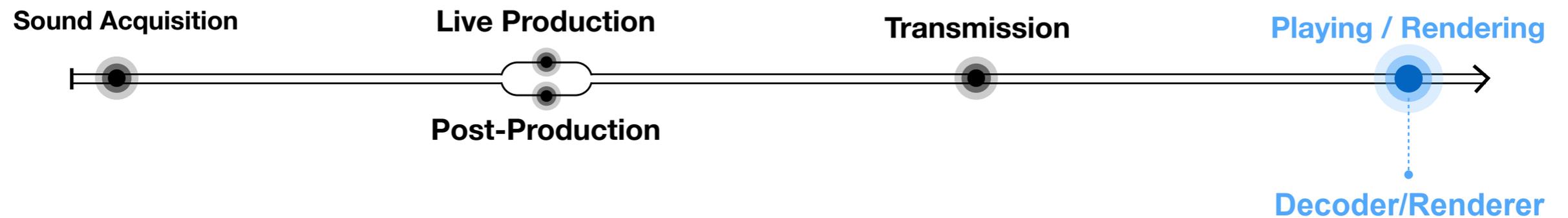
**Mastered
VR/360 Content
to Transmit**



Issues in Transmission

- **Format ≠ Codec**
- **There are and will be many useful codecs in the marketplace**
 - **e.g AAC 5.1 is already in all OS's over mobile, TV, Set-top-box, PC, and etc.**
- **Existing Formats**
 - **Facebook TBE:** Second Order Ambisonics (D) + Stereo (ND) through 10 audio channel stream
 - **Google Spatial Audio Format:** First Order Ambisonics through 4 audio channel stream
 - **MPEG-H 3D Audio:** Channel, Object, Ambisonics up to many number of audio channel stream
 - **G'Audio GA5:** Channel, Object, Ambisonics + Spatial encoding to adapt to legacy 5.1 channel stream

Playing / Rendering

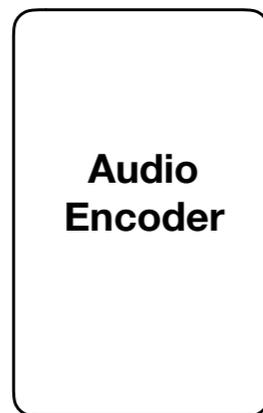


VR Renderer working in any devices

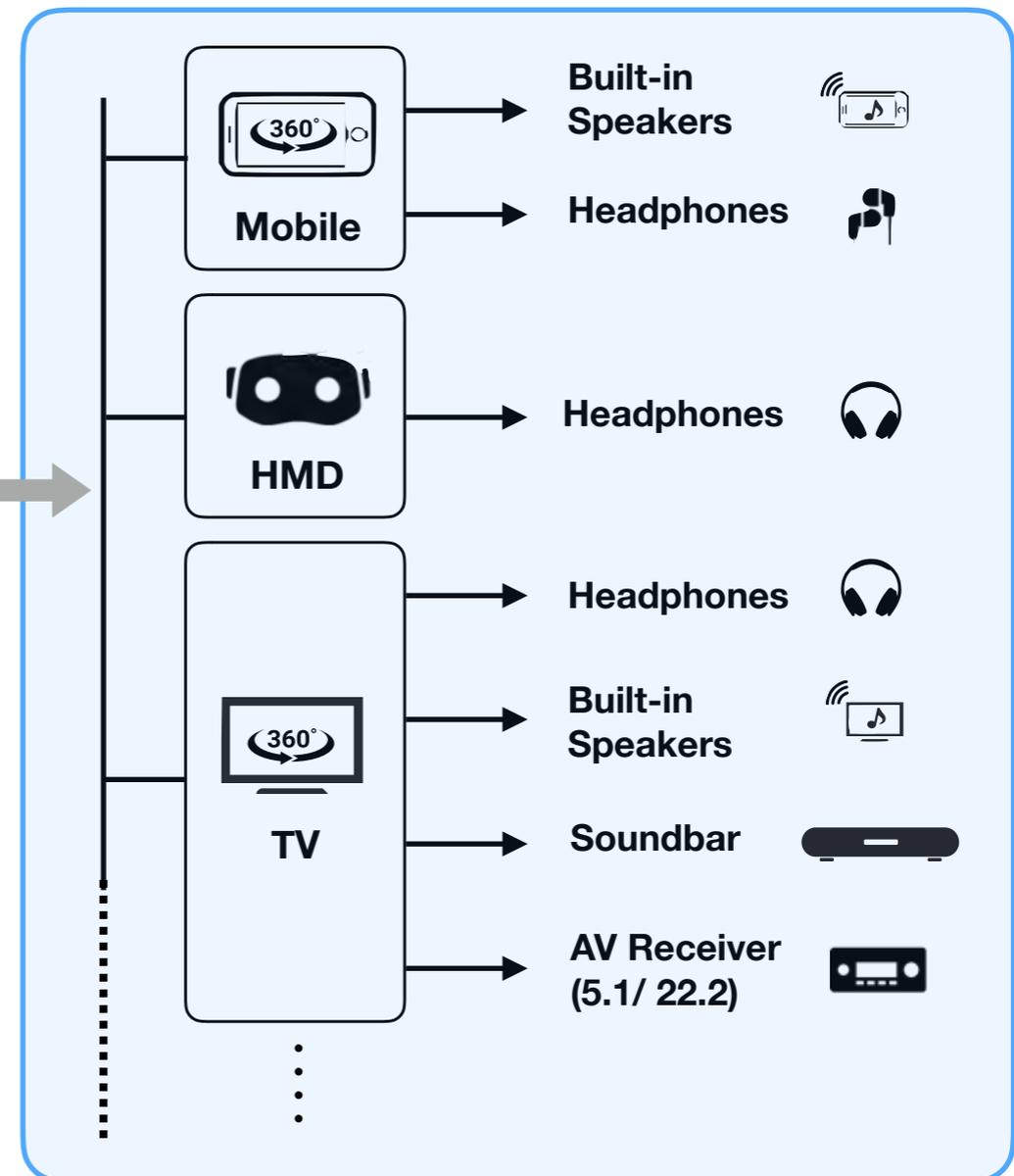
Sound Acquisition Live Production Transmission **Playing / Rendering**



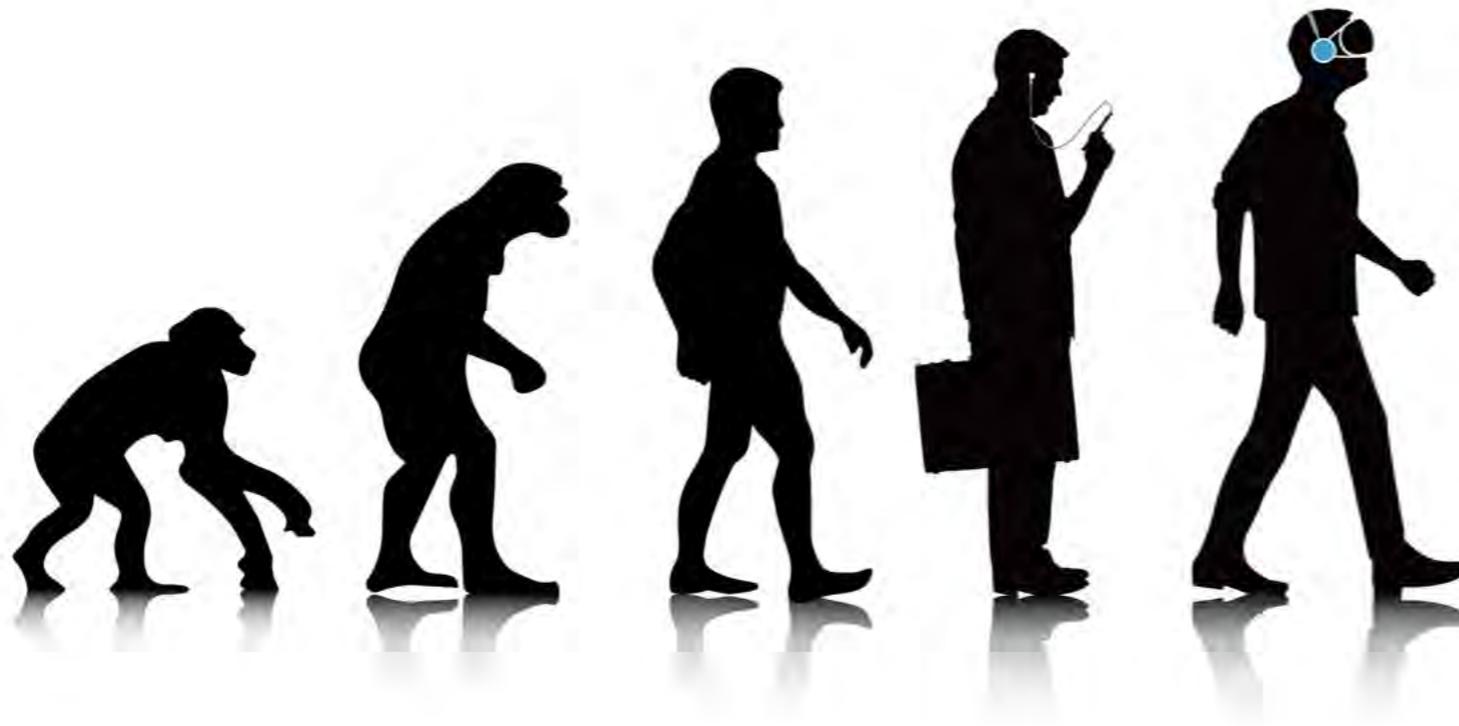
Post-Production



*Streaming or
Download (DASH/HLS)
via CDN*



Questions?



G'AUDIO

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