Ambisonics in an Ogg Opus Container
Draft-ietf-codec-ambisonics

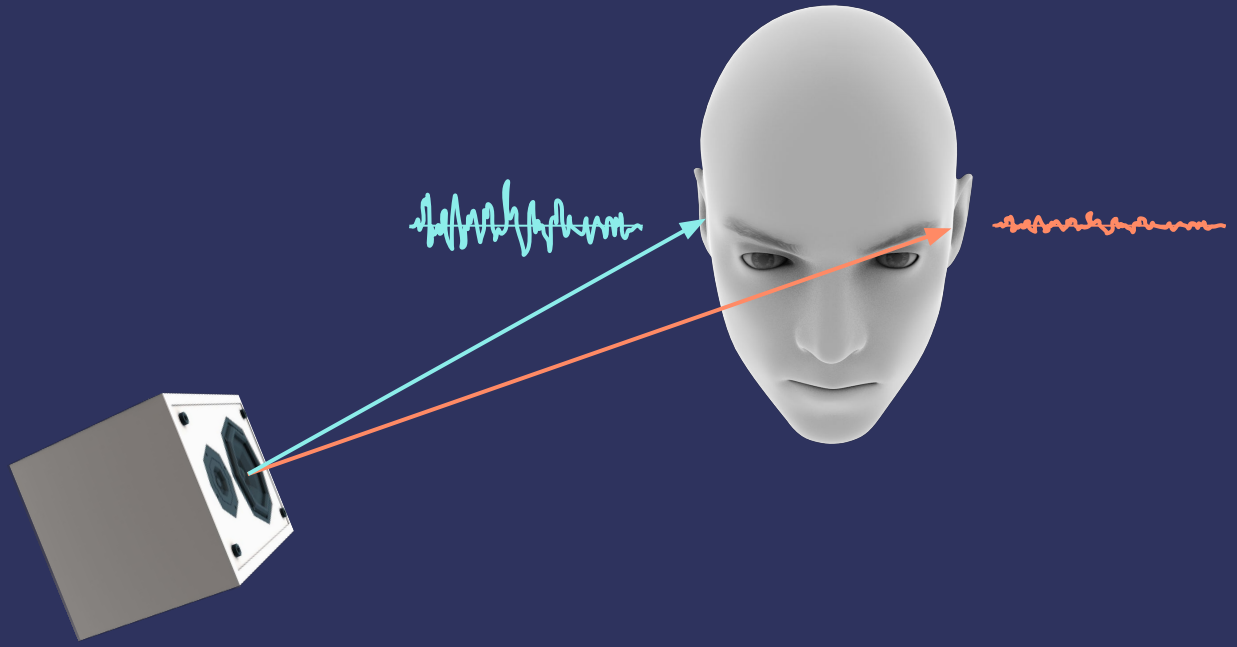
Andrew Allen
Google Inc.

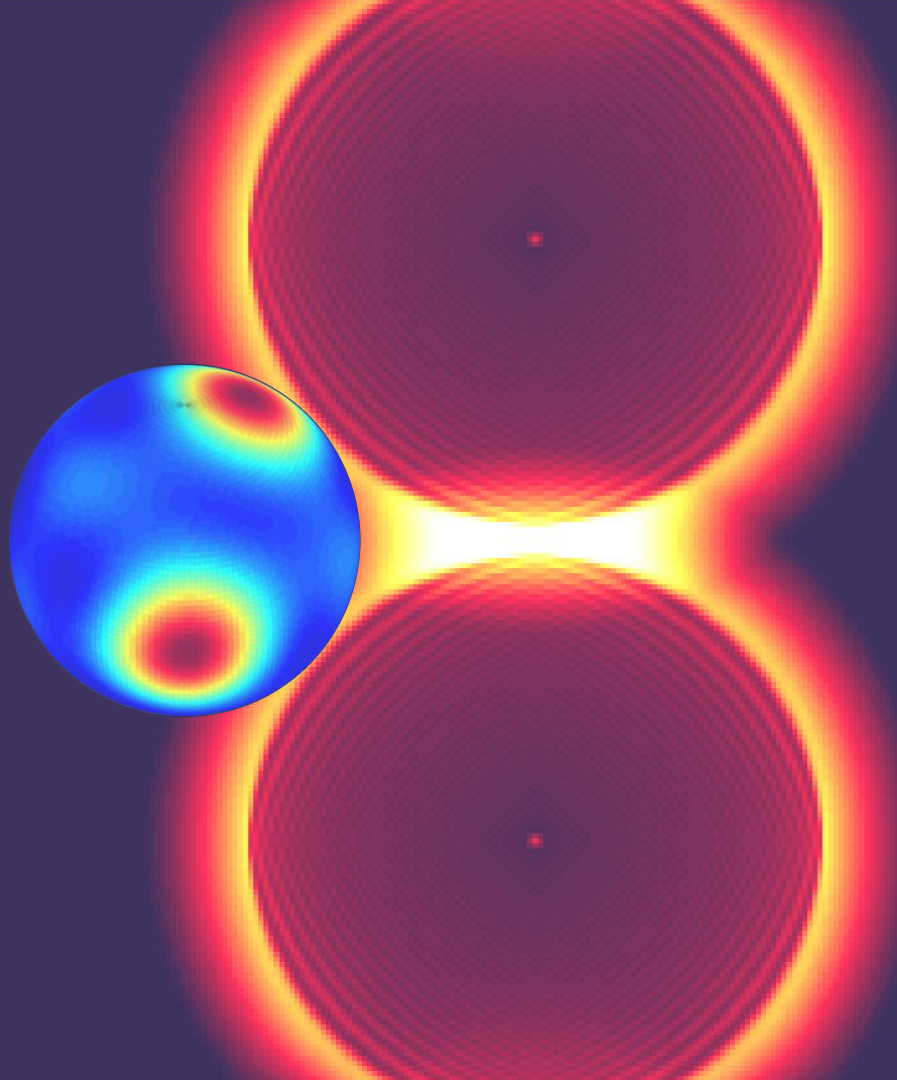
Agenda

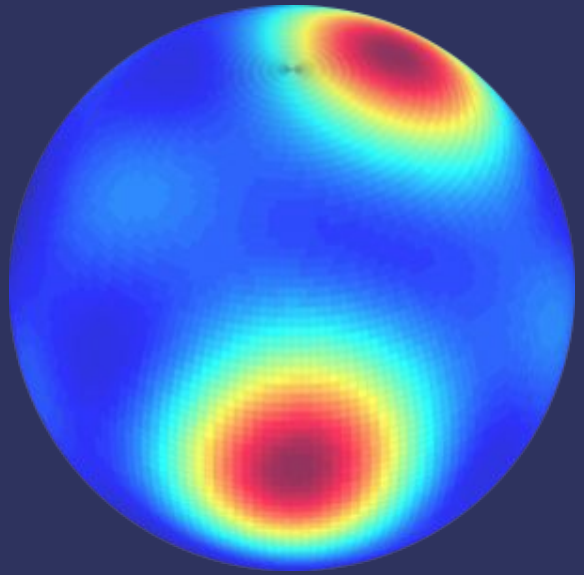
- Ambisonics Foundations
- Adding Ambisonics to Opus
  - Mappings
  - Calculations

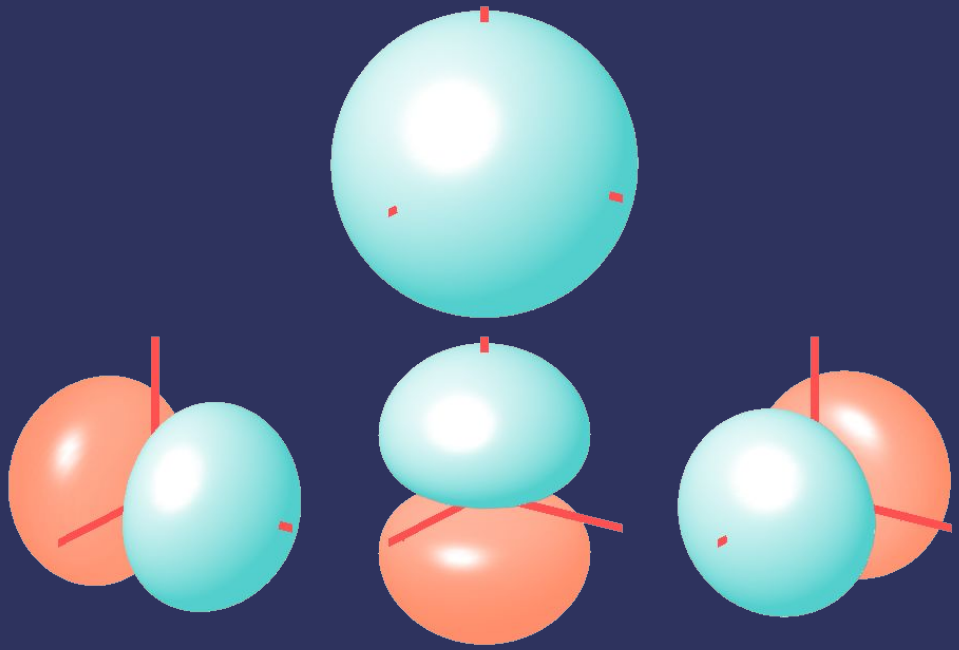
Agenda

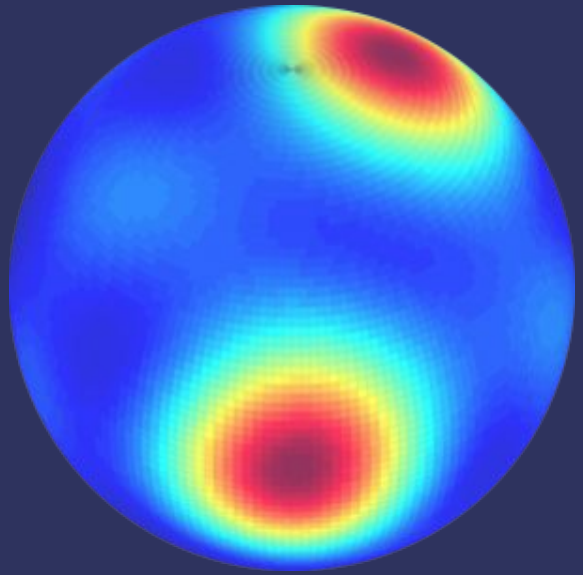
- Ambisonics Foundations
- Adding Ambisonics to Opus
  - Mappings
  - Calculations

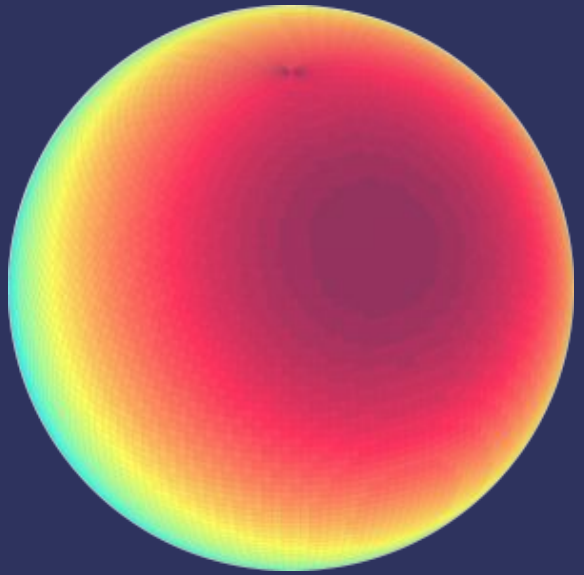




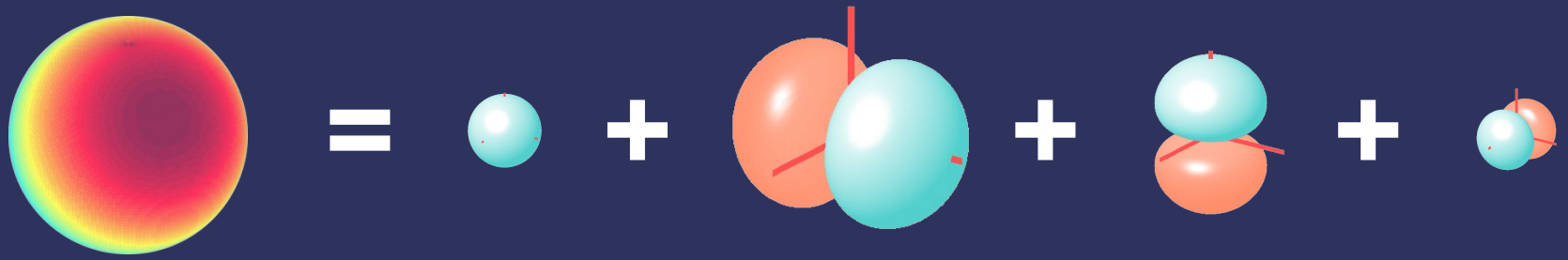


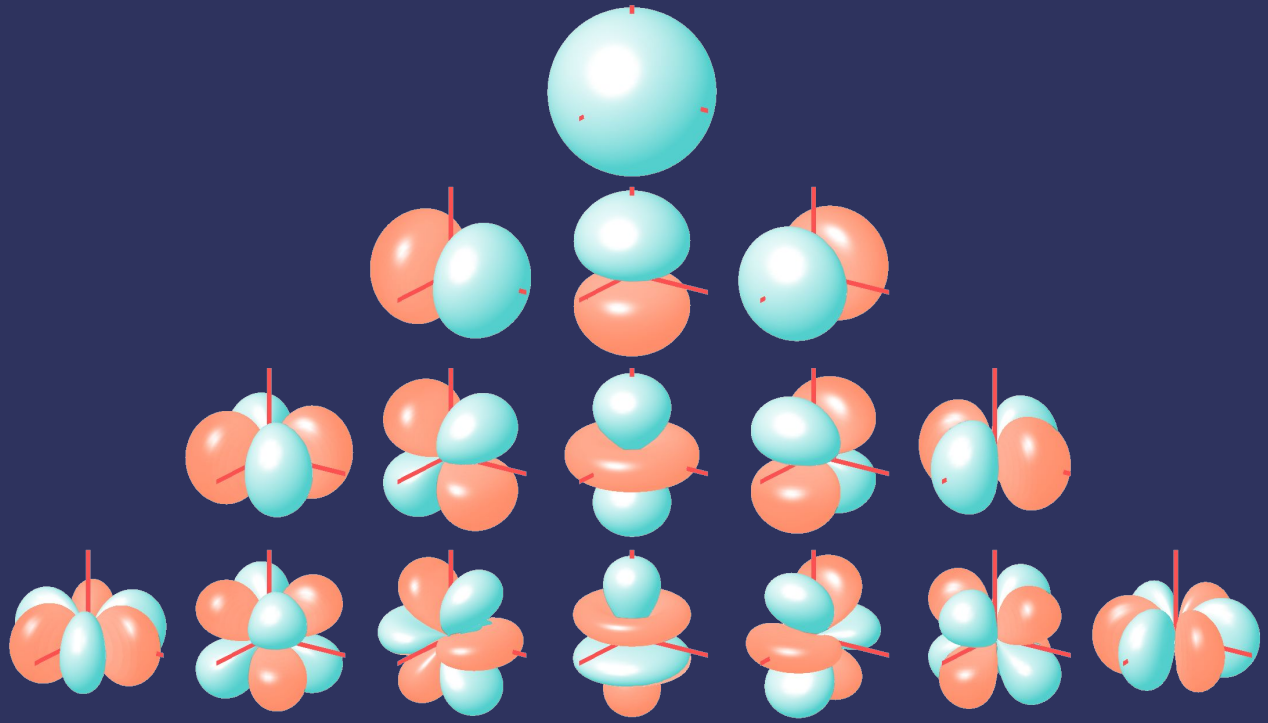


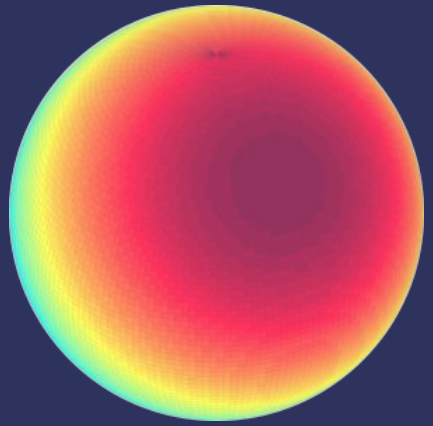




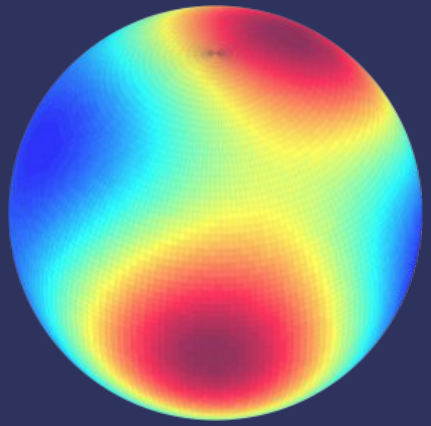
First order
Approximation



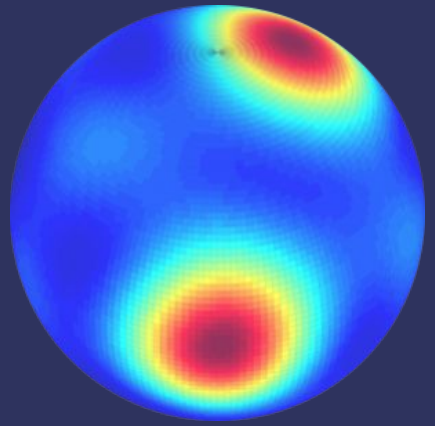




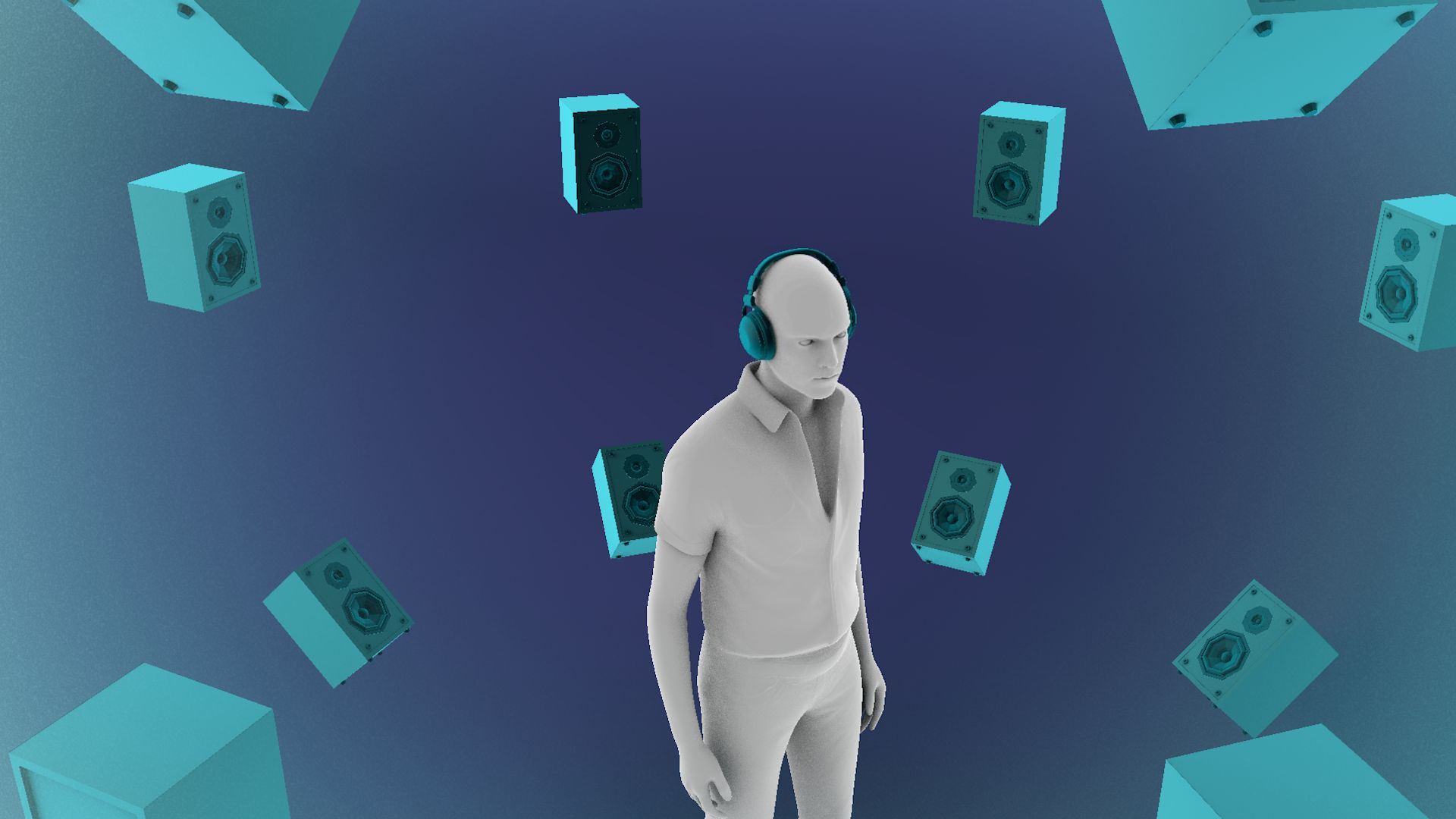
1st order
4 channels



3rd order
16 channels



Reality



Agenda

- Ambisonics Foundations
- Adding Ambisonics to Opus
  - Mappings
  - Calculations

Channel Mappings

- Ambisonics Opus Channel Mapping 2 & 3
- A demuxer implementation encountering Channel Mapping Family 2 or Family 3 MUST interpret the Opus stream as containing ambisonics

General Channel Mapping for 2 & 3

- Allowed numbers of channels:

$$(1 + n)^2 + 2j$$

for n = 0...14 and j = 0 or 1

n denotes the ambisonic order

j denotes separate non-diegetic (non-head-tracked) stereo stream

- Channels can be zeroed-out to support ‘mixed-order’ ambisonics

Channel Mapping 2 & 3 Representation

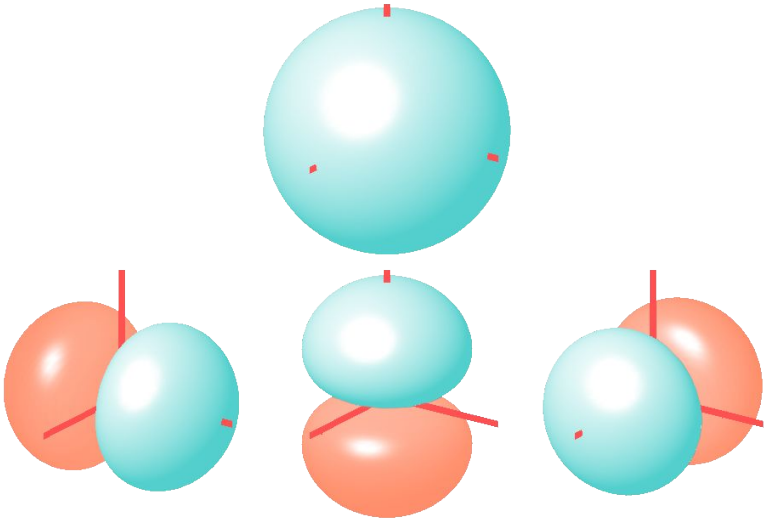
- Order of Ambisonics Channel Number (ACN)

  ACN = n * (n + 1) + m
  for order n and degree m;
  followed by 2 optional channels of non-diegetic stereo indexed (L, R)

- Ambisonic channels are expected to be normalized with Schmidt Semi-Normalization (SN3D)

Coding Details Channel Mapping 2

- Variable bit rate allocation
- More bits in the ‘W’ (Omnidirectional) Channel



Coding Details
Channel Mapping 3

KEY

U = encoder input streams

X = encoded/decoded channels,

S = decoder output streams

C = num. of input/output channels

K = num. of streams + num. of coupled streams

A = mixing matrix

D = demixing matrix **(stored in header)**

decoder

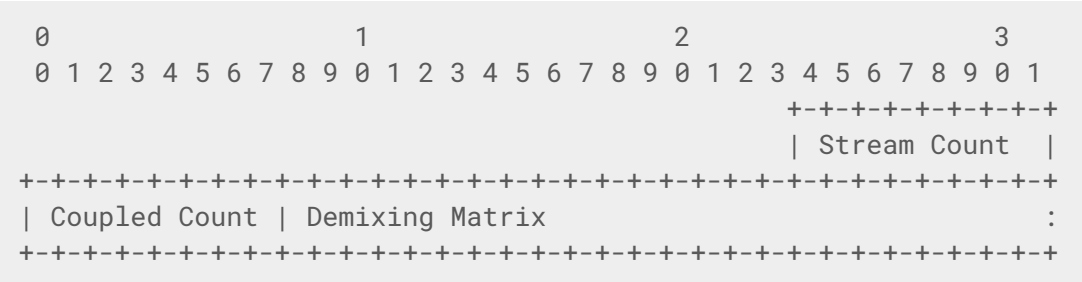
$$\begin{bmatrix} s_1 \\ s_2 \\ \vdots \\ s_c \end{bmatrix} = \begin{bmatrix} d_{1,1} & d_{1,2} & \dots & d_{1,k} \\ d_{2,1} & d_{2,2} & \dots & d_{2,k} \\ \vdots & \vdots & \ddots & \vdots \\ d_{c,1} & d_{c,1} & \dots & d_{c,k} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_k \end{bmatrix}$$

encoder

$$\begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_k \end{bmatrix} = \begin{bmatrix} a_{1,1} & a_{1,2} & \dots & a_{1,c} \\ a_{2,1} & a_{2,2} & \dots & a_{2,c} \\ \vdots & \vdots & \ddots & \vdots \\ a_{k,1} & a_{k,1} & \dots & a_{k,c} \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \\ \vdots \\ u_c \end{bmatrix}$$

Channel Mapping Tables

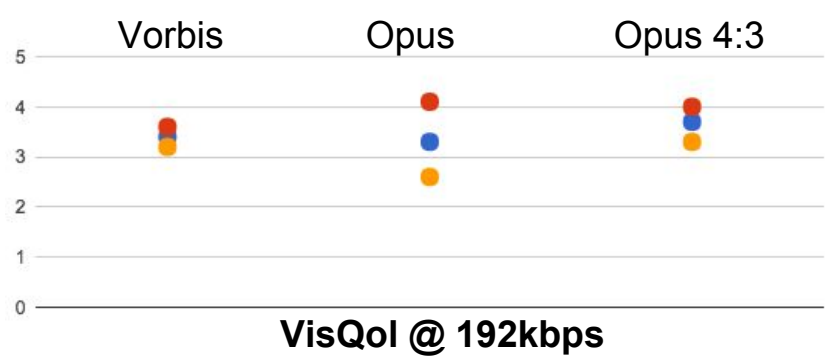
- Mapping 2 uses Mapping 1’s Mapping Table



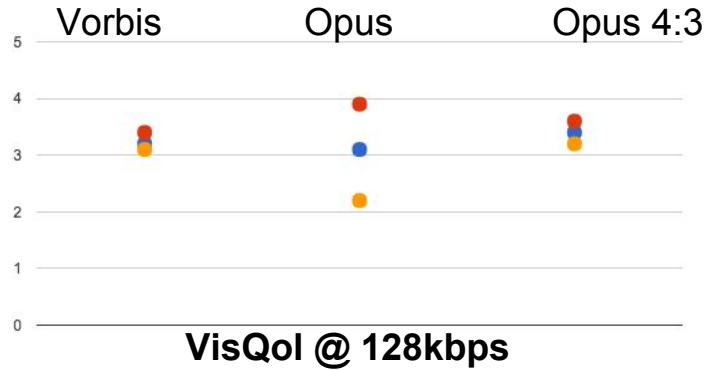
Channel Mapping Family 3’s Mapping Table

Questions

Comparison of Results

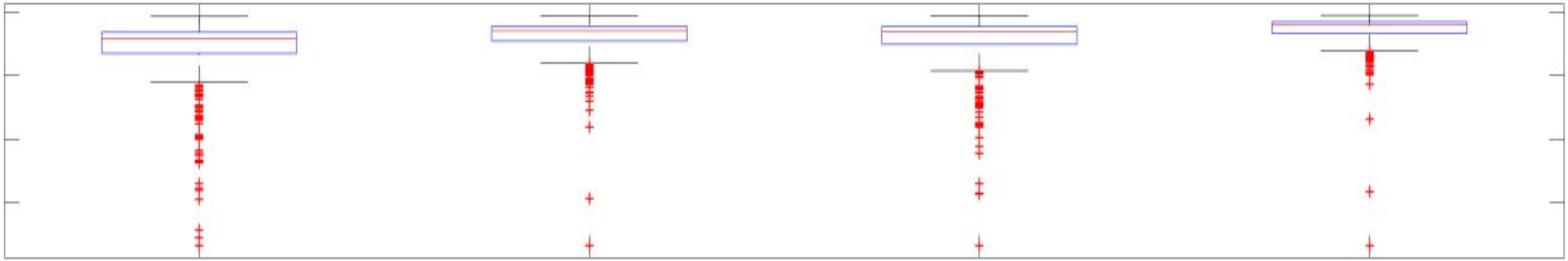


VisQol @ 192kbps



VisQol @ 128kbps

Directivity



Opus 128kbps | Opus 4:3 128kbps | Opus 192kbps | Opus 4:3 192kbps