

P.S. unassisted sound installation

- Example SC routine for channels testing and contents of the „hello.scd“ file

P.S. unassisted sound installation

- Example SC routine for sound („Private Netzwerke“)

Multichannel audio and artistic approaches

Tutorium WS24



INTRO: Definition and Historical Context

- What is Multichannel?
 - $2 <$
 - 5.1, 7.1 $<$
- how it started:
 - Varese „Poème Électronique“ - movement+immersion
 - surround sound (Dolby Surround and Quadraphonic)
 - Ambisonics and advanced techniques



INTRO: Importance in Artistic Approaches

- Immersion
- Expressive Potential
(*distance, movement, and directionality - acousmonium tradition*)
- Simulating Real or Creating Abstract space (*N.Barrett*)
- Audience Engagement
(*Eckel's installation with ping-pong balls*)



Methods of Panning and Spatialization

- **Basic Concepts**
 - **panning** (placement (amp, time delay), move horizontally) vs **spatialization** (+depth+height, more focus on motion)
- **Panning Techniques:**
 - **Stereo Panning:** Traditional left-right panning.
 - **Vector-Based Amplitude Panning (VBAP):** Spatial sound placement in 2D/3D spaces.
 - **Ambisonics:** Spherical sound encoding/decoding for full 3D sound field representation.
 - **Wave Field Synthesis (WFS):** Sound field reconstruction using an array of speakers.

Typical Hardware and Software Setups

- Hardware Components:
 - **Speaker Arrays**
 - **Audio Interfaces**
 - **Microphones for Recording Spatial Audio**
- Software Solutions:
 - **DAWs**
 - **Spatialization Plugins.**
 - **Dedicated Tools for Ambisonics and Wave Field Synthesis.**

Virtualized Acoustic Spaces



- Convolution Reverb and Impulse Responses (IRs):
 - **What is Convolution Reverb?**
 - **Creating and Using IRs.** (*ROOMS-binaural production for sound artists*)
- Applications in Art:
 - **Sound Installation** (*Antropocene Maze at DACA*)
 - **Interactive Spaces** (dynamic IRs *Diego Stocco*)

Challenges and Creative Solutions

- **Phasing** Issues (constructive or destructive interference), solutions:
 - Time Alignment
 - Avoiding Wide Stereo Panning in Multichannel Setups
 - Utilize Mono or Phase-Coherent Sources When Needed
- **Room** Acoustics (reflections, reverberation, and standing waves):
 - Site-Specific Composing
 - Acoustic Treatment
 - Convolution Reverb for Room Simulation

Challenges and Creative Solutions

- **Speaker** Placement Limitations (spatial precision of the composition)
 - Use Flexible Spatialization Techniques
 - Use Height Speakers or Overhead Arrays for 3D Perception
- **Listener** Position Variability (inconsistent experience for different locations)
 - Centralized Sweet Spot Design
 - Diffuse Spatialization
 - Multi-Zone Spatialization

Challenges and Creative Solutions

- Balancing **Direct and Reflected** Sound
 - Early Reflections Simulation
 - Dynamic Mixing of Reverb Levels
 - Directional Reverberation
- Sound **Localization** and Spatial Clarity
 - Sparse Spatial Distribution
 - Focal Points
 - Combining Localization Cues

Challenges and Creative Solutions

- **Technological** Limitations
 - Maximizing Available Channels
 - Hybrid Approaches
 - Simplified Multichannel Setups

Composing for multichannel: practical tips



Composing for multichannel: practical tips

1. Understanding the Speaker Setup (speakers: how many, where; audience: where)
2. Spatial Sound Design Techniques
 1. moving/panning - trajectories, speed
 2. layering and depth
 3. height and verticality
 4. static / dynamic spatialization
3. Realistic and Abstract Elements (field rec, synthetic snds, convolution reverb)

Composing for multichannel: practical tips

4. Compositional Strategies

1. Spatial Counterpoint (Marcoll - „Amproprifications“)
2. Call and Response in Space
3. Tension and Release through Space
4. Focus and Diffusion

5. Using Technology for Spatialization (also Binaural Rendering)

6. Interactive and Algorithmic Composing

1. Real-Time Interaction
2. Algorithmic Movement
3. Sensor-Based Spatialization

Composing for multichannel: practical tips

7. Testing and Refining the Composition

1. Iterative Listening
2. Adjust for Room Acoustics
3. Get Audience Feedback



examples/techniques to listen to:

1. A.Kobzar „0111“ (tape excerpts) - VBAP
2. D.Mayer „Matters 10“ - decorrelated pairs
3. 3D audio production competition (ambisonics, with moving sources):
 - Otto Livari „Thở“
 - Agnes K Mathe „Interspace “

A.Kobzar : 0111 (tape only)

for E-Violin(6-Strings), Cello, Flute, Clarinet, Percussion, 2 MIDI Keyboards with
MIDI pedals and electronics.

Idea for spatialization:

Networking connections/transmissions (and their fails) between the instruments. (COVID time) Amplified by the instrumental positions, I focused on introducing the movement of signals along the horizontal lines.

channels' order :

(stage, other instruments)

0 *audience* 1

5 *audience* 2

4 *audience* 3

(percussion)

Daniel Mayer : Matters 10

Matters 10 is the latest in this sequence of multichannel fixed-media works in which I've been experimenting with synthesis techniques, here: buffer rewriting (*). The simple spatialization concept relates to two properties of the sound material: (a) a stereo source with strong LR decorrelation plus swapping and (b) short phrases with rests. In the 8- channel version, the LR-swapping is preserved for "columns" of 4 speakers, while some of the single speakers of the columns might get muted, starting from the front or rear.

The parameters of these sequences – realized with SC patterns and intertwined with the synthesis process – change according to formal parts within the piece.

(*) <https://speculativesoundsynthesis.iem.sh/symposium/docs/proceedings/mayer/>

3D audio competition: Otto Livari : Thở

3D audio competition: Agnes_K_Mathe: Interspace

OTHER TECHNIQUES

DBAP

Distance-Based Amplitude Panning

DBAP focuses on controlling sound levels based on the distance between each speaker and the listener, rather than relying on angular vectors like VBAP. Sound levels are dynamically adjusted to create an illusion of proximity and direction based on distance.

MBAP

Multiple Bass Amplitude Panning

MBAP is a variant of VBAP adapted to manage low-frequency sounds, which can be challenging to localize and are often prone to phase cancellation and interference in multichannel setups. MBAP redistributes bass content across multiple speakers, focusing on smooth integration and minimizing destructive interference.

comparison

Technique	Key Feature	Ideal Speaker Setup	Strengths	Limitations	Best Use Cases
VBAP	Vector-based panning	Planar/2D & some 3D	Precise localization, smooth movement	Central sweet spot	Fixed seating, sound installations
DBAP	Distance-based panning	Flexible/irregular	Adaptable, works in wide areas	Lower directional precision	Large venues, irregular setups
MBAP	Bass management via amplitude panning	Subwoofers or bass-heavy setups	Clear bass localization, reduced phase issues	Limited to bass frequencies	Electronic music, large venues
Ambisonics	Spherical/3D encoding	Adaptable, scalable	True 3D, works with height	Processing-heavy, sweet spot issues	VR/AR, 360° video, immersive installations
Wave Field Synthesis (WFS)	Physical soundfield recreation	Large, linear speaker arrays	True-to-position 3D sound for large areas	Requires many speakers, high processing	Museums, theaters, large installations
Higher-Order Ambisonics (HOA)	Higher-precision spherical encoding	Adaptable, large arrays	Accurate 3D positioning, adaptable	More complex processing, scaling limitations	Complex 3D sound installations, VR/AR
Binaural Audio	Head-tracked, ear-encoded spatialization	Headphones, VR setups	Immersive, head-tracking for localization	Limited to headphone playback	Virtual reality, 360° video, personal installations
Dynamic Spatialization and Hybrid Systems	Combines multiple techniques dynamically	Adaptable arrays	Flexible and responsive, allows layered approaches	High processing, complex setup	Interactive, dynamic art installations

your suggestion:

how to control ambisonics in Reaper with TouchOSC, while the sound (16ch = 8 stereo sources) is sent from SuperCollider?

your suggestion:

*how to control ambisonics in Reaper with
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controlling multichannel setup

```
graph TD; A[controlling multichannel setup] --> B[where to control]; A --> C[how to control];
```

where to control

software

how to control

hardware

Controlling multichannel: where

DAW (Reaper)

OSC
MIDI
envelopes
LFOs

SuperCollider (Max/pd)

OSC
MIDI
patterns/sequences
UGens

combined

*for example, first
sound processing is
coupled within the
stereo panning in SC,
then overall spatial
movement in the
Ambisonic field is
controlled
in DAW*

Controlling multichannel: how

MIDI

korg nanokontrol2

OSC

TouchOSC

combined

korg nanokontrol2

+

TouchOSC

Controlling multichannel: how

midi vs osc

Aspect	MIDI	OSC
Resolution	7-bit (0–127)	32-bit floating-point
Data Flexibility	Fixed message format, limited to MIDI parameters	Customizable, user-defined messages
Network Capability	Limited, mostly local (5-pin or USB)	Network-native (UDP/IP), internet-compatible
Ideal Use Cases	Simple panning, basic control setups	Complex, high-precision spatialization, interactive installations

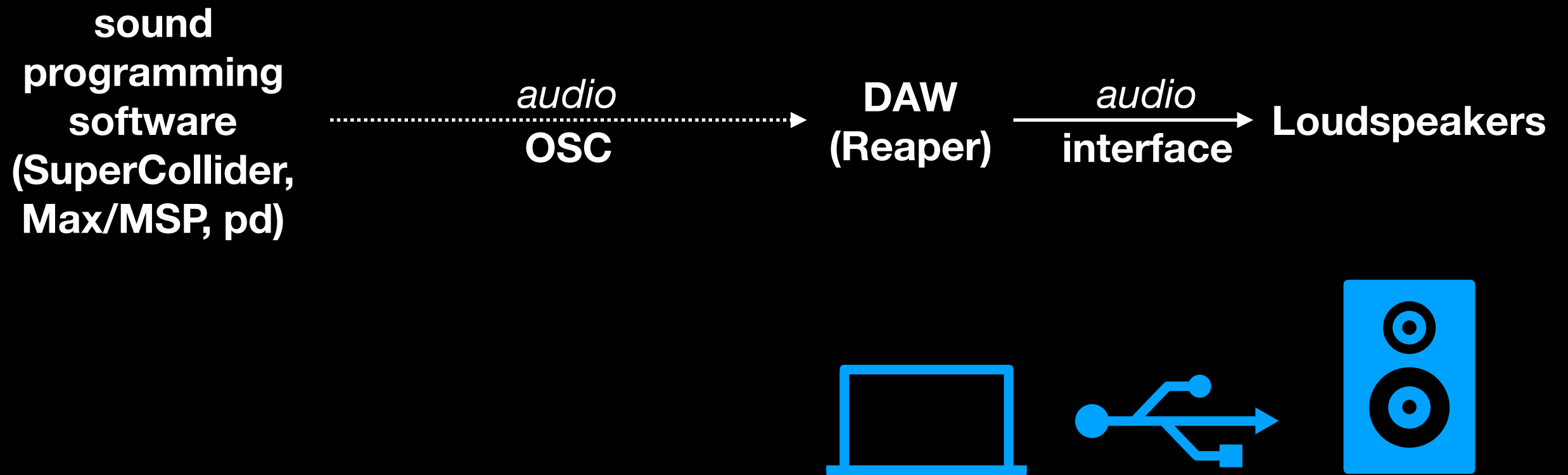
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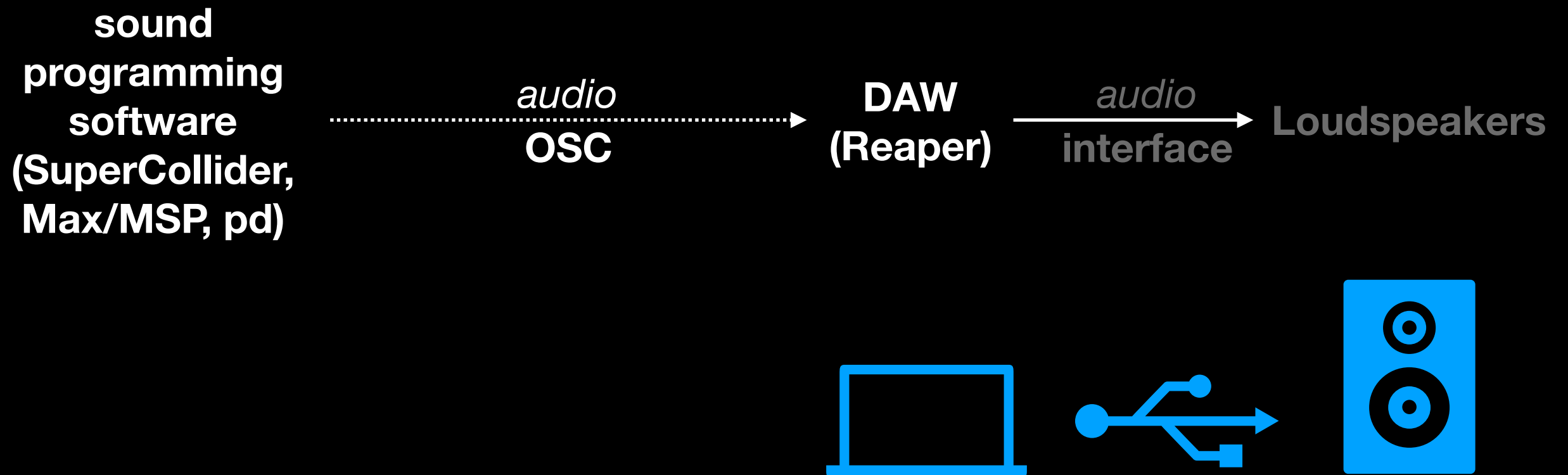
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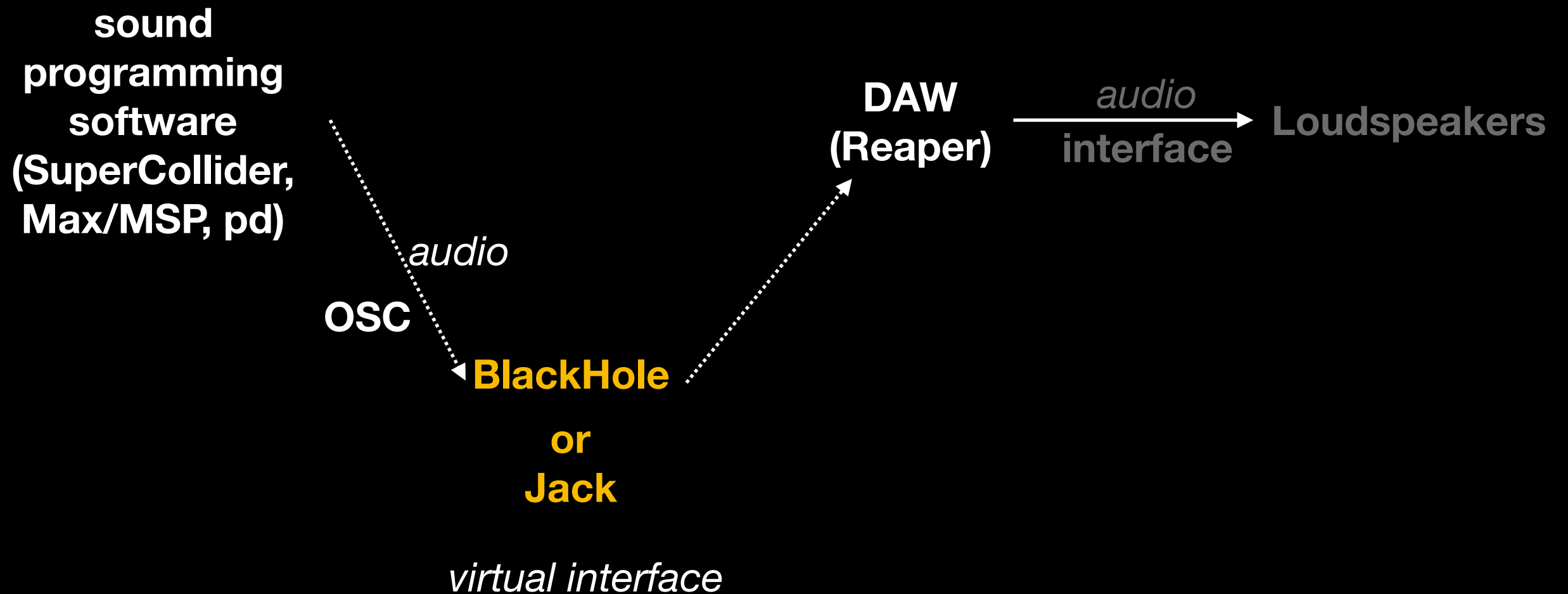
Controlling multichannel: routings



Controlling multichannel: routings



Controlling multichannel: routings





some links:

<https://leomccormack.github.io/sparta-site/docs/plugins/sparta-suite/>

<https://embody.co/blogs/technology/volumetric-amplitude-panning-and-diffusion-for-spatial-audio-production?currency=EUR>

<https://www.semanticscholar.org/paper/DBAP-Distance-Based-Amplitude-Panning-Lossius-Baltazar/132a028b9febadd03f2c75e5f79ca500c2dd04fd?p2df>