# A Quick Introduction to Wave Field Synthesis

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#### Technical Evolution of Sound Production & Reproduction







#### Wave Field Synthesis (WFS) - Concept



- Sound sources emit certain wave fields
- Reproduction with secondary sources according to Huygens Principle (1678)





#### Wave Field Synthesis (WFS) - Concept



•Distribution of secondary sources located on the boundary between the source domain and the receiver domain.

•DSP control (delay, gain, filter) applied to the transducer array in order to shape the wave field according to the primary source location.





#### Wave Field Synthesis (WFS) - Concept



Spatial coherence of the sound field









#### WFS reproduction, typical source 1

- "Virtual" point source
- Perceived at a precise position.
- Natural variation of localization cues with listener movements







### WFS reproduction, typical source 2

- "Virtual" point source
  - Eventually inside the listening room!







#### WFS reproduction, typical source 3

- Plane wave
- Perceived everywhere from the same angular direction.
- Unlike point sources, monitoring of direction instead of position
- "Follows" the listener movements







#### WFS creates Sound Perspective

- Immersive sound scene
- During navigation the listener experiences a multi-sensorial spatial situation (Augmented Reality).
- Variation of auditory cues remains coherent with listener movements throughout the sound installation.
- Elicits "presence", learning and memorization of sound scene spatial organization







#### Room effect synthesis



![](_page_9_Picture_2.jpeg)

![](_page_9_Picture_4.jpeg)

# Spatial sensation reproduction requires:

- Localization of virtual sources (direct sound).
- Room impression (depth, room-size, ...).
- Variation of acoustical cues coherent with listener movements.

![](_page_10_Picture_4.jpeg)

![](_page_10_Picture_5.jpeg)

![](_page_10_Picture_7.jpeg)

# WFS reproduction

• Based on loudspeaker arrays (dozens to hundreds of loudspeakers involved), each sound installation being different:

Impossible to store loudspeaker driving signals as for conventional formats (CD, DVD, SACD, ...).

- Synthesis of virtual sound sources with associated room impression.
- Requires a higher level coding:
  Content coding (MPEG 4)

![](_page_11_Picture_5.jpeg)

![](_page_11_Picture_7.jpeg)

### Summary

- WFS provides
  - Stable localization over a large listening area:
    - Holographic sound reproduction using virtual point sources
    - Creation of a invariant spatial disposition of virtual sources over the entire listening area using plane waves
  - Room effect reproduction using impulse responses, physical room parameters or perceptive parameters
  - Reproduction with conventional loudspeaker arrays or MAP panels
  - Storage and coding in MPEG-4 format

![](_page_12_Picture_8.jpeg)

![](_page_12_Picture_10.jpeg)