
Digital Entertainment: Media technologies for the future

Karlheinz Brandenburg

Technische Universität Ilmenau, Institut für Medientechnik
Fraunhofer Institut für Digitale Medientechnologie

December, 2006

Overview

- What is going on in media ?
 - Digital broadcast and its relatives
 - Global trends
- The „intelligent home stereo“
 - How to find my favorite music
 - Rich media management
 - Some examples
- Immersive Audio: Wave Field Synthesis
- Conclusions



What is going on in consumer electronics ?

- Digital TV
 - Still not everywhere
- Internet Audio
 - On all computers, 40% of people us it
 - For Christmas, mp3 players are on the top spot of childrens wish lists ☺
- Music from all around
 - There is serious competition for radio
- DVD Audio / SACD
 - Where are they ?



What is happening to the „old media“ ?

- For the first time in 50 years: the average time young people spent in front of the TV screen is decreasing
- Radio loses an substantial amount of listeners, especially among young people
- People spend more money on computer games
- Record companies and Hollywood studios complain about less business



The history of „new media“

- Radio
 - Cinema
 - TV
 - Compressed music (.mp3)
 - Digital TV
- > it always takes time for new art forms to develop



Global trends: Quantity leads to paradigm changes

- The number of TV programs:
 - 1
 - 5
 - 35
 - 300
 - 3000
- How do I find my favorite program ?
- EPGs, web sites, communities, Podcasts
- Example: MusicMatch Radio: Radio or not ?



Global trends: Global reach for special interests

- Special interests find their
 - Web sites
 - Music
 - Video
 - Discussion place on the Web
- Just 100 people can establish a well organised global group
- Blogs, fora, chat rooms, cooperative computer games create virtual worlds



New equipment (this was never sold)



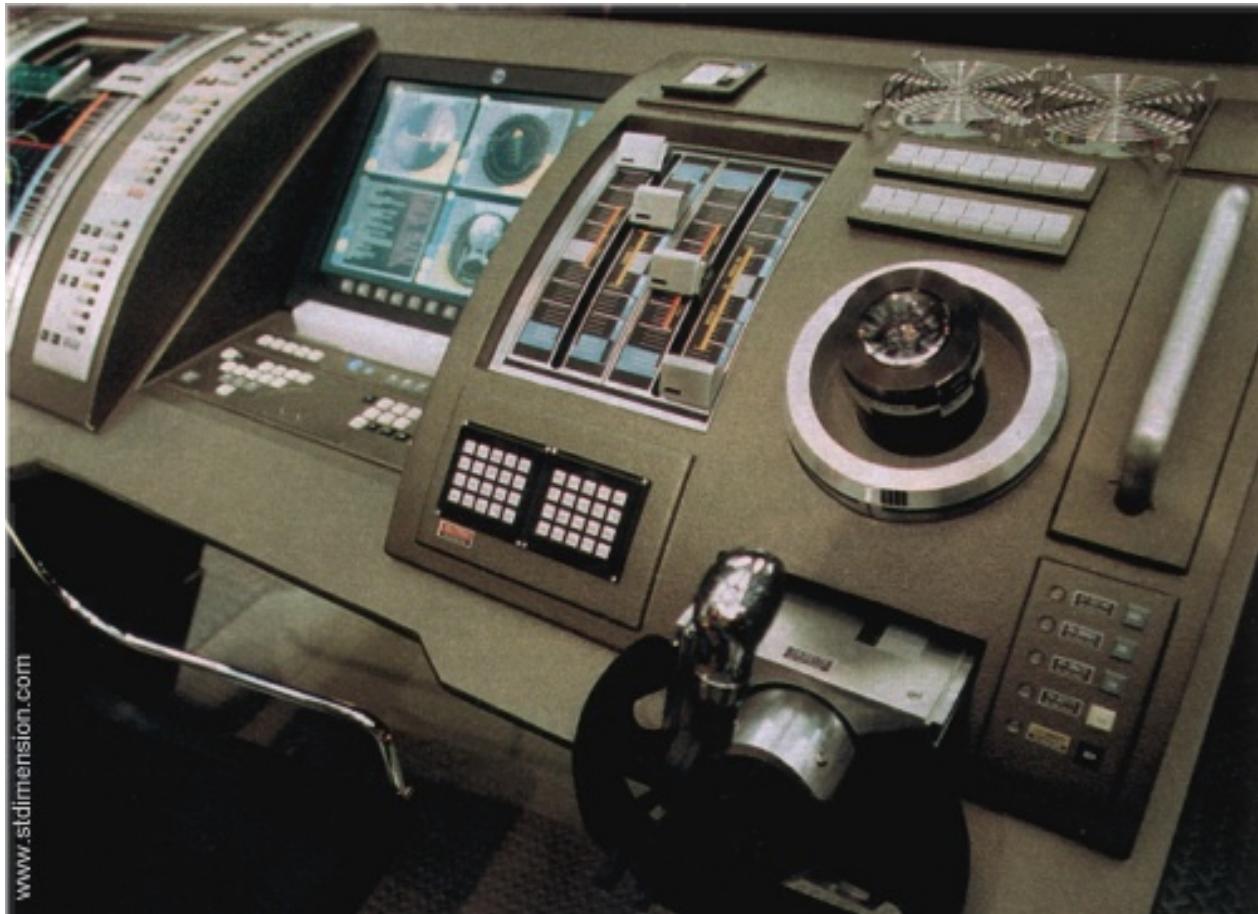
Where are my multimedia data ?

- Physically stored in my home (CD, DVD)
- On my home server
- On my PDA or mobile phone
- Detached on the net
- Just recreated from metadata whenever I need them



Examples: The future home stereo setup

(really ?? ☺)



Prof. Karlheinz Brandenburg, bdg@iis.fraunhofer.de



Fraunhofer Institut
Digitale
Medientechnologie



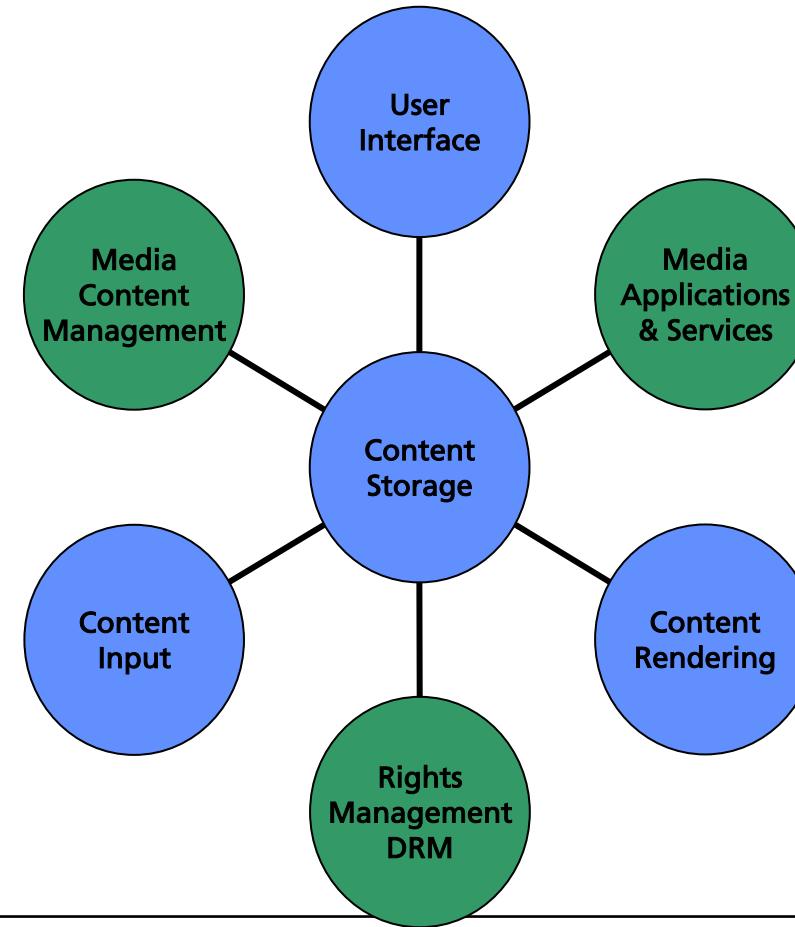
The home stereo of tomorrow:

- **Remembers my music:**
 - Each CD gets ripped just when I play it
- **Helps to search for my favorite music**
 - “query by humming”
 - Look for certain genres
 - Searches the Internet
 - Where can I listen to / buy this music ?
- **Helps to assemble my favorite music playlist**
 - What is similar, but new ?
 - “please play my favorite music for this time of the day”



The future of consumer electronics

Components tomorrow



Rich Media Management

Semantic
Media
Analysis

Multimedia
Search and
Recommen-
dation

Services and
Applications



Rich Media Management



Multimodal metadata retrieval

- Context-based metadata creation
(User, Usage)
- Content-based metadata creation
(Rhythm, Genre, Mood, Harmony, ..)

Storage of feature vectors and textual metadata

Machine learning
(Clustering, context adaptation,..)

Supports content-based/semantic queries

Allows for a lot of new services & applications

How to gather metadata ?

Sources

- Expert knowledge, deploying the public, metadata services (CDDB, FreeDB)
- Context-derived, collaborative filtering

Content-derived

- Automated extraction of relevant features from the content data
- Find clusters in the high-dimensional feature space that represent semantic properties or similarities
- Efficient algorithms (→ »embedded«)



Multimedia Information Retrieval – available technologies

Recognition, Similarity

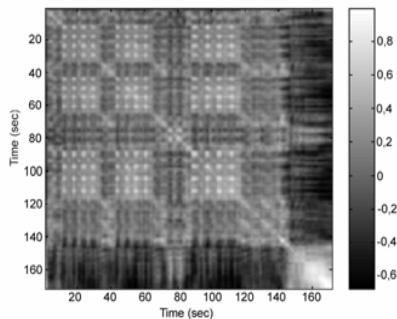
- AV-recognition (AudioID, PhotoID, VideoID)
- AV-similarity (Soundslike, PhotoID)
- Song-segmentation

Semantic Analysis

- Genre classification (GenreID), Speech-/Music discrimination
- Dominant melody transcription, Query by Humming (QbH)
- Bass transcription
- Tempo-, beat determination
- Drum pattern transcription
- Harmony transcription
- Face-, object detection & identification
- (Lead-) instrument recognition
- Singer detection and characterization



MIR-Technologies – Music Segmentation



- Inner-song similarities / dissimilarities based on a set of low-level audio features
- Measure of innovation
- Segment classification (verse, chorus)

Intelligent navigation within songs

- Retrieval of most significant part of a song (“audio-thumbnail”)
- Basis for a deeper semantic analysis of the segments (lead instrument, vocals, etc.)



MIR-Technologies – Rhythm

The Pulse Of Time...

- Important for beat-synchronized playlists
- Crucial for recommendation and genre determination

Retrievable Metadata



- Tempo (bpm)
- Bar measure
- Beat positions
- Tatum (grid)
- Transcribed rhythmic patterns
- → applicable for rhythmic similarity calculation

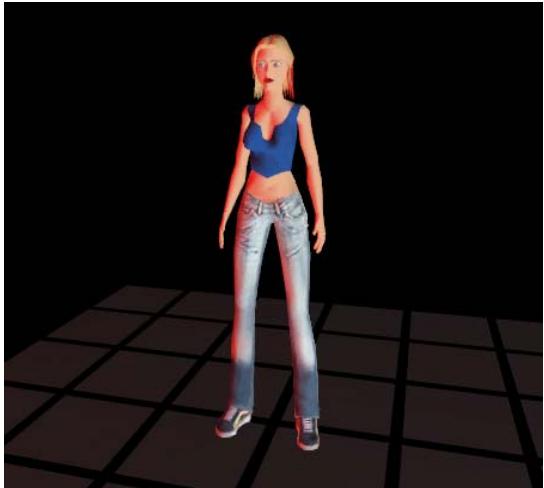
AudioID



Query by Humming at Saturn-Markt, München



Music-controlled animations or -games



- Avatar:
 - Content-derived information retrieval from music, e.g. beat-, intensity, mood
 - Control animation, content-based (beat-synchronous and emotion-preserving)
 - Visualization of 3-dimenional virtual figures in realtime (OpenGL, Direct3D)

Megatrends

- More is more than just more 😊
 - More TV programs
 - More bandwidth
 - More accessibility
 - More individualized services
- We will get to
 - Virtual worlds
 - New methods of communication
 - New types of broadcasting
 - E.g. blogs

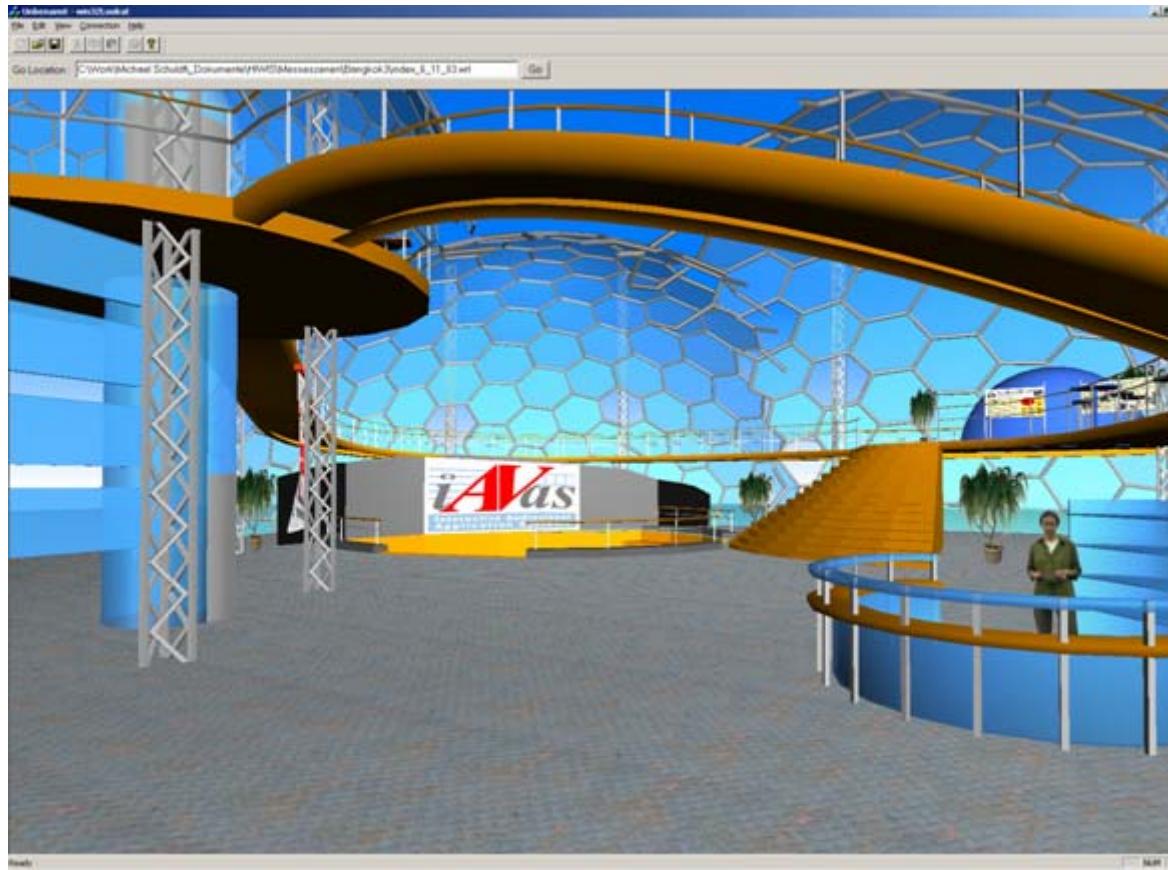


Interactivity: 20 years of „tommorow“ ...

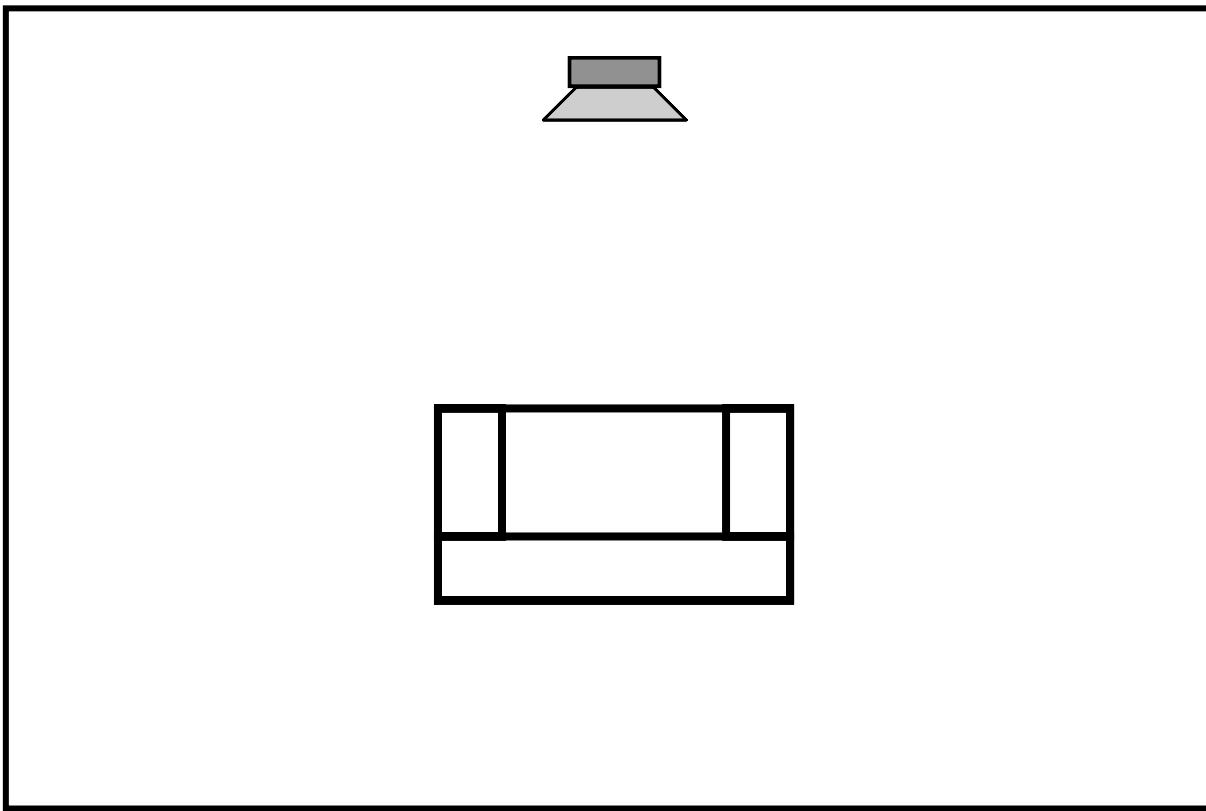
- Coach potatoes will survive
 - The computer game industry is surpassing the movie industry
 - Musical instruments make more money than CD's
 - Interactive worlds clearly grow faster
 - WWW
 - Computer games
- > Interactivity will be there tommorow ☺



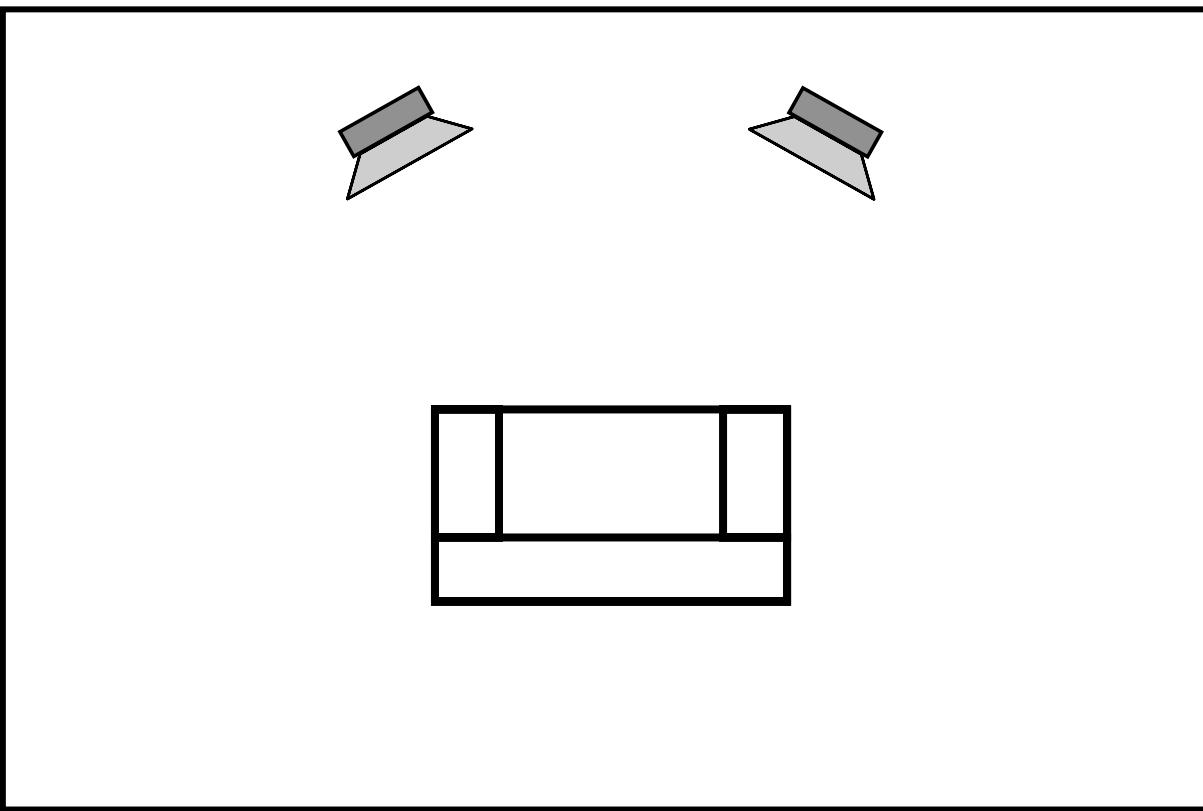
Immersive Systems: Example „Virtual trade show“



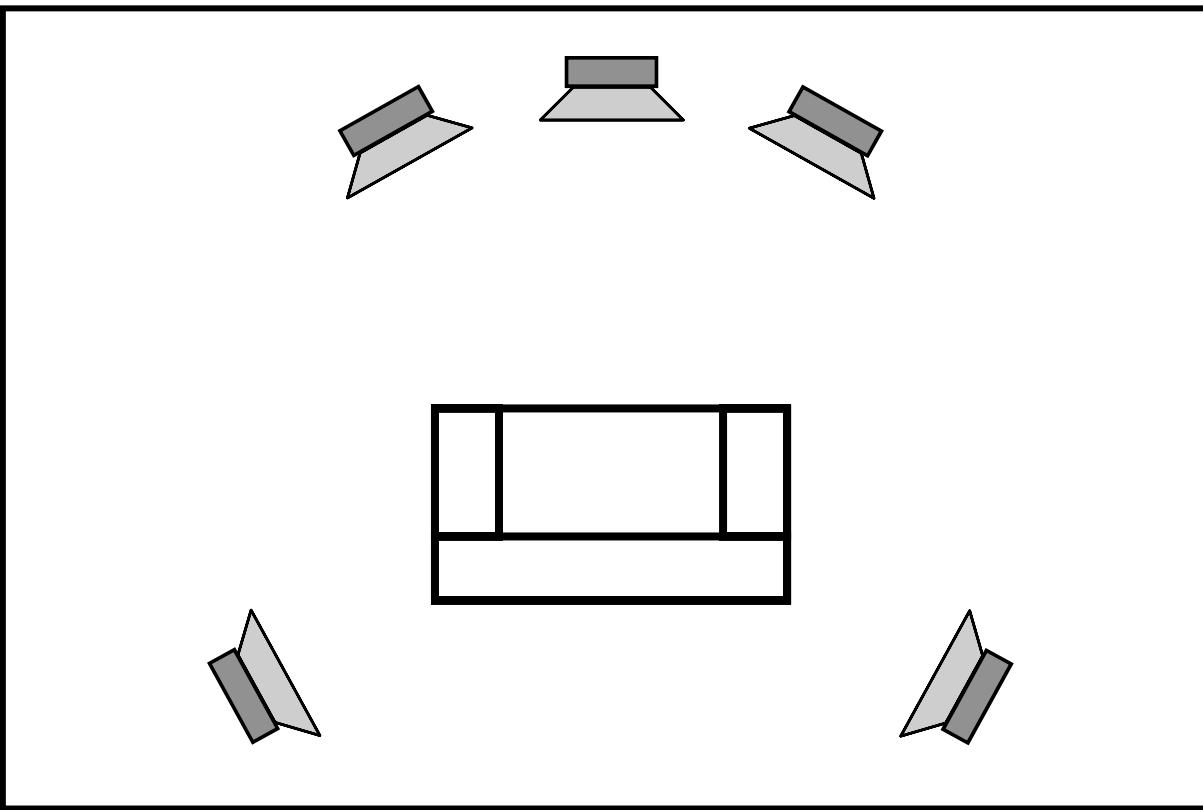
From mono ...



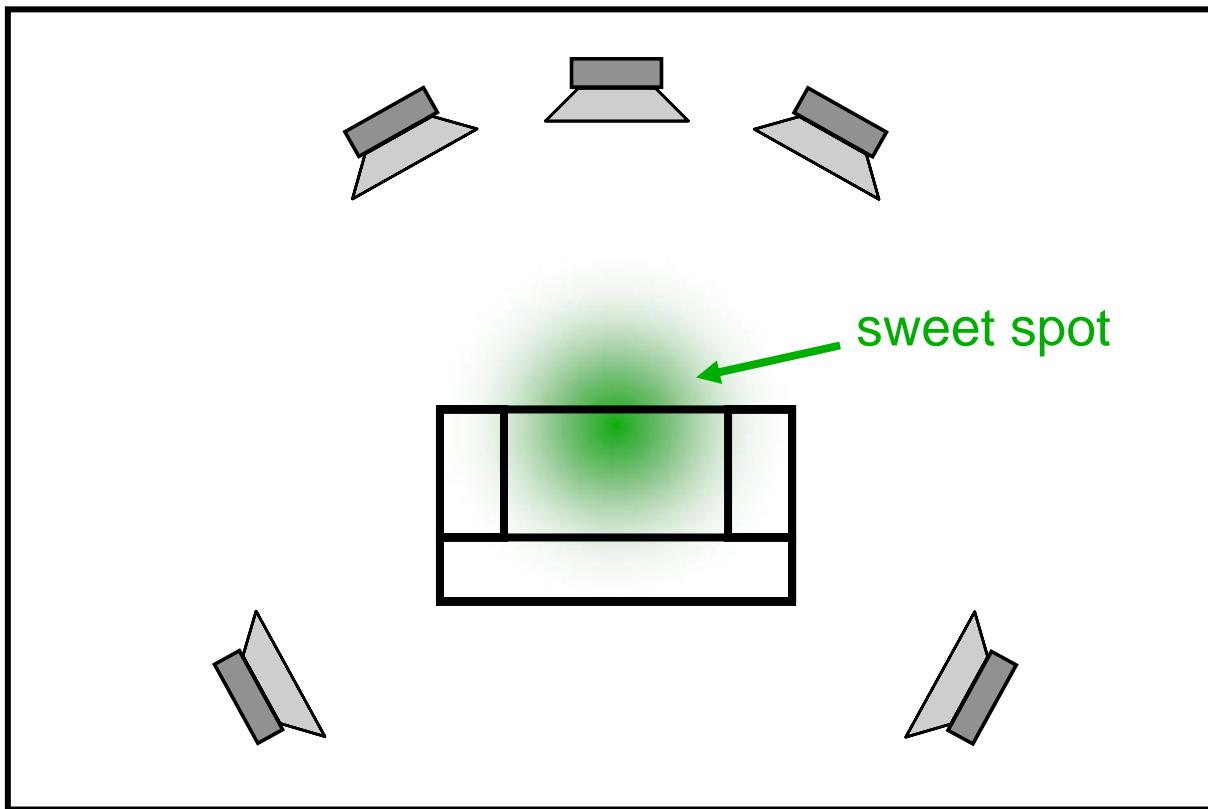
... across stereo ...



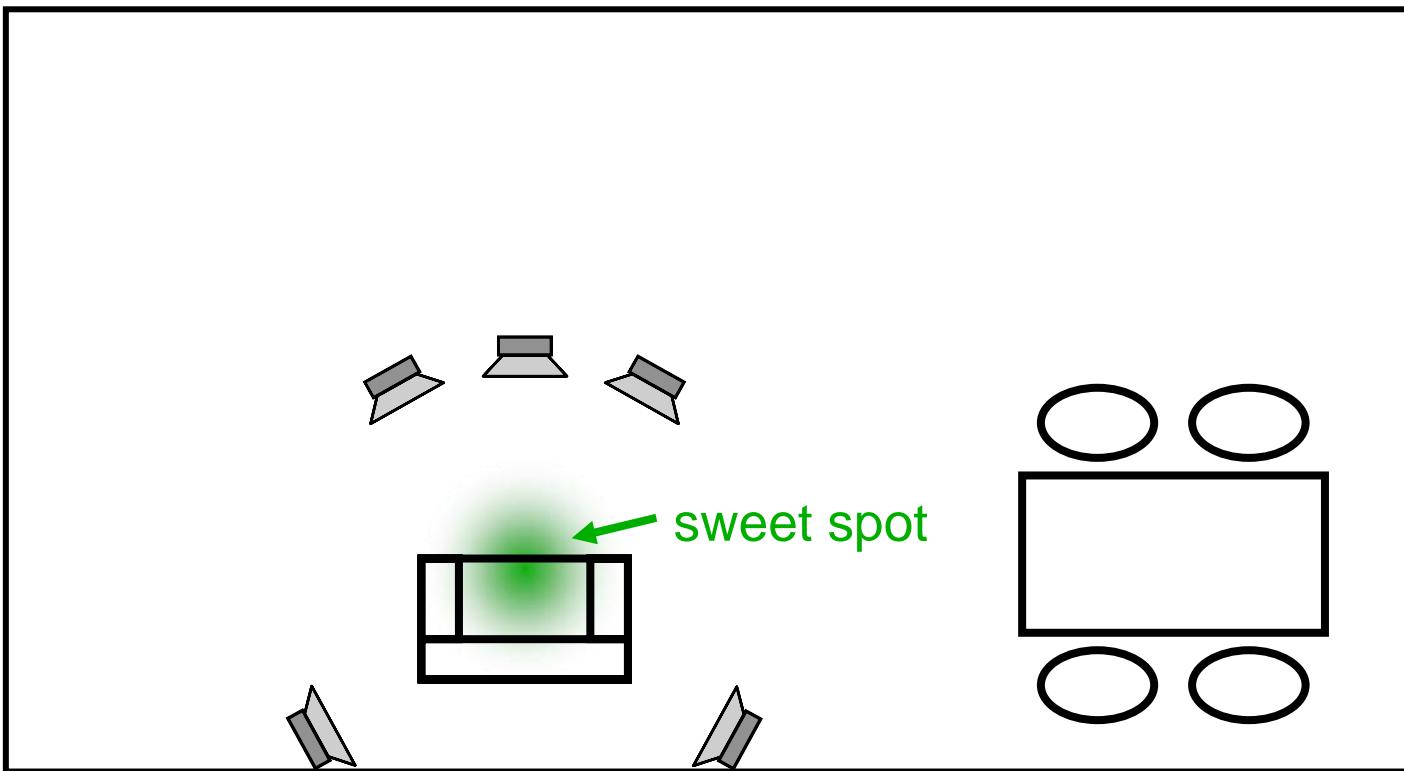
... to 5.1 surround



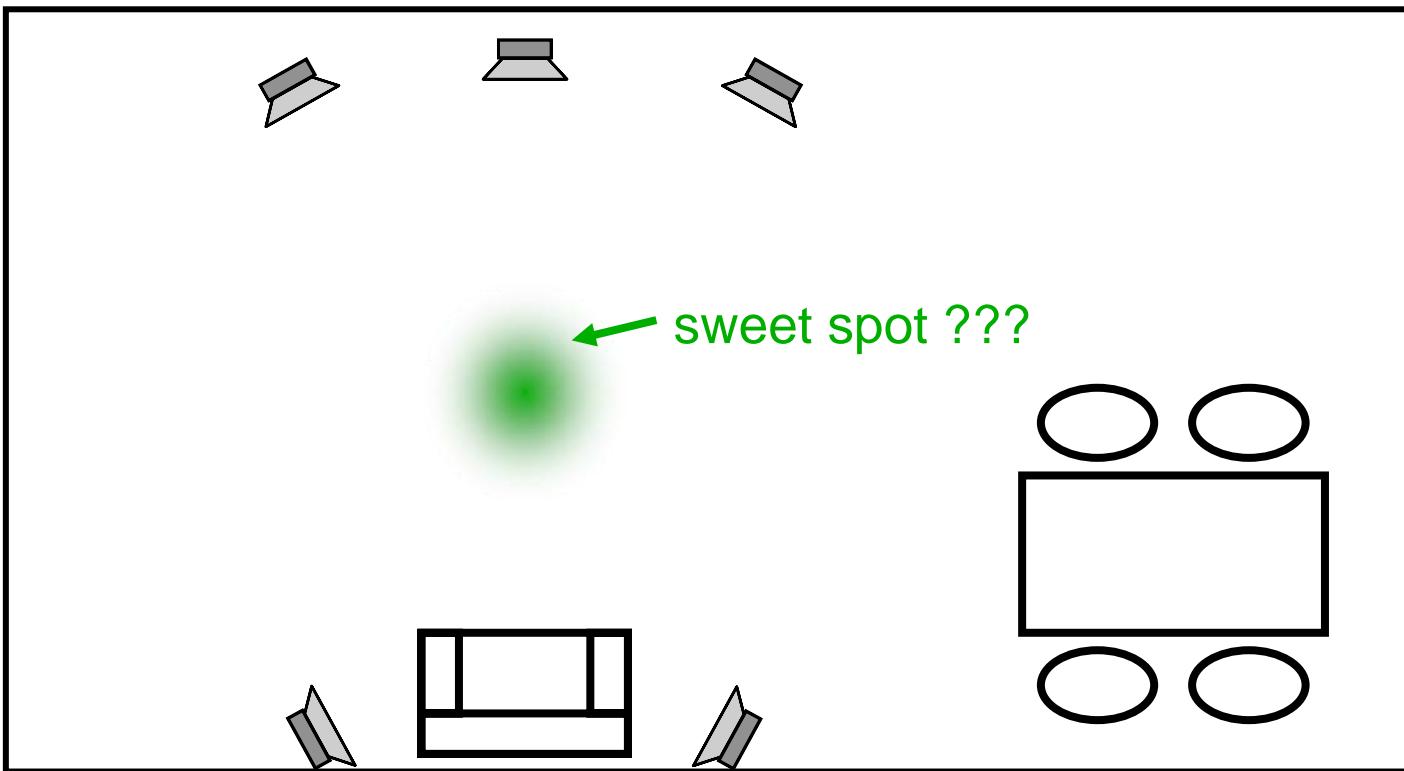
...but still not perfect!



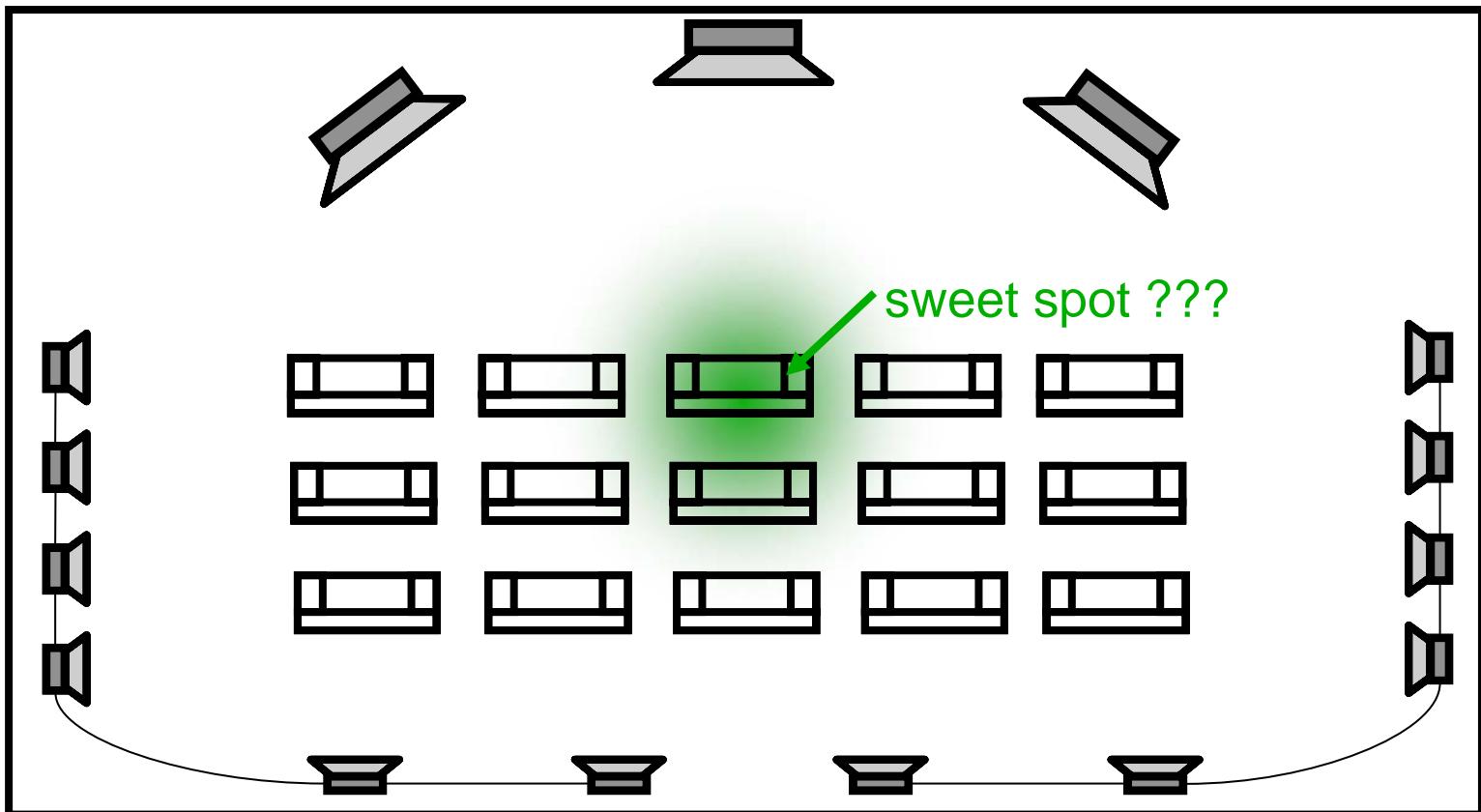
In the living room (1)



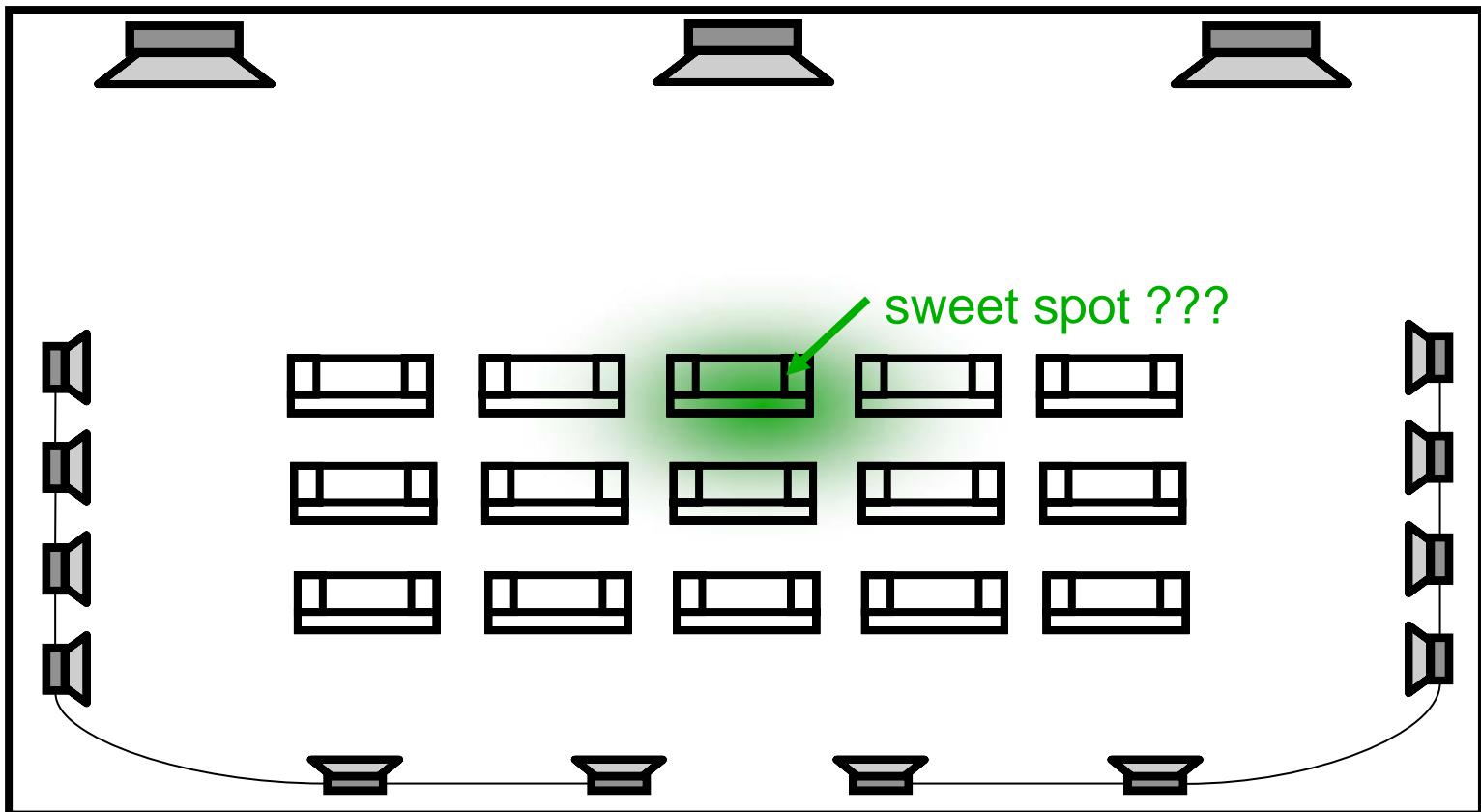
In the living room (2)



In the movie theater (1)

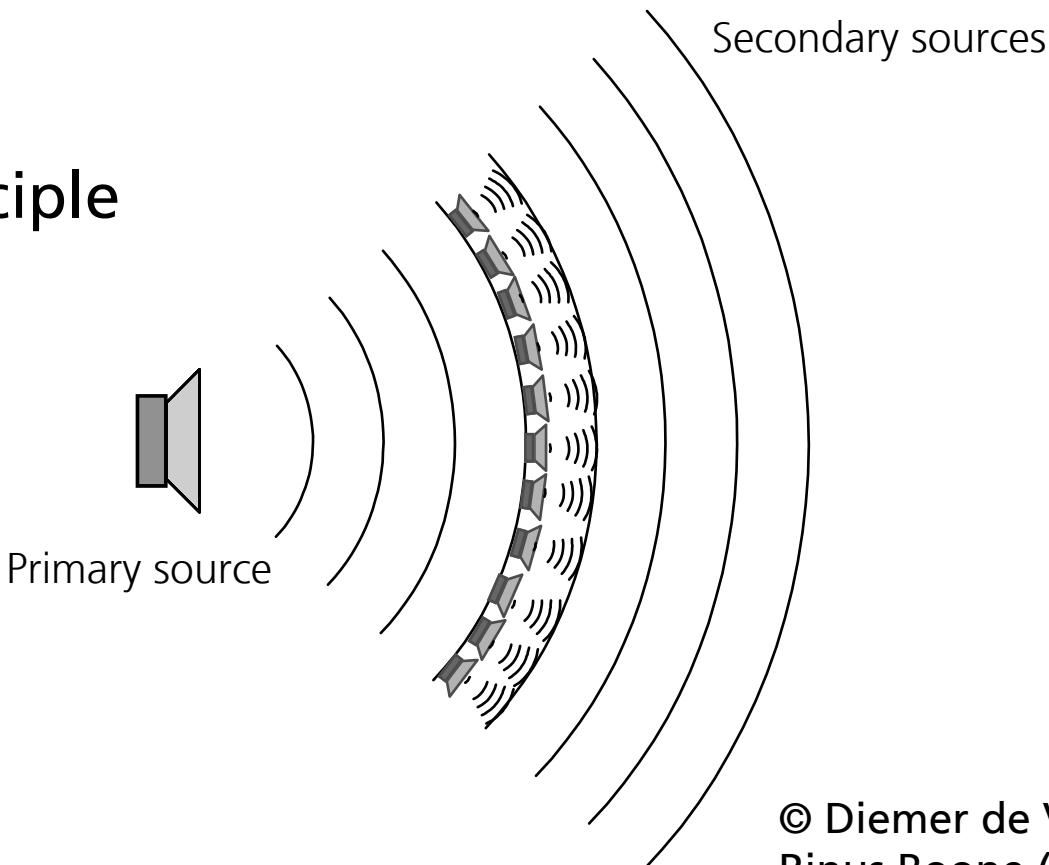


In the movie theater (2)



Solution: Wave Field Synthesis

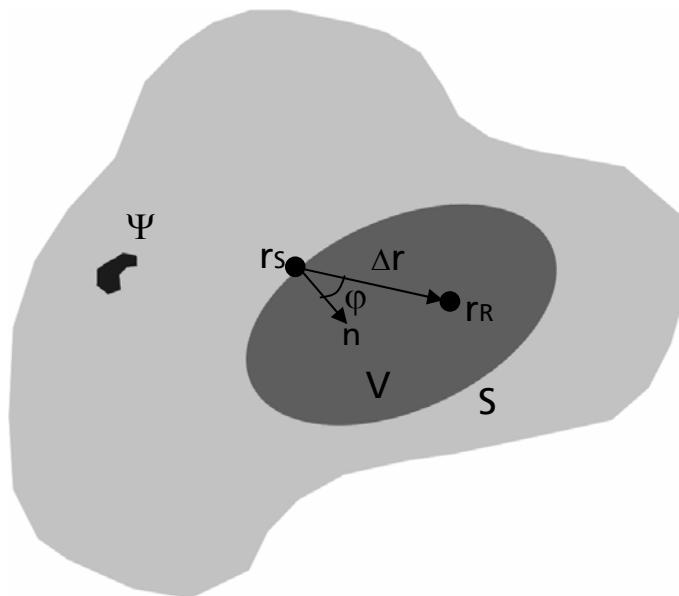
Huygens' Principle
(1690)



© Diemer de Vries &
Rinus Boone (TU Delft, NL)

Kirchhoff-Helmholtz Integral

$$P(r_R) = \frac{1}{4\pi} \oint_S \left[j\omega\rho_0 V_n(r_s) \frac{\exp(-jk\Delta r)}{\Delta r} + P(r_s) \frac{1+jk\Delta r}{\Delta r} \cos\varphi \frac{\exp(-jk\Delta r)}{\Delta r} \right] dS$$



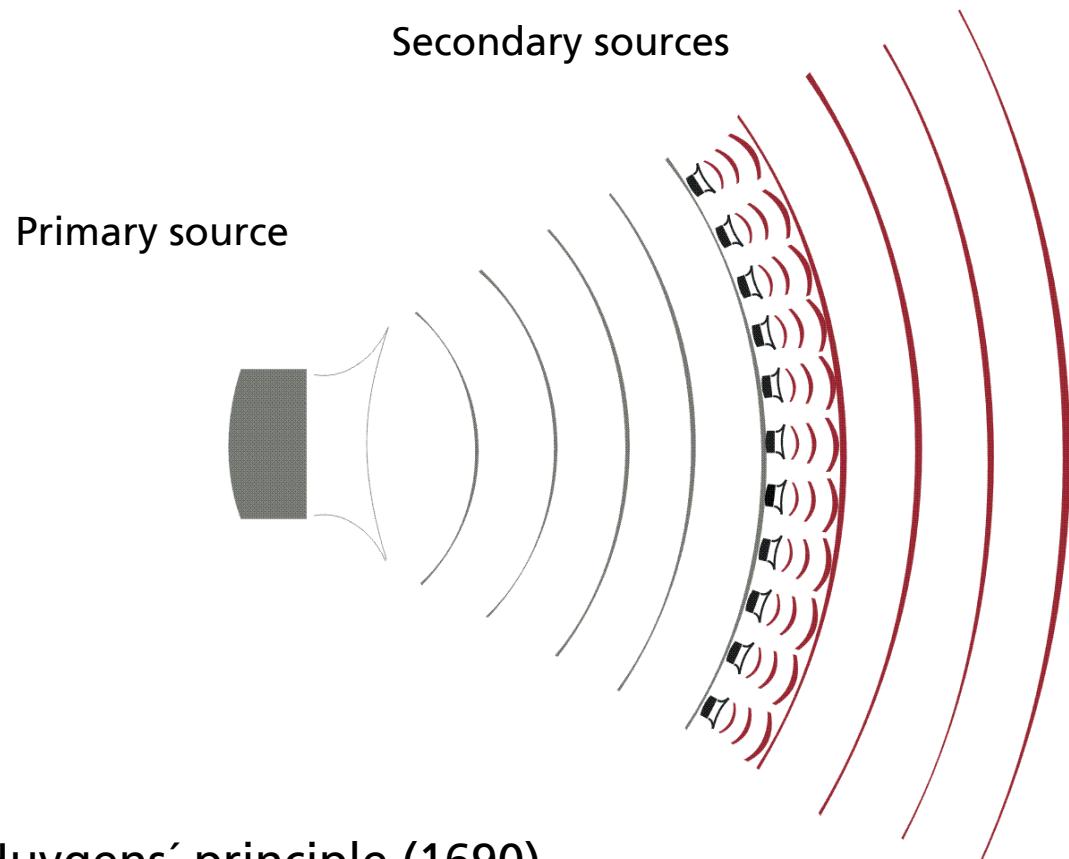
V_n - component of particle velocity in r_s ,

P - pressure,

ρ_0 - density function



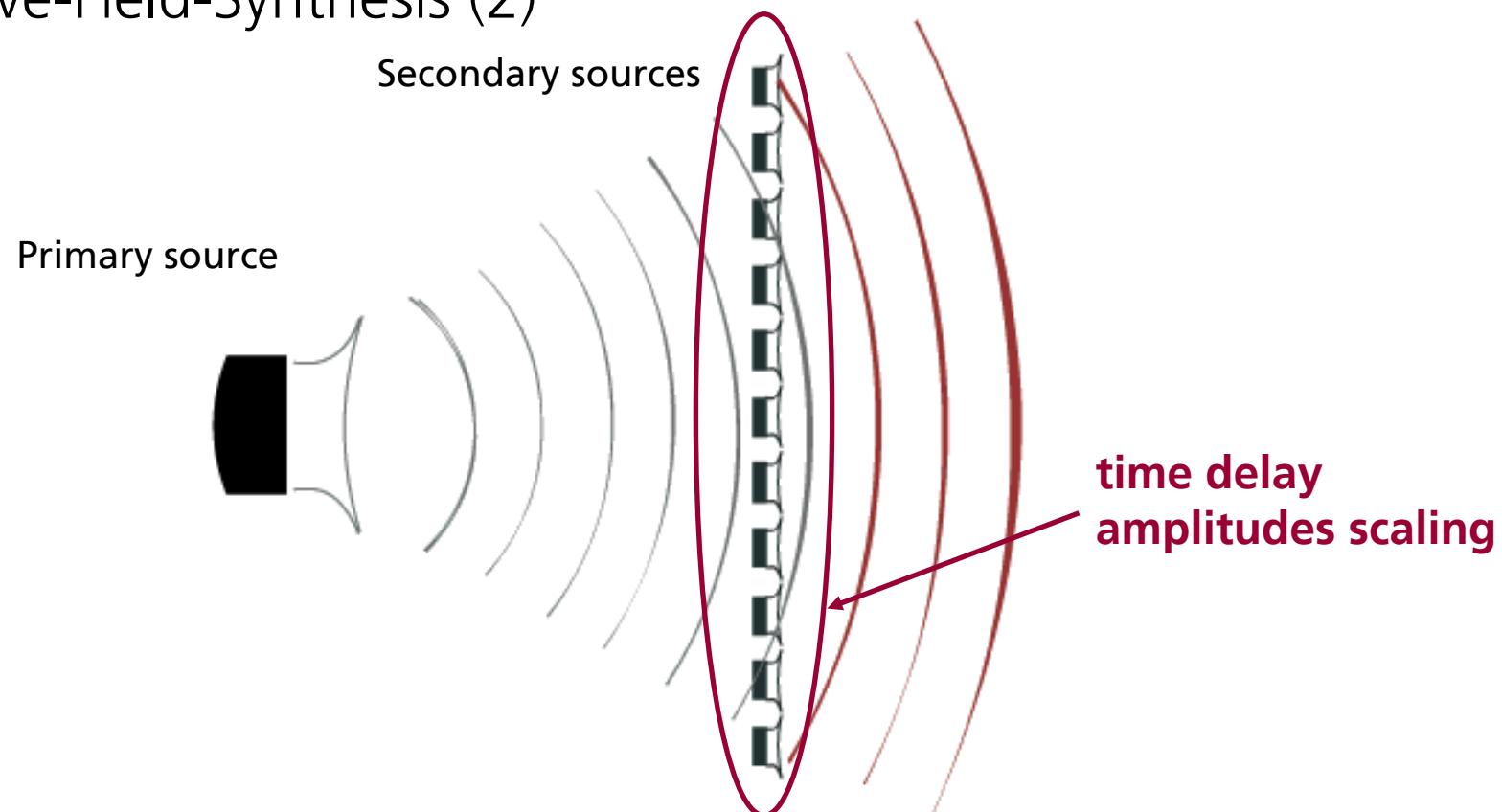
Wave-Field-Synthesis (1)



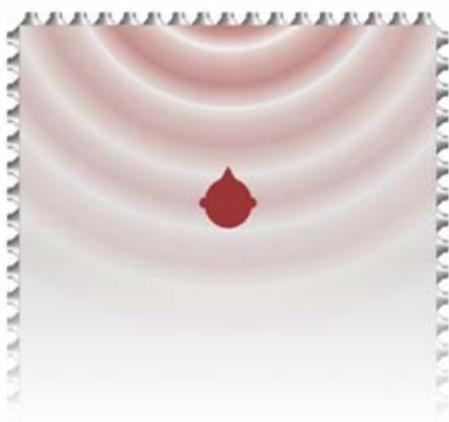
Huygens' principle (1690)

© Diemer de Vries &
Rinus Boone (TUD)

Wave-Field-Synthesis (2)



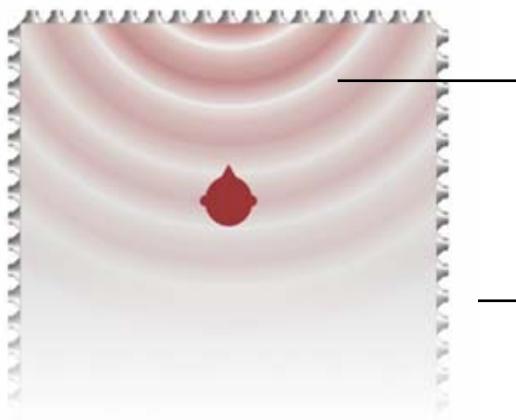
How does WFS work in practice ?



- A high number of separately controlled loudspeakers



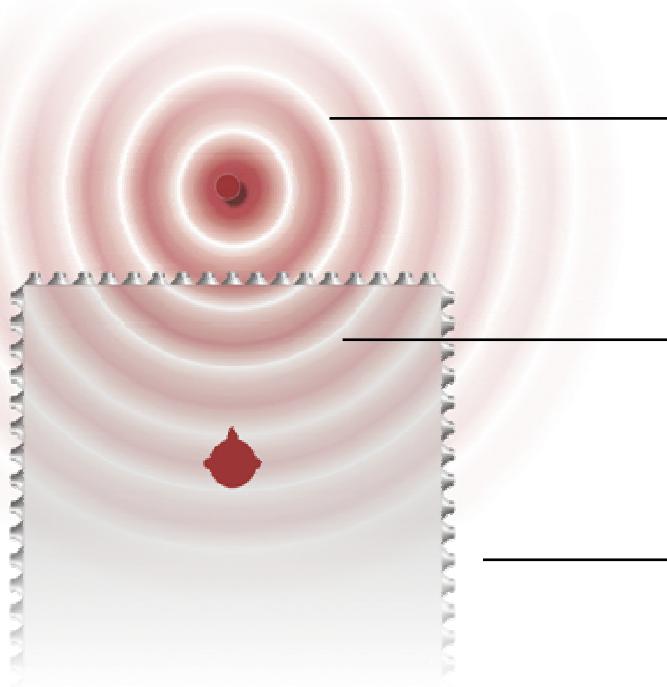
How does WFS work in practice ?



- IOSONO creates a wave field within the listening area (WFS based)
- A high number of separately controlled loudspeakers

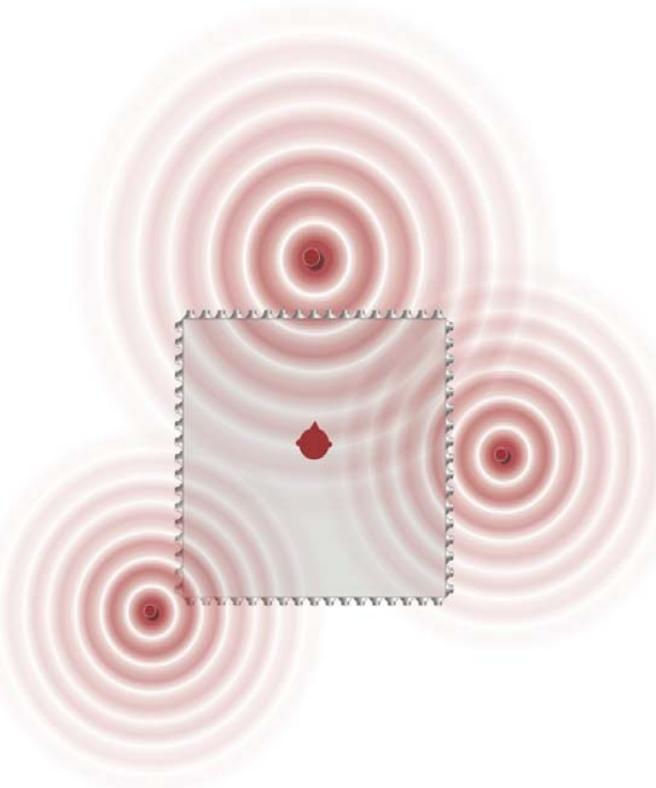


How does WFS work in practice ?



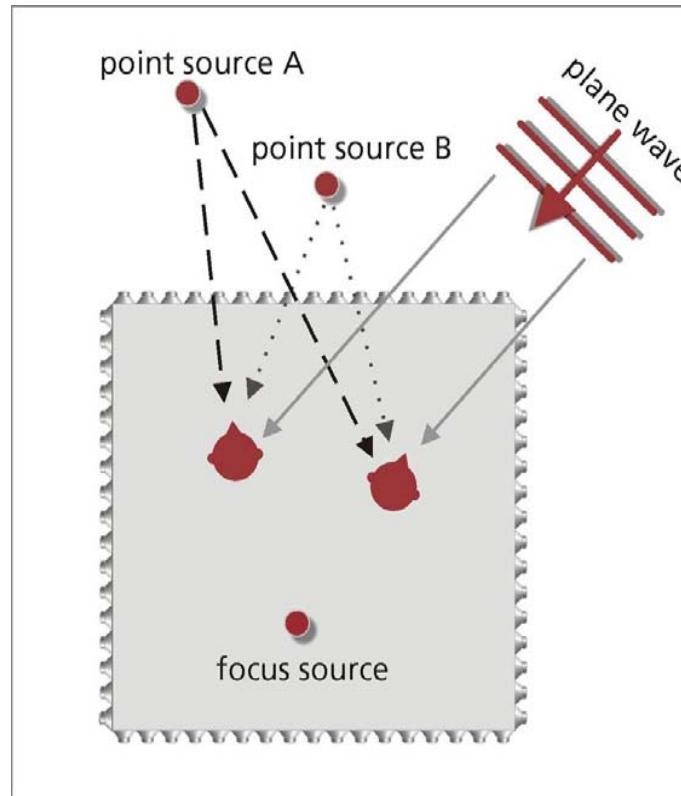
- The sound is perceived from a certain position behind the loudspeakers
- IOSONO creates a wave field within the listening area (WFS based)
- A high number of separately controlled loudspeakers

How does WFS work in practice ?

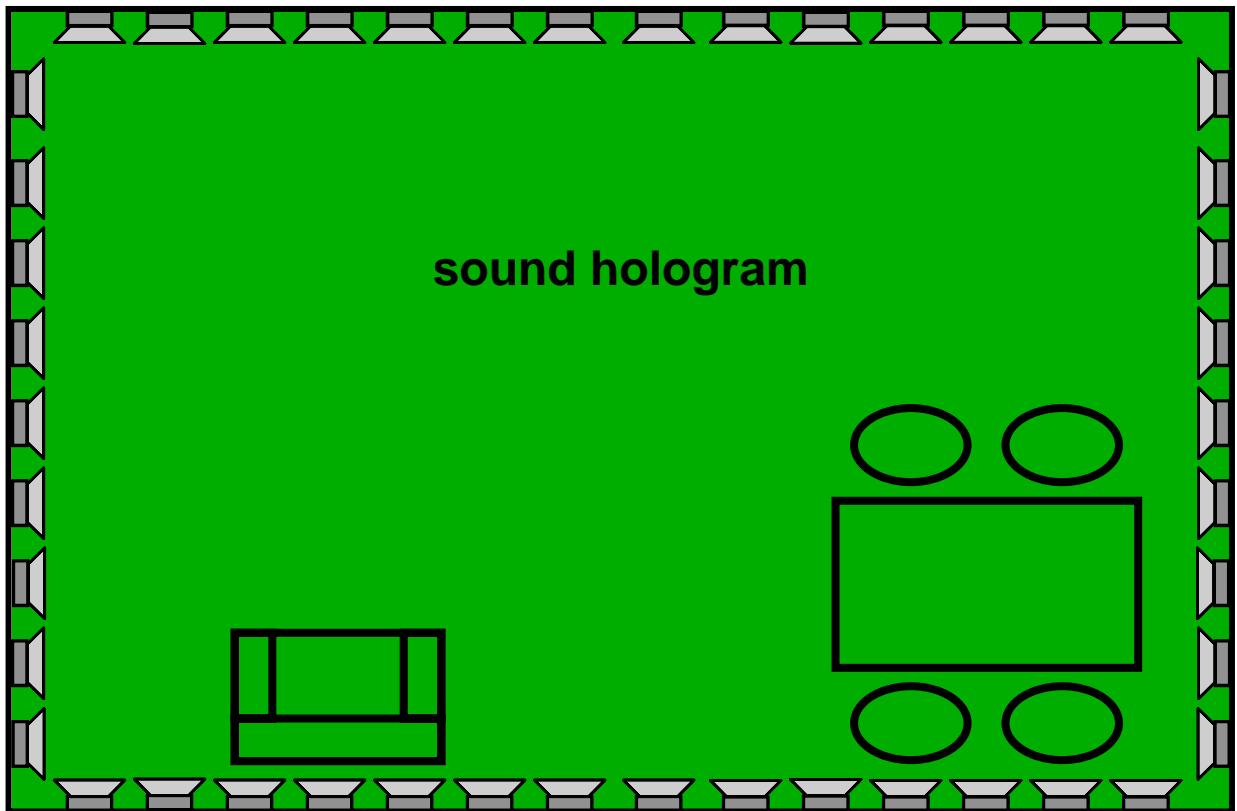


- Stable sound image on wide parts of the reproduction area
- Sounds are perceived within the room or behind the speaker array

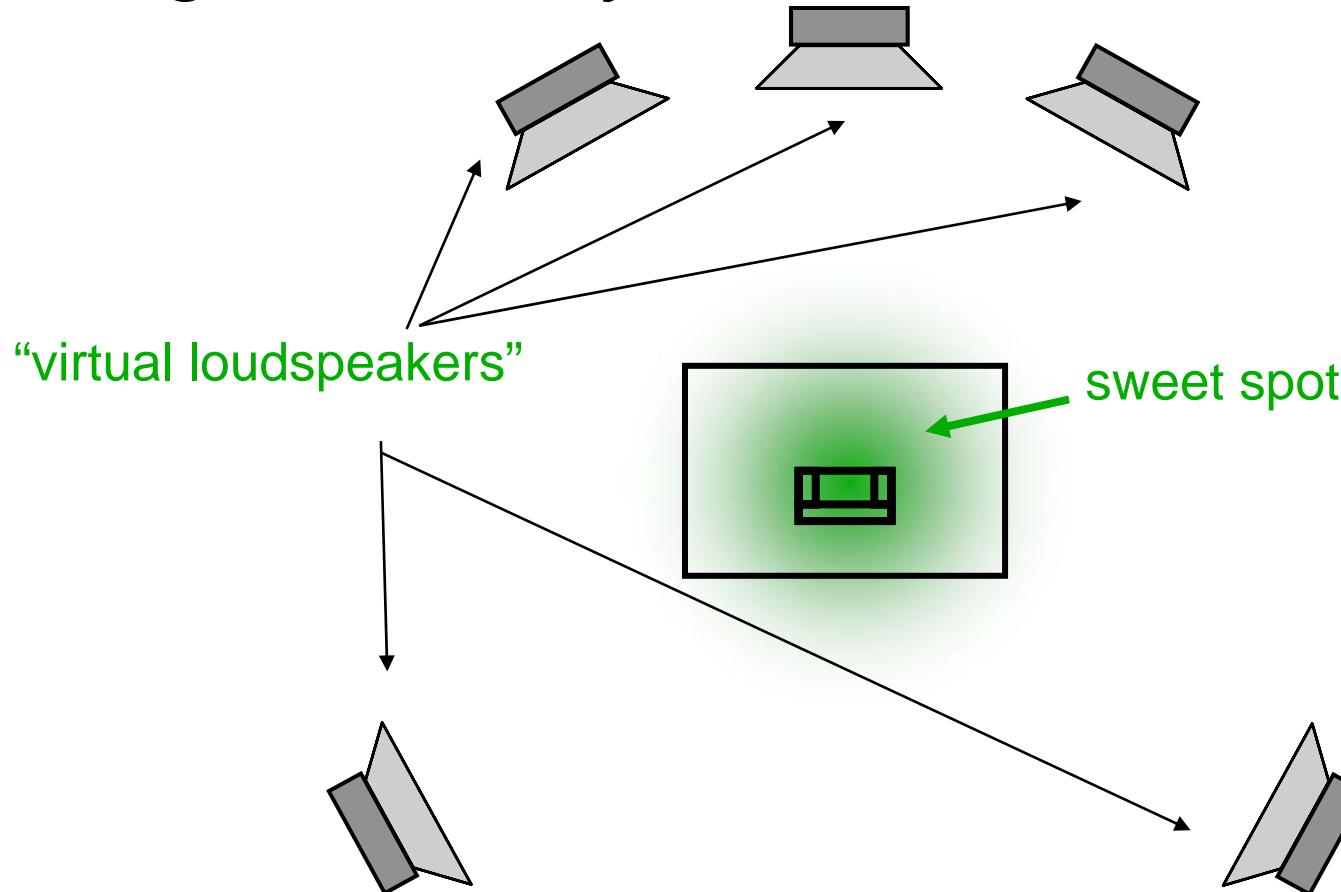
New creative potential



Wave Field Synthesis in the living room



... using Wave Field Synthesis



Data representation

- We need audio objects, not just tracks
- MPEG-4 already got everything standardized (3D Audio profile)
- Up to 32 separate sound sources (current limit)
- AudioBIFS provides location information
- DVD-ROM can store the data for a full feature film
 - Needs AAC coding
 - MPEG-4 AudioBIFS subset definition TBD

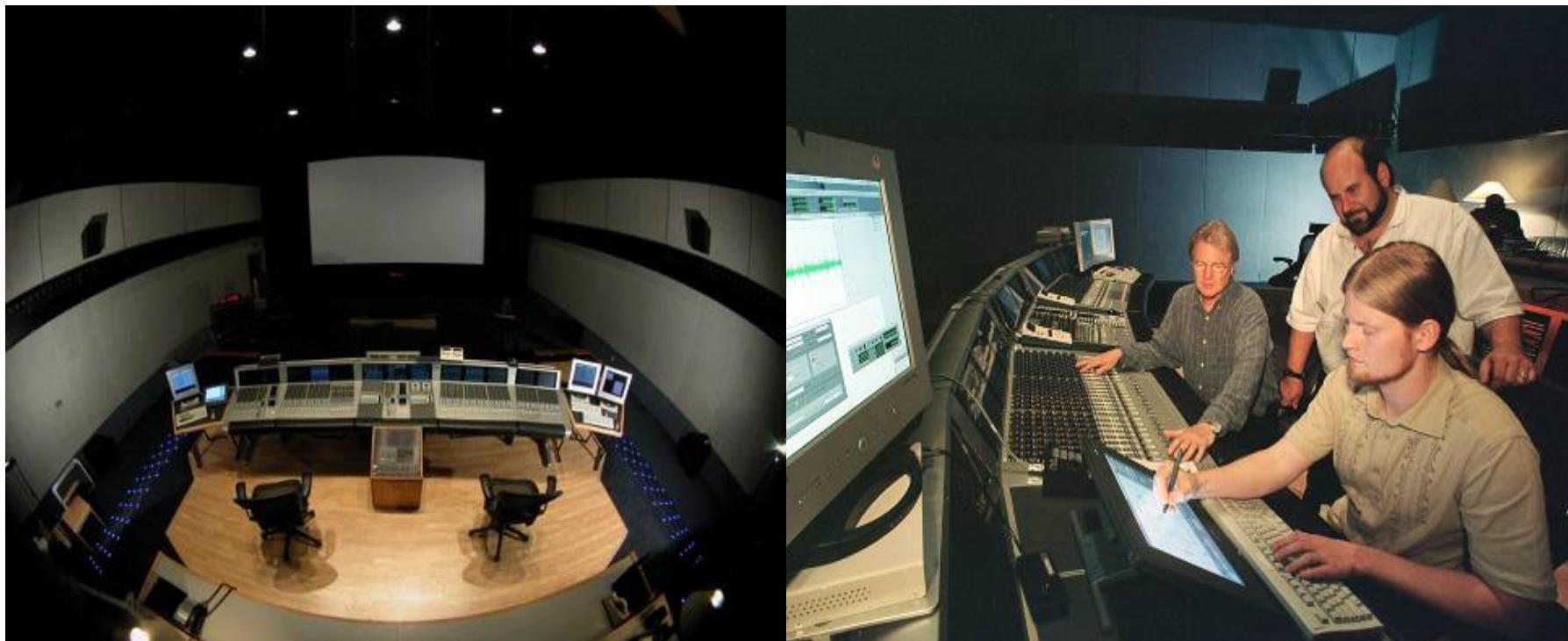


Examples of WFS Installations

The Ilmenau Movie Theater



IOSONO® Sound system at the Todd-AO sound stage (LA/USA)



IOSONO® Sound in the „4D Erlebnis Kino“ at



Prof. Karlheinz Brandenburg, bdg@iis.fraunhofer.de

Page 48



Fraunhofer Institut
Digitale
Medientechnologie



IOSONO® in the planetarium of the „Shafallah Center for Children with Special Needs”, Qatar



Bregenz Open Air Festival



Prof. Karlheinz Brandenburg, bdg@i



Fraunhofer Institut
Digitale
Medientechnologie



Bregenz



Prof. Karlheinz Brandenburg, bdg@iis.fraunhofer.de

Page 51



Fraunhofer Institut
Digitale
Medientechnologie



IOSONO® Home



Conclusions

- The age of digital media has just started
- Future systems are
 - Connected
 - Agnostic of transmission media (e.g. wireless or wired)
- Signal processing brings us a lot of new possibilities for future home multimedia devices
- Searching and recommendation are crucial applications for tomorrow's media architectures
- Immersive media are one future killer applications, for audio we can already do it

