Workshop 16:

MPEG Surround — The MPEG Standard For Parametric Multichannel Audio Coding

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Why This Workshop ?

AES Technical Committee on Audio Coding

- MPEG Audio standards: A success story
- Past workshops about MPEG-4 Audio
  (Version 1 @ 106th AES, Munich, 5/99;
  Version 2 @ 108th AES, Paris, 2/00;
  Extensions @ 114th AES, Amsterdam 3/03)
- Any new progress in MPEG Audio coding?
  - Lossless Audio Coding => Workshop 14
  - Most recently, a new specification was frozen (7/2006): “MPEG Surround” (parametric coding of multi-channel audio, initially named “Spatial Audio Coding”)

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MPEG Surround: The Presentations ...
Part 1: Basics, Technology and Performance

Context, Background and Related Technologies	Jürgen Herre *Fraunhofer IIS*
Technology Overview	Werner Oomen *Philips Applied Technologies*
Capabilities & Features	Jeroen Breebaart *Philips Research Laboratories*

MPEG Surround: The Presentations ...
Part 2: Applications

Application Overview	Kristofer Kjörling *Coding Technologies*
US Radio Applications	Greg Shay *Telos Systems / Axia / Omnia*
Outlook: Other uses of Spatial Audio Technology	Jürgen Herre *Fraunhofer IIS*

MPEG Surround - Context, Background and Related Technologies

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Some MPEG Audio Coding History

MPEG "Moving Pictures Expert Group", ISO/IEC JTC1/SC29/WG11

MPEG-1 (1992)	• First generic audio coding standard, Layers 1-3, (DAB, Worldspace, DVB, Internet Audio/"MP3")
MPEG-2 (1994)	• Extending MPEG-1 coders towards lower sampling rates & multi-channel...
MPEG-2 AAC (1997)	• More powerful mono ... multi-channel coding
MPEG-4 (1999+)	• New functionalities (scalability, object oriented representation, interactivity ...) – Extensions: Bandwidth extension; High-quality parametric audio coding; Lossless coding
MPEG-D	• *MPEG Surround*

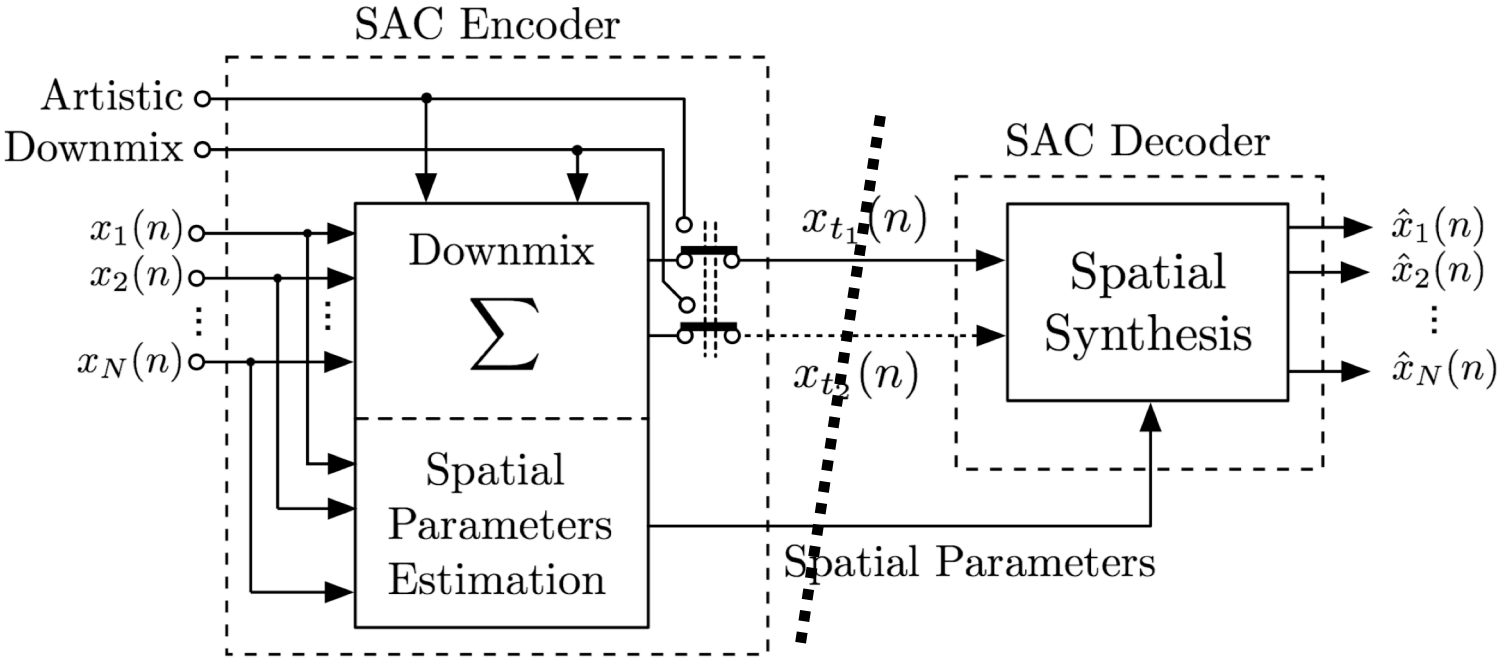
Context of this Work

Recent Development

- ‘Spatial Audio Coding’ multi-channel coding
- Extension of traditional stereo coding
  - Multi-channel audio at bitrates so far used only for transmission of 2 (or 1) channels
  - Backward compatible transmission: Upgrading existing distribution chains to multi-channel audio
- Very attractive for many applications
  - Digital Audio Broadcasting
  - Internet Music download und streaming
  - …
- Standardization within ISO/MPEG recently completed, new name: **MPEG Surround**

Basic Principle

MPEG Surround = Downmix + Parametric Spatial Synthesis



Note: Use of manually created (‘artistic’) stereo mix supported

MPEG Standardization

Work item, initially named "Spatial Audio Coding" (SAC), part of MPEG-4 Audio:

- Call for Proposals (CfP) in March 2004
- Evaluation of 4 submissions concluded in October 2004
- MPEG adopted combination of the two best submissions (Fraunhofer/Agere and Coding Technologies/Philips)
- Subsequently collaborative refinement within MPEG

Current Status:

- Specification frozen in July 2006
- "MPEG Surround", Part of MPEG-D

Some Related Technologies ...

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Parametric Stereo [Schuijers et al., 2003]

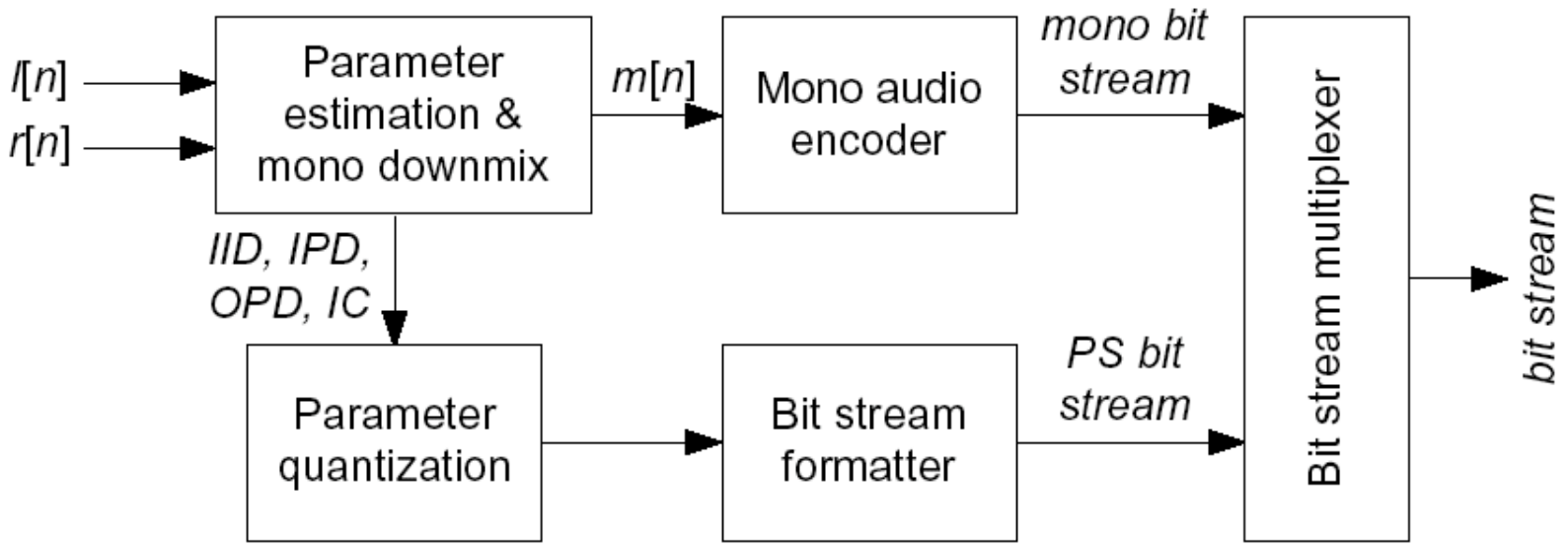
Idea

- Enhance compression efficiency by coding mono signal + perceptual parameters (two → one → two channel conversion)
- Use set of perceptual parameters:
  - Inter-channel Intensity Difference (IID)
  - Inter-channel phase relations (IPD/OPD)
  - Inter-channel coherence (ICC)
- Significantly better than intensity stereo!

Used by …

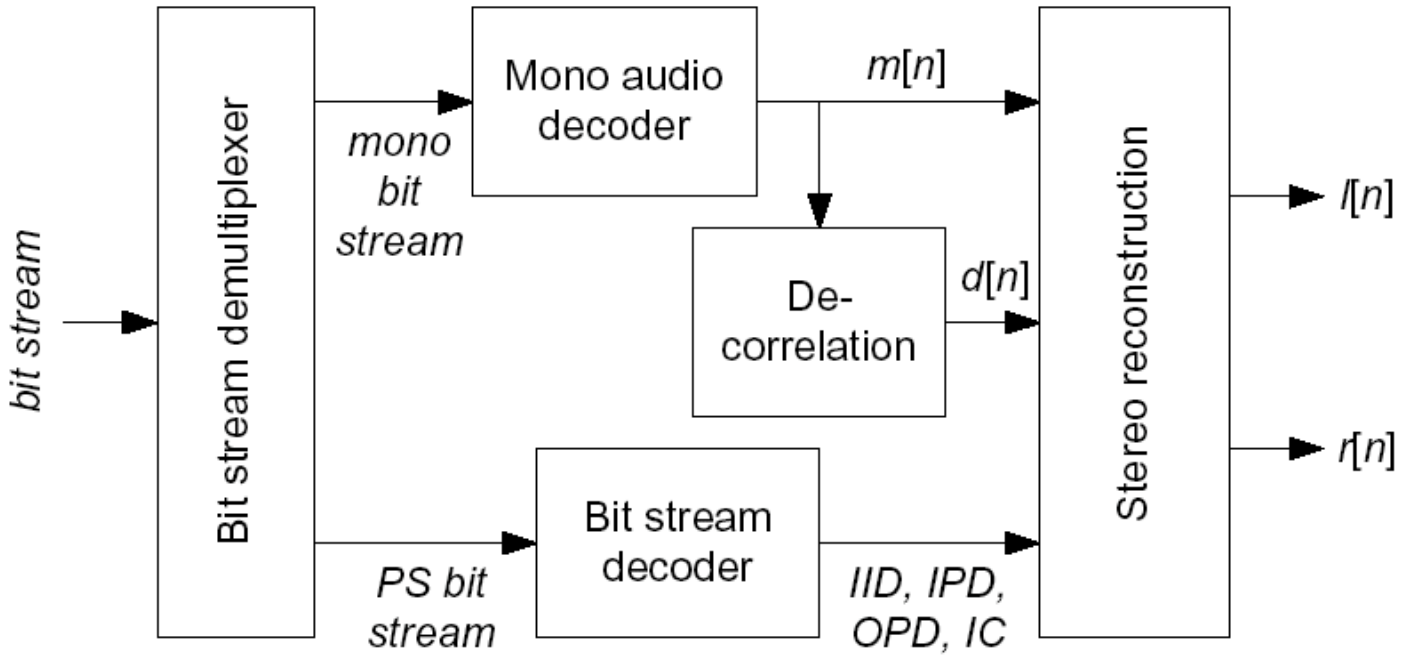
- MPEG-4 High-quality param. audio coding
- MPEG-4 HE-AAC v2 → 3GPP

Parametric Stereo Encoding



[Schuijers et al. 2004]

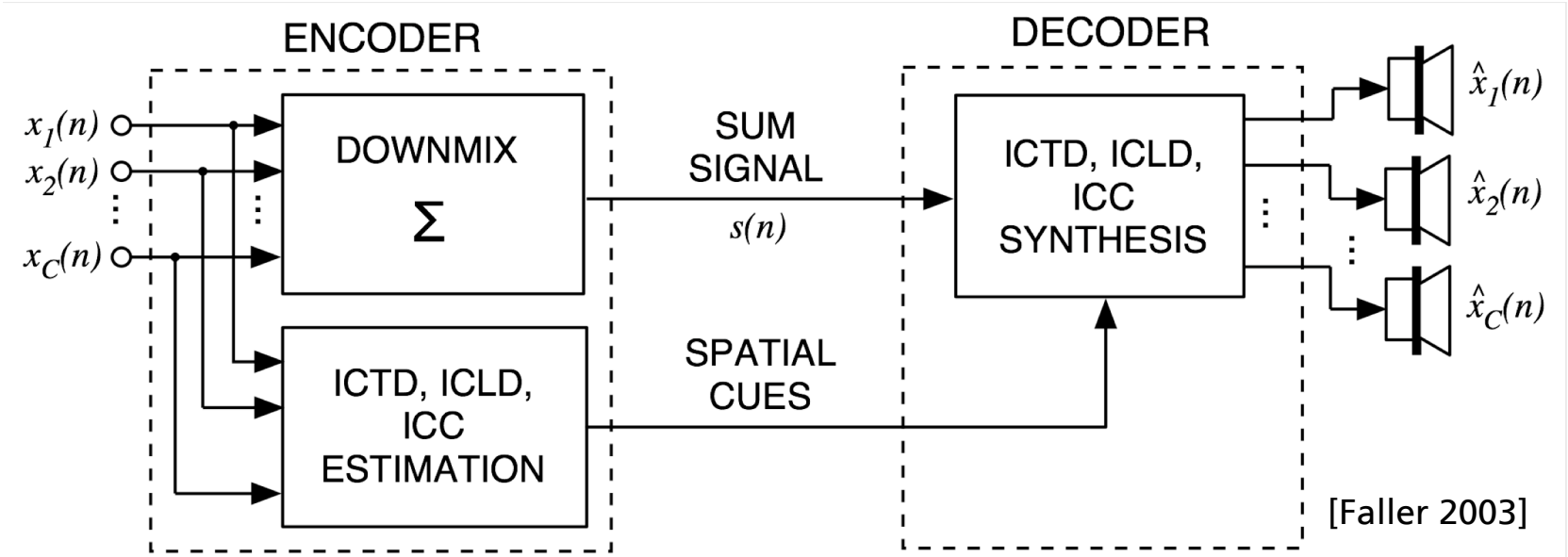
Parametric Stereo Decoding



[Schuijers et al. 2004]

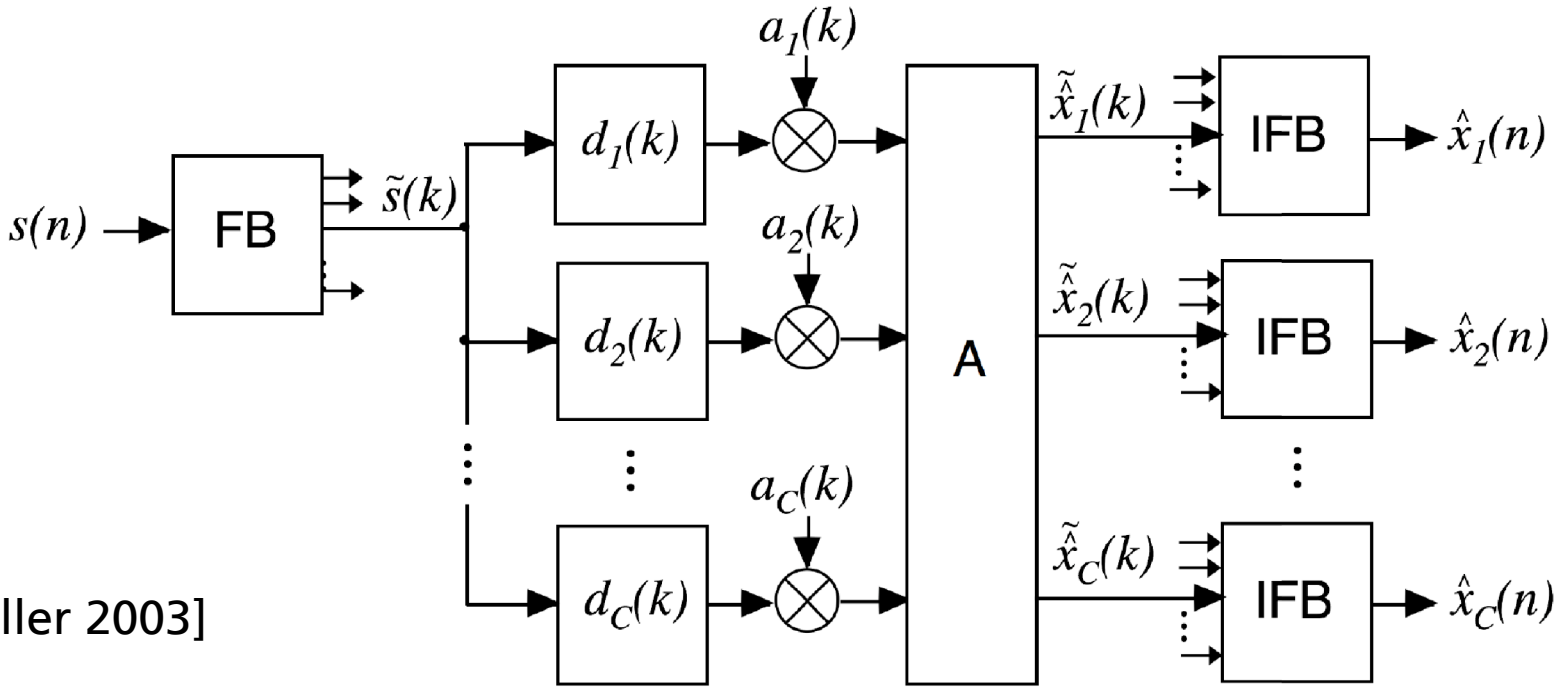
Binaural Cue Coding (BCC)

- Multi-channel scheme [Faller & Baumgarte, 2001ff]
- Uses inter-channel parameters: Level Differences (ICLD), Time Differences (ICTDs), Correlation (ICC)



Binaural Cue Coding (2)

Synthesis from one compatible mono downmix channel:



[Faller 2003]

Note: Later extended towards using several downmix channels

Matrix Surround

- Only way of delivering surround sound to consumers for a long time (“legacy format compatible”)
  - Widely deployed in professional and consumer market (Dolby, SRS, Lexicon, …)
  - Plenty of material available, but:
  - Limitations in spatial sound quality
- Transmits (dedicated) stereo downmix, but no explicit side information
- Relies on manipulation of phases for spatial encoding in downmix

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Performance Expectations

"What should we expect from MPEG Surround technology?"

Sound Quality	• Must be substantially better than matrixed surround (DPL2 et al.)! • Ideally: "Discrete"
Other Parameters	• Side information bitrate • Computational complexity • Other features • . . .

=> To be answered by the subsequent presentations!