

Workshop 10:

From SAC To SAOC - Recent Developments In Parametric Coding Of Spatial Audio

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Why This Workshop ?

AES Technical
Committee on
Audio Coding

- MPEG Audio standards very successful
- Past workshops about MPEG Audio:
 - MPEG-4 Version 1 @ 106th AES, 5/99;
 - MPEG-4 Version 2 @ 108th AES, 2/00;
 - MPEG-4 Extensions @ 114th AES, 3/03;
 - MPEG-4 Lossless Coding @ 117th & 121st AES;
 - MPEG Surround @ 120th & 121st AES;
- Any further progress in MPEG Audio?
 - Recently, a new standardization started:
"Spatial Audio Object Coding"
(parametric coding of audio objects)



What Is MPEG Spatial Audio Object Coding (SAOC) ?

What is does

- Efficient coding and interactive rendering of audio objects to any rendering setup
 - At bitrates so far used only for transmission of 2 (or 1) audio channels
 - Backward compatibility: Upgrading existing distribution chains to object-based audio

How it works

- Closely related to Spatial Audio Coding (SAC), i.e. parametric multi-channel coding, as it was standardized in MPEG Surround

Applications

- Personal/interactive audio re-mixes, teleconferencing, gaming, ...



The Presentations ...

General Background &
Technology Context

Jürgen Herre
Fraunhofer IIS, Germany

Principles of perceptual
object-based coding

Christof Faller
*Ecole Polytechnique Fédérale de
Lausanne (EPFL), Switzerland*

Application scenarios,
MPEG Technology, Part 1

Barbara Resch
Coding Technologies, Sweden

MPEG Technology, Part 2

Jeroen Breebaart
Philips Research Laboratories



MPEG Spatial Audio Object Coding (SAOC) - General Background & Technology Context

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Fraunhofer Institut for Integrated Circuits (FhG-IIS)
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Imagine ... (some interactive audio applications)

- ... you could do a personal / interactive remix of mono or stereo material according to your preference
 - Attenuate certain instruments (→ Karaoke)
 - Modify mix (“more drums, less strings”)
 - Control dialog level
- ... you could have teleconferencing with multi-channel rendering and interactive positioning / amplification of each talker

... while staying with low bitrates!

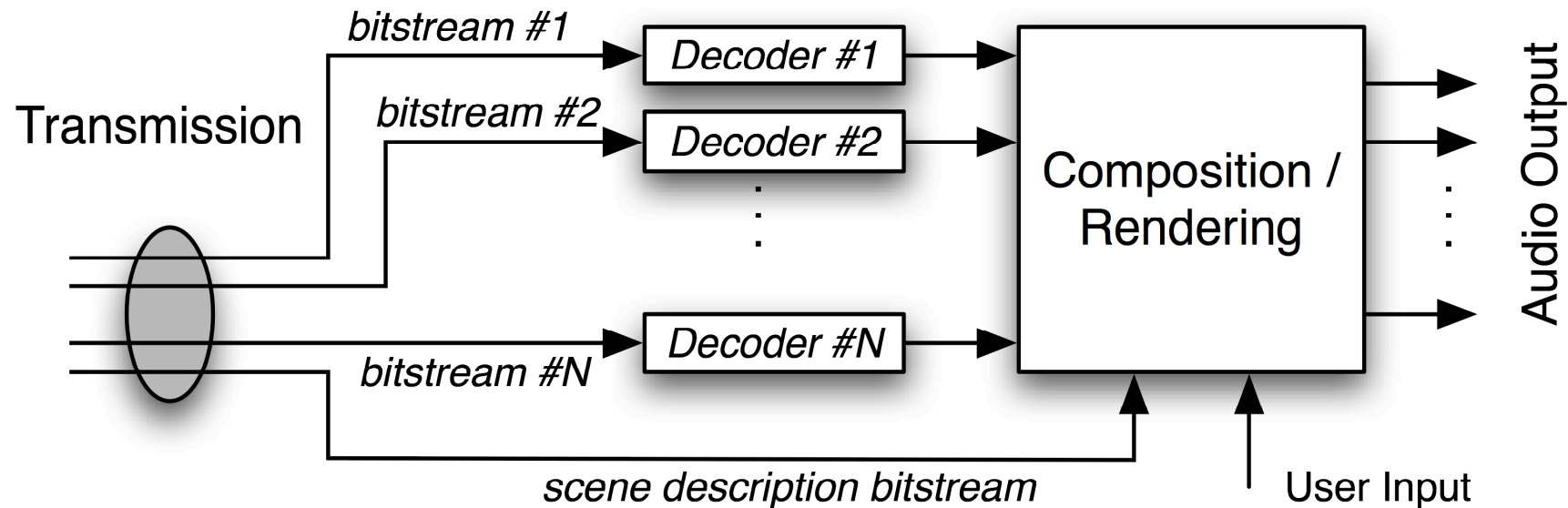


A First Crack At Interactive Object-Based Audio Technology ...



MPEG-4 Object Based Coding (1996ff)

Convey an A/V scene as objects + scene description → interactivity



- Bitrate and decoding complexity grow with number of objects ☹
- Considerable structural complexity ☹

Addressing The Efficiency Challenge In Multi-Channel / Surround Sound: Spatial Audio Coding (SAC)



Traditional Delivery Formats For Surround

Matrixed Surround (Prologic, Neo6, ...)

- Downmix of 5.1 sound into stereo signal, upmix at the receiver side
 - Efficient in terms of transmission bandwidth (same bitrate as stereo)
 - Backward compatible to stereo delivery
 - Limited computation necessary
 - *Significant loss in subjective audio quality*

Discrete Surround (AC-3, AAC, ...)

- Separate transmission of each channel
 - *Significantly higher bitrate than stereo*
 - Moderate amount of computation
 - High subjective audio quality possible



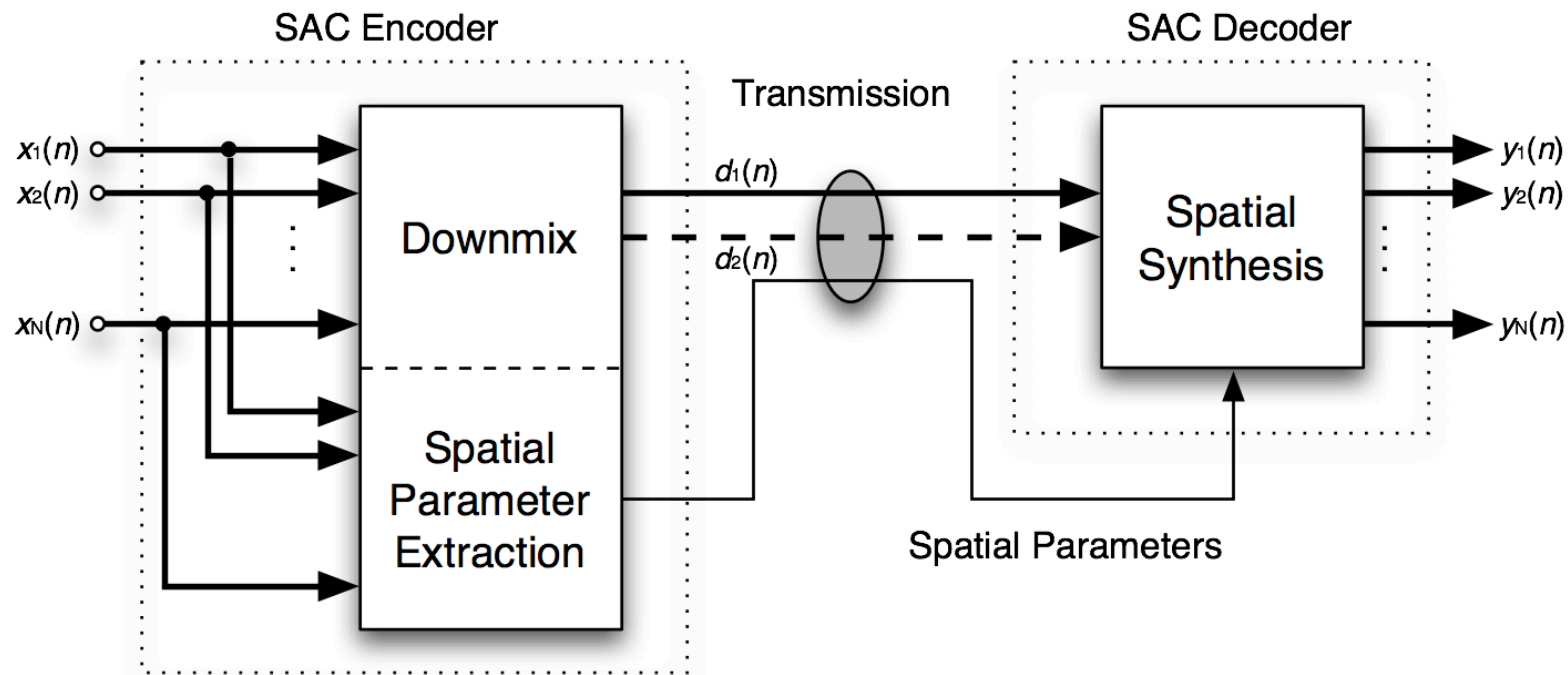
A Major Step Ahead: “Spatial Audio Coding”

- Significant progress in multi-channel low bitrate audio coding during recent years
- Concept of “Spatial Audio Coding” (SAC)
 - Compression efficiency:
Transmits multi-channel audio at bitrates used for 2-channel stereo (or even mono)
 - Backward compatibility:
SAC multi-channel audio is coded in a backward compatible way
⇒ existing infrastructures can be seamlessly upgraded to multi-channel / surround!
 - High subjective audio quality



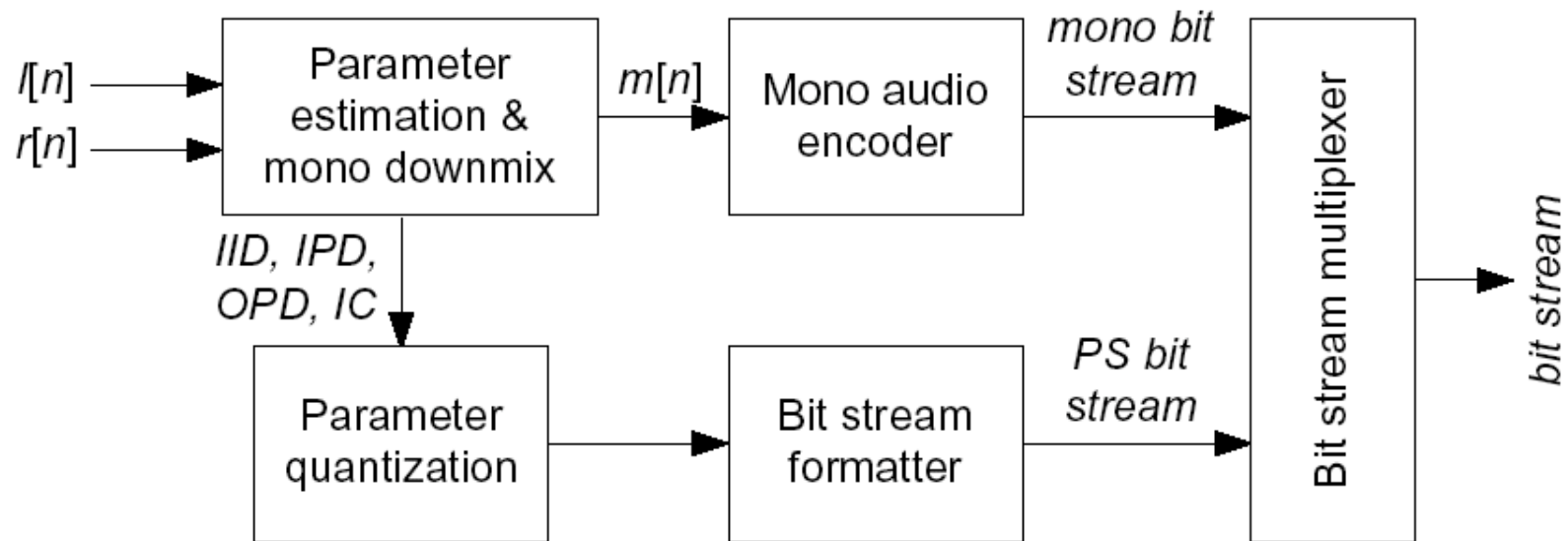
The Spatial Audio Coding Concept

“Spatial Audio Coding” = Downmix + Parametric Spatial Synthesis



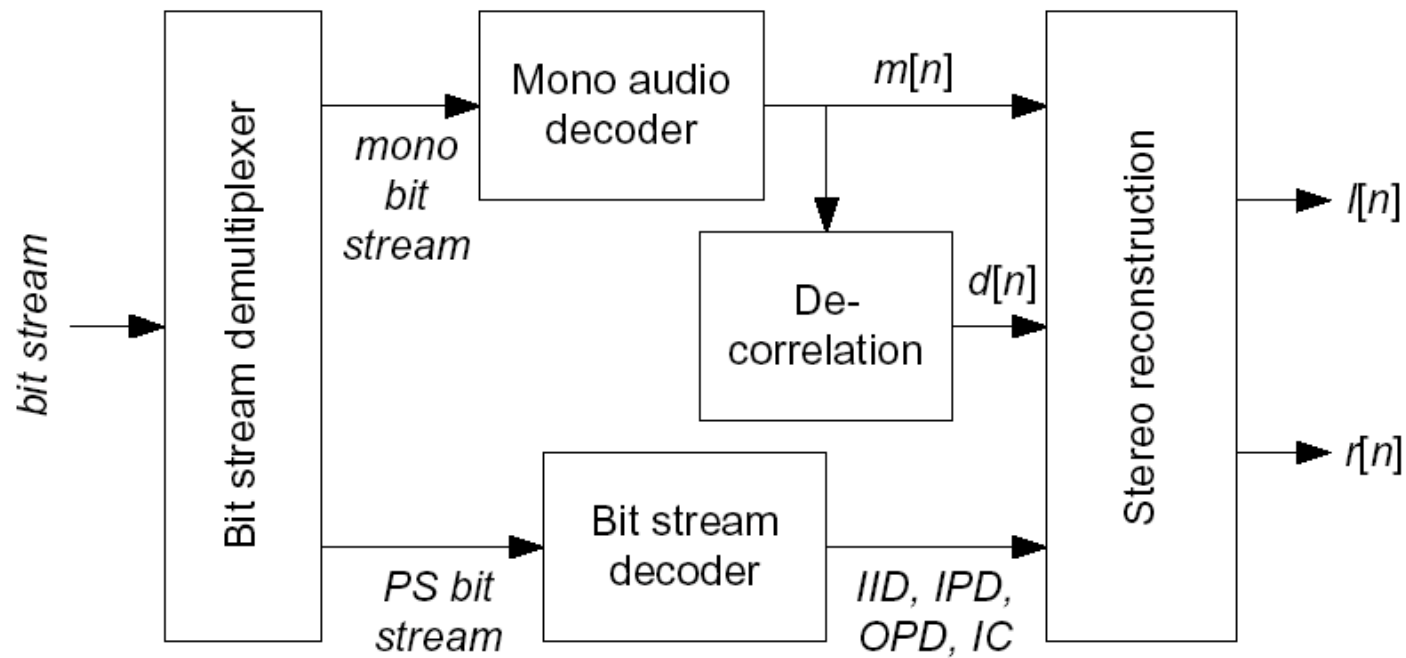
Related to: Matrix Surround, Parametric Stereo, Binaural Cue Coding

Parametric Stereo Encoding



[Schuijers et al. 2004]

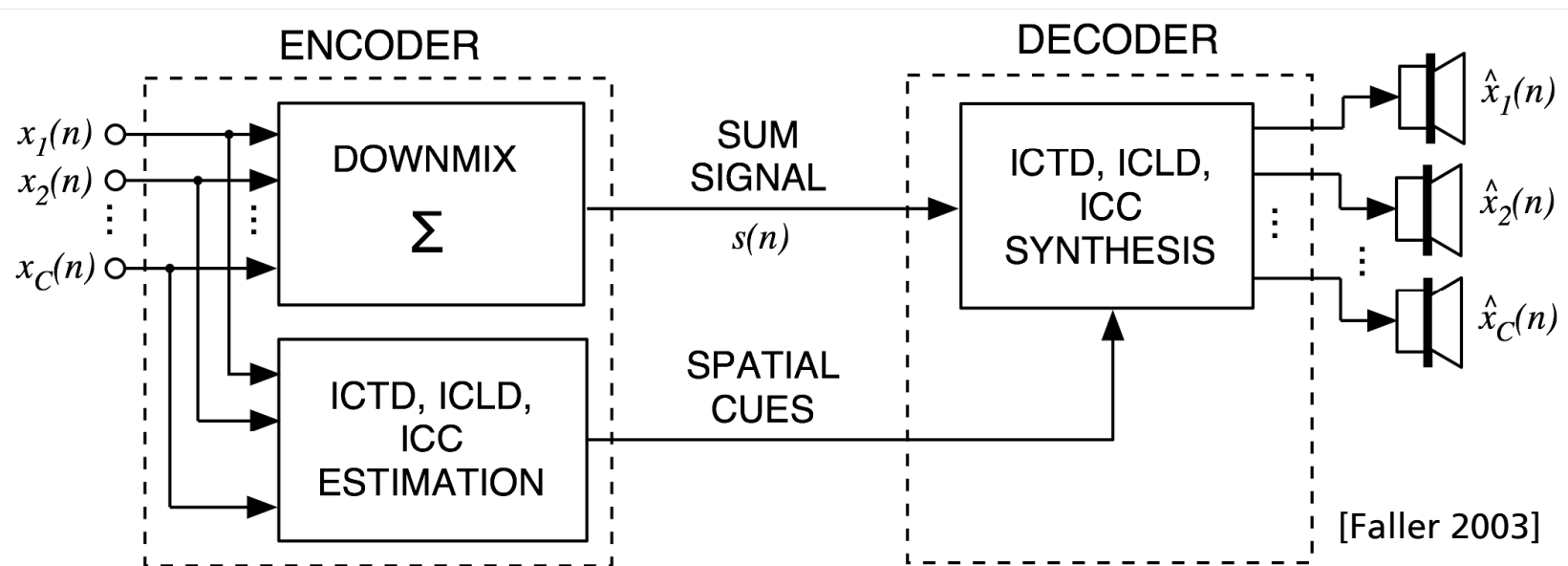
Parametric Stereo Decoding



[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)



MPEG Surround



- Work item "Spatial Audio Coding" (SAC)
- Technical development 3/2004 - 7/2006
- Main contributors: Fraunhofer IIS, Agere Systems, Coding Technologies and Philips
- Renamed into MPEG Surround (MPEG-D)

Applications:

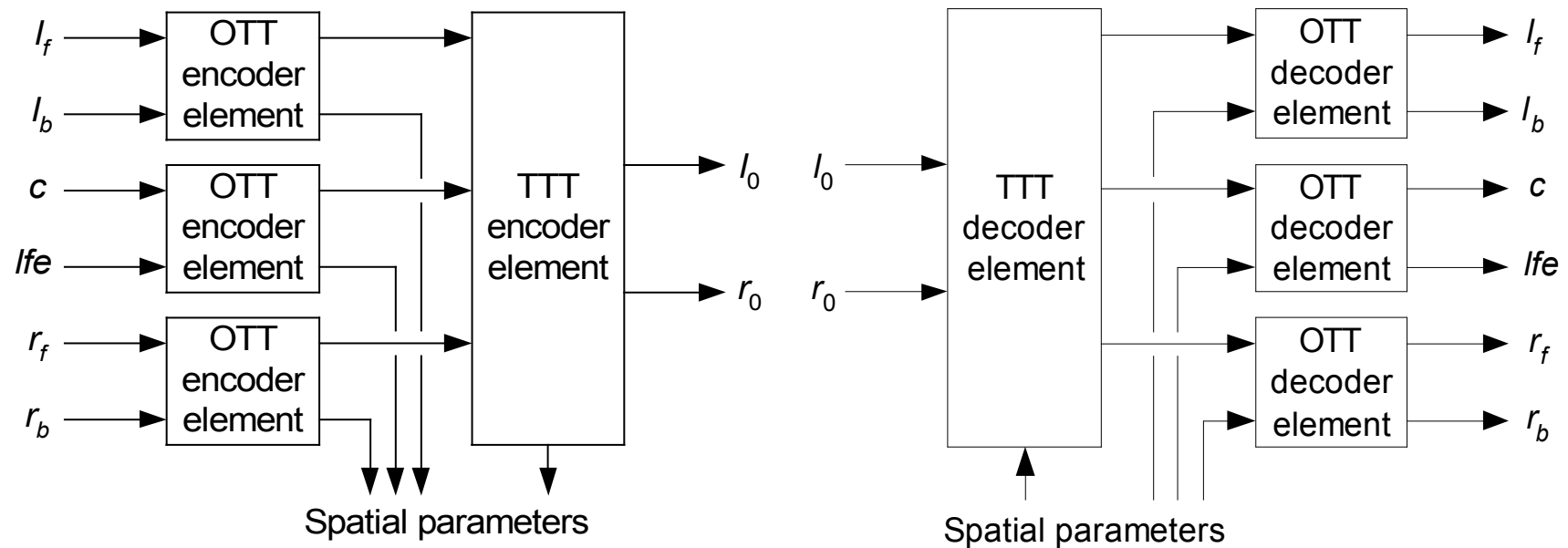
- Efficient & backward compatible upgrade of audio distribution to multi-channel, e.g.:
 - Music download service
 - Multi-channel streaming / Internet radio
 - Digital audio broadcasting

Underlying Idea: Hierarchical En/decoding

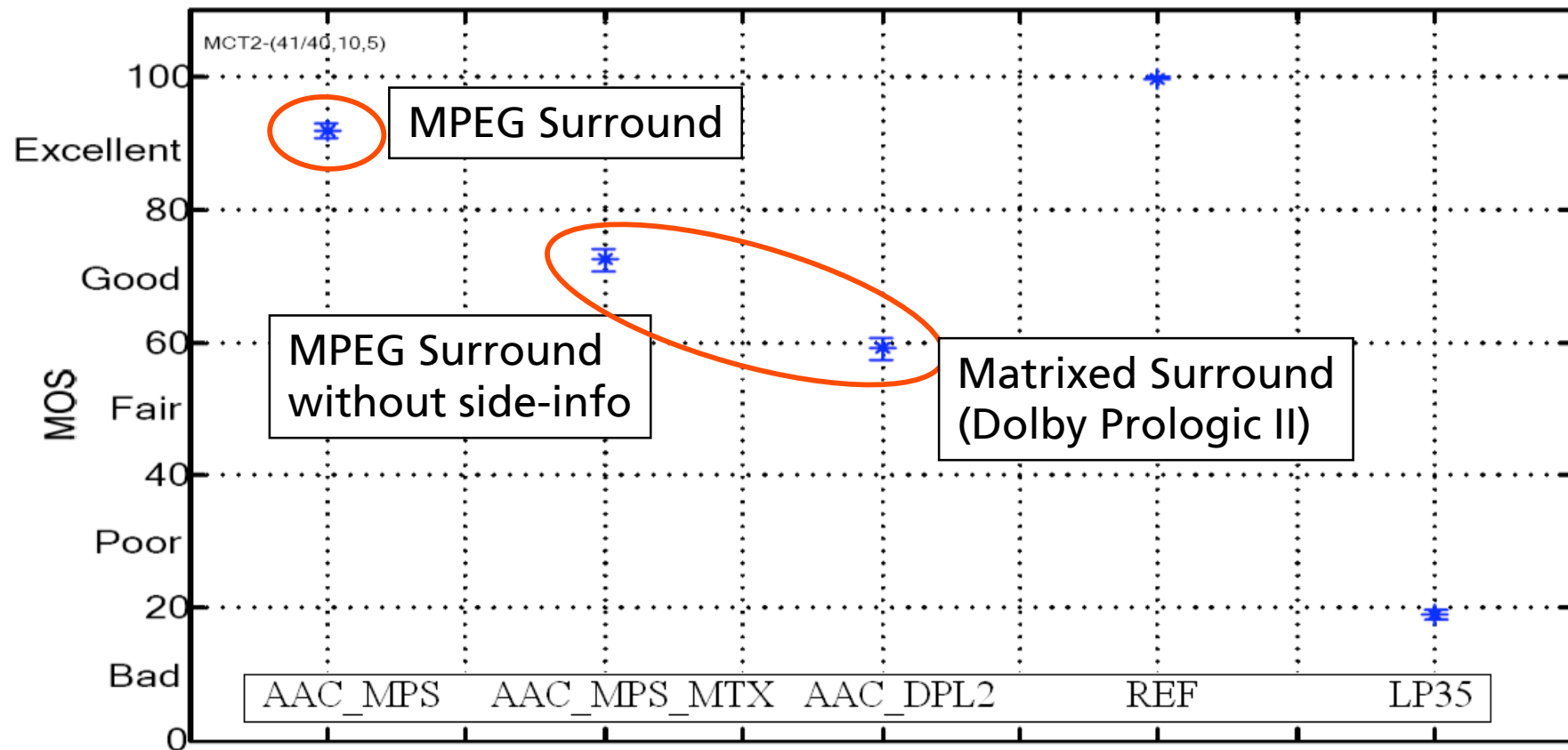
Encoder

Decoder

Example: "5-2-5 Coding"

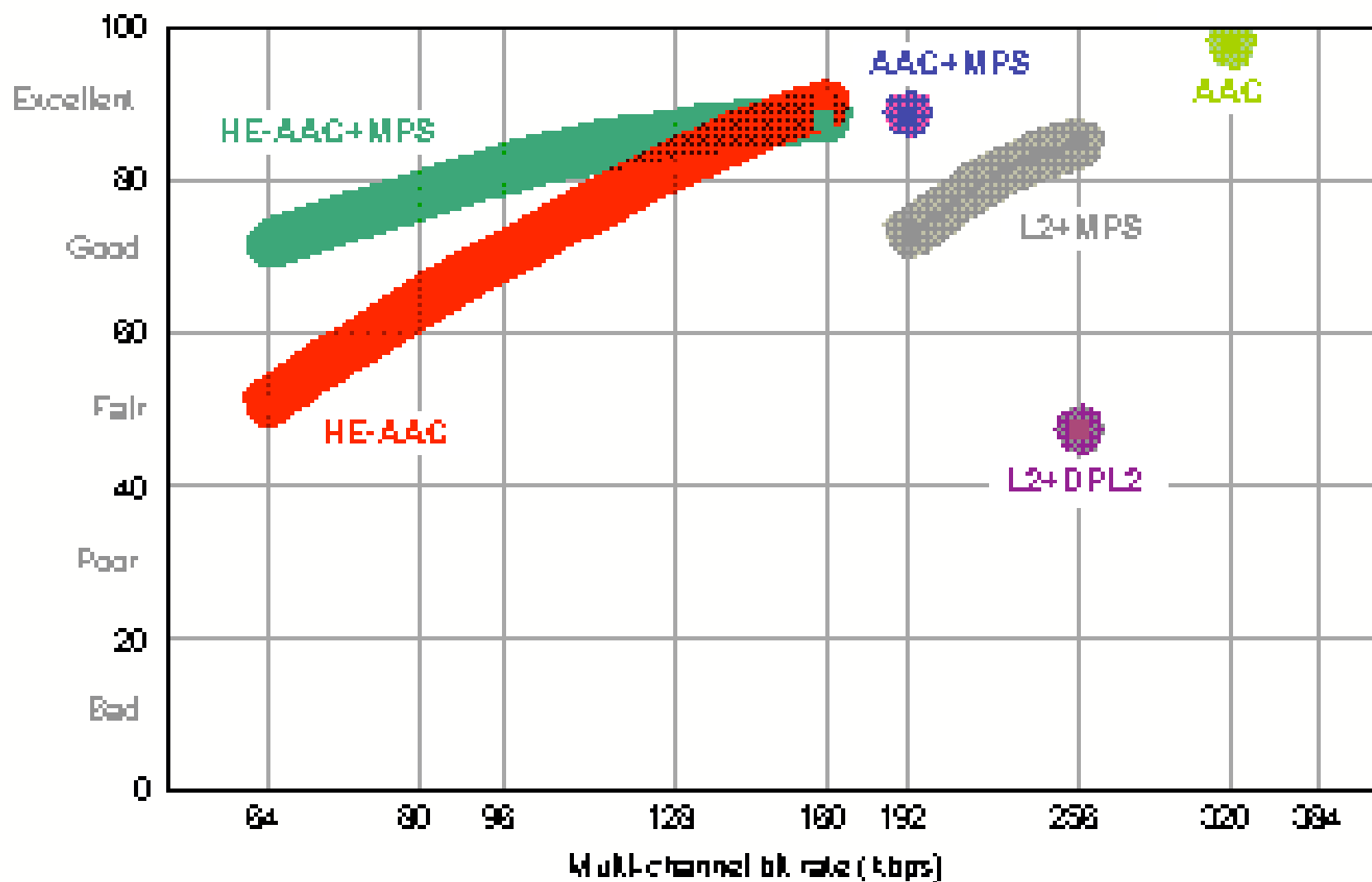


MPEG Surround: Recent Verification Test



“Music-Store” test scenario: Stereo downmix coded using AAC@160kbit

MPEG Surround Audio Quality



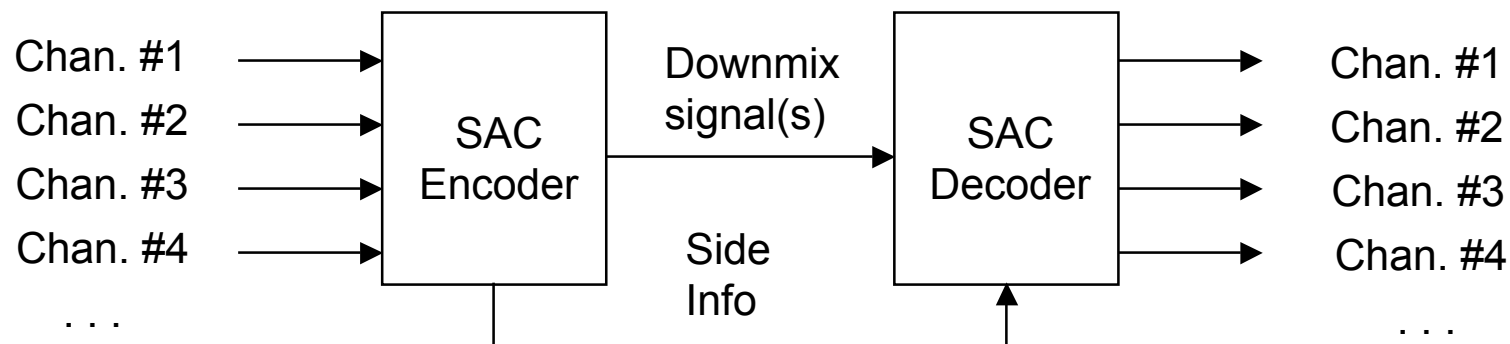
Next Generation Efficient Interactive Audio:

From *Spatial Audio Coding* to
Spatial Audio Object Coding



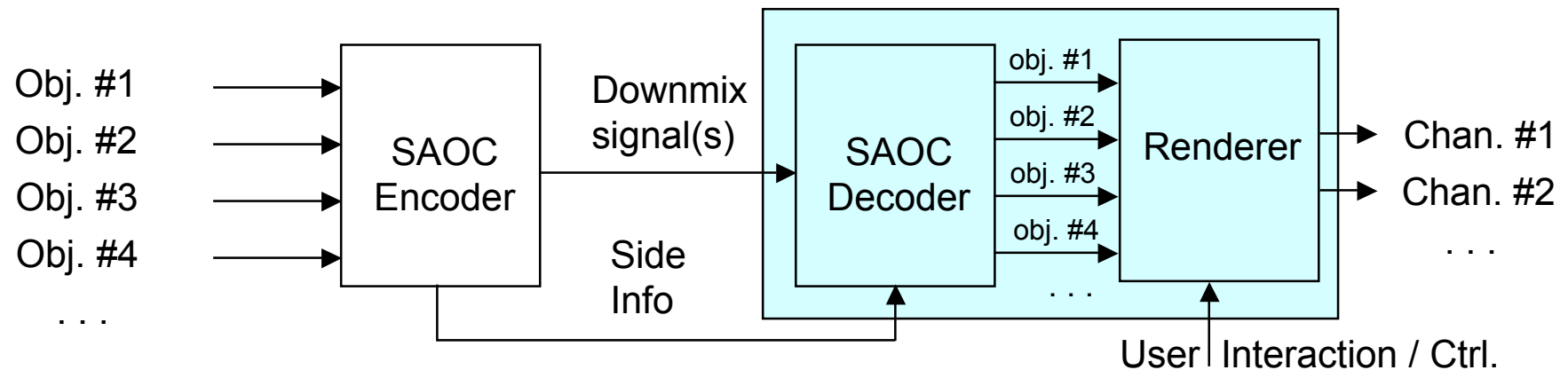
From Spatial Audio Coding (SAC) to SAOC

Regular Spatial Audio Coding: *Channel-oriented* scheme
(MPEG Surround)



From SAC to SAOC (2)

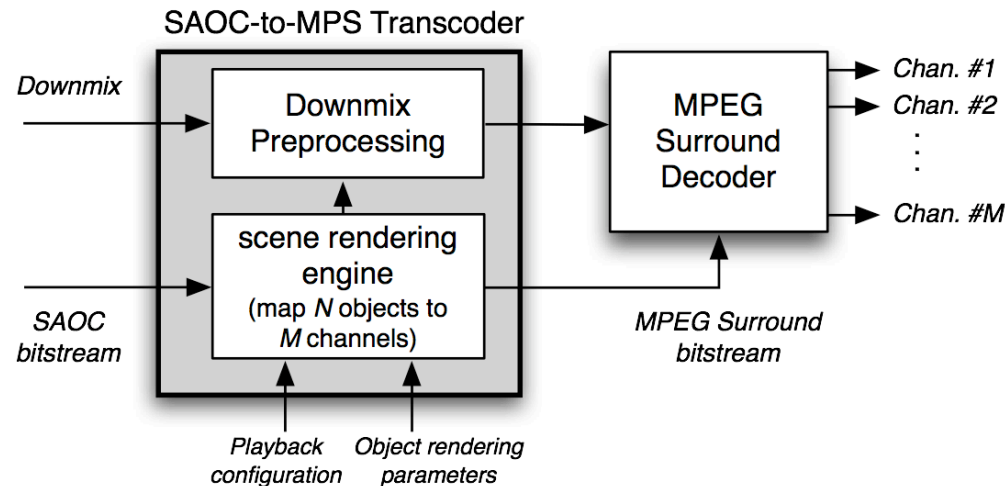
Alternative: *Object-oriented* Spatial Audio Coding



- Processes object signals instead of channel signals
- “Mixing”/rendering parameters vary according to user interaction
- Combined obj. decoding & rendering \Rightarrow computationally efficient!
- Previous work by Faller & Baumgarte [2001ff] and Faller [2006]

New MPEG Standardization Activities

- Started work on "Spatial Audio Object Coding" (SAOC)
- Use existing MPEG Surround technology for rendering:
Transcoding "SAOC" + rendering info → MPEG Surround



- Reference model and working draft to be available by 10/2007

“Take-Away Statements”

- Object-based audio enables *interactive* and *personalized* rendering
- Like Spatial Audio Coding, Spatial Audio Object Coding (SAOC) can bring significant progress here by exploiting human perception
 - High compression / computational efficiency
 - Stereo / mono backward compatibility
- MPEG standardization project just started



Thank you for your attention!

