MPEG-4 Version 2 Audio Workshop:

HILN - Parametric Audio Coding
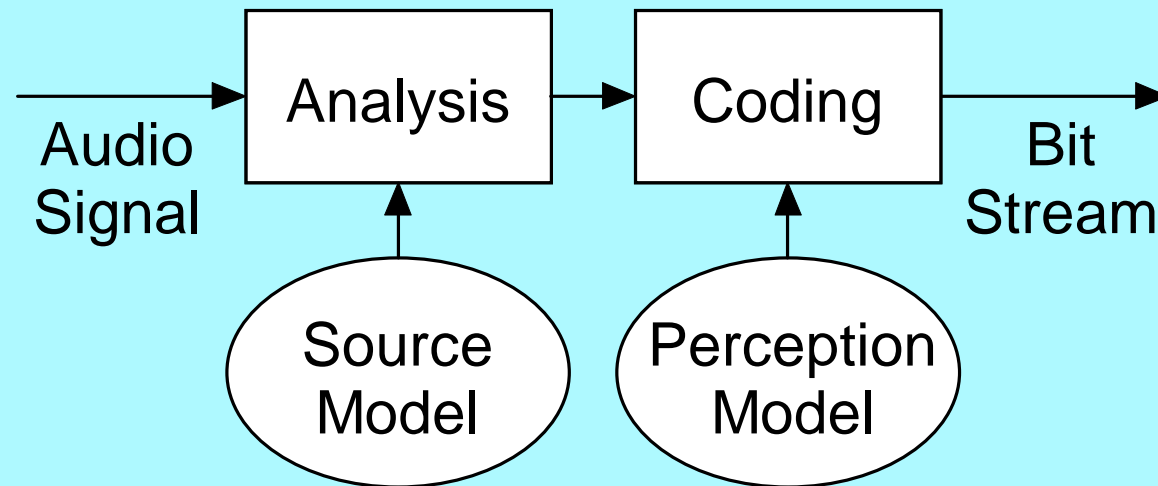
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Outline

- **Introduction**

- **What is "Parametric Audio Coding" ?**

- **HILN - MPEG-4 Parametric Audio Coding**

- **Audio Demonstration**

- **Outlook**

Introduction: MPEG-4 Audio Coding

● **MPEG-4 Audio Requirements:**

– efficient coding (various content types / bitrates)

– other functionality (e.g. scalability)

=> Combination of coding techniques required

– utilise different source and perception models

Introduction: Speech & Audio Coding

● **Established coding techniques:**

– Speech coding: Excitation + Resonances
                                  (CELP)

   => <u>source model</u> extensively exploited

– Audio coding: Spectral Decomposition
                                  (transform coding)

   => <u>perception model</u> extensively exploited

=> "waveform" coding techniques

What is "Parametric Audio Coding" ?

- **Representation of audio signal** *x*
  - *physical*: waveform $x(t)$
  - *abstract*: musical score (compact, ambiguous)

    => promising approach for efficient audio coding

- Encoding: *physical repr. => abstract repr.*

  but: automatic transcription to score very difficult !!!

- Audio Coding:

    *Compact representation of audio
    <u>automatically</u> derived from real-world signal*

What is "Parametric Audio Coding" ?

● Some source models for audio signals:

Model Assumption:	**Model Parameters:**
(quasi-)stationary	spectral samples
physically generated	excitation + resonances
pure tones	freq. & ampl. of sinusoids
transients	amplitude envelope
noise	noise spectrum

=> Problem: Choice of source model ?

Efficiency vs. Generality

(specialised model <u>not</u> suitable for arbitrary signals)

What is "Parametric Audio Coding" ?

- ● **Parametric Audio Coding**

  – combination of different <u>source models</u>
     => decompose audio signal into components

  – utilise <u>perception models</u>
     => pick "most relevant" components

- ● <u>Sound</u> represented by model parameters

     => <u>waveform</u> approximation not necessary

- ● **Parameter Quantisation and Coding**

  – quant. step size: "just noticeable differences"

  – entropy coding

MPEG-4 Parametric Audio Coding

- **MPEG-4 Audio Version 2: HILN**

  "<u>H</u>armonic and <u>I</u>ndividual <u>L</u>ines plus <u>N</u>oise"

  harmonic lines: fundamental freq. & LPC spectrum
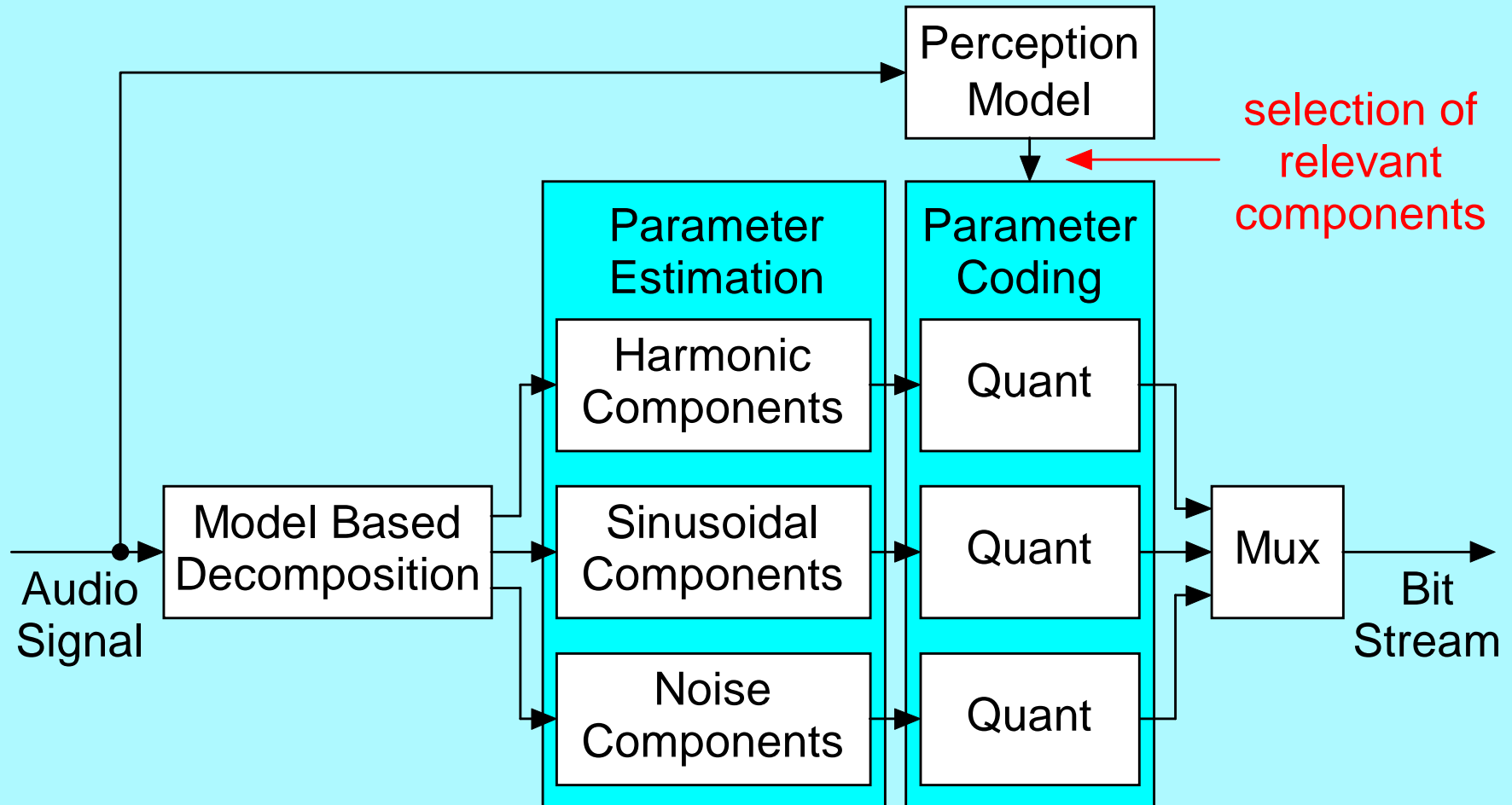
  individual lines: frequency & amplitude
  [opt.: ampl. envelope, start phase]

  noise: LPC spectrum

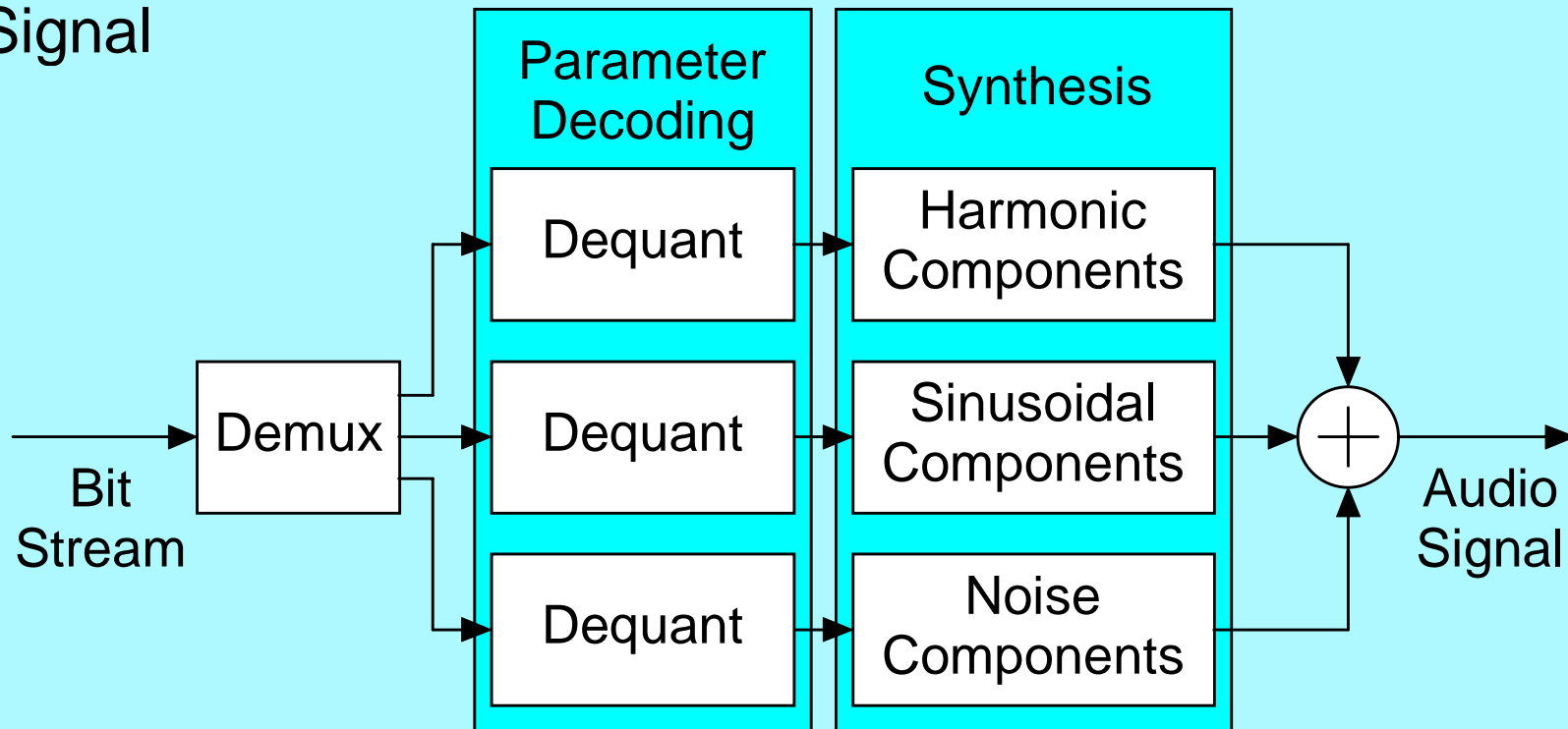 => 4 .. 16 kbit/s @ 8 kHz bandwidth (typ.)

MPEG-4 Parametric Audio Coding

Parametric Audio Encoder (HILN)

MPEG-4 Parametric Audio Coding

- **Demo:** HILN 16 kHz mono @ 6 kbit/s

Original
Signal

Parameter Decoding	Synthesis
Dequant	Harmonic Components
Dequant	Sinusoidal Components
Dequant	Noise Components

Bit
Stream

Demux

Audio
Signal

Parametric Audio Decoder (HILN)

MPEG-4 Parametric Audio Coding

- Additional Functionality of HILN
  - Bitrate scalability:

    - base layer   (major signal components)
    - enhancement layer(s) (minor signal components)
  - Signal modification in decoder:

    - speed and pitch change (parameter modification)
  - Error Robustness (UEP)

- Integrated Parametric Decoder (HVXC + HILN)
  - Example: speech + background music
                        2 kbit/s HVXC + 4 kbit/s HILN = 6 kbit/s

Audio Demonstration

- **Demo:** HILN 16 kHz mono @ 6 kbit/s

- Signal modification in decoder:
  - pitch change   +20%
  - speed change   +20%

- Comparison of MPEG-4 coding techniques:
  - original (8 kHz bandwidth)
  - speech coding (CELP)   6 kbit/s
  - transform coding (TwinVQ)   6 kbit/s
  - parametric audio coding (HILN)   6 kbit/s

Outlook

- HILN Encoder Optimisation (not normative)

    – improved signal segmentation
      (e.g. tonal / noise discrimination)

    – improved parameter estimation & tracking

- Combination of coding techniques

    – select best coding technique for actual signal

    – segmentation into audio objects
      (e.g. automatic segmentation of speech / music)

      ... but: *Audio objects are transparent!*

further reading ...

- *Official* MPEG Home Page

  http://www.cselt.it/mpeg/

- MPEG Audio Web Page

  http://www.tnt.uni-hannover.de/project/mpeg/audio/

- Parametric Audio Coding Bibliography:

  http://www.tnt.uni-hannover.de/~purnhage/