18-899 Special Topics in Signal Processing

Multimedia Communications:
Coding, Systems, and Networking

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Lecture 9

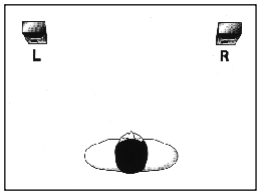
# MPEG-2 Audio

# MPEG-2 Audio

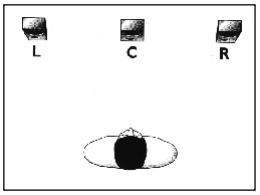
- Allows lower sampling rates
  - 16, 22.05, and 24 kHz (half of MPEG-1)
  - From wideband speech to mediumband audio
  - Higher frequency resolution
  - Layers I, II, and III
- Multichannel coding
  - Surround sound, multilingual, for visual/hearing-impaired
- Backward compatible (BC) and non-backward compatible (NBC) coding



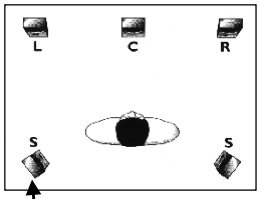
# Multichannel Audio




**2/0-stereo**

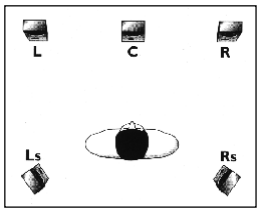



**3/0**

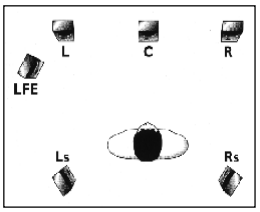



**3/1**

Surround




**3/2**




**3/2 with woofer (5.1 system)**

LFE: Low-frequency enhancement (woofer)

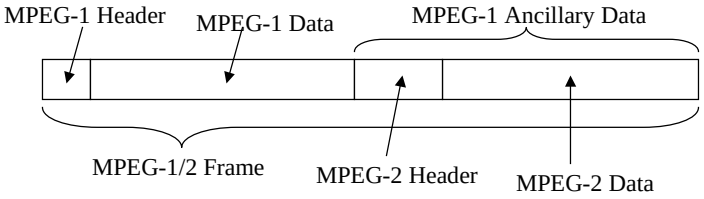
- 15~120 Hz
- Can be anywhere

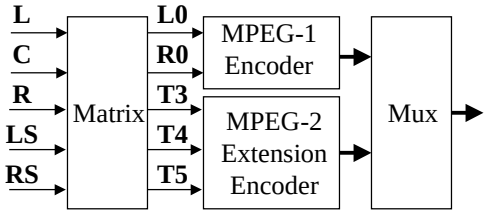
# Compatibility

- Forward compatibility
  - A new decoder can decode an old bitstream
  - Usually simple to achieve
- Backward compatibility
  - An old decoder can decode a new bitstream, at least partially
  - Usually limits the coding efficiency



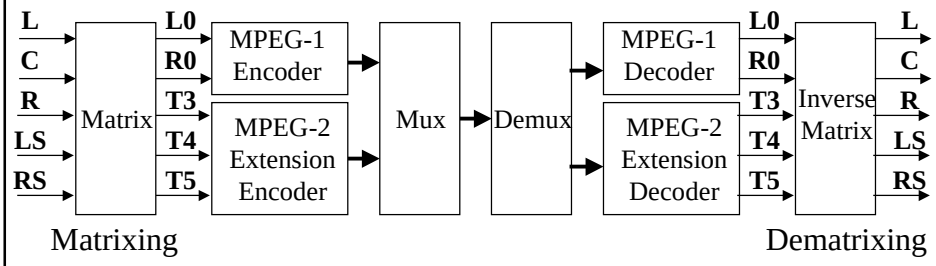
# MPEG-2 Backward Compatible Audio Coding




$$\begin{cases} L0 = \alpha(L + \beta \cdot C + \delta \cdot LS) \\ R0 = \alpha(R + \beta \cdot C + \delta \cdot RS) \end{cases} \quad \alpha = \frac{1}{1+\sqrt{2}}; \beta = \delta = \frac{1}{\sqrt{2}} \text{ or } \alpha = 1; \beta = \delta = 0$$

## Backward Compatible Audio Coding (cont.)



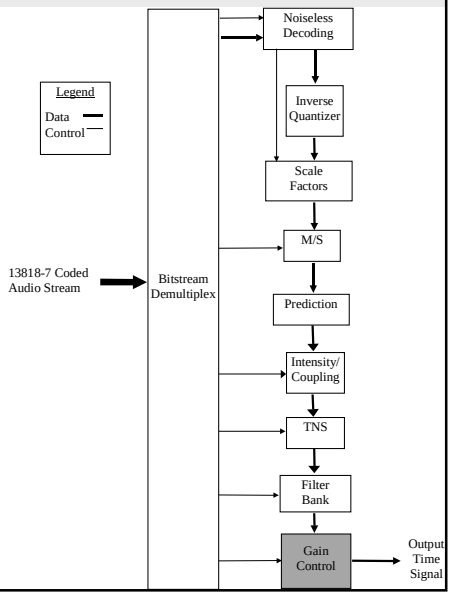



## Non Backward Compatible (NBC) Coding

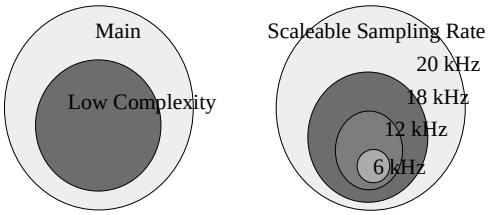
- MPEG-2 Advanced Audio Coding (AAC)
  - ISO/IEC 13818-7 (April 1997)
  - 320~384 kbits/s for 5 channels, 64kbits/channel
  - NBC at 320 kbits/s as good as BC coding at 640 kbits/s
  - 1~48 audio channels, 0~16 LFEs, 0~16 data streams
  - Same framework (perceptual subband coding) as MPEG-1, with some enhancements

# MPEG-2 AAC

- Encoder Enhancements
  - Preprocessing
  - High resolution filterbanks
    - 1024-line MDCT
  - Temporal noise shaping (TNS): time-dependent quantization
  - Coupling channel
  - Backward adaptive prediction in subbands
  - M/S stereo coding (intensity multichannel coding)
  - Noiseless coding (entropy coding): Huffman coding



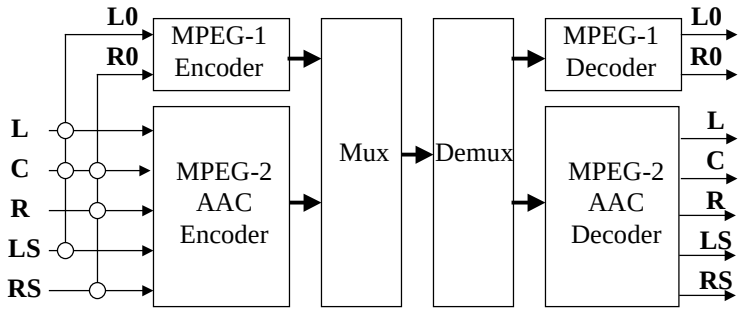

# MPEG-2 AAC Profiles




- Main profile
  - Best quality, highest complexity
  - 1024 or 128 MDCT
- Low-complexity profile
  - No temporal noise shaping, no prediction
- Scalable sampling-rate profile
  - Scalable output sampling rates and complexity
  - Uses hybrid filterbanks (like MPEG-1 Layer III)
  - No prediction, no coupling channel

# Simcast

- To achieve backward compatibility at the cost of higher bitrate






# References


- Peter Noll, "MPEG digital audio coding," *IEEE Signal Processing Magazine*, Sept. 1997, pp. 59-81
- http://www.cselt.it/mpeg/faq/faq-audio.htm
- http://www.tnt.uni-hannover.de/project/mpeg/audio/