Constrained-Energy Lapped Transform (CELT) codec

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CELT Characteristics

- Speech and music at 32 kHz and above
- 32 kb/s to 128 kb/s (scales to very high quality)
  - Sweet spot: 48 kb/s for speech, 64 kb/s for music
- Tunable delay down to 2 ms (8 ms typical)
- Complexity: 11 + 6 WMOPS (enc + dec)
- State RAM: 0.5 + 8.5 kB
- Scratch RAM: 7 kB
Very Low-Delay Coding

• Benefits
  • Reduces acoustic echo problems (even w/o AEC)
  • Enables new applications
    − Collaborative network music performances
    − Transparent network sound services
  • Better loss robustness (smaller losses)

• Challenges
  • Limited frequency resolution
  • Must minimize overhead in bit-stream
Technology

- Using the Modified Discrete Cosine Transform (MDCT)
- Dividing (roughly) into critical bands
- Explicitly coding the energy in each band with an entropy coder
  - Spectral envelope is preserved
- Using a spherical quantizer for encoding each band
Encoder Block Diagram

Input → Window → MDCT

Band energy → Q₁

PVQ → Q₂

Q₂ + coarse energy → Q₃

Q₃ - fine energy

Bit allocation → Desired bit-rate → Range coder

Bit-stream
Bit allocation (64 kb/s)
Quality

- Internal MUSHRA (ITU-R BS.1534) test

V0.3.2

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<th>Format</th>
<th>Ref</th>
<th>CELT</th>
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<th>G.722.1C</th>
<th>MP3</th>
<th>7 kHz</th>
<th>3.5 kHz</th>
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<td>70</td>
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<td>90</td>
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<tr>
<td>Music (64)</td>
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<td>50</td>
<td>60</td>
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<tr>
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V0.5.1

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Wideband
Resources

- Website: [http://www.celt-codec.org/](http://www.celt-codec.org/)
  - Source code
  - Papers/presentations
- Mailing list: [celt-dev@xiph.org](mailto:celt-dev@xiph.org)
- IRC: [irc.freenode.net #celt](irc://irc.freenode.net/celt)