Introduction

• Three MUSHRA-type tests performed in March 2011 at Google
• Both trained and untrained listeners
• Tests presented on Windows PC with headphones
Test 1 – Narrowband Mono Speech

- 3 different male and 3 different female speakers
- Reference files sampled at 48 kHz in low background noise
- 2 anchors: lowpass-filtered at 3.5 kHz and 7.0 kHz
- 17 listeners, no post-screening
- 3 narrowband codecs, all using 20 ms frames
  - iLBC at 15.2 kbps, constant bit rate
  - Speex NB at 11 kbps, constant bit rate
  - Opus NB at 11 kbps, variable bit rate
Overall Results – Narrowband Speech

Opus at 11 kbps is better than iLBC at 15 kbps and Speex at 11 kbps
Test 2 – Wideband and Fullband Mono Speech

- 3 different male and 3 different female speakers
- Reference files sampled at 48 kHz in low background noise
- 2 anchors: lowpass-filtered at 3.5 kHz and 7.0 kHz
- 17 listeners, no post-screening
- 4 wideband codecs, all using 20 ms frames
  - G.722.1 at 24 kbps, constant bit rate
  - Speex WB at 23.8 kbps, constant bit rate
  - Opus WB at 19.85 kbps, variable bit rate
  - AMR-WB at 19.85 kbps, constant bit rate
- 2 fullband codecs, both using 20 ms frames
  - G.719 at 32 kbps, constant bit rate
  - Opus FB at 32 kbps, constant bit rate
Overall Results - Fullband and Wideband Speech

Opus at 32 kbps is almost transparent
Opus at 20 kbps is better than LP filtered speech at 7 kHz
Test 3 – Fullband Stereo Music

- 10 stereo music files
  - Rock/R&B (Boz Scaggs)
  - Soft rock (Steely Dan)
  - Rock (Queen)
  - Jazz (Harry James Orchestra)
  - Classical (Purcell String Piece)
  - Electronica (Matmos)
  - Piano (Moonlight Sonata)
  - Vocals (Suzanne Vega)
  - Gloockenspiel
  - Castanets

- Reference files sampled at 48 kHz and 44.1 kHz
- 2 anchors: lowpass-filtered at 3.5 kHz and 7.0 kHz
- 9 listeners, no post-screening
- 6 codecs
  - AAC-LC (Nero) at 64 kbps, 21 ms frame size, constant bit rate (bit reservoir)
  - G.719 at 64 (2 x 32) kbps, 20 ms frame size, constant bit rate
  - MP3 (Lame) at 96 kbps, <100 ms, constant bit rate
  - Opus at 64 kbps, 20 ms frame size, constrained variable rate
  - Opus at 80 kbps, 10 ms frame size, constrained variable rate
  - Opus at 128 kbps, 5 ms frame size, constrained variable rate
Overall Results Fullband Stereo Music

Opus (at 64 kbps/20ms, 80 kbps/10 ms, and 128 kbps/5 ms) is
- equal in quality to MP3 at 96 kbps
- equal in quality to AAC-LC at 64 kbps
- better than G.719 at 64 kbps