Overview

- Common Audio Codecs
- History of HD Audio
- Samples of the Codecs
- Platforms Accommodating HD Audio Today
- Places Using HD Audio
- Future of HD Audio
- Benefits of HD Audio to ASR Technology
- Creating a Speech Engine to accommodate HD Audio
# Common Audio Codecs

## Audio Spectrum

<table>
<thead>
<tr>
<th>Frequency</th>
<th>0</th>
<th>10Hz</th>
<th>100Hz</th>
<th>1,000Hz</th>
<th>10,000Hz</th>
<th>22,000Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit Rate</td>
<td>1,411k bp/s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CD Quality Sound**

Audio spectrum 10Hz-22kHz
Requires 1,411k bp/s
Common Audio Codecs

- **Audio Spectrum**
  - 10Hz
  - 100Hz
  - 1,000Hz
  - 10,000Hz
  - 22,000Hz

- **G.711**
  - Only 300-3400Hz
  - Uses 64 kb/s
  - Developed in 1972

- **Bit Rate**
  - 0 64kb/s
  - 1,411k bp/s
Common Audio Codecs

Audio Spectrum

<table>
<thead>
<tr>
<th>Frequency</th>
<th>G.711.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>10Hz</td>
<td>Only 50-4000Hz</td>
</tr>
<tr>
<td>100Hz</td>
<td>Uses 80 kb/s</td>
</tr>
<tr>
<td>1,000Hz</td>
<td>Increased Quality</td>
</tr>
<tr>
<td>10,000Hz</td>
<td></td>
</tr>
<tr>
<td>22,000Hz</td>
<td></td>
</tr>
</tbody>
</table>

Bit Rate

| 80kb/s  | 1,411k bp/s |
Common Audio Codecs

Audio Spectrum

10Hz  100Hz  1,000Hz  10,000Hz  22,000Hz

G.711.0
Only 300-3400Hz
Uses 32 kb/s
To save on bandwidth

0  32kb/s  1,411k bp/s

Bit Rate
Common Audio Codecs

Audio Spectrum

<table>
<thead>
<tr>
<th>10Hz</th>
<th>100Hz</th>
<th>1,000Hz</th>
<th>10,000Hz</th>
<th>22,000Hz</th>
</tr>
</thead>
</table>

- G.729
  - Only 300-3400Hz
  - Uses 8 kb/s
  - VoIP – No Fax nor DTMF

- Bit Rate
  - 0 8kb/s
  - 1,411k bp/s
Common Audio Codecs

Audio Spectrum

10Hz  100Hz  1,000Hz  10,000Hz  22,000Hz

GSM
Only 300-3100Hz
Uses 6.5 kb/s
Most Popular Cell Platform

6.5kb/s  1,411k bp/s

Bit Rate
Common Audio Codecs

Audio Spectrum

10Hz  100Hz  1,000Hz  10,000Hz  22,000Hz

CDMA
Only 300-3100Hz
Uses 4 kb/s

4kb/s  1,411k bp/s

Bit Rate
Common Audio Codecs

Audio Spectrum

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Bit Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 Hz</td>
<td>64kb/s</td>
</tr>
<tr>
<td>1,411k bp/s</td>
<td></td>
</tr>
</tbody>
</table>

G.722 High Definition (HD)
Expands to 50-7000Hz
Uses 64 kb/s
Dev. 1987 for Broadcasters
Common Audio Codecs

Audio Spectrum

G.722.1 High Definition (HD)  
Expands to 50-14,000Hz  
Uses 32 kb/s  
Optimized for Speech and Music

Bit Rate

0 32kb/s  
1,411k bp/s
Common Audio Codecs

Audio Spectrum

<table>
<thead>
<tr>
<th>Hz</th>
<th>10Hz</th>
<th>100Hz</th>
<th>1,000Hz</th>
<th>10,000Hz</th>
<th>22,000Hz</th>
</tr>
</thead>
</table>

G.722.2  Adaptive Multi-rate
50-7,000Hz
Uses 6 - 23 kb/s
Changes with traffic rates

Bit Rate

0 23kb/s
1,411k bp/s
Chirps

Chirp – 48kHz - 384kbps

Chirp G711 – 8kHz - 64kbps

Chirp G722.2 (AMR-WB+) High - 22kHz - 36kbps

Chirp G729 – 8kHz - 8kbps

Chirp G722.2 (AMR-WB) Low - 16kHz - 6kbps
Voiced Segments Example

Example - 48kHz - 384kbps

Example Disrupted

Example G711

Example Disrupted G711

Example G722.2 High

Example Disrupted G722.2 High
Common Audio Codecs

Example G722.2 Low

Example Disrupted G722.2 Low

Example G729

Example Disrupted G729
The Platforms Accommodating HD Audio Today
The Places Using HD Audio

Orange has since rolled out HD voice in the UK, France, Belgium, Romania, Moldova, Republic of Armenia, the Dominican Republic, and Catalonia.

With Switzerland and Luxembourg soon to follow.
The Places Using HD Audio

June 2011: Three UK launched HD Voice calls onto their network

May 2011: Three Austria introduced HD Voice for Austrian subscribers

June 2011: Telstra activated the "largest HD Voice network in the world" for Australian users

August 2011: T-Mobile Austria

August 2011: T-Mobile Poland

October 2011: T-Mobile Czech Republic

November 2011: Deutsche Telekom Germany

November 2011: Three Austria

February 2012: Swisscom Switzerland

June 2012: KPN Netherlands

In the future: Asia?

Soon: USA?
The Future of HD Audio in Mobile

- HD voice upgrade easier with GSM, no massive equipment upgrades required at base station/tower side

- CDMA2000 requires a new network infrastructure every participant in a call must be connected to a cell site that supports CDMA2000 1X Advanced

- CDMA2000 and GSM variants of HD voice are not interoperable in the foreseeable future, so calls drop to narrowband codecs

- LTE, HD voice is actually built-in. The network operator needs to enable HD voice on the network

- For wireline networks (standard telephony), HD voice is not yet available

- Calls routed over Wi-Fi can be HD
The Future of HD Audio in US Mobile

- In the United States T-Mobile will have the first HD Audio using the Apple iPhone 5G
- Sprint will enable it by upgrading to CDMA2000 1X Advanced.
- No other CDMA carriers will offer HD voice through CDMA2000 1X Advanced
- Verizon Wireless and AT&T will have support for the technology with VoLTE deployment
- Only Verizon Wireless has announced plans to offer support for HD voice on LTE
Benefits of HD

- Conference Calls are much clearer so the actual speaker is better identified
- Easier to understand the conversation and important intonations
- Non-native Speakers are easier to understand
- Better Automatic Speech Recognition with all utterances Short and Long
- As an Aside: Open Source Patent and Royalty Free “Speex” codec has an Ultra Wide HD codec for 32kHz
What we are doing with HD

HD Ready – needs acoustic models with 16kHz data

Acoustic Models

HD Ready – Already uses data 16kHz data

Decoder

HD Ready - Needs tuning for 16kHz data

Front End Signal Processing

Input Speech

Output Result

Speech

Result
Conclusion

- A 16khz audio stream can use the same or less bandwidth than a standard 8khz g711 stream

- Equal damage to a G.722x stream will cause equal or greater problems due to the compression being greater

- LumenVox is HD ready today and only needs to create the Acoustic Models in 16kHZ
Thank You!

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