Voice Over LTE (VoLTE) Technology

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Tim Burke
Range of Frequencies Humans Can Hear

Human Hearing

Range of Frequencies Designed For Entertainment

AM Radio

FM Radio

Video Streaming
Range of Frequencies Designed For Communications

**Telephony**
- 300 Hz to 3,400 Hz

**HD Voice**
- 50 Hz to 7,000 Hz

**HD Voice & Music**
- 50 Hz to 20,000 Hz

Mobile phones have codec’s built into the device to reproduce voice.
What is a Voice Codec (Coder-Decoder) ?

A codec converts an audio signal (your voice) into compressed digital form for transmission and then back into an uncompressed audio signal for replay.

- Technology is called Pulse Code Modulation (PCM) is a waveform codec
- “Brute Force” technique for digitizing analog voice

Convert analog signal (waveform) into 1’s and 0’s by sampling signal at set points in time
Most Current Codec’s Use Synthesis Techniques

“Loudness” or “Pitch”

“F” Sound

Convert analog signal into 1’s and 0’s by analyzing sounds, pitch, volume and performing sophisticated “look-up’s” in Codebooks (databases)
Current Mobile Phone Voice Codecs

- **Standard Voice (GSM & 3G)**
  - AMR-NB codec
    - 12 kbps
    - 3,400 Hz

- **HD Voice (VoLTE)**
  - AMR-WB Codec
    - 12 kbps
    - 7,000 Hz

- **Music over Skype or WhatsApp**
  - OPUS Codec
    - 8 kbps and 4,000 Hz
    - increasing to 64 kbps and 20,000 Hz

GSM, 3G and VoLTE use Quality of Service (QOS) technology to guarantee service levels.
Mean Opinion Scores (MOS)

<table>
<thead>
<tr>
<th>MOS</th>
<th>Quality</th>
<th>Impairment</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Excellent</td>
<td>Imperceptible</td>
</tr>
<tr>
<td>4</td>
<td>Good</td>
<td>Perceptible but not annoying</td>
</tr>
<tr>
<td>3</td>
<td>Fair</td>
<td>Slightly annoying</td>
</tr>
<tr>
<td>2</td>
<td>Poor</td>
<td>Annoying</td>
</tr>
<tr>
<td>1</td>
<td>Bad</td>
<td>Very annoying</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Codec</th>
<th>MOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCM or G.711 (64 kbps)</td>
<td>4.2</td>
</tr>
<tr>
<td>G.722 (64 kbps)</td>
<td>3.9</td>
</tr>
<tr>
<td>G.729 (8 kbps)</td>
<td>3.7</td>
</tr>
<tr>
<td>AMR NB (12.1 kbps)</td>
<td>3.6</td>
</tr>
<tr>
<td>AMR WB (12.6 kbps)</td>
<td>4.0</td>
</tr>
<tr>
<td>AAC - HE (16 kbps)</td>
<td>3.9</td>
</tr>
<tr>
<td>OPUS (16 kbps)</td>
<td>4.1</td>
</tr>
</tbody>
</table>
Circuit Switching Versus Packet Switching

**Circuit Switching**

Original message ➔ Routed across a fixed and dedicated network path ➔ Original message

"Mr. Watson, come here I need you"

**Packet Switching**

Original message ➔ Broken into packets ➔ Routed across changing network path ➔ Reassembled to form original message

"Mr. Watson, come here I need you"

GSM and 3G Voice are circuit switched technologies

VoLTE is a packet switched technology … needs IMS technology
Interoperability of GSM, 3G and VoLTE Voice Services

- Once operators LTE coverage matches 3G coverage then VoLTE is deployed … no longer a need to hand-down to 3G voice in LTE coverage
Re-farming of spectrum to LTE all voice and data will be on LTE
Resulting in substantial CAPEX and OPEX cost savings
VoLTE Subscriptions On The Rise

VoLTE subscriptions by region (billion)

VoLTE subscriptions are expected to reach 5.5 billion in 2023

- Latin America
- North America
- Asia Pacific
- Middle East and Africa
- Europe
VoLTE - Strong Market Uptake Expected

**Subscribers**
- Better user experience
  - HD voice, HD voice+ and video calling with simultaneous LTE surfing, faster call set-up times
  - Seamless voice handover between LTE and Wi-Fi
  - IP messaging, sharing of content (e.g. pics, maps) during calls and call establishment
  - Enabling new services like multi-device using one number and call transfer between smartphones, tablets, laptops, watches …

**Operators**
- Enables building new user services based on IMS/VoLTE platform
- Improved spectrum utilization:
  - Free up spectrum from 2G/3G to utilize for LTE
  - Migrate 2G/3G voice to VoLTE
  - Reduce bandwidth required for voice over LTE

**Implications**
- VoLTE launched in > 125 networks in over 60 countries
- More than 1300 VoLTE-enabled device models available
- VoLTE subscriptions grew 3X in 2017
- Forecast 5.5 billion VoLTE subscriptions by 2023
- VoLTE support in IoT Cat-M devices
  - IoT use cases it is valuable to make basic voice calls (VoLTE)
  - Alarm panel in an elevator or call a lost dog via its IoT enabled collar.

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Mobile Voice (VoLTE) Quality Approaches Landline

- U.S. VoLTE Mean Opinion Scores (MOS): 3.9
- Landline MOS Targets: 4.1
- VoLTE call setup time matches fixed voice (< 3 seconds)

Also, OTT Video Calling gains wide acceptance at decreasing speeds

Source: Signals Ahead, VoLTE Testing Report, T-Mobile USA, June 2016
VoLTE Feature Phone At $20

- 4G VOLTE Capable
- GSM (900/1800)
- LTE (Bands 3, 5, 40)
- Supports Android Applications (Android 6.0)
- Dual core 1.2Ghz
- Size: 121mm x 51mm x 15 mm
- 2.4” Screen (QVGA)
- VGA Camera
- 2000mAh Battery
- 4GB Memory
- No WiFi