Why Audio and Voice Offload Matters

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Agenda

• Why offload audio/voice processing to DSP is necessary
• Why choosing the right DSP is important
• What to consider when choosing an audio/voice DSP
• Why Tensilica HiFi DSP family is the best option for audio, voice offload
Audio and voice processing offload to a dedicated DSP is necessary

Getting the best performance/watt/area

- Apps processor host CPU isn’t power efficient for audio and voice
  - Apps processor is general purpose for control with signal processing assist
- Optimized audio/voice DSPs such as Tensilica® HiFi DSPs are 30X or more power efficient than the general purpose apps processor
- Offloaded audio playback increases playback time in battery-powered devices
- A dedicated DSP is necessary for glitch-free audio in real-time playback and record
  - System latency issues often cause delayed processing
Challenges

• Proliferation of audio and voice standards

• Increased demand for horsepower at same or lower power
  – Multichannel audio support moving to the smartphone
  – Object-based audio in home entertainment
  – Sophisticated voice processing such as beam forming
  – High quality, high fidelity becoming more important, including mobile market

• Faster time to market

Voice
- AMR Narrowband/Wideband
- GSM FR/EFR/HR
- ITU G.7xx
- EVS for LTE
- SILK, OPUS
- AEC / LEC
- Phrase Trigger
- Voice Recognition
- Speaker ID
- Noise Suppression

Mobile
- MP3, AAC, WMA
- Ogg Vorbis, FLAC
- Dolby Digital Plus
- DTS Headphone:X
- Qsound
- AM3D
- NXP S/W
- Waves

Home
- Dolby MS10/MS11/MS12
- Dolby Atmos
- DTS Master Audio
- DTS:X
- MPEG H
- Audyssey

Automotive
- HD Audio
- DAB/DAB+, DRM
- Audio Post-processing
- Voice Pre-processing
- Active Noise Cancellation
- Voice Activation
### Considerations when choosing an Audio/voice DSP

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power and energy efficiency</strong></td>
<td>• Longer battery life</td>
</tr>
<tr>
<td><strong>Ease of programming and full development environment</strong></td>
<td>• Faster time to market</td>
</tr>
<tr>
<td><strong>Scalability across algorithms and products</strong></td>
<td>• One architecture to learn</td>
</tr>
<tr>
<td><strong>Reliable, proven DSP architecture</strong></td>
<td>• Lower development risk</td>
</tr>
<tr>
<td><strong>Strong ecosystem for required third-party software</strong></td>
<td>• Off-the-shelf availability for critical applications</td>
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</table>
Tensilica HiFi DSPs
HiFi DSP for audio/voice

• #1 audio/voice DSP architecture for SoCs
  – >70 HiFi licensees across a wide range of products
  – >70 partners in the HiFi ecosystem
  – >150 production-proven audio and voice software packages

<table>
<thead>
<tr>
<th>Smartphones</th>
<th>Tablets and PCs</th>
<th>DVC/DSC</th>
<th>BD Players</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Smartphone" /></td>
<td><img src="image2.png" alt="Tablet" /></td>
<td><img src="image3.png" alt="DVC/DSC" /></td>
<td><img src="image4.png" alt="BD Player" /></td>
</tr>
<tr>
<td>DTV and STB</td>
<td>Terrestrial and Satellite Radios</td>
<td>Automotive</td>
<td>Gaming</td>
</tr>
<tr>
<td><img src="image5.png" alt="DTV" /></td>
<td><img src="image6.png" alt="Satellite Radio" /></td>
<td><img src="image7.png" alt="Automotive" /></td>
<td><img src="image8.png" alt="Gaming" /></td>
</tr>
</tbody>
</table>

• Tensilica® customers will be shipping >1 billion HiFi cores/year this year - 2015
HiFi key target applications

• Mobile – smartphones, tablets, Ultrabooks
  – Audio and voice
  – Always-on voice trigger, face trigger

• Wearables – smart watches, glasses
  – Always-on voice trigger, face trigger
  – Audio and voice
  – Sensor fusion
    – Indoor pedestrian location tracking - pedestrian dead reckoning
    – Biometrics

• Home entertainment – DTV, STB, gaming
  – Audio codecs such as Dolby, DTS
  – Audio post processing
  – Interactive audio and voice codecs for real-time gaming

• Automotive – digital radio, head unit infotainment
  – HD radio, DAB, DAB+, DRM, T-DMB, Sirius-XM
  – Audio codecs such as Dolby, DTS
  – Audio post processing, active noise control
HiFi audio applications

Sample of customers

Used by more than half of the Top 20 Tier 1 Semi and many System OEMs
HiFi ecosystem – announced partners
HiFi audio approach

All audio and voice codecs are written in C

- Ease of programming
- Simplifies maintenance of existing codecs and development of new codecs
- Minimizes time to port special audio algorithms or proprietary audio software

Control and DSP capabilities

- Optimized instruction set for DSP processing of audio and VoIP
- Built on a 32-bit RISC architecture for excellent control capabilities
- Advanced C/C++ compiler with vectorization – write everything in C

Processor optimization/configuration

- Complete flexibility to add/configure caches and local memories
- Add more I/O bandwidth than the system bus allows
- Add other instructions for handling proprietary algorithms
## HiFi portfolio summary

<table>
<thead>
<tr>
<th>HiFi Mini (Ultra low power)</th>
<th>HiFi 2 / EP (Mainstream)</th>
<th>HiFi 3 (Leading Energy Efficiency)</th>
<th>HiFi 4 (Ultimate High Performance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Lowest power for always-on functions</td>
<td>- Balance in area (power) / performance</td>
<td>- Most energy efficient/highest MMACs/mw</td>
<td>- Highest performance/highest MMACs/MHz</td>
</tr>
<tr>
<td>- Target applications: Voice trigger, Voice recognition, Sensor fusion, All “always-on” functions</td>
<td>- Most popular audio DSP architecture</td>
<td>- Target applications: Mobile devices, Home entertainment, Automotive</td>
<td>- Best 32-bit performance</td>
</tr>
<tr>
<td>- Smallest area</td>
<td></td>
<td>- Optimized for HD audio codecs and post-processing and voice codecs / pre-processing</td>
<td>- Target applications: Home/automotive, Complex multi-mic voice/speech noise reduction / pre-processing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Good fit for multi-DSP use cases</td>
</tr>
</tbody>
</table>

150+ software packages compatible across all HiFi cores
MP3 decoder example analysis

Example of a typical good-quality MP3 song (5 minutes of music)
- 44.1kHz, 128kbps, stereo

- HiFi Mini is perfect for low-power audio playback
- HiFi Mini takes less footprint (MHz and power) to decode MP3 streams than a small controller

<table>
<thead>
<tr>
<th></th>
<th>MCPS (MHz)</th>
<th>Core Power (uW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HiFi Mini</td>
<td>48.3%</td>
<td>57.1%</td>
</tr>
<tr>
<td>Small MCU</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

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Tiny MP3 power is great, but offload implementation also matters

**Android offloading requirements**

**True tunneling**

- Audio decode and post-processing totally offloaded to DSP
- DSP able to output directly to renderer
  - Maximizing the off time of the host processor
  - Minimizing the amount of data copied back to the host
- Easy-to-use driver for interprocessor communications compatible with Android
- Other approaches only use OMX layer or proprietary – not part of Android DSP SW
  - Broad library of DSP codecs
  - Broad library of post-processing
  - Audio framework to support mobile use cases

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**Diagram: CPU interrupts per second (smaller is better)**

<table>
<thead>
<tr>
<th></th>
<th>OMX</th>
<th>Android (HAT) 64Kb</th>
<th>Android (HAT) 512Kb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio decode</td>
<td>100</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Audio decode:</td>
<td>44.1kHz, 256kbps, stereo</td>
<td>CPU interrupts per second</td>
<td>(smaller is better)</td>
</tr>
</tbody>
</table>
HiFi Audio Tunneling (HAT) reference for Android

- HiFi kernel driver: reference for porting to a given platform or SoC
  - Sample board support package delivered as source
  - Firmware loading for the HiFi DSP on system start
  - Defines communications between host and HiFi
- Framework for HiFi DSP
  - Schedules audio tasks
  - Communication to HiFi kernel driver
  - Compatible with all relevant components: codecs, post-processing modules – not just basic AAC and MP3 decoders

“Android 4.4 adds platform support for audio tunneling … Tunneling can dramatically improve battery life for use-cases such as listening to music over a headset with the screen off. For example, with audio tunneling, Nexus 5 offers a total off-network audio playback time of up to 60 hours, an increase of over 50% over non-tunneled audio.”

Source: https://developer.android.com/about/versions/kitkat.html
Summary

Audio offload is necessary

- For the best performance, power, and area
- To meet the growing demand for audio and voice processing

Not all audio DSPs are equal

- Choosing the right DSP is critical to success

HiFi family of audio DSPs

- Have the most efficient in PPA
- Are easy to program
- Are easy to integrate
- Are supported by the most extensive ecosystem
- Have the most advanced and extensive software packages
- Are proven with billions of cores shipped to date