Explore how TI audio solution and technology is reshaping sound

Fredy Zhang

Next-generation vehicles for the road ahead

Connected Cars

ADAS & Autonomous Driving

Hybrid electric & electric

Premium Audio

OEMs are increasingly aiming to address:

Passenger safety features that meet evolving regulatory requirements

Immersive in-cabin entertainment systems with **premium audio**

OEMs can reimagine the in-cabin experience with TI's new chips

AM275x-Q1 MCUs and AM62D-Q1 processors

Deliver **premium audio** using highly-integrated SoCs with a next-generation **C7x DSP core**, enabling greater than four times the processing performance of competing devices.

TAS6754-Q1 Class-D audio amplifier

Deliver class-leading audio performance and power consumption with half the number of inductors compared to existing Class-D amplifiers with TI's **1L modulation technology**.

TI 音频 SoC 革新汽车音频系统设计
TI's Audio SoCs revolutionizing Automotive Audio design

Immersive 3D sound
Dolby DCX

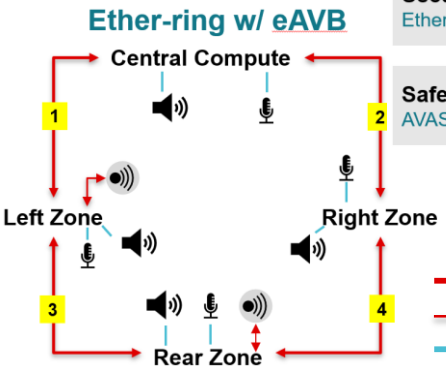
Quieter Cabins
Road Noise Cancellation

Boost listening experience
32 plus speakers tuning

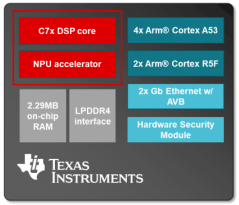
Personalized Sound
Engine Sound Synthesis, Chime

Secured high quality Audio
Ethernet AVB, Security

Safer roads
AVAS / Pedestrian alert



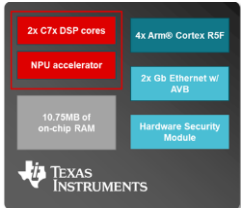
极具性价比的系统：单芯片解决方案满足您的系统需求
Affordable system: Single-chip solution for all your need



AM62D
MPU + DSP +MCU
DDR based

Unified Software

AM275
MCU + DSP
DDR less



快速量产：产品级的软件、丰富的第三方生态系统
Faster TTM: Production ready software, rich third-party eco-system

Free RTOS, SMP, drivers

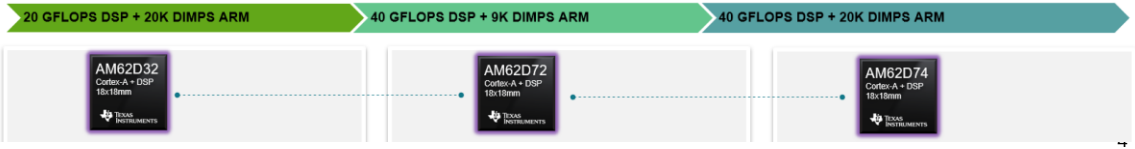
*Audio Weaver
Product of DSP Concept

AUTOSAR

Ethernet AVB

DSP programing

面向未来：单一平台可扩展内存和性能满足高中低配的需求
Future-proof : Scalable memory and performance with one platform



Texas Instruments

Why TI SoCs for automotive premium audio processing

Industry leading audio processing

Vector based DSP core	• C7x achieves 4-8x more processing compared to scalar-based architecture
On-chip NPU	• C7x with MMA forms NPU, and process both traditional and AI based audio algorithms.
Optional Arm cores	• Industry-standard Cortex®-A53 and Cortex®-R5F cores for readily deployable software

Advanced memory solution

Single-cycle access L2 mem	• Up to 4.5MB
DDR-less design	• Up to 10MB+ on-chip SRAM, with expandable OSPI, HyperRAM options
DDR-based design	• LPDDR4-32b, and OSPI option

Comprehensive SoC integration

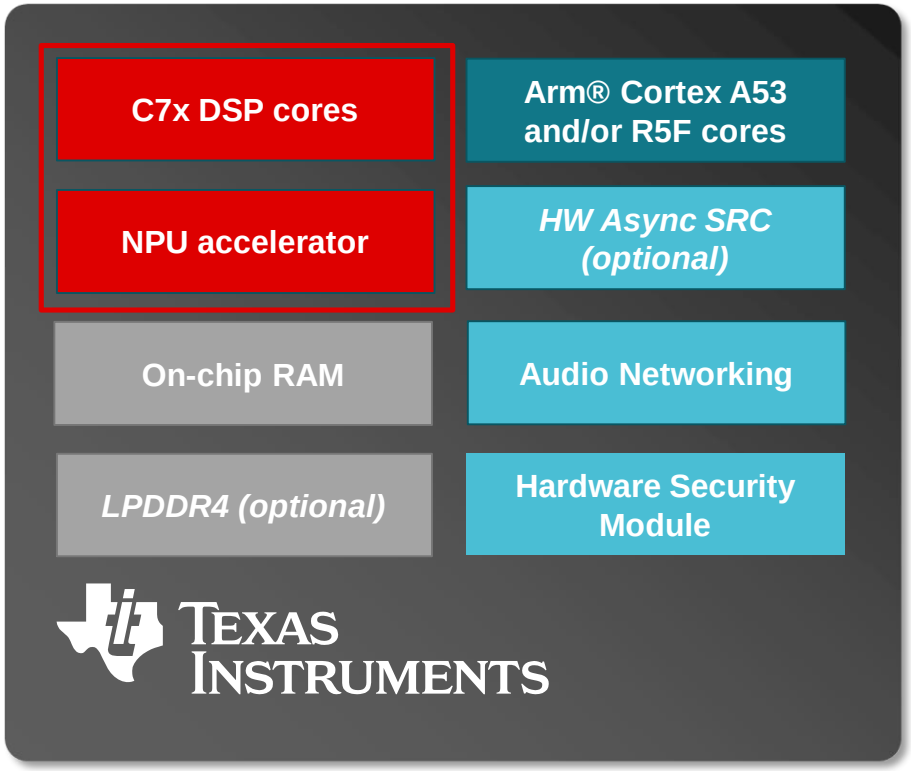
Audio Networking	• HW enabled PTP and AVTP/AVB stack with 2p-eth switch
Security	• HSM fulfilling SHE/EVITA highest level requirements, secure storage, crypto HWA and more
Safety MCU	• ASIL-B complaint target. Process AUTOSAR/safety OS or AVAS

AM275x-Q1 and AM62D-Q1: Achieve industry-leading processing performance for automotive audio systems

The AM275x-Q1 MCU and AM62D-Q1 processor both integrate TI's next-generation **C7x DSP** core for audio applications.

- Achieves **four to eight times** more processing performance than competing devices
  - Run at 1GHz, providing **40 GFLOPS** per core
  - Each core is capable of managing multiple audio features simultaneously
- Features of the C7x DSP include:
  - 256-bit vector architecture
  - Single-cycle accessible L2 memory
  - Integrated NPU to enable AI algorithms

Enable immersive automotive audio with highly-integrated, scalable devices



The AM275x-Q1 MCUs and AM62D-Q1 processors **integrate:**

- Up to two vector-based C7x DSP cores
- Multiple Arm® cores
- On-chip memory with external memory options
- Audio networking with Ethernet AVB
- Neural processing unit for AI enablement
- Hardware security module
- Functional safety-capable

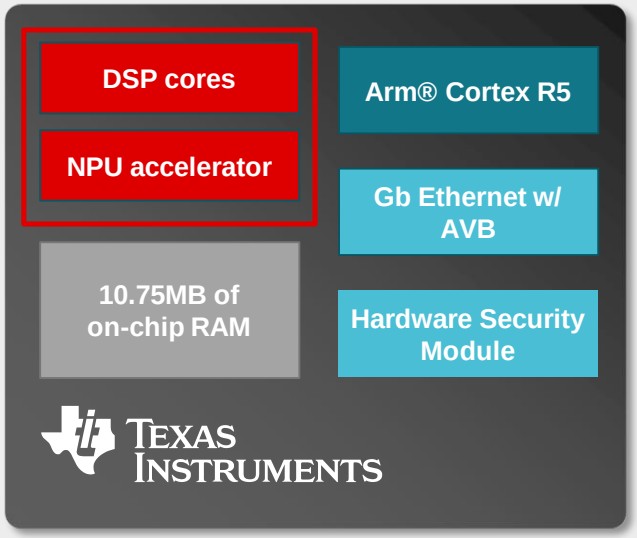
Helps OEMs deliver **premium features** including:

- Spatial and localized audio
- Latency-reduced active noise cancellation
- Real-time audio tuning
- AVAS, ESS and other passenger safety sounds

Two different architectures for a range of use cases

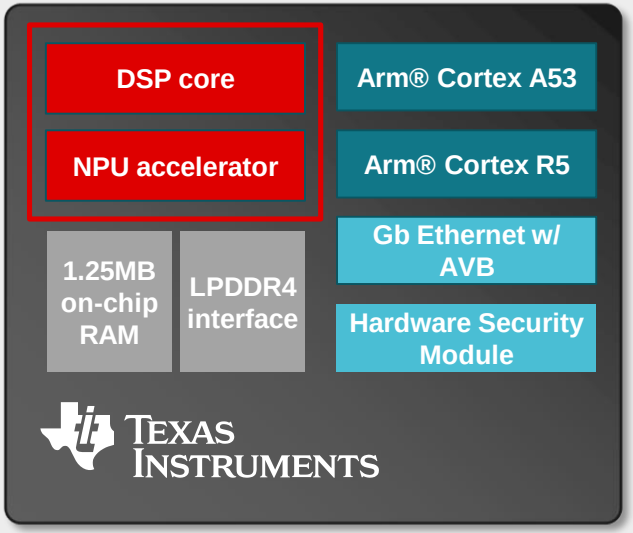
AM275x-Q1 MCU

Single-chip DSP solution for premium audio with **DDR-less** microcontroller



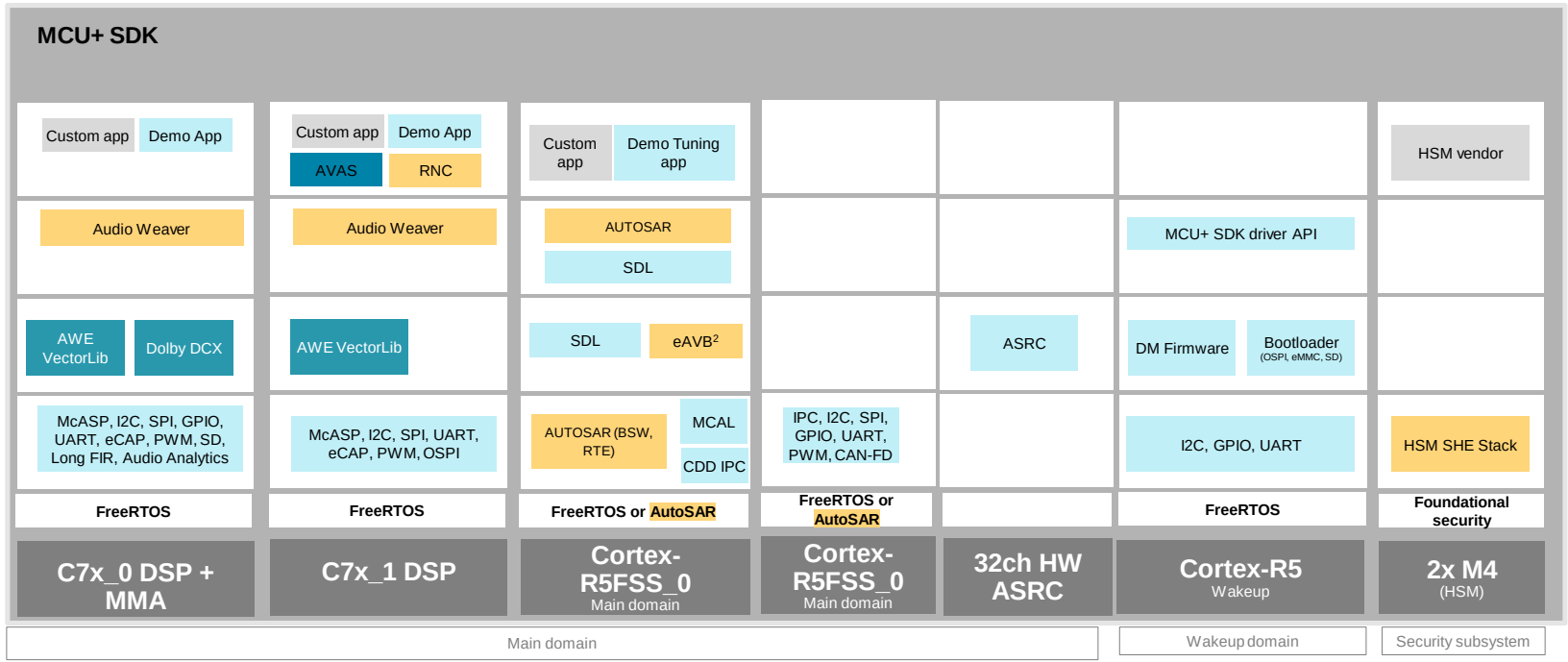
AM62D-Q1 processor

Single-chip DSP solution for premium audio with **DDR-based** processor



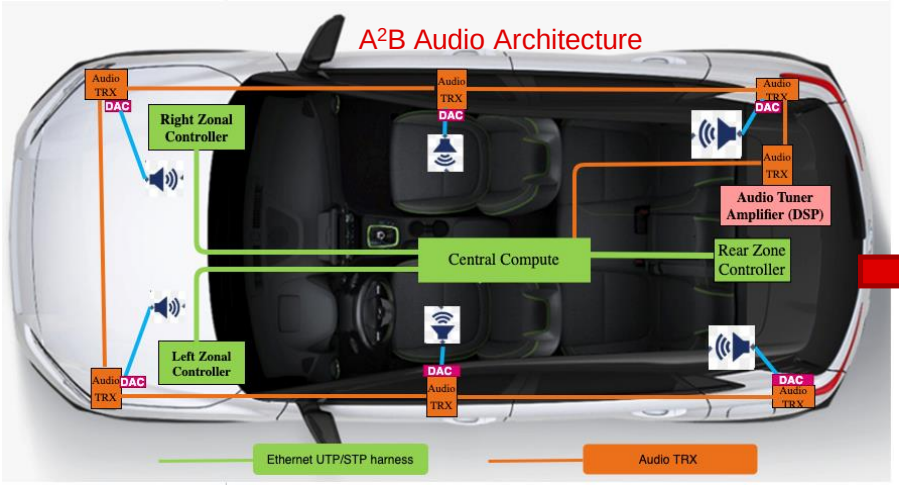
Two architectures, Single software investment

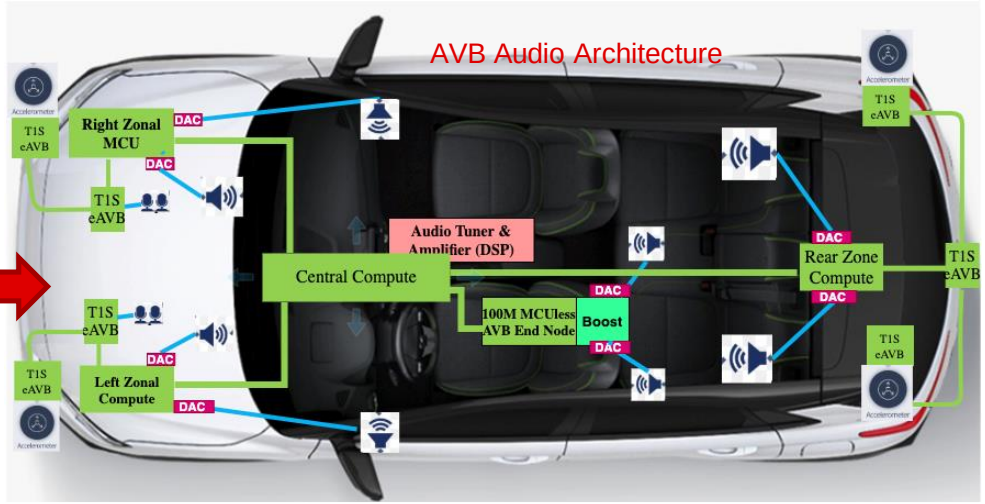
AM275 Audio SDK Software stack | FreeRTOS based



[1] Eval version packaged w/ SDK

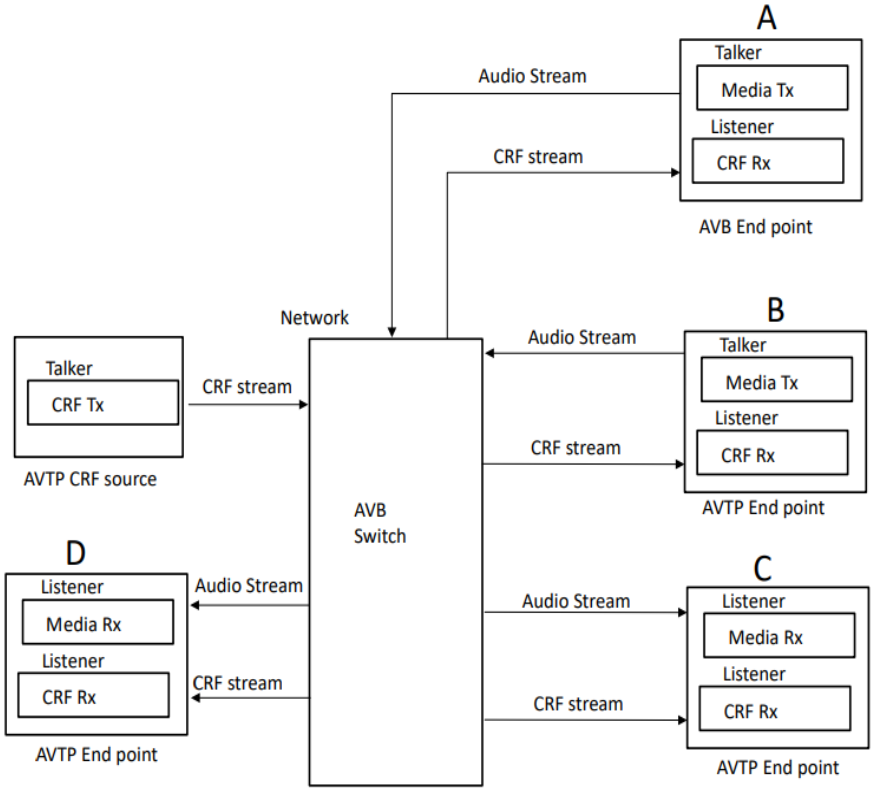
Audio over Ethernet





	A²B	Audio over Ethernet	Benefits
Audio bus	*Need dedicated harness & A²B ICs*	*re-use zonal ethernet backbone*	*Cost savings from A²B ICs & dedicated harness (>$4)*
Network Architecture	*Dedicated network & Need conversion to I2S at IVI/CC)*	*Seamless routing on high-speed Ethernet Zonal backbone*	*Homogenous Ethernet based networking solution*
Open standards based	*Proprietary*	*IEEE, Interoperable solution*	*De-risk supply/cost constraint*
Audio Clock synchronization	*Proprietary & not synced w/ rest of n/w*	*IEEE 802.1AS based*	*Synchronized to rest of the Car network for seamless transport*
Network Security	*Unsecured*	*Secure network using MACsec*	*Cybersecurity compliance*

Audio over Ethernet



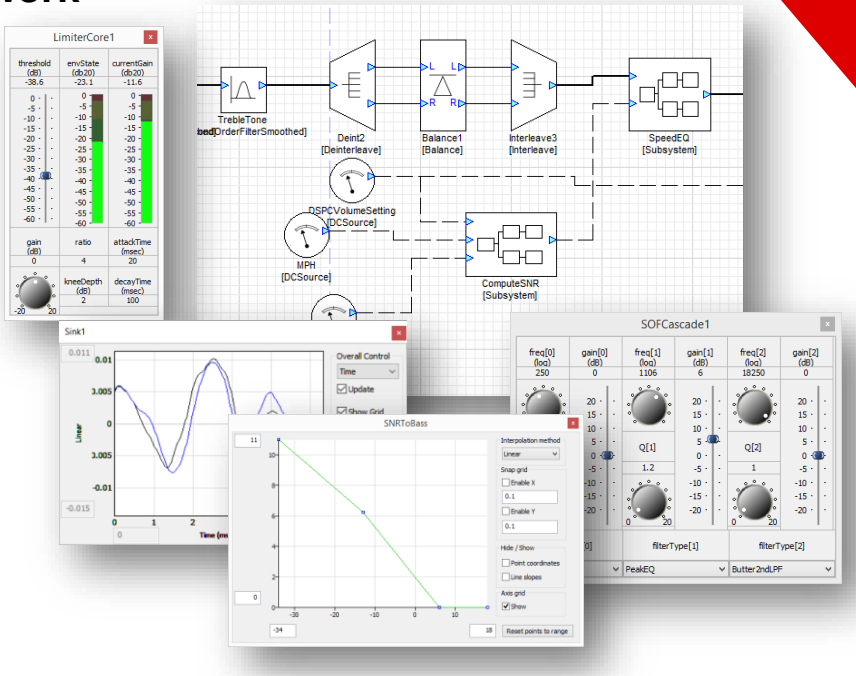
- **CRF Talker,** samples the clock (reference clock) and generates a stream of timestamps to transmit over the network.
- **CRF Listener** receives the generated timestamps and recovers the media/codec clocks from these timestamps.
- **Audio talker** (Source) is an AVB end station that is the source or producer of a stream.
- **Audio listener** (listener) is an AVB end station that is the destination or consumer of a stream
- **Bridge** is a network device that is utilized for AVB streams switching.

Audio Weaver benefits

Hardware agnostic, low-code tooling audio framework

BENEFITS

- All key automotive use cases enabled
  - Entertainment, telephony, voice assistant, AVAS, Chimes, and RNC
- Full driver support including low latency paths
- Highly efficient code for ARM and DSP cores
- Multicore Enablement
  - Easily access multi heterogenous cores from a single cockpit
- Customizable block diagrams showing full system functionality
- Unlimited design flexibility
- Easy access to 3rd party IP
- Precisely profile target CPU resources (MHz and memory)
- Run on Windows PC for early development
- Optional tuning tools



FULL FEATURED

Hierarchy, IP protection, subsystem inspectors, multi-rate, multi-threading, multi-core, automation API, regression testing, custom module API, control signals, batch processing, latency tracker, debug modules, and more…

Audio Weaver: The Framework

Invent, design, tune, debug, profile: all **in Real-Time**

From a Black Box to the ToolBox

Full Transparency for the Audio Designs

AWE Designer

Windows-based graphical design environment

- ✓ Standard Edition: Design GUI
- ✓ Pro Edition: Works with MathWorks® MATLAB® platform

AWE Core

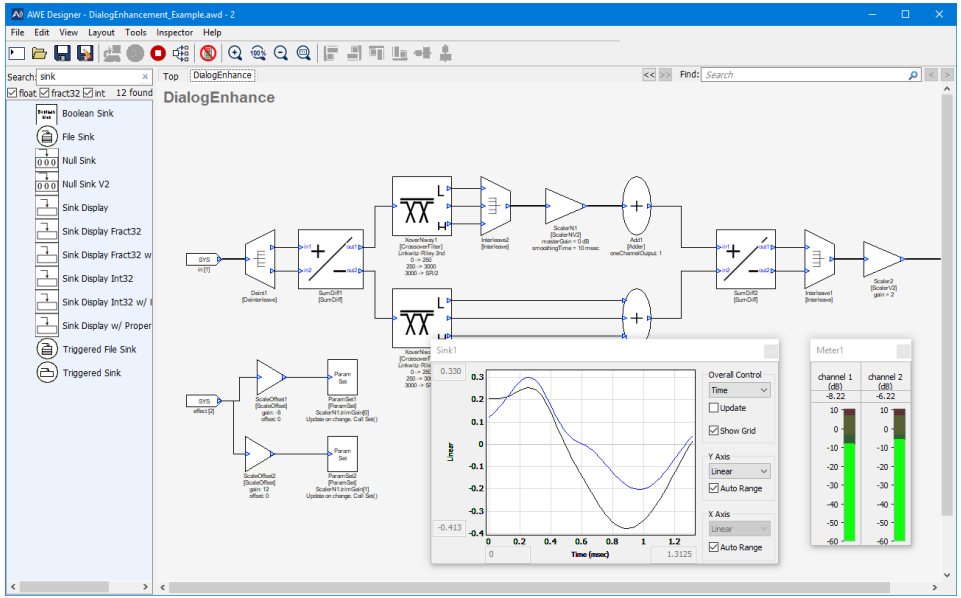
The embedded processing engine

- ✓ Optimized target-specific libraries
- ✓ Available for multiple processors
- ✓ Supports multicore and multi-instance implementation

Audio IP Modules

Building blocks from low-level primitives to complete designs

- ✓ From DSP Concepts and our third-party partners



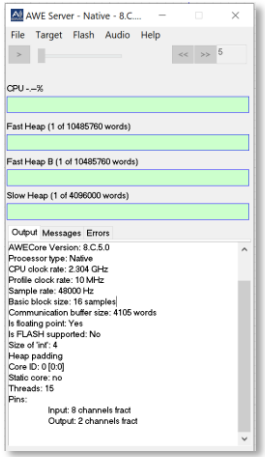
Audio Weaver: How It Works

Without generating code, **AWE Designer** sends an audio processing recipe to the **AWE Core** that tells the embedded target which modules to use, how to connect the modules, and which parameter settings to use.

AWE Designer

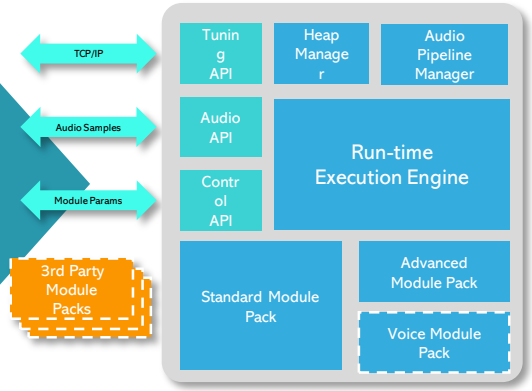
.AWS Script

AWE Server



.AWB Binary

AWE Core



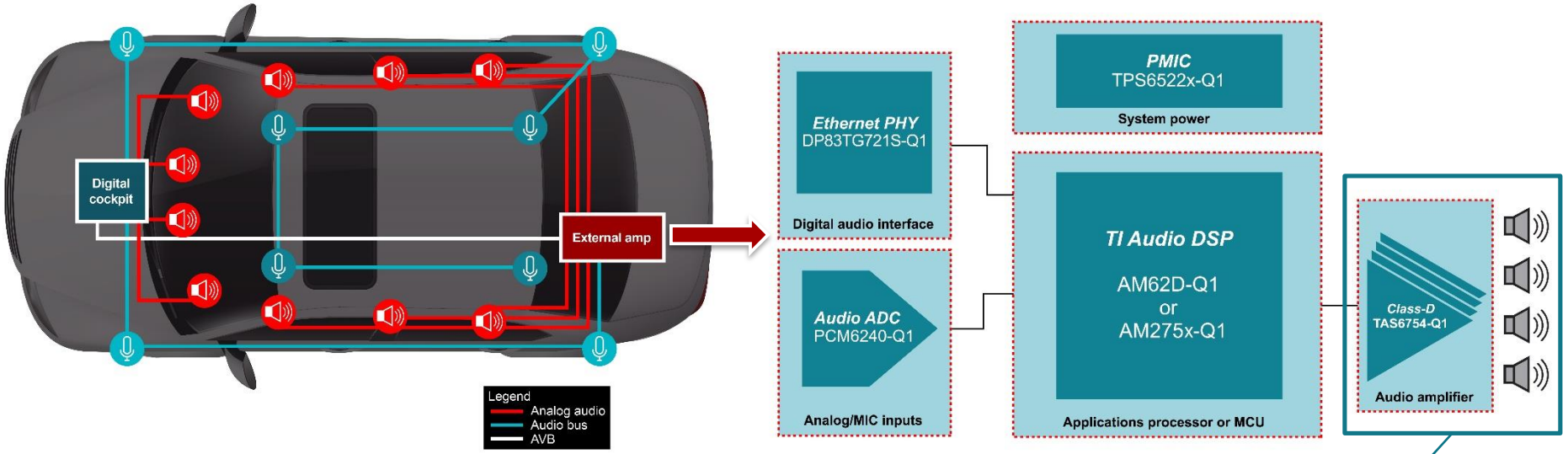
Processing chains built in the **AWE Designer** windows-based graphical design environment using the 550+ Audio Weaver modules are stored as an **.AWD layout** file

AWE Designer outputs an **.AWS Script** file to the **AWE Server** that includes text-based commands to run the **.AWD layout**. **AWE Server** sends the **.AWB binary** to the embedded **AWE Core**.

AWE Core is the audio engine and processing library that is embedded into a product. **AWE Core** runs the libraries and modules selected in the **AWE Designer layout**.

TI analog and embedded processing for a premium automotive audio system

With the AM275x-Q1 and AM62D-Q1 EVMs, engineers can develop their system with the processors and complementary analog and power components:



New TAS6754-Q1 audio amplifier

- Industry's first to achieve Class-D performance with half the number of inductors per channel using TI's innovative 1L modulation technology.

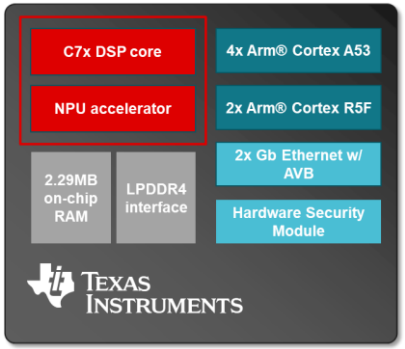
Single-chip premium audio processing demo on AM62D

Showcases premium automotive audio using the highly-integrated, high-performance **AM62D-Q1:** DDR-based processor featuring TI's C7x vector DSP core with on-chip NPU.

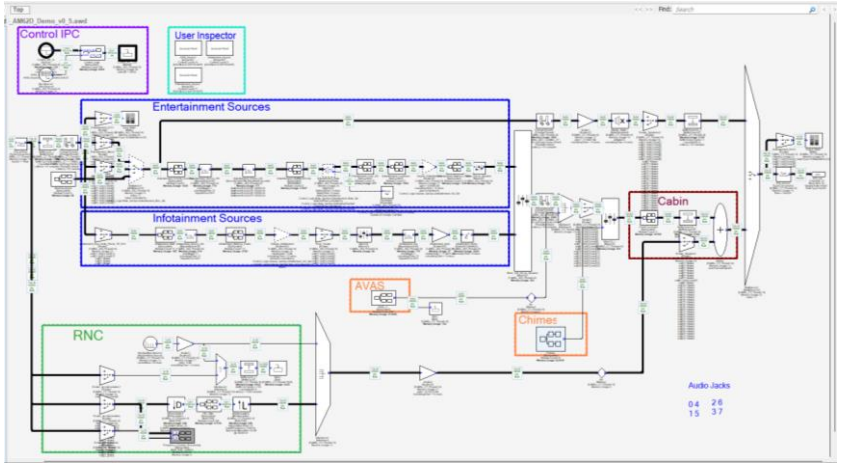
Demo processing utilization

- **65% C7x DSP utilization** with following audio processing –
  - RNC stub on 16 samples
  - 32-ch audio tuning
  - AVAS, chimes
  - Send/receive AVB packets from R5F
- **20% 1x A53 utilization:** Processing entertainment and infotainment source selection
- **Cortex-R5F:** AVB and Ethernet tuning

AM62D-Q1



32-ch Audio tuning, RNC, AVAS, Chime and AVB



Audio Weaver Layout

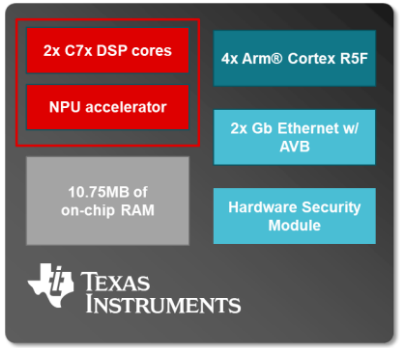
Premium Audio Processing on AM275

Showcases premium automotive audio using the highly-integrated, high-performance **AM275-Q1**: DDR-less MCU featuring TI's C7x vector DSP core with on-chip NPU, accompanied by TI's newest Class-D audio amplifier, **TAS6754-Q1**.

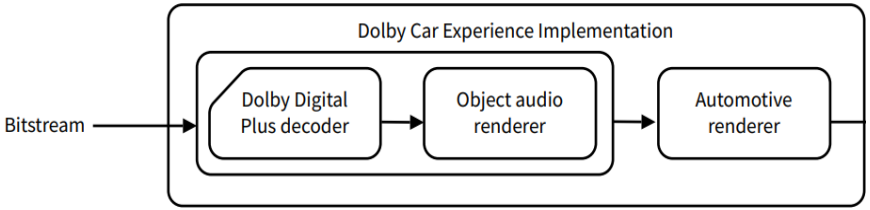
Demo processing utilization

- **8% C7x DSP utilization :** showcasing 7.1.4 Dolby DCX decoding and rendering
- **Class-D audio amplifier's 1L modulation technology:** cuts total number of inductors needed on board by 50%

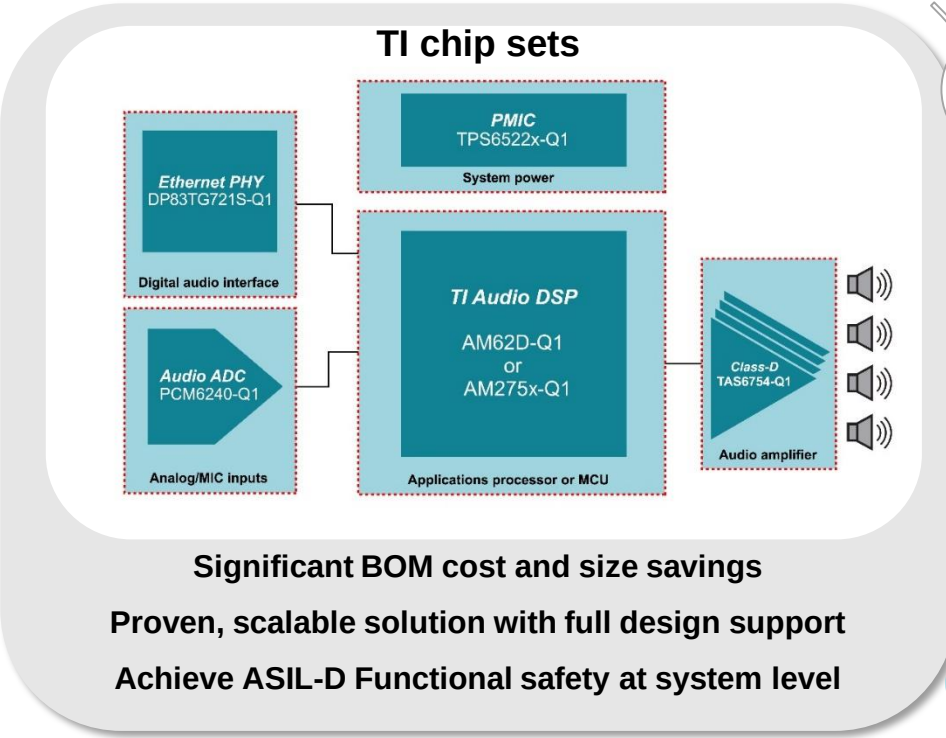
AM275-Q1



7.1.4 Dolby DCX decoding and rendering



Complete the design with more TI components



Optimized system cost & size (Class D AMP TAS6754-Q1 & DAC / ADC TAS5312-Q1 PCM6240-Q1)

TAS6754-Q1 - Industry's first to achieve Class-D performance with half the number of inductors per channel

Audio Networking (DP83TG721-Q1 ETH PHY)

Proven power solution (PMIC TPS6522x-Q1)

Full design support

Start reimagining in-cabin experiences today

AM2754-Q1

- Preproduction quantities: ti.com/AM2754-Q1
- Evaluation module: AUDIO-AM275-EVM

AM62D-Q1

- Preproduction quantities: ti.com/AM62D-Q1
- Evaluation module: AUDIO-AM62D-EVM

Company blog, “Reimagining the in-vehicle experience with innovative audio processing technology.”

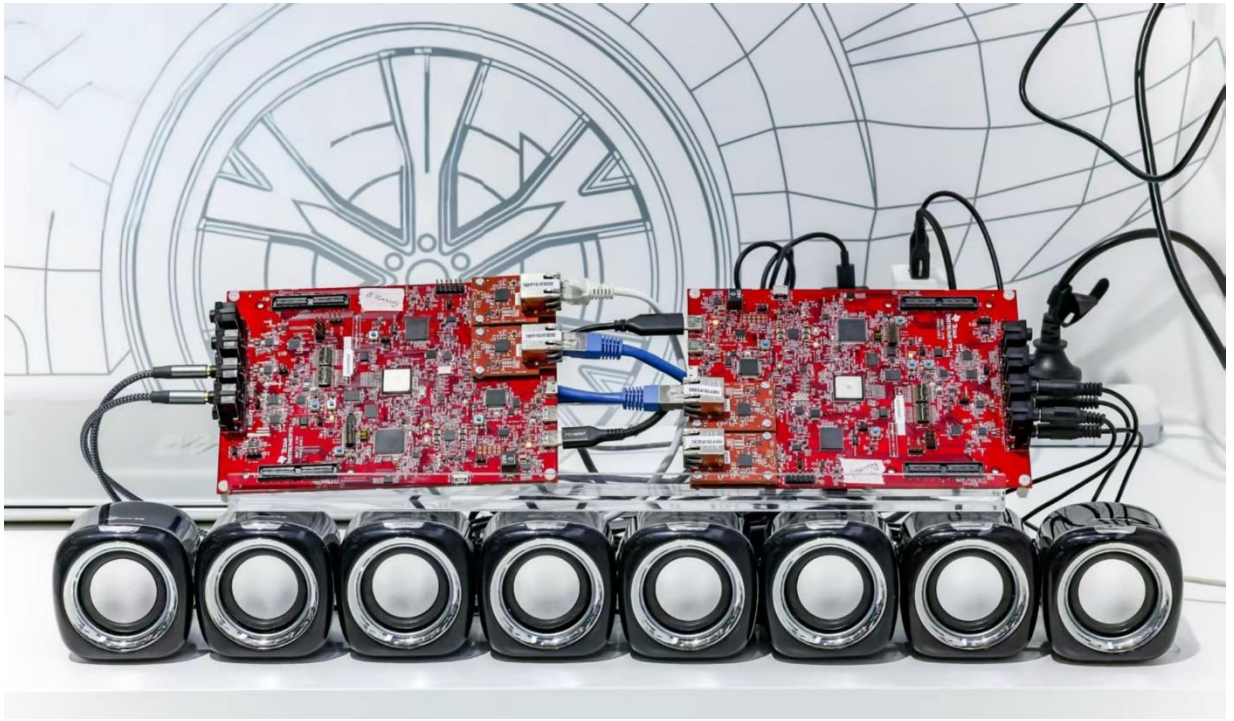
Technical article, “Designing high-performance premium automotive audio systems with highly integrated processors.”

TAS6754-Q1

- Preproduction quantities: ti.com/TAS6754-Q1
- Evaluation module: TAS6754Q1EVM

Technical article, “Shrinking automotive audio system designs with Class-D amplifier 1L modulation.”

Questions?



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