Device virtualization for connected vehicles
Fact sheet

The automotive industry moved from having standalone systems for various functions such as Infotainment, Telematics, Instrument cluster, Diagnostics and more to more integrated systems handling multiple functions. Due to the demand for more vehicle features, OEMs have integrated multiple Electronic Control Units (ECUs). This has resulted in an explosion of ECUs in their vehicles.

Powered by Type-I ASIL B Certified hypervisor, and automotive features virtualization capabilities (camera, audio, multimedia, graphic, network), HARMAN Device Virtualization solution recommends the best way to collocate various environments on the same hardware. This reduces costs and testing/integration efforts while improving performance and guaranteeing security and safety. HARMAN's Device Virtualization capabilities enable multiple operating systems to run on a single hardware platform, securely and with full isolation. HARMAN supports diverse hardware and software platforms and enables RAM and persistent storage to be portioned and allocated per virtual machine-specific performance requirements. It fully virtualizes all hardware resources including CPU, memory, networking, interface and peripheral devices.

Key highlights of the solution
- Type-I, bare-metal hypervisor
- ASIL B certified and ISO 26262 ASPICE Level 1 certified
- Guest OS-agnostic, i.e., can run any type of operating system (not tied to any proprietary RTOS)
- Hosts several guest OSes on the same CPU (single or multi-core)
- Small footprint, highly-efficient code designed for minimum overhead
- State-of-the-art freedom of interferences mechanisms
- Advanced safety and security mechanisms
- Feature virtualization services are proposed to provide a complete virtualized automotive architecture

Top-line Benefits
- Running in hundreds of millions of devices globally
- Reduced network and software complexity
- Reduced maintenance and integration costs
- Cost savings on shared hardware resources

HARMAN ExP
Making Time in the Car, Time Well spent
Mobility is more than getting from one place to another. It’s about shifting from one state of being to the next. HARMAN ExP doesn’t just move people from one place to another, it delivers in-vehicle experiences that put people first, so time in the car, becomes time well spent.

HARMAN ExP bundles advanced technologies to deliver meaningful consumer experiences, enables OEMs to unlock new market opportunities, and empowers HARMAN to create value today while positioning our customers to thrive tomorrow.

HARMAN ExP maximizes customers’ time and quality of life in four key consumer benefits:

Accomplishment, Well-being, Social Connection, and Enjoyment
## Features and benefits

### Multiple hardware and Operating Systems (OS) support
- Supports hardware of ARM V8 32 and 64 bits, Intel x86/x64 (VT) platforms
- Operating Systems (OSs) are not modified and fully native

### State-of-the-art technology enabling freedom of interferences mechanisms
- Head unit can run both performant and real time OSs on a single board while being fully separate from each other
- Memory isolation using second stage Memory Management Unit (MMU)
- Device isolation using System Memory Management Unit and VM life-cycle control
- Temporal isolation based on priority-based, real-time guest OS scheduler

### Peripheral Device management

#### Device sharing and pinning
- Allows sharing of all hardware resources (networks, graphic, multimedia, audio, cameras and more) across automotive applications with highly performant communication system
- Can dedicate some specific HW devices access to specific virtual machines and ensure exclusivity

#### Device emulation
- Provides device emulation system so that Guest OSs are using their native driver Input/Output and memory accesses are trapped by the hypervisor
- Emulation of the native device is performed at register level. The Hypervisor manages and arbitrates access to the hardware devices

### Critical safety
The safety critical Guest OSs continue working in native mode, while collocated with non-safety critical ones so that a crash of non-safety critical Guest OSes does not impact the safety of the critical ones

### VCPU scheduling and real time warranty
Pinning virtual CPUs to dedicated physical CPUs and assigning is to a Real Time Guest OS ensures real time performance

### Advanced security mechanisms
- Secured boot and inter-VM communication channels through use of bridge components. Multi-VM boot leverages the chain of trust established from the OEM bootloader to the system image
- Controlled access to TrustZone Execution Environment and IPsec / VPN networking
- Policies all normal-to-secure world transition requests via SMC

### Graphics virtualization
- Rich, flexible FW enabling complex display configurations, including PIP
- Support GPU HW assisted virtualization when available

### Multimedia
- Near native performance – HD video encoding and decoding at 60+ FPS
- Camera virtual driver allows to preview and record information
- The virtual audio front-end driver exports Advanced Linux Sound Architecture (ALSA) devices to the client applications

### Networks
Can be used for sharing various communication systems by providing adapted virtual drivers (Ethernet, IP, Can Bus, 3G/4G)

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**HARMAN**

More than 50 million automobiles on the road today are equipped with HARMAN audio and connected car systems. Our software services power billions of mobile devices and systems that are connected, integrated and secure across all platforms, from work and home to car and mobile. HARMAN’s latest innovations leverage Samsung’s connected lifestyle and hardware expertise, allowing automakers to create an ecosystem of unique, smart, enhanced and rich in-vehicle experiences. Together HARMAN and Samsung are architects of experience, designing the most intuitive and immersive interactions with in-vehicle technology. HARMAN is a wholly-owned subsidiary of Samsung Electronics Co., Ltd.

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