

Towards Intelligent Automobile Cockpit via A New Container Architecture

(Operational Systems Track)



CELLS

塞奥思

Lin Jiang

Xi'an Yunzhiji Technology, China

Feiyu Zhang

Xi'an Yunzhiji Technology, China

Jiang Ming

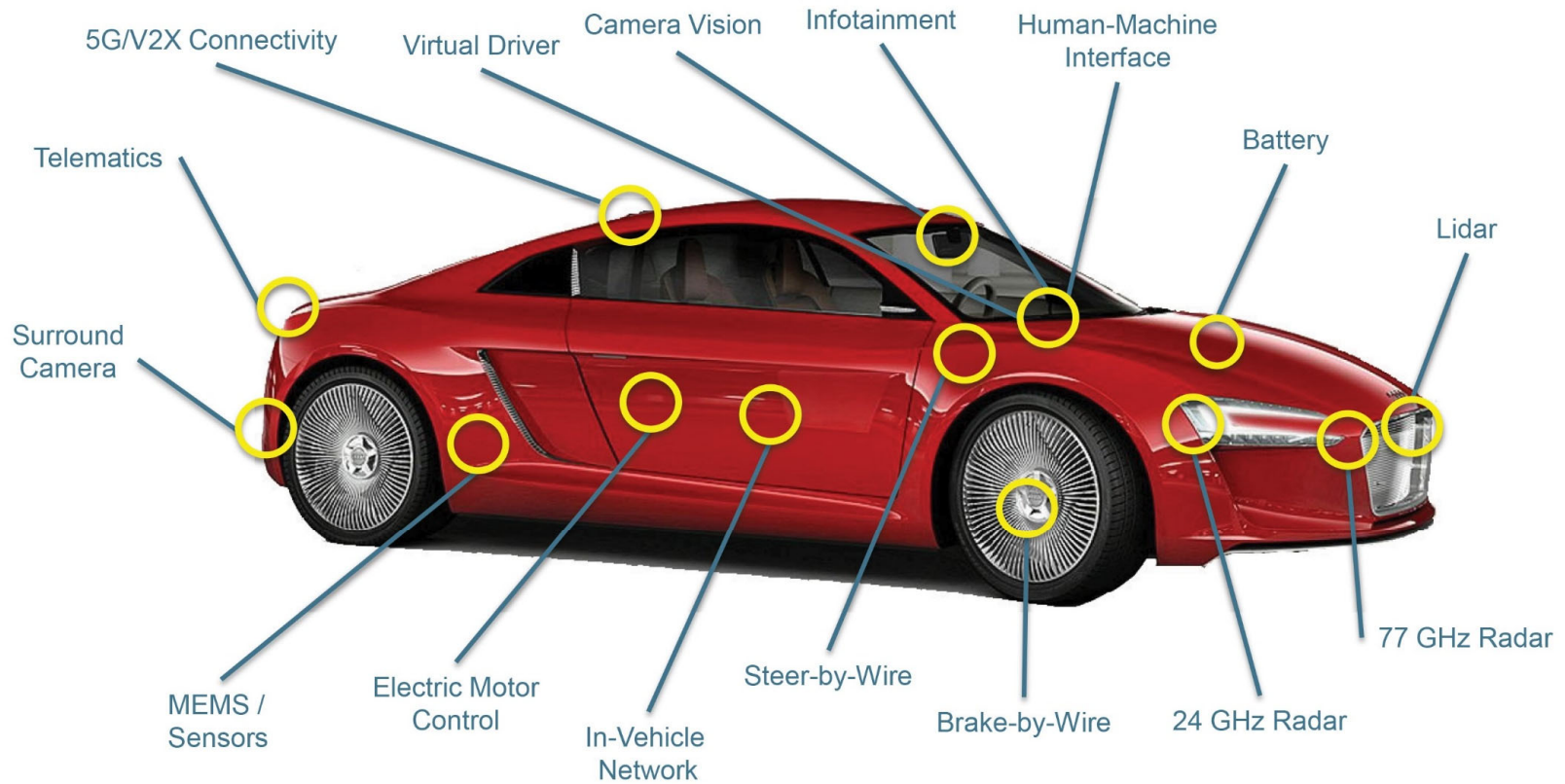
Tulane University, USA



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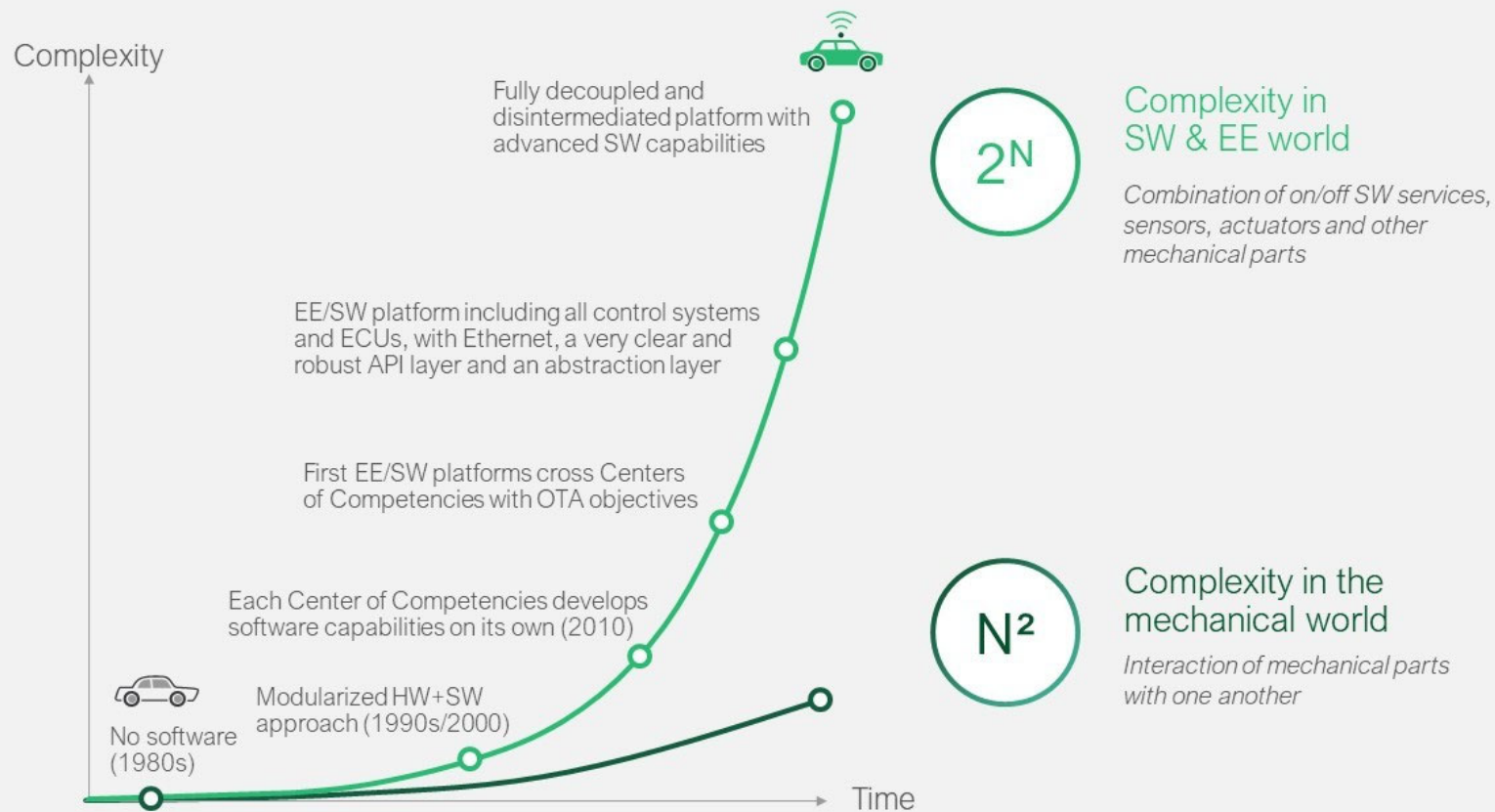
Automotive Electrical and Electronic (E/E) Systems

- A vast array of sensors, actuators, and ECUs

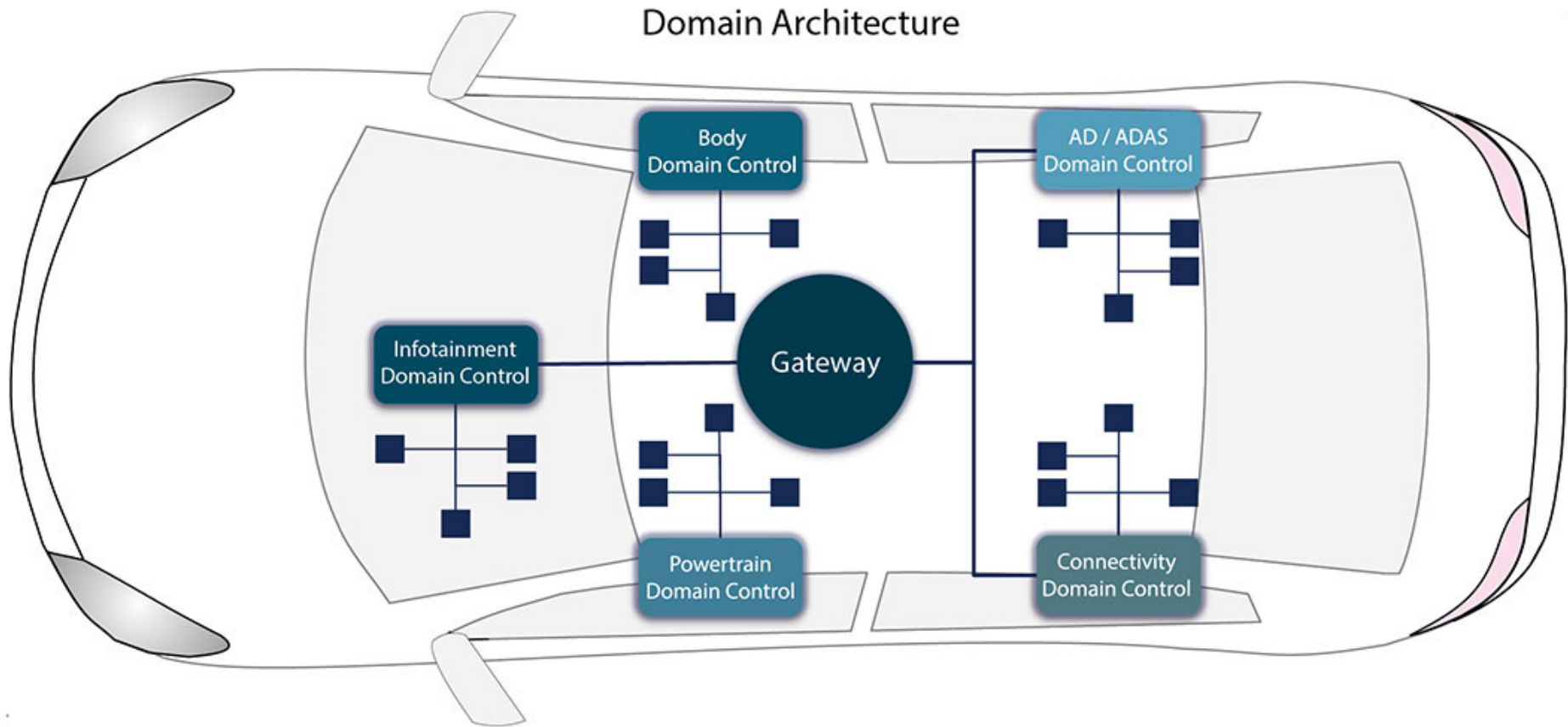


2 E/E Architecture Evolution: Increasingly Bulky

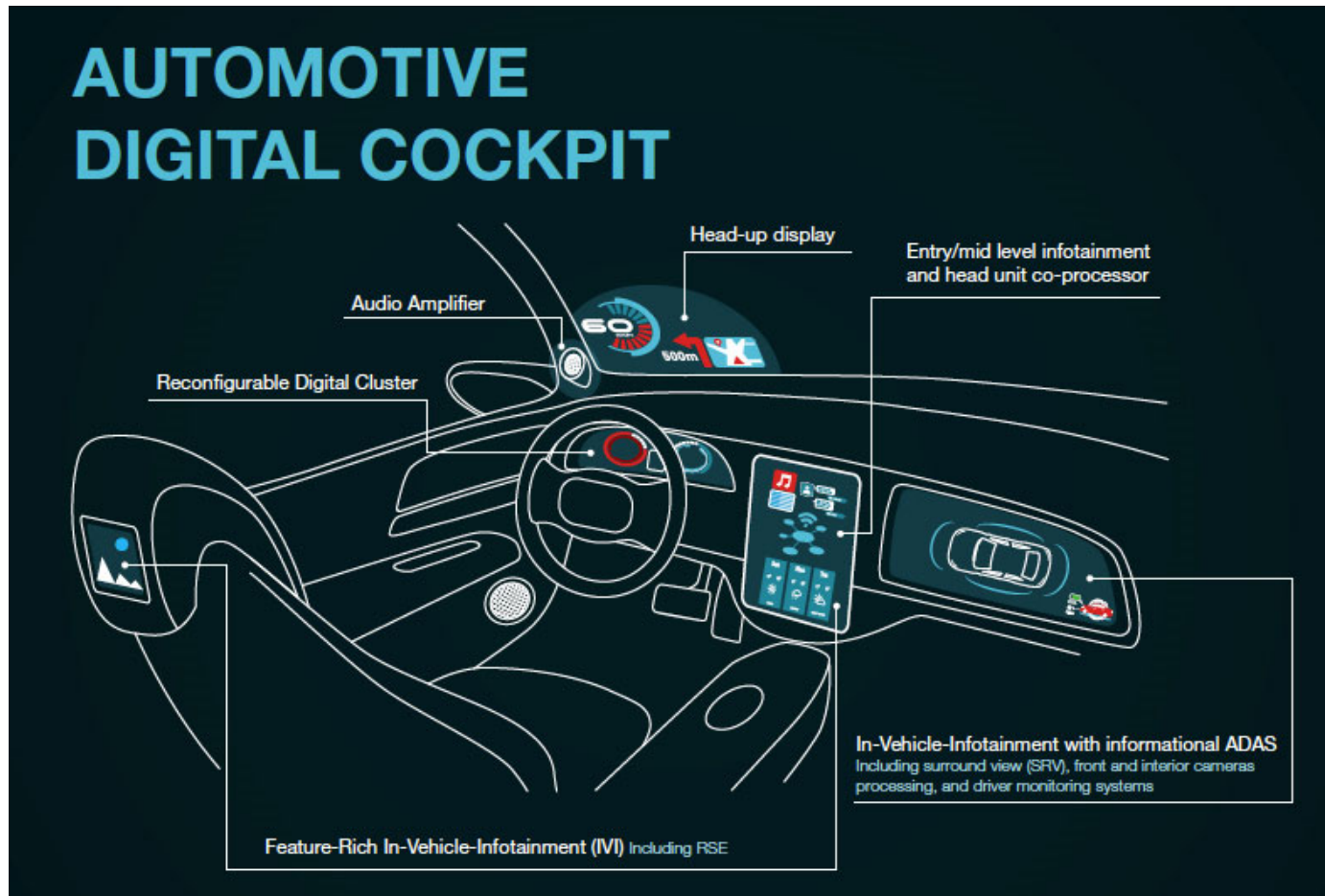
EXHIBIT 1 | Facing exponential complexity in modern car engineering



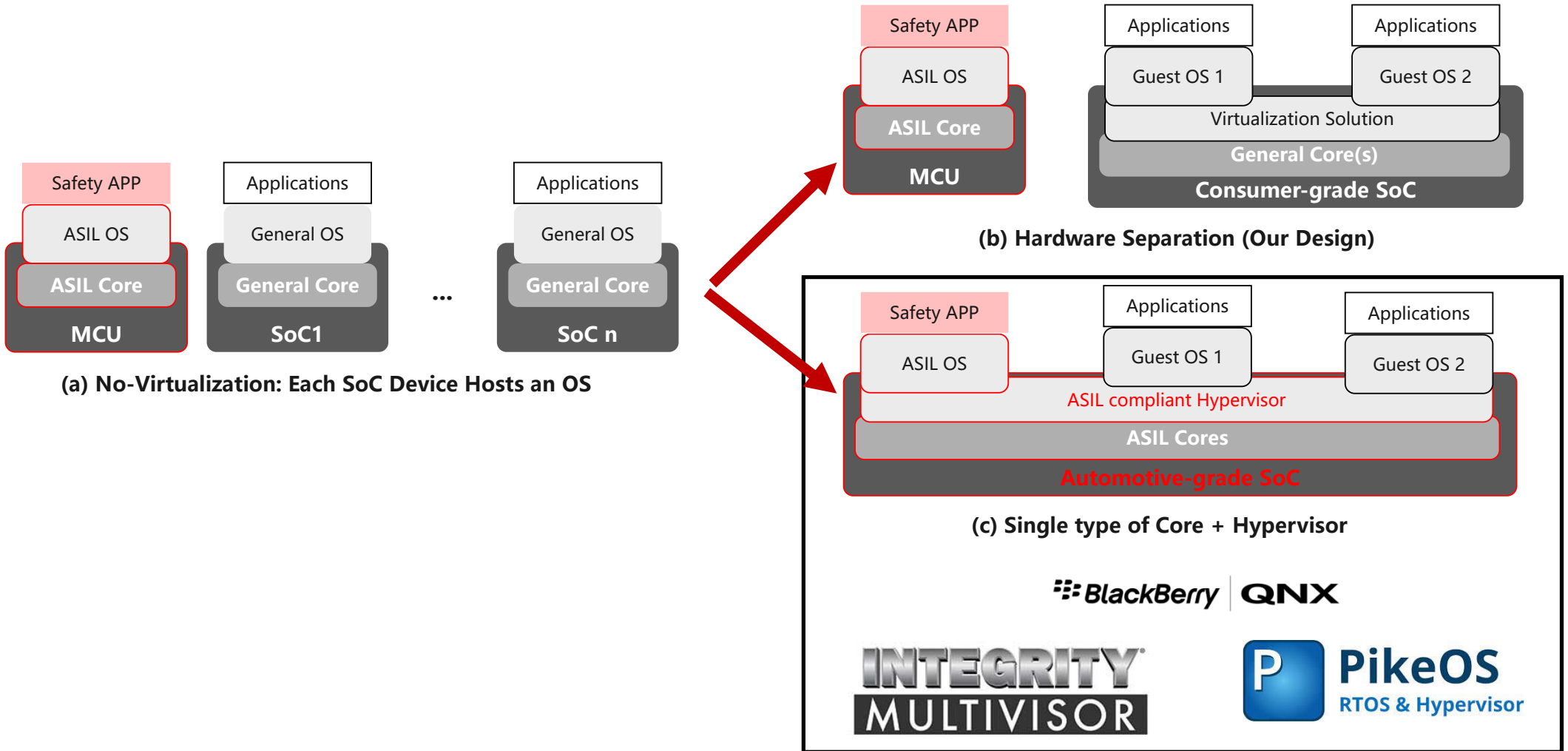
3 Various Functional Domains



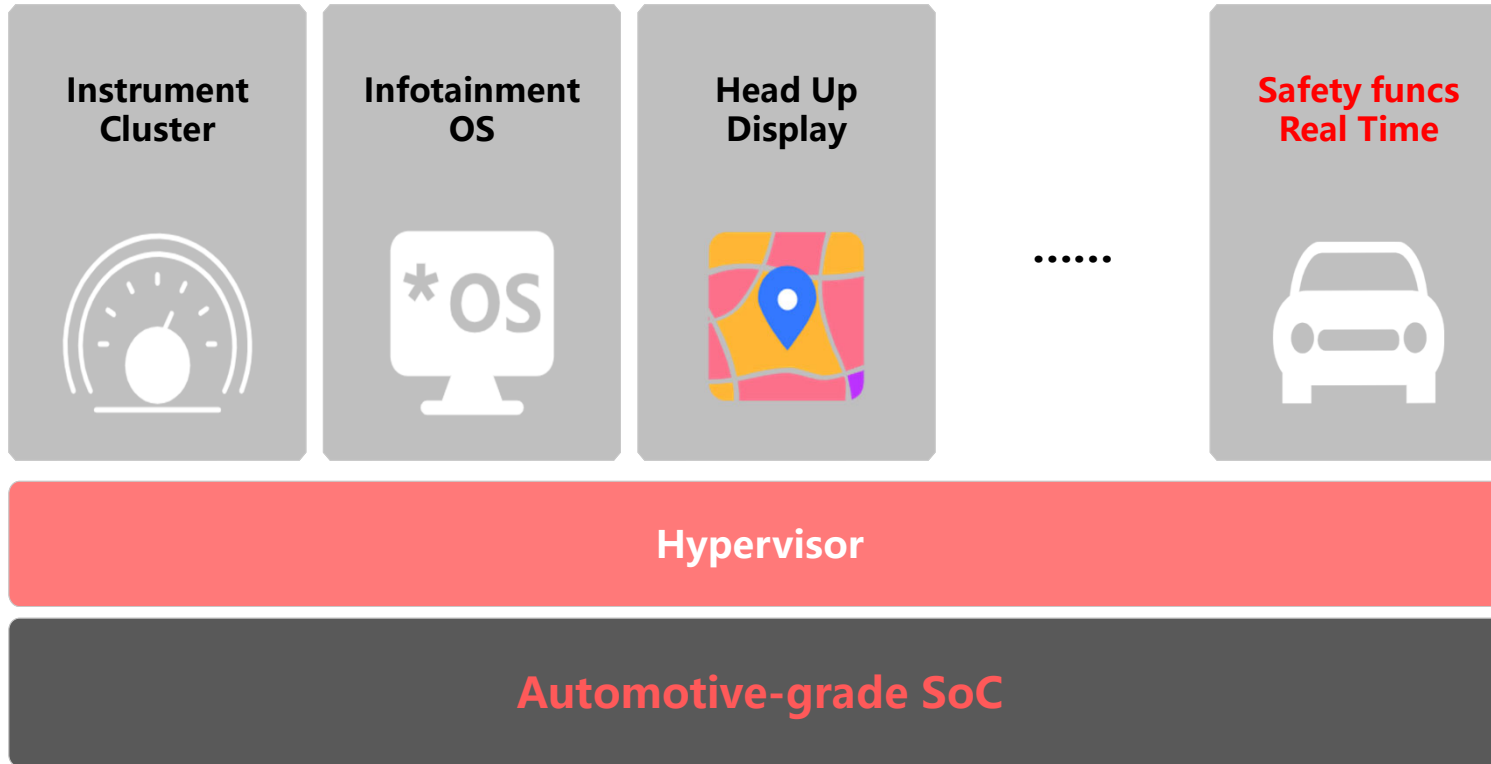
4 Cockpit/Infotainment Domain



5 In-Car Virtualization on System-on-Chip (SoC) Devices



6 Limitations of Microkernel Architecture



- **Safety:** enable performance monitoring, fault detection and restart guest operating system and applications.
- **Configurability:** provision system resources, including memory and devices.
- **Hardware virtualization:** use hardware virtualization acceleration, when available.
- **Multicore guests:** run multiple guest operating systems(Android, Linux, etc.) on multiple cores with overlapping configurations to take advantage of Hypervisor's priority-based automatic load balancing.

However, it has two characteristics:

1. It has requirements for hardware chips, such as **virtualization** and functional **safety**.
2. Most of them are **commercial solutions**, such as QNX Hypervisor, INTEGRITY Multivisor, and PikeOS Hypervisor.

7 Automotive Chip Crisis

Chips	Production Cost	Unit Price (\$)	Supply Chain Shortages?
Automotive-grade SoC	High	300~500	Yes
Consumer-grade SoC	Low	70~150	No
Automotive-grade MCU	Minimum	5~10	No

Automotive Chip-Shortage Cost Estimate Surges to \$110 Billion

- Global automakers seen losing output of 3.9 million vehicles
- AlixPartners raises cost projection from previous \$61 billion



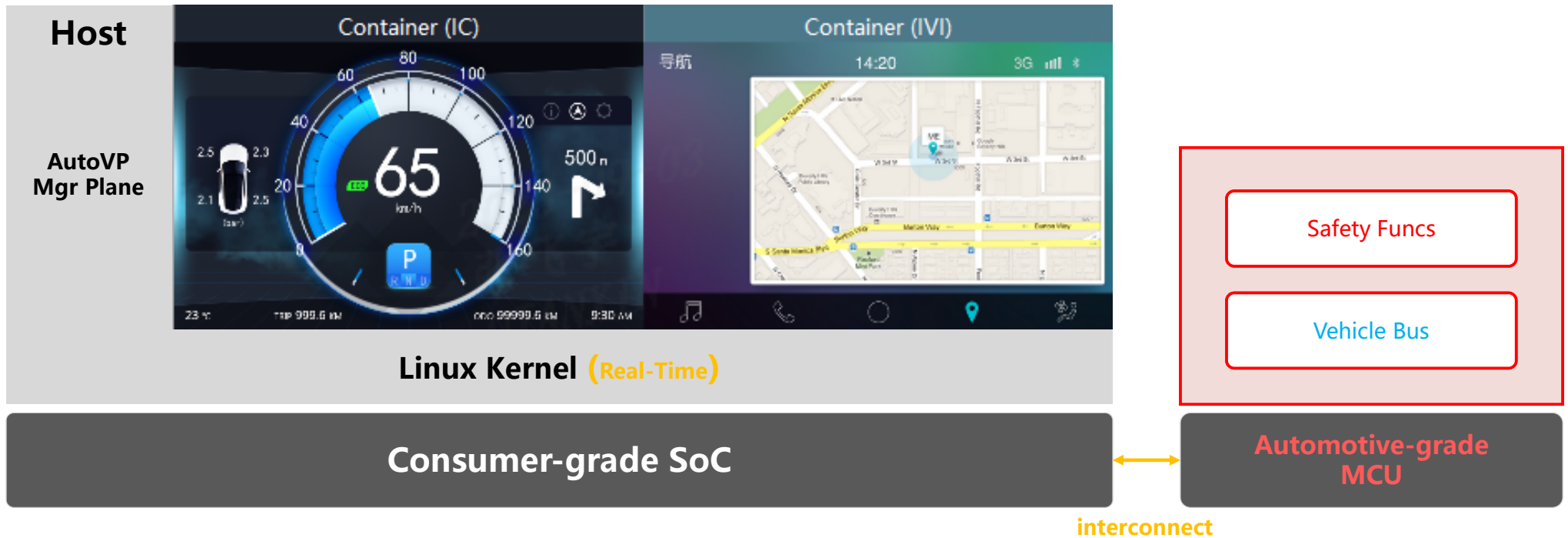
How does Semiconductor Shortage Affect the Automotive Industry?

By Pritisha Priyadarshini / February 14, 2024

How does Semiconductor Shortage Affect the Automotive Industry?

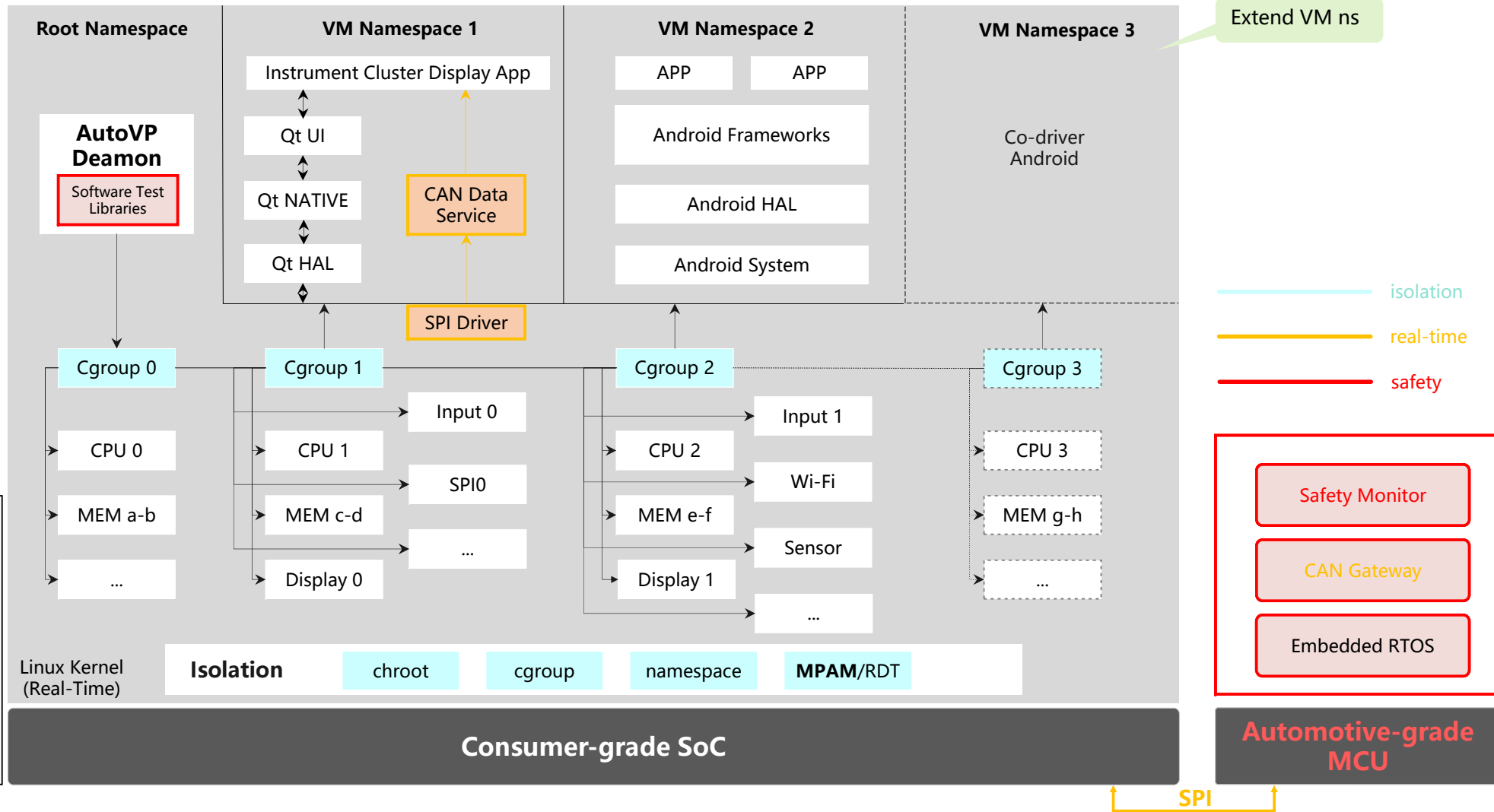


8 AutoVP Overview: Mixed-Criticality Decoupled Design



- **Cost-effective hardware solution**
- **Scalable cockpit deployment**
- **Comply with automotive functional safety requirements (ISO 26262)**

9 In-Vehicle Container Implementation



10 Device Virtualization Methods

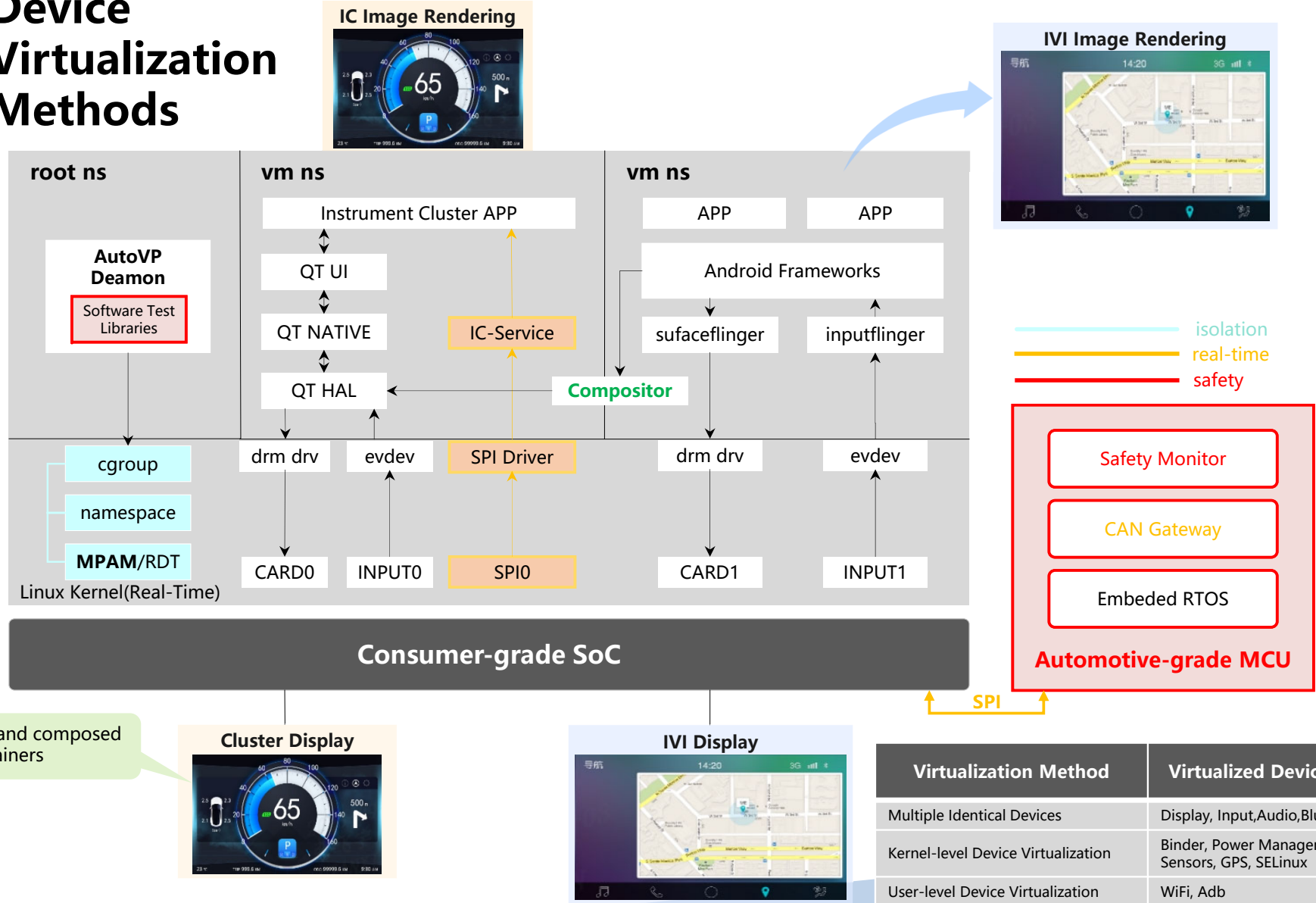
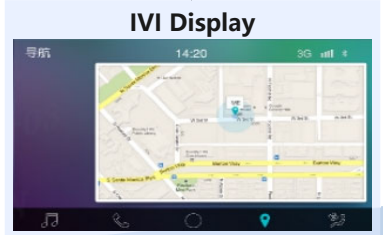
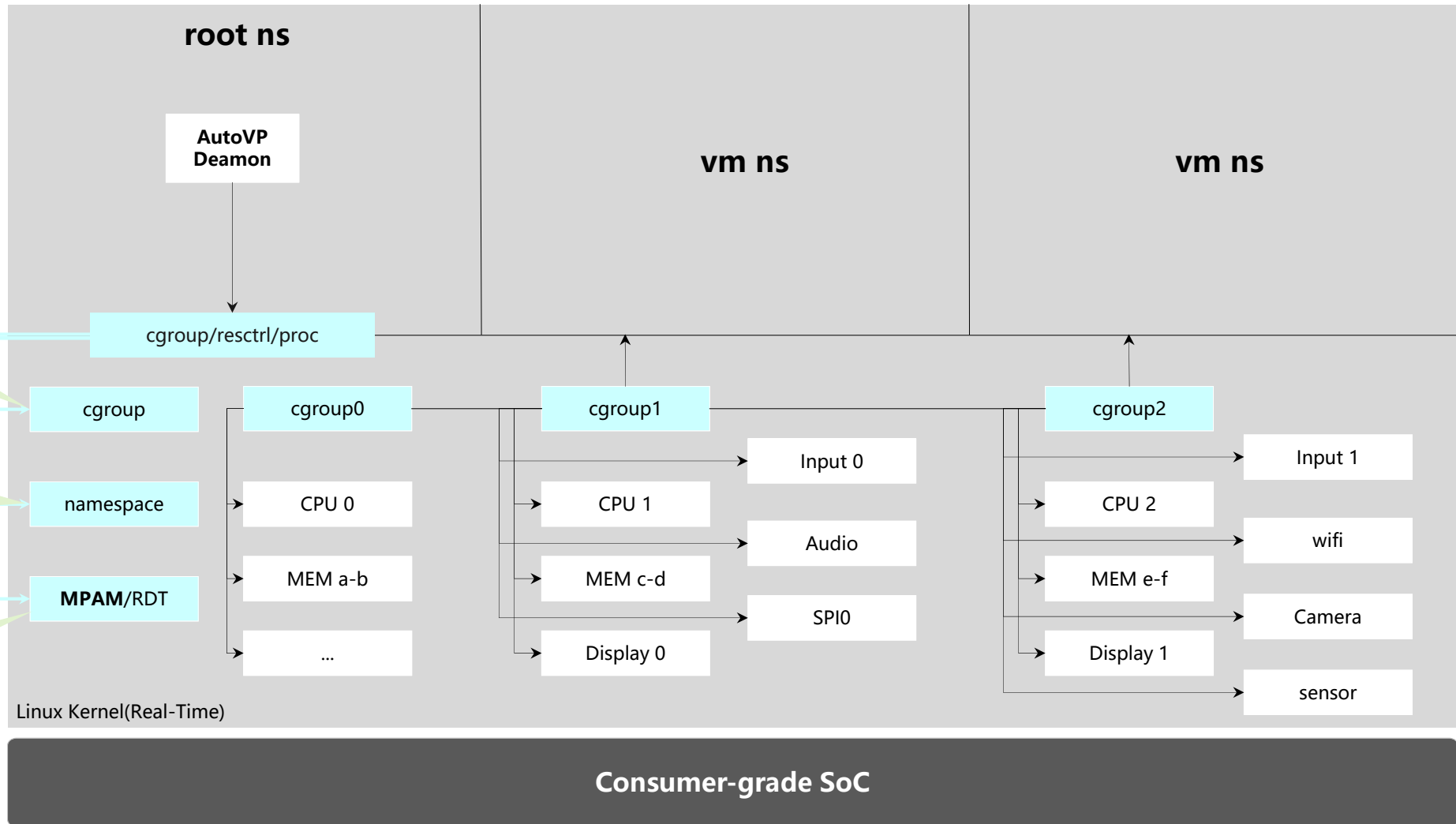


Image rendered and composed by multiple containers

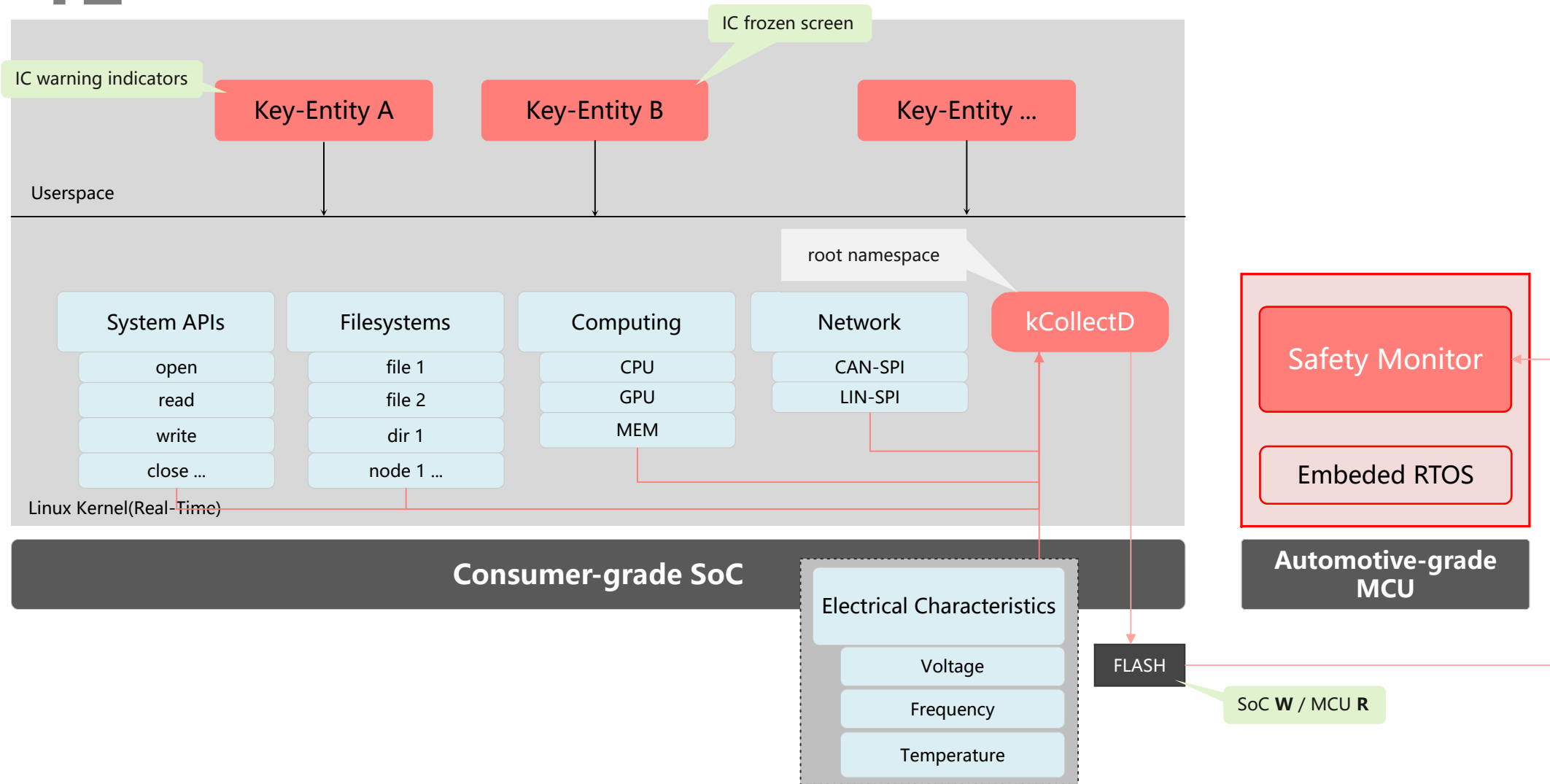


Virtualization Method	Virtualized Devices and Services
Multiple Identical Devices	Display, Input, Audio, Bluetooth
Kernel-level Device Virtualization	Binder, Power Management, Network Sensors, GPS, SELinux
User-level Device Virtualization	WiFi, Adb

11 Resources Isolation

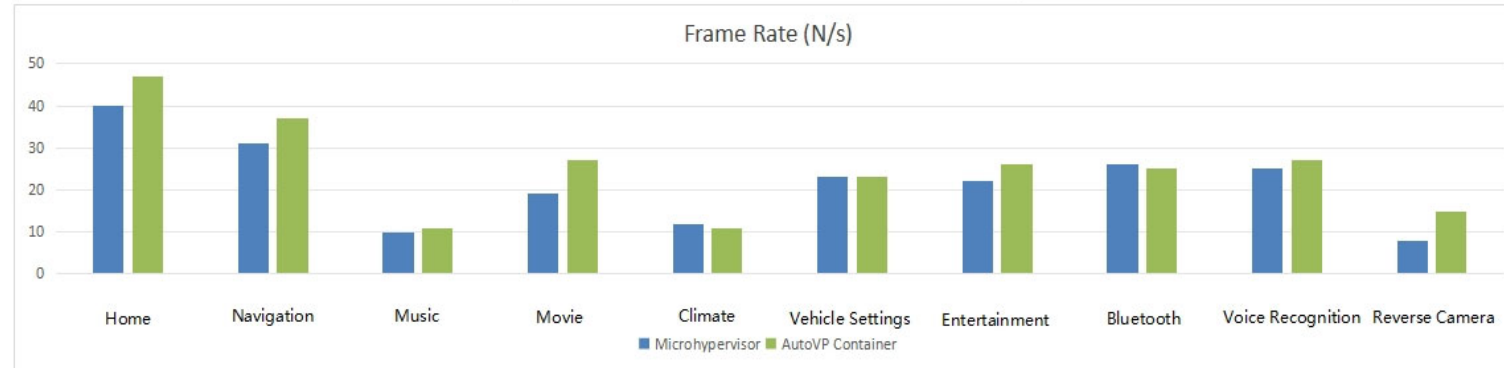
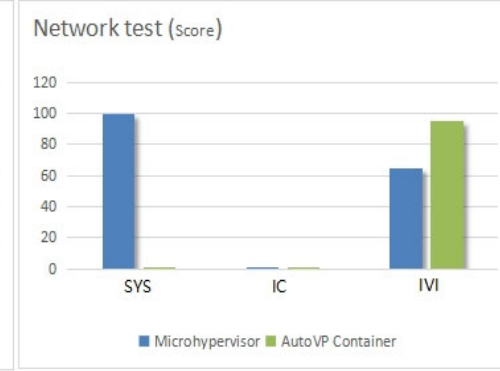
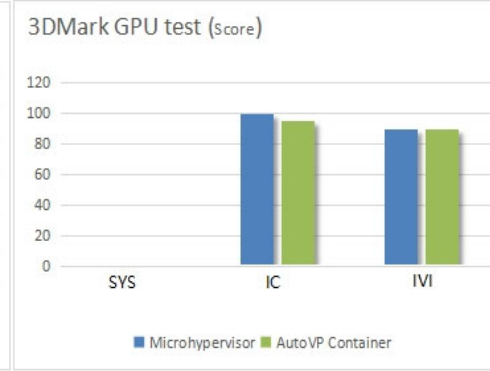
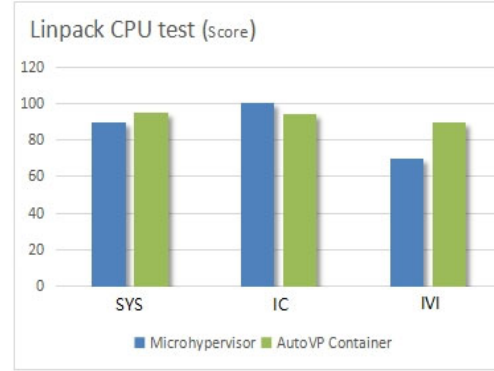
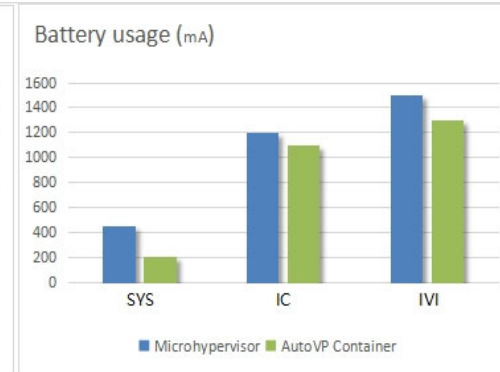
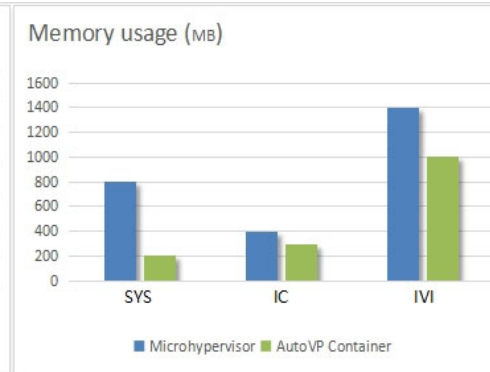
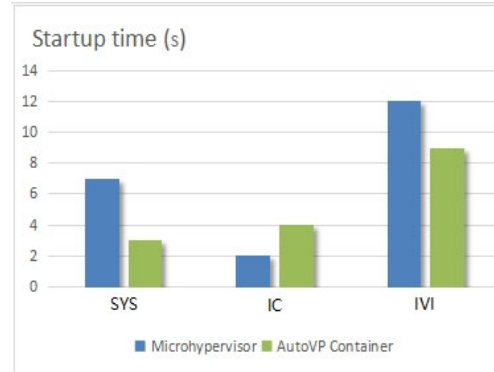


12 Safety Monitor



13 Experiment

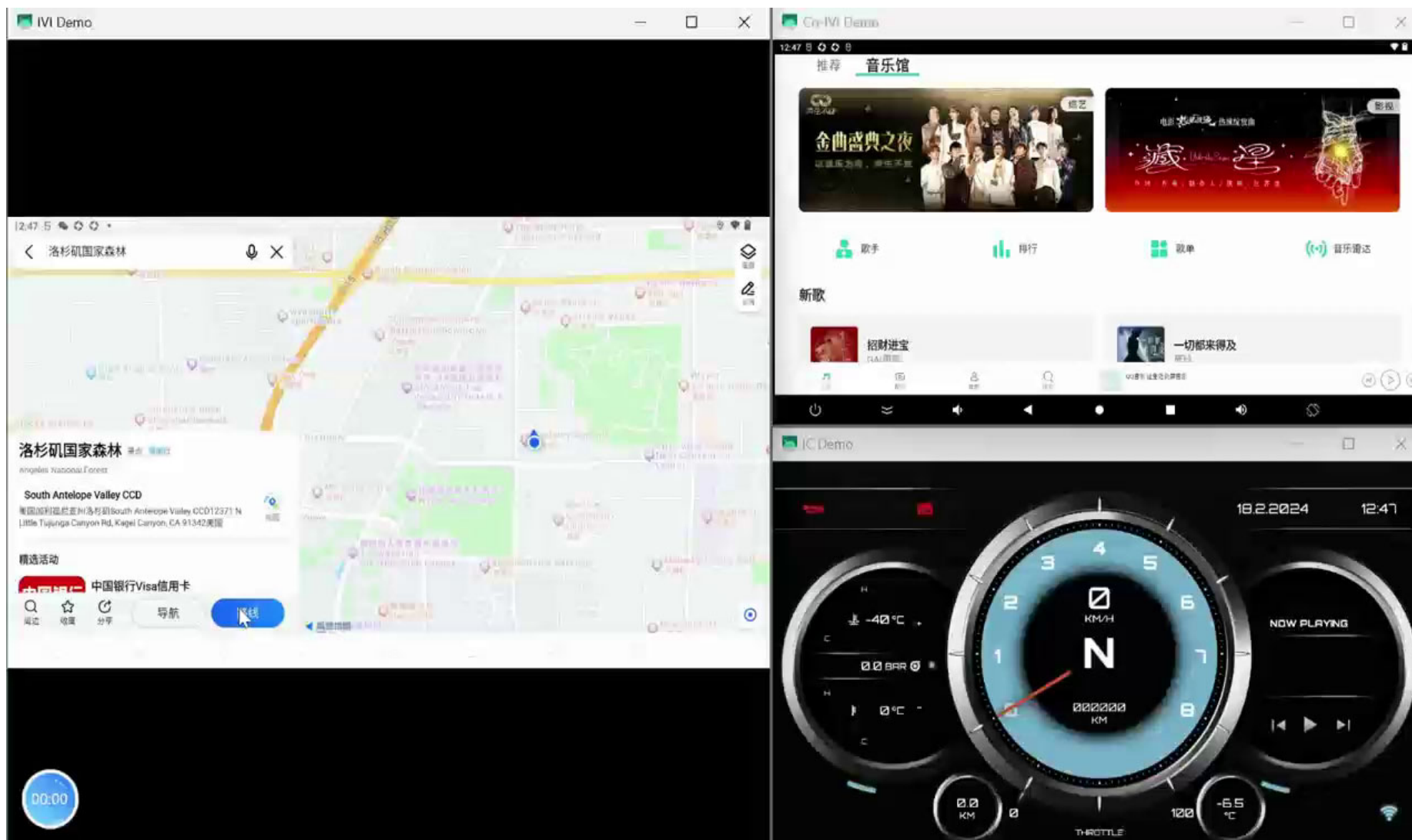
Hardware platform	
SoC	
CPU	ARM Cortex-A710(ARMv9 MPAM) x8 2.15GHz
GPU	ARM Mali-G78 x24 Flexible Partitioning
DDR	LPDDR5x 7500Mbps 16GB
Display	2x DP1.3 2x HDMI2.1 1xDSI1.2
WiFi/BT	1xWi-Fi 6 (802.11ax) & 2x BT 5.2
UFS	1xUFS3.1 128GB
Audio	2x SPK/ 2x MIC/ 2x Earphone
MCU	
MCU	Aurix TC397XX
Boot Sequence	
Microhypervisor	AutoVP
Application Domain (Instrument Cluster)	Root Namespace
System Domain	VM Namespace 1 (IC Display)
Android VM (In-Vehicle Infotainment)	VM Namespace 2 (In-Vehicle Infotainment)



14 Real-world Deployment

- **AutoVP has been deployed in two flagship electric vehicle models under a leading automotive manufacturer.**
- **The installation volume in the past year has exceeded **one million units**.**
- **Prototype is available at:** <https://github.com/jianglin-code/AutoVP>

15 Demo Video



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Q & A

