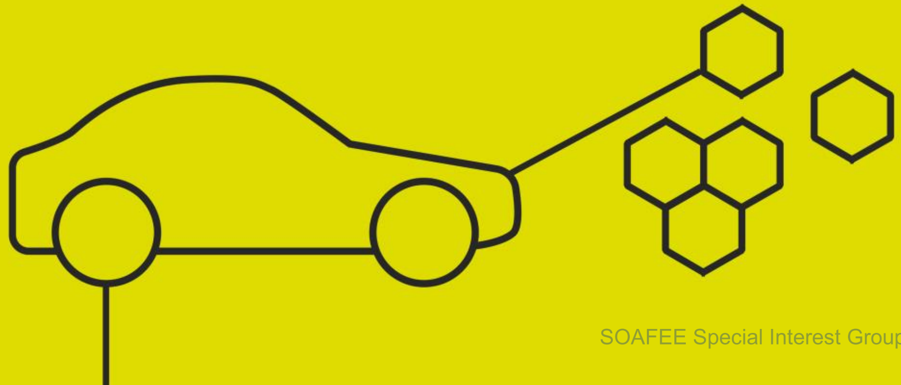
SOAFEE

Deterministic SDV

- Overview
- Who Is Responsible for the Deterministic System?



Soichiro ‘Mats’ Matsumoto, Product Manager @eSOL

2025-05-15

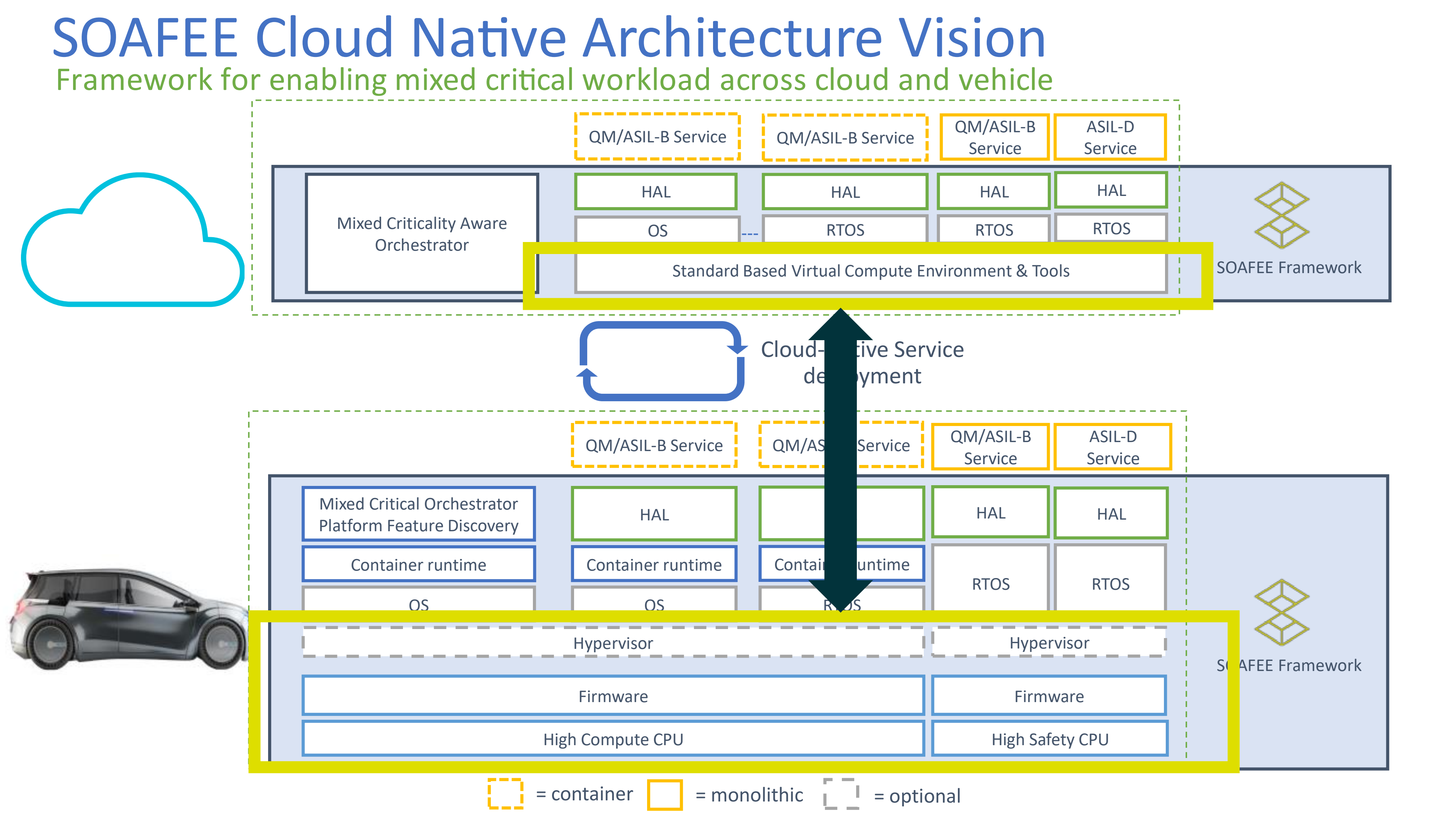
Agenda & Objectives

- SOAFEE Architecture Recap & Challenges
- Real-World Example: Why Deterministic SDV Is Challenging
- What Is Determinism & Why Does It Matter?
- ECU Consolidation in the SDV Era
- Who Is Responsible for the Deterministic System?
- Summary & Next Steps

SOAFEE

Scalable Open Architecture For Embedded Edge

Recap: SOAFEE Architecture



SOAFEE Cloud Native Architecture Vision

Framework for enabling mixed critical workload across cloud and vehicle

QM/ASIL-B Service

QM/ASIL-B Service

QM/ASIL-B Service

ASIL-D Service

Mixed Criticality Aware Orchestrator

HAL

HAL

HAL

HAL

OS

RTOS

RTOS

RTOS

Standard Based Virtual Compute Environment & Tools

SOAFEE Framework

Cloud- tive Service de yment

QM/ASIL-B Service

QM/AS Service

QM/ASIL-B Service

ASIL-D Service

Mixed Critical Orchestrator Platform Feature Discovery

HAL

HAL

HAL

Container runtime

Container runtime

Contai untime

RTOS

RTOS

OS

OS

R OS

Hypervisor

Hypervisor

Firmware

Firmware

High Compute CPU

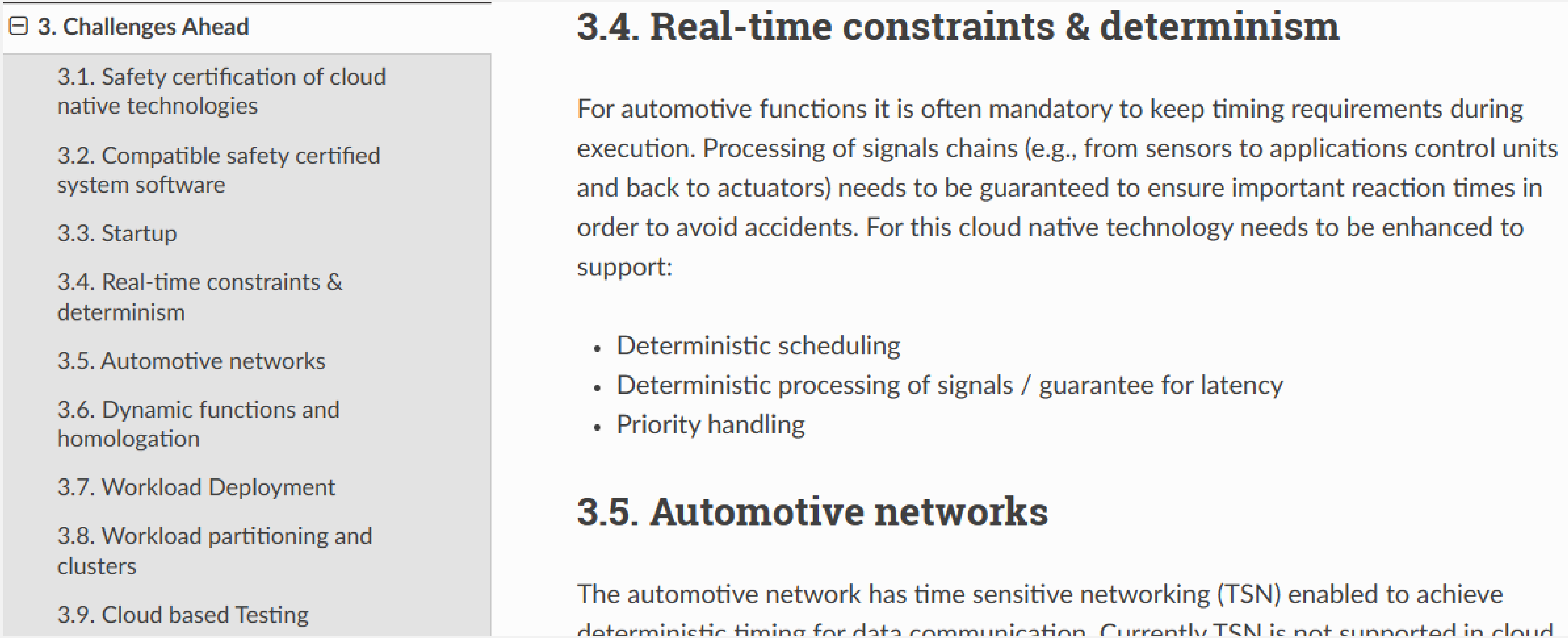
High Safety CPU

S AFEE Framework

⬚ = container □ = monolithic ⬚ = optional

https://architecture.docs.soafee.io/en/latest/contents/architecture.html#

Recap: SOAFEE Challenges



3.4. Real-time constraints & determinism

For automotive functions it is often mandatory to keep timing requirements during execution. Processing of signals chains (e.g., from sensors to applications control units and back to actuators) needs to be guaranteed to ensure important reaction times in order to avoid accidents. For this cloud native technology needs to be enhanced to support:

- Deterministic scheduling
- Deterministic processing of signals / guarantee for latency
- Priority handling

3.5. Automotive networks

The automotive network has time sensitive networking (TSN) enabled to achieve deterministic timing for data communication. Currently TSN is not supported in cloud

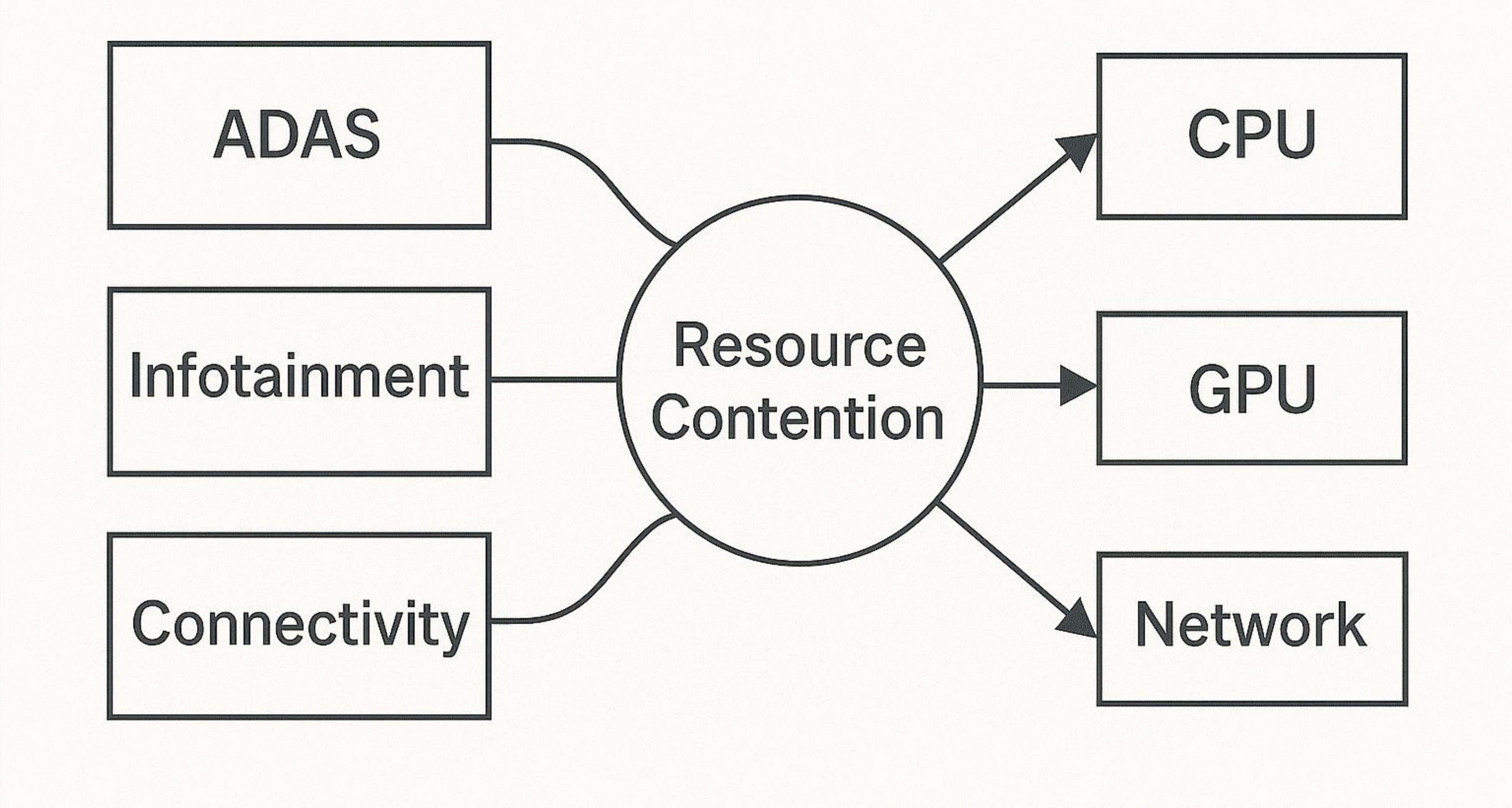
https://architecture.docs.soafee.io/en/latest/contents/challenges.html

Agenda & Objectives

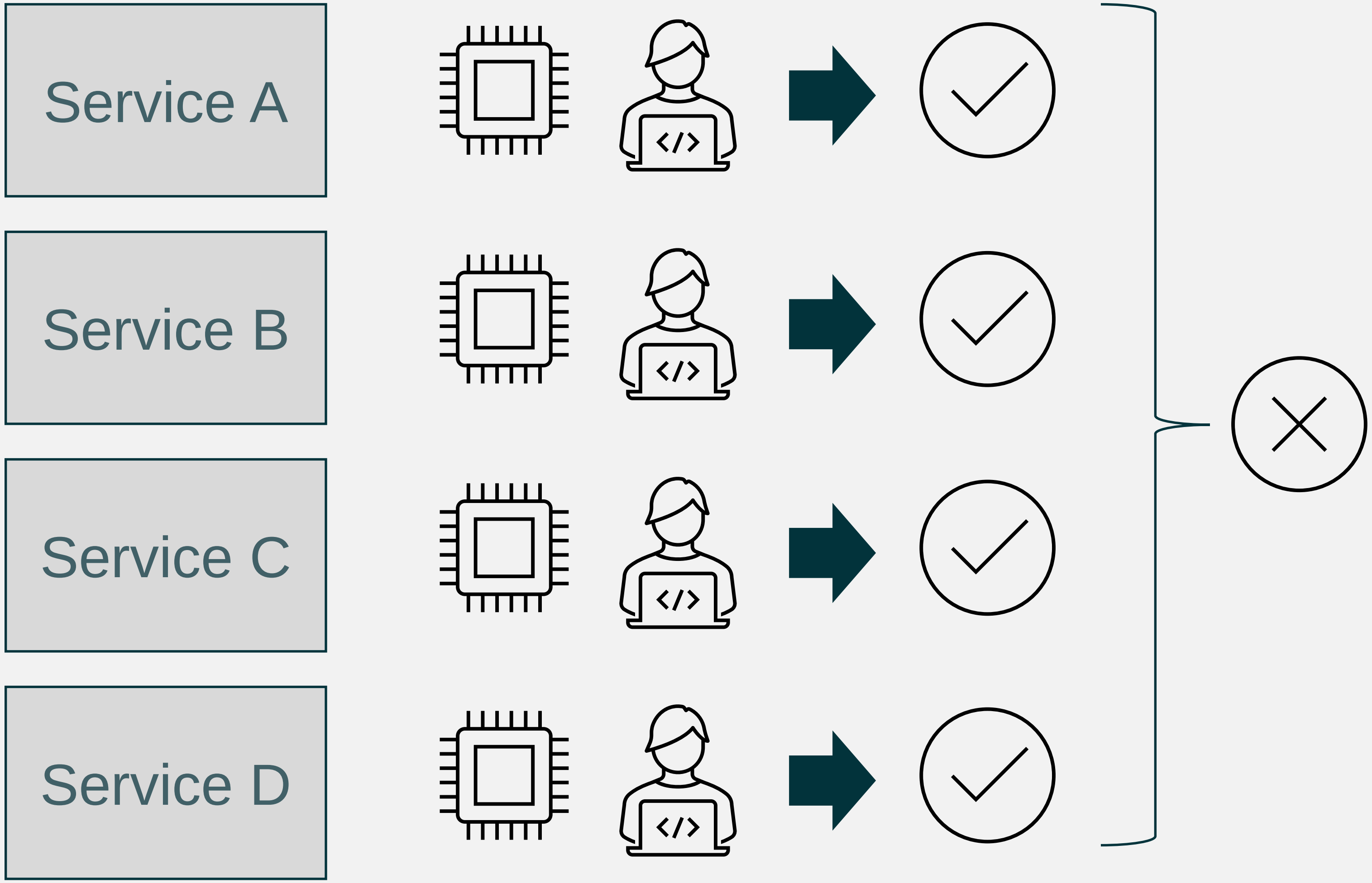
1. SOAFEE Architecture Recap & Challenges
2. Real-World Example: Why Deterministic SDV Is Challenging
3. What Is Determinism & Why Does It Matter?
4. ECU Consolidation in the SDV Era
5. Who Is Responsible for the Determinism System?
6. Summary & Next Steps

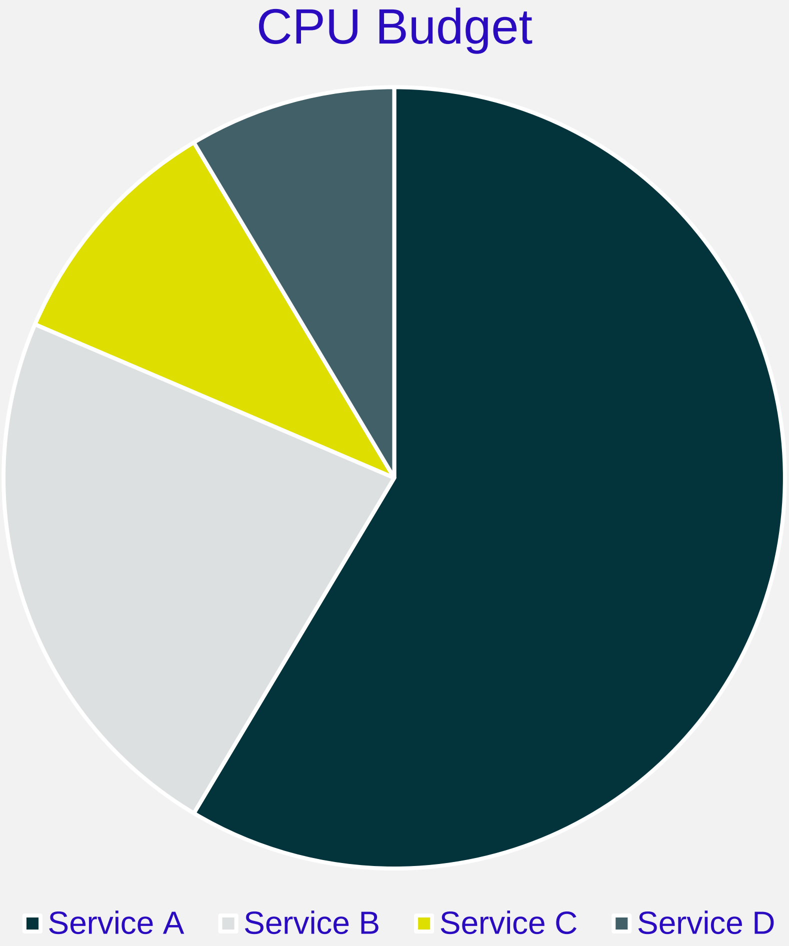
Real-World Challenges

- Multiple sub-teams, single high-performance SoC
- Conflicting resource requests (CPU, GPU, memory, cache, bus…)



Real-World Challenges





Real-World Challenges

- No countermeasure for non-deterministic behavior leads to:

Development delays

Cost overruns

Bugs

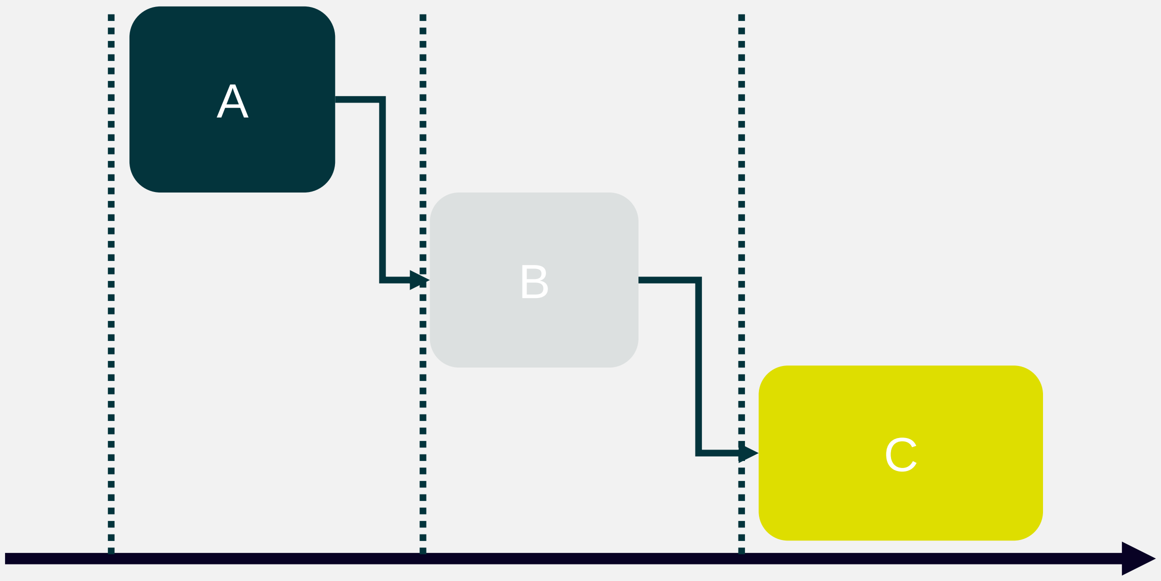
Reduced functionality

Agenda & Objectives

1. SOAFEE Architecture Recap & Challenges
2. Real-World Example: Why Deterministic SDV Is Challenging
3. What Is Determinism & Why Does It Matter?
4. ECU Consolidation in the SDV Era
5. Who Is Responsible for the Determinism System?
6. Summary & Next Steps

What Is Deterministic Behavior?

- Predictable Timing
- Consistent Outcomes

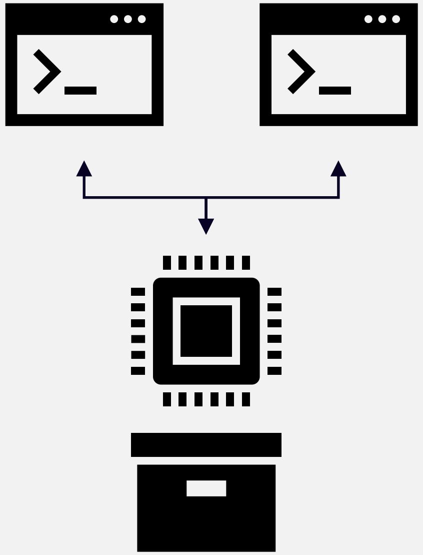


Determinism(s) in systems

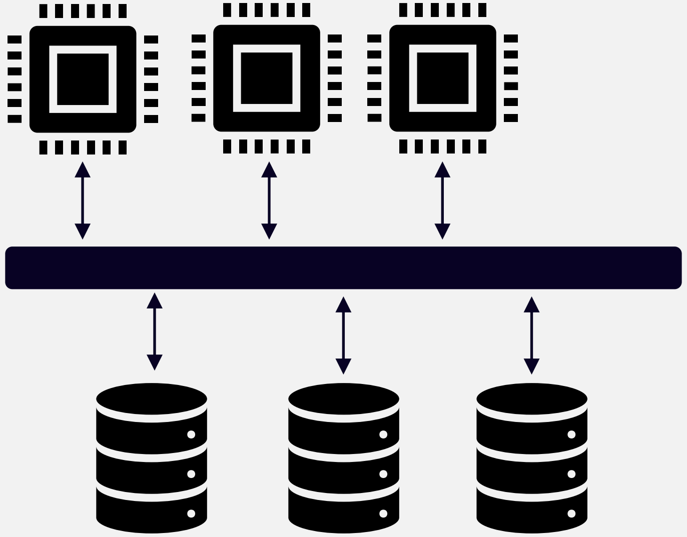
Logical Determinism
(Not a philosophical one)

Temporal Determinism

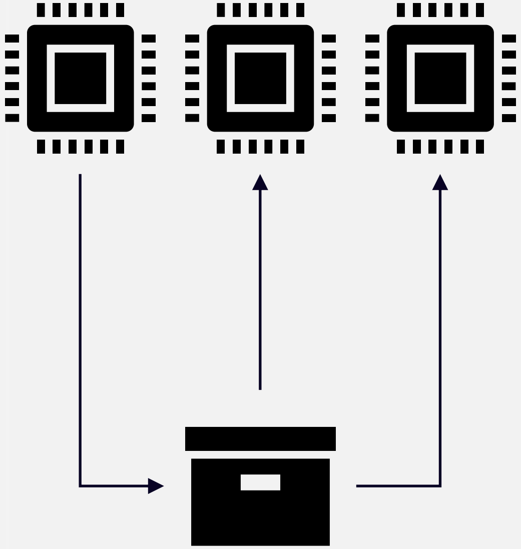
How your system loses temporal determinism



Unpredictable cache misses



Unpredictable Memory Bus and DRAM Contention



Unpredictable Inter-Core Interference

Importance of Determinism

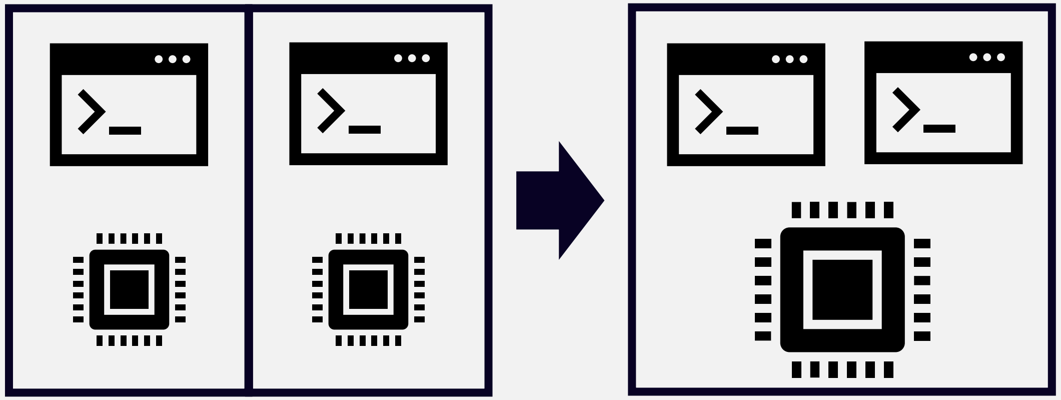
Safety Risks

Poor UX

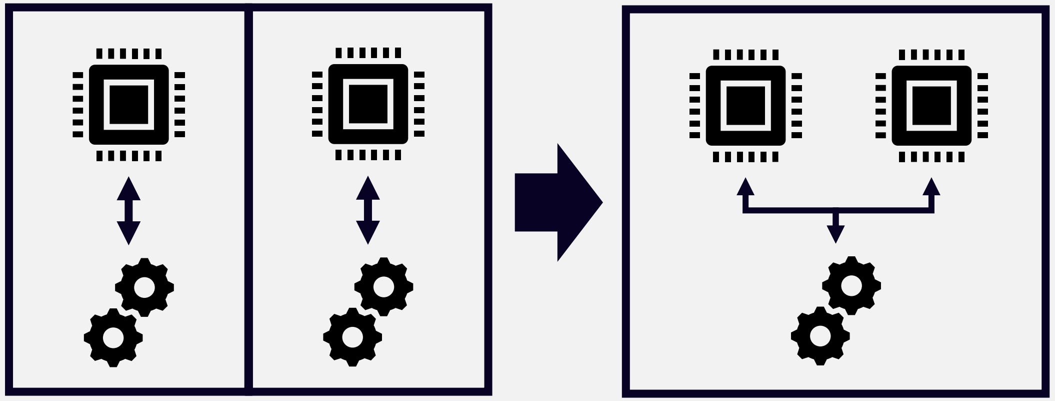
Agenda & Objectives

1. SOAFEE Architecture Recap & Challenges
2. Real-World Example: Why Deterministic SDV Is Challenging
3. What Is Determinism & Why Does It Matter?
4. ECU Consolidation in the SDV Era
5. Who Is Responsible for the Deterministic System?
6. Summary & Next Steps

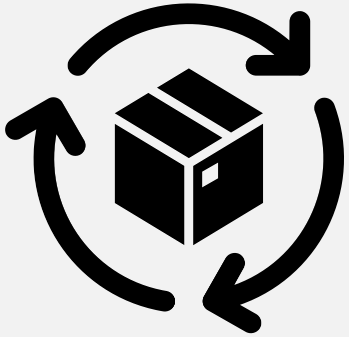
What makes your system unpredictable in the SDV Era



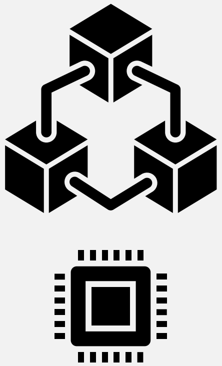
Consolidation



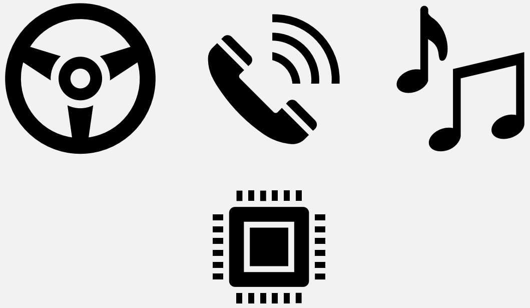
Shared Device



OTA Update



Virtualization

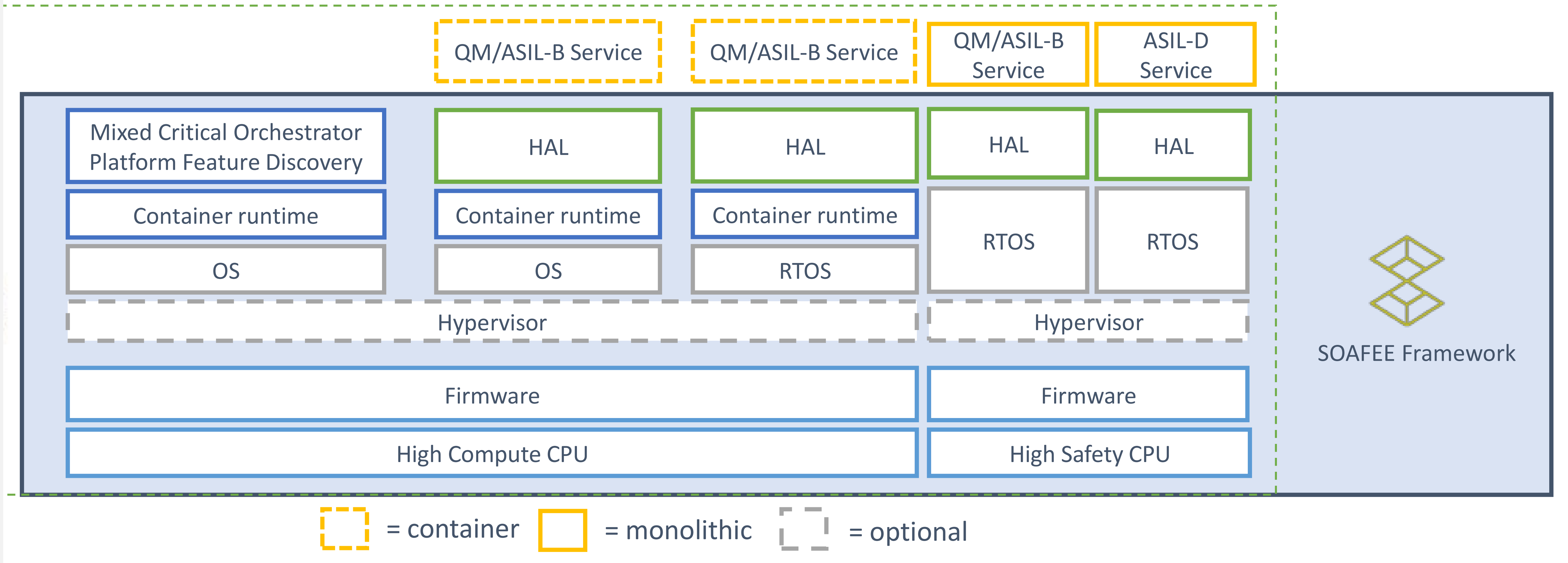


Mixed Criticality

Agenda & Objectives

1. SOAFEE Architecture Recap & Challenges
2. Real-World Example: Why Deterministic SDV Is Challenging
3. What Is Determinism & Why Does It Matter?
4. ECU Consolidation in the SDV Era
5. **Who Is Responsible for the Deterministic System?**
6. Summary & Next Steps

No single layer can guarantee determinism alone



QM/ASIL-B Service

QM/ASIL-B Service

QM/ASIL-B Service

ASIL-D Service

Mixed Critical Orchestrator Platform Feature Discovery

Container runtime

OS

HAL

Container runtime

OS

HAL

Container runtime

RTOS

HAL

RTOS

HAL

RTOS

Hypervisor

Hypervisor

Firmware

Firmware

High Compute CPU

High Safety CPU

SOAFEE Framework

= container = monolithic = optional

Each layer nurtures its counterspell

- Hardware
  - Cache partitioning, Runtime profile, Memory bus QoS…
- OS / Hypervisor / Container Runtime
  - Real-time scheduling, guest partitioning, device virtualization…
- Middleware
  - TSN, IPC frameworks, QoS management…

Agenda & Objectives

1. SOAFEE Architecture Recap & Challenges
2. Real-World Example: Why Deterministic SDV Is Challenging
3. What Is Determinism & Why Does It Matter?
4. ECU Consolidation in the SDV Era
5. Who Is Responsible for the Deterministic System?
6. Summary & Next Steps

Key Points

- Determinism = predictability in timing & behavior
- ECU consolidation → more resource conflicts
- System-wide approach: hardware + OS + middleware + app
- Everyone shares the responsibility → **Collaboration at SOAFEE**

- Try abstracting your low-levels, but do not completely ignore the layered architecture underneath. It’s physics.

What’s Coming Next

- Dr. Yang Zhang (AutoCore) → TSN & Deterministic Networking
- Dr. Ravi Akella (DENSO) → Cloud Integration, Deterministic Scheduler

SOAFEE

Thank You