The Application of Micro-kernel Based Operating System in Cross-domain Computing for Intelligent Vehicles

Ding Wang

Black Sesame Technologies Co., Ltd

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What makes automotive software special?

Safety Criticality

Real-time Requirements

Complex Systems

Regulatory Compliance

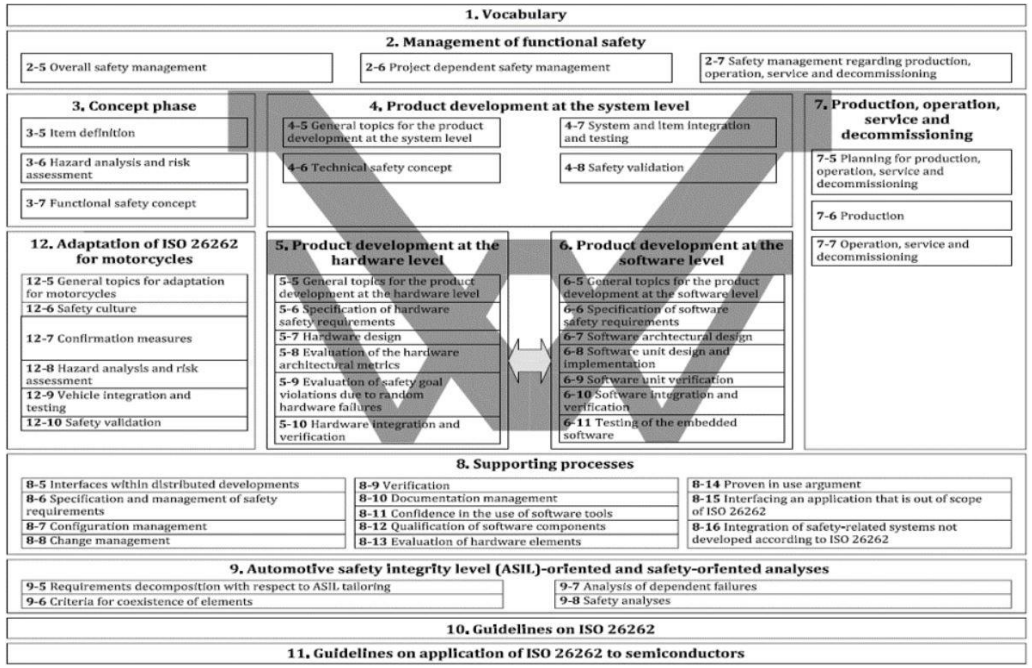
Long Product Lifecycles

Environmental Constraints

Hypervisor

What is Functional Safety?

ISO 26262



ASIL

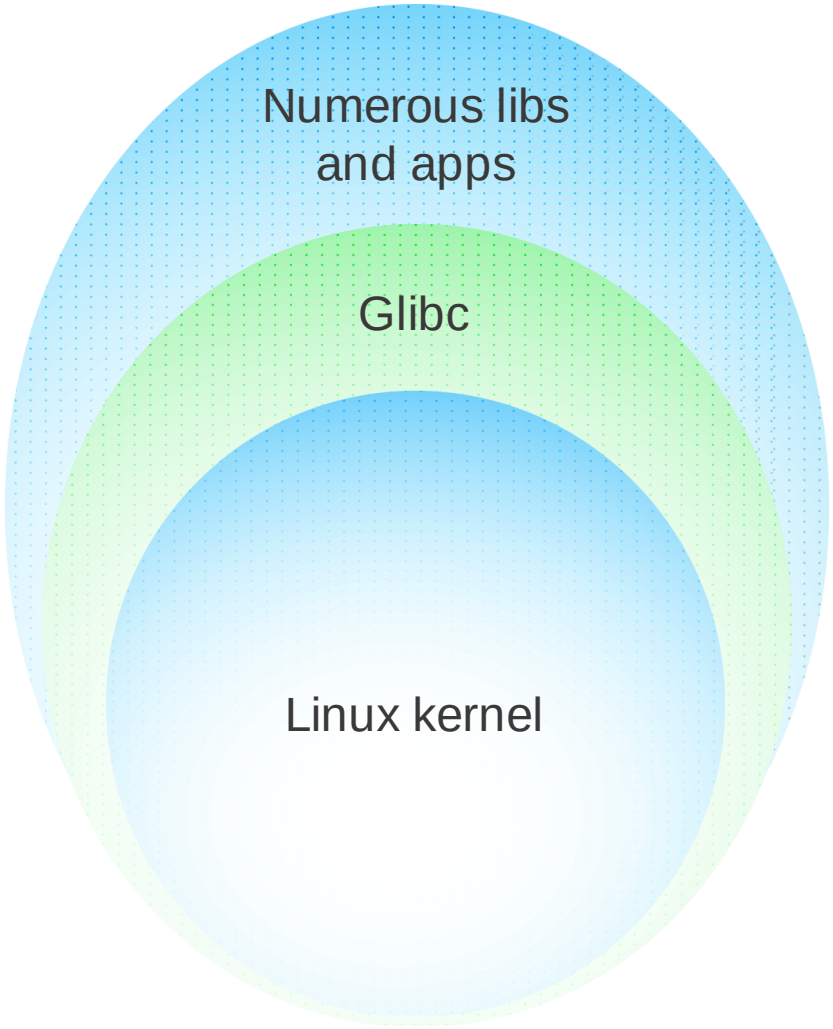
Automotive Safety Integrity Level

Severity	Exposure	Controllability		
		C1	C2	C3
S1	E1	QM	QM	QM
	E2	QM	QM	QM
	E3	QM	QM	A
	E4	QM	A	B
S2	E1	QM	QM	QM
	E2	QM	QM	A
	E3	QM	A	B
	E4	A	B	C
S3	E1	QM	QM	A
	E2	QM	A	B
	E3	A	B	C
	E4	B	C	D

About $10-100 cost per LOC for ASIL-D certification

Hypervisor

Nobody can check all these codes for functional safety



Numerous libs and apps

systemd: 750,338 LOC
libc++: 570603LOC
ffmpeg: 1,391,908LOC
Opencv: 2,185,540LOC .....

GNU C Library

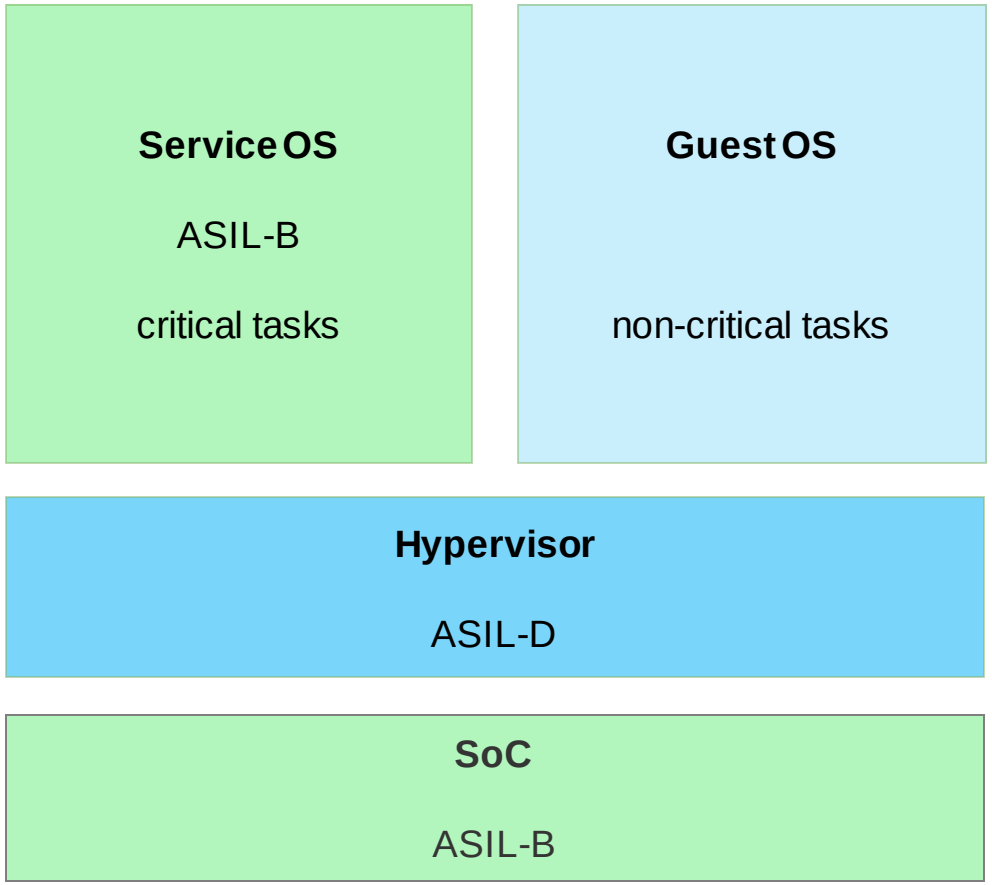
has had 40,366 commits made by 724 contributors
representing 1,423,198 lines of code
https://openhub.net/p/glibc

Kernel

has had 1,197,344 commits made by 26,958 contributors
representing 34,199,731 lines of code
https://openhub.net/p/linux

Dual-Kernel Solution

A system engineering solution

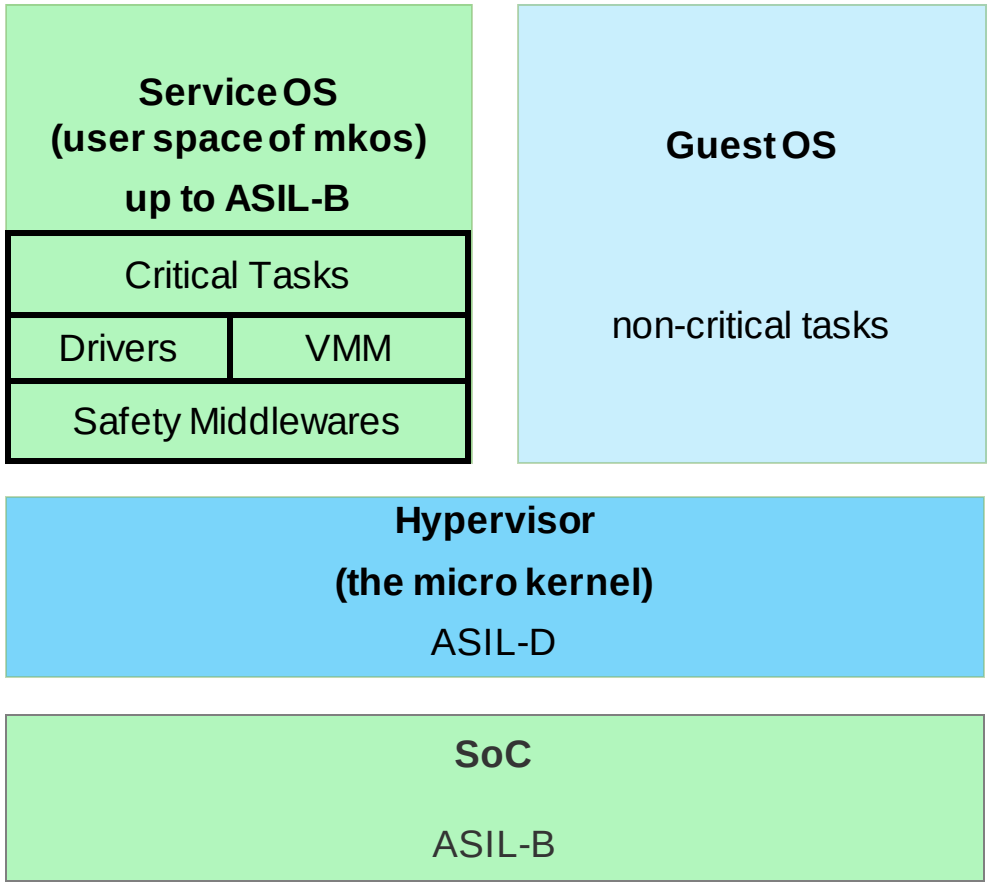


- Hypervisor
  - up to ASIL-D
  - doing kernel switch and cross OS communication
- Service OS
  - upto ASIL-B, maybe a ASIL-D kernel and ASIL-B middlewares
  - running critical tasks
- Guest OS
  - can be Linux
  - for non-critical tasks

The whole system is achieved ASIL-B.

Micro-kernel based hypervisor

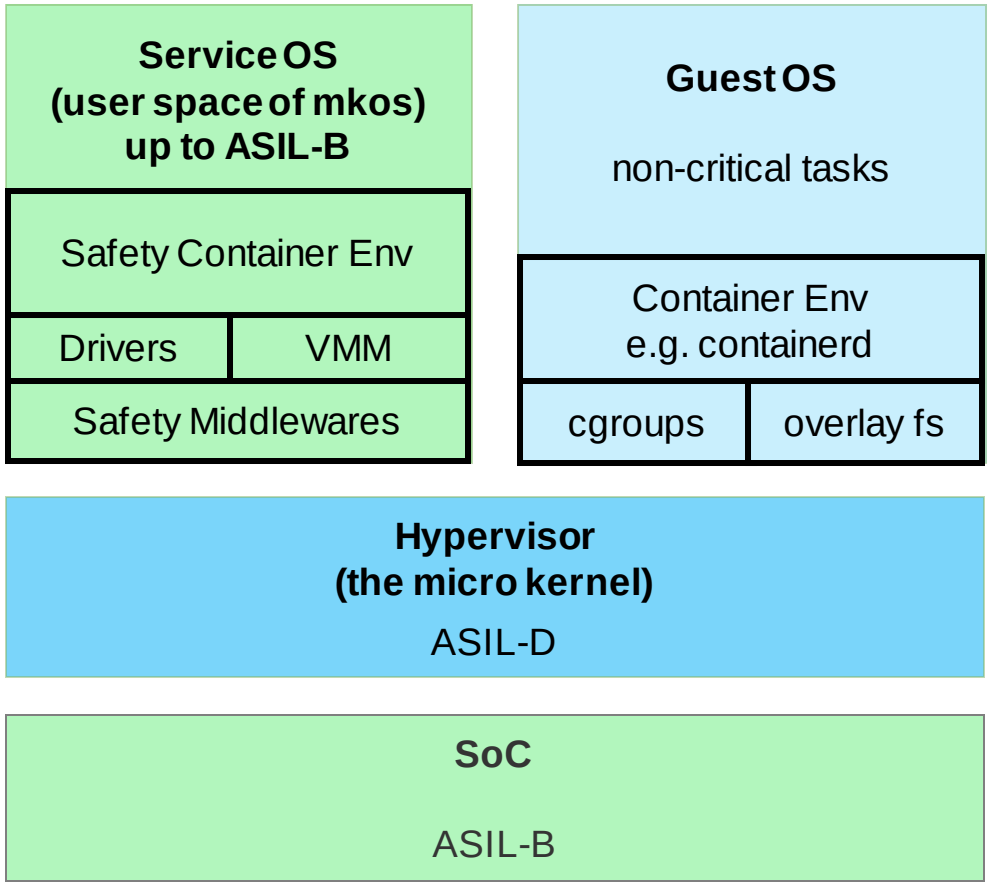
Micro-kernel as hypervisor and SOS



- Hypervisor
  - the micro kernel itself.
- Service OS
  - not the VM, but just the user space of the micro kernel OS.
- Guest OS
  - a VM running on micro kernel OS.
  - for non-critical tasks
- Advantages
  - strengthen SOS, for realtime, realiability, etc.
- Disadvantages
  - weaken GOS, for schedule, latency, etc.

Container support

Container support in SOS and GOS



- Service OS
  - a safety container environment
- Guest OS
  - standard container environment

With container support, the architecture requirement of SOAFEE can be met.

Applications can be developed/tested/deployed in container mode.

Technical Trends

1 Centralized Computing

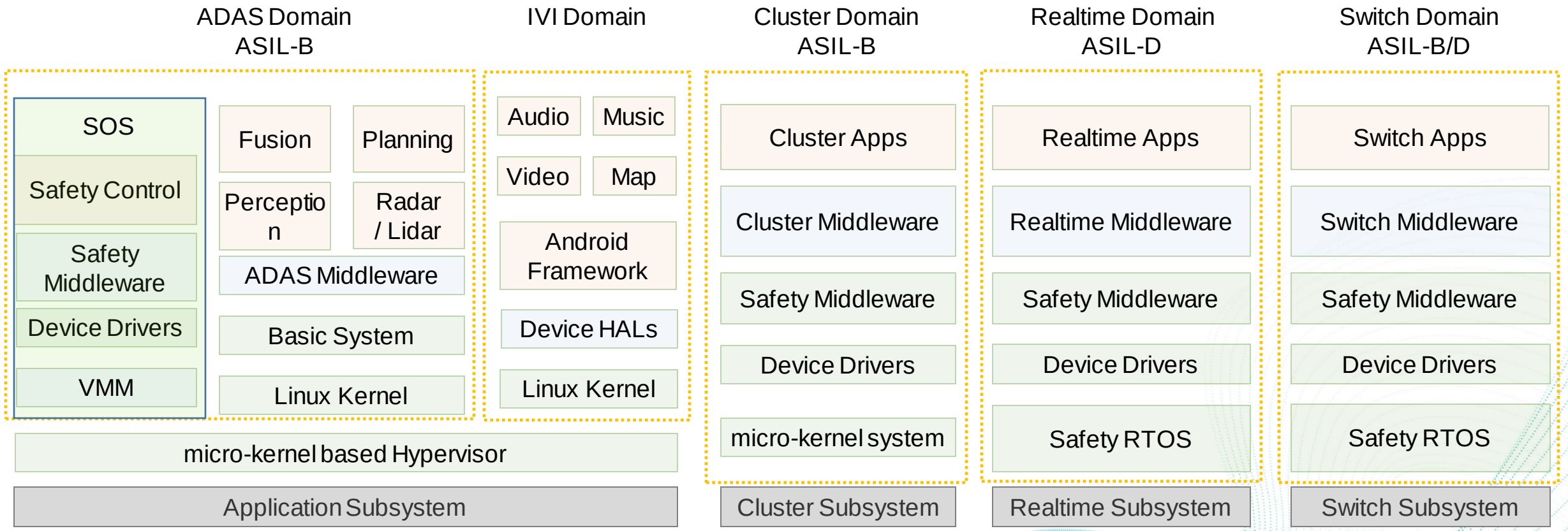
2 Distributed Computing

Product | Cross-domain SoCs – Wudang Series

The first cross-domain computing platform for intelligent vehicles in China
and target towards cross-domain computing scenarios.

(launched in Apr. 2023, sample deliveries are planned for 2023)

Cross-Domain Computing



Thanks