Instrument Cluster Expert Group

IC-EG Japan development team

Topics

- Introduction of Instrument Cluster EG
- What does Instrument Cluster EG aim
- Architecture overview
- Challenge
- Next

Background – Instrument Cluster -

- Instrument Cluster Expert Group launches from March 2019

Instrument Cluster (New EG)

- Create profile for Cluster(HUD)
- Shrink and optimize AGL base as much as possible for low cost system.
- Possible use cases include motorcycles
- Functional Safety for Instrument Cluster

https://wiki.automotivelinux.org/_media/agl_roadmap_tokyo_2019_amm.pdf

AUTOMOTIVE GRADE LINUX

Member of Expert Group

OEM

Suzuki (Leader), Toyota, Honda, Mazda

Denso, Panasonic, Continental, NipponSeiki

DensoTen, AisinAW

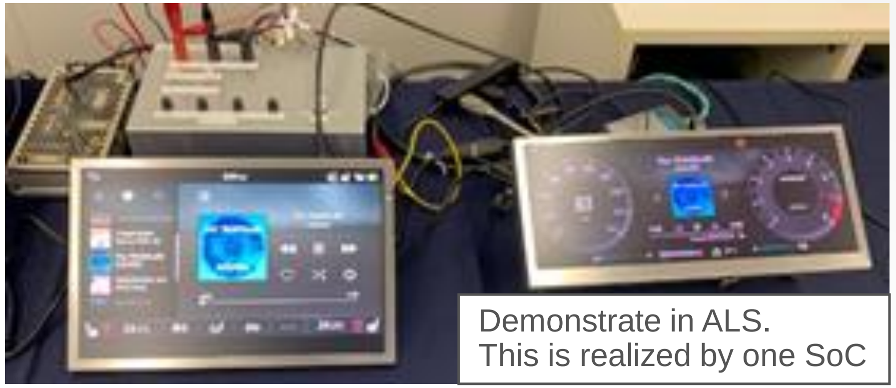
Motivation

Create Cluster centric platform

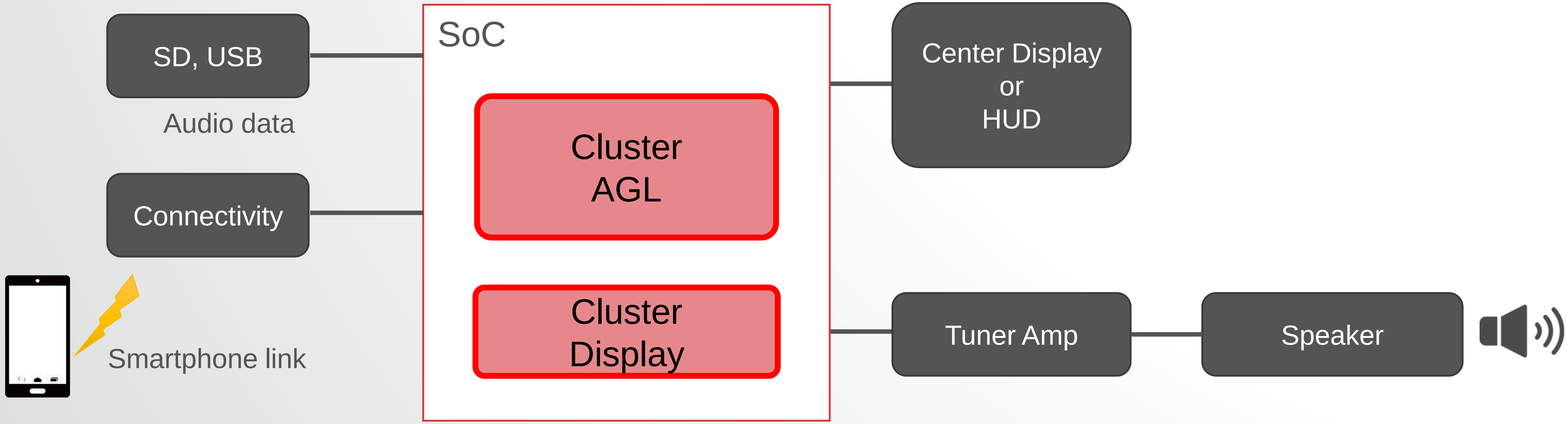
- We want to create a base platform for Cluster, not a platform based on conventional IVI.
- There are different system requirements between IVI and Cluster.
- Instead of a system based on the conventional IVI system, it is necessary to consider a new system suitable for Cluster.
- We want to use AGL as the basis for production. In order to achieve this, we want to define performance targets that can satisfy the quality of the product, and create an AGL ecosystem that satisfies those targets.

What does Instrument Cluster EG aim?

- Shrink and optimize AGL base as much as possible for light weight system
  - e.g. Possible use cases include motorcycles


Demonstrate in ALS.
This is realized by one SoC

- Instrument Cluster with simple IVI
  - Target product system image example is as follows.



Relationship of IVI

Relationship of IVI and cluster function

- Cluster functions will not change so.
- The larger the HW Spec is, the more functions IVI have.

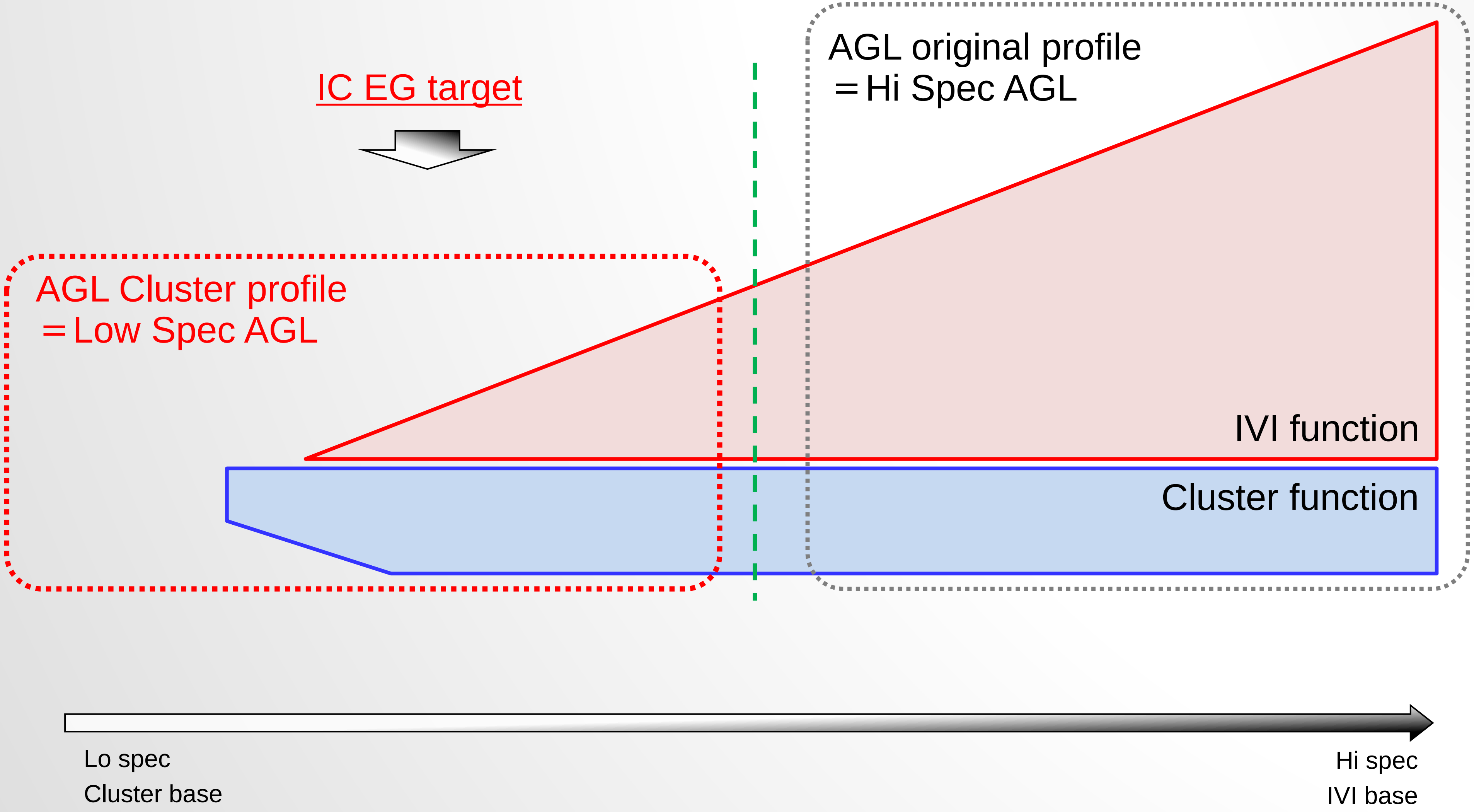
Approach to cluster centric platform

- There are different system requirements between IVI and Cluster
- Quality and robustness is required in cluster. (Functional Safety, Boot time, etc.)

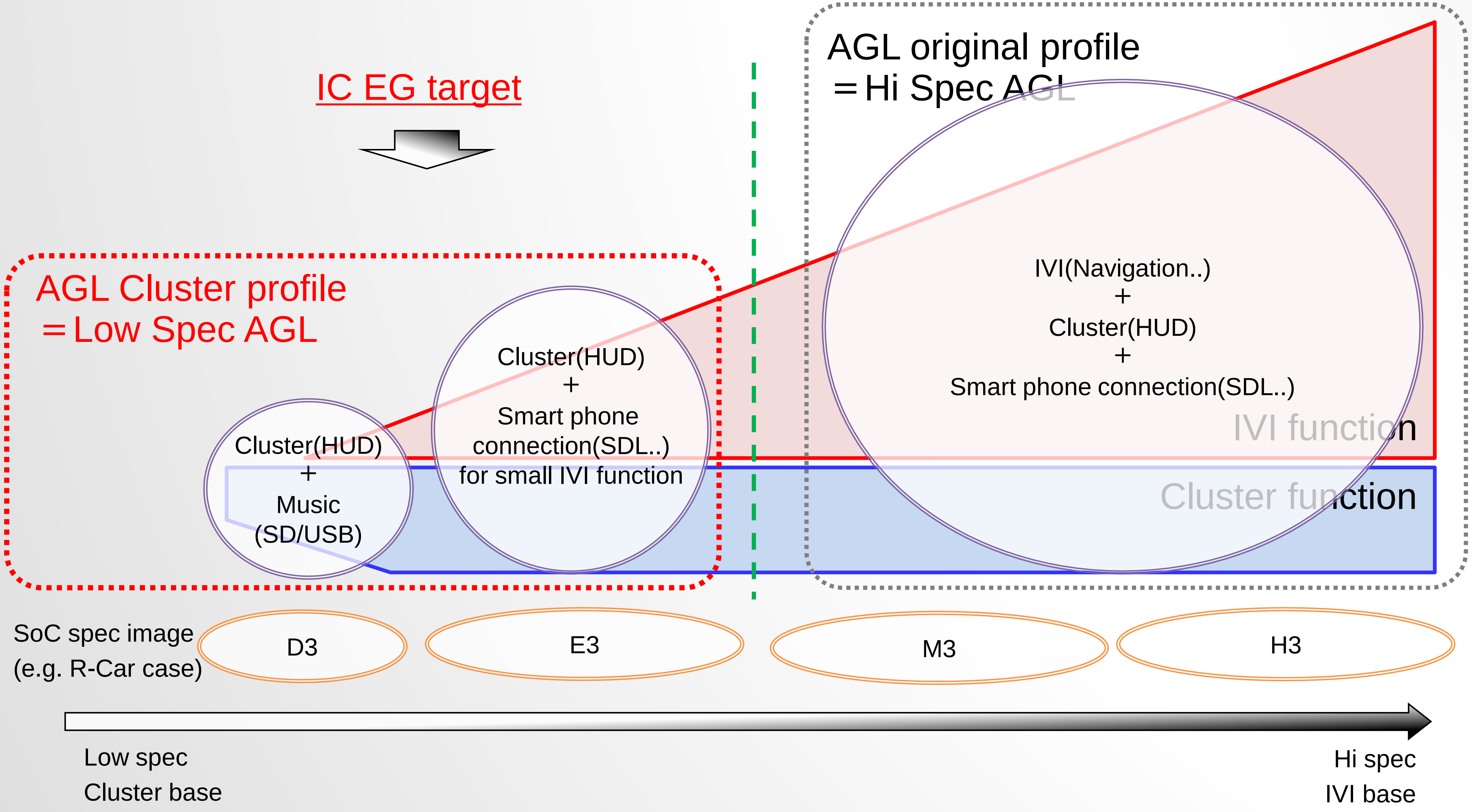
We call cluster centric platform as

"Low Spec AGL"

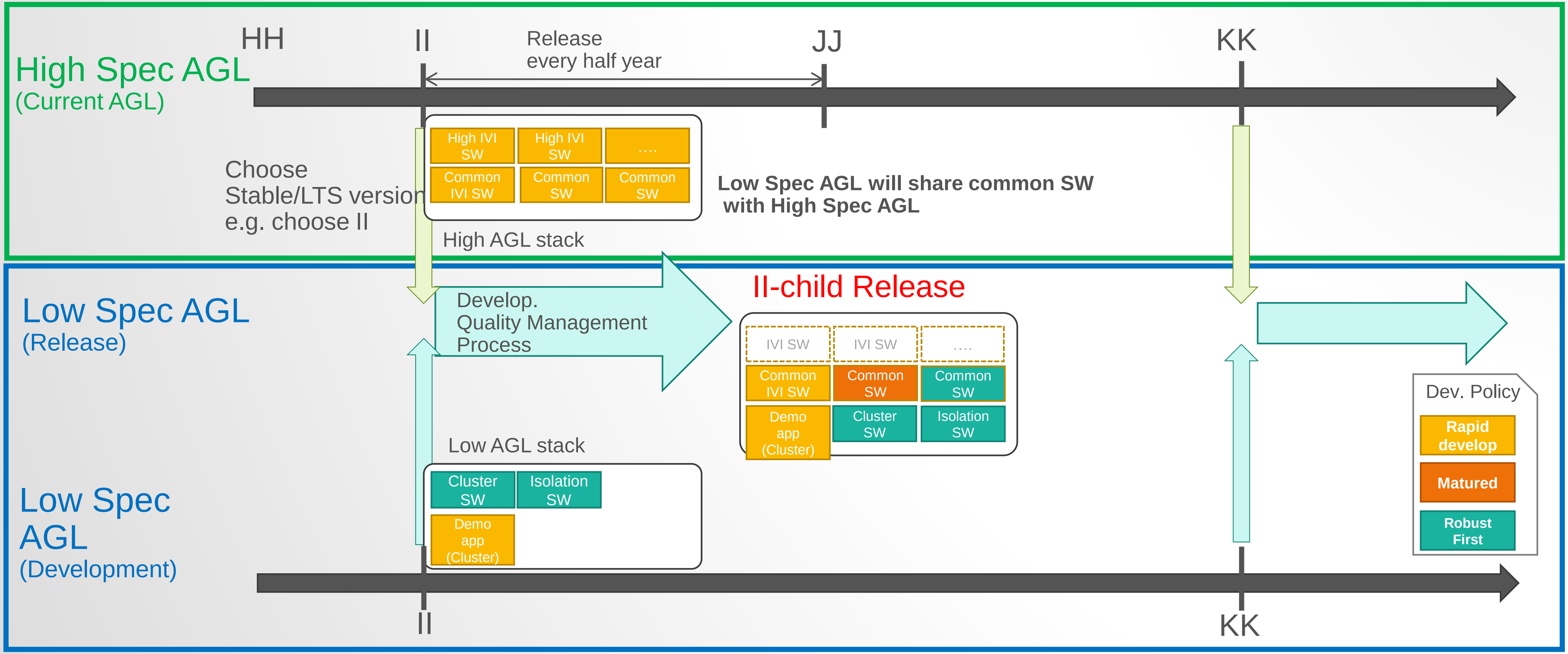
Hi Spec and Low Spec AGL relation



Hi Spec and Low Spec relation

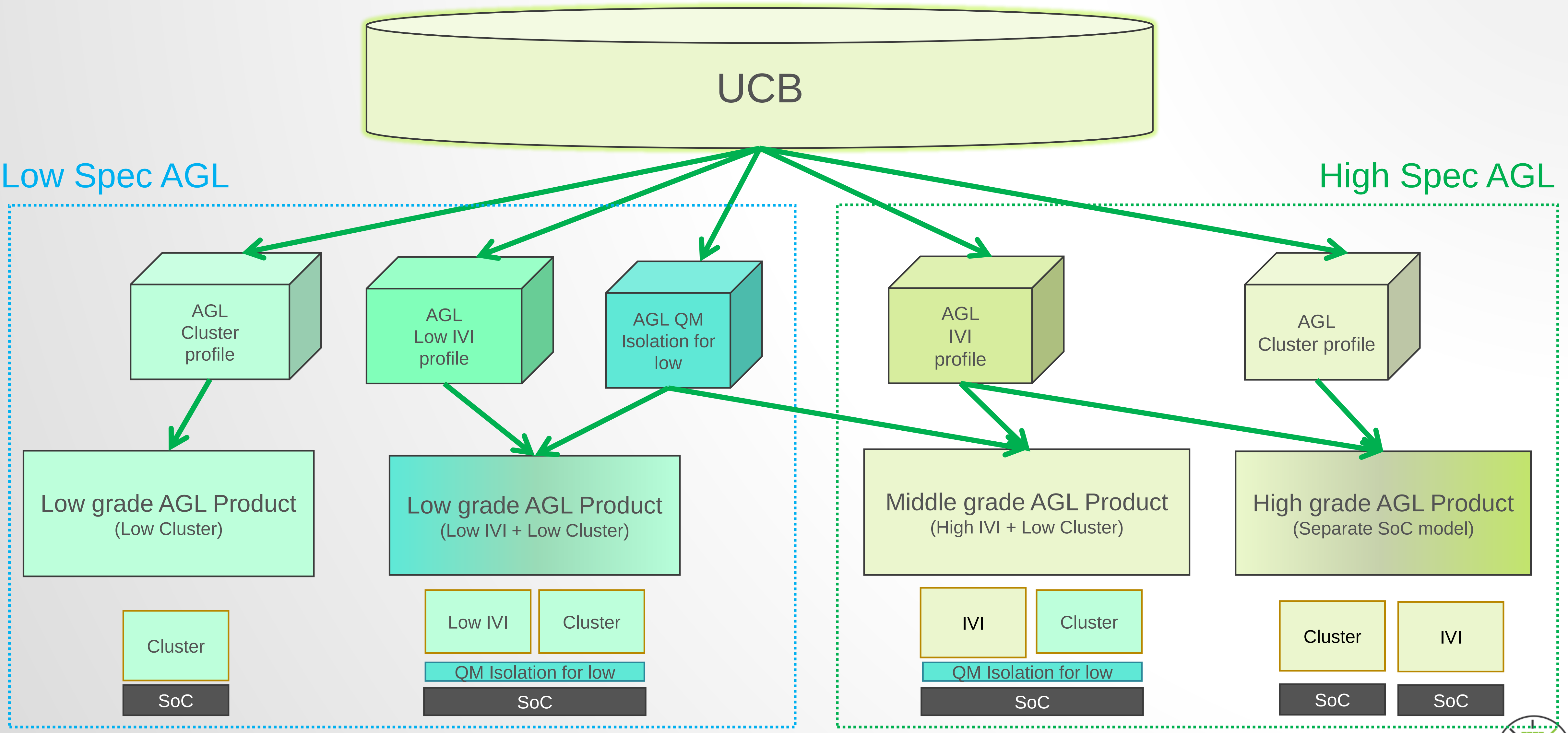


Development cycle of Low Spec AGL



Development speed is different, so Low Spec AGL release will be slow.
Cluster's first priority is robustness, so eventually Low Spec AGL will branch off from High Spec AGL

Relationship between High Spec AGL and Low Spec AGL



Goal - Realize AGL system suitable for Low Spec AGL

1. Quality and Robustness

- Approach the achievement of functional safety

2. Light weight system

- Work on Low Spec SoC
- Fast boot. Cluster must be ready as fast as current cluster product on RTOS.

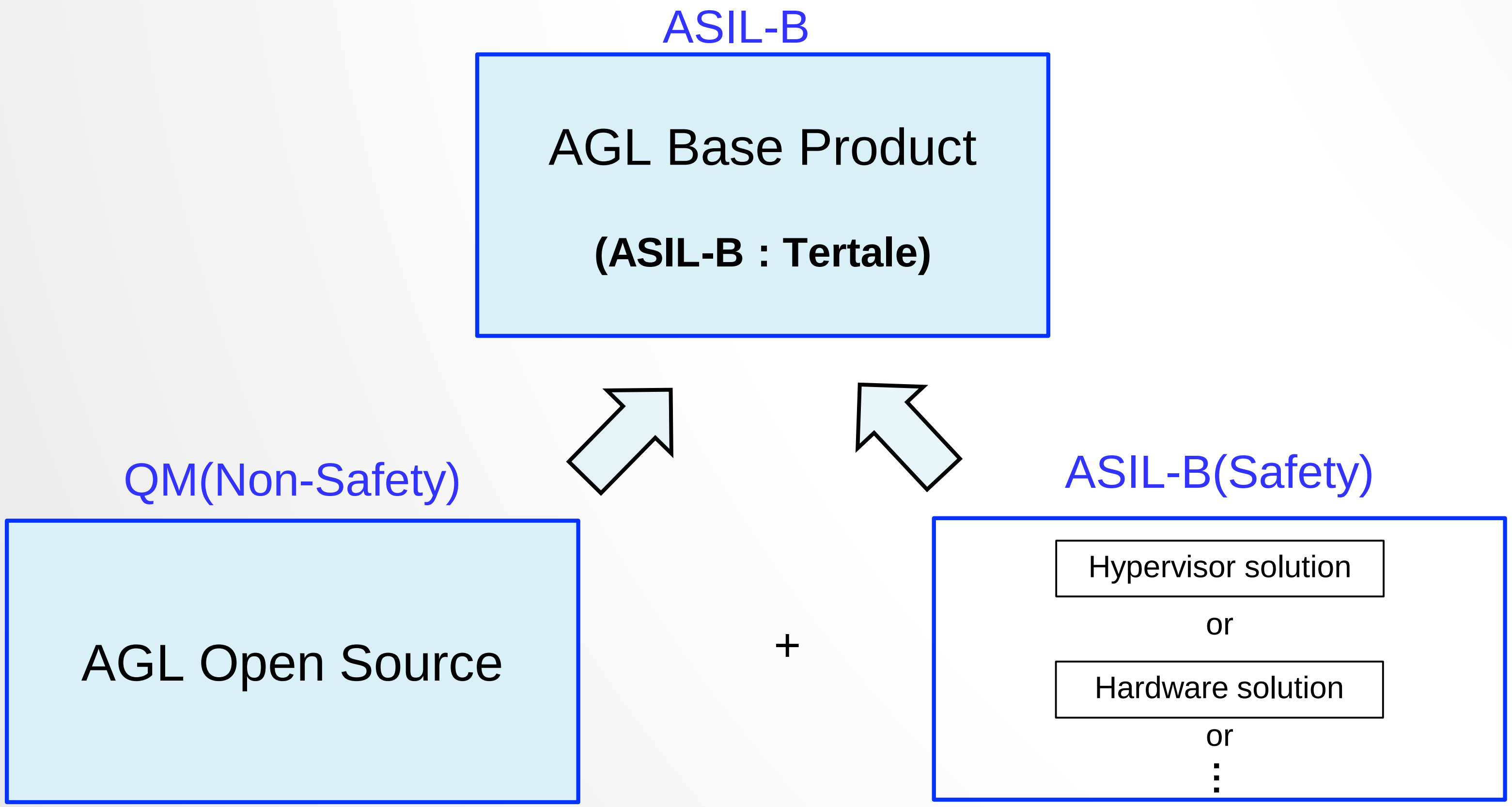
3. Scalability and Maintainability

- Integrate cluster with small IVI integrated system because only cluster system is already in market
- In product, enable to add new features, while keeping 1, 2 goal achieved

Functional safety

- Functional safety has high dependency on vehicle system architecture.
- It is difficult to get ASIL-B with Linux. In functional safety method, the system should separate main function and safety function.
- Main function is a function of our system.
- Safety function is a function to safe of the vehicle, when the system fails.
  - It should monitor main functions.
    - Which main function must need a monitoring? It depends on your system design.
  - It must be isolated from main function.
  - It is not generic.
- We exclude functional safety from the scope of development.

Functional safety



Achieve ASIL-B for the entire cluster system

Functional safety

Main function is included in the scope

- It requires advanced quality management.
- It requires open innovation.
- It requires cyber security.
- It requires fast boot.
- It requires various functions.
- …

Safety function is out of scope

- What function does it include?
- Which OS do you use?
- Which communication method do you use?

Depends on your system design!

Main function

Safety function

Functional safety will be discussed in the ELISA Project.

ELISA

ENABLING LINUX IN SAFETY APPLICATIONS

Isolation method

Isolation method is out of scope

- Hardware separation? Using hypervisor?

Depends on your system design!

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Functional safety

Main function is included in the scope

- It requires advanced quality management.
- It req
- It req
- It req
- It requires various functions.
- …

IC EG Target

- Achieve Quality Management

Main function

Safety function is out of scope

- What function does it include?
- Which OS do you use?
- Which communication method do you use?

Depends on your system design!

Safety function

Isolation method

Isolation method is out of scope

- Hardware separation? Using hypervisor?

Depends on your system design!

Functional safety will be discussed in the ELISA Project.

ELISA ENABLING LINUX IN SAFETY APPLICATIONS

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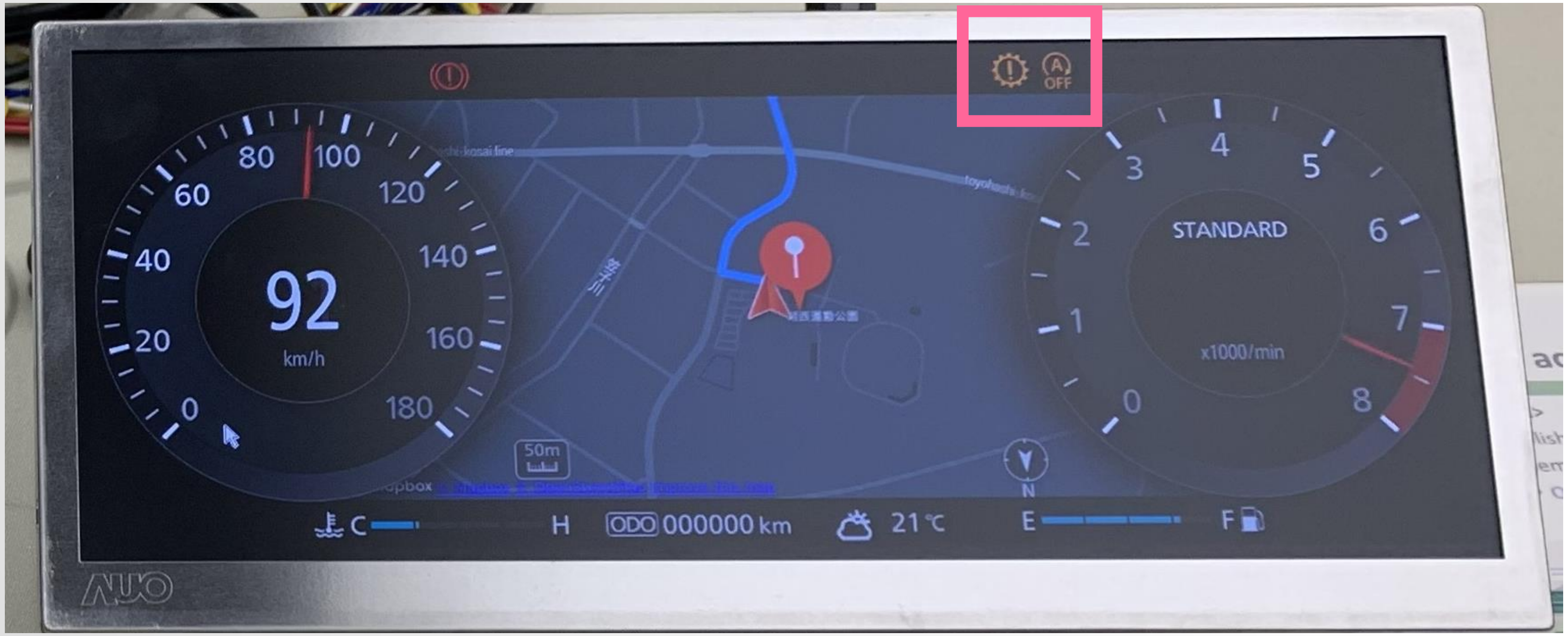
What function will relate to Functional Safety ?

- Typically, warning lamp will relate to Functional Safety
- In other case, warning buzzer will relate to Functional Safety



Engine Stop
Transmission gear failure etc

- If those function is realized by main function, it should be monitored by safety side.

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Antinomy in automotive quality management

- Automotive system (main function) has many antinomies.

IVI		Instrument Cluster
• Rapid innovation • Adding new future • Short-term development	Antinomy	• Advanced quality management • Full path coverage testing • Formal verification
• Rapid bug fix • Rapid security fix • Fix! Fix! Fix!	Antinomy	• Careful bug fixes • Does not want to change • Hates new bugs
• Various functions • Many pre-installed applications • Install applications from store	Antinomy	• Selected functions • Combinational verification • Fast boot

Monolithic system development

IVI		Instrument Cluster

• Rapid innovation
  • New features
  • Short-term development
	⇔ Antinomy	• Advanced quality management
		  • Full path coverage testing
		  • Formal verification

If both IVI and Instrument Cluster are running on a single system:

- We have to do full path coverage test and formal verification when we want to add new features to IVI.
- It is not short-term development.
- That's why we will not be able to achieve rapid innovation

Monolithic system development

IVI		Instrument Cluster

• Rapid bug fixes
  • Rapid security fix
  • Fix! Fix! Fix!
	⇔ Antinomy	• Careful bug fixes
		  • Do not want to change
		  • Hate new bugs

If both IVI and Instrument Cluster are running on a single system:

- The IVI system needs rapid security fixes. It's more important than new minor bugs. Because IVI system is connected to the outside.
- On the other hand we do not want to change common software stacks, because even minor bugs can cause serious situations. When we change the system, we have to perform verification.

Monolithic system development

IVI	Instrument Cluster
• Various functions • Many pre-installed applications • Install applications from store	• Selected functions • Combinational verification • Fast boot

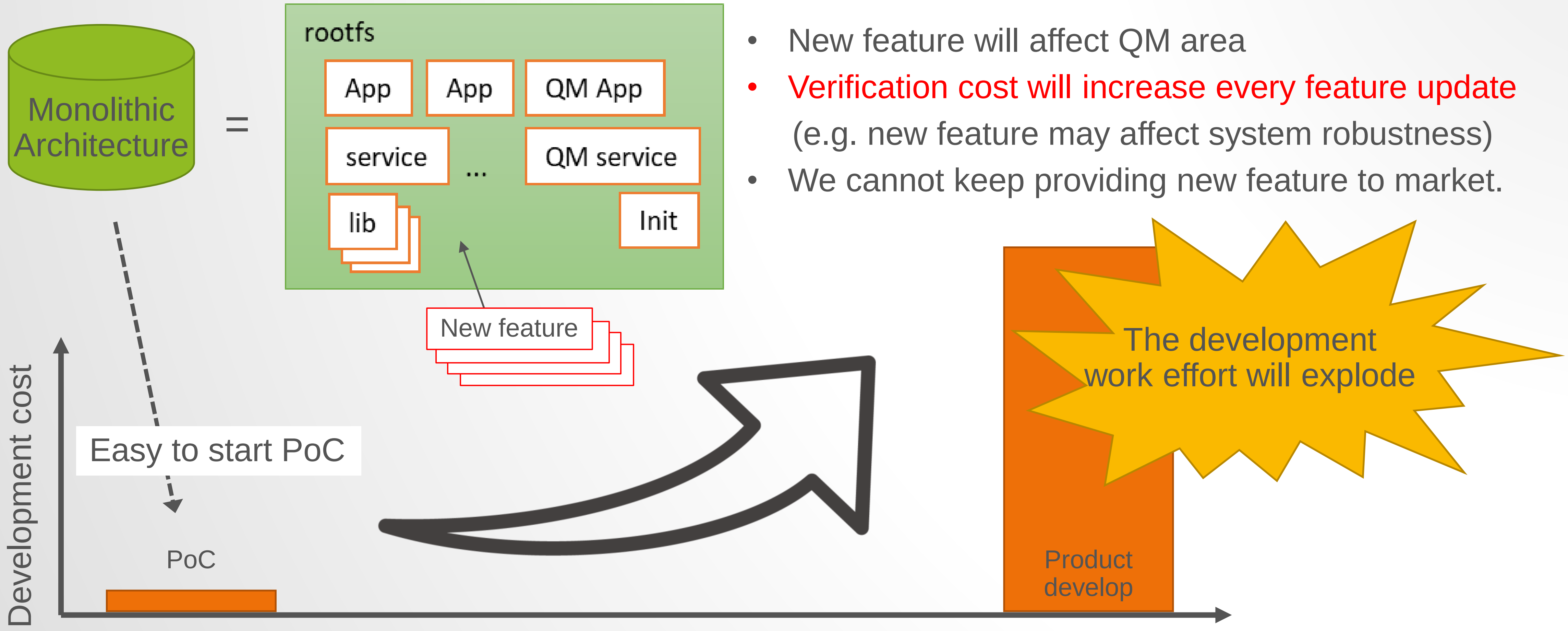
Antinomy

If both IVI and Instrument Cluster are running on a single system:

- The IVI system has many pre-installed applications. End user can also install applications from the app store. On the other hand, Instrument Cluster has limited functionality because its safety related system requires combinatorial validation.
- It is impossible to perform combinatorial validation on a complex system. It means that it is difficult to integrate Instrument Cluster into an existing IVI system.
- A large application framework for IVI prevents fast boot of Instrument Cluster.

Monolithic system development

- New feature will affect QM area
- Verification cost will increase every feature update
  (e.g. new feature may affect system robustness)
- We cannot keep providing new feature to market.



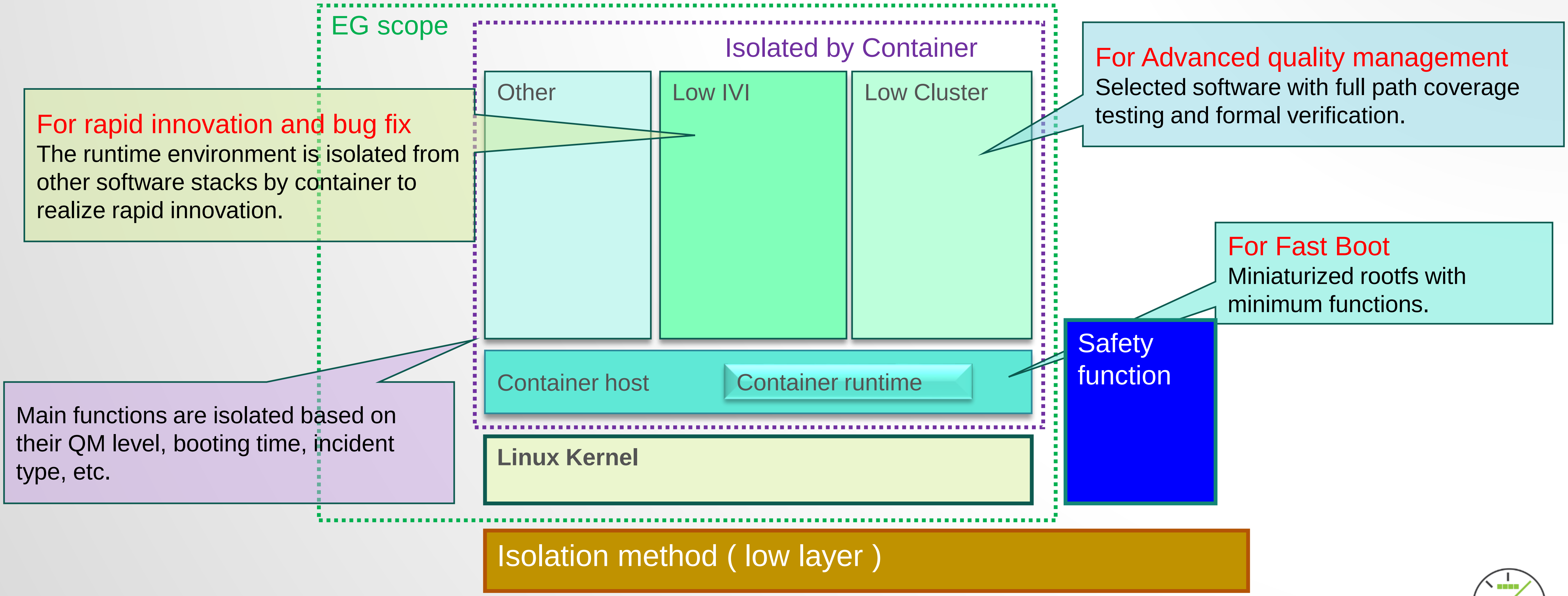
It is difficult to apply monolithic architecture to instrument cluster product

So what solution ?

Answer is QM Isolation

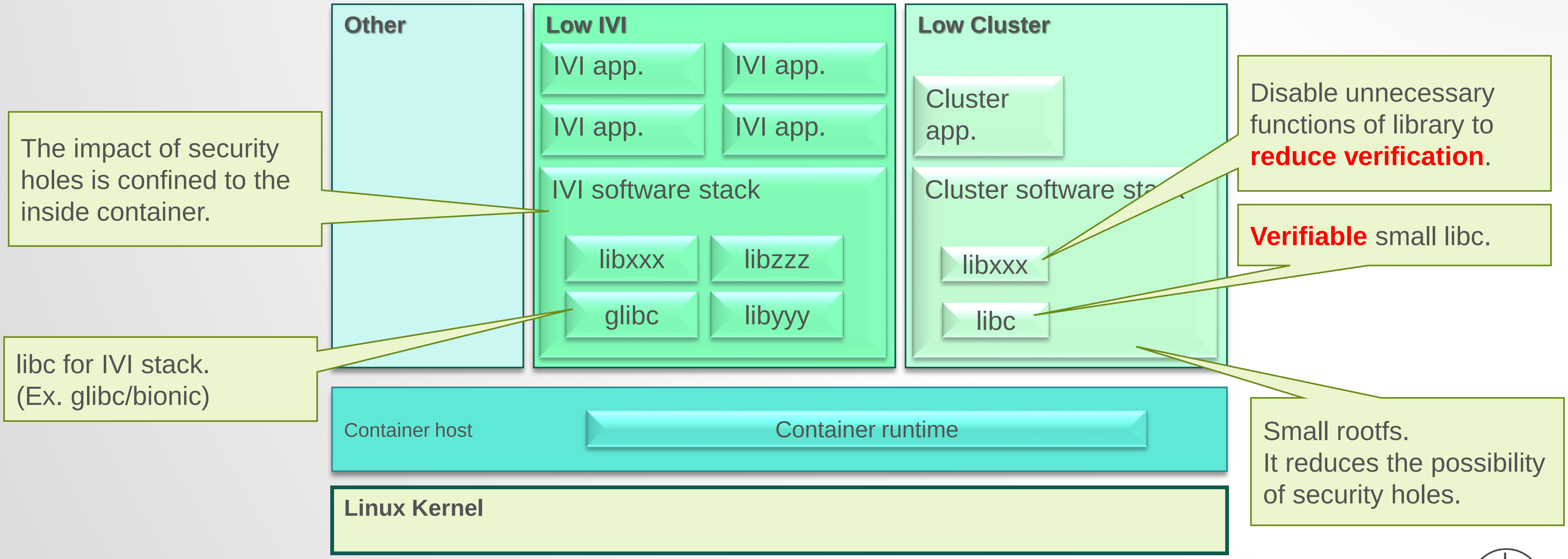
QM Isolation

- Our answer to solve various antinomies is “one more isolation method” with open source.

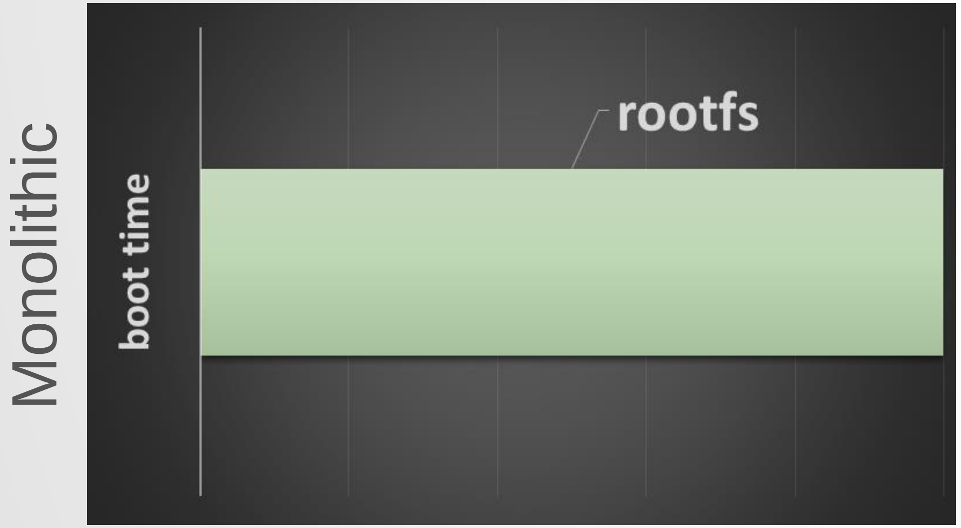


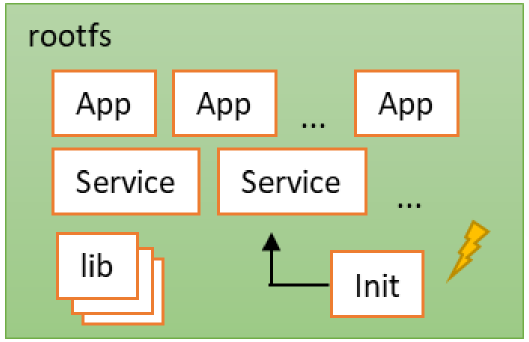
What is QM isolation

- Separate and optimize each software stacks using containers.
  - Various isolations such as access control and resource restrictions are performed by the container.

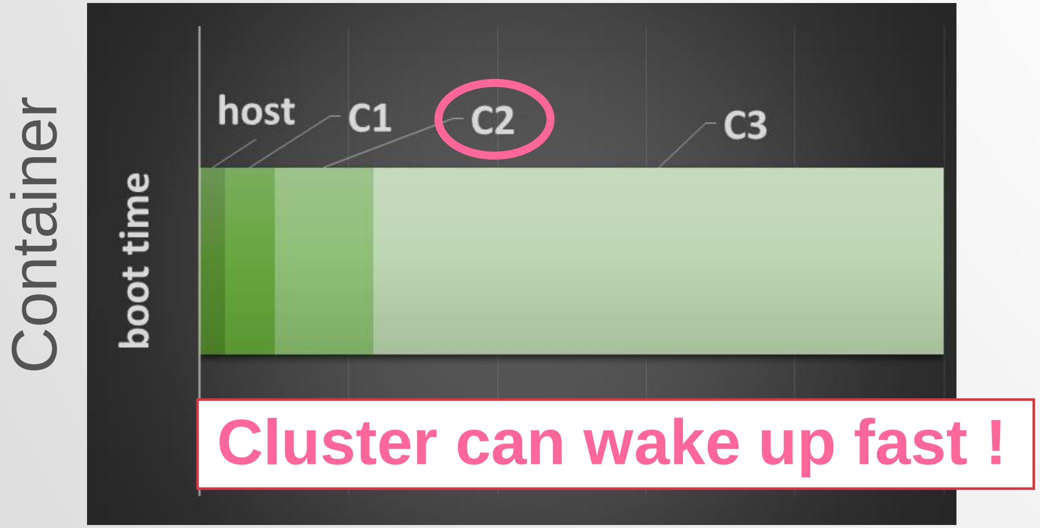


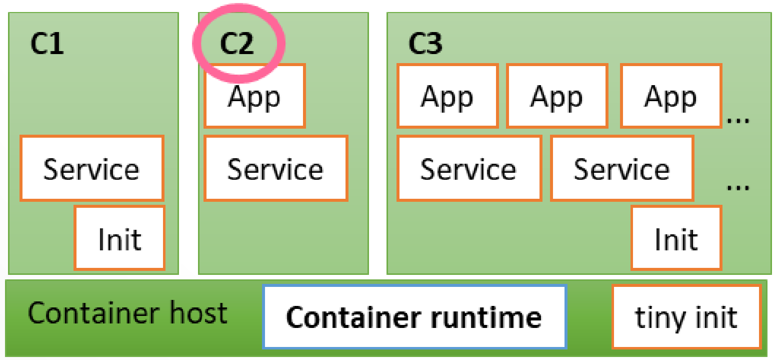
Why does container can boot fast?





- System has all resources in one rootfs
- System size will be big
- Launch all system components at one time.





- Separate filesystem into several containers
- Each container and host size can be small
- Separate booting

Challenge of container architecture

Quality Management for Linux Kernel

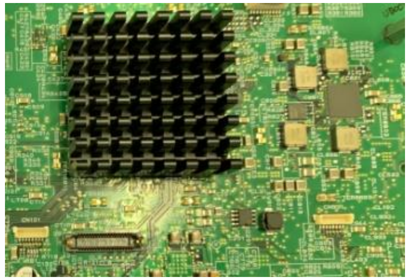
- We would like chip vender offer Kernel for QM isolation
- Minimize Kernel land (move drivers to user land)
- Cgroup, namespace and LSM is necessary at the moment
- Collabolate with ELISA Project

Current Work

Architecture

Target
Performance

Spec
(Spec EG)



Reference
Hardware
(R-Car E3)

Reference Design

Create source code according to above information

Source code

Next…

- Start detail architecture discussion e.g. Container, GUI, Sound, CAN etc.
- Start discussion with ELISA Project for Functional Safety and Quality Management.
- Create Spec
- Create Requirement for Cluster and Low IVI collaborating with Spec EG

Thank you