TOYOTA

An Open Software Platform and the Ecosystem for Connected Vehicles

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BR Connected Strategy & Planning

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68%

of new vehicle will be "connected vehicle" in 2025

(from recent SBD report / world-wide)

What is Connected Vehicle?

(1) Information services for the driver

What is Connected Vehicle?
(1) Information services for a driver (examples)

Mobility support
- Dynamic POI search
- Live location information
  (parking info, live store info, …)
- Dynamic Map & Traffic
- Dynamic & customized route

Enrich life in a vehicle
- Access to the internet
- Dynamic Music
  (internet radio, music on demand…)
- Social connectivity

Life touch services
- Personal schedule
- SNS

What is Connected Vehicle?

(1) Information services for the driver

(2) Enhanced safety & security

What is Connected Vehicle?
(2) Safety & Security (examples)

Remote monitoring & control
- Remote health check
- Remote vehicle control
  (door open/close, engine on/off)
- Remote alert
  (incl. Stolen vehicle tracking)

Remote maintenances
- Remote diagnostics
- Maintenances warning
- OTA software update

Driving support
- Eco-driving support
- Safety driving advice

What is Connected Vehicle?

(1) Information services for the driver

(2) Safety & security

(3) New services & businesses

What is Connected Vehicle?
(3) New services & businesses (examples)

- Provide information according to the driving skills and current driving load

- Automatics control of home appliances depends on vehicle location

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- Dynamic park & ride support
- Dynamic charge station info for EV

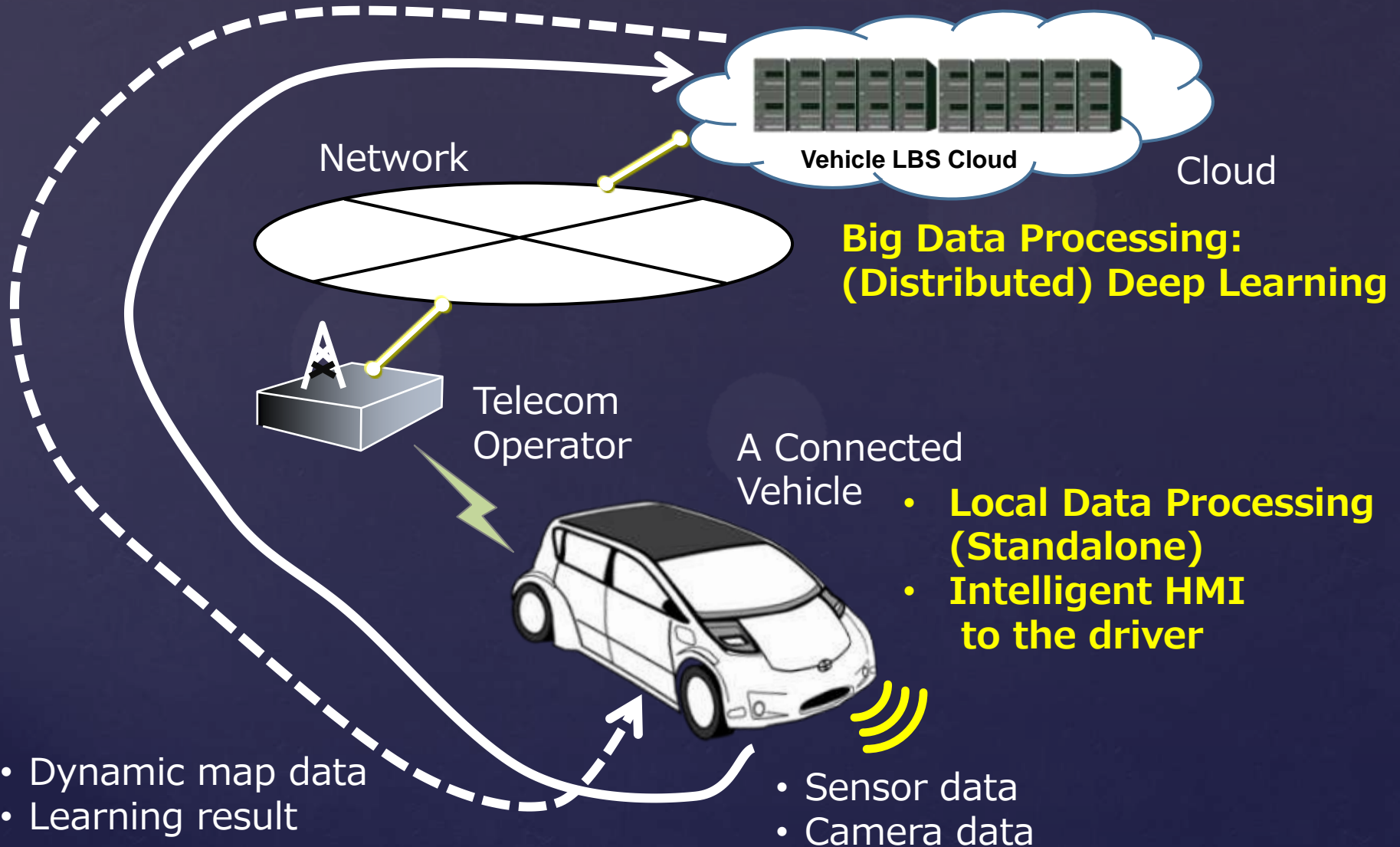- Integration of HEMS for charging vehicle battery for PHEV

- Traffic control
- Advanced Driving Assistance system with cloud data

What is Connected Vehicle?

(1) Information services for the driver

(2) Enhanced safety & security

(3) New services & businesses

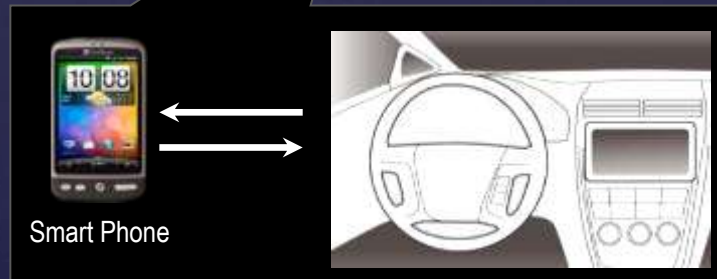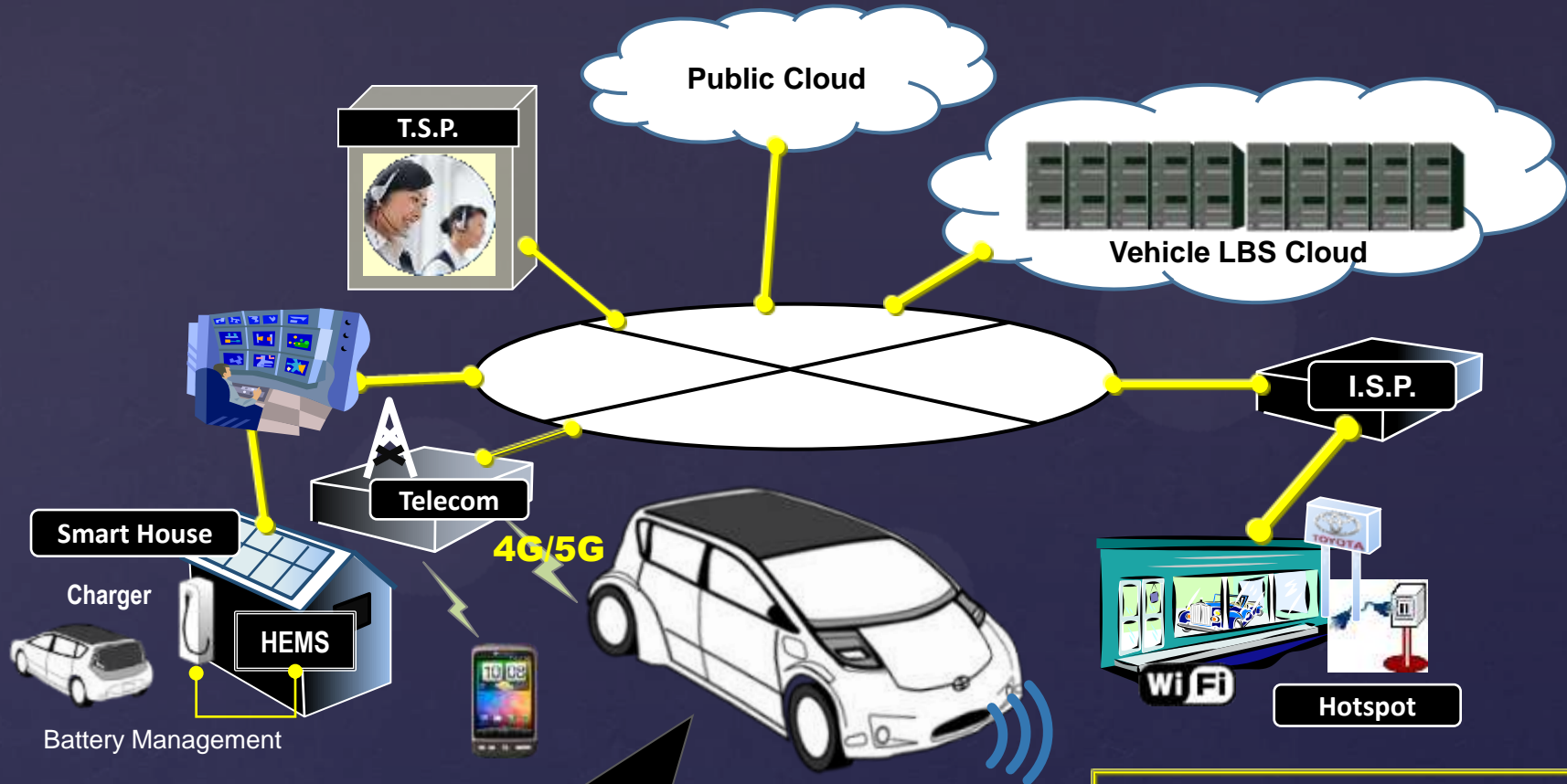(4) Enhanced vehicle capability

What is Connected Vehicle?
(3) Enhanced Vehicle capability(examples)

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Network

Vehicle LBS Cloud

Cloud

Big Data Processing: (Distributed) Deep Learning

Telecom Operator

A Connected Vehicle

- **Local Data Processing (Standalone)**
- **Intelligent HMI to the driver**

- Dynamic map data
- Learning result

- Sensor data
- Camera data

How to realize it?

Overall Systems View

Public Cloud

T.S.P.

Vehicle LBS Cloud

I.S.P.

Smart House

Telecom

4G/5G

Charger

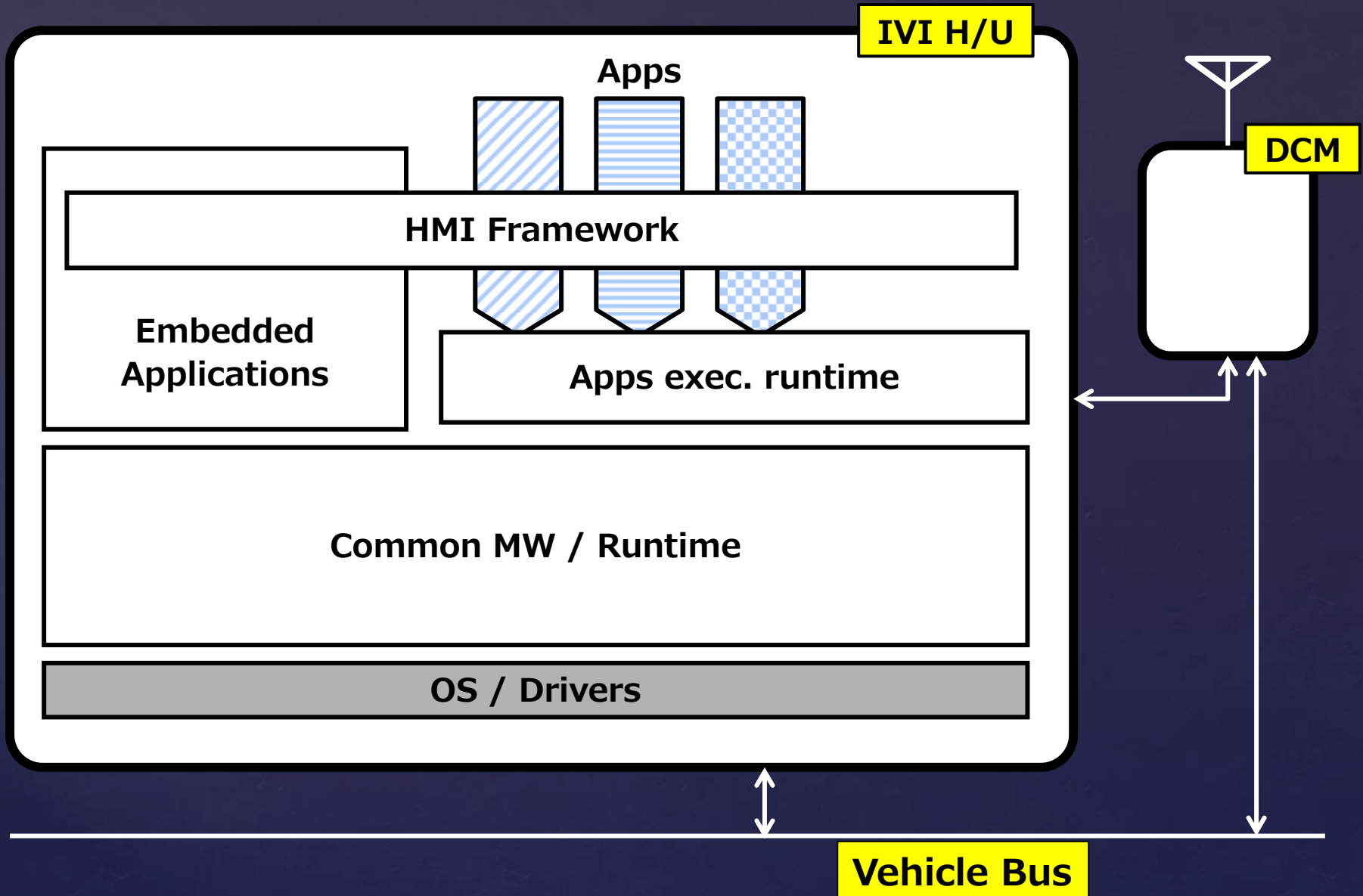**HEMS**

Battery Management

Smart Phone

Wi Fi

Hotspot

- **Need standard protocols & APIs**
- **Need open collaboration across industries**

In-vehicle Systems Overview

Requirements of In-Vehicle system

For reducing cost of the <u>development of the software platform</u>:
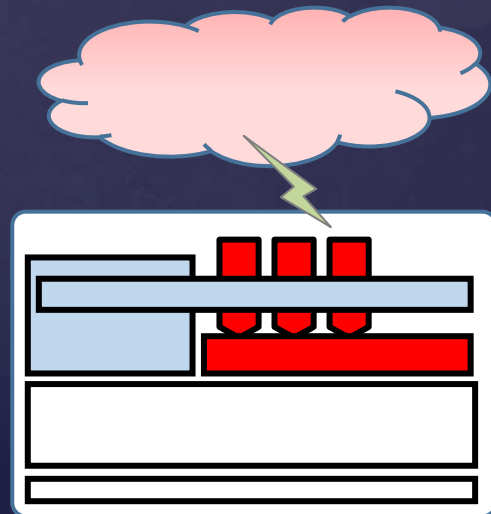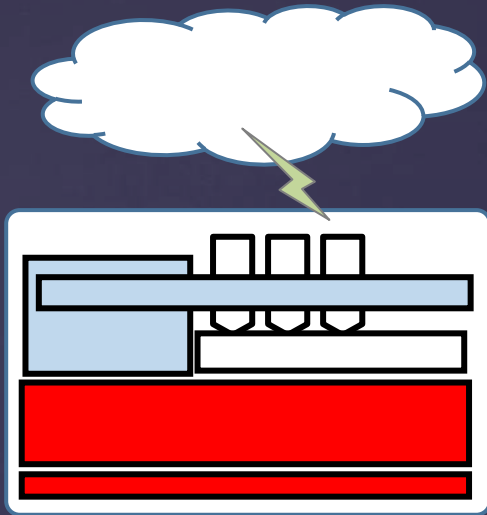
- Common & collaborative shared development for:
  - ➢ Cross-OEMs/Tier-1s
  - ➢ Cross-generations

In-vehicle software ecosystem

In addition,
for reducing cost of the <u>services & applications</u>:

- Common & shared behavior (=protocols and APIs) for:
  - ➢ Cross-OEMs/Tier-1s
  - ➢ Cross-generations
  - ➢ Cross-regional
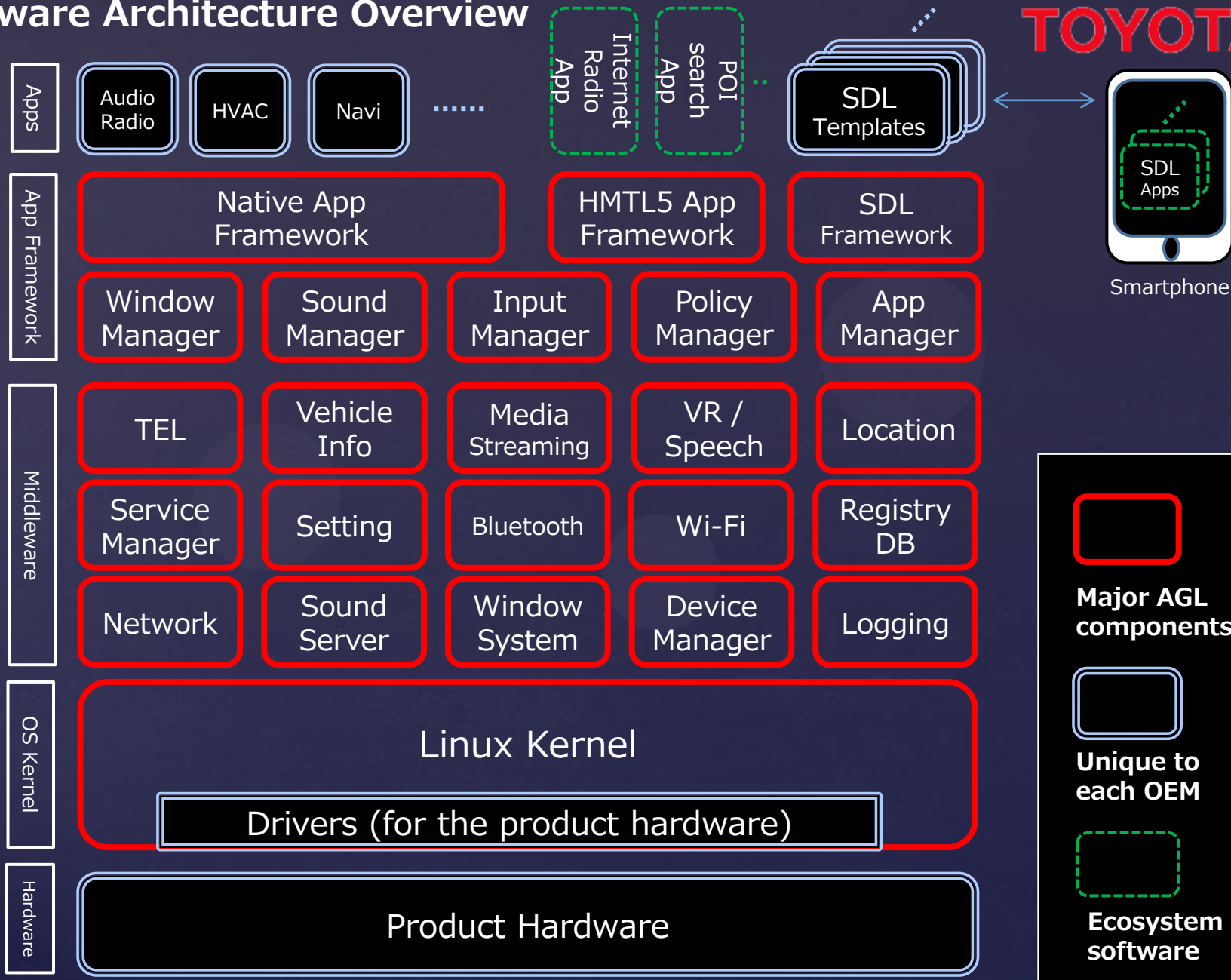 - ➢ Cross-models of vehicle
  - ➢ Cross-grades of vehicle

CV service ecosystem

What does its software should be in vehicle?

Software Architecture Overview

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Apps: Audio Radio | HVAC | Navi | ...... | Internet Radio App | POI search App | SDL Templates

Smartphone — SDL Apps

App Framework:
- Native App Framework
- HMTL5 App Framework
- SDL Framework

- Window Manager | Sound Manager | Input Manager | Policy Manager | App Manager

Middleware:
- TEL | Vehicle Info | Media Streaming | VR / Speech | Location
- Service Manager | Setting | Bluetooth | Wi-Fi | Registry DB
- Network | Sound Server | Window System | Device Manager | Logging

OS Kernel:
- Linux Kernel
- Drivers (for the product hardware)

Hardware:
- Product Hardware

Legend:
- Major AGL components
- Unique to each OEM
- Ecosystem software

- Still keeping "Code First" approach
  - We don't hesitate to change the requirement spec.
- More OEMs, Tier-1s, silicon vendors, and software vendors are joining.
- The AGL distribution project is rapidly progressed.
  - AGL system architecture team is closely working with GENIVI architecture team members.
  - More reference hardware from silicon vendors are prepared with their BSPs.
  - Phase-1 (Basic package) has been completed.
  - Phase-2 (incl. infrastructure for making the distro) will be completing very soon.
  - We may be able to release the v1.0 distribution in a few month!

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- Phase 1 - 100% Completed
  - Yocto layers and Bitbake recipes for a minimal AGL Build
    - QEMU
    - Renesas Porter
    - Sample Qt 5 apps
  - Linux Foundation Hosted Infrastructure
    - Git https://git.automotivelinux.org/
    - Gerrit https://git.automotivelinux.org/gerrit/#/
    - Jira https://jira.automotivelinux.org/
    - Jenkins (available soon)
- Phase 2 – Getting closer to complete
  - Complete build including demo apps with app framework
  - Complete code governance model
  - Complete test infrastructure

Summary

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- A "Connected Vehicle" has a lot of potentials.

- Open collaboration is essential for realizing "Connected Vehicle" services.

- Having common software across the industry is the key of the success in terms of both:
  - ➤ Unified open software in vehicle (for reducing PF development cost)
  - ➤ Open collaboration manner (for reducing both PF development cost and Service/Apps development cost)

In-vehicle software ecosystem

CV service ecosystem

Thank you.