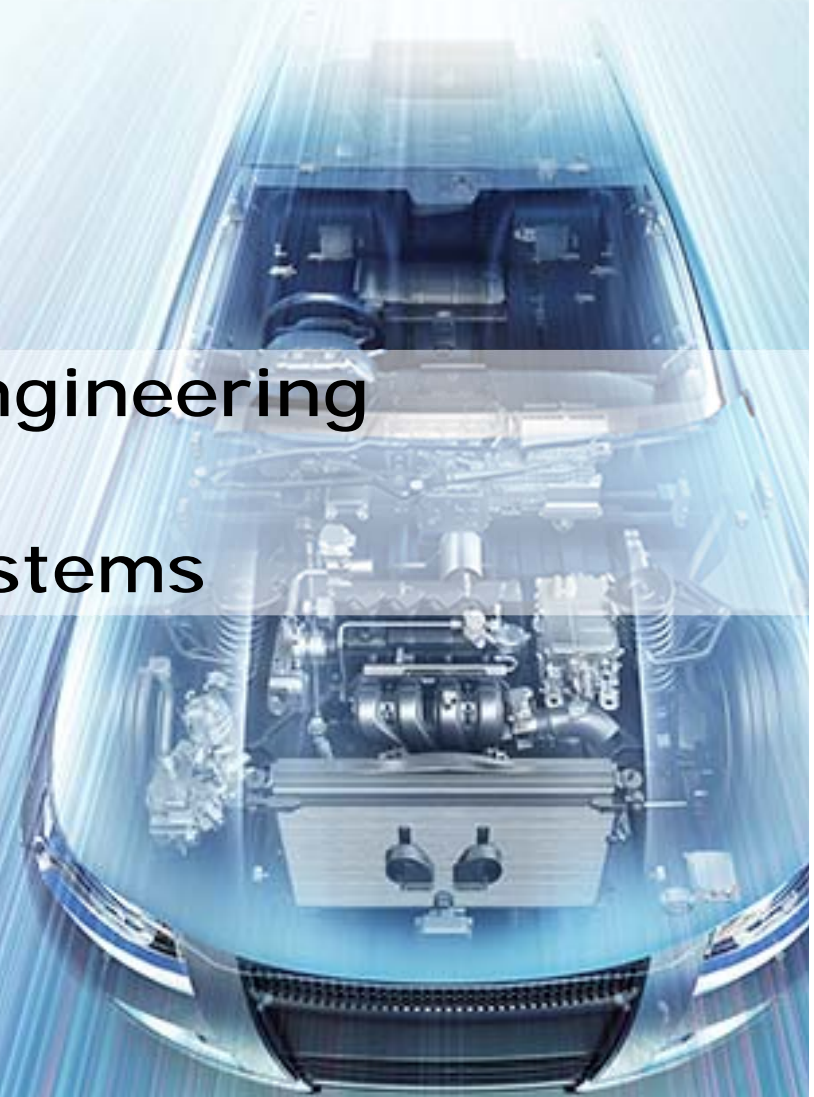**DENSO**

Crafting the Core

APLE: Agile Product Line Engineering
Parking Support System
of Automotive Software Systems

DENSO CORPORATION
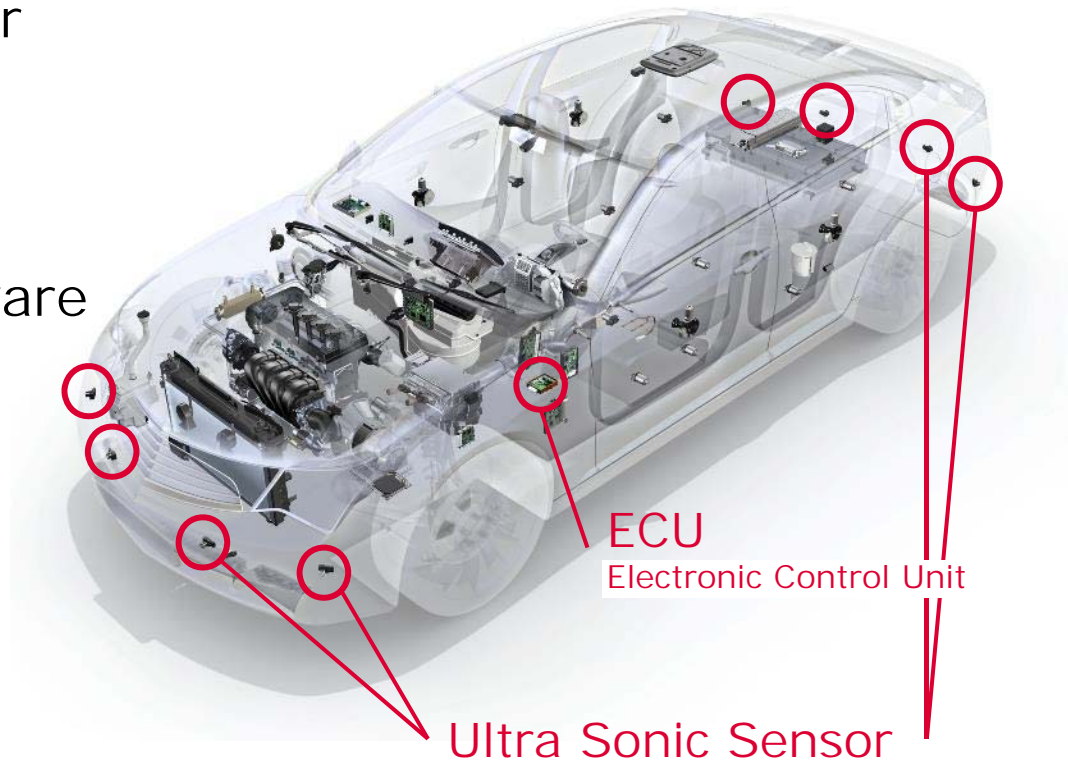
Position

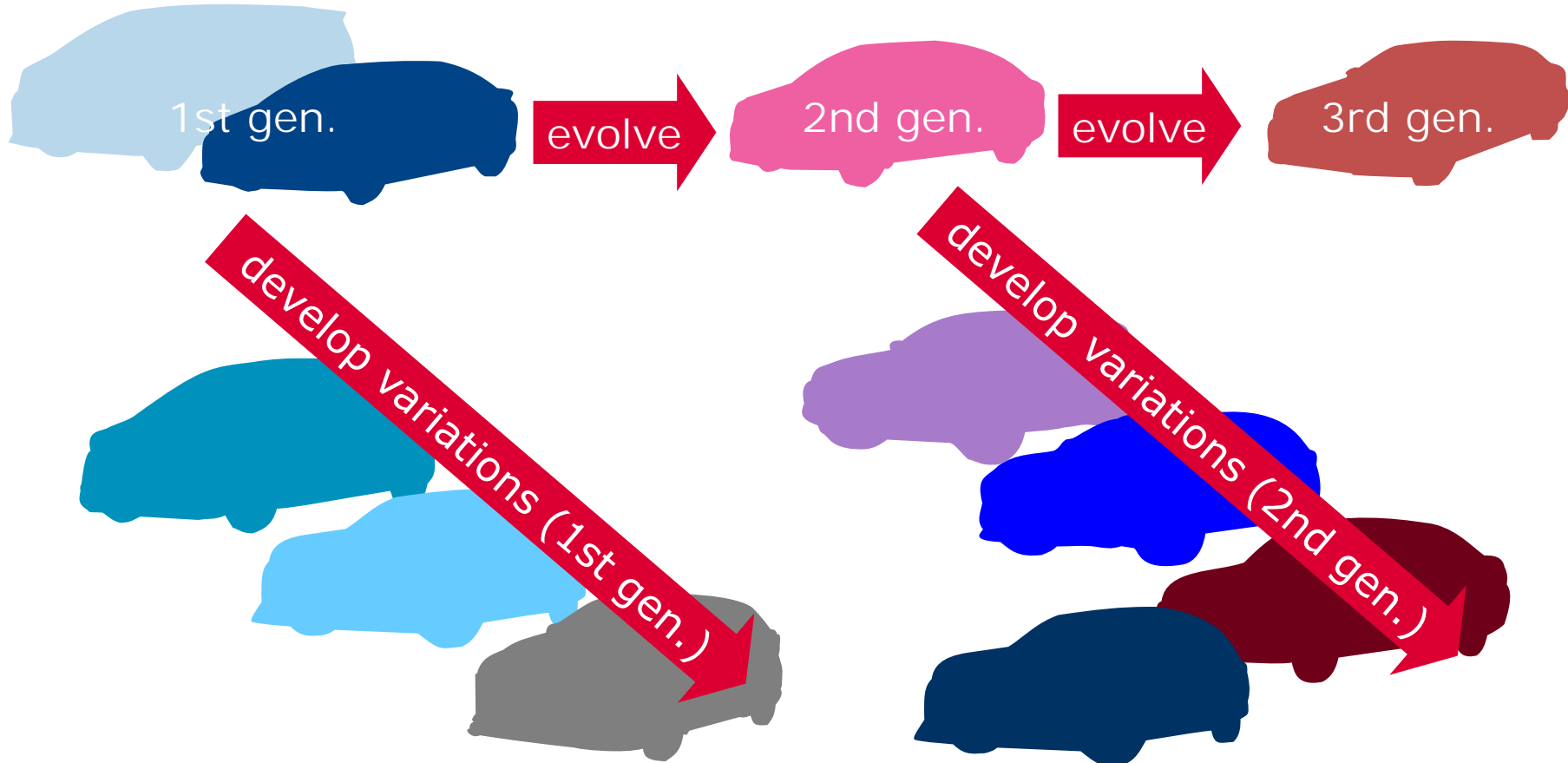Automotive System

- Parking Support System

- Ultra Sonic Sensor

Embedded Software

- ECU built in software

ECU
Electronic Control Unit

Ultra Sonic Sensor

DENSO
Crafting the Core

Business Environment

Technology competition is active and expected to expand

1st gen. → evolve → 2nd gen. → evolve → 3rd gen.

develop variations (1st gen.)

develop variations (2nd gen.)

Ship 17 products, 100 variations per year

DENSO
Crafting the Core

Commonality and Variability

・Commonality

  - Functional Logic :
        Alert, Collision Reduction, Auto Steering ...

  - Software Platform for ECU

・Variability

  - Type of sensor for collision detection :
        Ultra sonic sensor, Laser radar, Camera ...

  - Number of Sensors : 8, 12

  - Functional Combination

  - Variation of peripheral ECU : Gas or HV, Braking system ...
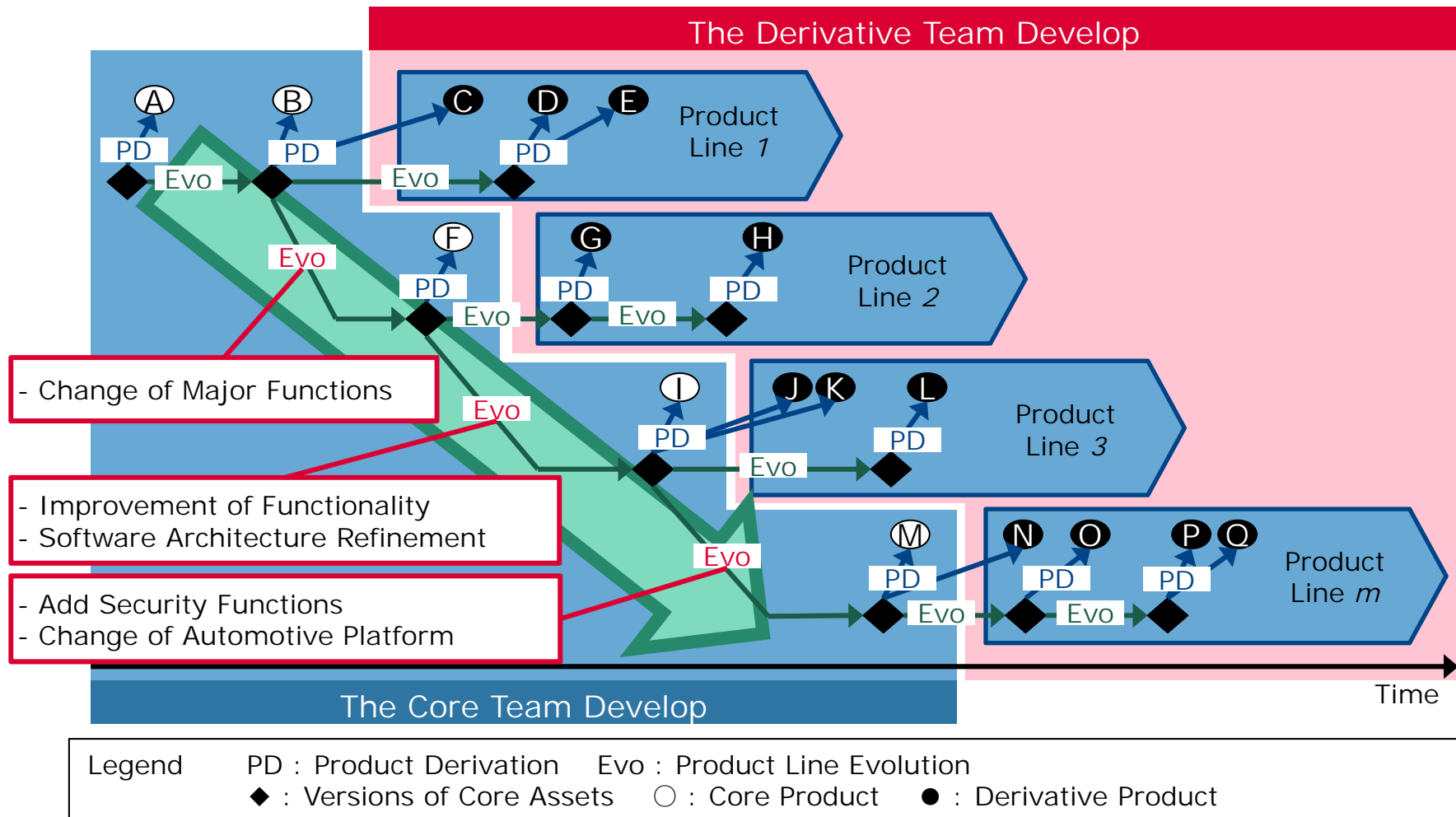
  - Vehicle adaptation control table

DENSO
Crafting the Core

Architecture

- Component based architecture with AUTOSAR

- Separate evolvability and variability
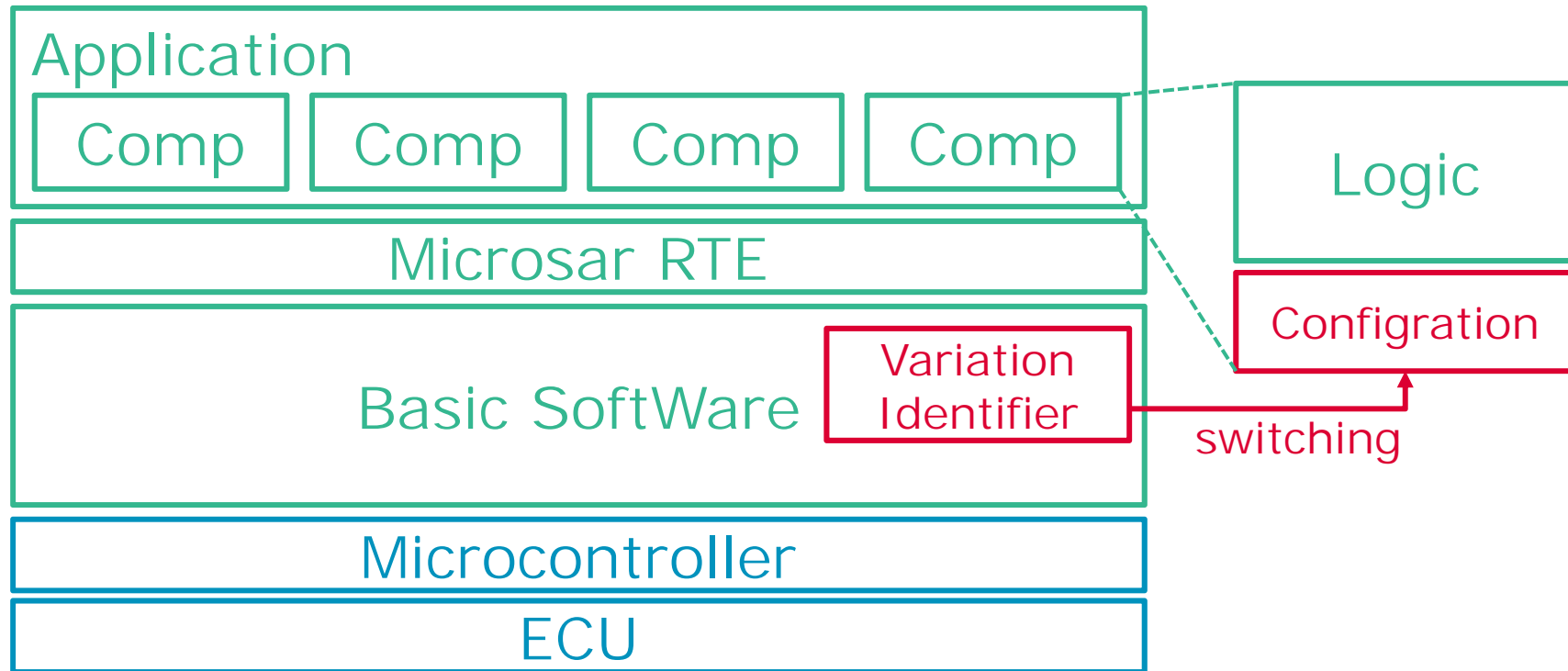
The core assets are managed separately and integrated

Development Organization

Legend
PD : Product Derivation   Evo : Product Line Evolution
◆ : Versions of Core Assets   ○ : Core Product   ● : Derivative Product

Collaborate with 2 divisions in the practice of SPLE

History

2000   Conventional Ultra Sonic Sensing System

           Configuration Tool

2013   First Architecture for Parking Support System

              AUTOSAR Architecture

              Configuration system

2016   Refactoring Architecture

              Management of Core Assets

2017   Concurrent Multiple Software Product Line Development

              Now Challenging

DENSO
Crafting the Core

Adaptation to Criteria

Identified product line

Commonalities and Variabilities

As shown in the first half of the presentation

Impact of product line

The derivative team ships 14 products, 80 variations per year

Less than 1/7 of the core team of developers

Commercially successful — Double Production Volume in 3 years

Document

- K. Hayashi, M. Aoyama, and K. Kobata. 2015. A Concurrent Feedback Development Method
and Its Application to Automotive Software Development. In Proc. 2015 APSEC. pp. 362–369.

- K. Hayashi, M. Aoyama, and K. Kobata. 2017. Agile Tames Product Line Variability. In Proc. 21st SLPC.

DENSO

Crafting the Core