Agile Development of Software Platform in Intelligent Driving Domain Controller based on AUTOSAR

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Agenda

► Development and Challenge in Intelligent Driving Domain Controller of Baidu Apollo
► MCU Platform Software of Intelligent Driving Domain Controller
► Agile Development of MCU Software in Intelligent Driving Domain Controller
► Summary
Strategy of Baidu Intelligent Driving Group

Apollo in intelligent vehicle, intelligent traffic, Robotaxi builds core power for growth apart from mobile business

- **Robotaxi**
  - Apollo Go
    - Provides Robotaxi service for private customer

- **Private cars**
  - ASD
    - Apollo Self-Driving
    - Provides intelligent vehicle solutions for business customer

- **City traffic**
  - ACE
    - Apollo Connected Efficient Mobility
    - Provides intelligent traffic solution (V2X), already deployed in 51 cities

Improvement of traffic efficiency can increase 2.4%-4.8% GDP of China
# Baidu ASD Products Matrix

## Intelligent Cockpit

<table>
<thead>
<tr>
<th>Duer OS</th>
<th>Duer SDK</th>
<th>Apollo Robo-Cabin Domain Controller+SDK</th>
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</table>

- An important component of intelligent cockpit

## Intelligent Driving

<table>
<thead>
<tr>
<th>AVP</th>
<th>ANP2.0</th>
<th>ANP3.0</th>
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<tbody>
<tr>
<td>Apollo Valet Parking</td>
<td>Apollo Navigation Pilot (Highway)</td>
<td>Apollo Navigation Pilot (Highway + Urban)</td>
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</table>

- Cooperate with intelligent driving HMI + HD Map

## Intelligent Map

<table>
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<tr>
<th>Navi Map</th>
<th>HMI-Map</th>
<th>HD-Map</th>
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- Apollo Navigation Pilot (Highway + Urban)
Roadmap of Baidu intelligent driving products
integration of 3 scenes

Pure Car AVP 1.0
- First-generation parking products AVP 1.0
  - Memory parking HAVP (single-layer)
  - Remote parking RPA
  - 360° Panoramic AVM
- High sound assistance UPA
- Fusion automatic parking FAPA

Mid-low power: 8-32 TOPS

Second-generation parking products AVP 2.0
- Functional progression:
  - AVP 1.0 all features
  - Mechanical position, low-speed AEB
- Performance improvement:
  - Parking time ↓
  - Path planning distance ↑
  - Path planning time ↓
  - Parking & Car HMI
  - Chip: TDA4-VM (8T) | Sensor: 5V12S

Mid-low power: 8-32 TOPS

Third-generation parking products AVP 3.0
- Functional progression:
  - AVP 2.0 all features
  - HAVP (layered), intersection, long-term memory path...
- Performance improvement:
  - Parking time ↓
  - Path planning distance ↑
  - Cruise speed ↑
  - Real-time planning
  - Chip: 2 x Orin-X (508T) | Sensor: 11V5R12S + 2L

High power: 508 TOPS

City Road Driving
- Road intersection / right turn
- Road掉头
- No protection left turn
- Ring road
- Obstructed left turn
- Main road switching

Integrate 3 scenes

Multi-domain integration ANP 3.0

City Road Driving
- ANP 2.0 all features
- Automatic through ETC

High speed driving
- ANP 2.0 all features
- Automatic through ETC

High speed driving
- ANP 2.0 all features
- Automatic through ETC

Software Architecture of Intelligent Driving Domain Controller

- **Application Layer**
  - Localization
  - Visual Perception
  - PNC

- **Framework Layer**
  - Apollo OS Built-In Service
  - OS-level Service

- **Hardware Abstraction Layer**
  - POSIX OS (Linux/QNX)

- **HW Abstraction**
- **Services**
- **AUTOSAR OS**
- **AUTOSAR Runtime Environment**
- **MCU**
- **Cloud system**
- **SoC**

- **Applications**
SOA architecture based on DDS within controller

- Dynamic publish and subscribe services base on data. Enables flexible deployment of applications
- Enhanced QoS services based on data fulfills requirements on real-time, reliability and data sequence.
- A DDS stack is integrated in MCU based on Eth stacks of AUTOSAR CP
- ASIL-D authenticated
Challenged in MCU software development

Simultaneous development of several projects on the same controller platform. Maintenance of several development branches.

Tight coupling software components.

Requirements change frequently. Shorter development cycles.
Inspiration from AUTOSAR

Core principles of AUTOSAR:
• Decoupling between SW and HW
• Modulation of SW
• Standardization of interfaces
Improvement of SW Architecture

**Loosely coupling:**
- Modulation of SW. Define clear boundaries between components
- Define interfaces for data exchange between modules

**Mainline SW architecture:**
- Platform SW: core logics independent from projects specific requirements and external interfaces
- Base SW: project-specific and vehicle types relevant logics
  - Project A
    - Platform SW
    - Base SW A
  - Project B
    - Platform SW
    - Base SW B
Methodology of mainline SW architecture

SW layers:
- AUTOSAR BSW belongs to Base SW
- Most CDDs are Platform SW
- Signal abstraction makes most APP independent from projects
- Define interfaces between Base SW and Platform SW

SW Management
- One Platform repository and several projects
- Base repositories
- Platform SW + Project Base SW = Project Output
- Changes in Platform SW work on all projects
- Quality assurances with help of CICD
Agile development of MCU software in intelligent driving domain controller

Release delivery of domain controller
2~3 months

MCU SW releases
1 week

MCU SW development
1 day

- SW requirements
- SW design
- SW development
- SW tests
- Verification and validation

- Release plan
- SW development
- Module tests
- Integration tests
- Bug fix
- SW Release

- Daily plan
- Coding
- Continuous integration
- Continuous deployment

- Push codes
- Code repo
- Results
Close loop

Data server

Vehicle tests

Data analysis

log and data of test and problems

Rapidly deployment

New output

SW improvement

Data analysis

Vehicle tests

log and data of test and problems

Rapidly deployment

New output

SW improvement

Data server
Joint-development in MCU based on AUTOSAR

**OEM**
- ECU Extract .arxml / .dbc
- SWC description .arxml
- SWC implementation and interface definition .c, .h
- Local compiling and tests
- SWC object 文件 .obj
- Vehicle integration test

**Baidu**
- AUTOSAR development and configuration tools
- MCU implementation and interface definition .c, .h
- MCU base project .obj
- Integration
- Binary file .hex
- Integration test
Summary

• MCU modulation and mainline SW architecture makes simultaneous development of one platform for several different projects and vehicle types possible.

• With the help of agile development and CICD, the rapidly changing requirements are fulfilled and the quality of deliveries is assured.