Integration Architecture for the Automotive Digital Thread

OSLC Fest 2022

Jens Krueger, NTT DATA
is part of the **NTT Group**, with over **330,000** employees in more than **80+ countries** and revenues of over **108 billion dollars**.

- **88%** of the Fortune 100 are customers
- **80+** Countries
- **#1** operator of Data Centres
- **#5** IT Consultancy in Germany
- **#4** Global internet traffic
- **$3.6 B**
  R&D invest with
  **5,000**
  R&D researcher
- **Germany**
  385 MEUR rev.
  2000 employee
  12 locations
- **#5**
  Top Employer
  Germany
  **2022**
SAY DIGITAL THREAD AGAIN
I DARE YOU
Agenda

Product Development

Product Operations

Product Interoperability

IT Infrastructure
Product Development

Connecting product structures
Digital thread to connect product structures throughout the lifecycle for traceability and automation

Digital thread connects the system break-down
- requirements
- architecture models
- items (mechanical, electrical, software)
- manufacturing planning
- test plans / results

Configuration & change management with versions, revisions, alternatives, options, baselines

Horizontal and vertical traceability in Automotive SPICE

Authoritative data for type approval (homologation)

PLM – ACES ALM integration

Source: Raytheon, PDT Europe 2020

Source: Automotive SPICE PAM 3.0
ACES ALM defined

**ACES**
- Autonomous, Connected, Electric and Shared
- The four major strategic pillars of automotive companies

**ALM**
- Application Lifecycle Management
- Managing software from its initial conception, through the development & testing phase and ongoing support to its end of life
- ALM tools provide support for activities such as software planning, requirements management, team collaboration, development, test, integration & build

**ACES ALM**
- Application Lifecycle Management for ACES software
- For incar (embedded) and related data / offboard / backend software

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ACES ALM Software Lifecycle

ECU Functions / Applications
- Operating System
  - Middleware
  - Runtime Environment
  - OS Services
  - HW Abstraction / Drivers

Data
- Parameters
- Neural networks
- ...

Incar / Onboard
- Connected Backend / Cloud
  - Functions / Services
  - Update Management
  - Data collection
  - Security Operations Center
  - 3rd party interface (e.g. HERE)
  - ...

Offboard Apps
- Phone
- Watch
- Desktop apps
- Browser apps
- Diagnostics
- ...

Types of ACES Software

Portfolio & Requirements
Design & Development
Integration, V&V
Deployment
Operations, Maintenance
End of Life
Drivers of ACES ALM

ACES engineering business drivers
- Separation of hardware and software
- Domain-controller architectures
- Integrated enterprise & embedded IT
- Data-driven engineering, e.g. ADAS functions

Processes & Methods
- Model-based systems engineering (MBSE)
- Process & tool baselines
- Variant & configuration management and PLE
- Scaled Agile

Regulatory requirements
- Automotive SPICE
- Lifecycle management / Software Update Management
- Cyber Security
- Functional Safety

IT strategy drivers
- Cloud-native architectures
- Developer experience
Product Operations

Connecting operations data
Digital thread to connect product structures with operations data for feedback and data-driven engineering

Requirements optimization by understanding customer behavior in different markets

Product portfolio and variance optimization by understanding actual function usage in the fleet

After-sales optimization by tracing back error codes to design data and requirements

Regulatory compliance

- China Real Time Monitoring for BEV
- UNECE R155 / 156 SUMS CSMS
United Nations Economic Commission for Europe (UNECE)
Taskforce “Cybersecurity and Over The Air Issues”.

„Software Update Management System“ (SUMS R156)
- Transparency: Ensure authenticity, integrity and traceability of software and updates for vehicles
- Integrity: Verify, validate and protect software and update
- Safety: Ability to ensure recoverability and to prevent malfunction of the vehicle
- Enable adaptions throughout the lifetime of the vehicle (RXSWIN)

„Cyber Security Management System“ (CSMS R155)
- Security: Establish measures to prevent cyber attacks (Incar, backend & connections) & manipulation
- Compliance: Consider threats, mitigations and principles to certify compliance
- Ensure cyber security over the lifetime of the vehicle
Product Interoperability

Connecting digital twins
Digital thread to connect multiple digital twins for mobility systems and smart city
Standards as enabler for interoperability

Source: prostep ivip SSB (Standardization Strategy Board)
IT Infrastructure

Connecting data silos
Digital thread integrates data across a heterogenous application landscape for automation and scalability

Model-Based Systems Engineering
Digital Twin / Digital Thread
Agile, Data-Driven Product Development
SENSEI - Systems Engineering and Scalable Enterprise Integration
NTT DATA Systems Engineering Integration Architecture Blueprint

Data Engineering
- Reporting
- Adv. Analytics
- AI/ML Training

End-User Apps
- Engineering
- Requirements Management

Partner Integration
- Collaboration
- Data Exchange

Consumer Apps

Cross Function

SE Data Integration
- Ontology
- Meta Data Management
- Linked Data

Process Integration
- API Management

Integration Foundation
- ETL/ELT
- Data Lake
- Data Virtualization
- Streaming
- Messaging

Backend

Resource / PLM Backbone
- Commercial off the Shelf Software
- Self-Developed Software

Access Management
- Identity Management
- Permission Management

NTT DATA
SENSEI
Systems Engineering Integration

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