Integrating AI Models with Data Collection

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14 May 2025

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Accelerating the future of connected vehicles

Applications of AI in Vehicles

- **Advanced Driver Assistance Systems (ADAS)**
  - Object detection and recognition
  - Driver assistance
  - Driver monitoring
- **Autonomous Driving**
  - Perception (sensor fusion)
  - Path planning
  - Vehicle command and control
  - Safety monitoring
- **Predictive Maintenance**
  - Realtime vehicle data analysis
  - Recognize failure relevant deviations
  - Optimize service content and intervals
- **Vehicle User Interface**
  - Speech recognition and response
  - Personalization
  - Driver emotion monitoring & intervention
- **Cybersecurity**
  - Detect anomalies in vehicle network traffic
  - Realtime cyberattack identification
  - Realtime intrusion defense
- **Energy Management**
  - Range prediction
  - Battery usage optimization

Challenges of AI in Vehicles

- **Safety and Reliability**
  - Unexpected behavior
  - Overfitting
  - Hallucinations
  - Black-box nature
- **Data Privacy**
  - Risk of data leaks or misuse.
- **Security Vulnerabilities**
  - Added complexity
  - Unexpected Behavior
  - Spoofing
  - Command Injection
- **Legal and Ethical Issues**
  - Liability
  - Ethical dilemmas in decision-making
  - Deception
- **Creation & Maintenance**
  - Proper training data
  - Proper data labeling
  - Model degradation (drifting)
  - API and version compatibility
- **Higher Resource Requirements**
  - Heat and power

VSS Challenge: Data for Global Model Training

- **Advanced Driver Assistance Systems (ADAS)**
  - Is recognition correct
  - When does the system deactivate itself
  - Driver recognized state vs performance
- **Autonomous Driving**
  - Is the fused world view correct?
  - Actual route vs best route
  - Driver interventions
  - Safety violations
  - Precrash Data
- **Predictive Maintenance**
  - Data around unexpected failures
- **Vehicle User Interface**
  - User feedback
- **Cybersecurity**
  - False positives
  - False responses
- **Energy Management**
  - Deviation between prediction and actual use
  - Ineffectiveness of operations

Model Updates Change Signal Profile!

System Requirements

- **Robust Application Over-the-Air Update**
  - Incremental (modular)
  - Selfaware in-vehicle software framework
  - Version tracing and compatibility
- **Dynamic Data Acquisition**
  - Plan Updatable during operation
  - Vehicle specific signal catalogues
  - Uniformly named signals (VSS)
- **Unit Carrying Signals**
  - All values have measurement units, e.g., Degrees Fahrenheit
  - Simplified interpretation by AI models

Software-Defined Data Collection

Evolution of Data Collection

Static Aquisition

- Predefined Signals
- Limited control

Rules w/ Fixed Operations

- Downloadable Rules
- Predefined Signals
- Predefined Operations
- Frequency Control
- Event Triggers

Dynamic Network & Nodes

- Network of Nodes
- Dynamically Updatable
- Dynamically Defined Nodes
- Based on Application Framework
- Eases Merging Multiple Data Aquisition Plans
- VSS selfawareness

Vehicle Data Collection Process

Conversion

- Convert native data to vehicle independent signals
- Partially covered by VSS
- No filtering
  - Only CAN & AUTOSAR signals.

Signal Conversion Manifest

Preprocessing

- Compose signals not present natively.
- Compress data
- Store data
- React to triggers
- Subsystem modeling
- Interact w/ AI Model

Software Bundles

Selection

- Decide what signals to send when
- Uses both converted signals and preprocessed data
- Describable as a network

Data Acquisition Plan

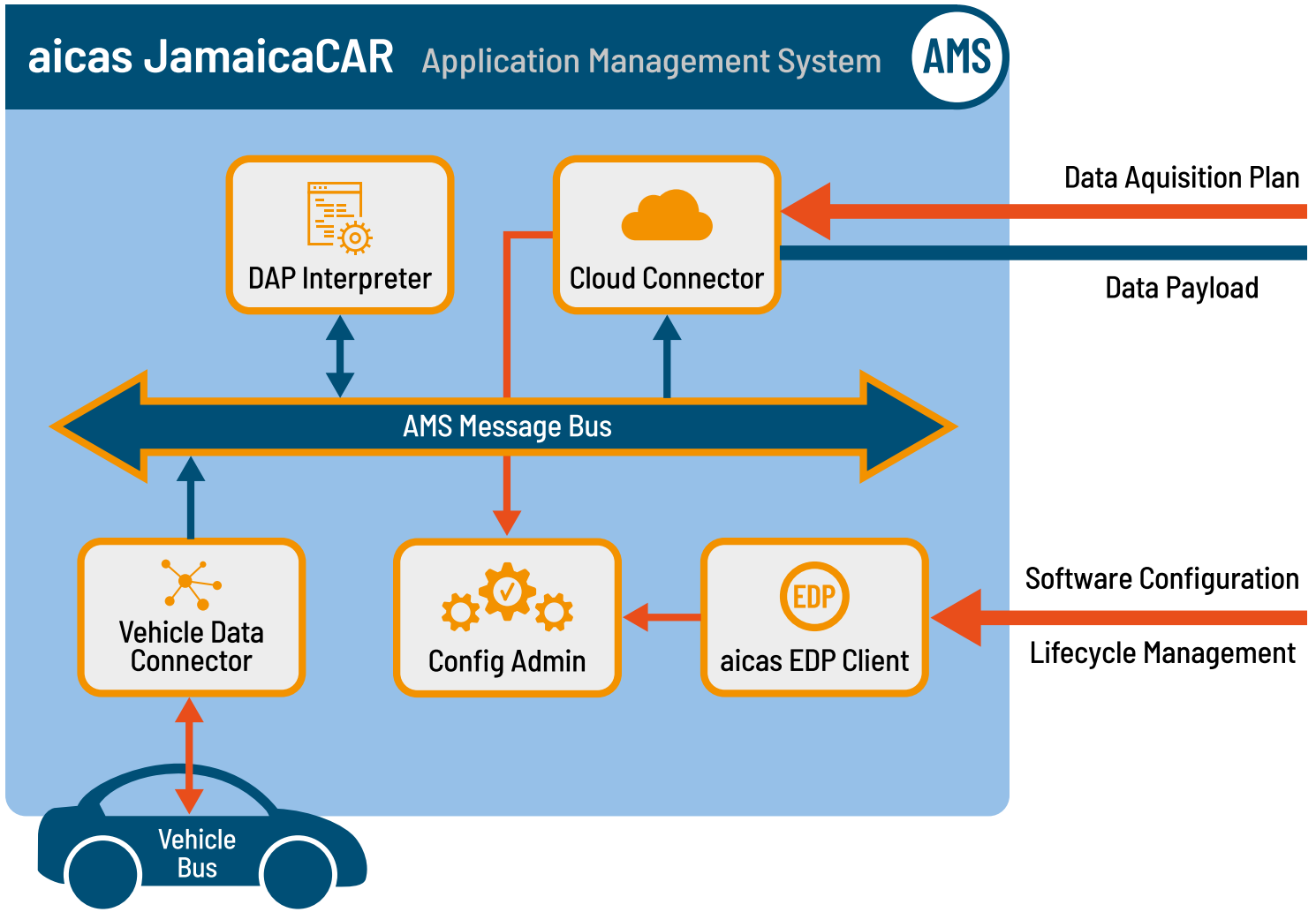
Transmission

- Connect to server
- Transmit requested data
- Handle all failure modes such as network disconnect and server failure

Sparkplug

Integrating AI into Data Collection

1. Alls AI models must be field upgradable.
2. Signal catalogue must be dynamically updates
3. Data Acquistion Plan must be dynamically changeable
4. Each vehicle must know what signal it can supply (selfawareness)
5. There must be a well-defined process for updates of all three components.



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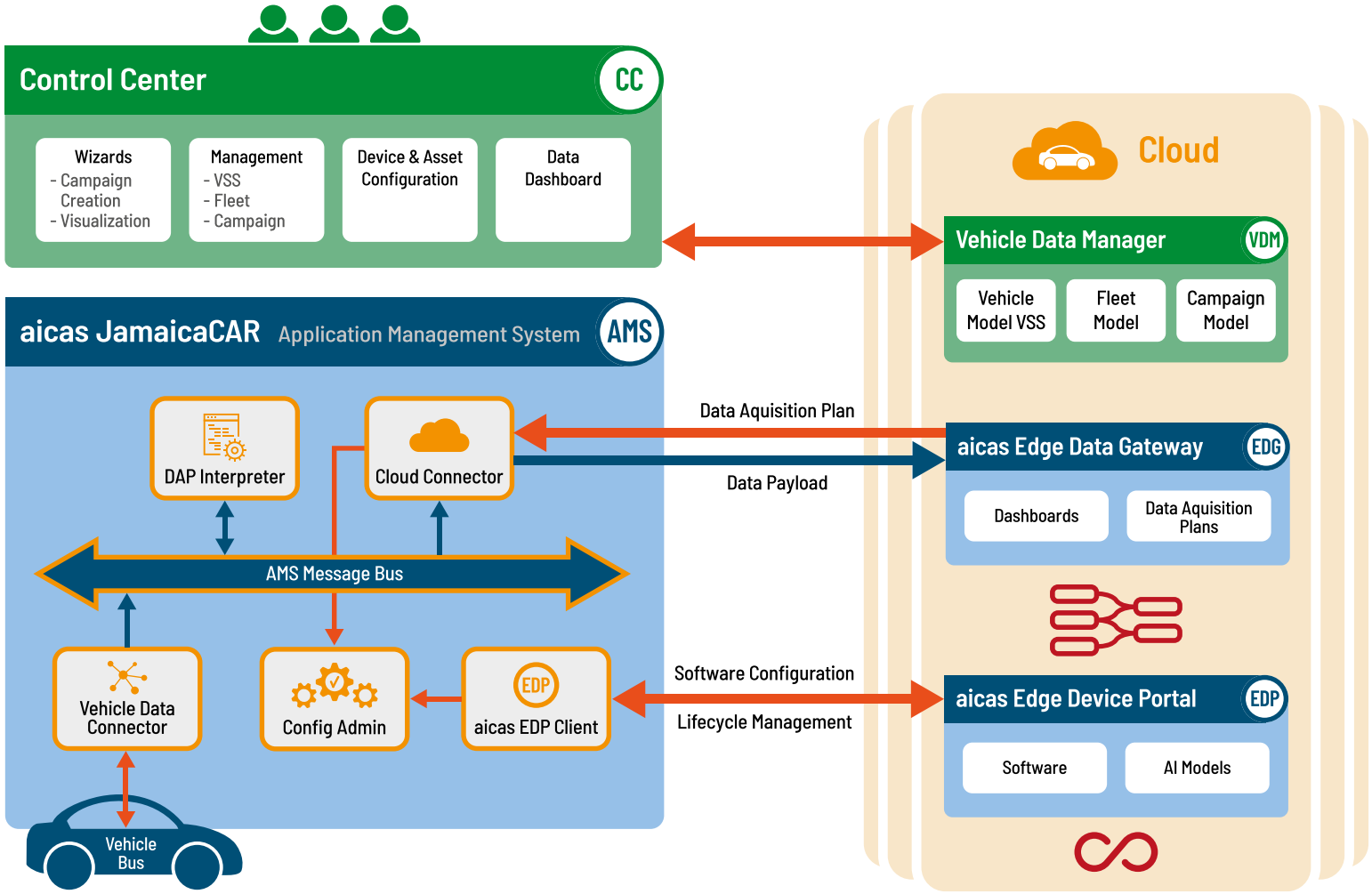
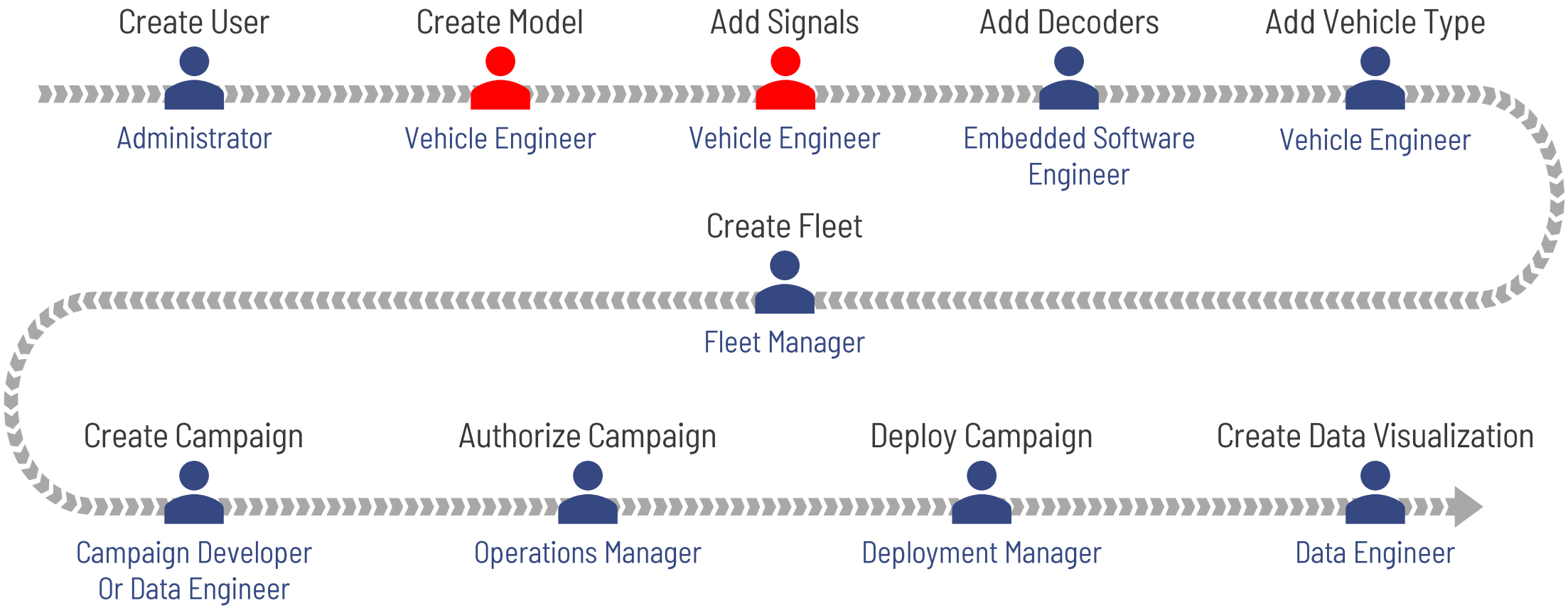
Vehicle Support Architecture



Role-Based Access



Who needs Data Collection? Example Roles and Permissions

Acquisition Element	Create	Read	Use	Authorize	Update	Delete
Vehicle connector	ESW Eng	ESW Eng SW Eng	ESW Eng SW Eng	QA	ESW Eng	ESW Eng Ops Mgr
Enterprise VSS catalog	Vehicle Mgr	Vehicle Mgr SW Eng	Vehicle Mgr SW Eng	QA	Vehicle Mgr	Ops Mgr
DB Schema	IT Eng	IT Eng SW Eng	IT Eng SW Eng	QA	IT Eng	Ops Mgr
Vehicle Data	Vehicle Eng	Vehicle Eng Data User	Vehicle Eng Data User	Vehicle Mgr	Vehicle Eng	Vehicle Mgr Ops Mgr
Vehicle Definition (VSS)	Vehicle Eng	Vehicle Eng Data User	Vehicle Eng Data User	Vehicle Mgr	Vehicle Eng	Vehicle Mgr
Fleet	Fleet Mgr	Fleet Mgr Data User	Fleet Mgr	Deploy Mgr	Fleet Mgr	Fleet Mgr
Data Acquisition Plan	Data User	Data User	Data User	Deploy Mgr	Data User	Data User
Campaign	Data User	Data User	Data User	Ops Mgr	Data User	Data User
Visualization Template	UI Design	UI Design Data User	UI Design Data User	Data Mgr	UI Design	UI Design

AI Impact on Data Collection Process

- Data Collection and Model Generation Need Coordination
- Devops and data collection process must be interoperable
- Necessary to maximize business value creation and robustness

Tracing Software Providence

UN Global Regulations

Cyber Security and Software Updating

- UNECE r155—vehicle cybersecurity and cybersecurity management systems
- UNECE r156—vehicle software updates and software update management systems

ISO Guidance and Best Practice

Road Vehicles

- ISO/SAE 21434:2021 Cybersecurity engineering
- ISO 24089:2023 Software update engineering

US Government: EO 14028—SECURING THE SOFTWARE SUPPLY CHAIN

Challenges of Regulatory Guidelines

- Implicit assumption that software update is global: one number for everything
- Does not consider that the vehicle could track all installed software: selfawareness
- Does not address modular update
- If not handled correctly, this could be the death of the software defined vehicle

These issue can be handled through version naming conventions, but that is awkward

Summary

- The use of AI increases vehicle functionality.
- It also increases OEM risk.
- Robustness is paramount
  - Modular updatability
  - Well-defined unit carrying data (signals) and data catalogue (VSS)
  - Dynamic, synthetic signals
  - Seamless integration with and between AI models
  - Selfaware framework
- So is the Process
  - Role-based access w/ change review and testing process
  - Well documented change history

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Thank you for your attention!
Please visit us this evening.

Simplifying Edge-to-Cloud

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Integrating AI Models with Data Collection

2:05 PM – 2:25 PM Wednesday

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Machine Learning (ML) is a game changer for vehicle data collection. Most systems are still rather static, where a fixed set of signals are collected. There are OEMS, that have systems, where data collection can be tailored using a data acquisition plan, either as collection rules or a data flow network. Even here, the challenge is to bring this flexibility to the customer. It is much easier to offer a selection of the signals already being collected than provide a system where the customer can select from the thousands of available signals and configure triggers and rates. Models could be used both to reduce the data that needs to be transmitted and help an OEM data customer to provide a plan that provides only the data actually needed and combine different plans for deployment to a vehicle. This talk will discuss what is necessary to integrate ML with data collection.