Using FMI/ SSP for Development of Autonomous Driving

presented by Jochen Köhler (ZF)

FMI User Meeting 15.05.2017
Prague / Czech Republic
Motivation I

• Autonomous Driving is a Megatrend for the automotive industry
• Intensive cooperation of companies is mandatory
• Simulation is essential for efficient development and future homologation of products
• Platforms and interchange standards are needed and decided upon in the very near term (< 1-2 years).
• Great chance for further FMI impact, however limited time horizon for needed evolution...
Motivation II

- **HAD & Connected System Simulation Environment**

  **Environment**
  - 3D Road Network & Infrastructure
    - Freeway, rural & Urban roads, Buildings
    - Traffic signs, traffic lights
    - Street markings
  - Traffic
    - Vehicles, Pedestrians
    - Objects
  - Environmental Conditions
    - Weather, Lighting
    - Friction coefficient

  **Sensors**
  - (Models)
    - Radar
    - Lidar
    - Camera
    - Inertial & wheel speed sensors
    - GPS, map data

  **System Fct**
  - Environment Perception
  - Decision Making
  - Motion Planning & Control
  - Actuator Management
  - Odometry/Localisation

  **Server, Cloud**

  **Test Scenarios**
  - Simulation Environment

  **Vehicle Model**

  **Actuation**
  - Brake
  - Steering
  - Power Train

  **Connectivity**

  **HAD System Functional Chain**

  **FMI /SSP for Autonomous Driving (BOSCH, BMW, ZF, dSPACE, PMSF) – FMI-User Meeting 15.05.2017**
Motivation II

FMI provides insufficient datatypes for sensors

- **Environment**
  - 3D Road Network & Infrastructure
    - Freeway, rural & Urban roads, Buildings
    - Traffic signs, traffic lights
    - Street markings
  - Traffic
    - Vehicles, Pedestrians
    - Objects
  - Environmental Conditions
    - Weather, Lighting
    - Friction coefficient

- **Sensors**
  - Radar
  - Lidar
  - Camera
  - Inertial & wheel speed sensors
  - GPS, map data

- **System Fct**
  - Environment Perception
  - Decision Making
  - Odometry/Localisation
  - Vehicle Motion Control

- **Server, Cloud**
  - Connectivity

- **FMI Co Simulation ✔**

- **HAD & Connected System Simulation Environment**

- **FMI**

FMI / SSP for Autonomous Driving (BOSCH, BMW, ZF, dSPACE, PMSF) – FMI-User Meeting 15.05.2017
Usage of SSP in defining Simulation Architecture for ADAS in ZF

Signal dictionaries

Environment: Infrastructure, Car2X, Traffic, Weather

Driver: Behavior, Human mechanics, HMI

Ego-Vehicle: Driveline, Gearbox, Actuators, Driveline, Chassis, Actuators, Axles, Wheels, Sensors, Cameras, Radar, Lidar

ADAS functions: Sensing, Perception, Planning, Actuating

FMI /SSP for Autonomous Driving (BOSCH, BMW, ZF, dSPACE, PMSF) – FMI-User Meeting 15.05.2017
SmartSE solutions in SE Collaborations

- **Partner A**
  - Model Content
    - Model Data Management
    - IP-Protection
  - WP 5
  - WP 6

- **Partner B**
  - Model Data Management
  - IP-Protection
  - WP 5
  - WP 6

- Standardized architecture & artifacts
  - WP 2

- Standardized processes & formats
  - WP 3
  - WP 4
Usage of FMI / SSP for Autonomous Driving

• Motivation:
  – AD system models require integration of environment simulation, sensor models, AD algorithm components with driving dynamics
  – Sampled systems, requiring complex data types (object lists, reflex lists, ...) with dynamic sizing and large scalar content (>> 10000 scalars)
  – Complex connectivity, exchange of connected systems between platforms

• Requirements:
  – Extension of FMI with more interface data types:
    • Opaque binary data types (e.g. length-terminated, MIME-Type tagged)
    • Better: Integration of proper Interface Description Language
    • Not needed: Use of those data types as continuous variables in ADEs
  – Extension of SSP with matching connector types.

• Activities:
  – SmartSE: Unification of driver models, common driver model interfaces
  – FMI + Open Simulation Interface as sensor model interface standard
Requirements to FMI / SSP

- Better support in FMI (2.1?) for sampled data systems in FMI for Model exchange or hybrid Co-Simulation include sensor, controller and ECU-SW models in system simulation.
- Improve Standard compliance of FMI supporting tools by extended cross-checking in order to fulfill requirements to support homologation.
- SSP Standard must be compatible / convertible to ASAM Standard used for ECU-SW description.
Conclusions

• Standards are essential for cross-company development and simulation of HAD systems

• A few major points are presented here
  – Standards for sensor interfaces → Extension of FMI standard
  – Standards for connection and parametrization of FMUs → SSP
  – Shared good practice / usage hints for FMI, co-simulation
  – Approach for cross divisional specification, creation and maintenance of standardized models
Backup
FMUs from 5 different companies combined to “System Model”
For each FMU different variants used (6 cycle-, 4 driver-, 3 vehicle-FMU variants)
In sum 72 FMU-combinations created and simulated on dSPACE VEOS platform
Results:
  – All FMU combinations can be simulated
  – All driver FMUs allow to follow velocity profiles like EUDC, FTP75, WLTC, …
  – For seamless exchange between companies, FMU interface specification must be very accurate and ideally machine readable
  – Template FMUs according to proposal from Modelica SSP project could be helpful:
    • Template FMUs could be generated from “System Model”
    • Template FMUs should be importable in modelling tools to transport interface