If you have a smartphone, tablet or notebook at your fingertips…

Please open:

http://www.quizsocket.com/

and enter Quiz ID

2BX3N3
A Functional Reference Architecture for Autonomous Driving

Prof. Dr. Ramin Tavakoli Kolagari
Increasing Complexity Will Force OEMs to Compete on Multiple Fronts

Past: OEMs compete with one another

2030: OEMs compete in a complex market landscape

- Tier 0.5
- Tier 1
- Tier 1
- Tier 1

- Established suppliers
- OEMs
- Established OEMs

- Tech giants
- Software
- Consumer electronics
- Mobility providers
- Chinese OEMs
- Speciality OEMs
- Emerging OEMs

Source: (I)
Which modeling languages do you know?

A: UML
B: UML and SysML
C: UML and SysML and EAST-ADL/AUTOSAR
D: None of these languages
EAST-ADL
EAST-ADL
Background

- Increasing Complexity and Criticality of Vehicle Electronics
- Errors due to engineering flaws are a major threat to Safety
- Improved Engineering Methods are Necessary
- Standardization of ontology and specifications

- Approach: System Modelling based on EAST-ADL

Source: (XVII)
EAST-ADL
Background

Capture Specifications of Automotive Electronic Systems

Architecture Description Language
An information model that captures engineering information in a standardized way

Source: (XVII)
EAST-ADL
Re-Inventing the Wheel?

- Why not UML?
  - The EAST-ADL profile allows usage of UML
- Why not SysML?
  - EAST-ADL is based on applicable SysML concepts
- Why not AUTOSAR?
  - EAST-ADL complements Autosar
- Why not proven proprietary tools?
  - EAST-ADL integrates external tools and provides an information structure for the engineering data regardless of tool
- Why not proven open scientific/academic approaches?
  - EAST-ADL integrates relevant approaches

Source: (XVII)
EAST-ADL & AUTOSAR Representation

- **System Model**
  - **Vehicle Level**
    - **Technical Feature Model**
  - **Analysis Level**
    - **Functional Analysis Architecture**
  - **Design Level**
    - **Functional Design Architecture**
    - **Hardware Design Architecture**
  - **Implementation Level**
    - **AUTOSAR Application SW**

**Abstract functions**

**Features of the vehicle**

**Hardware topology, concrete functions, allocation** to nodes

**Software Architecture** as represented by AUTOSAR

Source: (XVII)
EAST-ADL Abstraction Levels
EAST-ADL Abstraction Levels
EAST-ADL
Vehicle Level

Characterization of Vehicle by a means of Features

• Stakeholder requested functional or non-functional characteristics
• Describes "what", but shall not fix the "how"
• Specified by requirements and use cases
• Configuration points to create a vehicle variant
• ProductFeatureModels for Configuration of TechnicalFeatureModel

Source: (XVII)
Abstract Functional description of the EE system
- Realizes functionality based on the features and requirements
- Abstract functional definition avoiding implementation details
- Defines the system boundary
- Environment model defines context
- Basis for abstract safety analysis

Source: (XVII)
Concrete functional definition
• Functional definition of application software
• Functional abstraction of hardware and middleware
• Hardware architecture
• Function-to-hardware allocation
• No SW Architecture

Source: (XVII)
EAST-ADL
Design Level: Function interaction end-to-end

Model structure supports interaction with the environment and end-to-end functional definitions

Source: (XVII)
EAST-ADL
Implementation Level

Software-based implementation of the system
• AUTOSAR Software components represent application functionality
• AUTOSAR Basic software represents platform
• ECU specifications and topology represent hardware
• Model is captured in AUTOSAR
  - Software component template
  - ECU resource template
  - System Template

Source: (XVII)
EAST-ADL Extensions

Source: (XVII)
Which statement about requirements engineering describes the situation at the automotive industry best?

A: Requirements are elicited at the beginning of a project only and should remain unchanged.

B: Requirements are elicited and documented throughout the development of a product. Changed requirements should be documented even during maintenance.

C: Functional requirements are elicited independent of nonfunctional requirements.

D: None of these statements.
EAST-ADL Extensions

Source: (XVII)
EAST-ADL
Language Definition

- Metamodel defined in Enterprise Architect
- Documentation autogenerated from model
- Exchange format autogenerated using AUTOSAR rules
- AUTOSAR elements can be integrated

Source: (XVII)
AUTOSAR
EAST-ADL and AUTOSAR

- **EAST-ADL**
  - to support the engineering effort for automotive embedded systems

- **AUTOSAR**
  - to capture the software architecture
How many innovations of today’s vehicles are driven by electronic/electric?

A: 70%
B: 80%
C: 90%
D: All major innovations
AUTOSAR Vision

Source: (XVIII)
AUTOSAR Vision

Yesterday

AUTOSAR

Application Software

Customer needs

- Adaptive Cruise Control
- Lane Departure Warning
- Advanced Front Lighting System
- ...

Using standards

- Communication Stack
- OSEK
- Diagnostics
- CAN, FlexRay

Hardware

Standardized Methodology

HW-specific (ECUs)
AUTOSAR Partners (status November 2015)

Source: (XVIII)
AUTOSAR achievements and outlook (1/2)

Milestones, just to name a few

- AUTOSAR founded
- First release
- Basic SW complete
- Release 4.0.1 Feature enrichment
- Release 4.1.1

- Derived applications
- New development methods

- Multicore support
- Functional safety
- Ethernet
- ...
AUTOSAR achievements and outlook (2/2)
Milestones, just to name a few

- 2013: 10 years of AUTOSAR 6th AOC, Nov 2013
  - Release 4.2.1
    - Large data communication via Ethernet and CAN FD
    - Integration of non-AUTOSAR systems
  - Release 4.2.2
    - CAN Flexible Data Rate
    - Global time synchronization
    - Sender Receiver Serialization
  - Release 4.3.0
    - Long Term Objectives:
      - Quality
      - Maturity
      - Backward compatibility
      - Closing gaps
      - Market needs
      - Effort

Source: (XVIII)
Exploring AUTOSAR Software Architecture

Source: (XVIII)
AUTOSAR and EAST-ADL
Important Similarity

- Same “Meta-Meta Model”
  AUTOSAR Meta Modelling Guideline used
  -> Easy to integrate AUTOSAR and EAST-ADL
  -> EAST-ADL concepts like safety and requirements can reference AUTOSAR elements

- Domain Model of EAST-ADL
  - Defined in Enterprise Architect
  - AUTOSAR template profile (atp stereotypes) applied
  - Possible to process through AUTOSAR MMT tool

Source: (XVII)
On which metamodeling level resides a Java program?

A: M0: instance level
B: M1: type level
C: M2: meta level
D: M3: meta meta level
AUTOSAR
Metamodelling
AUTOSAR and EAST-ADL Structural Compliance
AUTOSAR and EAST-ADL
Examples of function-to-component Mappings (1/3)

(Composite) Function to SW Component
AUTOSAR and EAST-ADL
Examples of function-to-component Mappings (2/3)

n Function to 1 SW Component
AUTOSAR and EAST-ADL
Examples of function-to-component Mappings (3/3)
AUTOSAR Adaptive Platform
Which technology achievements will most likely drive new automotive software systems?

A: Processors
B: CAN Bus
C: Functional Programming
D: Ethernet
Architecture
Adaptive Platform Level

Adaptive Application

Adaptive AUTOSAR API:
APIs and services exposed to Applications by functional clusters.

Adaptive AUTOSAR specification:
Behavior of software platform from Application and Network perspective.
Organized in functional clusters, not specification of internal architecture!

Functional Clusters:
- Assemble functionalities of the Adaptive Platform
- Define clustering of requirements specification
- But, do not constrain the SW architecture of a platform implementation
  ➔ No definition of modules

(Virtual) Machine / Hardware

In scope of R1.0.0
Planned for future releases

Source: (XXIII)
One machine is generally occupied exclusively by one Software Platform Instance.
Architecture
Vehicle Level

Source: (XXIII)
Releases and revisions of AUTOSAR
Functional Reference Architecture
Are fully autonomous vehicles already commercially available?

A: yes, but only for the high-end market
B: yes, 2% of all new cars
C: yes, 10% of all new cars
D: no
SAE Levels of Automation

Driver in the loop:
- Example: Lane Departure Warning, Adaptive Cruise Control, Tesla’s Autopilot, Volvo’s Drive Me Ver 1, Volvo’s Drive Me Ver 2, Robo taxi
- Driver in the loop: Yes (required) for 0, Not required for 1 to 5

Take over time:
- Example: ~1 s for 1, Seconds for 2, Minutes/Emerg. Stop for 3 to 5

Driver activity:
- Example: Not allowed for 0 to 2, Specific for 3 to 4, All (even sleeping) for 5

Fault tolerance:
- Example: Fail-safe/silent for 0 to 2, Fail-operational for 3 to 5

Source: (II)
References


(V) EAST-ADL White Paper: www.east-adl.info

(XVII) MAENAD Concept Presentations: http://www.maenad.eu/presentations.html

(XVIII) AUTOSAR: https://www.autosar.org/

Discussion Groups
Agenda

• Please find together in a group of five
• 15 minutes discussion
• be prepared for a short presentation of the scenario and your discussion results
Assume the following scenario: Insurances start thinking about adapting insurance rates dependent of the driver’s behavior by using data of the vehicle sensors: a telematics box in the vehicle would send data every 20 seconds to an off-board unit, where the driving behavior is analyzed. Data processed would comprise speed, daytime or nighttime trip, braking/acceleration, city or interurban tour… Insurances could calculate a score for each driver participating in the program based on which a discount for the next insurance year would be calculated. Participation in the program is voluntary, but those insurance holders that are not participating have to pay the higher standard rate.

Please discuss this scenario in your group. You should (at least) cover the following aspects:

- impact on the society
- data privacy protection
- data collection on stock
- „same behavior should be treated same—different behavior should be treated differently“
- personal-related data versus a procedure to manipulate behavior

Can you think of similar scenarios in the context of global digitalization?

How should the society be equipped in order to be prepared to cope with this and similar industrial endeavors?
Assume the following scenario: Once technological and regulatory issues have been resolved, up to 15% of new cars in 2030 could be fully autonomous. Providing services in the designated manner constitutes the normal operation of an autonomous vehicle. However, malfunctions and damages are to be expected. It is also to be expected that the use of autonomous vehicles will lead to negative aftereffects, unpredicted breakdowns, and unintended side effects of some sort. When dealing with such unwanted effects, one must consider first and foremost that not only is it the user of an autonomous vehicle that comes into contact with it/its sphere of activity, but the same is true for third parties, such as guests or traffic participants.

Now, who is responsible for a malfunction of an autonomous vehicle resulting in a fatal accident?

- the driver has no steering wheel and no pedals
- the car manufacturer/suppliers have no insight into the details of what happens in the neural net that is controlling the motion of the vehicle
- the autonomous vehicle is part of a general public driving system; decisions met cannot be ascribed to a single vehicle
- the insurance company is not prepared to insure systems (rather than legal entities)
- the society pushes the development of autonomous vehicles because autonomous vehicles are proven to increase road safety significantly

Do you know similar societal challenges in the history of technological innovations?

How should the society be equipped in order to be prepared to cope with this and similar scenarios?
Discussion Group 3
Autonomous Automotive Systems

Computer science becomes applied ethics: autonomous automotive systems will in future get into situations where they have to decide about life and death. An autonomous car that prioritizes the safety of its owner above all will find no societal acceptance; the same is true for a car that forces its passengers into a heroic death. Shall the decision about life and death be made by a random generator? or shall the final decision be met by the driver? will this in future with advancing technology be possible at all? Micro sensor technology will soon outperform human perception speed. In the sensitive correspondence of the sensors within and outside of the car, a human intervention may become an incalculable disturbance.

Those in favor of autonomous driving refer to the small number of traffic deaths: autonomous vehicles are never distracted, tired or irrational; and which human being does not lose track of the consequences of his or her acting in the moment of an accident? In contrast to this view is the opinion that with the disappearance of the driver even a feeling for the situation and for the value of the involved persons will disappear.

What happens, when algorithms replace drivers? Assume the following scenario: two persons run in front of an autonomous car, a truck drives on the other lane towards the autonomous car, and the pavement to the right is highly populated with pedestrians. Shall the car endanger the driver by siding to the left or endanger the pedestrians by siding to the ride? Or shall the car continue straight ahead and endanger the two persons? Please discuss the mentioned scenarios. What is problematic about them? Can you imagine similar scenarios for autonomous driving? What is the key difference between these cases and nowadays fatal accidents? Do you think that a societal agreement can be found about how to cope with these cases?