SysML for Automotive Software
Development and Integration

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Agenda for this presentation

- Background for SysML
- Introduction to SysML
- Guiding questions for our research
- Introduction to Case Study
- Discussion of the SysML model
- Conclusions
Background

• Systems Modelling Language (SysML) - based on the Unified Modelling Language (UML).

• UML is a de-facto standard in many industries.

• Visual language.

• Simulation features for many diagrams.

• Automatic code generation through tool vendors.
Limitations and practical problems

- **Language and semantics:**
  - large number of diagrams.
  - Inadequate for modelling timing constraints.
  - Inadequate for modelling relationships between hardware and software.

- **Practical usage:**
  - Mainly used for high-level requirements capture.
  - Inappropriate use of the language.
  - Issues of model transfer between tools – ex. Rational Rose to I-Logix Rhapsody.
Aims of SysML consortium

• Help capture systems information in a precise and efficient manner to enable integration and reuse in a wider context.

• Help communicate systems information correctly and consistently among various stakeholders.

• Help analyse and evaluate the system being specified, to identify and resolve system requirements and design issues, and to support trade-offs.
Version 0.9

- **SysML**
  - **Structure**
    - Class
    - Assembly
  - **Behaviour**
    - Activity
    - Sequence
    - Timing
    - State Machine
    - Use Case
  - **Requirement**
  - **Parametric**
  - Interaction Overview

- New
- Modified from UML 2.0
Software tools that support SysML

**Tools**

- iLogix Rhapsody
- ARTiSAN Real-time Studio
- Telelogic TAU

**Important Features**

- Support requirements through to implementation and test.
- Support SysML diagrams.
- Add-ons? For scenario-based test and validation; generation of test cases.
Guiding questions for the research

• How does SysML support software development?

• Is the use of SysML only appropriate to a higher level of abstraction?

• Is software development possible in a systems engineering framework?

• Who needs to know and use which diagrams – as OEM, as supplier?

• Will it help produce highly reliable automotive software?
Case study

- 4X4i Driver Information System for a Premium Vehicle

Related documentation

- Requirements specification documents including updates.
- Documentation and experiences of minor/major problems faced during the current process of specifying.
- Conferences, workshops, training and white papers from websites.
Requirements Capture

Driver Information System Use Cases

- View Navigation Information
- Access Rear Entertainment
- Access Front Entertainment
- Access 4X4Info
- Phone

Driver
Rear Passenger
Refinement of a “Access 4X4i Info” use case:
Importance/questions – Use Cases

- clear and concise unlike current documents
- high-level to refined ones
- easy to use items in other diagrams i.e., duplications reduced
- helps model functionality further, easier to plan V & V
- Consistency check in tools– actors connected to use cases and vice-versa etc.
A generalised platform using assembly diagram
Different configurations

• Variants
• Optional components

Class diagram
Sequence description (Platform 1)

SCENARIO 1: Mode Change - CD - OFF Road Information

DESCRIPTION: The sequence describes how the user changes from CD mode to Off-Road Compass mode by depressing the OffRoad hard key on the HLDF.

PREREQUISITES: User is listening to CD. DisplayView is CD. 6-Disk CDC Changer present. Previous Off Road view was Compass. Vehicle is stationary.

SEQUENCE:

User presses OffRoad hard key to request mode change.

User → HLDF: HardKey(OffRoadInfo);

TouchScreenApplication within HLDF internally switches to Off Road View to Compass (Last used state).

Off Road Information is displayed.

CD is still playing.

End of data flow.

APPLICABILITY: RADIO
Sequence diagrams (Platform 1)

Platform 1 - Mode Change CD - OffRoad

- Driver
- Front Passenger
- OffRoad Button
- Touch Screen Display
- Driver InfoSys

Presses OffRoad
System updates display to previous OffRoad

OffRoad Pressed

Update Display to last OffRoad
**SCENARIO 2: Mode Change - CD - OFF Road Information**

**DESCRIPTION:** The sequence describes how the user changes from CD mode to Off-Road Suspension mode by depressing the Menu hard key on the HLDF.

**PREREQUISITES:** User is listening to CD. DisplayView is CD. 6-Disk CDC Changer present. Previous Off Road view was Suspension. Vehicle is stationary.

**SEQUENCE:**

User presses Menu hard key to request mode change.

User → HLDF: HardKey(Menu);

TouchScreenApplication within HLDF internally switches to Menu

From Menu screen user presses 4x4i info soft key.

User → HLDF: SoftKey(4x4iInfo);

TouchScreenApplication within HLDF internally switches to Suspension (last used state)

Off Road Information is displayed.

CD is still playing.

End of data flow.

**APPLICABILITY:** RADIO
Platform 2 - Mode Change CD - OffRoad

Driver

Front Passenger

Menu Button

4X4Info Button

Touch Screen Display

Driver InfoSys

Presses Menu HardKey

Menu HardKey Pressed

4X4Info SoftKey Pressed

Update Display to Menu

Update Display to last OffRoad
Sequence diagrams

View steering angle (relates to corresponding use case)

Presses 4X4Info HardKey
If first time selection
seq
else
seq
end alt
Driver steers
seq

Information on which parts of the Driver InfoSys are involved is shown on a separate diagram.
Steering angle information flow through the systems

steering angle to Bus 1
Gateway reads information
Converted message gatewayed
Gateway reads information
Converted message gatewayed
steering angle info. displayed
Conclusions

- A SysML model could augment paper specifications
- Assembly diagrams
- Use case, sequence diagrams
- Links to all phases of the system development lifecycle
Next Steps

Completion of case study

- Results of modelling; evaluations by partners etc.

Define and implement Technology transfer mechanisms

- Appropriate training.

Final report on application of the technique

- Available to research partners.

Develop recommendations for further research

- Comparative study of SysML and alternatives (AADL).

Continuation in new projects

- DTI funded Validation of Complex Systems.