Evaluation of various Tools (Entwurf)

There are lots of tools available for modeling and simulation. Here I evaluated the advantages and disadvantages of different tools based on modeling and simulation requirements. Based on the evaluation, Matlab and OMNeT++ were identified as viable modeling and simulation tools for this master thesis. Although SysML has been evaluated and chosen previously by BMW as modeling language, the usability of SysML doesn’t support real network simulation.

SysML

SysML is a general-purpose graphical modeling language for representing systems. SysML was developed to support the transition from a document-based approach to a model-based approach in systems engineering[ S. Friedenthal, A. Moore, and R. Steiner. A Practical Guide to SysML: The Systems Modeling Language. Morgan Kaufmann/OMG Press, 2011], In a model-based approach, a coherent

model of a system needs to be managed instead of documents that represent the system. Many disciplines apply a model-based approach. Electrical engineering has also used automated circuit design and analysis instead of the manual circuit design since the 1980s. Nowadays, a number of case studies have been carried out to define the applicability and suitability of the SysML language in the automotive domain[E. Andrianarison and J.-D. Piques. SysML for embedded automotive systems: A practical approach. In Embedded Real Time Software and Systems (ERTS2), pages 1–10, Toulouse, France, 2010. ERTS2 series.

L. Apvrille and A. Becoulet. Prototyping an embedded automotive system from its UML/SysML models. In Embedded Real Time Software and Systems (ERTS2), pages 1–10, Toulouse, France, 2012. ERTS2 series

]. Furthermore, BMW has extended the SysML with its own requirements and interest in MagicDraw. So BMW specific SysML Tool will be analysed.

OMNeT++

OMNeT++ is an extensible, modular, component-based C++ simulation library and framework, primarily for building network simulators. “Network” is meant in a broader sense that includes wired and wireless communication networks, on-chip networks, queueing networks, and so on. Domain-specific functionality such as support for sensor networks, wireless ad-hoc networks, Internet protocols, performance modeling, photonic networks, etc., is provided by model frameworks, developed as independent projects.

Although OMNeT++ is not a network simulator itself, it has gained widespread popularity as a network simulation platform in the scientific community as well as in industrial settings, and building up a large user community. It provides a component (modules) architecture for models. Components are programmed in C++, then assembled into larger components and models using a high-level language (NED). Reusability of models comes for free. .[ <https://omnetpp.org/intro/>]

During the years OMNeT++ has been available, countless simulation models and model frameworks have been written for it by researchers in diverse areas, I focused for this master thesis on in-vehicle network. The INET Framework can be considered the standard protocol model library of OMNeT++. INET contains models for the Internet stack and many other protocols and components. Based on it, the research group CoRE from HAW Hamburg [https://core-researchgroup.de/] has developed several extension to INET Framework. I used the following 3 extensions: CoRE4INET (event-based simulation of real-time Ethernet), FiCo4OMNeT (Fieldbus Communication For OMNeT++), and SignalsAndGateways(a connection between the 2 extensions above).

Matlab/Simulink

Matlab/Simulink owns various possibilities in terms of simulation.

Although the toolbox System Composer enables the specification and analysis of architectures for model-based systems engineering and software architecture modeling, and Simulink has its own module for simulating CAN and Ethernet Networks from Vehicle Network Toolbox, a detailed evaluation of a communication network and ECU can’t be achieved with Matlab/Simulink.

Another functionality is Simulink Coder, it enables the automatic C++ code generation. However the result is not compatible with OMNeT++ environment, since OMNeT++ has its own APIs.

For this master thesis, the following functionalities are considered as criteria for the evaluation: Model Analysis, Sequence Diagramm, State Machine, Dynamic simulation.

|  |  |  |  |
| --- | --- | --- | --- |
| Name of Functionality | MagicDraw (SysML) | Matlab/Simulink | OMNeT++ |
| Model Analysis | Yes | Yes | Yes |
| Sequence Diagramm | Yes | Yes | Yes |
| State Machine | Yes | Yes | Yes |
| Real-time CAN Fieldbus Simulation | No | Only basic function | Highly customizable |
| Real-time Ethernet Simulation | No | Only basic function | Highly customizable |
| Simulation Result Analysis | No | Yes | Yes |
| Possibility for custom adjustment | Yes | Yes | Yes |

Due to the necessity of a real simulation of the whole architecture (based on communication network and several components), OMNeT++ was chosen for this master thesis.