The Modelling of Energy Flows in Railway Networks using XML-Infrastructure Data

Andreas Heckmann* and Sebastian Streit◇
German Aerospace Center (DLR)
* Institute of System Dynamics and Control, Oberpfaffenhofen, D-82234 Wessling
◇ Institute of Vehicle Concepts, Pfaffenwaldring 38-40, D-70569 Stuttgart

The paper reports on an activity of the DLR project Next Generation Train that led to the implementation of the Modelica RailwaySystem Library. This package provides the capabilities to simulate the energy flow in electrical railway networks on which railway vehicles are running. In particular the interaction of vehicle and its energy infrastructure is considered.

From the modeling point of view two specific problems had to be taken into account. Railway vehicles may be interpreted as energy sources or sinks that are moving in an inhomogeneous network. The network consists of catenaries or conductor lines that are supplied by power stations and may of may not be separated in isolated sections. Depending on the number and the instantaneous position and running state of the vehicles different types of flows may occur in parallel: energy may flow from power station to vehicle, or vice versa or from one vehicle to another vehicle.

As a second important aspect, the evaluation of the energy consumption of a vehicle is of course a function of the track characteristics such as length, slope, radius, positions of power station etc. so that data on the infrastructure topology and properties are required [1]. To this purpose, the library provides access to external infrastructure data, that are filed using the railway markup language RailML. This is a XML-based data format, advanced by the non-profit RailML initiative, see http://www.railml.org/web/.

In order to give a first impression, the example model in Fig. 1 presents a trivial network with 6 tracks, where 2 vehicle are running on. 6 power stations supply the DC-urban-train-network. Energy consumption due to conduction losses and traction is considered in this initial implementation. However the simulation framework of the RailwaySystem library does not introduce any restrictions on the modeling of the energy subsystems and is open for further extensions.

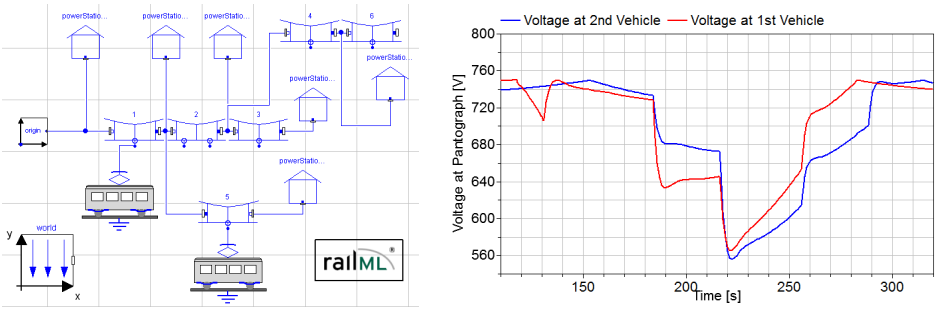

Figure 1: Diagram layer with a trivial network with 6 tracks and 2 vehicles and simulation result of the voltages of both vehicles as a function of time.

References

[1] D. Hürlimann. *Objektorientierte Modellierung von Infrastrukturelementen und Betriebsvorgängen im Eisenbahnwesen*. Zürich, 2001. PhD thesis ETH Zürich.