Developing Dependable Automotive Embedded Systems using the EAST-ADL

- Representing continuous time systems in SysML

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Disposition

- **Presentation of EAST-ADL; An architecture description language for automotive embedded systems**
- Presentation of SysML parametric diagrams
- An approach to model Modelica components using SysML parametric and internal block diagrams
- Using SysML activity diagrams to model continuous block diagrams

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EAST-ADL in general

- An architecture description language for automotive embedded systems
- Version 1 developed in the EAST-EAA project (2002-2004)
- Version 2 being refined in the ATESST project (2006-2008)
- Implemented as a UML2 profile

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EAST-ADL

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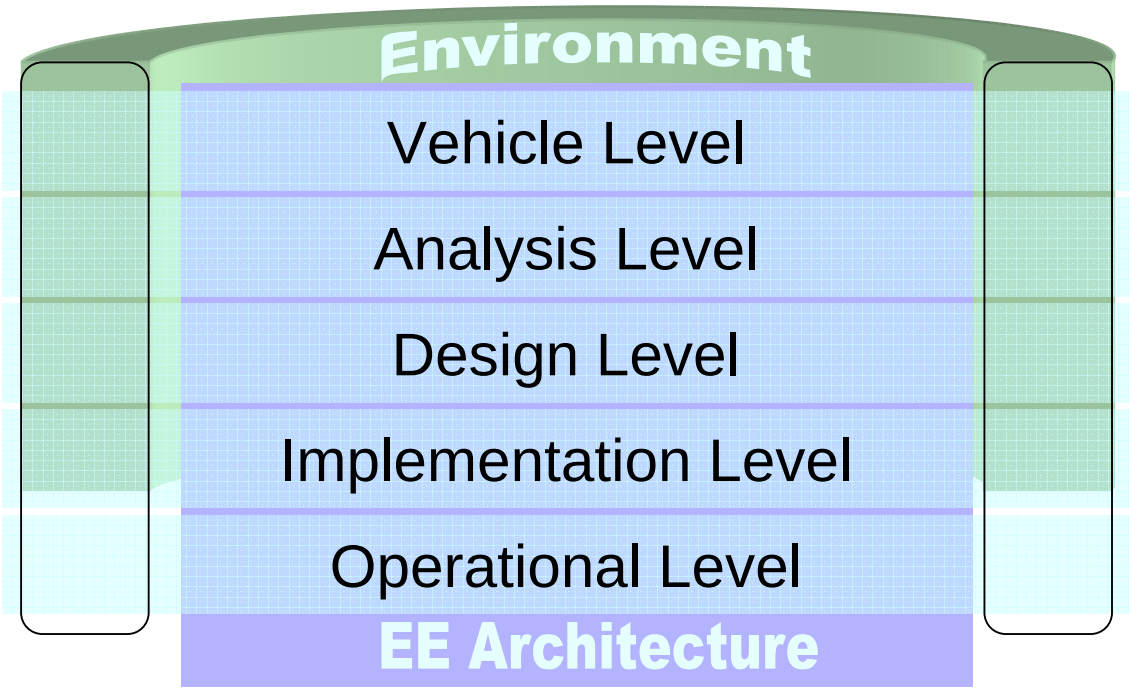

EAST-ADL-features

- vehicle feature modeling including concepts to support product families
- concepts for defining variability in all parts of a model
- vehicle environment modeling to define context and perform validation
- structural and behavioral modeling of software and hardware entities in the context of distributed systems.
- requirements modeling and tracing with all modeling entities
- other information part of the system description, such as a definition of component timing and failure modes, necessary for design space exploration and system verification purposes

Re-inventing the wheel?

- Why Not UML?
  EAST-ADL works with a specialization of UML2
- Why not SysML?
  EAST-ADL is a specialization of applicable SysML concepts
- Why not AUTOSAR?
  EAST-ADL complements AUTOSAR with e.g. functional spec & requirements
- Why not proven proprietary tools (Simulink, Statemate, ...)
  ATESST integrates external tools and provides an information structure for the engineering data regardless of tool
- Why not information management tools such as product data management tools (PDM)?
  Such tools lack an information model for automotive embedded systems and the connections to external domain tools.
- MARTE, AADL, MODAF...

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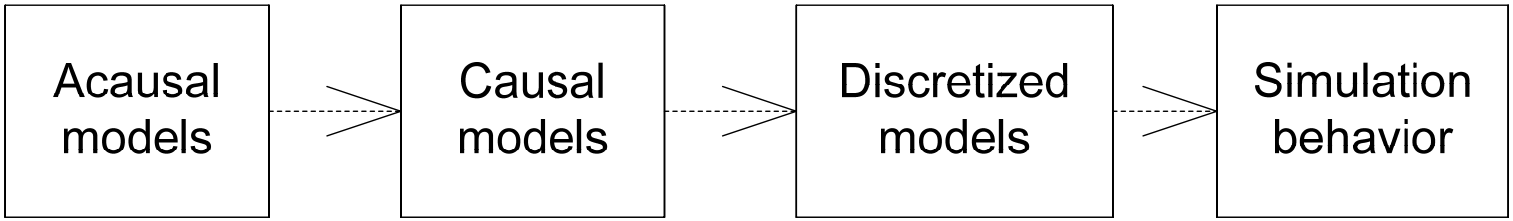
Behavior modeling in EAST-ADL

- Notation that allows simulation and verification
- Integration to other tools

Environment modeling:



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SysML

- a modeling language that supports the specification, analysis, design, verification and validation of systems which may include hardware, software, information, processes, personnel, and facilities.
- UML2 profile
- Four behavioral and five structural diagrams

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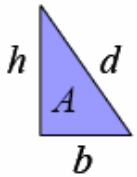
Parametric diagrams

- Parametric diagrams one of two new diagrams in SysML
- In SysML specs - example of Newtons equation, which can be modeled in continuous time

COBs – composable objects (from Georgia Institute of Technology)

a. Shape Schematic-S

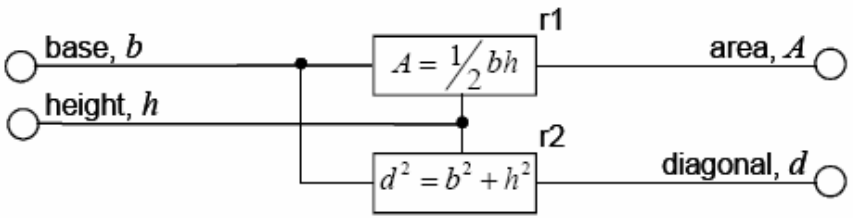


b. Relations-S

$r_1 : A = \frac{1}{2}bh$

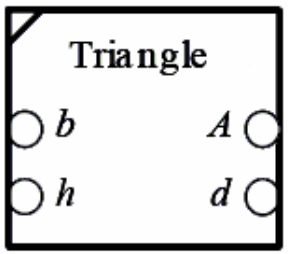
$r_2 : d^2 = b^2 + h^2$

c. Constraint Schematic-S



d. Subsystem-S

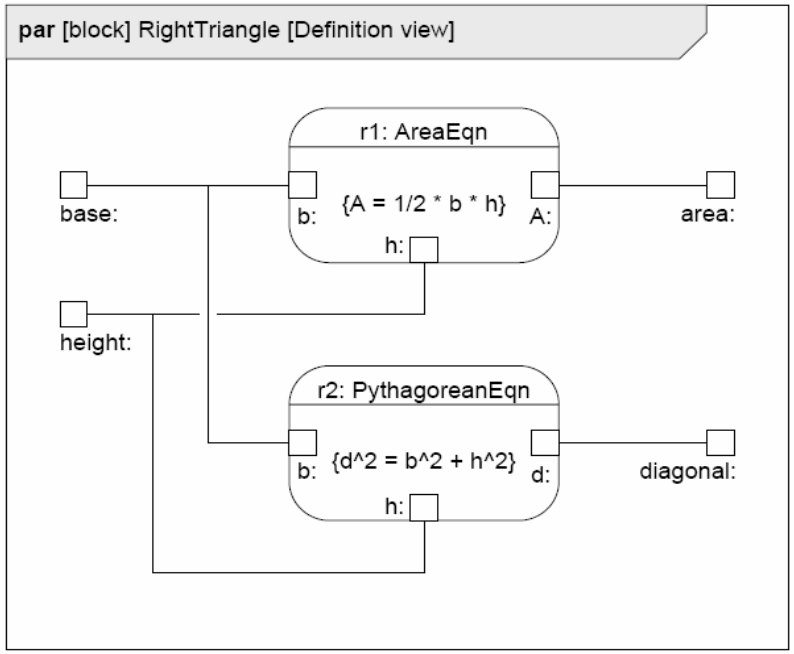
(for reuse by other COBs)



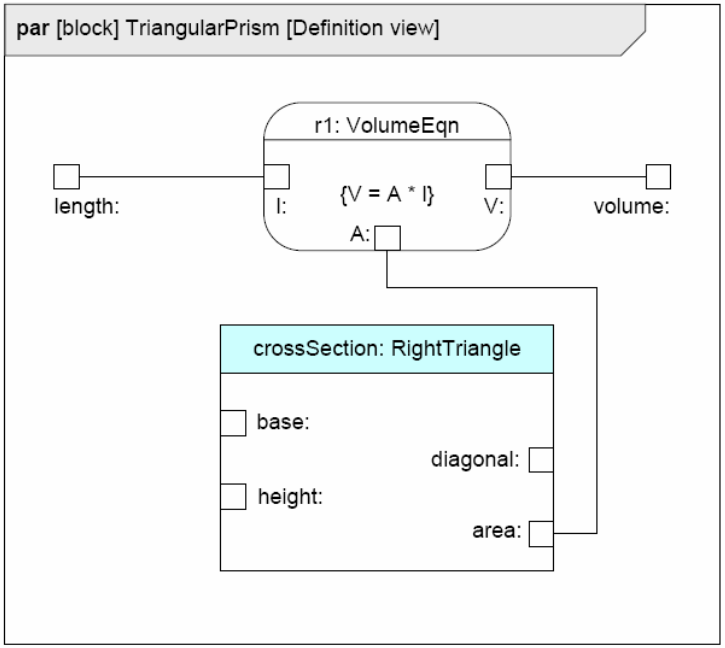
e. Lexical COB Structure (COS)

```
COB triangle SUBTYPE_OF geometric_shape;
   base, b      : REAL;
   height, h    : REAL;
   diagonal, d : REAL;
   area, A      : REAL;
RELATIONS
   r1 : "<area> == 0.5 * <base> * <height>";
   r2 : "<diagonal>**2 == <base>**2 + <height>**2";
END_COB;
```

SysML Parametric diagrams



(b) RightTriangle parametric diagram.



(c) TriangularPrism parametric diagram.

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Using parametric diagrams to describe a Modelica component

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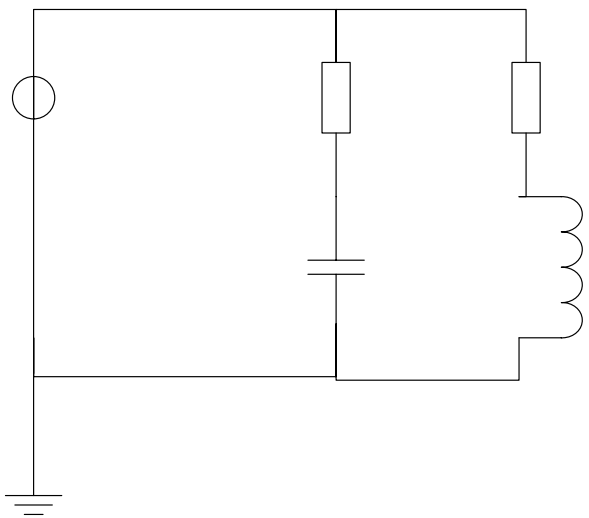
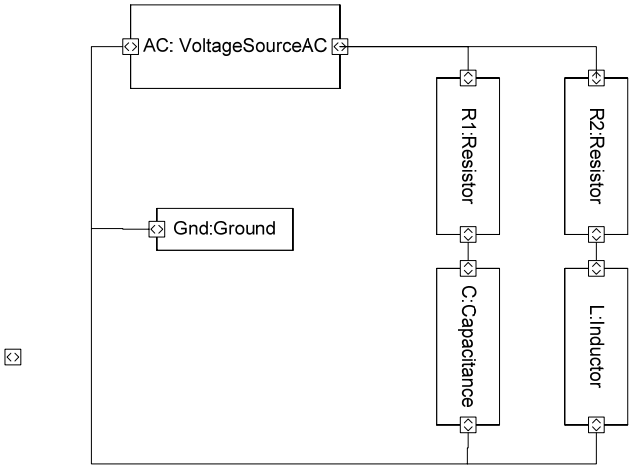
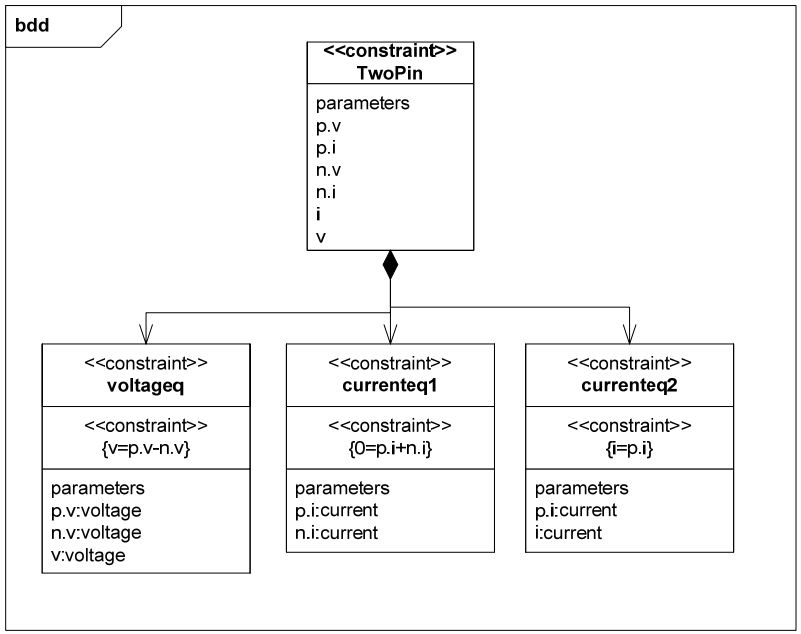
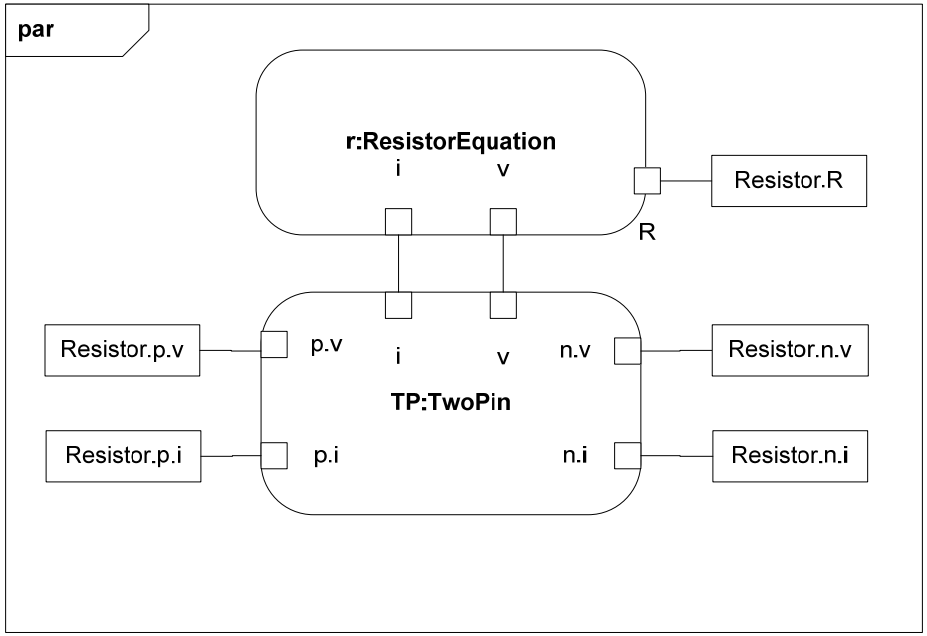


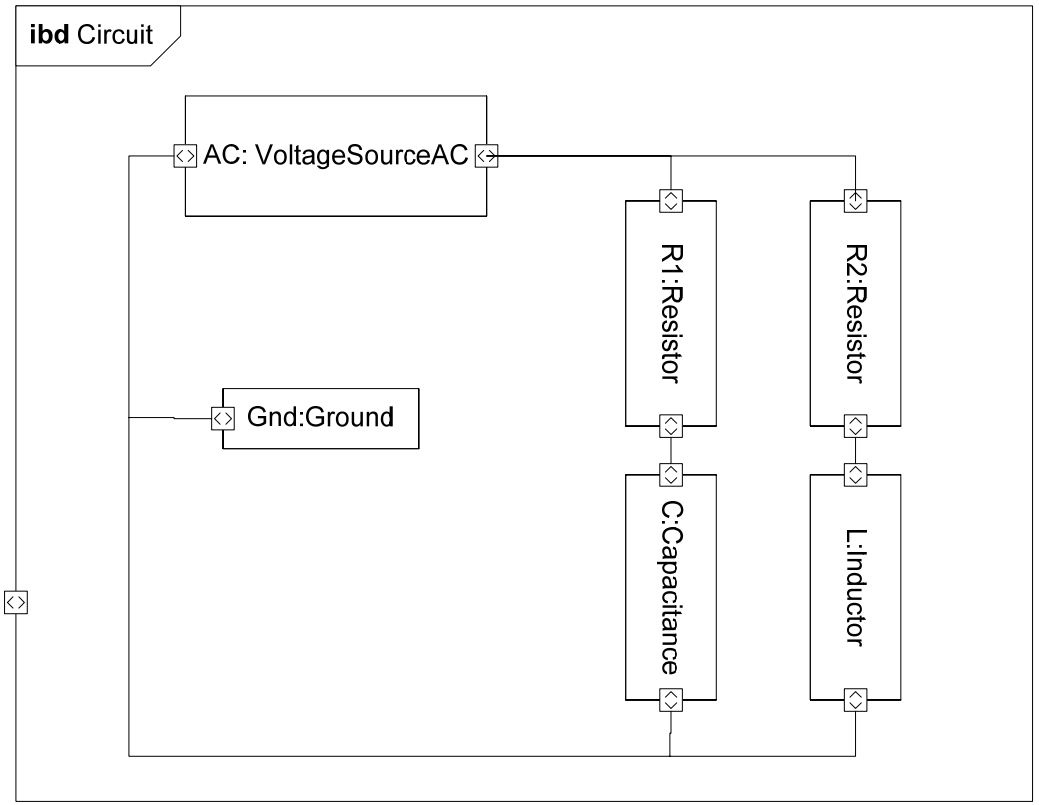


Definition of TwoPin constraint, and a resistor





Internal block diagram of the circuit



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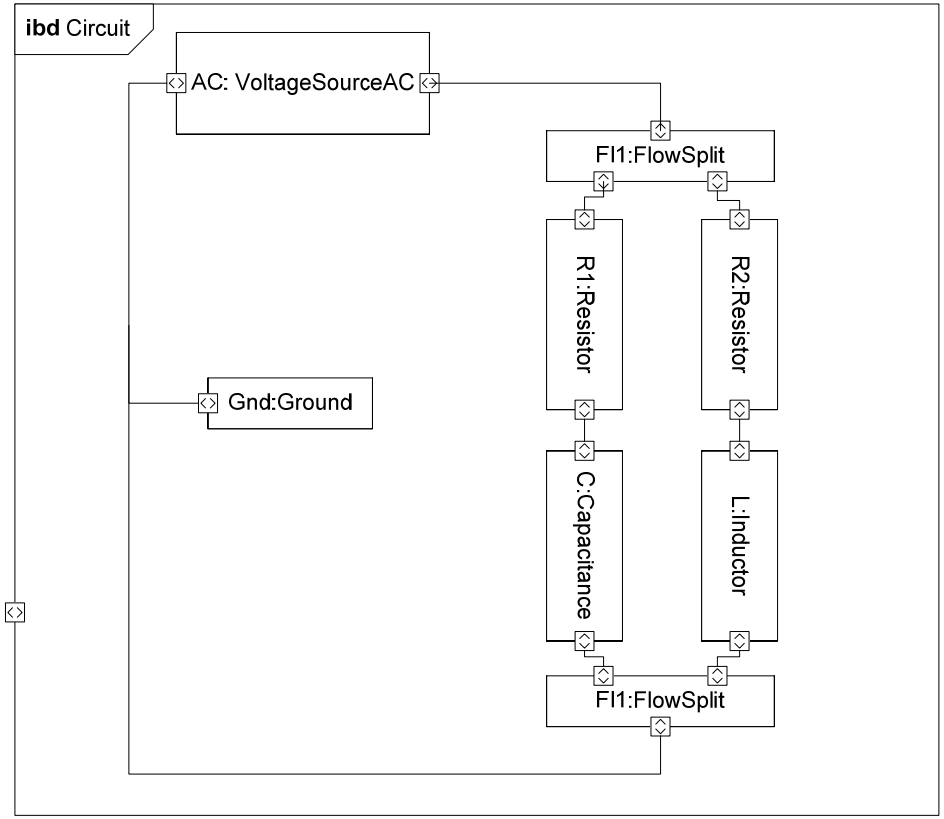
”Corrected” internal block diagram of the circuit



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Block model version of the circuit using an activity diagram

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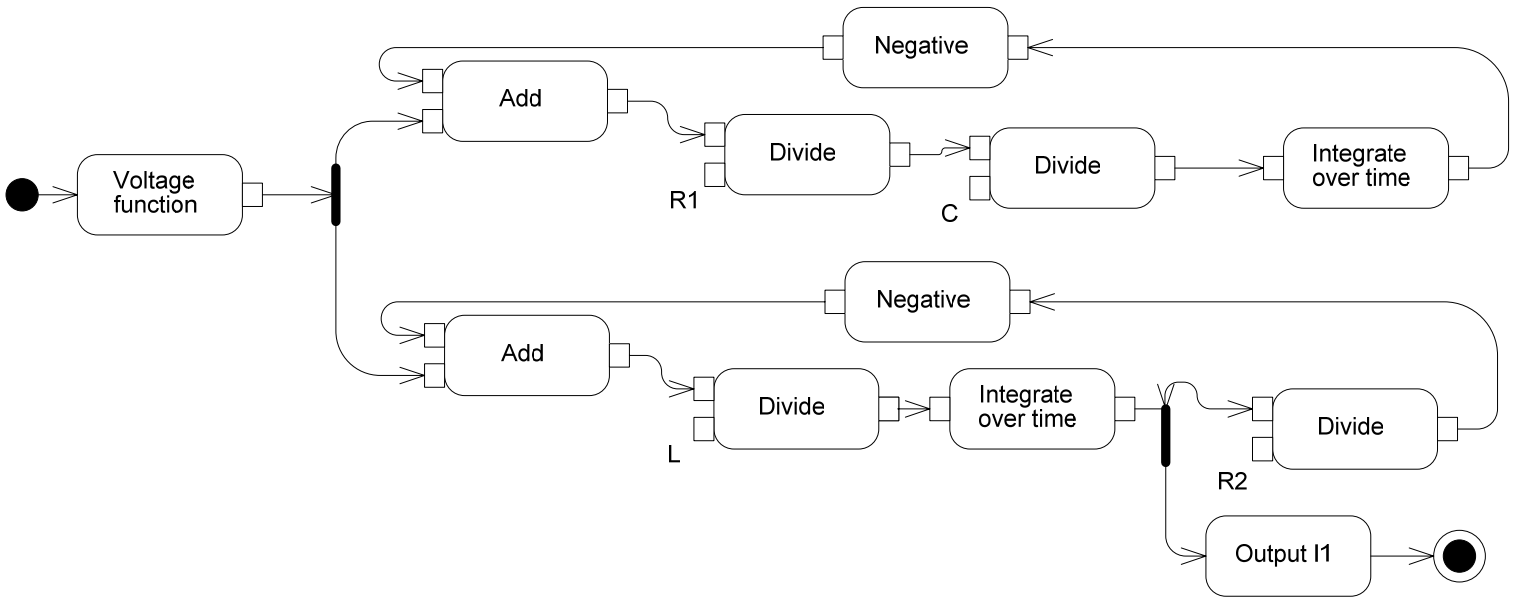

Conclusions

- EAST-ADL is an information model for automotive embedded systems, developed by major parts of the european automotive industry
- EAST-ADL uses five abstraction levels for the embedded system, plus environment models

- Two different approaches of modeling continuous systems in SysML have been presented.
- SysML parametric diagrams is a way to display acausal relations. These diagrams are not directly compatible with Modelica constructs. Separation flow/effort important
- A Modelica <> SysML exchange/integration/profile is of interest
- Activity diagrams could be used to model block diagram systems

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Thank you for your attention!