TU Clausthal

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A Catalog-based Platform for Integrated Development of Simulation Models

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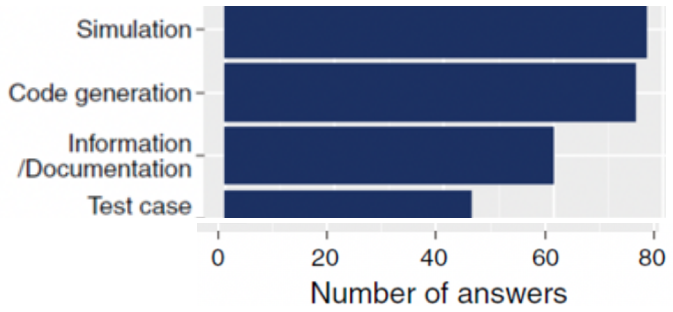
ESES 2020

Simulation Models in Systems Development

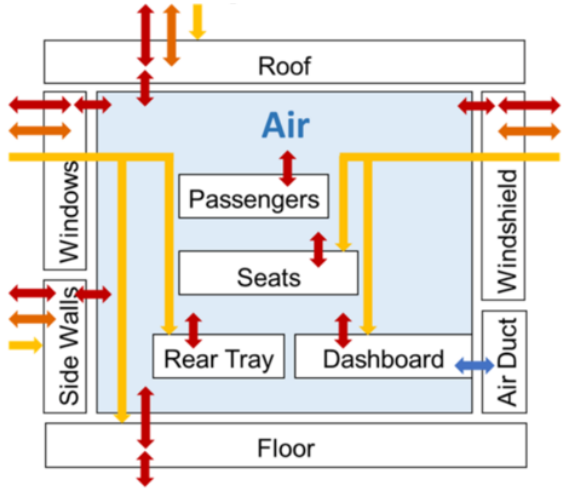
- Model Based Engineering: To handle complexity and reduce development costs and time of complex systems.



(1) Purpose of model-based development in industry according to a survey by Liebel et al.

- Simulation can be used in the automotive domain to identify potentials for energy saving of electrical vehicles.

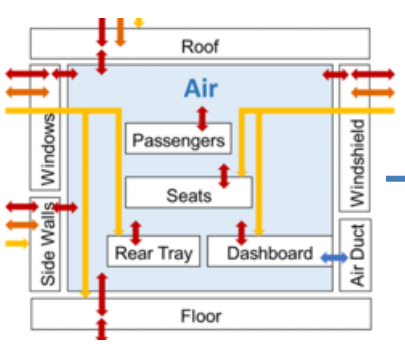
- Simulation Models can be reused and integrated as subsystems to develop complex system simulations supported by tool-automation.
  - TIL Suite from TLK-Thermo



(2) Example: Heat transfer for thermal coupling of air and components in a vehicle cabin

(1) Liebel, Grischa, et al. "Model-based engineering in the embedded systems domain: an industrial survey on the state-of-practice." *Software & Systems Modeling* 17.1 (2018): 91-113.
(2) Engel, Peter et al. “Modeling of Automotive HVAC Systems Using Long Short-Term Memory Networks.” (2019).

Vision for an Industrial Value Chain: Model Supplier/Integrator relationship



Model Integrator A
Platform

Passengers

Seats

Reuse of simulation models

Model Supplier B
Platform

Integrates subsystem

Developer A1
Workspace

Integrates subsystem

Developer A2
Workspace

use

Toolframework

develops simulation models

Developer B2
Workspace

develops subsystem

Developer B1
Workspace

use

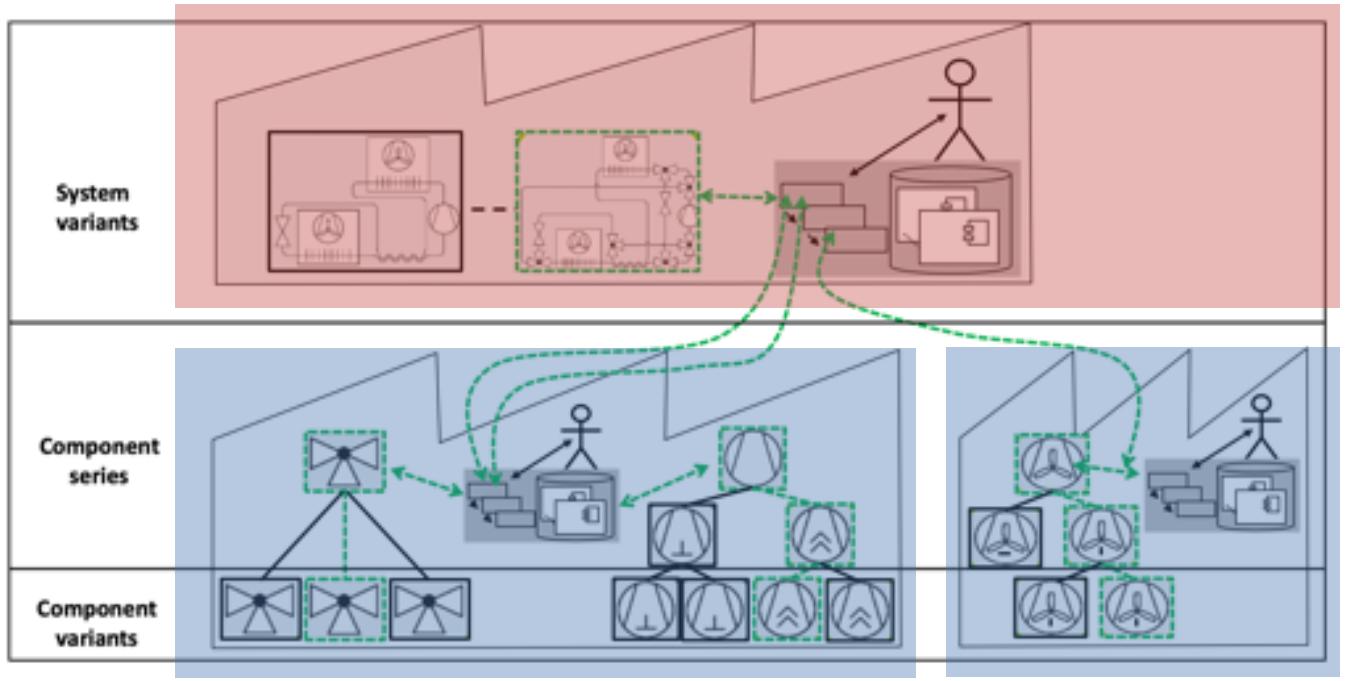
Toolframework

Outline

- **Introduction**
- Catalog based Platform Infrastructure
- Platform Services
- The Design of the Integrated Platform
- Conclusion

The Platform approach

- The platform on supplier/integrator site is used to manage simulation models as reusable components.
- Components can be reused as variants of series to ease the integration step at the integrator site.
- Problem: There is no common standard to describe the meta-data of components from different simulation model suppliers.
- System integrators have to cope with additional effort in the integration step.
  - Developers implement not reusable solutions (e.g., finding optimization parameters, interface-adapter, …).



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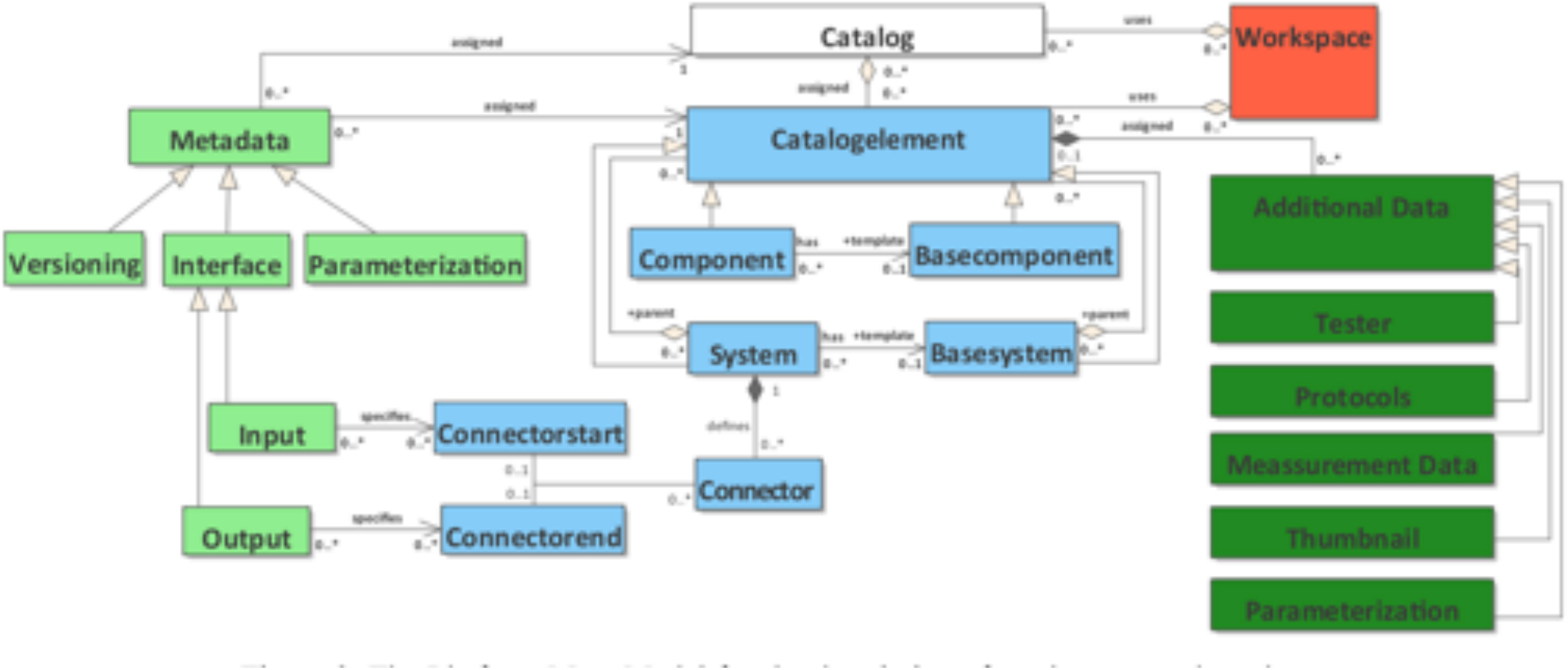
Catalog based Platform Infrastructure

- A description language for modelling the structure of catalogs and system simulation models.



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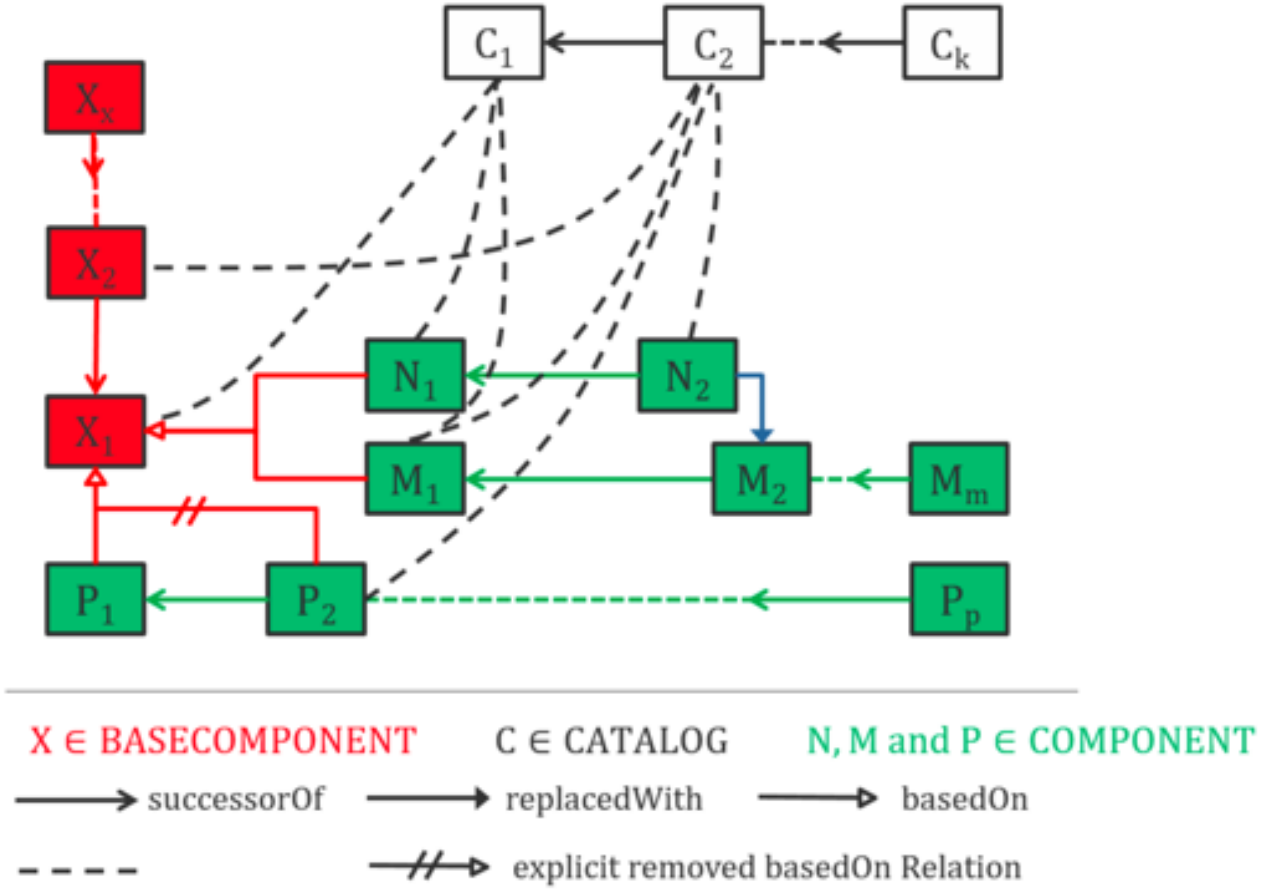
Versions and Variants for a Managed Evolution

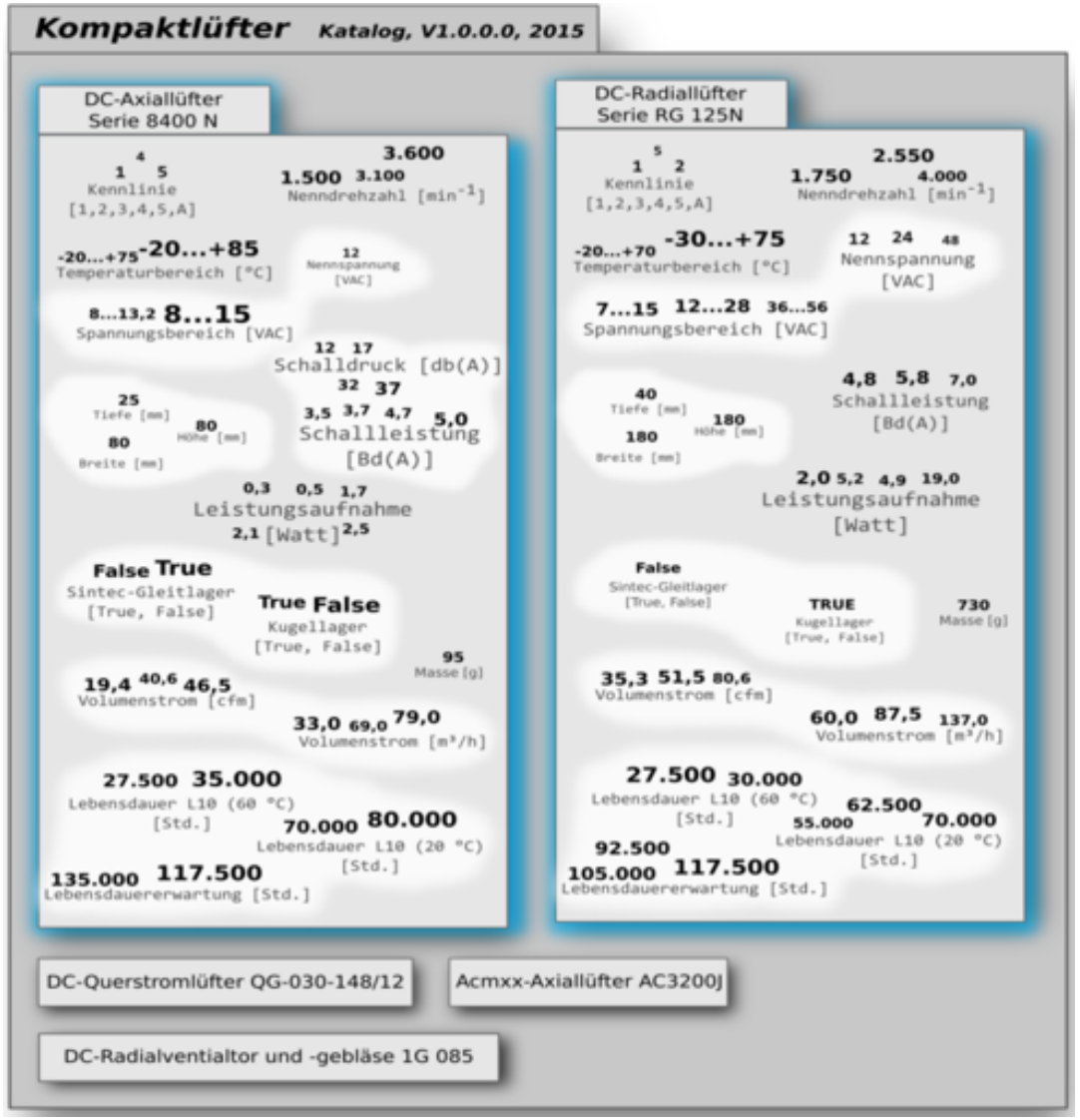
- Each catalogelement can be assigned a version/interface information using the concept of metadata.

- Relations for a managed evolution
  - basedOn: Allows to derive variants sharing the features from the basecomponent.
  - remove: A prototype from a rapid prototyping step is no longer a different variant.
  - successorOf: Further development of a component (e.g., bugfix).
  - assignedTo: To differentiate the component's catalog's origin.
  - replacedWith: A version is no longer supported.



Thumbnail based Search

- The view of this search service allows the developer to get the variants properties and their distribution within the series at a glance.
- The thumbnails of the view ease the comparison of variants from different series using tag clouds, which are generated from the meta-data.
- A cloud can form a group for variants with the same property…
  - … identifier
  - … unit
- The larger the font-size of a tag cloud, the more variants are found.



Other services

- Refactoring
  - A service for the automatic indication of changes in a catalog to developers
  - The automation supports the following cases
    - To replace a component, because it has a bug.
    - To improve an existing component.
    - To replace a component by another different component.

- Modelinversion
  - Allows fast solving of algebra-differential equation to calculate steady-state simulation results.
  - As an example to control the temperature to a certain operating range, an appropriate state of the simulation behaviour must be reachable.

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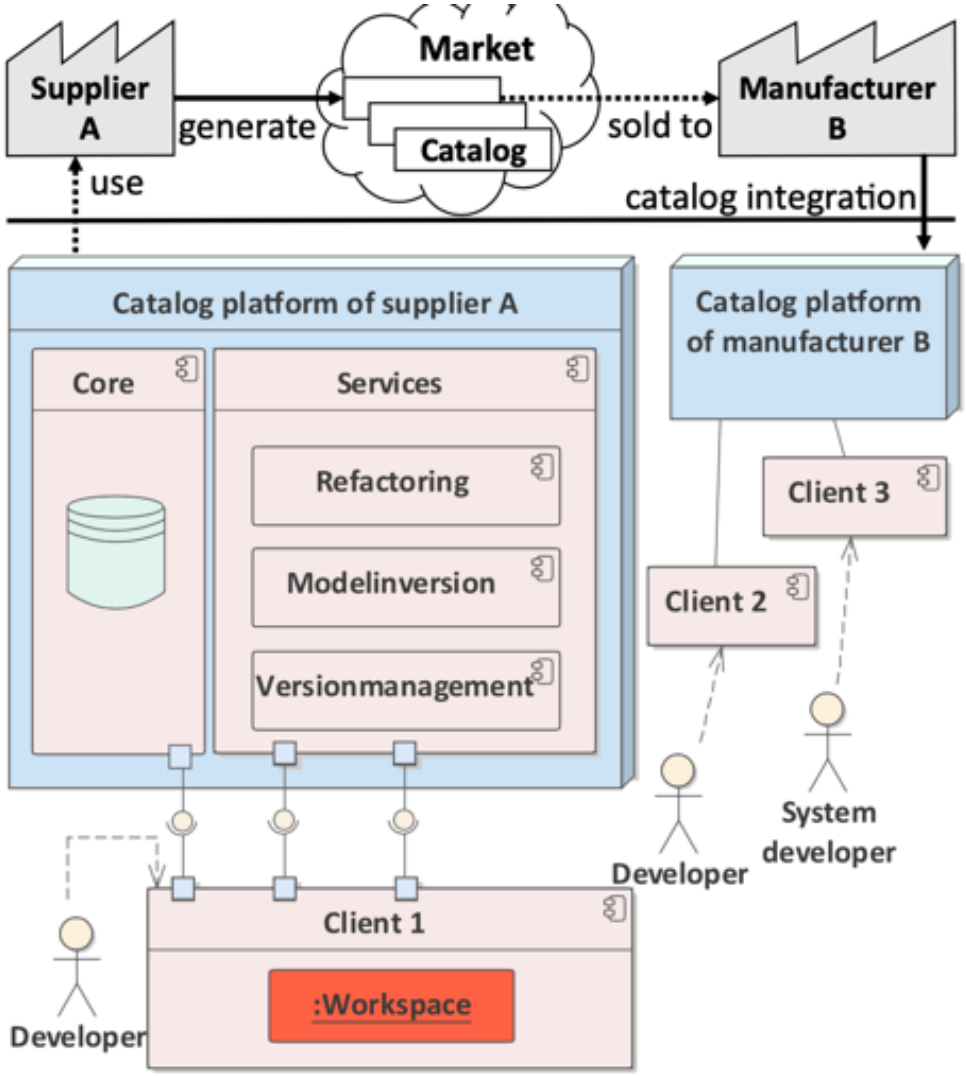
Design of the Integrated Platform

- Client, Server based architecture

- Services and Database side
  - EMF based technology for the implementation of the catalog infrastructure. Services are implemented in java *.jar.

- Workspace side
  - Is implemented as a graphical development environment based on eclipse libraries.
  - The catalogs and services can be accessed by the developer using the workspace.



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Conclusion

- The current state of practice in the integrator/supplier based development of simulation models requires great expertise and manual handling in the model integration step.

- We proposed a catalog platform designed to enable seamless and integrated development of simulation models.

  - The infrastructure of the platform is used for modelling and exchanging catalogs between integrators and suppliers.
  - Moreover, different services are provided by the platform to automate several development tasks

- Acknowledgement
  - The results of this contribution are based on the work of the project “Kataloggestützte interdisziplinäre Entwurfsplattform für Elektrofahrzeuge”, which is supported by a funding from the Federal Ministry of Education an Research of Germany.