Simantics: Open Simulation Platform

OSMC Annual Workshop 2009

Juha Kortelainen
Hannu Niemistö

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Business from technology

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- Simantics features
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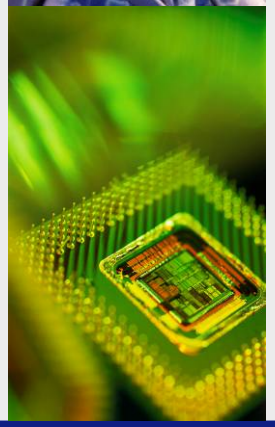
– Part 1 –
Short VTT Presentation

VTT in brief 2008

Customer sectors

- Biotechnology, pharmaceutical and food industries
- Electronics
- Energy
- ICT
- Real estate and construction
- Machines and vehicles
- Services and logistics
- Forest industry
- Process industry and environment



Focus areas of research:

- Applied Materials
- Bio- and Chemical Processes
- Energy
- Information and Communication Technologies
- Industrial Systems Management
- Microtechnologies and Electronics
- Technology in the Community
- Business Research

Personnel: 2 740 (31.12.2007)
Turnover: 241 M€ (budget for 2008)

VTT's operations

Research and Development ■ Strategic Research ■ Business Solutions
■ Ventures ■ Expert Services ■ Corporate Services

VTT SERVICES

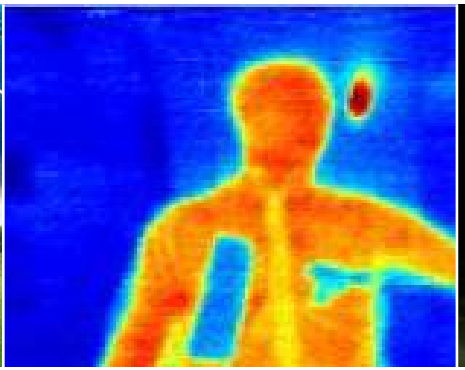
Effective research

- 150 – 200 notifications of inventions and software yearly.
- 950 patents and patent applications in the beginning of 2008 in VTT's patent portfolio.
- Partnership in 13 enterprises based on VTT's technology.
- About 2,000 publications yearly.
- 2,900 publications in VTT's own publication series during the past 20 years.

Research results

Biofuel cell is a viable source of electricity

New technology for the utilisation of renewable energy

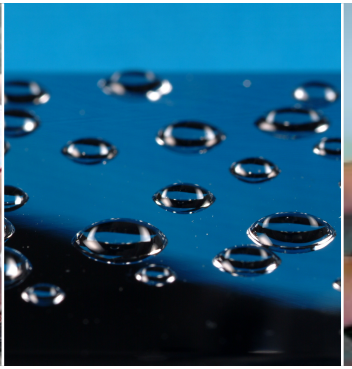


Security technology based on terahertz (THz) imaging

RFID technology for forklifts

Services in support of healthcare and health promotion

Mobile services for the young and elderly

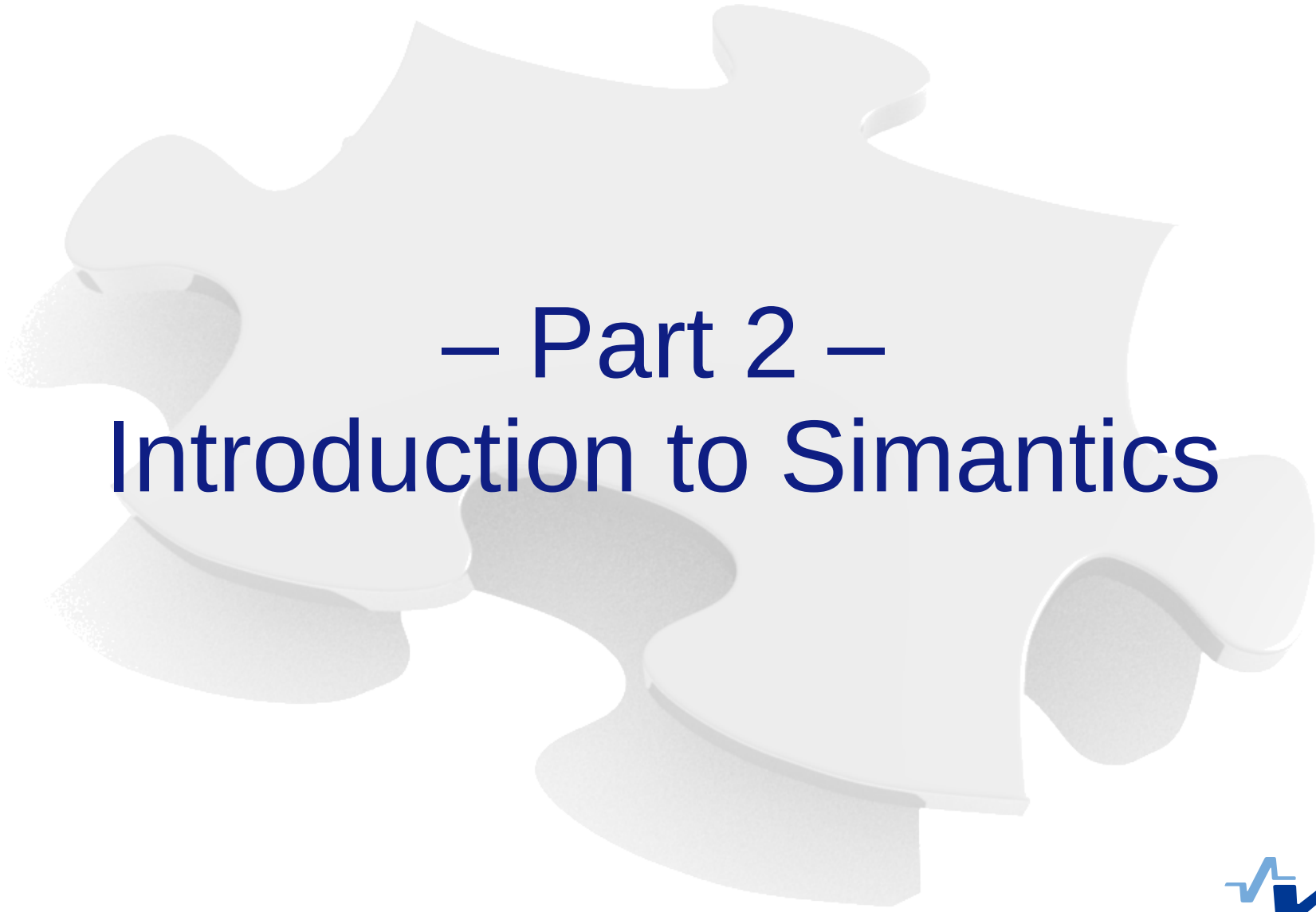


Second-generation smart materials

Tailored printing paper reduces production costs

Competitiveness with technology and market foresights

For more examples see: www.vtt.fi

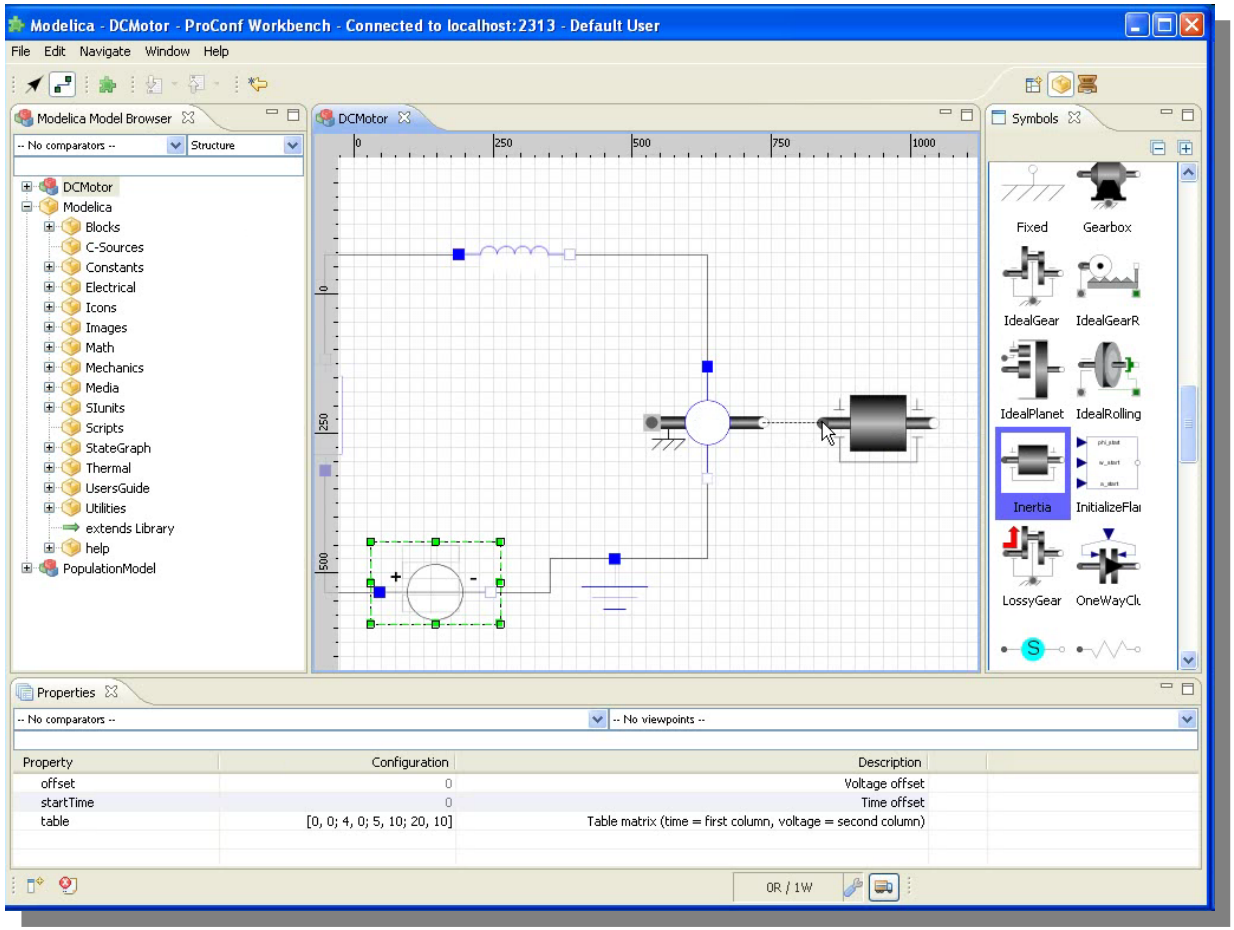


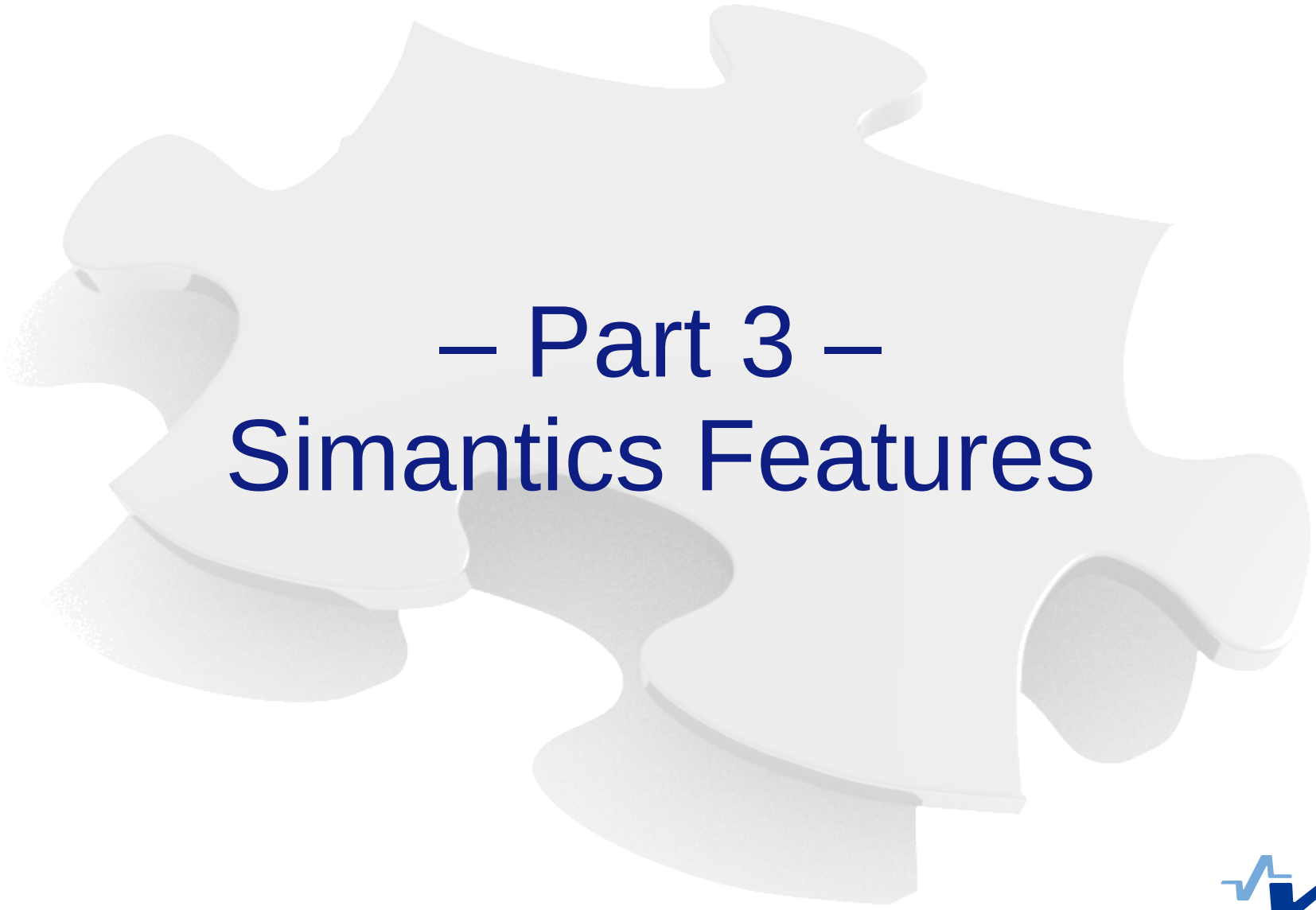
– Part 2 –
Introduction to Simantics

What is Simantics?

1. **An internal project of VTT Technical Research Centre of Finland**
   - Simantics is a *Complex Systems Design/eEngineering* theme project
   - Project duration September 2006 – December 2009
   - Project budget 1540 k€ (total)
2. **Software platform for modelling and simulation**
   - Application development platform
   - Integration solution for modelling and simulation
   - Efficient semantic ontology based modelling implementation
3. **Software development community and philosophy**
   - Simantics is an open source project, the platform is open for everyone to adopt for use
   - Flexible licensing allows both open source and proprietary project be built on the platform
   - Cumulates and rationalises modelling and simulation software development and use

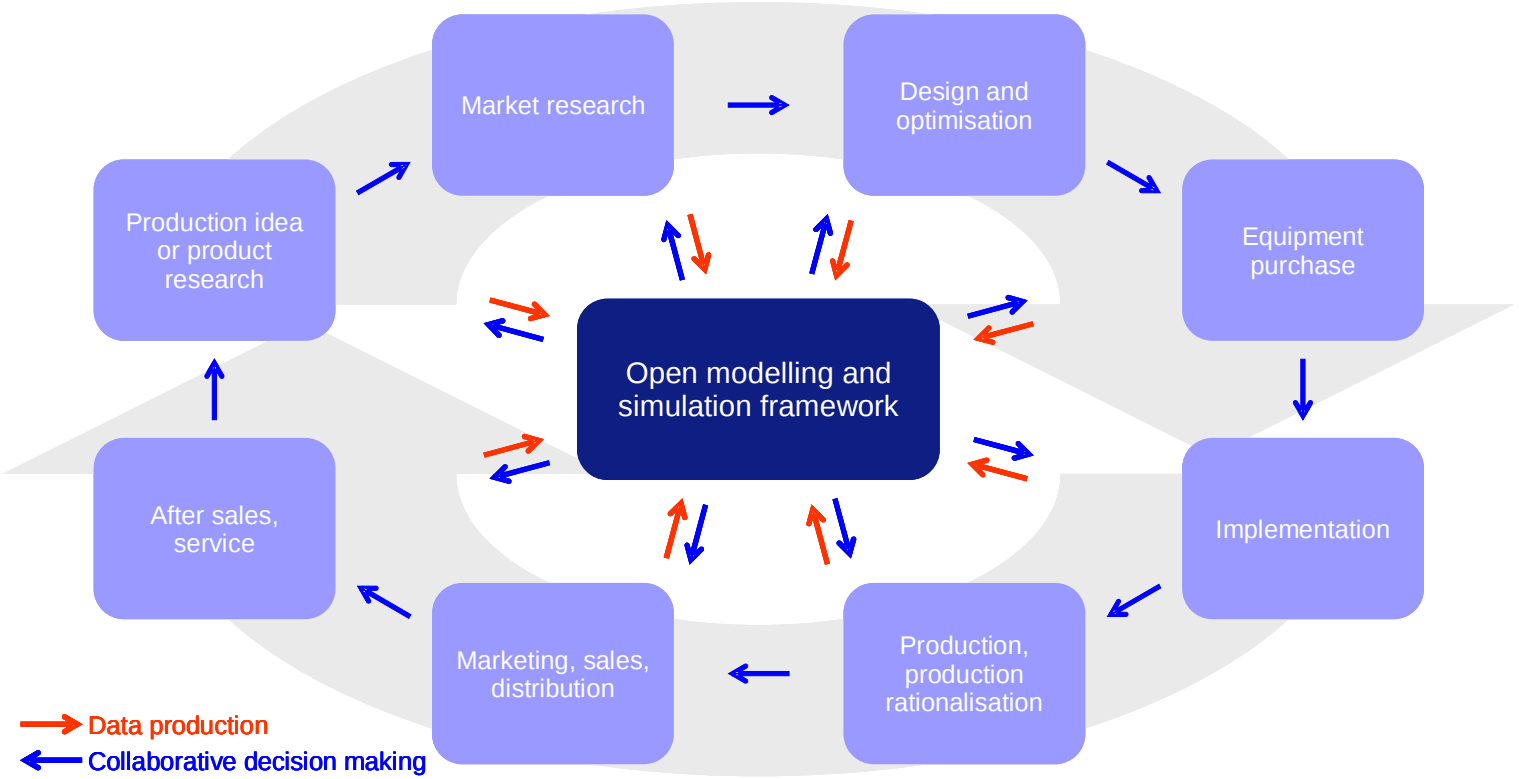
Demonstration: Modelica on Simantics





– Part 3 –
Simantics Features

Engineering Life Cycle



Non-Domain Specific Requirements for a Future Simulation Environment (1)

- **Neutral tools and formats:** Model configuration has to be neutral i.e. it should not be simulation tool specific.
- **Multi-level simulation:** Seamless support for simulation in different levels of details i.e. conceptual level simulation at the beginning of the product life cycle, more detailed simulation in later phases and seamless moving between these levels.
- **Unified modelling tools:** There should be general, unified model composing and modification tools for different background tools.
- **General, rationalised pre-processing tools:** There should exist high level component modelling, meshing, model topology editing, simulation management and runtime adaptive tools.
- **General, rationalised post-processing tools:** Simulation data visualization using suitable modern methods of computer graphics (2-D, 3-D, augmented reality) should be common for different models and different levels of details. This way results from these models can be visualized in a common and intuitive way.

Non-Domain Specific Requirements for a Future Simulation Environment (2)

- **Heterogeneous system simulation:** Support for multi-domain and multi-physics simulation.
- **Tool interoperability:** There should be better links from simulators to different engineering applications. Only this way simulation can find its way to the everyday engineering.
- **Results interoperability:** The simulation system should provide seamless exchange of model and simulation results data between different modules in the simulation process.
- **Distributed modelling and simulation:** Need for distributed simulation model configuration and usage including version and access control.
- **Model quality improvement:** Support for validation and verification of simulation models should be a built-in feature in a modelling and simulation framework.
- **Component based solvers:** There should exist a way for software component based simulation i.e. model algorithms can be developed, added, removed and changed run time as part of the larger scale model.

Plug-in Architecture for Modelling and Simulation

Plug-in (*

APROS simulation engine

Plug-in (*

OpenFOAM CVM CFD simulation environment

Plug-in (*

Elmer FEM multi-physics simulation environment

Plug-in (*

OpenSceneGraph visualisation environment

Plug-in (*

BALAS simulation engine

Simantics Platform

- *Eclipse* based application framework
- *Apache Batik* 2D diagram framework
- OpenCASCADE 3D geometry kernel
- …
- Editors (text, 2D diagram, 3D geometry)
- Structural data handling and mapping
- Project/team management tools
- Distributed modelling and simulation facilities
- …

Plug-in (*

OpenDX and *ParaView* post-processing and visualisation tools

Plug-in (*

VTT-Talo building simulation environment

Plug-in (*

Octave mathematical language environment

Plug-in (*

OpenModelica system simulation environment

ProCore triple engine Modelling database management

Historian Simulation results database management

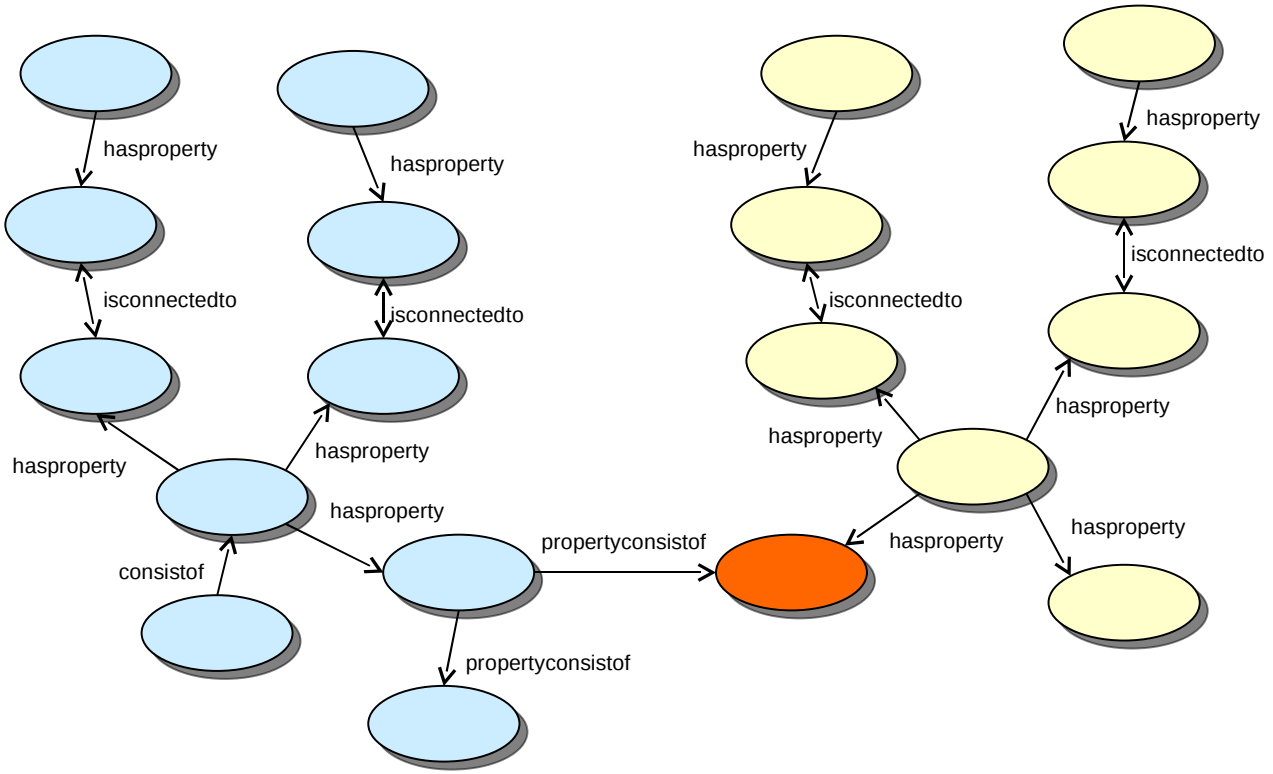
Plug-in (*

…

*) Plug-ins are examples what could be connected to the Simantics platform

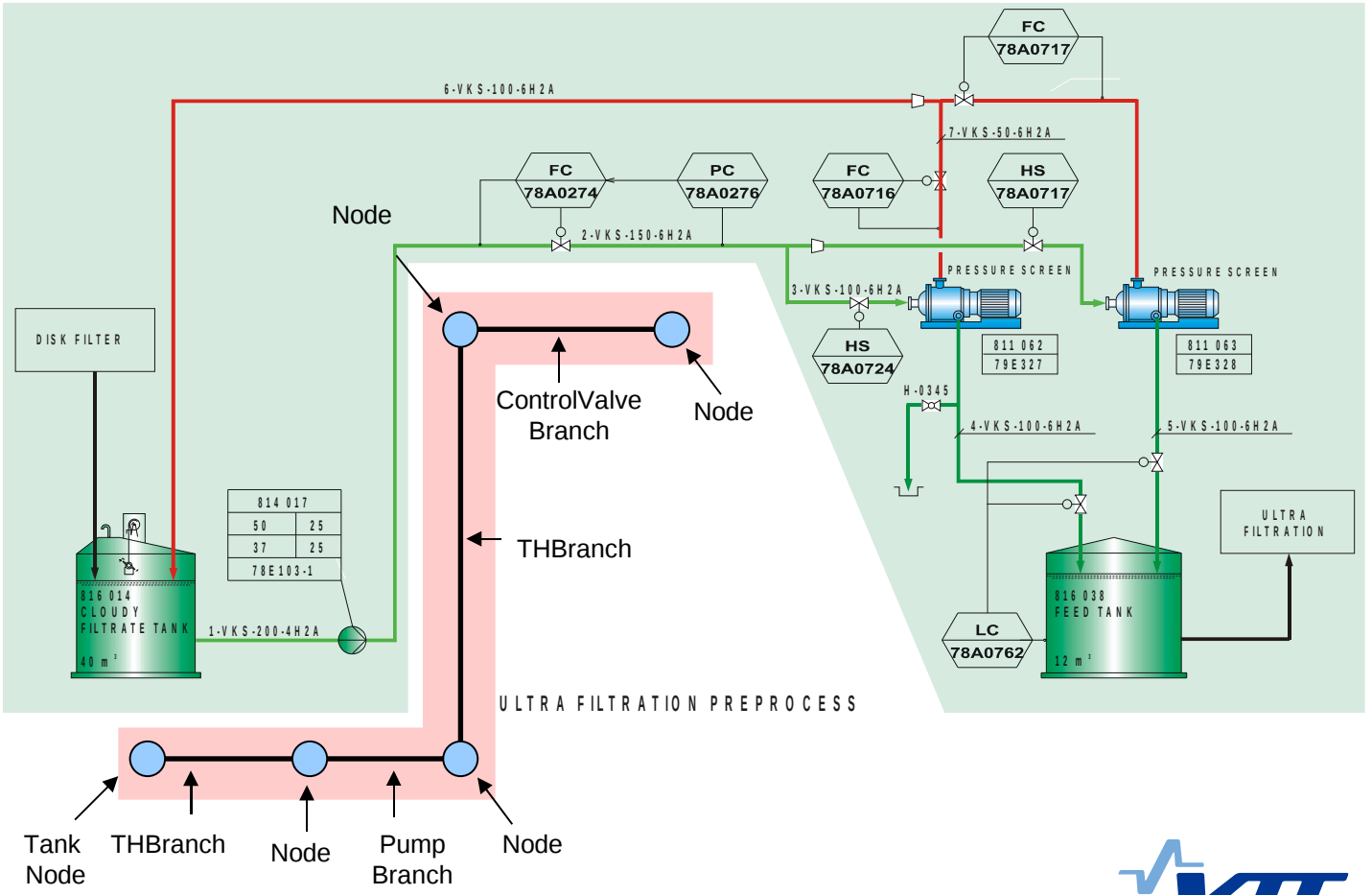
Ontology Based Modelling and Simulation

Different modelling and simulation approaches are modelled as ontologies and mapped together to form a consistent graph of model configurations.



Ontology Based Modelling Example: Pipeline Design

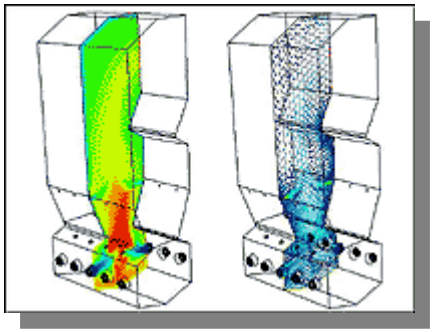
Ontology based modelling enables Different views to the same system data



Examples

- Seamless support for simulation in different levels of details i.e. conceptual level simulation at the beginning of the product life cycle, more detailed simulation in later phases and seamless moving between these levels.

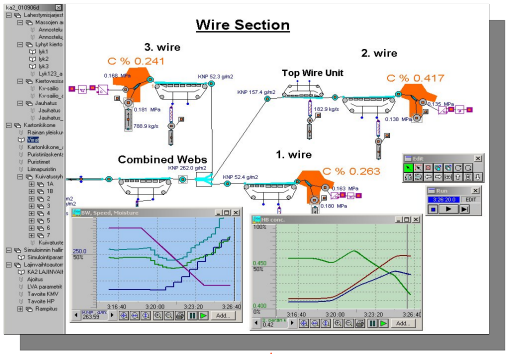
Computational Fluid Dynamics



e.g. *Fluent*, *OpenFOAM*

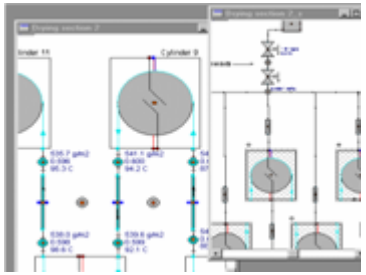
Boundary values

Dynamic large scale process simulation



e.g. *Apros*

Steady state process simulation



e.g. *Balas*, *Prosim*, *Solvo*

Initial states to the dynamic simulation

Examples

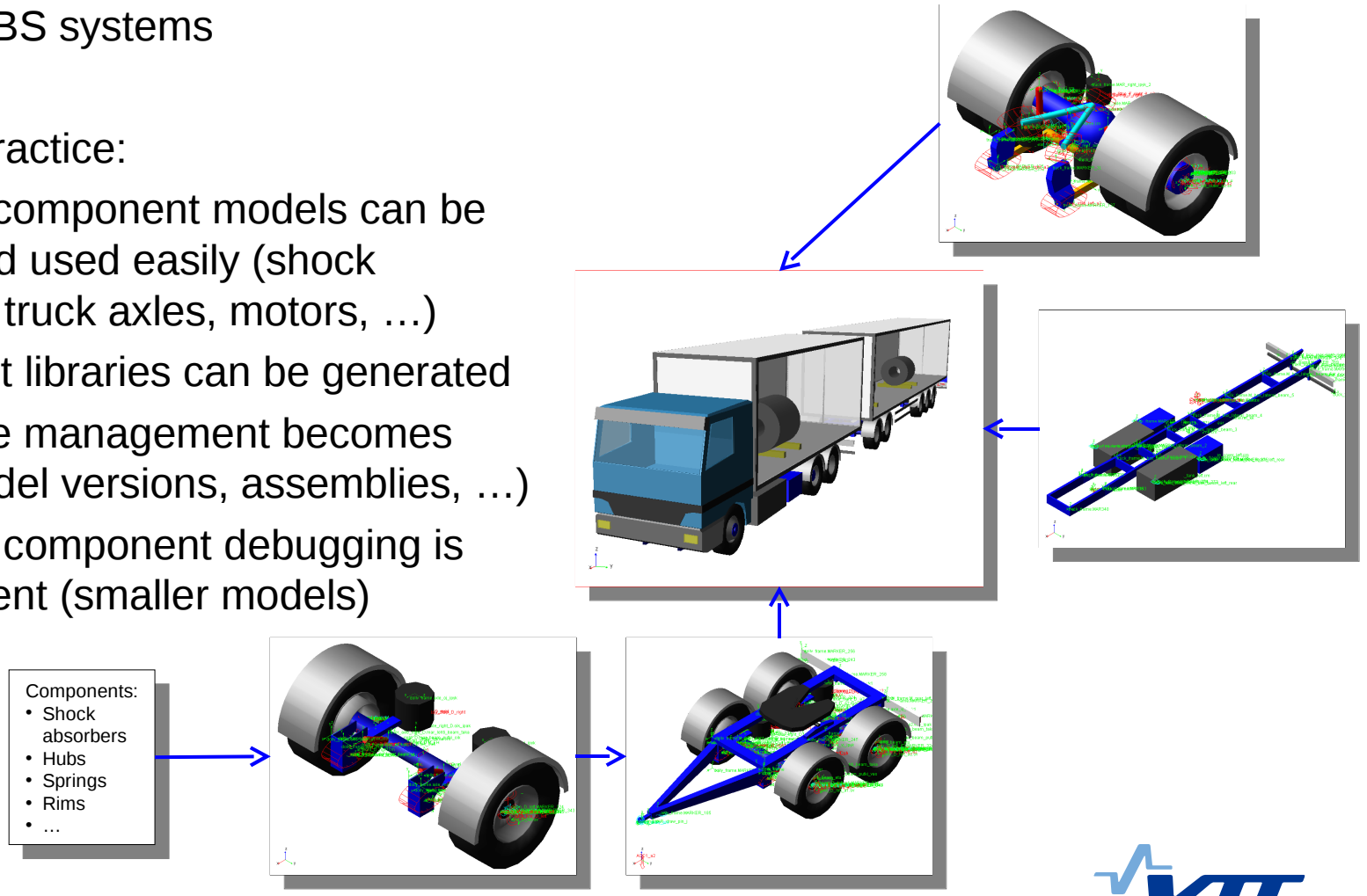
- Simulation data visualization using suitable modern methods of computer graphics (2-D, 3-D, augmented reality) should be common for different models and different levels of details. This way results from these models can be visualized in a common and intuitive way.

Examples

1. Modelling sub-systems and assemblies in MBS systems

Benefits in practice:

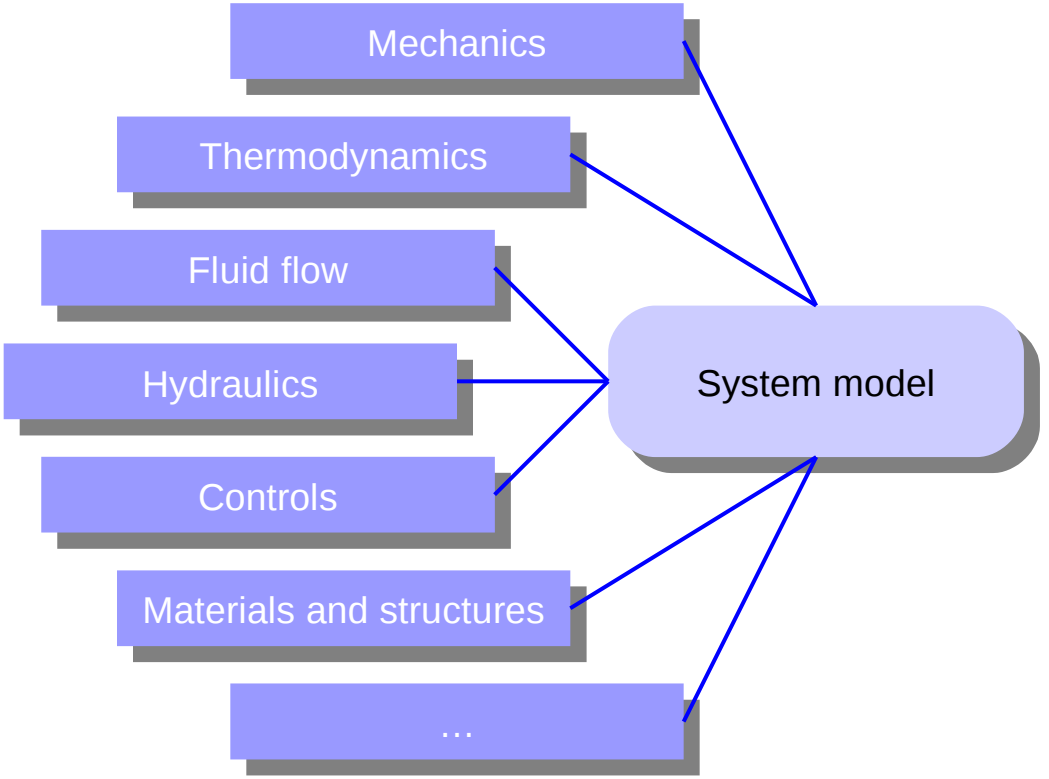
- High level component models can be created and used easily (shock absorbers, truck axles, motors, …)
- Component libraries can be generated
- Model base management becomes easier (model versions, assemblies, …)
- Model and component debugging is more efficient (smaller models)
- …



Examples

1. Heterogeneous system simulation

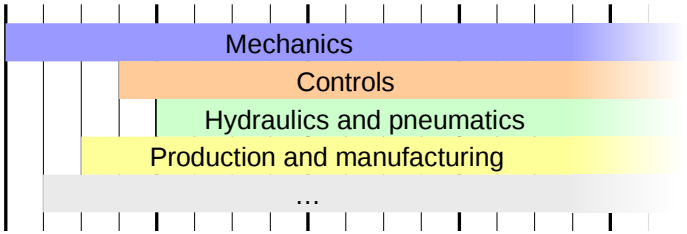
- Products are becoming more complex and product development is becoming networked
- Designers should be able to use tools that are the most convenient for their work flow
- Designers of different domains need simulation feedback from other domains

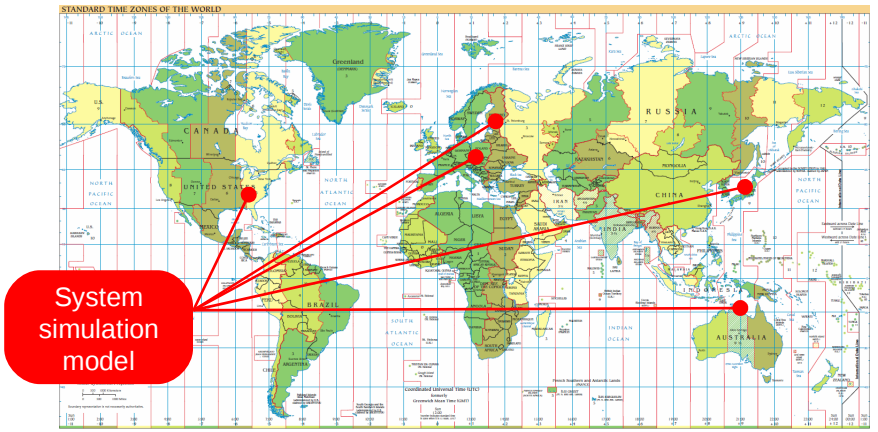


Examples

1. Distributed modelling and simulation

- Concurrent modelling and simulation is mandatory for remarkable shortening of time-to-market
  - Faster modelling and simulation tools can't solve the demand for efficiency
- Virtual product development should be independent of physical location of designers
  - Design of heterogeneous systems can be distributed worldwide, also the modelling tools and methods should allow this
- Distributed simulation
  - Model data is distributed, so should be simulation
  - Parallel or connected separated simulations





Summary: Why Use Simantics?

- Neutral tools and formats
- Unified modelling tools
  - General, rationalised pre- and post-processing tools
- Heterogeneous system simulation
  - Tool interoperability
  - Results interoperability

Rationalise simulation software use, development and maintenance

- Multi-level simulation
- Distributed modelling and simulation
- Structured, layered modelling
- Modelling quality improvement
- Component based solvers

Introduce new modelling and simulation techniques

– Part 4 –
Simantics Continuation

Simantics Project Map

Application of Simantics

Codes

Cyclide

Academy of Finland proposals

???

???

User Interface development

Nose

Nase

Interface development

OPC-UA Data Model

Core technology development

Simantics

Software development

APROS 6.0

BALAS 4.0

Local Energy Planning Tool

Solver integration

PhaseField

LSCFD

Human Thermal Model

Design data integration

Sefram

Solver development

OpenModelica

OPENPROD

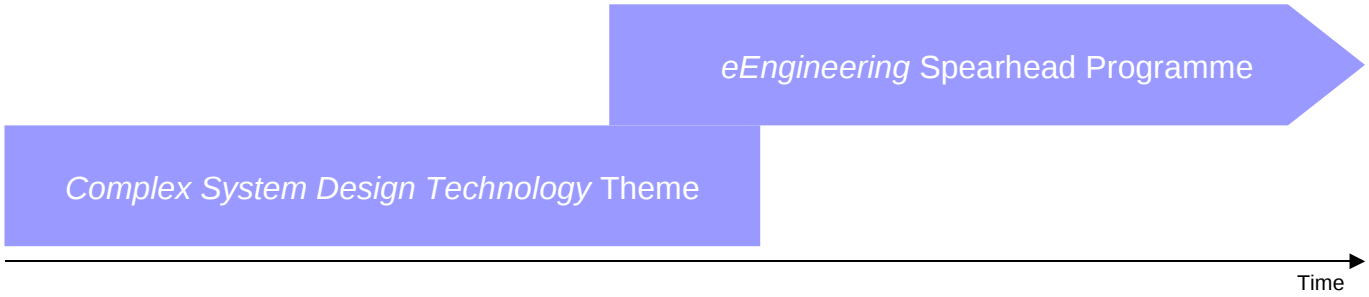
Simantics Project Continuity at VTT

VTT's commitment to Simantics development:

2. VTT theme projects continuation
   - Simantics project continuation 2009

- VTT spearhead programmes, *eEngineering*
  - One of the strategic research topics at VTT

- Application of Simantics in other research projects



Software Products: APROS 6.0

- APROS provides application oriented model libraries for full-scale modelling and simulation of industrial processes, such as
  - pulp and paper mills (*APROS Paper*),
  - combustion power plants (*APROS Combustion*), and
  - nuclear power plants (*APROS Nuclear*),

  all including gas/liquid flow networks, process automation and electrical systems.
- APROS 6.0 is a development project of Fortum and VTT to develop a new version of APROS based on **Simantics technology**. Project has started January 1 2008 and is planned to continue until mid 2010 when APROS 6.0 will be released.

More information on APROS can be found from http://apros.vtt.fi

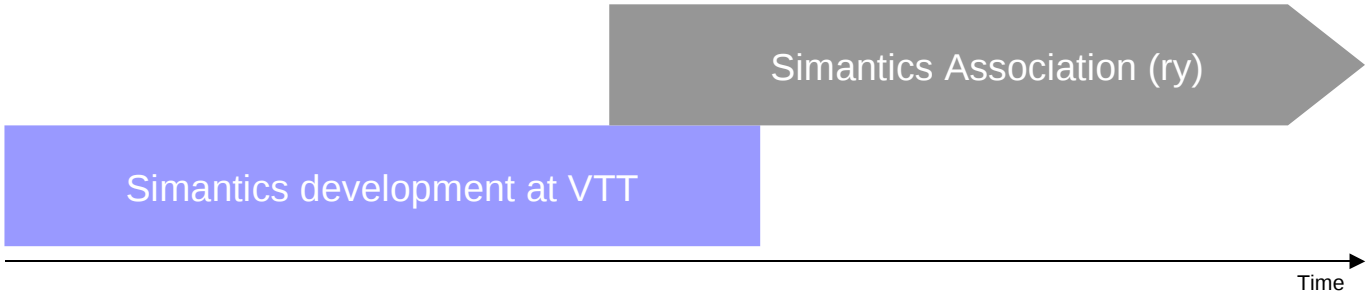
Software Products: BALAS 4.0

- BALAS is a steady state simulation package for chemical processes with emphasis on pulp and paper. The software has been developed at VTT Technical Research Centre of Finland over the last 20 years and several Finnish paper mills, engineering companies and equipment manufacturers currently use it.
- BALAS 4.0 is a development project of VTT to develop a new version of BALAS software based on **Simantics technology**. The project started June 1 2008 and will continue until the beginning of 2010 when new BALAS version will be officially released.

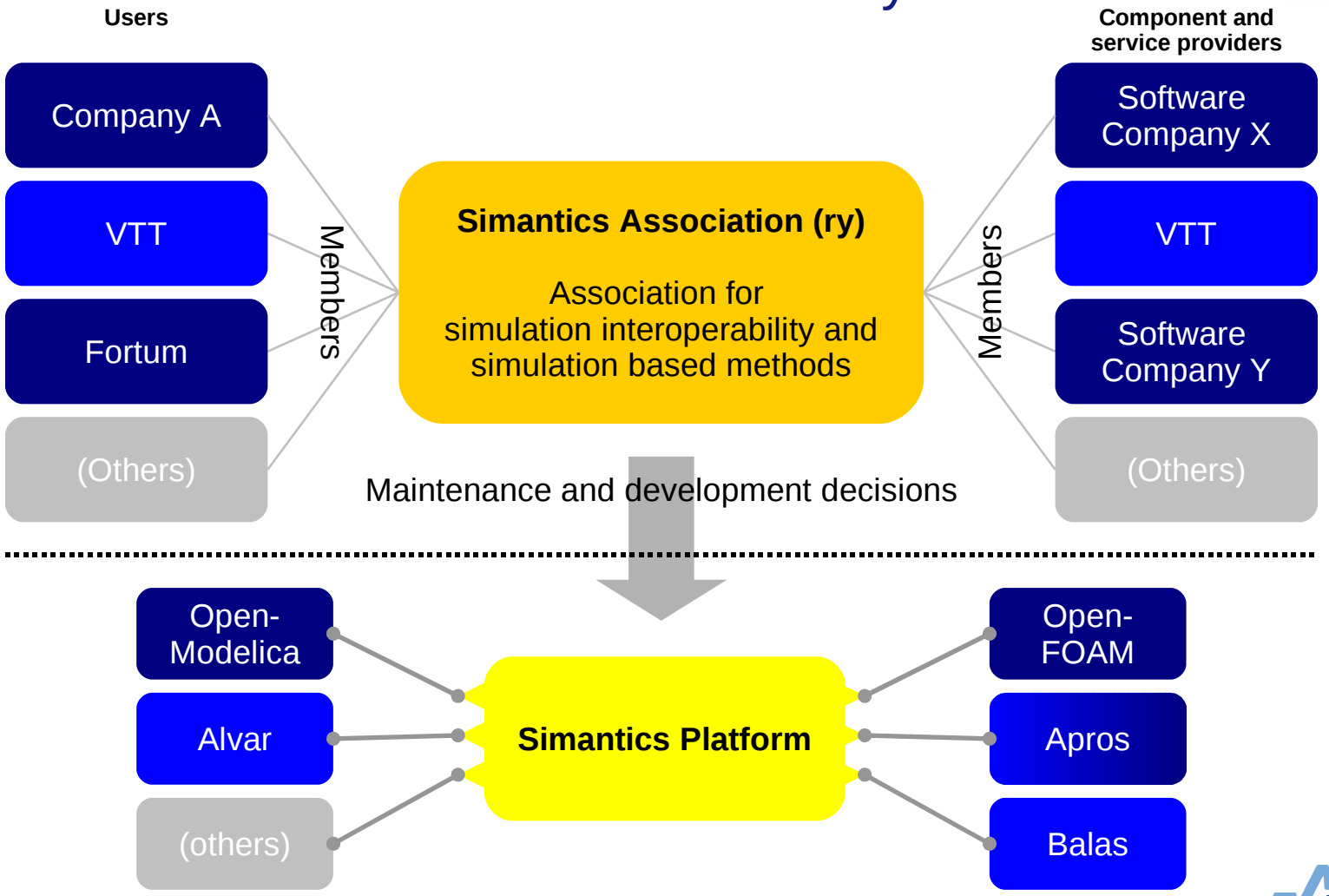
More information on BALAS can be found from http://virtual.vtt.fi/virtual/balas/

Planned Simantics Association and Simantics Licensing

- What is Simantics Association needed for?
  - As a open source software platform Simantics needs a neutral home base
  - An actor to guide the development and resources
  - A promoter to spread the word
- What does the proposed licensing model mean?
  - The *Eclipse Public License* (EPL) is proposed for the platform
  - EPL license: http://www.eclipse.org/legal/epl-v10.html
  - What does this mean to the community and its members?



Plan for Simantics Ecosystem



Simantics Development

- Platform development would be coordinated by Simantics Association
  - Core development
  - Generic functionality
  - Simantics release administration
  - "Big lines"
- Simantics Association could offer support services like developer and end user forums, help for documentation and a place for contacting
- For development on Simantics the platform will contain efficient and easy-to-use developer tools
  - Ontology and plug-in development tools
  - Building on Simantics should be as easy as possible; this helps to adopt the system and thus to spread its use

Questions and answers