Ontology based Integration Platform for Modelling and Simulation - Simantics

Tommi Karhela
VTT Technical Research Centre of Finland
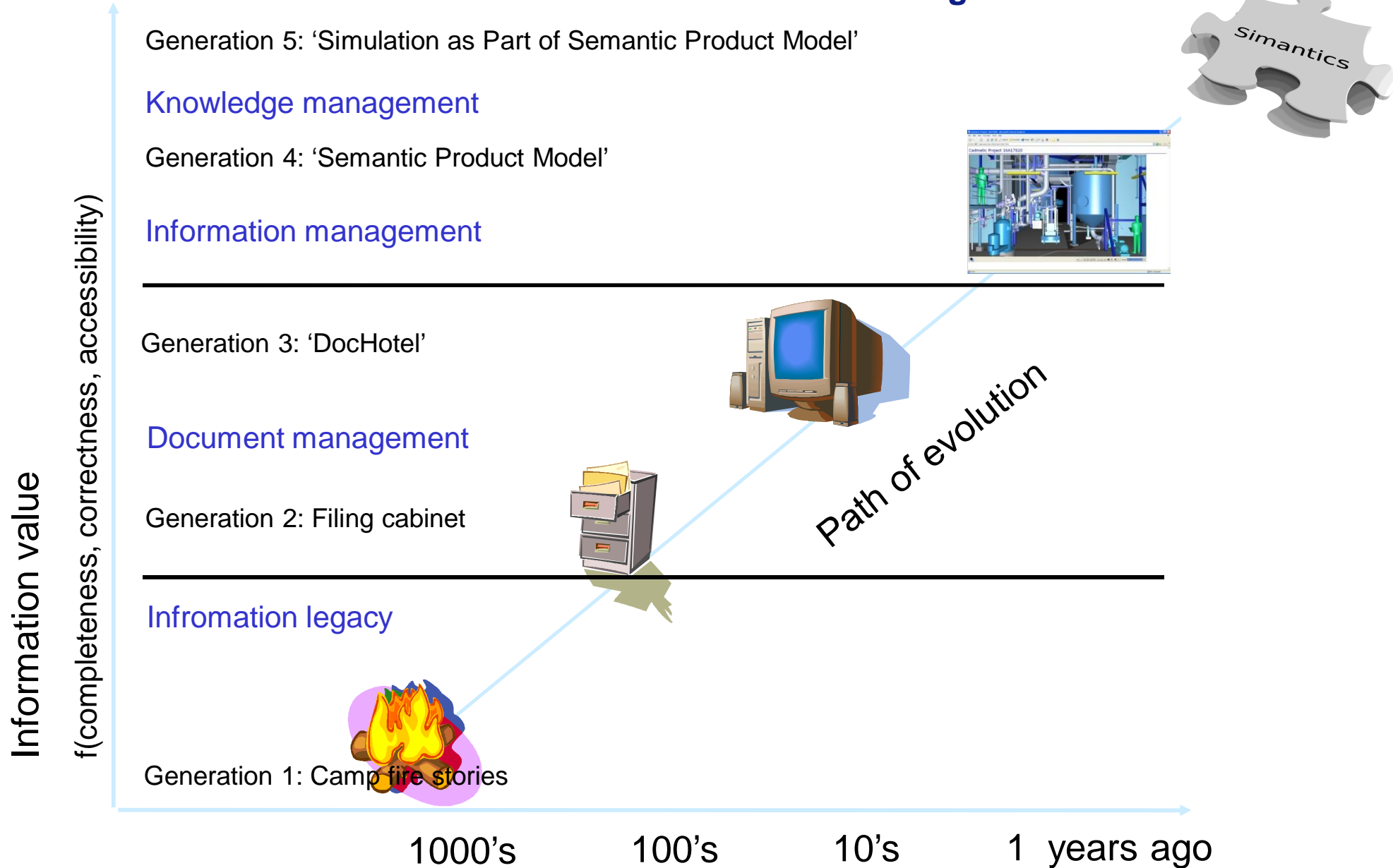
What is Simantics?

Open platform for modelling and simulation

- Developed at VTT since 2006
- Application development platform
- Integration solution for modelling and simulation
- Semantic graph based representation of data
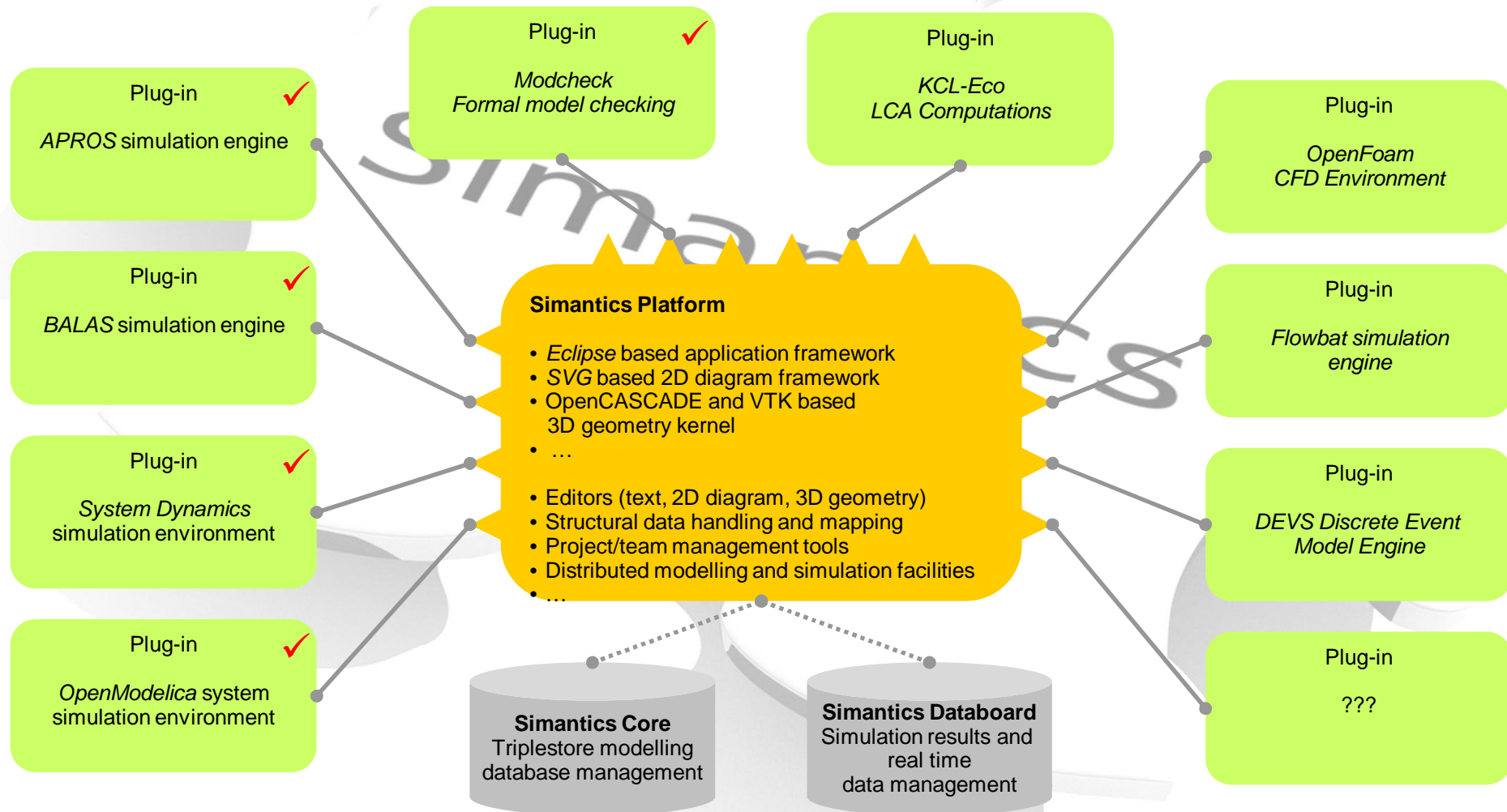- Licenced under Eclipse Public Licence

Goals

- Reusable components for modeling and simulation infrastructure (less focus on solver technology)
- Multi-disciplinary, multi-level simulation and modeling
- Supports the whole life cycle of the facility or product
- Distributed simulation
- Model integration
- Solver integration
- Team work

Different Generations of Information Management

Generation 5: 'Simulation as Part of Semantic Product Model'

Knowledge management

Generation 4: 'Semantic Product Model'

Information management

Generation 3: 'DocHotel'

Document management

Generation 2: Filing cabinet

Infromation legacy

Generation 1: Camp fire stories

Simantics

Path of evolution

Information value

f(completeness, correctness, accessibility)

1000's   100's   10's   1 years ago

Plug-in Architecture for Modelling and Simulation

Plug-in ✓

APROS simulation engine

Plug-in ✓

BALAS simulation engine

Plug-in ✓

System Dynamics simulation environment

Plug-in ✓

OpenModelica system simulation environment

Plug-in ✓

Modcheck Formal model checking

Plug-in

KCL-Eco LCA Computations

Plug-in

OpenFoam CFD Environment

Plug-in

Flowbat simulation engine

Plug-in

DEVS Discrete Event Model Engine

Plug-in

???

Simantics Platform

- *Eclipse* based application framework
- *SVG* based 2D diagram framework
- OpenCASCADE and VTK based 3D geometry kernel
- …

- Editors (text, 2D diagram, 3D geometry)
- Structural data handling and mapping
- Project/team management tools
- Distributed modelling and simulation facilities
- …

Simantics Core
Triplestore modelling database management

Simantics Databoard
Simulation results and real time data management

For more information, visit: www.simantics.org

Integration Environment for Design and Simulation Tools

OpenModelica
System Simulation

Company
Specific
Simulators

Simulation
Engineer

Design
Engineer

Apros
Dynamic
Process Simulation

3D
Design

Common
User Interface
Environment

Automation
Design

Solvo
Steady State
Process Simulation

Simantics

Plant Design System
e.g. SmartPlant
Foundation or Comos

Balas
Steady State
Process Simulation

Process
Design

Simulation
Information
Management

Engineering
Information
Management

Elmer
Multiphysics

Design
Engineer

Simantics - Open Operating System for Modelling and Simulation

Simantics Components

Products
Perspectives
Components
External

| Apros | Balas | System Dynamics | KCL-Eco | Modcheck | ... |

| Ontology Development | Project Management | Modeling and Simulation | Team Features |

| Ontology Development | Spreadsheet | Documentation | Chart | Validation | Mapping |
| Development Environment | 2D | Browsing | Experiment control | Events | Constraint Language |

| Eclipse | Databoard | Core API |
| Java | Core |
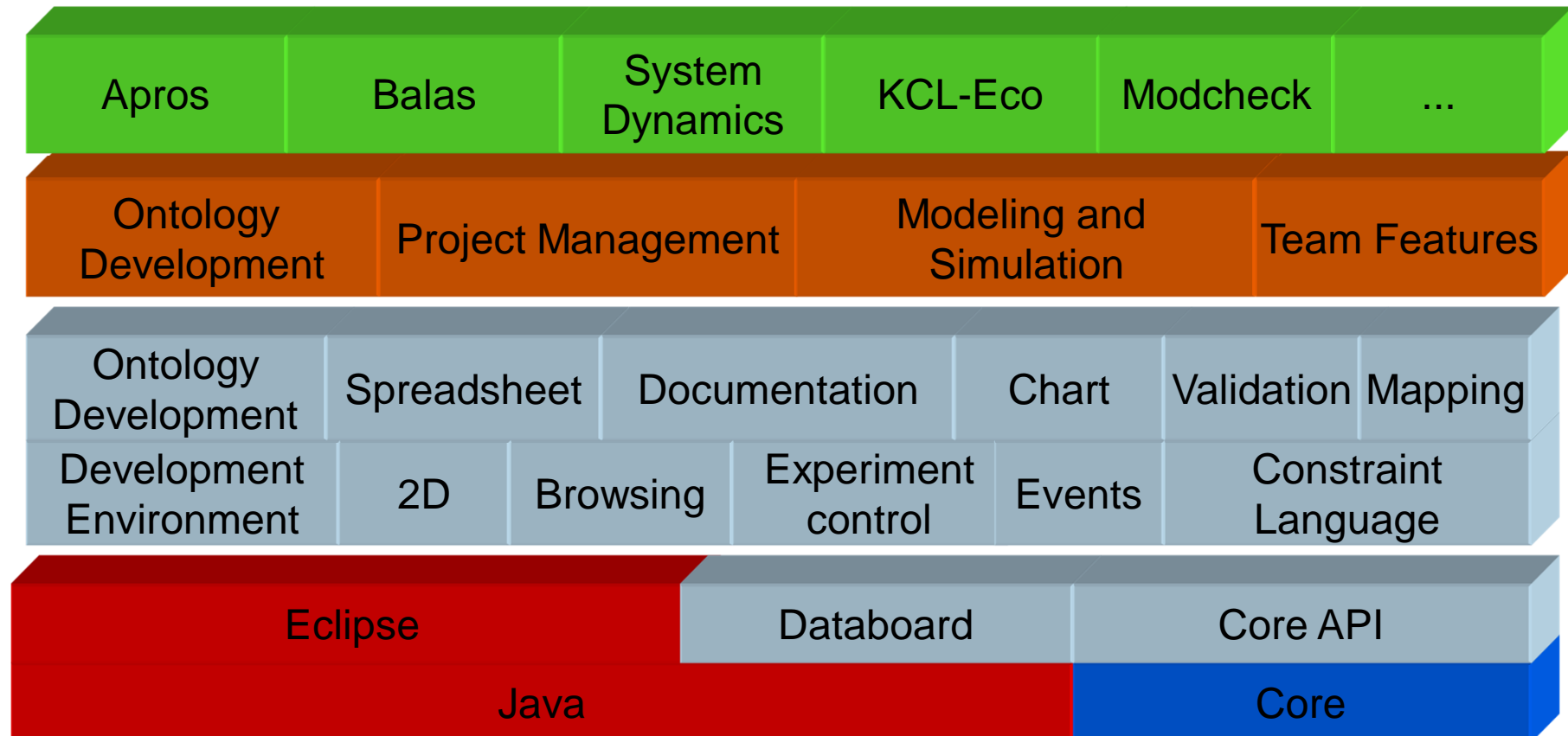
Ontology Language – Layer0

Formal specification at http://dev.simantics.org/images/c/c8/Layer0.pdf
Used graphical notation is described at https://www.simantics.org/wiki/index.php/Graphical_ontology_notation
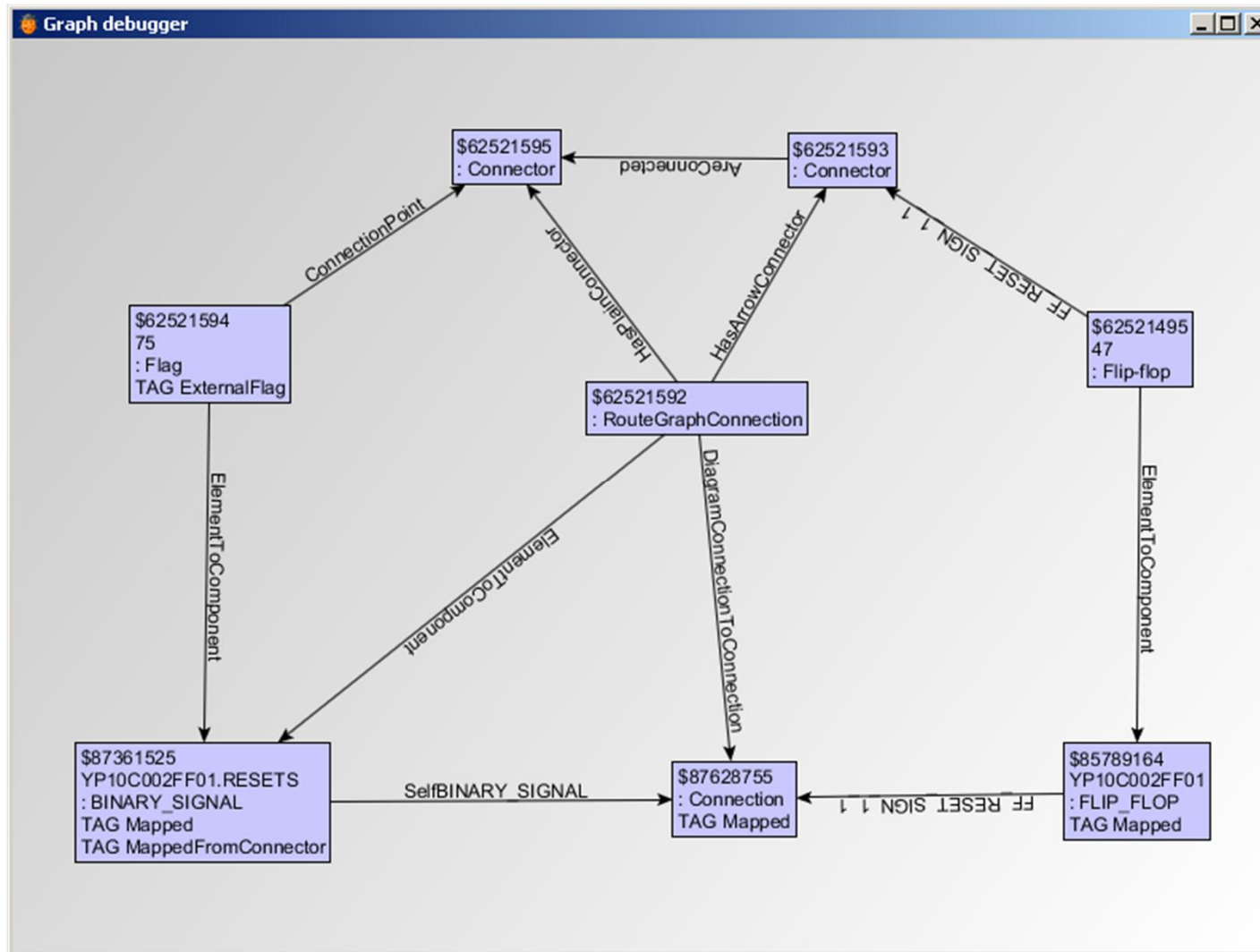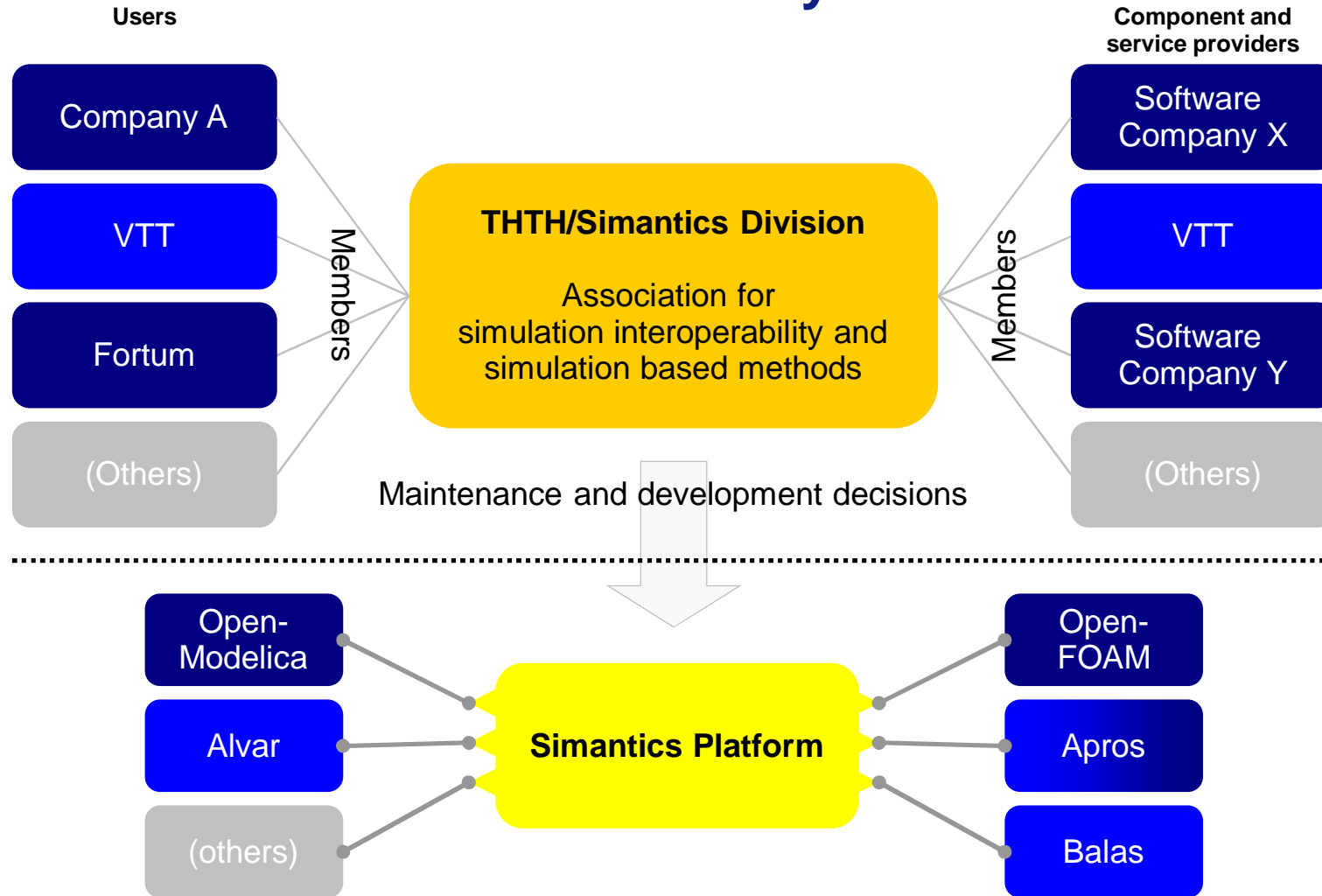
Why Ontologies?

- Flexibility: Quite different data models of different simulators and design systems expressed using the same language
- Model validation
    - Capturing knowledge of experienced modellers (rules)
- Semantic queries
- Model transformations
- Model annotations

Ontology challenges

- Performance issues
- Quite complex low level API's
    - Need for experienced and skillful programmers in the core
- Ontology versioning
    - Model migration from one ontology version to another
    - Code plugins that would handle several ontology versions

Simantics Ecosystem

Users

Component and service providers

Company A

VTT

Fortum

(Others)

Members

THTH/Simantics Division

Association for
simulation interoperability and
simulation based methods

Members

Software Company X

VTT

Software Company Y

(Others)

Maintenance and development decisions

Open-Modelica

Alvar

(others)

Simantics Platform

Open-FOAM

Apros

Balas

THTH ry:
Teollisuuden hajautetun tiedonhallinnan yhdistys
Association of Decentralized Information Management for Industry
http://www.ththry.org/

Some Members of the Simantics Development Team

Kalle
Kondelin

Antti
Villberg

Hannu
Niemistö

Tommi
Karhela

Toni
Kalajainen

Tuukka
Lehtonen

Marko
Luukkainen

VTT creates business from technology