DYMASOS – Dynamic Management of Physically Coupled Systems of Systems

Steps towards innovation

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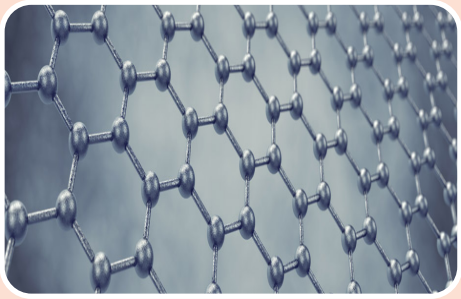
This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 611281.

Management Methods



Population-control techniques that are motivated by the behavior of biological systems

Market-like mechanisms that achieve global optimality by the iterative setting of prices or resource constraints

Coalition games, where agents group dynamically to pursue common goals

Industry-driven case studies

Electricity distribution grid

HEP ODS d.o.o.

Chemical production complex

BASF The Chemical Company

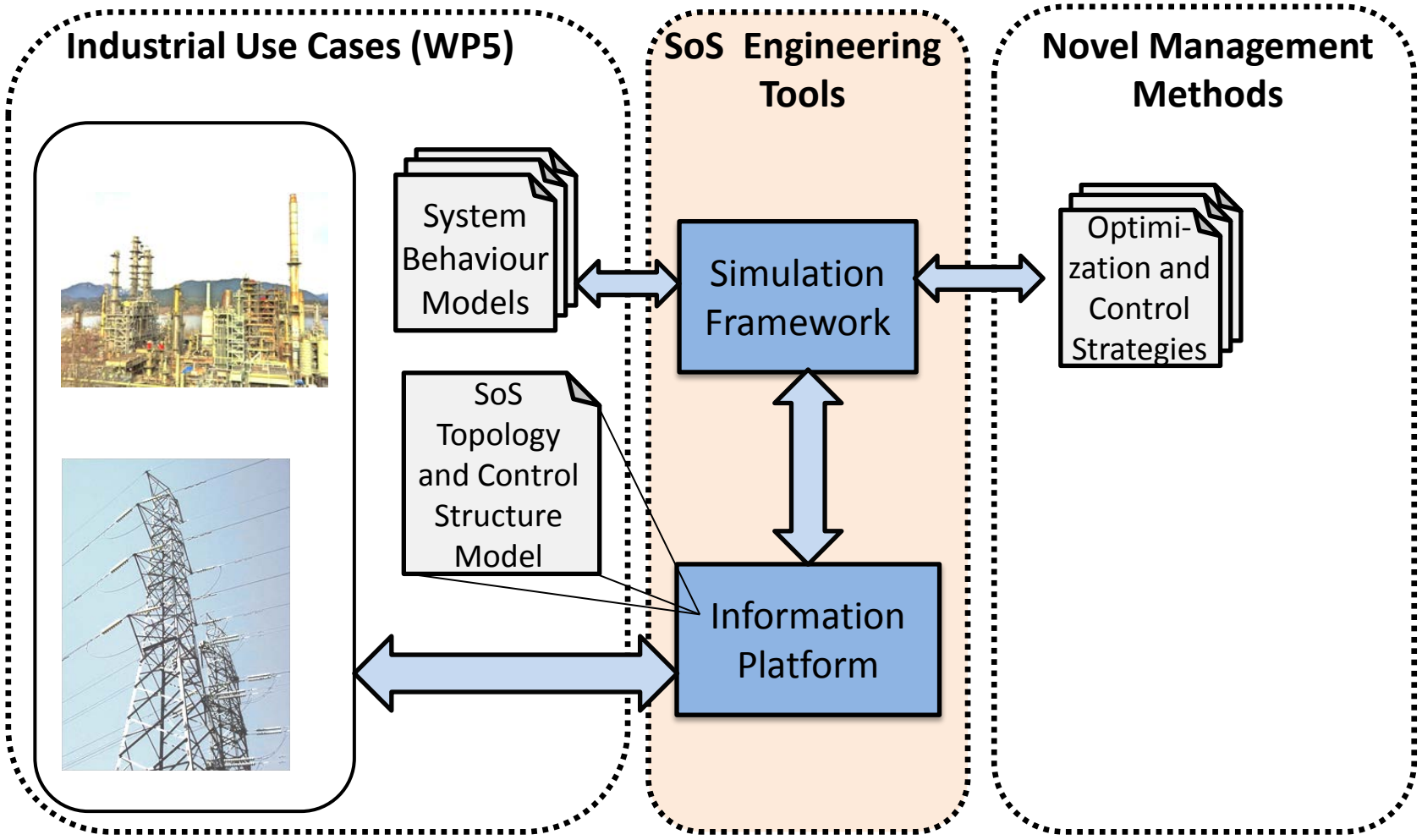
Charging systems for electric vehicles

ayesa

Steam network management of a large interconnected chemical plant

INEOS THE WORLD FOR CHEMICALS

DYMASOS tools



Innovation at INEOS

- **Main objective**
  - Improve the energy management of an industrial site using a market-based algorithm to achieve **significant energy savings**
    - **Goal:** Reduction of specific energy consumption by **5%**
- **Strategy**
  1. Simulation studies in DYMASOS
  2. Pilot installation of an internal, automated steam market implementation as decision support for plant management
     - Quantitative evaluation of approach and savings potential
     - Detailed understanding of product integration of an integrated petrochemical site
  3. If successful: Introduction to productive operation

Innovation at BASF

- **Main objective: First proof of concept**
  - Determine if market-based management approaches are **applicable under typical industrial constraints** (robustness, profitability, maintainability, etc.)
  - Investigate the **prerequisites** that are required **to successfully apply such methods in industrial environments**
- **Strategy**
  1. Simulation studies in DYMASOS & exploitation strategy development in WP6
     - Main outcome and prerequisite for next step: **Strong business case**
  2. If successful: Follow-up transfer project
     - **Requirement:** Support by commercial suppliers and consultants

Innovation at AYESA

- **Main objective: New, improved management methods for the electric vehicle charging network**
  - Evaluation of new models of interconnection between different electric vehicle charging operators and the distribution network.
  - Detailed understanding of ways to:
    - **Balance production and consumption** in electric vehicle charging.
    - **Integrate management** among the different actors.
    - **Minimize the impact** of electric vehicle charging **on the grid**.

- **Strategy:**
  1. Simulation studies in DYMASOS.
  2. If successful: Implementation of the most promising management method (**all three have a potential**) in the AYESA electric vehicle management system.

Innovation at HEP

- **Main objective**
  - Obtain new management technologies for distribution grid control that:
    - Enable a **significant reduction of losses** and **improve power quality**,
    - **Evade grid incidents** and **detect and recover from problems**,
    - Enable **plug-and-play interconnection** to energy sources
- **Strategy**
  - Guide the development process and evaluate applicability in simulation studies
  - **Long-term plan:** Introduction into the coming era of active distribution grids

Innovation in Engineering Tools

- **DYMASOS Modeling and Simulation Framework**
  - Development of a prototype by TUDO and euTEXoo
  - Demonstration on the industrial cases
  - Further development by TUDO & euTEXoo & (possibly) external partner, e.g. from the Modelica Eco-System

- **DYMASOS Information Platform**
  - Development of a prototype by RWTH
  - Demonstration at an industrial site
  - Connection to other tools
  - Commercialization via SME's or provision of open software

From research to innovation

TRL advancement		
▪ TRL-2 to TRL-4/5	▪ TRL-4/5 to TRL-7	▪ TRL 7 to TRL 9
Activities		
▪ Technical developments, ▪ Case study developments, ▪ Dissemination to industrial parties and tool providers, ▪ Definition of exploitation strategy, ▪ Valuation of project results (feedback by academia and industry).	▪ **Quantitative scoping studies / pilot tests in industrial environments (in DYMASOS focus areas, i.e. chemical production and energy systems),** ▪ **Quantitative business case development and showcasing,** ▪ Acquisition of new funding avenues, ▪ Showcasing of DYMASOS software suite to suitable larger tool providers and other high-tech SMEs, ▪ Determination of preliminary consulting and deployment service options for smaller SMEs, ▪ Technical maturation.	▪ Development of mature software suite in cooperation with a tool provider, ▪ Development of attractive licensing options for customers, ▪ Development of suitable marketing tools, ▪ Establishment of international expert and consulting networks for SoS management and engineering, ▪ Extension of marketing efforts to other industrial domains, ▪ Development of mature consulting and deployment service options for smaller SMEs.

TRL 1 – basic principles observed

TRL 2 – technology concept formulated

TRL 3 – experimental proof of concept

TRL 4 – technology validated in lab

TRL 5 – technology validated in relevant environment

TRL 6 – technology demonstrated in relevant environment

TRL 7 – system prototype demonstration in operational environment

TRL 8 – system complete and qualified

TRL 9 – actual system proven in operational environment

Summary

- **Several developments with high potential for real innovation**
- **Most promising ones:**
  - **Population control** to steer large systems with many independently acting units (users)
  - **Market-based algorithms** to coordinate subsystems that do not want to share information
  - **Platforms** for simulation and validation and for information management
- **Pilot applications and scoping studies are the key to take-up by end-users and service and software providers!**