Adopting system engineering methodology to Virtual Power System design flow

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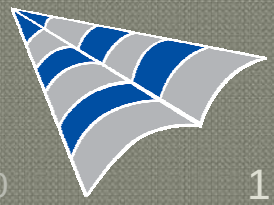
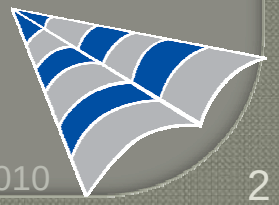


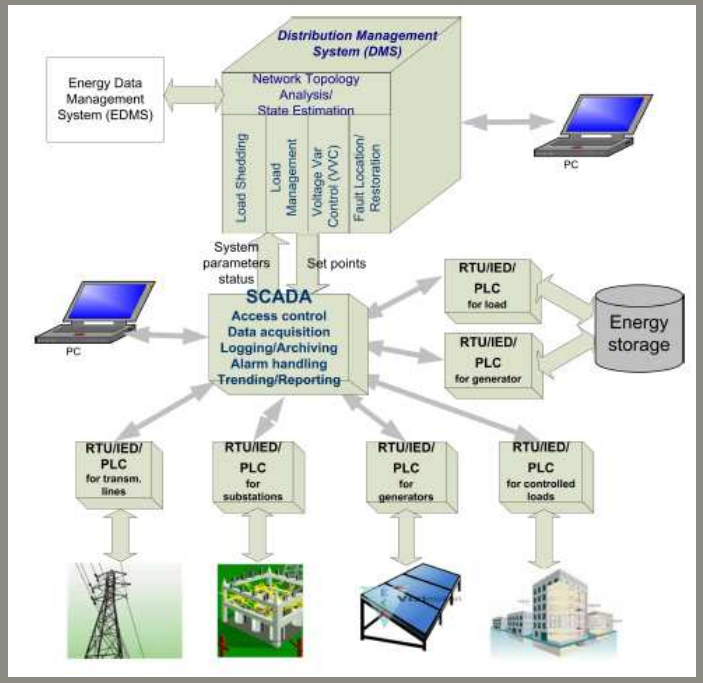
Outline

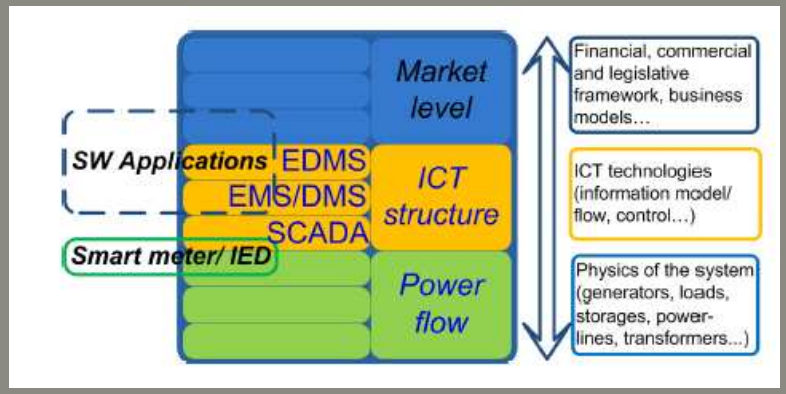
- Structure of modern power systems - SmartGrids
- Distributed Energy Resources
- Virtual Power System (VPS)
- Commercial and Technical VPS
- UML/SysML as system engineering
- Modeling methodology for VPS – from user requirements to functional ones
- Case study – Advanced Metering Infrastructure
- Conclusions and future work



Structure of modern power systems

- Power system are experiencing an evolution

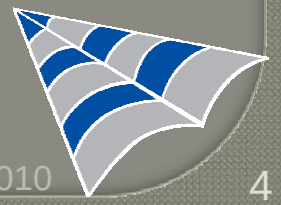




Smart grid challenges

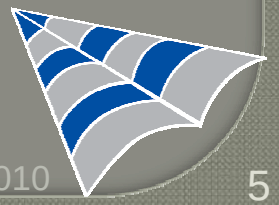
- Increased *stability and reliability* of supply
- Better support for new market and *business models* as well as for *DSM*
- *Modular and scalable* approach in system design
- Facilitated *maintenance*
- End-to-end *interoperability* i.e. self-describing/self-identifying devices
  - *Plug-and-play* installation

- Massive insertion of non-controllable generators



Distributed Energy Resources

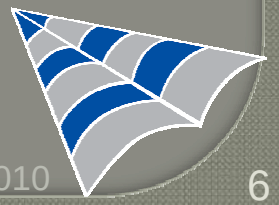
- Heterogeneous renewable resources
- Global push for further development
- Technical issues
- Commercial issues
- Massive insertion on distribution level



Virtual Power System

- DER problem – efficient integration
- Smart grid problem – computational and communicational overhead

- A concept defined by AlpEnergy project
- An autonomous entity in commercial and technical terms
- Promising solution for filling the gap – Virtual Power System



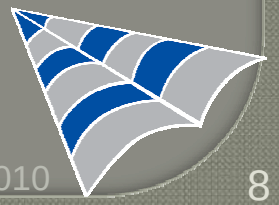
Virtual Power Plant - structure

- Commercial Virtual Power Plants – CVPP
- Technical Virtual Power Plants – TVPP

(according to Fenix project)

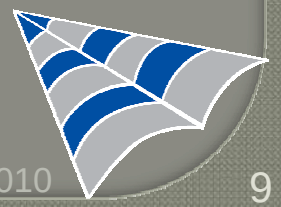
CVPP vs. TVVP

- Optimization and scheduling of production based on predicted needs of consumers
- Maintenance and submission of DERs' characteristics and costs (portfolio)
- Building DER bids and submitting them to the market
- Selling energy provider by DERs to the Market
- TVVP – optimizes technical operation of VPP according to production requests from CVPP



UML/SysML for system engineering

- UML and it's extension SysML are widely accepted standard for specification, modeling and analysis
- A mean to tackle complexity of modern systems – used in system engineering
- Common understanding platform
- From user requirements through system ones to functional requirements of concrete embedded systems



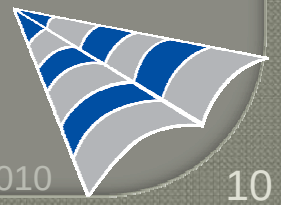
Modeling methodology

- VPS is multidisciplinary requiring holistic approach
- Request for unified specification and modeling
- Unified Modeling Language (UML)

Our goals

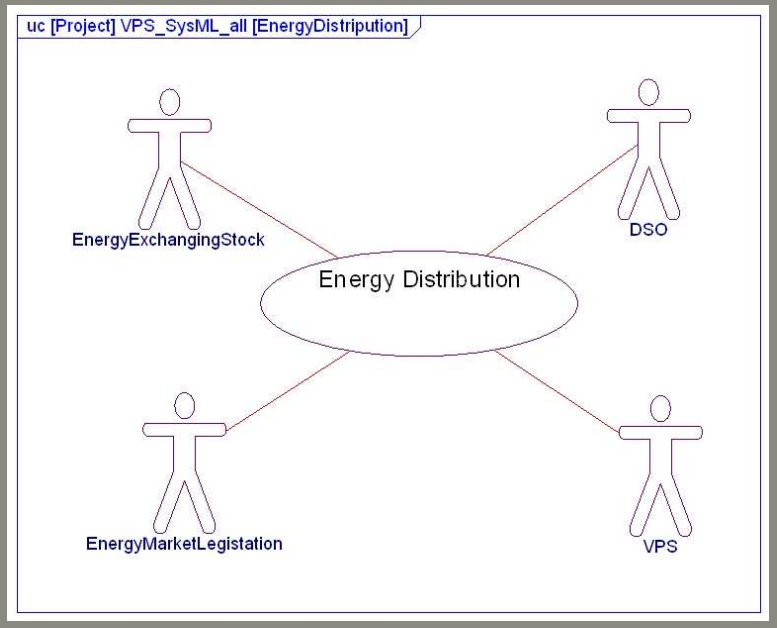
– Developing a mutual communication and understanding platform (relating – energy exchange stock, utilities, authorities, technology providers …)

- Efficient gathering of user requirements and their translation into system and functional ones



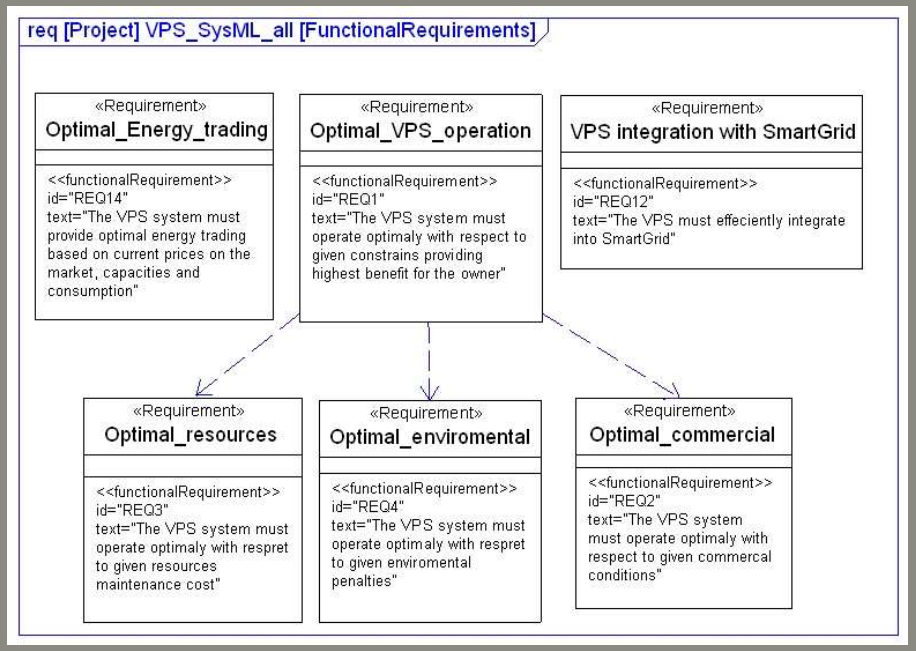
Modeling methodology(cont.)

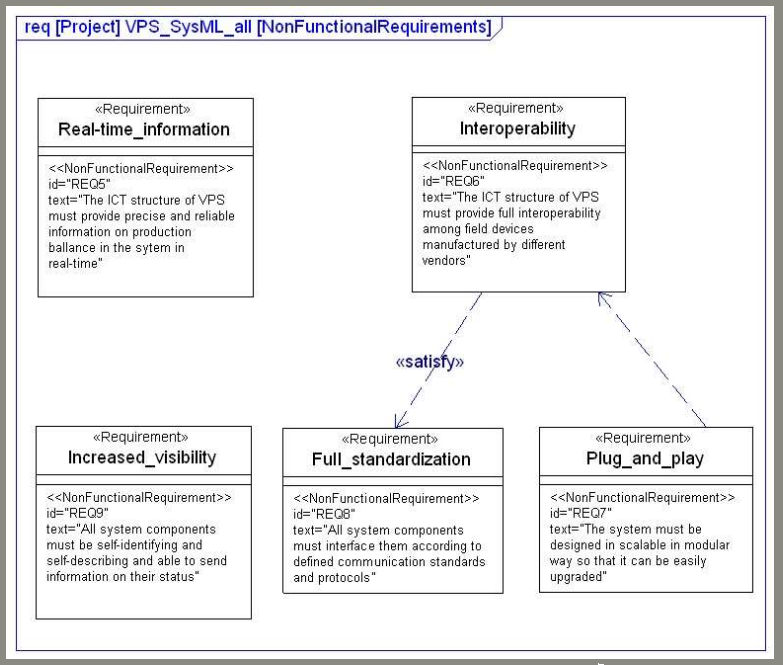
- It starts with ideas and goals definition and context description
  - Context diagram (general abstract model) -> basic stakeholders determination -> user requirements -> system requirements (services) -> functional requirements -> component description



Modeling methodology(cont.)

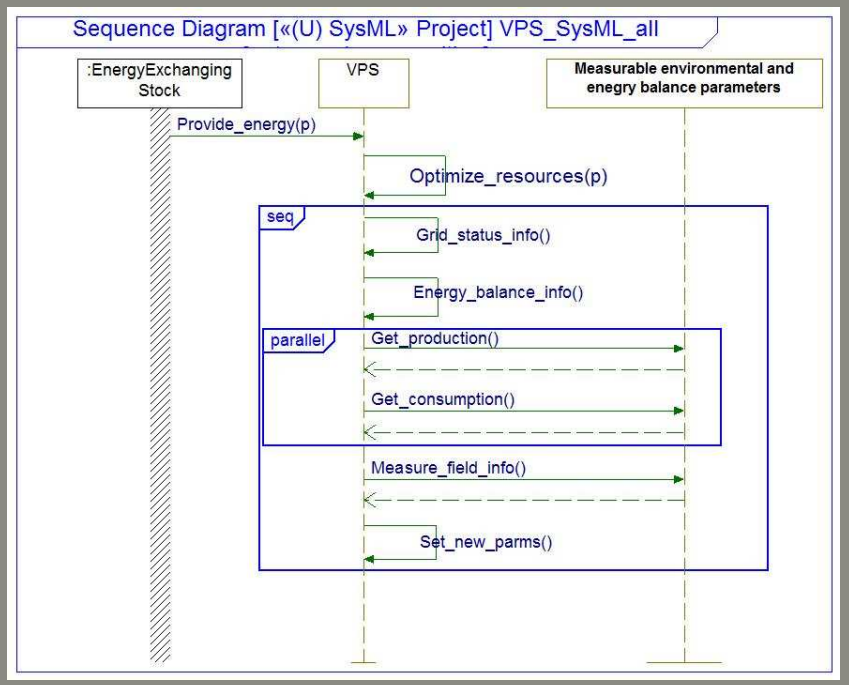
- User requirements collection – in text mode using some natural language

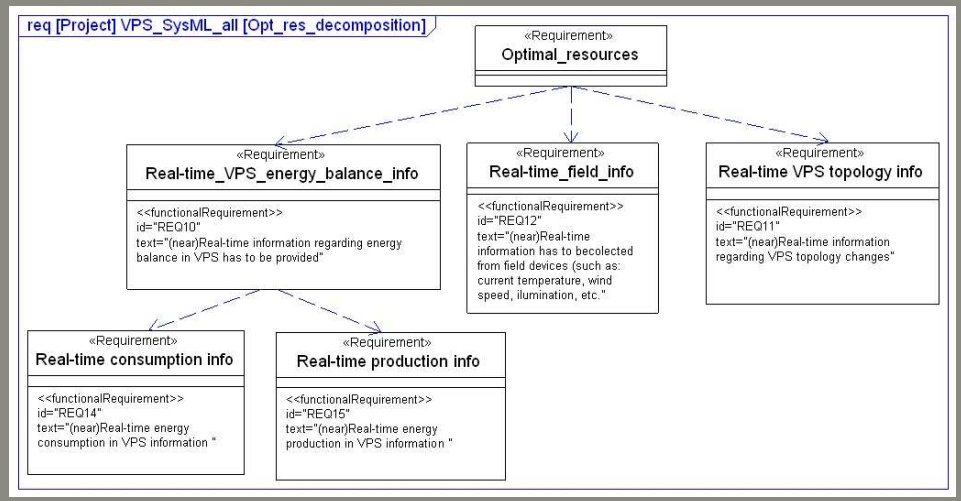




Modeling methodology(cont.)

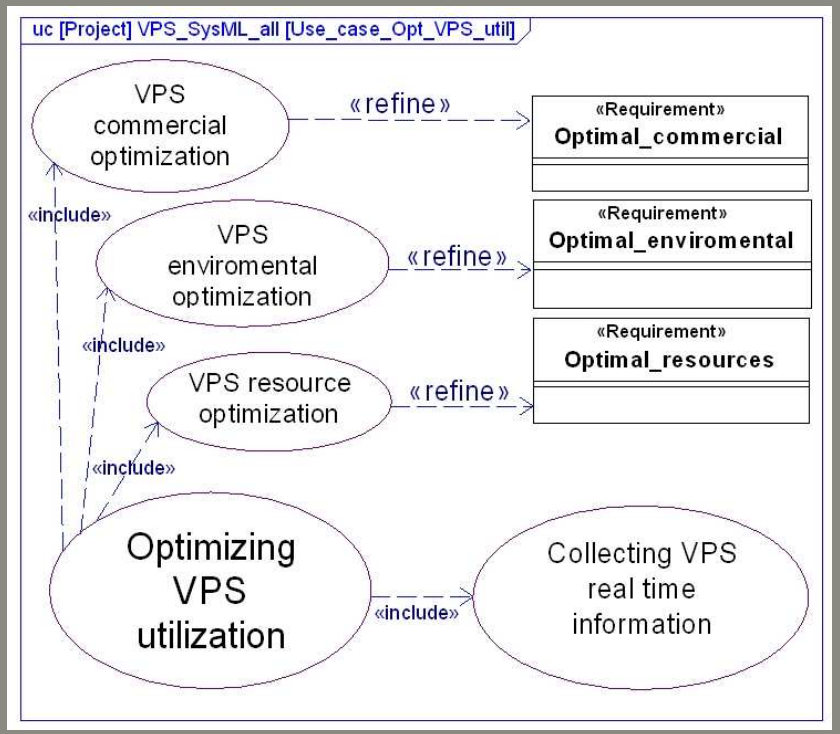
- VPS – system requirements definition

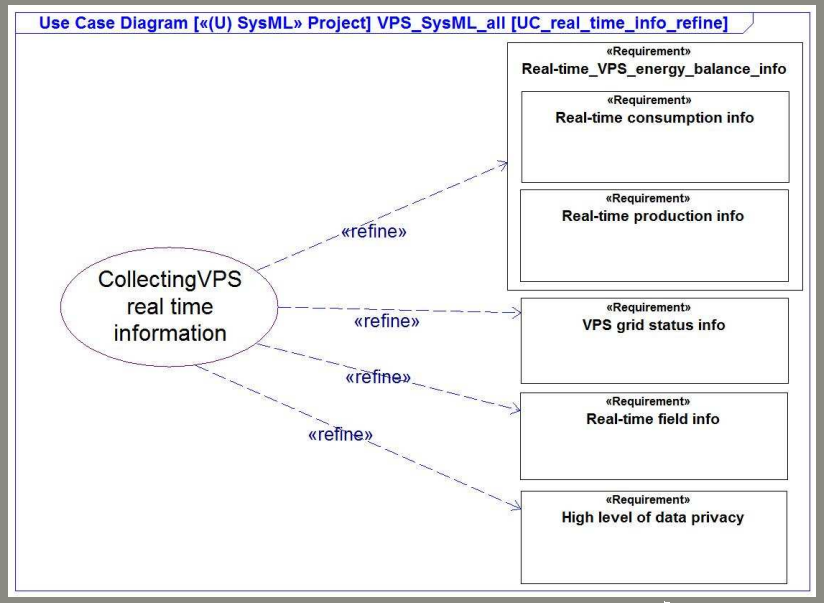




Modeling methodology(cont.)

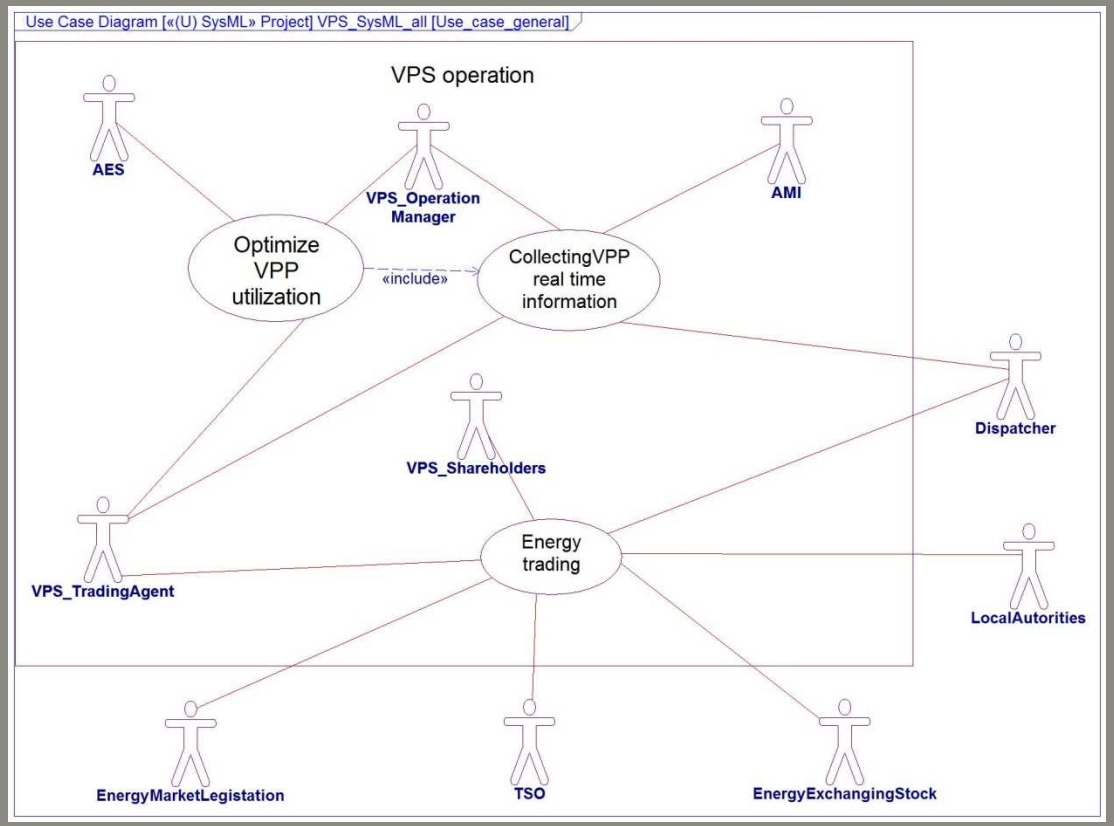
- Relating user requirements with services to satisfy them – system behavior





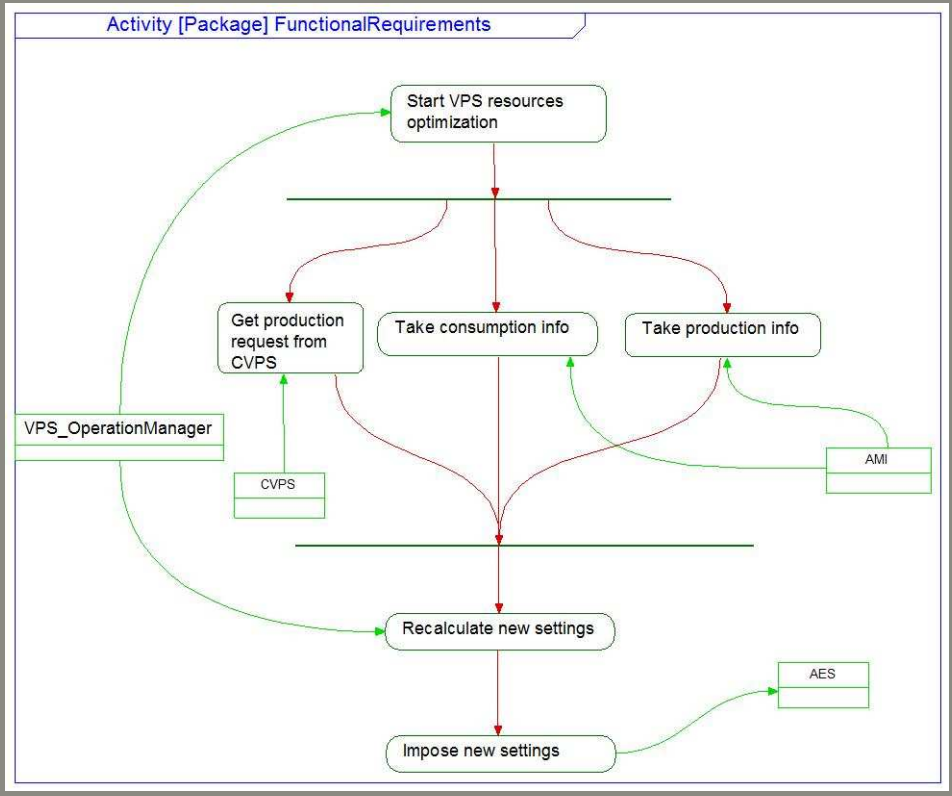
Modeling methodology(cont.)

- Relating services (use cases) and actors



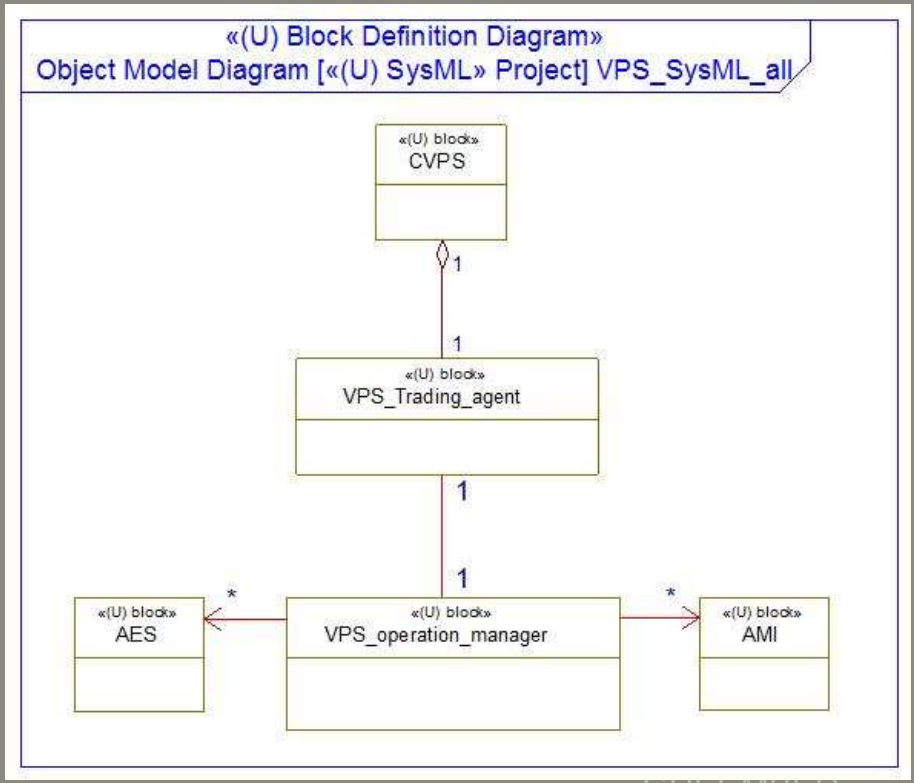
Modeling methodology(cont.)

- Realization of services (use cases) through activities (use cases flow) – when and who!



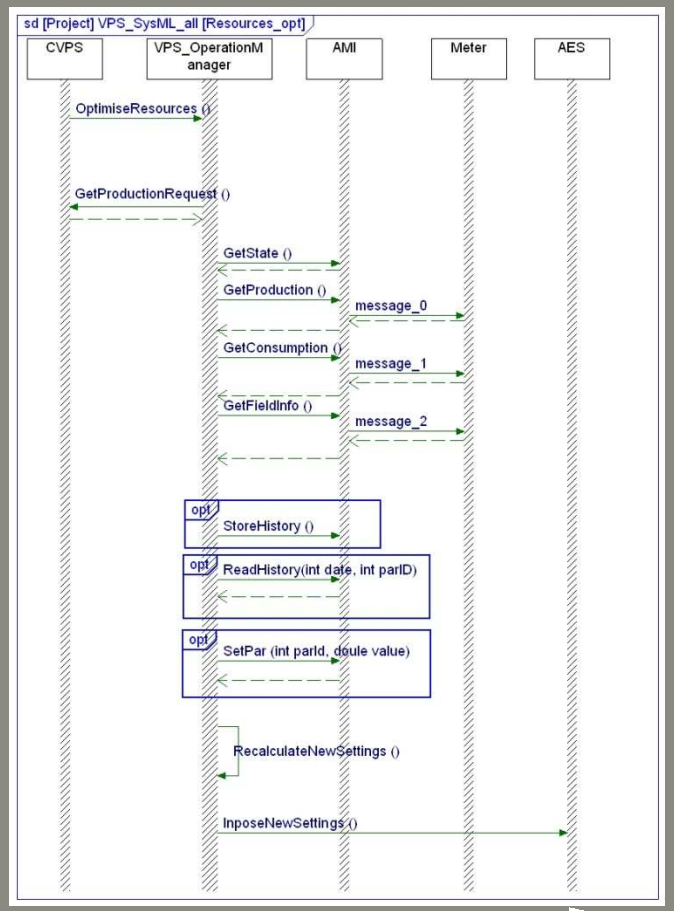
Modeling methodology(cont.)

- System structure – static (structural) – component diagram



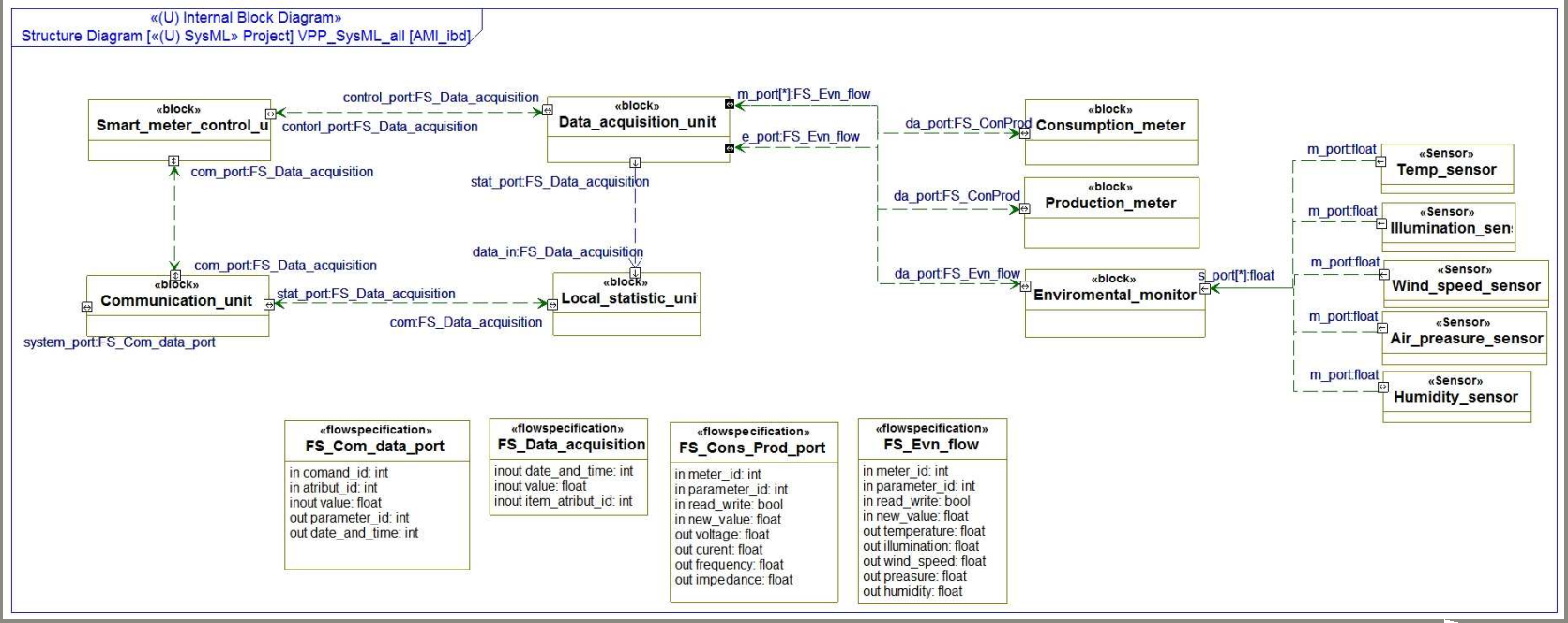
Case study – Advanced Metering Infrastructure

- Defining the structure of the system – dynamic (behavioral) – sequence diagram
- Getting functional requirement for the concrete component (i.e. device)



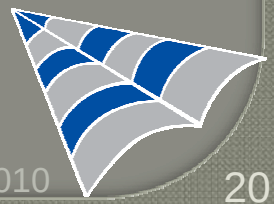
Case study – Advanced Metering Infrastructure

- Internal block diagram of a concrete component (AMI)



Conclusions and future works

- VPS – a concept to aggregate DER
- VPS – as a technical and trading module inside Smart grid
- Modeling methodology
  - As mutual communication platform
  - Requirements collecting instrument
  - Transition of user requirements into system and functional ones
    - Demonstrate using AMI as a case study
- Fine grain representation of all VPS elements



Thank you

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