DREAM project presentation
Winter School
René Kamphuis, TNO & Raphael Caire Grenoble INP
15th of December 2015
The DREAM project aims to **build** and **demonstrate** an industry-quality reference solution for **DER aggregation-level control and coordination**, based on commonly available ICT components, standards, and platforms **for every actors** (DER owners, grid operators, etc...) of the Smart Grids.
Major challenge and outcome of DREAM

- Enhance **market based approach to Distribution level with DNO validation** ➔ validate concepts and recommend regulation evolutions
  - Validate the concept on different grid types and propose evolution for a market based approach of both **energy/ancillary services/emergency reserve** markets & coordination
  - DSO role: market enabler/facilitator (market platform + validation at different voltage levels)
  - DSO role: market participant (buying flexibilities to solve constraints in real time)

- Show that increased **distributed “intelligence”** combined with **limited structural modifications** is able to allow **larger amounts of DER** (including RES, novel loads and storages), decrease costs without compromising quality of service, taking into account the **interaction of ADA functions**.
DREAM vision – focus on key components

- Transmission Network
- Distribution Network
- Primary Substation digital control
- Substation aggreg
- MV ARTU
- Energy box/Smart Meter
- Flexibilities from both load and generation
- Data Concentrator - ARTU LV aggreg commercial/technical
- Market
- Aggregators
- DSO
- TSO

Dream: 4
Heterarchical approach of DREAM

- **Heterarchical approach**: self-created and ever-changing hierarchy depending on topology and current operational constraints
  - Several operation modes (normal, congested / abnormal, contingency) with automatic, smooth transitioning, no interaction between them

- The heterarchical architecture is adopted in order to pursue **full local autonomy** in which the global information is minimized (or eliminated for very large amount of actors). This implies that:
  - (1) external higher levels of control can change according to the activity to be coordinated.
  - (2) the communication between entities will not, necessarily, have a master/slave relationship, for example, they can co-operate, **negotiate or dynamically change roles** from master to slave and vice-versa.
  - (3) a **new** entity can be introduced or an **existing ones** can be **modified without significant structural changes**.
Heterarchic approach and energy/balancing markets [1]

- Remote controllable switch with IED
- E: emergency point (remotely controllable) with IED

Level 3 Substation Cell

Substation Cell

HV/MV substation

MV elementary cells

LV "Microgrid" cell
Including all the DER energy boxes

TSO

DSO
Heterarchic approach and energy/balancing markets [2]
Heterarchic approach and congestion [1]

Remotely controllable switch with IED
E: emergency point (remotely controllable) with IED

I > I_{\text{max}}

Aggregation of downstream MV elementary cells

MV elementary cells

LV cell Including all the building energy boxes or meter + data concentrator

Dream: 8
Heterarchic approach and congestion [2]

Remotely controllable switch with IED
E: emergency point
(remotely controllable) with IED

I > I_{\text{max}}

Aggregation of up/downstream MV elementary cells

MV elementary cells

LV cell
Including all the building energy boxes or meter + data concentrator

DSO

HV/MV substation

HV/MV substation

HV/MV substation
Framework presentation
Winter School
René Kamphuis, TNO
15th of December 2015
UML context: D5.3 contents

- Logical View
  - Class diagrams
- Use Case View
  - Sequence diagrams
- Implementation View
  - Package, component diagrams
- Deployment View
  - Deployment diagrams
DREAM Framework dependencies (example)

Projects

- pure DREAM Framework
- DREAM Framework Prototype Use Case 1
- DREAM framework prototype field test Use Case 1

Milestones

- << Release >> Version 1.0
- << Release >> Version 1.1
- << Release >> Version 1.2
- << Snapshot >> Version 1.2
- << Snapshot >> Version 1.2
- << Release >> Version 1.1
- << Release >> Version 1.1
- << Release >> Version 1.0
- << Snapshot >> Version 1.0
- << Snapshot >> Version 1.0

Legend:
- dependency
- stable version
- unstable / in development
DREAM Framework continuous integration setup

1. Declare new dependencies

2. Commit the changes

3. Take the changes (checkout of each commit)

4. Build projects using **maven**

5. Fetch needed artifacts (=.jar-files) from artifactory during build

6. Deploy projects (snapshot releases)

### Dependency config file

- pom.xml

- Contains all necessary information required for a maven build: e.g. project name, version, but also dependencies of a project

### Developer

- Fetch DREAM Framework artifacts

- Add full releases manually using Maven

### Repository

- Binary repository manager

### Jenkins

- Continuous integration tool

### Video on artifactory: [https://youtu.be/aa4YBDUDWy0](https://youtu.be/aa4YBDUDWy0)
Trial overview
Winter School
Raphael Caire, Grenoble INP
15th of December 2015
Trial overview
HEDNO dataset of Crete Island (market based approach)

HEDNO / island of Crete. Crete has a population of 650,000 inhabitants. It has a thermal installed capacity of 815 MW with twenty-eight generation engines, with a peak power consumption of 611 MW in 2009. It has a HV transmission network of 150 kV and a distribution network organized in four areas: Chania with 58 distribution lines; Agios Nikolaos with 29 distribution lines; Rethymno with 9 distribution lines; and Heraklion with 78 distribution lines at 15 kV and 20 kV voltage levels.
HEDNO trial in Greek mainland (market + Voltage)
SEA trial in Italy (private DSO/energy provider)

SEA airport system of Milan includes Malpensa and Linate. **Malpensa airport** is Milan intercontinental airport and operates two passenger terminals and a cargo terminal.

Milano Malpensa airport, 48 km from Milan with links to the main cities of Northern Italy and Switzerland by rail and road, with its wide range of domestic, international and intercontinental flights, is northern Italy's main airport.

Operational characteristics of **energy management** at SEA Airport of Malpensa, featuring:

- a **significant range of loads**, with strict continuity requirements on selected uses, including **safety critical devices**;
- a local generation provided by a **trigeneration plant** that produces **electricity, heat and chilled water** (part of the electricity is sold to third parties through the national grid, while heat and cooled water are only used inside the airport);
- several independent sub-users (shops, restaurants, etc.) and heavy constraints on **quality of service** to travellers and air carriers.
KEMA/TNO trial in Netherland (lab)

**KEMA test facility**, created in the INTEGRAL project a living lab smart grid together with Dutch research center ECN, software company ICT and utility Essent, This ‘PowerMatching City’ consists of 25 interconnected households equipped with micro cogeneration units, hybrid heat pumps, PV solar panels, smart appliances and electric vehicles.

The existing lab will be used for energy box validation, connected virtually with other trials.
The Grenoble INP lab for assessing the feasibility of such control mechanism in emergency situation (post fault conditions) with the related control of self-healing developed within the INTEGRAL STREP project.

This network is a reduced scale (20kV $\Rightarrow$ 400V ; 30 MVA $\Rightarrow$ 30 kW) from a real French Distribution Network with 3 substations (63/20kV), emulations of distributed generators and controllable loads.

Frequency support is tested.
ES trial in North East of France

ES Réseaux Facility: Strasbourg will install 5 RTU prototypes from Telvent in MV/LV substations on a group of selected feeders. Some of the MV and LV customers connected to this feeder will be equipped with energy boxes.
Pitch for products / solutions
Winter School
Raphael Caire, Grenoble INP
15th of December 2015
WP2 Pitching Result No. 1: Get confident on DREAM benefits for your business

<table>
<thead>
<tr>
<th>Communication item</th>
<th>Description for Result No. 1 Elevator Pitch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target / Title</td>
<td>Get confident on DREAM benefits for your business</td>
</tr>
<tr>
<td>Value proposition / Benefits / Offer</td>
<td>Assessing the expected advantages of individual DREAM solutions</td>
</tr>
<tr>
<td>Unique Selling Proposition (USP) / Qualification /</td>
<td>• Specific model driven assessment</td>
</tr>
<tr>
<td>Competitive Positioning</td>
<td>• Analysis covers business assessment (actors perspective) and can be complemented by assessment using key</td>
</tr>
<tr>
<td></td>
<td>performance indicators (use case perspective)</td>
</tr>
<tr>
<td>Confidence-building</td>
<td>Highest confidence on the achievement of planned objectives</td>
</tr>
<tr>
<td>Contact / Offering Company</td>
<td>HSG</td>
</tr>
</tbody>
</table>


WP2 Pitching Result No. 1: Get confident on DREAM benefits for your business

» Get confident on DREAM benefits for your business «

Assessing the expected advantages of individual DREAM solutions

- Specific model driven assessment
- Analysis covers business assessment (actors perspective) and can be complemented by assessment using key performance indicators (use case perspective)

Highest confidence on the achievement of planned objectives
WP2 Pitching Result No. 2: Profitability assessment of DER involvement on the Day-ahead wholesale market

<table>
<thead>
<tr>
<th>Communication item</th>
<th>Description for Result No. 2 Elevator Pitch</th>
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<tbody>
<tr>
<td>Target / Title</td>
<td>Profitability assessment of DER involvement on the Day-ahead wholesale market</td>
</tr>
<tr>
<td>Value proposition / Benefits / Offer</td>
<td>Reduction of barriers towards large DER roll-out</td>
</tr>
</tbody>
</table>
| Unique Selling Proposition (USP) / Qualification / Competitive Positioning | • Specific model driven assessment  
  • [...] |
| Confidence-building                     | Resilient results by through accurate data analytics |
| Contact / Offering Company              | Grenoble INP |
WP2 Pitching Result No. 2: Profitability assessment of DER involvement on the Day-ahead wholesale market

» Profitability assessment of DER involvement on the Day-ahead wholesale market «

Reduction of barriers towards large DER roll-out

- Specific model driven assessment
- [..]

Resilient results by through accurate data analytics

Contact
## WP2 Pitching Result No. 3: Excel-based simulation tool for testing different pricing schemes and bid scenarios

<table>
<thead>
<tr>
<th>Communication item</th>
<th>Description for Result No. 3 Elevator Pitch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target / Title</td>
<td>Excel-based simulation tool for testing different pricing schemes and bid scenarios</td>
</tr>
<tr>
<td>Value proposition / Benefits / Offer</td>
<td>Simple analysis of response of local resources to price signals</td>
</tr>
</tbody>
</table>
| Unique Selling Proposition (USP) / Qualification / Competitive Positioning | • Specify various pricing schemes  
• Take into account the form of the local resources’ bid functions |
| Confidence-building | Easy to use and transparent calculation |
| Contact / Offering Company | ICCS |
WP2 Pitching Result No. 3: Excel-based simulation tool for testing different pricing schemes and bid scenarios

»Excel-based simulation tool for testing different pricing schemes and bid scenarios«

Offer
Simple analysis of response of local resources to price signals

Features
- Specify various pricing schemes
- Take into account the form of the local resources’ bid functions

Easy to use and transparent calculation

Contact
# WP2 Pitching Result No. 4: Day-ahead management and functional integration of local resources connected to the distribution network

<table>
<thead>
<tr>
<th>Communication item</th>
<th>Description for Result No. 4 Elevator Pitch</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target / Title</strong></td>
<td>Day-ahead management and functional integration of local resources connected to the distribution network</td>
</tr>
<tr>
<td><strong>Value proposition / Benefits / Offer</strong></td>
<td>Modeling the interdependence in the decision-making process regarding electricity prices and volumes of diverse entities connected to the distribution network</td>
</tr>
</tbody>
</table>
| **Unique Selling Proposition (USP) / Qualification / Competitive Positioning** | • Control of local resources by means of price signals  
• Optimisation by taking into account the response of various local resources to these prices |
| **Confidence-building**                   | Assistance for the managing entity in making informed decisions regarding the prices                       |
| **Contact / Offering Company**            | ICCS                                                                                                       |
WP4 Pitching Result No. 4: Day-ahead management and functional integration of local resources connected to the distribution network

» Day-ahead management and functional integration of local resources connected to the distribution network «

Day-ahead / Intraday market

- Forecasted energy prices
- Utility functions
- Price signals
- Buy energy

MV Aggregator

- DER

Offer

- Control of local resources by means of price signals
- Optimisation by taking into account the response of various local resources to these prices

Making informed decisions regarding the prices
WP4 Pitching Result No. 5: Implementation of strategies to offer momentary, primary process flexibility to imbalance markets

<table>
<thead>
<tr>
<th>Communication item</th>
<th>Description for Result No. 5 Elevator Pitch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target / Title</td>
<td>Implementation of strategies to offer momentary, primary process flexibility to imbalance markets</td>
</tr>
<tr>
<td>Value proposition / Benefits / Offer</td>
<td>Resolving conflicts between DSOs, TSOs and BRPs by using customer flexibility</td>
</tr>
</tbody>
</table>
| Unique Selling Proposition (USP) / Qualification / Competitive Positioning | - Agent-mediated bottom-up approach with PowerMatcher based on micro-economic theory  
  - Agents express their primary process status in a generic way by a bid curve |
| Confidence-building                              | Extension of the highly reliable PowerMatcher approach                                                     |
| Contact / Offering Company                       | TNO                                                            |
WP2 Pitching Result No. 5: Implementation of strategies to offer momentary, primary process flexibility to imbalance markets

» Implementation of strategies to offer momentary, primary process flexibility to imbalance markets «

Resolving conflicts between DSOs, TSOs and BRPs by using customer flexibility

- Agent-mediated bottom-up approach with PowerMatcher based on micro-economic theory
- Agents express their primary process status in a generic way by a bid curve

Extension of the highly reliable PowerMatcher approach
### WP2 Pitching Result No. 6: Trading load and generation flexibility within a congested, physical part of the electricity network

<table>
<thead>
<tr>
<th>Communication item</th>
<th>Description for Result No. 6 Elevator Pitch</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target / Title</strong></td>
<td>Trading load and generation flexibility within a congested, physical part of the electricity network</td>
</tr>
<tr>
<td><strong>Value proposition / Benefits / Offer</strong></td>
<td>Resolving a local congestion problems</td>
</tr>
</tbody>
</table>
| **Unique Selling Proposition (USP) / Qualification / Competitive Positioning** | - Hybrid, micro-economic agent-based approach in a heterarchic setting  
  - Reconfiguration of VPP                                                                                                                                                                                                                 |
| **Confidence-building**                     | Extension of the highly reliable PowerMatcher approach                                                                                                                                                                                       |
| **Contact / Offering Company**              | TNO                                                                                                                                                                                                                                          |
WP2 Pitching Result No. 6: Trading load and generation flexibility within a congested, physical part of the electricity network

» Trading load and generation flexibility within a congested, physical part of the electricity network «

The aggregated bid curve as function of day-time gives an overview of the available demand response.

Aggregated PowerMatcher bid curves for simulated DG-RES area showing the development of flexibility over a number of days.

The cluster equilibrates at the green/blue coded 0 kW level.

- Hybrid, micro-economic agent-based approach in a heterarchic setting
- Reconfiguration of VPP

Contact

Resolving a local congestion problems
## WP3 Pitching Result No. 1: LV4MV

<table>
<thead>
<tr>
<th>Communication item</th>
<th>Description for Result No. 1 Elevator Pitch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target / Title</td>
<td>Optimized LV constraints management based on LV flexibilities</td>
</tr>
<tr>
<td>Value proposition / Benefits / Offer</td>
<td>Solve voltage deviations and current congestions with the most economical flexibilities</td>
</tr>
</tbody>
</table>
| Unique Selling Proposition (USP) / Qualification / Competitive Positioning | • ...  
  • ... |
| Confidence-building                                     | The admissible LV Voltage profile with the minimum cost                           |
| Contact / Offering Company                              | ...                                                                             |
| Main User / Beneficiary                                 | DSO, aggregator, prosumers                                                      |
WP3 Pitching Result No. 1: LV4MV

» Optimized LV constraints management based on LV flexibilities«

Offer
Use remaining flexibility to increase the amount of DRES interconnected + increase voltage allowance whenever possible

Features
- Anticipation
- Ranking of flexibility
- Computation of new margins
- Test for flexibility usage to pass next 15 minutes

Contact
Increase the use of existing asset while keeping end user in acceptable margins
### WP4 Pitching Result No. 1: Take advantage of an active power grid to solve technical constraints

<table>
<thead>
<tr>
<th>Communication item</th>
<th>Description for Result No. 1 Elevator Pitch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target / Title</td>
<td>Take advantage of an active power grid to solve technical constraints</td>
</tr>
<tr>
<td>Value proposition / Benefits / Offer</td>
<td>Integration of renewable energies while at the same time increase robustness of grid operation</td>
</tr>
<tr>
<td>Unique Selling Proposition (USP) / Qualification / Competitive Positioning</td>
<td>• Solving constraints as local as possible with no central server but through heterarchical management</td>
</tr>
<tr>
<td></td>
<td>• Very flexible optimisation</td>
</tr>
<tr>
<td></td>
<td>• Allowing the interaction of local control methods of the generators to provide fall back strategy in the case of communication disruptions</td>
</tr>
<tr>
<td>Confidence-building</td>
<td></td>
</tr>
<tr>
<td>Contact / Offering Company</td>
<td>University of Kassel</td>
</tr>
<tr>
<td></td>
<td>Elisabeth Drayer</td>
</tr>
<tr>
<td></td>
<td><a href="mailto:elisabeth.drayer@uni-kassel.de">elisabeth.drayer@uni-kassel.de</a></td>
</tr>
<tr>
<td>Main User / Beneficiary</td>
<td>DSO</td>
</tr>
</tbody>
</table>
WP4 Pitching Result No. 1: Take advantage of an active power grid to solve technical constraints

» Take advantage of an active power grid to solve technical constraints «

Use the possibilities of an active power grid to solve grid constraints

- Optimisation to solve all sorts of problems and constraints (voltage, current, losses) in a distinct grid area (cell) by using provided flexibilities
- Cells can work together or pass over the control to a higher grid level
- Local Control of generators to build fall back strategy in case of communication disruption

Contact

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VERSITAT
<table>
<thead>
<tr>
<th>Communication item</th>
<th>Description for Result No. 2 Elevator Pitch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target / Title</td>
<td>Self-Healing grid infrastructure</td>
</tr>
<tr>
<td>Value proposition / Benefits / Offer</td>
<td>Fast resupply of as many loads as possible after a fault has happened by reconfigure the grid</td>
</tr>
</tbody>
</table>
| Unique Selling Proposition (USP) / Qualification / Competitive Positioning | • Fast resupply of as many loads as possible after a fault by trying to reconfigure as locally as possible  
• New grid configuration does respect grid constraints (voltage, current, fault devices)  
• Flexibilities can be used if no valid solution can be found                                                                                             |
| Contact / Offering Company                 | Grenoble INP / University of Kassel  
Raphael Caire / Elisabeth Drayer  
[raphael.caire@g2elab.grenoble-inp.fr](mailto:raphael.caire@g2elab.grenoble-inp.fr) / [elisabeth.drayer@uni-kassel.de](mailto:elisabeth.drayer@uni-kassel.de) |
| Main User / Beneficiary                    | DSO                                                                                                                                                                                                                                     |
WP4 Pitching Result No. 2: Self-Healing grid infrastructure

» Self-Healing grid infrastructure«

(1) Fault isolation

(2) Reconfiguration within a substation area

(3) Peer-to-Peer reconfiguration between securing substations

(4) Reconfiguration on the whole grid area

Establish a new grid configuration to resupply as much load as possible after a fault has occurred

- Fault detection and isolation
- Reconfiguration within the area of a substation
- Peer-to-peer reconfiguration between securing substations
- Reconfiguration on the whole grid area
- Use of flexibilities

Contact
### WP4 Pitching Result No. 3: Offer frequency support flexibility for the TSO

<table>
<thead>
<tr>
<th>Communication item</th>
<th>Description for Result No. 3 Elevator Pitch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target / Title</td>
<td>Offer frequency support flexibility for the TSO</td>
</tr>
<tr>
<td>Value proposition / Benefits / Offer</td>
<td>DSO can propose frequency support flexibility for the TSO by relying on small scale dispatchable loads.</td>
</tr>
<tr>
<td>Unique Selling Proposition (USP) / Qualification / Competitive Positioning</td>
<td>• ???</td>
</tr>
<tr>
<td>Contact / Offering Company</td>
<td>Grenoble INP / Schneider Electric Raphael Caire / Gaspard Lebel <a href="mailto:raphael.caire@g2elab.grenoble-inp.fr">raphael.caire@g2elab.grenoble-inp.fr</a> / <a href="mailto:gaspard.lebel@g2elab.grenoble-inp.fr">gaspard.lebel@g2elab.grenoble-inp.fr</a></td>
</tr>
<tr>
<td>Main User / Beneficiary</td>
<td>DSO</td>
</tr>
</tbody>
</table>
WP4 Pitching Result No. 3: Offer frequency support flexibility for the TSO

Propose frequency support at low cost to stabilize the network and thus help integration of Renewables

- Creating frequency drop control with DER
- Aggregate and coordinate flexibilities in LV network compliant with AMI
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Associate Professor
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