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EC- ICT 7th Framework Collaborative Project - Grant 318023

Smart Control of Energy Distribution Grids over Heterogeneous Communication Networks

http://www.smartc2net.eu/

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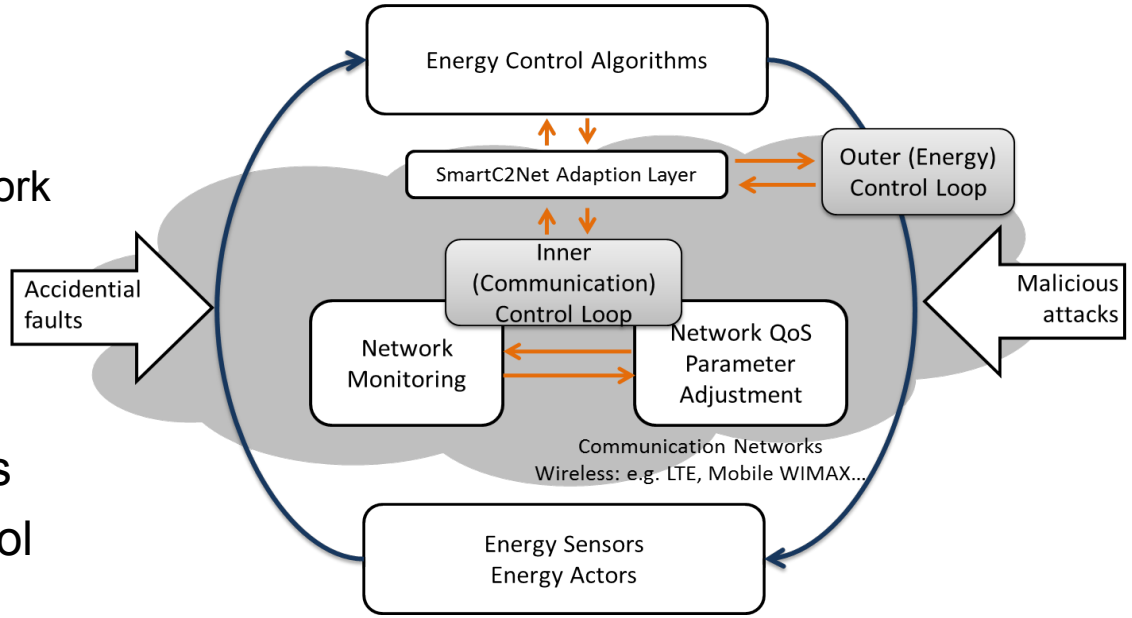
SEVENTH FRAMEWORK PROGRAMME

Objective

Enable **robust smart grid control** utilizing **heterogeneous third-party communication infrastructures**.

Robustness and interoperability target:

- Variability of network performance
- Security threats due to additional network interfaces and the use of off-the-shelf communication technology
- Seamless information exchange for heterogeneous infrastructures using IP based middleware functions for adaptive management and control



→ Optimize interplay between two control loops

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Approach

- design **Smart Grid control applications** that
  - are aware of communication network behaviour
  - react to changes of information and network quality
- **dynamically change network configurations** (including QoS settings), information access procedures, and interaction protocols with grid actuators
- investigate **protective measures**
  - against maliciously created network property fluctuations
  - against attacks on the developed adaptivity solution
- **assess** QoS/resilience indicators of the designed technologies
- **integrate** the designed mechanisms into **use-cases,** showing their effectiveness

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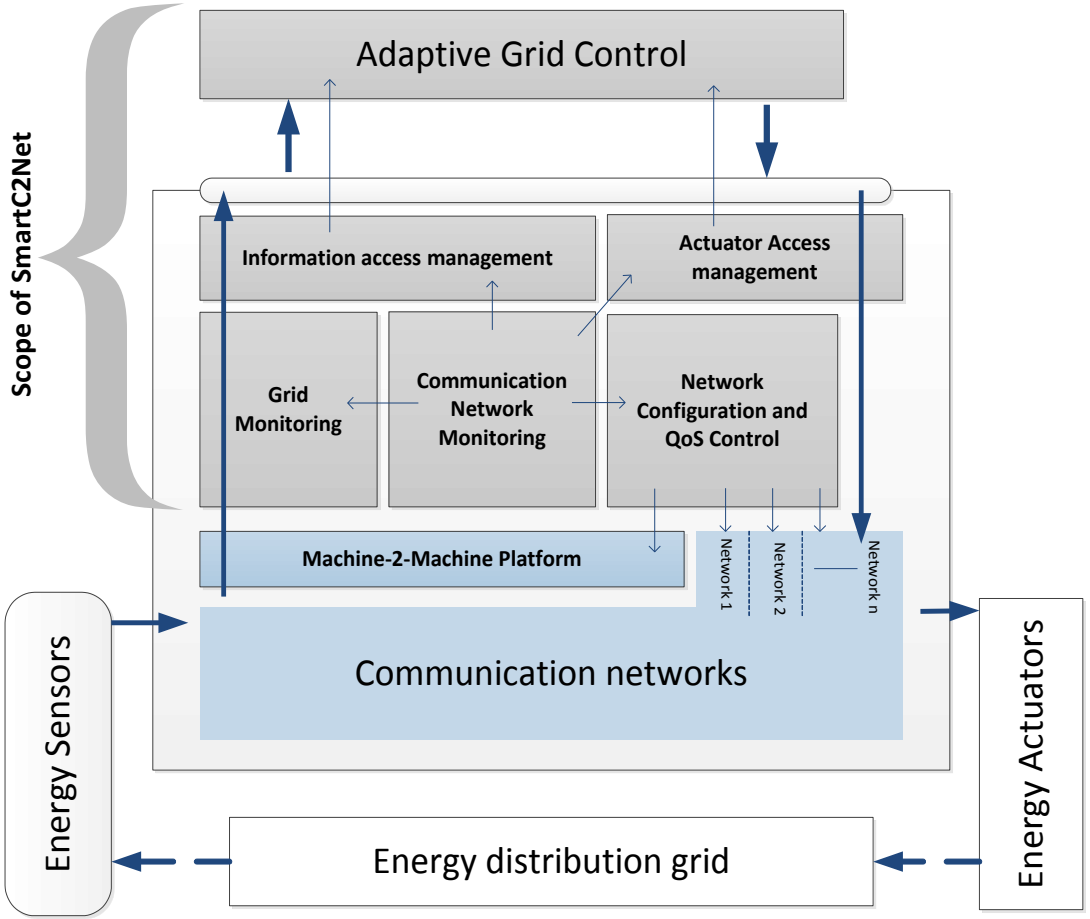
Outcome

- Monitoring Framework (WP2)
  - gathering network and grid related info
  - work over heterogeneous networks
  - adapt to changing network conditions
  - → Testbed realization
- Mechanisms to adapt network QoS and information access strategies (WP3)
  - to grid control requirements
  - to current network capabilities
  - → Testbed realization
- Adaptive (Grid) Control strategies (WP4)
  - to distributed execution environment
  - achieving robustness in specified fault and degradation scenarios
  - → Testbed realization
- Integrated Assessment Approach for Smart Distribution Grid Control (WP5)
  - Comprehensive framework
  - Covering both communication and control level



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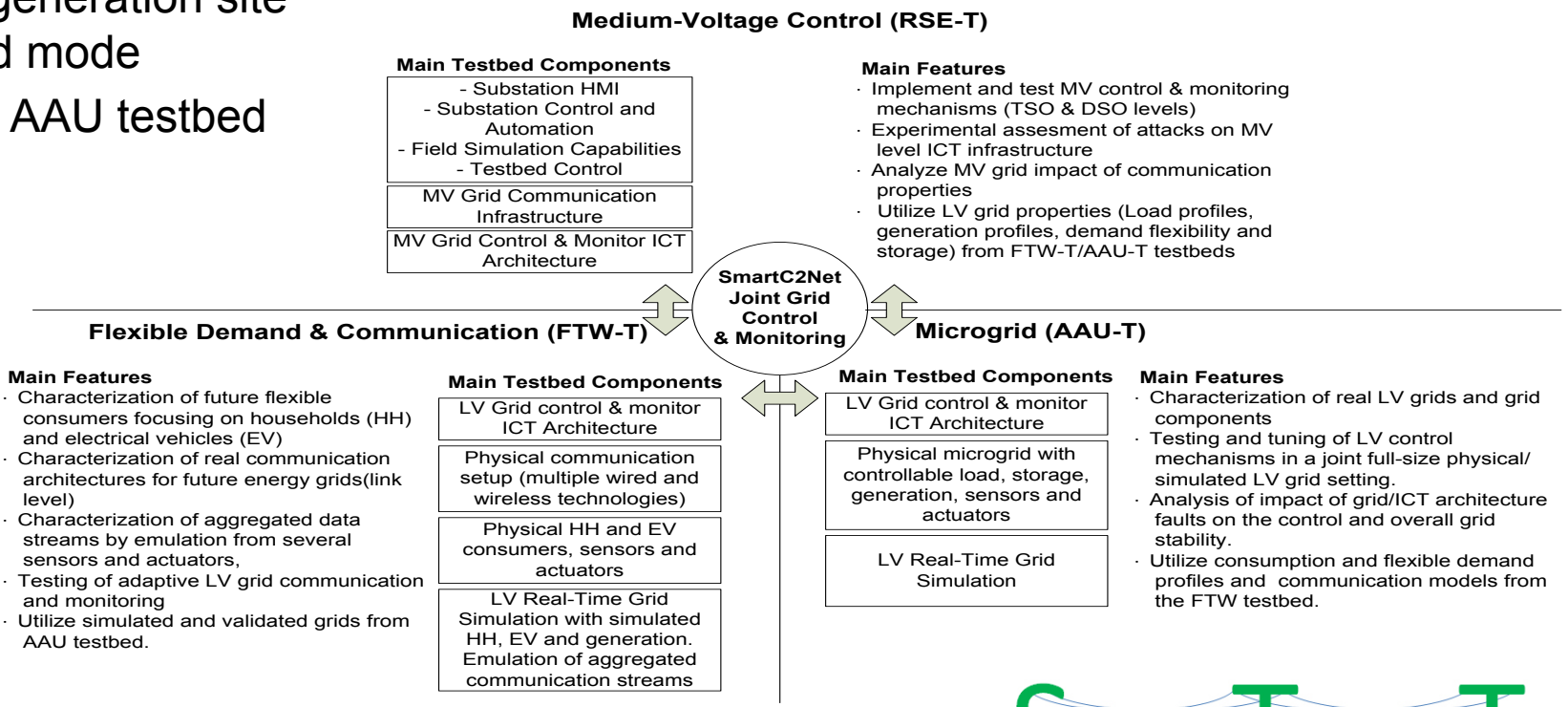
Use Cases

- Medium Voltage Control
  → RSE testbed
- Self-optimized Low Voltage Grid Domain
  - Households and distributed Generation
  - Electric vehicle charging
  - External generation site and island mode

  →FTW and AAU testbed

- Use Case interactions (LV<->MV)



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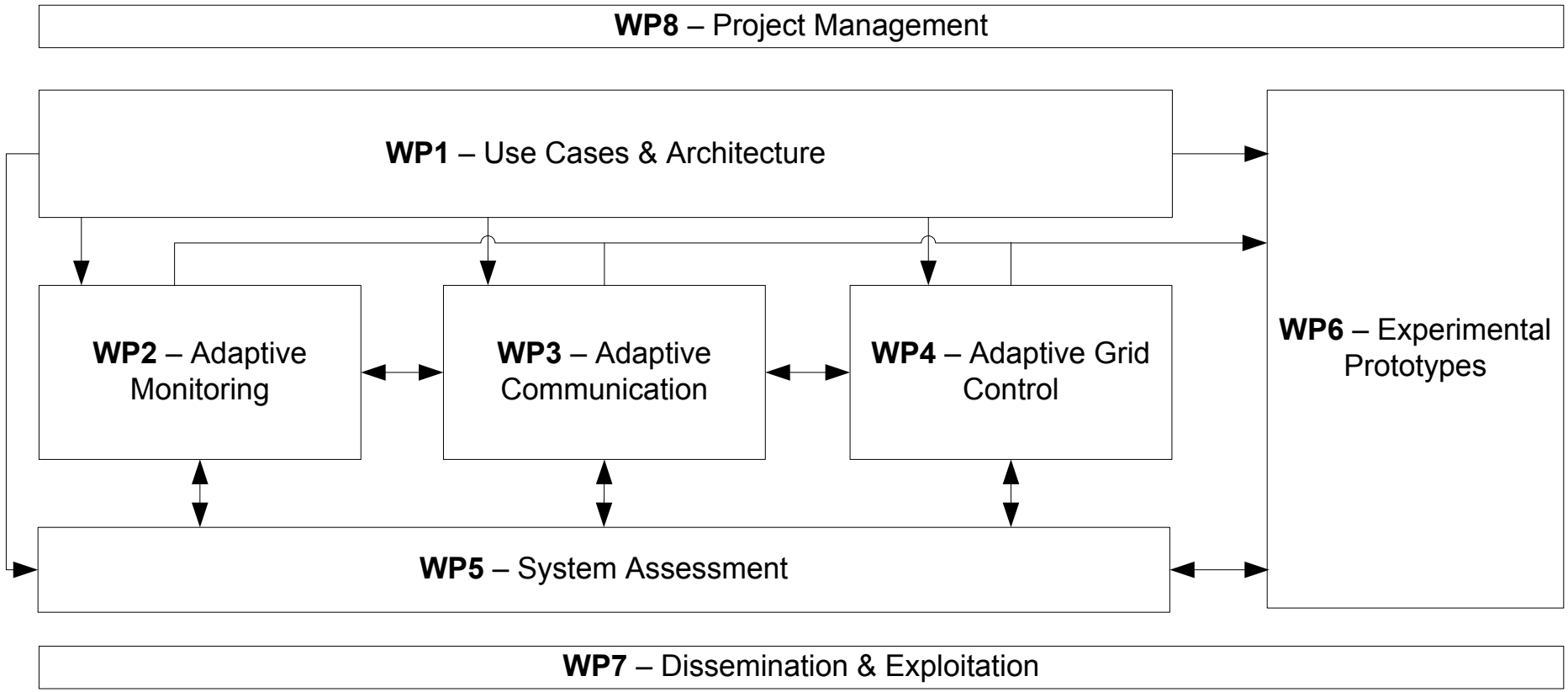
Work-packages



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Focus on modelling and analysis of interdependencies in Power Grid distribution

- Define a **stochastic modelling framework** well suited to characterize and analyze the **interdependencies** between
  - the control &communication infrastructure
  - the controlled power infrastructure
- Address the **distribution grid** consisting of the low voltage and the medium-voltage level containing generation, storage, and different consumers (private households, office buildings, industrial plants)
- The focus is on **interdependencies,** since they are powerful vehicles for failure propagation
- The goal is to **quantitatively assess** their impact on the resilience/QoS of these infrastructures
- The aim is to have a **general evaluation framework**, populated by building blocks, representing basic events, and composable to potentially represent any Power Grid distribution configurations

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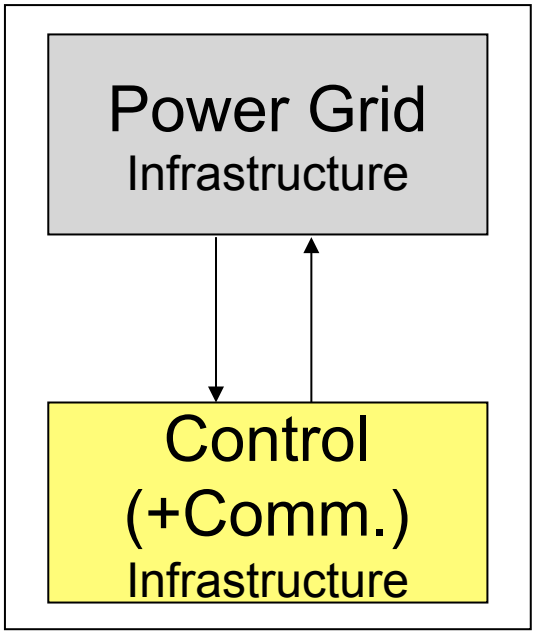
Modeling framework – main aspects



- Capture structural and behavioral aspects of the two infrastructures components (at a proper level of abstraction)
- Appropriate abstraction level of infrastructures representation to trade between
  - Sufficient accuracy
  - Manageable complexity of the modelling process and model solution
- About the **control infrastructure** we aim at representing the **effect** of the application of the control functions/actions on the grid topology (in terms of **grid reconfiguration**), instead of modeling in detail the control itself
- Major modelling framework characteristics we look at:
  - Composition, through reusable generic submodels
  - Discrete and hybrid state representation
  - Measures for quantifying the impact of interdependencies
  - Combination of analytical and simulation solution techniques

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Major challenges to be addressed

- Optimize reconfiguration in presence of:
  - Non-linear equations to model power flow (accounting for both active and reactive power)
  - Flexible generators (Distributed Energy Resources – DER)
  - Flexible loads (both Storage and different typologies of Consumers)
  - Smart meters
  - Accidental faults (to both Grid and Control Infrastructures) and Malicious Attacks (to the Control Infrastructure)
  - Heterogeneity of electrical components (in terms of electrical parameters) and of communication networks
  - ….

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On-going steps

- Logical scheme of a Smart Grid, by identifying the main system elements to be considered in the modelling framework
- State definition for the main system elements to be considered
- Representation of dynamic behaviors
- Failure model
- Interdependencies
- Some possible measures of interest
- Initial thoughts on the modelling of the hierarchical control system

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