ENERGY IN TIME WORKSHOP

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Automatic Operational Plans Generation

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Outline

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- Operational Plans
- Operational Plan Generator (OPG)
- Conclusions

Introduction

- Energy and cost saving strategies in the building operation phase will impact the building life cycle cost
- BMS can be used to save energy, adapting the operating conditions to internal and external factors in the building
- Prediction of those factors would help to anticipate energy demands.

BMS and BEMS

- **BMS (*Building Management System)***

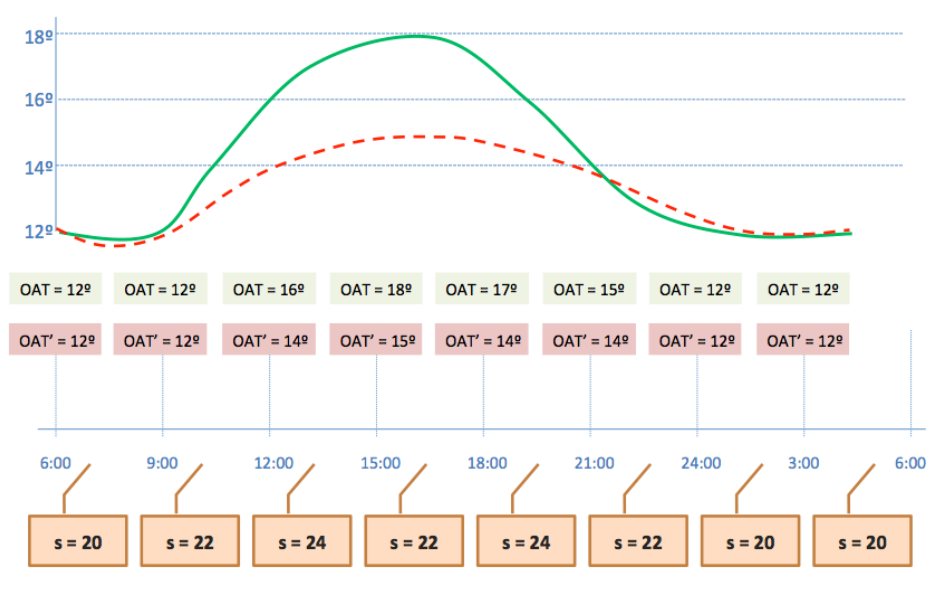
  Computer-based control system that controls and monitors the building mechanical and electrical equipment (HVAC, lighting, power systems…)

- **BEMS (*Building Energy Management System)***

  Components of the BMS related to the energy management
  - Provides managers with a global view of the building energy-related performance
  - Systems controlled by the BEMS are estimated to be responsible up to a 70% of energy consumption in a building
  - Minor changes in BEMS policy can save energy and reduce emissions
  - Includes several heterogeneous software and hardware systems
  - Collect data about several energy usage and building status parameters, including both indoor and outdoor measurements
  - Do not usually process this large amount of data, which could be further analysed to provide better operation plans improving energy performance

Operational Plan

- An operational plan consists in a set of instructions (or setpoints) to be executed by the BEMS in a given future time period
- A good operational plan can aid to save energy
- If an operational plan can anticipate the conditions for a certain period before being scheduled can produce better results



Characteristics of Operational Plans

- Operational plans requires certain information and technical knowledge that is not always available
- Taking a calibrated model representing the most accurate conditions of the building in a certain time frame and using advanced algorithms, it is possible to test the effect of different operational plans in the building
- The simulations performed are a measure of the energy savings achieved while satisfying energy demand and comfort restrictions
- The building control policy can be adapted to the actual operating conditions, and to failure events by tuning the setpoints of the current operational plan
- An adaptable operational plan softens the impact of deviations between predicted building conditions and current conditions

Optimal Operational Plan

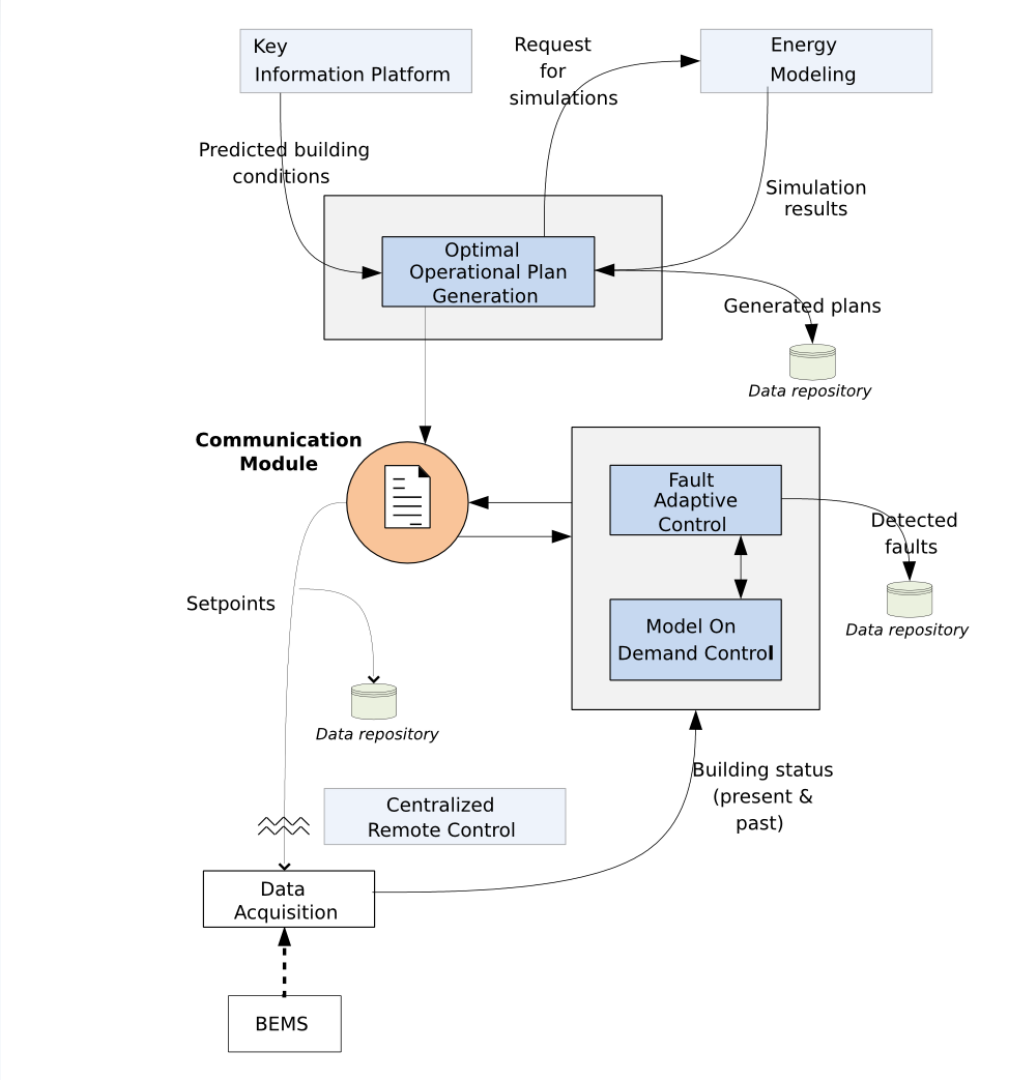
- An optimal operational plan is the one that can provides more energy savings
- Operational Plans implement strategies that are known to save energy
- The selection of an optimal plan relies on testing different plans with different setpoint values for some expected building conditions during the operation period
- Operational Plan generator (OPG), which is the software module that calculates the set of instructions (or setpoints) to be executed by the BEMS in a given period

Strategies

- *A **strategy** is a possible combination of values for the different actionable parameters and input in the building's control.*
- The domain of the strategies is the set of all the possible combinations of building inputs.
- Not all the possible strategies are correct or can be applied in the building.
- Only valid strategies (strategies that are meaningful and relevant to the building) are used to generate operational plans

Optimal Operational Plan Generator (OPG)

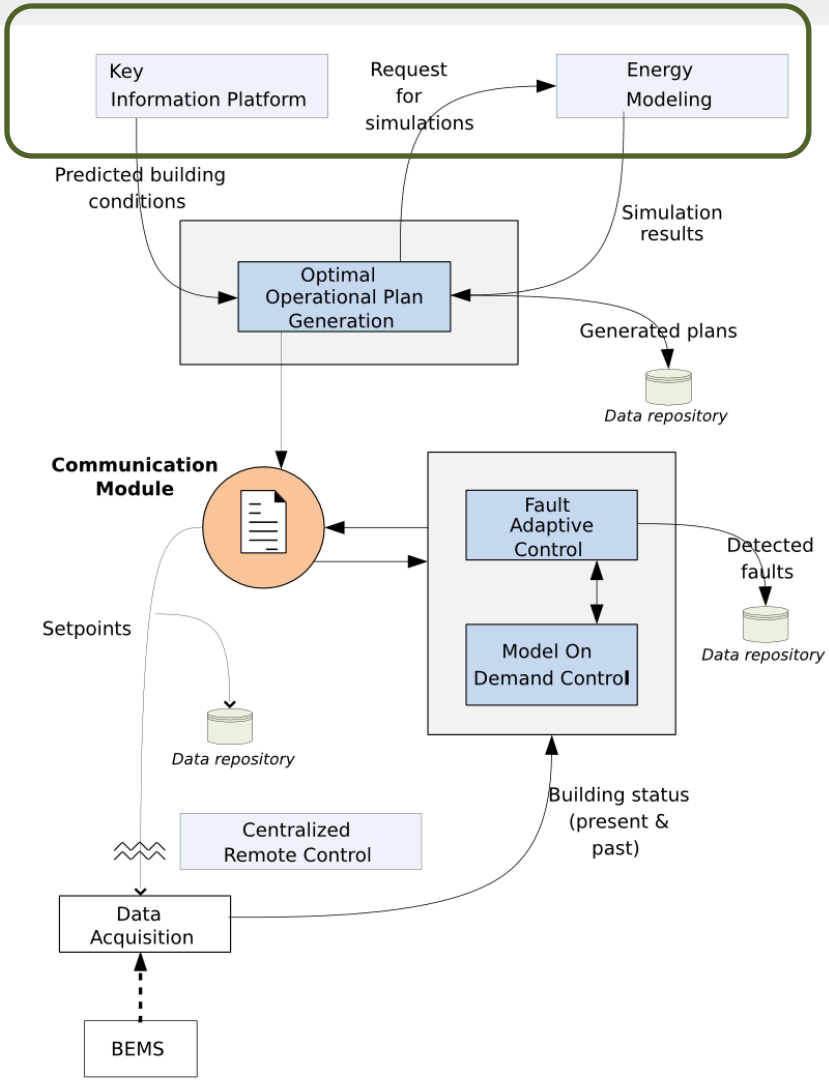
- The **Operational Plan Generator**, implements the procedures for the automatic generation of the operational plans (OPs) for the daily energetic operation of the building
- Plans are based on the expected energy behavior of the building according to the simulations performed in the simulation model
- The objective of this module is to generate the optimal operational plan for a specific period of time.



Building Monitoring and Modelization

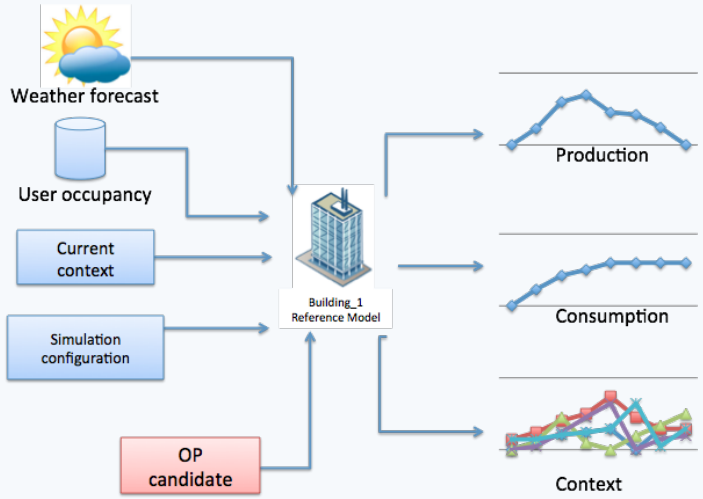
Operational plans are based on the expected energy behavior of the building according to the simulations performed on the **model**.

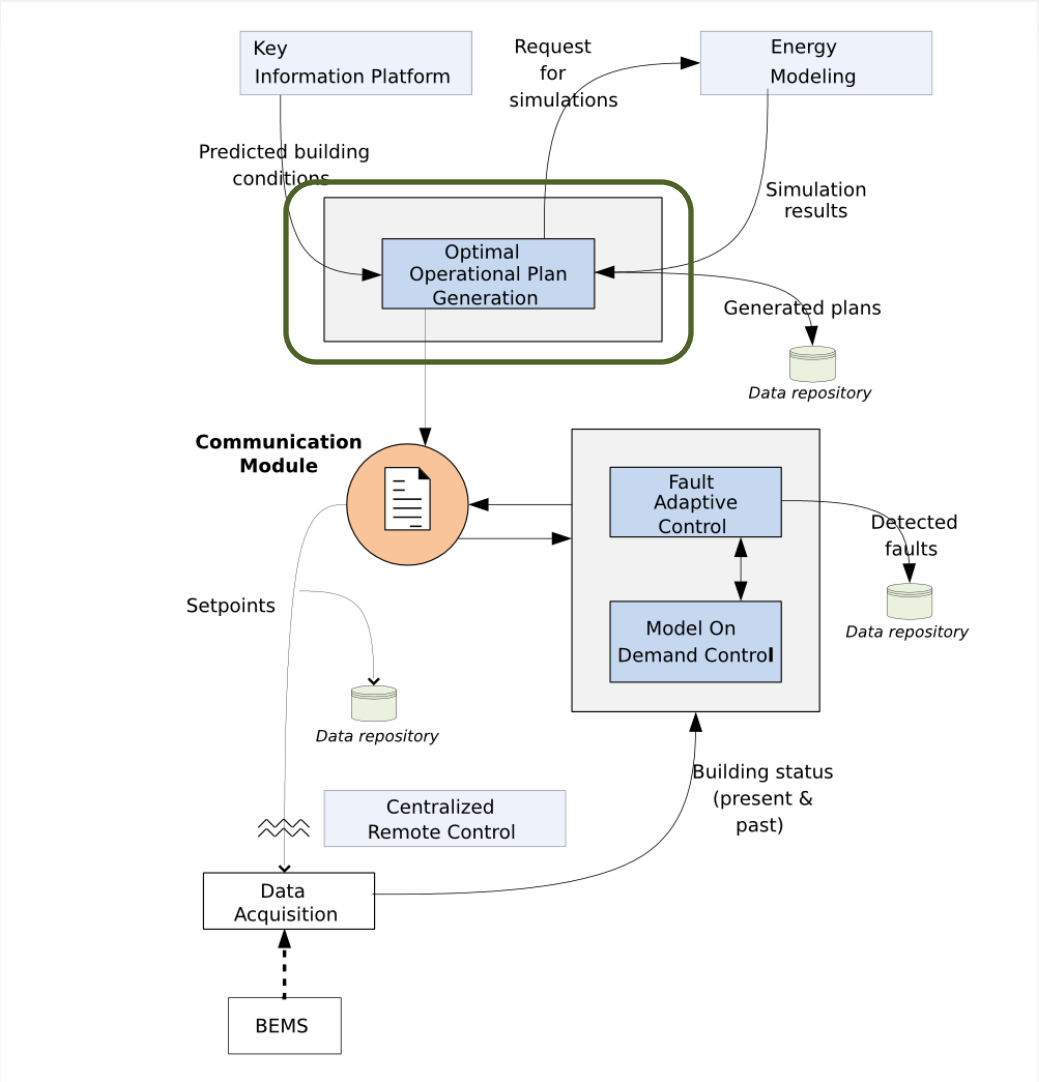
Monitoring and up to date information from the *external factors* of the building is obtained through the **Key Information Platform**



Generating the Operational Plan

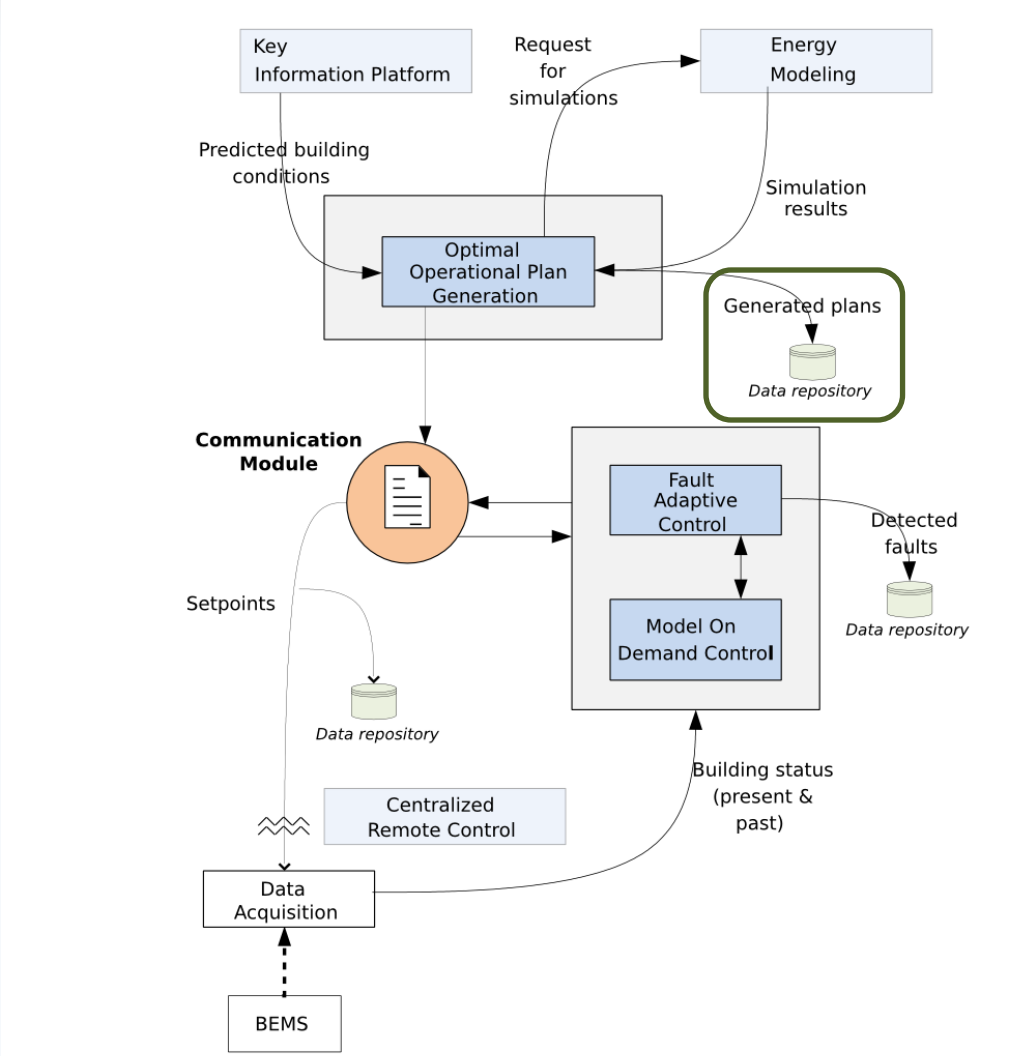
Taking external factors of the building from the Key Information Platform and internal factors from the simulation model, different configurations are tested, and the most efficient is selected





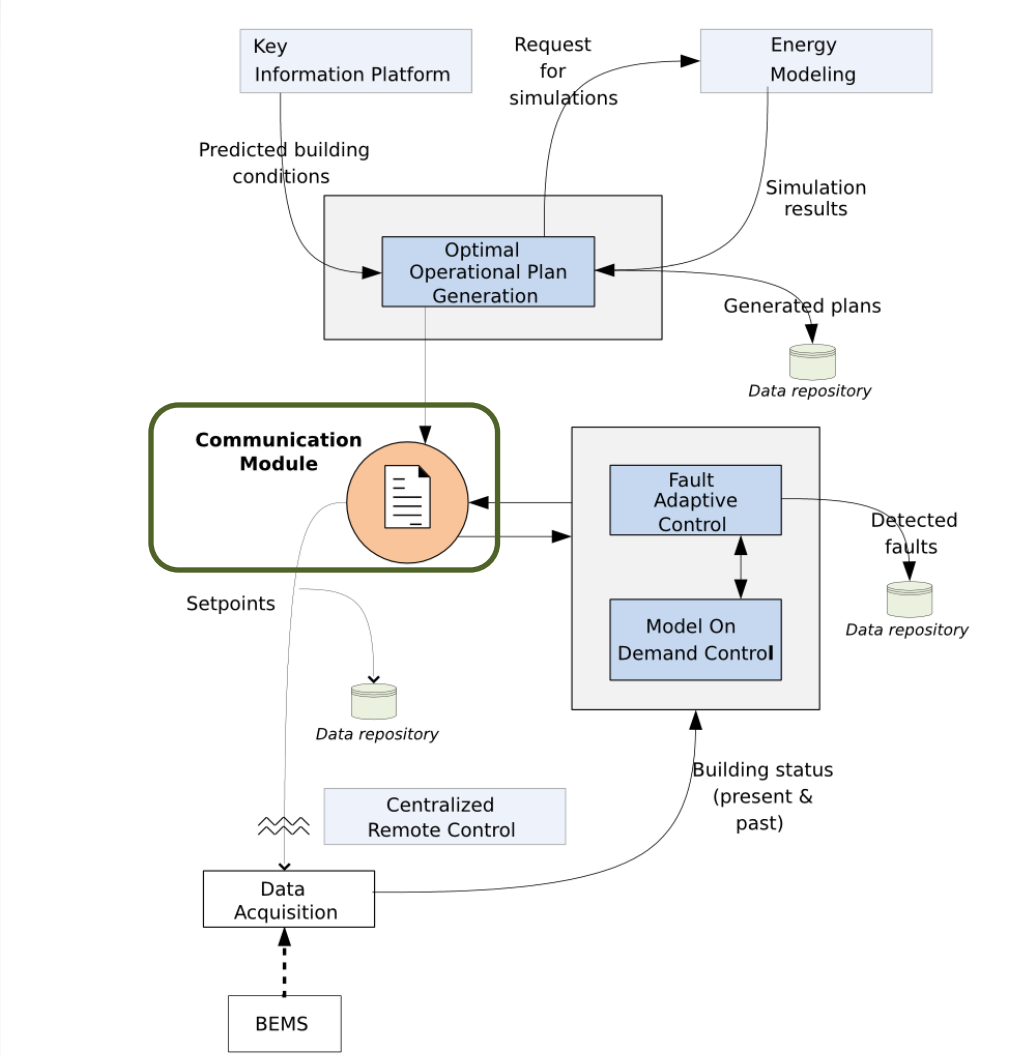
Storing the Operational Plan

The Optimal Plan generated by the OPG is stored along with the associated context



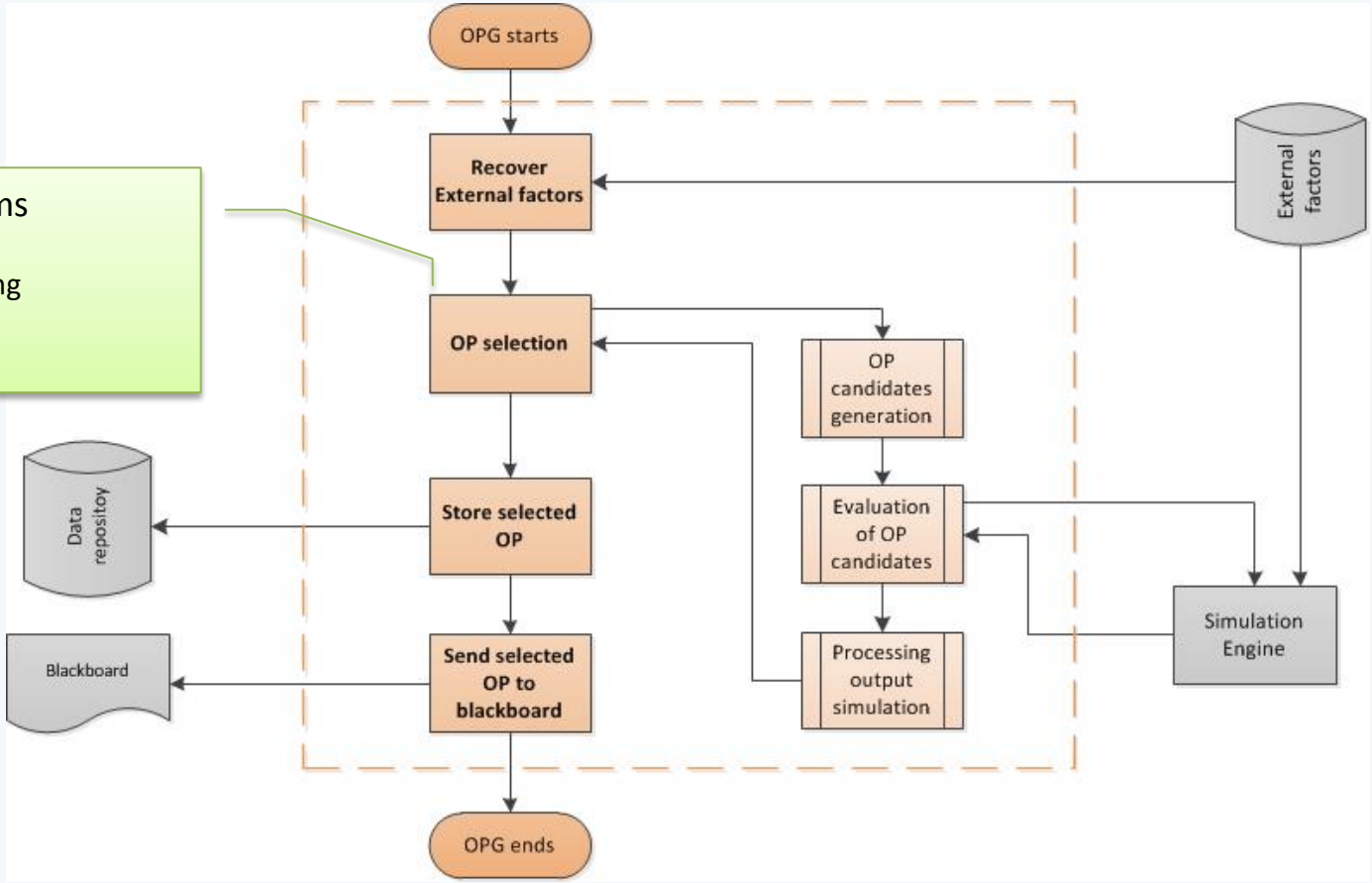
Sharing the Operational Plan

The Optimal Plan generated must be shared with the other components and later sent to the BEMS



Operation Plan Generation Algorithm

Pluggable algorithms
Heuristic Search
Evolutionary Computing
Parallel Algorithms
…



Conclusions

- The selection of an Optimal Operational Plan can reduce costs and emissions while producing energy savings
- Changing external and internal factors can produce deviations in from the expected performance
- These changes can be detected and corrected by:
  - Model on Demand Control
  - Fault Adaptive Control

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Thanks!

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