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Exploiting Software Performance Engineering Techniques to Optimise the Quality of Smart Grid Environments [Vision Paper]

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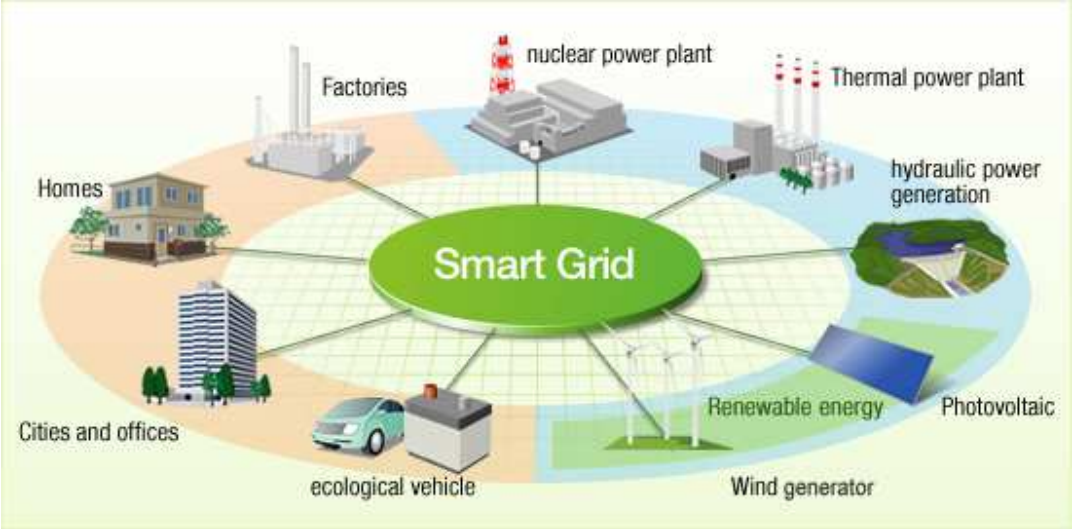
» Goal:

> SPE research to optimise the quality of Information and Communications Technology (ICT) applications underlying SMART GRID environments

Smart Grid (SG) is an electrical grid that uses communication technology to gather and act on information to efficiently distribute the electric energy.



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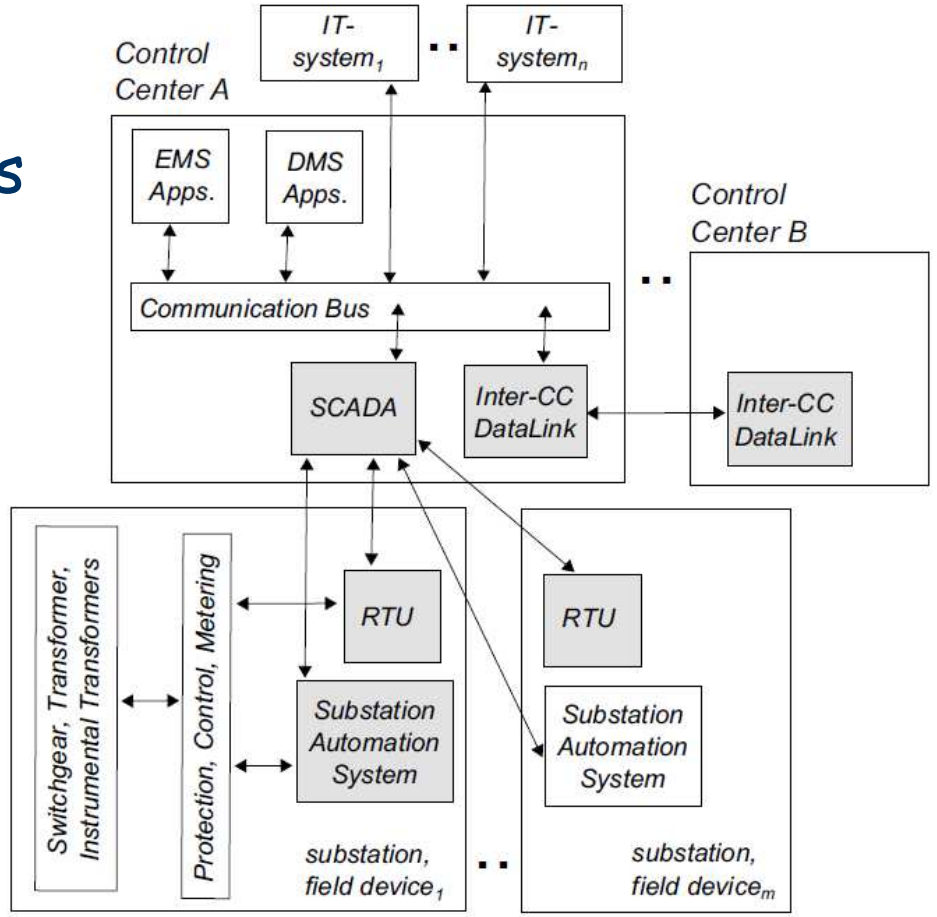
» Smart grid environments – basic concepts

> **control centers** need to handle operational demands

> **substation field devices** include remote terminal units (RTU) and substation automation systems that communicate with SCADA (system control and data acquisition)



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» SPE challenges in the context of SG environments (1/3):

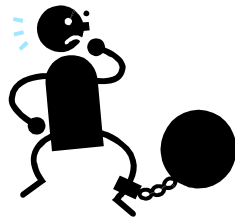
Systems span multiple domains, i.e. from the physical generation, transmission and distribution of energy (governed by the laws of electromagnetism) to the prediction of human end user demand and their response to incentives such as price signals.

CHALLENGE: meaningfully decompose the system into scenarios amenable to timing analysis and in particular, for us as SPE researchers, to identify and delineate the scenarios related to software performance.

» SPE challenges in the context of SG environments (2/3):

Systems are critical infrastructures, i.e. additional performance requirements and scenarios may be derived from reliability, security, and cost requirements.

Reliability- failure scenarios such as electrical equipment failure might lead to changed workload conditions for the control centre systems



Security- diverse attacks (e.g., DoS, MitM or SQL injection) can be identified

Cost- a disruption of multiple power lines due to a storm might cause sudden changes in the available generated power and its price

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» SPE challenges in the context of SG environments (3/3):

Systems are data-intensive, i.e. enormous amounts of data will potentially be generated, transmitted, and analysed. There is a trade-off between accurate analysis of the system state and performance.

CHALLENGE: many SPE methods and tools focus on control flow, less on data flow. Enhancing SPE methods and tools by models for data flow might be required to make them applicable.

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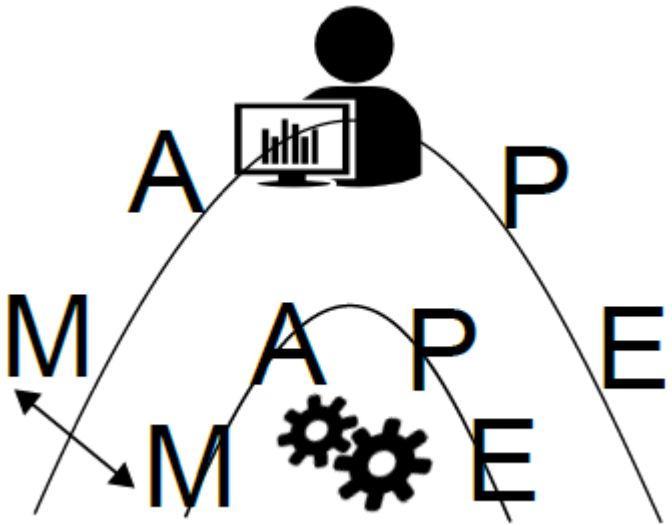
» PROBLEM: SG systems are data intensive and critical systems that span on multiple domains, hence ICT applications need to manage a huge amount of data over heterogeneous devices and networks.

OUR VISION: an inner loop is identified to deal with ICT applications that can be automatically reconfigured with a set of pre-defined and non-invasive refactorings, whereas an outer loop is meant to consider the human intervention in the optimisation process.



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» MAPE

- MONITORING: the most relevant energy-related services of smart grids are monitored;
- ANALYSING: the QoS status of smart grids services is estimated to predict in advance their processing capabilities;
- PLANNING: if energy-related services suffer or will suffer from poor performance, then design alternatives are devised and compared;
- EXECUTING: the selected design alternatives are actually realized to improve the processing capabilities.

» Contributions

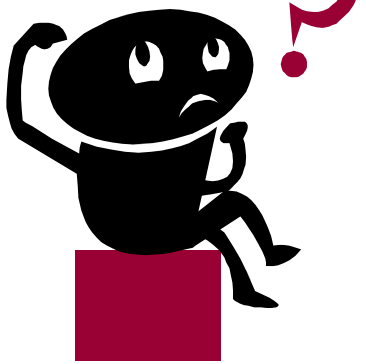
- > Envision the usage of SPE techniques for the ICT infrastructure underlying SG thus to optimise its quality:
  - > smart grids span multiple domains, so it is necessary to collaborate between such different domains.
  - > smart grids are critical infrastructures, so other dependability attributes such as reliability and security should be considered.
  - > smart grids are data-intensive systems, so models will need to consider data flow as well.

» Future works

- > Include the experience of SG experts, as this additional knowledge contributes to improve the MAPE process that need to be experimented in real-world smart grids.

Thank you!

Questions



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