Success Story
COMET

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ftw Creating Communication Technologies

SMART C²NET

FTW
Forschungszentrum Telekommunikation Wien
Programme: COMET – Competence Centers for Excellent Technologies
Programme line: K1-Centres

SmartC2Net, 01/12/2012-30/11/2015, strategic/ multi-firm

Smart Energy Distribution System Control Over Heterogeneous Communication Networks

Stability and cost-efficient operation of power distribution grids are the main targets of novel information-rich Smart Distribution System control approaches, while at the same time aiming to reduce costs for the grid infrastructure. However, adding intelligence to the power grid requires communication and computation infrastructure, with consequent requirements for additional investments. To be cost efficient, it is therefore essential to enable intelligent power grid operation leveraging existing communication infrastructures.

Smart Energy Distribution Grids

The energy ecosystem is rapidly developing towards less dependence on fossil fuels as well as nuclear power. As a consequence grid architectures have to support more decentralized energy production - primarily based on renewables. In addition, new high demand energy systems are being introduced such as heat pumps and electrical vehicles. Enabling this future energy system involves several stakeholders including energy prosumers, energy companies, distribution companies as well as new actors entering the new market. They all need to be able to manage their assets and jointly work towards the goal of increasing energy efficiency as well as minimizing costs for establishing and operating of this new infrastructure.

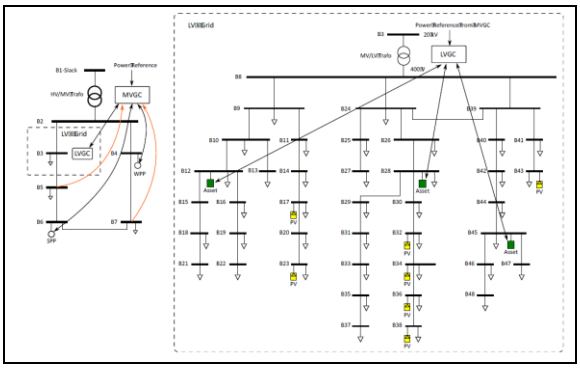

Fig. 1: Example Distribution Grid (Medium-Voltage on the left, Low-voltage on the right) and Control Architecture

Use-cases and Benefits for Smartness

FTW's research took a starting point in connectivity and data management solutions for Smart Homes and Smart Buildings. The investigation of charging management algorithms for electric vehicles and the embedding of such charging management solutions in

bmwfw Federal Ministry of Science, Research and Economy
bmvit Austrian Ministry for Transport, Innovation and Technology

real-time data processing in telematics systems extended such demand management approaches to future scenarios of substantial electric vehicle penetration. The last two use-cases cover energy balancing and voltage control functionality which will assure power quality and stability of future energy distribution grids.

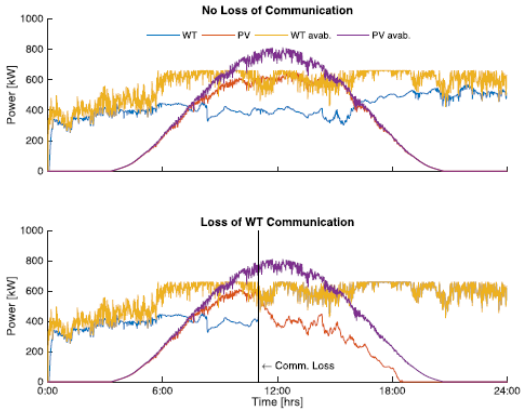

Fig. 2: Reference tracking of a low voltage grid over an ideal communication network (upper graph) and under the influence of communication outages.

Resilient operation over heterogeneous communication networks

Robustness of the described controllers to communication network variability was enhanced by creating awareness of connectivity properties at the controller. Furthermore, the monitoring system contains approaches for reliable information access and for adaptive scheduling of information access, both of which were shown to be effective for control performance improvement in certain fault scenarios, partially even under assumptions of future control cycles of few seconds to tens of seconds. The adaptive scheduling approaches thereby utilized a novel approach based on information quality metrics, for which mathematical models can be more easily derived while those were shown to be efficient to achieve control performance optimization in such layered networked control systems. Finally, also dedicated communication network prioritization and reconfiguration approaches for backhaul networks based on Software-Defined Networks were investigated and shown efficient to mitigate certain fault cases.

Impact and effects

The research results clearly showed that intelligent distribution grid operation can be realized in a robust manner over existing communication infrastructures even despite the presence of accidental faults and malicious attacks. The solutions have been demonstrated to a large audience of different industrial stakeholders at the European Utility Week in November 2015 in Vienna. The control approaches and the interfaces to the grid and network monitoring are currently followed up for product realizations by the industrial project partners.

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