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Publications:

Smart Grid Communication Infrastructure Comparison
Communication between Distributed Energy Resources and aggregators is required to improve the efficiency of power use and solve stability issues. For the communication, the probability of delivery for measurements and control commands determines the possible power system services. The probability of delivery is determined by the processing units, data connection, middleware, and serialization. The comparison is made based on multiple experimental setups to test the performance of different middleware and serialization with different processing units and data connections in a Smart Grid context. The hardware includes Beagle Bone, Raspberry Pi, and Dell laptop processing units, and the data connections include 1, 10, 100 and 100 Mbit/s. The results show that there are better alternatives to XMPP and Web Services middleware and XML serialization as advocated for by the prevalent communication standards, and gives guidance in choosing the best software and hardware depending on the use case.

General information
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Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Energy system operation and management, Department of Applied Mathematics and Computer Science, Software Engineering
Authors: Petersen, B. S. (Intern), Bindner, H. W. (Intern), Poulsen, B. (Intern), You, S. (Intern)
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Publisher: IEEE
Main Research Area: Technical/natural sciences
Communication between Distributed Energy Resources (DERs) is necessary to efficiently solve the intermittency issues caused by renewable energy, using DER power grid auxiliary services, primarily load shifting and shedding. The middleware used for communication determines which services are possible by their performance, which is limited by the middleware characteristics, primarily interchangeable serialization and the Publish-Subscribe messaging pattern. The earlier paper “Smart Grid Serialization Comparison” (Petersen et al. 2017) aids in the choice of serialization, which has a big impact on the performance of the communication as a whole. This paper identifies the dis-/advantages of the different middleware, shows that there are better alternatives to Web Services and XMPP, and gives guidance in choosing the most appropriate middleware depending on the context. YAMI4 and ZeroMQ are generally the strongest candidates for Smart Grid distributed control, but WAMP should also be considered in the future.


Smart Grid Serialization Comparison
Communication between DERs and System Operators is required to provide Demand Response and solve some of the problems caused by the intermittency of much Renewable Energy. An important part of efficient communication is serialization, which is important to ensure a high probability of delivery within a given timeframe, especially in the context of the Internet of Things, using low-bandwidth data connections and constrained devices. The paper shows that there are better alternatives than XML & JAXB and gives guidance in choosing the most appropriate serialization format and library depending on the context.

Algebraic Varieties and System Design
Design and analysis of networks have many applications in the engineering sciences. This dissertation seeks to contribute to the methods used in the analysis of networks with a view towards assisting decision making processes. Networks are initially considered as objects in the category of graphs and later as objects in the category of hypergraphs. The connection with the category of simplicial pairs become apparent when the topology is analyzed using homological algebra. A topological ranking is developed that measures the ability of the network to stay path-connected. Combined with the analysis of cover ideals of hypergraphs, the topological ranking demonstrates the non-trivial decisions that needs to be considered in system design. All the methods developed here have an underlying common structure, namely that they all appear at solution sets for systems of polynomials. These solution sets are called algebraic varieties.
On the significance of the noise model for the performance of a linear MPC in closed-loop operation

This paper discusses the significance of the noise model for the performance of a Model Predictive Controller when operating in closed-loop. The process model is parametrized as a continuous-time (CT) model and the relevant sampled-data filtering and control algorithms are developed. Using CT models typically means less parameters to identify. Systematic tuning of such controllers is discussed. Simulation studies are conducted for linear time-invariant systems showing that choosing a noise model of low order is beneficial for closed-loop performance. (C) 2016, IFAC (International Federation of Automatic Control) Hosting by Elsevier Ltd. All rights reserved.

Electric vehicle integration in a real-time market

This project is rooted in the EDISON project, which dealt with Electrical Vehicle (EV) integration into the existing power grid, as well as with the infrastructure needed to facilitate the ever increasing penetration of fluctuating renewable energy resources like e.g. wind turbines. In the EDISON project, the EV is introduced as an energy buffer used to store excess energy produced at off-peak hours, while at the same time potentially benefiting the consumer by offering cheaper charging. This role as a buffer, predominantly used for delayed charging, also known as “smart charging”, can also be used for ancillary services to help stabilize the grid at critical periods, e.g. by providing near instant up- or down regulation. The initial goal of this project is to develop the components for a simulation platform for large scale EV integration studies. By interfacing the EV simulation with an externally simulated model of the power grid, it is be possible, in real-time, to simulate the impact of EV charging and help to identify bottlenecks in the system. In EDISON the vehicles are aggregated using an entity called a Virtual Power Plant (VPP); a central server monitoring and controlling the distributed energy resources registered with it, in order to make them appear as a single producer in the eyes of the market. Although the concept of a VPP is used within the EcoGrid EU project, the idea of more individual control is introduced through a new proposed real-time electricity market, where the consumers will have direct access to the current price. As opposed to the hourly spot-price market of today, the real-time market see price updates as often as every couple of minutes. To allow the individual resources to react to these changes, independent of each other, so called “smart controllers” are needed at the device level. In order for this market to work, however, the proper ICT network- and server-infrastructure has to be developed. The primary goal of this PhD project, has been to investigate the scope of this ICT infrastructure, required to realise price-signal based charging of electric vehicles, in accordance with the EcoGrid EU market.
Generating Geospatially Realistic Driving Patterns Derived From Clustering Analysis Of Real EV Driving Data

In order to provide a vehicle fleet that realistically represents the predicted Electric Vehicle (EV) penetration for the future, a model is required that mimics people driving behaviour rather than simply playing back collected data. When the focus is broadened from on a traditional user-centric smart charging approach to be more grid-centric, it suddenly becomes important to know not just when- and how much the vehicles charge, but also where in the grid they plug in. Since one of the main goals of EV-grid studies is to find the saturation point, it is equally important that the simulation scales, which calls for a statistically correct, yet flexible model. This paper describes a method for modelling EV, based on non-categorized data, which takes into account the plug in locations of the vehicles. By using clustering analysis to extrapolate and classify the primary locations where the vehicles park, the model can be transferred geographically using known locations of the same classification.

Ranking Entities in Networks via Lefschetz Duality

In the theory of communication it is essential that agents are able to exchange information. This fact is closely related to the study of connected spaces in topology. A communication network may be modelled as a topological space such that agents can communicate if and only if they belong to the same path connected component of that space. In order to study combinatorial properties of such a space, notions from algebraic topology are applied. This makes it possible to determine the shape of a network by concrete invariants, e.g. the number of connected components. Elements of a network may then be ranked according to how essential their positions are in the network by considering the effect of their respective absences. Defining a ranking of a network which takes the individual position of each entity into account has the purpose of assigning different roles to the entities, e.g. agents, in the network. In this paper it is shown that the topology of a given network induces a ranking of the entities in the network. Further, it is demonstrated how to calculate this ranking and thus how to identify weak sub-networks in any given network.
Integrating Intelligent Electric Devices into Distributed Energy Resources in a Cloud-Based Environment

Until now the main purpose of Distributed Energy Resources (DERs) has been to compliment the power plants. However, if DERs are to play a larger role in the power grid of the future, then improved communication and cooperation between these resources and the system operators is necessary. Cooperation requires intelligence at the level of the DER as well as at the aggregator level, and in order to efficiently facilitate this, communication must be easily achievable.

This project presents a proof-of-concept plug-and-play cloud solution for next generation DERs, built upon the IEC 61850[15] standard, that enable easy communication and cooperation between DERs and system operators.

Intelligent Electric Vehicle Integration - Domain Interfaces and Supporting Informatics

This thesis seeks to apply the field of informatics to the intelligent integration of electric vehicles into the power system. The main goal is to release the potential of electric vehicles in relation to a reliable, economically efficient power system based on renewables. To make intelligent EV integration a reality, it is prudent to understand the domain in its entirety. In this thesis, this is reflected by a thorough investigation of the stakeholders most relevant to the synergistic relationship between electric vehicle and grid. The market can give system operators access to the exibility of electric vehicles while at the same time creating an immediate economic incentive for the EV owner. A fleet operator is introduced to allow a fleet of electric vehicles to participate in the markets. Examples are provided on the specific markets and services in which the electric vehicle may be best suited to participate. The next stakeholder investigated is the distribution system operator representing the low voltage grid. The challenge is assessed by considering a number of grid impacts studies. Next, a set of grid congestion mitigation strategies are proposed with a special attention to the impact that congestion would have on the operation of a fleet operator. The third and most important stakeholder is the electric vehicle owner. The emphasis is on the plug in patterns of a number of Danish electric vehicles.
vehicle drivers. The objective is to understand how owner behavior will influence charging flexibility. It is indicated how plug in behavior may be predicted and how the resulting flexibility may be applied to achieve several different goals. After having investigated the aims, constraints and requirements for the above stakeholders, the attention, in the second part of the thesis, is turned to three vital topics within the eld of informatics. The first topic is the control architecture that determines the placement and relationship between control systems used to control electric vehicle charging. A centralised market-based architecture is chosen and its ability to support smart charging. Finally it is described how considerations to each of the stakeholders can be included in the optimization done by the fleet operator. It is shown how dierent markets can be considered and how stochastic optimizationcan be used to model uncertainty in regards to plug in behavior and grid congestion. A large part of the above work have been done as contributions to the EDISON project in which the Thesis Author has participated. During the project the author has built a technical platform for testing several of the technologies mentioned above, against a small fleet of electric vehicles. This thesis is meant as an input for market players, system operators, fleet operators, fellow researchers and anyone with an interest in the role of the electric vehicle in the future power system.

General information
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Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Department of Applied Mathematics and Computer Science, Software Engineering
Authors: Andersen, P. B. (Intern), Østergaard, J. (Intern), Poulsen, B. (Intern), Gantenbein, D. (Ekstern)
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Simulation Tool For Energy Consumption and Production: The development of a simulation tool for measuring the impact of a smart grid on a building
In order to promote adoption of smart grid with the general public it is necessary to be able to visualize the benefits of a smart home. Software tools that model the effects can help significantly with this. However, only little work has been done in the area of simulating and visualizing the energy consumption in smart homes. This paper presents a prototype simulation tool that allows graphical modeling of a home. Based on the modeled homes the user is able to simulate the energy consumptions and compare scenarios. The simulations are based on dynamic weather and energy price data as well as a controller unit of the user’s choice. The results of the simulations can be compared using a dynamic reporting window that allows the user to create custom charts of the data. The application has been designed such that it can easily be extended with additional controller units, price and weather data as well as appliances and other electrical components used in the modeled homes.

General information
State: Published
Organisations: Department of Applied Mathematics and Computer Science, Software Engineering, Department of Electrical Engineering, Center for Electric Power and Energy, Technical University of Denmark
Authors: Nysteen, M. (Ekstern), Mynderup, H. (Ekstern), Poulsen, B. (Intern), Træholt, C. (Intern)
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Source: dtu
Source-ID: u::10020
Publication: Research - peer-review › Article in proceedings – Annual report year: 2013
Utilizing a Flexibility Interface for Distributed Energy Resources Through a Cloud-Based Service

With governments around the world pushing for an ever increasing shift towards renewable energy production, large numbers of controllable distributed energy resources are starting to appear. Already a multitude of proposed control solutions have seen the light of day, but most are focused solely on the control itself and not the more practical network- and data management issues that follows trying to handle such huge portfolios. This papers covers a cloud based solution to the aforementioned issues, greatly aiding aggregators scale to meet future demands. It also includes a flexibility interface that are currently being researched by iPwr, that is mapped to the well tested standard of IEC 61850 as additional sub-nodes. By mapping to existing standards, no major changes would be needed to adapt existing systems.

General information
State: Published
Organisations: Department of Electrical Engineering, Center for Electric Power and Energy, Department of Applied Mathematics and Computer Science, Software Engineering, Technical University of Denmark
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2013

Prediction and optimization methods for electric vehicle charging schedules in the EDISON project

Smart charging, where the charging of an electric vehicle battery is delayed or advanced in time based on energy costs, grid capacity or renewable contents, has a great potential for increasing the value of the electric vehicle to the owner, the grid and society as a whole. The Danish EDISON project has been launched to investigate various areas relevant to electric vehicle integration. As part of EDISON an electric vehicle aggregator has been developed to demonstrate smart charging of electric vehicles. The emphasis of this paper is the mathematical methods on which the EDISON aggregator is based. This includes an analysis of the problem of EV driving prediction and charging optimization, a description of the mathematical models implemented and an evaluation of the accuracy of such models. Finally, additional optimization considerations as well as possible future extensions will be explored. This paper hopes to contribute to the field of EV integration by coupling optimized EV charging coordination with the EV utilization predictions on which the former heavily relies.

General information
State: Published
Organisations: Centre for Electric Technology, Department of Electrical Engineering, Center for Electric Power and Energy, Energy resources, services and control, Electric Energy Systems, Electric Components, Department of Informatics and Mathematical Modeling, Computer Science and Engineering, Software Engineering
Authors: Aabrandt, A. (Intern), Andersen, P. B. (Intern), Pedersen, A. B. (Intern), You, S. (Intern), Poulsen, B. (Intern), O’Connell, N. (Intern), Østergaard, J. (Intern)
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Links: http://www.ieee-issgt.org/
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Source-ID: n::oai:DTIC-ART:iel/363601038::15501
Publication: Research - peer-review › Article in proceedings – Annual report year: 2012
Economic Dispatch of Electric Energy Storage with Multi-service Provision
This paper develops a generic optimization model that explores the difficulty met by Electric Energy Storage (EES) systems when economic dispatch for multiple-service provision is requested. Such a model is further used to investigate the economic performance of an EES system which meets the 10-minute balancing requirement and hourly load shifting opportunities in the Western Electricity Coordinating Council (WECC) area for a 2030 load scenario. Piecewise linear equations are used to represent the cost function of varying load. The results show that when EES is economically dispatched, to achieve multiple value streams could result in more saving than to provide single service.

General information
State: Published
Organisations: Electric Components, Department of Electrical Engineering, Centre for Electric Technology
Authors: You, S. (Intern), Træholt, C. (Intern), Poulsen, B. (Intern)
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Electric Energy Storage, Multiservice, Economic dispatch
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2011

Is micro-CHP price controllable under price signal controlled Virtual Power Plants?
As micro-combined heat and power (micro-CHP) systems move towards mass deployment together with other kinds of distributed energy resources (DER), an increasing emphasis has been placed on how to coordinate such a large diversified DER portfolio in an efficient way by the Virtual Power Plant (VPP) like aggregators. Compared to the centralized direct control scheme, a decentralized control scheme “control-by-price” is proposed for the VPP operation. The corresponding scheme has advantages in scalability, transparency and simplicity. In this context, a short term economic analysis is conducted for three different micro-CHP systems to investigate the feasibility of being controlled by price. Such analysis is relevant for both controller designs for micro-CHP systems and VPP related operations. The results indicate that controlling the micro-CHP systems by price is feasible but could result in jumpy responses.

General information
State: Published
Organisations: Electric Components, Department of Electrical Engineering, Software Engineering, Department of Informatics and Mathematical Modeling
Authors: You, S. (Intern), Træholt, C. (Intern), Poulsen, B. (Intern)
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Virtual power plant, Control-by-price, Distributed energy resources, Micro-CHP
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2011
Developing Virtual Power Plant for Optimized Distributed Energy Resources Operation and Integration

Distributed Energy Resources (DER) are small-scale power generation and storage technologies, (typically in the range of a few kWe to tens of kWe) located close to the customer side. They are right now under heavy development and have a great market potential in the near future. However, these sources are usually deployed in way of “fit and forget” which to a great extent confines their value and presents challenges in relation to:

- Optimized DER operation related to time varying onsite demand requirements, ambient conditions and electricity prices, etc.
- Coordinated control of many small units in the electric power system
- Efficient electricity market participation to benefit both power system operation and DER owners

To address these issues, an innovative concept Virtual Power Plant (VPP) is investigated in this PhD study. Based on a comprehensive overview of the state of the art of VPP, the Market-Based VPP (MBVPP) concept is proposed. The function-based MBVPP provides a generic and flexible solution for the DER integration by connecting the DER to the bulk power system operation via market participation.

Two schemes for managing the DER generation and trading portfolios, direct control and price signal control have been discussed and simulated. Due to their prevalence and controllability, the μCHP systems are modeled to represent the general DER technology in the corresponding studies. For the direct controlled VPP, all the μCHP units are optimally controlled by the VPP operator based on forecasted market and demand information. For the proposed price signal scheme, an Artificial Neural Network (ANN) is developed to characterize and estimate the price responsiveness of a μCHP group. It is found that although the prognosis result is relatively good, the price signal controlled scheme is still challenged by many uncertainties which reside in the nature of price signal control such as jumpy response. To demonstrate the feasibility of the VPP, a prototyped VPP with two Dachs μCHP systems is set up in the laboratory as a proof of concept. It has shown that, on the premise of an advanced Information and Communication Technology (ICT) infrastructure, the VPP represents a feasible solution to be implemented.

Electric Vehicle Fleet Integration in the Danish EDISON Project: A Virtual Power Plant on the Island of Bornholm

The Danish EDISON project has been launched to investigate how a large fleet of electric vehicles (EVs) can be integrated in a way that supports the electric grid while benefitting both the individual car owners and society as a whole through reductions in CO2 emissions. The consortium partners include energy companies, technology suppliers and research laboratories and institutes. The aim is to perform a thorough investigation of the challenges and opportunities of EVs and then to deliver a technical platform that can be demonstrated on the Danish island of Bornholm. To reach this goal, a vast amount of research is done in various areas of EV technology by the partners. This paper will focus on the ICT-based distributed software integration, which plays a major role for the success of EDISON. Key solution technologies and standards that will accommodate communication and optimize the coordination of EVs will be described as well as the simulation work that will help to reach the goals of the project.
Facilitating a generic communication interface to distributed energy resources: Mapping IEC 61850 to RESTful services

As the power system evolves into a smarter and more flexible state, so must the communication technologies that support it. A key requirement for facilitating the distributed production of future grids is that communication and information are standardized to ensure interoperability. The IEC 61850 standard, which was originally aimed at substation automation, has been expanded to cover the monitoring and control of Distributed Energy Resources (DERs). By having a consistent and well-defined data model the standard enables a DER aggregator, such as a Virtual Power Plant (VPP), in communicating with a broad array of DERs. If the data model of IEC 61850 is combined with a set of contemporary web protocols, it can result in a major shift in how DERs can be accessed and coordinated. This paper describes how IEC 61850 can benefit from the REpresentational State Transfer (REST) service concept and how a server using these technologies can be used to interface with DERs as diverse as Electric Vehicles (EVs) and micro Combined Heat and Power (μCHP) units.

General information
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Bibliographical note
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Source: orbit
Source-ID: 264094
Publication: Research - peer-review › Article in proceedings – Annual report year: 2010
A Market-Based Virtual Power Plant
The fast growing penetration of Distributed Energy Resources (DER) and the continuing trend towards a more liberalized electricity market requires more efficient energy management strategies to handle both emerging technical and economic issues. In this paper, a market-based Virtual Power Plant (MBVPP) model is proposed which provides individual DER units the access to current electricity markets. General bidding scenario and price signal scenario as two optional operation scenarios are operated by one MBVPP. In the end, a use case of a MBVPP with micro Combined Heat and Power (μCHP) systems demonstrates the potential benefits and operation scenarios of the MBVPP model.

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A study on electricity export capability of the μCHP system with spot price
When a number of μCHP systems are aggregated as a virtual power plant (VPP), they will be able to participate in the electricity wholesale market with no discrimination compared to conventional large power plants. Hence, this paper investigates the electricity export capability of the μCHP system when the electricity buyback price is given at a value equalizing the dynamic spot price. A μCHP system is modeled with optimized generation, and the marginal price of electricity export for such system is explained. A sensitivity analysis of several key factors, e.g. fuel price, heat to power ratio of the μCHP unit, which influence the export capability of μCHP system, is firstly carried out in the intraday case study, followed by the annual case study which explores the annual system performance. The results show that the electricity export capability of a μCHP system is closely related to its technical parameters, the associated energy price during the trade, as well as the demand profile. Furthermore, the μCHP system running under fluctuating spot price is likely to gain more profit than that running under a fixed electricity export price.

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Main Research Area: Technical/natural sciences
Generic Virtual Power Plants: Management of Distributed Energy Resources under Liberalized Electricity Market

The emergence of Virtual Power Plant (VPP) can be attributed to the major boost of distributed energy resources (DER), which satisfies the changing needs of modern society on energy industry. Based on this concept, DER units disregarding the differences in each individual technology are loosely aggregated with a unique interface to the external grid and energy market. This paper gives a broad overview of state-of-the-art VPP concepts and proposes a detailed generic VPP (GVPP) model running in liberalized electricity market environment. An attempt is made to provide an outline of the main functions that are necessary for the efficient operation of GVPP. By applying with the function-based design (FBD) method, GVPP developers with different system requirements are able to get the most flexibility out of the GVPP model. This is demonstrated in a case study wherein different GVPP scenarios are employed. Tools and methods associated with the functions are also briefly presented to further facilitate the development of GVPP.

Using Service Oriented Architecture in a Generic Virtual Power Plant

The purpose of this paper is to find and describe a suitable software framework that can be used to help implement the concept of a Generic Virtual Power Plant in the future power system. The Generic Virtual Power Plant concept, along with the utilization of distributed energy resources, has many interesting properties that can influence the future shape of power markets. The concept holds many promises including cheaper power to the consumer, a more flexible and responsive power production and the support of a more environment-friendly development. In order to realize a software solution supporting the Generic Virtual Power Plant, an array of different software design principles, patterns and architectures must be applied. Especially Service Oriented Architecture (SOA) can aid in implementing the Generic Virtual Power Plant.
Evaluation of a Generic Virtual Power Plant Framework Using Service Oriented Architecture

The purpose of this paper is to find and describe a suitable software framework that can be used to help implement the concept of a generic virtual power plant in the future power system. The generic virtual power plant concept, along with the utilization of distributed energy resources, has many interesting properties that can influence the future shape of power markets. The concept holds many promises including cheaper power to the consumer, a more flexible and responsive power production and the support of a more environment-friendly development. In order to realize a software solution supporting the generic virtual power plant, an array of different software design principles, patterns and architectures must be applied. Especially Service Oriented Architecture (SOA) can aid in implementing the generic virtual power plant. An analysis of the Nordic power market has been carried out in order to identify potential issues and barriers, henceforth mentioned as challenges, connected with the introduction of the generic virtual power plant concept. In this paper, three use case scenarios will show how each of these challenges can be overcome by the proposed solution framework. The use case scenarios will be tested by a prototype that has been developed as proof of concept.
Theoretical evaluation of a generic virtual power plant framework using service oriented principles

General information
State: Published
Organisations: System Security, Department of Informatics and Mathematical Modeling, Electric Energy Systems, Department of Electrical Engineering
Authors: Decker, M. (Ekstern), Poulsen, B. (Intern), Andersen, P. B. (Intern), Traeholt, C. (Ekstern), Østergaard, J. (Intern)
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A prototype of a documentation system that supports the development and maintenance of product configuration systems

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Organisations: Department of Management Engineering, Computer Science and Engineering, Department of Informatics and Mathematical Modeling, Industrial Engineering and Management
Authors: Haug, A. (Intern), Degn, A. (Ekstern), Poulsen, B. (Intern), Hvam, L. (Intern)
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Scopus rating (2014): SJR 0.181 SNIP 0.377
Scopus rating (2013): SJR 0.144 SNIP 0.437
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BFI (2012): BFI-level 1
Creating a documentation system to support the development and maintenance of product configuration systems

General information
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Organisations: Department of Management Engineering, Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Authors: Haug, A. (Intern), Degn, A. (Ekstern), Poulsen, B. (Intern), Hvam, L. (Intern)
Publication date: 2007

Host publication information
Title of host publication: Proceedings of the 2007 WSEAS International Conference on Computer Engineering and Applications, Gold Coast, Australia, January
Main Research Area: Technical/natural sciences
Conference: 2007 WSEAS International Conference on Computer Engineering and Application, 01/01/2007
Electronic versions: imm5133.pdf
Links:
http://www2.imm.dtu.dk/pubdb/p.php?5133
Source: orbit
Source-ID: 199915
Publication: Research › Article in proceedings – Annual report year: 2007

Prototype of Generic Server for Wind Power Plants Using IEC 61400-25 Standard

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling, Electric Power Engineering, Department of Electrical Engineering
Authors: Olsen, A. K. (Ekstern), Ösdil, B. (Ekstern), Poulsen, B. (Intern), Pedersen, K. O. H. (Intern), Johansen, K. (Ekstern)
Pages: 273-290
Publication date: 2007
Main Research Area: Technical/natural sciences

Publication information
Journal: International Journal of Distributed Energy Resources
Volume: 3
Issue number: 4
ISSN (Print): 1614-7138
Ratings:
ISI indexed (2013): ISI indexed no
Prototype of generic server for wind power plants using IEC 61400-25 standard

IEC 61850[1] has defined a family of standards for the power grid. For instance, the new IEC 61400-25[2] defines protocols for communication, control, and monitoring of wind power plants (WPP). This standard includes a wide range of mandatory and optional elements in the defined models, ranging from interfaces for control and monitoring to a standardized and secure way of handling communication. An analysis focusing on isolating the necessary requirements has been carried out based on the IEC 61400-25 in order to create a generic prototype which can be used by WPP vendors. The main communications interface of the prototype utilizes web services and the prototype developed is comprised of several independent modules to allow for the possibility of choosing a fully customizable setup by the end user. Configuration of the system needs to be done in a simple way, ensuring a flexible and reusable system, where different choices for the system can be added or left out depending on user specifications. From the requirements a prototype with the purpose of examining the key aspects of these definitions has been elaborated.

Implementation of Ecopower MINI CHP unit and the test facility

General information
State: Published
Organisations: System Security, Department of Informatics and Mathematical Modeling
Authors: Schulthess, T. (Ekstern), Ryhiner, D. (Ekstern), Espersen, A. (Ekstern), Poulsen, B. (Intern)
Publication date: 1998

Host publication information
Title of host publication: 22nd CIMAC conference, Copenhagen 18-21 May 1998
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 223754
Publication: Research › Article in proceedings – Annual report year: 1998

Theoretical and experimental evaluation of an object oriented real-time robot control scheme

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, System Security
Authors: Poulsen, B. (Intern)
Publication date: 1995

**Publication information**

Original language: English


Main Research Area: Technical/natural sciences

Source: orbit

Source-ID: 223753

Publication: Research › Ph.D. thesis – Annual report year: 1995

### Theoretical and experimental evaluation of an object oriented real-time servo control module

**General information**

State: Published

Organisations: System Security, Department of Informatics and Mathematical Modeling

Authors: Poulsen, B. (Intern), Andersen, N. (Ekstern), Jannerup, O. (Ekstern)

Publication date: 1995

**Host publication information**

Title of host publication: ICAR '95 7th International Conference on Advanced Robotics, Sant Feliu de Guixols, 20-22 Sept. 1995

Main Research Area: Technical/natural sciences


Source: orbit

Source-ID: 223749

Publication: Research › Article in proceedings – Annual report year: 1995

### An object oriented expert identifier system: Computing and control division

**General information**

State: Published

Organisations: System Security, Department of Informatics and Mathematical Modeling

Authors: Ferrante, P. (Ekstern), Caldwell, D. (Ekstern), Poulsen, B. (Intern)

Publication date: 1994

**Host publication information**

Title of host publication: Colloquium on "The Design, Implementation and Use of Object-Oriented Systems"

Place of publication: Savoy Place, London, 10 January, 1994

Publisher: The Institution of Electrical Engineers

Main Research Area: Technical/natural sciences

Conference: Colloquium on "The Design, Implementation and Use of Object-Oriented Systems", 01/01/1994

Source: orbit

Source-ID: 223730

Publication: Research › Article in proceedings – Annual report year: 1994

### Experimental evaluation of a tracking control scheme for a three link robot manipulator

**General information**

State: Published

Organisations: System Security, Department of Informatics and Mathematical Modeling

Authors: Poulsen, B. (Intern), Kristensen, P. (Ekstern), Andersen, K. (Ekstern), Caldwell, D. (Ekstern)

Publication date: 1994

**Host publication information**

Title of host publication: EURISCON '94 European Robotics and Intelligent Systems Conference, Malaga, 22-26 August

Main Research Area: Technical/natural sciences


Source: orbit

Source-ID: 223747

Publication: Research › Article in proceedings – Annual report year: 1994
Object oriented modelling of multi-functional tactile sensing

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, System Security
Authors: Caldwell, D. (Ekstern), Ferrante, P. (Ekstern), Poulsen, B. (Intern), Wardle, A. (Ekstern)
Publication date: 1994

Host publication information
Title of host publication: EURISCON ‘94 European Robotics and Intelligent Systems Conference, Malaga, 22-26 august
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 223731
Publication: Research › Article in proceedings – Annual report year: 1994

A multivariable control scheme based on LQG-control for a two link hydraulic test robot manipulator

General information
State: Published
Organisations: System Security, Department of Informatics and Mathematical Modeling
Authors: Conrad, F. (Ekstern), Poulsen, B. (Intern), Zhou, J. (Ekstern), Sørensen, P. (Ekstern), Trostmann, E. (Ekstern)
Publication date: 1992

Host publication information
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 223755
Publication: Research › Article in proceedings – Annual report year: 1992

Projects:

Model Predictive Control based on Stochastic Differential Equations - An Artificial Pancreas with Fast Insulin, Glucagon and Multiple Sensors
Department of Applied Mathematics and Computer Science
Period: 01/09/2014 → 28/02/2018
Number of participants: 5
Phd Student:
Hagdrup, Morten (Intern)
Supervisor:
Madsen, Henrik (Intern)
Poulsen, Bjarne (Intern)
Poulsen, Niels Kjølstad (Intern)
Main Supervisor:
Jørgensen, John Bagterp (Intern)
Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU)
Project: PhD

Reference architecture and infrastructure for modularity-based distributed control
Department of Electrical Engineering
Period: 01/06/2014 → 31/05/2017
Number of participants: 7
Phd Student:
Petersen, Bo Søborg (Intern)
Supervisor:
Poulsen, Bjarne (Intern)
You, Shi (Intern)
Main Supervisor:
Bindner, Henrik W. (Intern)
Examiner:
Andersen, Peter Bach (Intern)
Deconinck, Geert (Ekstern)
Olsen, Jesper Løvenstein (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Samfinansieret - Andet
Project: PhD

PROActive INtegration of sustainable energy resources enabling active distribution networks
Department of Electrical Engineering
Center for Electric Power and Energy
Energy system operation and management
Department of Applied Mathematics and Computer Science
Software Engineering
Period: 01/01/2014 → 31/12/2017
Number of participants: 4
Acronym: PROAIN
Project participant:
Petersen, Bo Søborg (Intern)
Poulsen, Bjarne (Intern)
Bindner, Henrik W. (Intern)
You, Shi (Intern)

Dynamic Coverage and Flow Coordination in Multi-Agent Networks
Department of Electrical Engineering
Period: 15/05/2013 → 08/02/2017
Number of participants: 7
Phd Student:
Aabrandt, Andreas (Intern)
Supervisor:
Hansen, Vagn Lundsgaard (Intern)
Poulsen, Bjarne (Intern)
Main Supervisor:
Træholt, Chresten (Intern)
Examiner:
Wu, Qiuwei (Intern)
Jensen, Anders Nedergaard (Ekstern)
Scaglione, Anna (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.

Relations
Publications:
Algebraic Varieties and System Design
Project: PhD
Electric vehicle integration in a real-time market

Department of Electrical Engineering
Period: 01/02/2011 → 18/03/2015
Number of participants: 7
Phd Student:
Pedersen, Anders Bro (Intern)
Supervisor:
Gantenbein, Dieter (Ekstern)
Poulsen, Bjarne (Intern)
Main Supervisor:
Østergaard, Jacob (Intern)
Examiner:
Wu, Qiuwei (Intern)
Jørgensen, Preben (Ekstern)
Kempton, Willett (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: Institut stipendie (DTU) Samf.

Relations
Publications:
Electric vehicle integration in a real-time market
Project: PhD

Intelligent Electric Vehicle Integration - Domain Interfaces and Supporting Informatics

Department of Electrical Engineering
Number of participants: 7
Phd Student:
Andersen, Peter Bach (Intern)
Supervisor:
Gantenbein, Dieter (Ekstern)
Poulsen, Bjarne (Intern)
Main Supervisor:
Østergaard, Jacob (Intern)
Examiner:
Bindner, Henrik W. (Intern)
Lopes, João A. Peças (Ekstern)
Mølbak, Tommy (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: 1/3 FUU, 1/3 inst 1/3 Andet
Project: PhD

Generic Virtual Power Plant for Micro Combined Heat and Power Units

Department of Electrical Engineering
Period: 01/10/2007 → 23/03/2011
Number of participants: 6
Phd Student:
You, Shi (Intern)
Supervisor:
Poulsen, Bjarne (Intern)
Main Supervisor:
Træholt, Chresten (Intern)
EcoGrid DK: 50% wind power in the Danish Electric Power System
The object of the EcoGrid.dk research programme is to develop new long term technologies and market solutions for power systems with an increased share of distributed generation and renewable energy sources while maintaining the reliability of supply. The programme will focus on the identification and evaluation of new architectures and structures for the power system and development of new solutions for enhanced customer participation and pioneering concepts of system control and operation. The EcoGrid programme will cover research and development activities within related areas, and the programme will initiate and coordinate these activities. EcoGrid.dk will look for global solutions with reference to the Danish power system and the new Danish energy policy the objective of which is at least 30% renewable energy in the overall energy system in 2025, and indications that wind power can cover 50% of electricity demand in 2025.

Department of Electrical Engineering

Centre for Electric Technology
Period: 01/05/2007 → 01/07/2008
Number of participants: 13
wind power, electric power system, architectures, market, measures
Acronym: EcoGrid
Project ID: 55486
Project participant:
Nyeng, Preben (Intern)
Xu, Zhao (Intern)
Chandrashekhara, Divya K (Intern)
Poulsen, Bjarne (Intern)
Horstmann, Jørgen Peter Frederik (Intern)
Chen, Yu (Intern)
Jóhannsson, Hjörtur (Intern)
Saleem, Arshad (Intern)
You, Shi (Intern)
Garcia-Valle, Rodrigo (Intern)
Vlachogiannis, Ioannis (John) (Intern)
Project Manager, organisational:
Østergaard, Jacob (Intern)
Lind, Morten (Intern)

Financing sources
Source: Forsk. Private danske - Andre
Name of research programme: Forsk. Private danske - Andre
Amount: 666,000.00 Danish Kroner
Project

Opbygning af et digitalt objektorienteret robotsystem som tillader integration af eksterne sencorer
Department of Electrical Engineering
Period: 01/02/1992 → 02/08/1995
Number of participants: 3
Phd Student:
Poulsen, Bjarne (Intern)
Main Supervisor:
Jannerup, Ole Erik (Intern)
Examiner:
Rasmussen, Henrik (Ekstern)
Financing sources
Source: Internal funding (public)
Name of research programme: Gammel ordning u/skema-SU
Project: PhD