An open source multi-agent software toolkit for intelligent power distribution
PROJECT PROPOSAL SUMMARY

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Abstract

The electricity industry in many countries is facing new pressures due to escalating demand and environmental concerns such as climate change. The application of information technology to power systems in order to make electricity grids intelligent is gaining momentum as a means to achieve electricity networks which are more efficient, can accommodate greater amounts of distributed and renewable energy resources and provide demand management. This document presents a project proposal for the development of an open source multi-agent software toolkit for intelligent power distribution to support learning, research and collaboration in this area. An introduction to the topic of intelligent power grids and an overview of the purpose and aims of the project are presented.

Introduction

This document presents a project proposal for the development of an open source toolkit for developing multi-agent software systems for power system control. The project is being undertaken as part of an honours year thesis towards a Bachelor of Software Engineering degree.

The Future of Electricity Grids

The Need for Change

The electricity industry around the world is facing new challenges driven by issues such as environmental concerns, greater need for energy efficiency, diversification of energy sources and market deregulation. Current grid systems are proving inadequate to address these issues and have been termed both inefficient and unreliable [1]. One key issue is the fact that there is a growing trend to introduce renewable energy sources as well as other types of electricity generation distributed throughout the grid [2], but existing systems were designed only to support centralised remote generation sites [3]. These distributed resources present a substantial change to way the electricity infrastructure is managed and controlled [2]. In order to cope with such issues there is agreement within the electricity industry that a massive transformation is inevitable [1].

The Intelligent Grid

The intelligent grid, or smart grid, refers to the application of information technology to power systems, and is expected to address many of the shortcomings of the current grid [1]. Electricity grids are expected to evolve into networks in which the nodes become active and intelligent and a vast number of system parts communicate with and influence each other [2]. The goals of a more intelligent grid would be to provide utility companies with precise control over their assets and services as well to empower consumers to adjust

their energy use and reduce their energy costs. An intelligent grid is also proposed to be self-healing and resilient to system anomalies [1].

Multi-agent Software Systems

A software agent is a piece of software that acts autonomously on behalf of a user or another program. Agents exhibit four key properties: autonomy (they operate without human intervention), sociality (they interact with other agents), reactivity (they perceive and react to their environment) and pro-activity (they exhibit goal-oriented behaviour by taking initiatives). A multi-agent system (MAS) is a combination of several agents working in collaboration to achieve the overall goal of the system. MAS have become a powerful tool in the development of complex systems [4].

MAS in Power Systems

Power system control is currently accomplished by Supervisory Control and Data Acquisition (SCADA) systems. There is, however, a growing trend towards the utilisation of automated multi-agent systems. Research has been conducted investigating the application of MAS to various aspects of power systems such as system disturbance diagnosis, system restoration, system visualisation, micro-grid operation [5] [6] and distributed energy resource management [7] [8]. Research and commercial applications in this area are occurring word-wide, for example in Australia [7] [8], the United States [9], and Europe [10]. Software developed by previous researchers however, is not publicly available to be used by other researchers or students and there does not currently exist any publicly available or open source toolkit specific to this area.

Project Description

The purpose of the project is to develop an open source software toolkit for the development of multi-agent systems specific to power systems. The toolkit has been given the name GridIQ. GridIQ is intended to be used by power systems or software engineering students or researchers to facilitate learning about MAS in power systems. The toolkit will enable the application of MAS to virtual power systems through integration with a power system simulation tool and will provide a default set of agents for power system control that may be modified or extended. GridIQ will be released as an open source project in order to encourage collaborative input and development.

GridIQ aims to leverage existing systems and technology where possible. The toolkit will utilise an existing MAS development framework as well as an existing power system simulation tool. The aim of GridIQ is to provide a bridge between these two types of existing systems and provide a well documented platform to facilitate learning, experimentation and collaboration for students and researchers.

Bibliography

[1] H. Farhangi, "The path of the smart grid", *Power and Energy Magazine, IEEE*, vol. 8, pp. 18 -28, January-February . 2010.

[2] M.P.F. Hommelberg, C.J. Warmer, I.G. Kamphuis, J.K. Kok and G.J. Schaeffer, "Distributed Control Concepts using Multi-Agent technology and Automatic Markets: An indispensable feature of smart power grids" in *Power Engineering Society General Meeting, IEEE* ,2007, pp. 1 -7.

[3] K.I. Geisler, "A smarter greener power grid" in *Power Systems Conference*, pp. 1-3, March. 2009.

[4] S. Franklin and A. Graesser , "Is it an Agent, or just a Program?: A Taxonomy for Autonomous Agents" in *Proceedings of the third international workshop on agents, theories, architectures, and languages* ,1996, pp. 21--35.

[5] M. Pipattanasomporn, H. Feroze and S. Rahman , "Multi-agent systems in a distributed smart grid: Design and implementation" in *Power Systems Conference and Exposition, IEEE/PES* ,2009, pp. 1 -8.

[6] Z. Jiang, "Agent-Based Control Framework for Distributed Energy Resources Microgrids" in *International Conference on Intelligent Agent Technology, IEEE/WIC/ACM* ,2006, pp. 646 -652.

[7] R. Li, J. Li, G. Poulton and G. James., "Agent-Based Optimization Systems for Electrical Load Management" in *1st International Workshop on Optimisation in Multi-Agent Systems* ,2008, pp. 60-69.

[8] Y. Guo, A. Zeman and R. Li, "A Reinforcement Learning Approach to Setting Multi-Objective Goals for Energy Demand Management" in *7th International Conference on Autonomous Agents and Multiagent Systems* ,2008, pp. 65-72.

[9] D.A. Cohen , "Intelligent agent applications for integration of distributed energy resources within distribution systems" in , pp. 1 -5, july. 2008.

[10] A.L. Dimeas and N.D. Hatziargyriou , "Control Agents for Real Microgrids" in , pp. 1 -5, nov.. 2009.