Multi Agent System for Energy Management

Software Requirements Specification
Version 1.0

Group CI-G2
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# Table of Contents

1. **INTRODUCTION** .................................................................................................................. 1  
   1.1 **OVERVIEW** ................................................................................................................... 1  
   1.2 **PURPOSE** ..................................................................................................................... 1  
   1.3 **SCOPE** .......................................................................................................................... 1  

2. **OVERALL DESCRIPTION** .................................................................................................... 2  
   2.1 **PRODUCT PERSPECTIVE** .............................................................................................. 2  
   2.2 **PRODUCT FUNCTIONS** ............................................................................................... 2  
   2.3 **USER CHARACTERISTICS** ............................................................................................ 4  
   2.4 **CONSTRAINTS** .............................................................................................................. 4  

3. **FUNCTIONAL REQUIREMENTS** ............................................................................................ 5  
   3.1 **HIGH LEVEL DIAGRAM** ............................................................................................... 6  
   3.2 **EXTERNAL INTERFACE REQUIREMENTS** .................................................................... 7  
   3.5.1 **USER INTERFACES** .................................................................................................... 7  
   3.5.2 **SOFTWARE INTERFACES** .......................................................................................... 7  

4. **NON FUNCTIONAL REQUIREMENTS** .................................................................................... 8  

5. **DEFINITIONS, ACRONYMS AND ABBREVIATIONS** .............................................................. 9  

6. **REFERENCES** ..................................................................................................................... 9
1. Introduction

1.1 Overview

This document elaborates the functional and non-functional requirements regarding our project. It describes each of the functional and non-functional requirements provided by the stakeholders in detail. It basically describes all the needs and expectations of our clients in an organized and structured manner.

1.2 Purpose

This document is intended to specify the functional, non-functional requirements of a multi-agent system for energy management. The main purpose of this document is to list down requirements and get them approved by the supervisor. This document would also be considered as the basis for the design and test specification document for our product.

1.3 Scope

This document covers the high level descriptions of all the functionalities which are expected by MAS for Energy Management. The scope of this document would be limited to describing features of the software and constraints to be met. Thus, it would not go into detail on any specific programming languages, development tools or design specifications.

- Simulators would be used for the final demonstration as the sources and sinks of the power system.

- However several of the sinks would be replaced by actual devices.

- Network cables would be used to connect the agents.

- We would not be handling any sort of authentication of agents in this project.

The requirements mentioned in this document may become subject to changes with the progress of the project. However, such changes would be done in order to make the project feasible or become more meaningful. If such changes occur, they would be discussed with the supervisor, and the necessary permission would be obtained for alterations.
2. Overall Description

2.1 Product Perspective

The main perspective of this project would be to manage power sources and sinks in an efficient and collaborative manner such that the maximum power consumed by all the devices would be at a minimum. Thus resulting in reduced peak hour power which would drastically reduce the energy dissipated by the power lines and other power controlling and transmission devices.

An additional advantage of this endeavour would be to reduce the initial cost of development of the national power grid by reducing the capacity of the power lines.

However, due to the limitations of the project scope, we would mainly be focussing on building a prototype of the above mentioned scenario rather than an actual implementation to suit the Sri Lankan context. In other words, we would be mainly targeting in proving the conceptual facts of the problem and would be proving them with our project.

2.2 Product Functions

The product allows two main functionalities to be performed: “managing power sources” and “managing power sinks”. These two basic functionalities are explained below.

The system would maintain managed power consumption such that the requirements of each and individual agent gets sufficed, and an overall goal is maintained by the system. In doing so, the overall efficiency of the system would be increased by reducing the energy quantities wasted.

Individual agents would be able to communicate with each other via a specific protocol which would enable them to exchange their current status and power needs. In doing so, the agents would be able to collaborate with each other and together maintain a cooperative goal instead of only achieving individual goals (However, agents would behave selfishly).

Each agent would be able to communicate with each other agent regardless of where the other agent physically exists. That is, the agents would be able to communicate even though the others are accessed via a proxy.
In critical cases the agents should be intelligent enough to make their own decisions. In case of emergency power failure, the agents should switch back and order themselves to operate as they did prior to the power failure. But under large durations of power failure, it would not be practicable or feasible to bring the system back to transient operations immediately. Thus the application should require a minimum delay to get back to normal working conditions. However we cannot guarantee a recovering duration for the process, due to the unpredictability of the state of each agent and the operational time.

One agent is expected to control only one device. This device would be controlled by the agent from the responses the agent perceives through its senses. Whereas the senses described in this situation would be the communication protocols and the sensors connected to the device. The overall control done by the agent would be to change the controllable parameters of the device. As an example, refer to an agent controlling a fridge. Here, the agent can be in charge of controlling the state of the fridge. i.e.: either on/off, or it can be in charge to control the temperature of the fridge.

The system should be able to adapt to new changes. That is, the system can handle additional agents being added to the system as well as removal of existing agents from the system. Given that each of the devices being added complies with the existing system requirements and meets the necessary interfaces. However adding or removing an agent from the system would not require any changes to be made to the software or any configuration files of the main system.

If an agent fails, the device would operate independently disregard of the network or other agents. In other words, the device would operate as if there was no system to control power consumption.

There would be a mechanism for monitoring the current status of the system via a Graphical User Interface (GUI). The system shall allow users to generate reports depending on their requirements.

The system would need to work with simulators in the early stages. That is, simulators would represent real life devices and hence we would depend on the signals of the simulators for demonstrations in the earlier phases. However certain real life devices need to be added for the final demonstration. The agents would be interconnected using wireless technologies such as Bluetooth or Wi-Fi. However we would be using network cables for our demonstration.
Each agent should be capable of doing the necessary calculations within itself. Such calculated data would be interchanged within other agents abiding to the transmission protocols.

### 2.3 User Characteristics

The intended users for this project are computer literate persons who are experienced in using computers. Users may or may not have experience in using client-server based application. User interaction with the system will be very limited because agents are autonomous.

The users of the system are regarded to be people without highly technical literacy of computing. Thus, the GUI provided must be simple and understandable for a person who is new to computing. Therefore, configuration data must not be included in places where the general users interact with.

### 2.4 Constraints

The followings are constraints for our project:

- The project shall be delivered by February, 2009.

- Initial phases will be developed on outputs of simulators.
3. Functional Requirements

Below is a list of functional requirements that we could identify for our product up to now:

<table>
<thead>
<tr>
<th>Req. ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR-1</td>
<td>Reduce peak current value and peak power</td>
</tr>
<tr>
<td>FR-2</td>
<td>Manage power sources and sinks</td>
</tr>
<tr>
<td>FR-3</td>
<td>Agents should be able to interact with each other for decision making</td>
</tr>
<tr>
<td>FR-4</td>
<td>The system shall allow communication among agents irrespective to their locations in network</td>
</tr>
<tr>
<td>FR-5</td>
<td>Agents should be able to make their own decisions even without network connection.</td>
</tr>
<tr>
<td>FR-6</td>
<td>The system shall allow each agent to control only one item.</td>
</tr>
<tr>
<td>FR-7</td>
<td>Agents should be as simple and capable of running on embedded devices.</td>
</tr>
<tr>
<td>FR-8</td>
<td>System should be expandable by adding and removing agents.</td>
</tr>
<tr>
<td>FR-9</td>
<td>If an agent fails, the device would operate independently.</td>
</tr>
<tr>
<td>FR-10</td>
<td>System should have interfaces for monitoring and controlling the status of the system and agents.</td>
</tr>
<tr>
<td>FR-11</td>
<td>System should initially work with simulators which would represent devices</td>
</tr>
<tr>
<td>FR-12</td>
<td>Some of the simulator devices should be replaced with real world equipments at the end of the project</td>
</tr>
<tr>
<td>FR-13</td>
<td>Agents should be intelligent to do necessary calculations which are needed for their functionalities.</td>
</tr>
</tbody>
</table>
3.1 High level diagram
3.2 External Interface Requirements

3.5.1 User Interfaces

There shall be a Graphical User Interface for the system. GUI should allow user to monitor the status of the system and generate reports.

3.5.2 Software Interfaces

The system shall provide a set of Application Programming Interfaces (API) for future development and enhancements of the system (Especially for developing agents for devices).
4. Non Functional Requirements

Below is a list of non functional requirements that we could identify for our project up to now.

<table>
<thead>
<tr>
<th>Req. ID</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFR-1</td>
<td>Unified Process shall be used as the project lifecycle.</td>
</tr>
<tr>
<td>NFR-2</td>
<td>The system and agents should have a fast response time.</td>
</tr>
<tr>
<td>NFR-3</td>
<td>The system should use the network optimally.</td>
</tr>
<tr>
<td>NFR-4</td>
<td>The code should be reusable.</td>
</tr>
<tr>
<td>NFR-5</td>
<td>The system must be safe to use.</td>
</tr>
<tr>
<td>NFR-6</td>
<td>System should generate appropriate log files and should be searchable</td>
</tr>
<tr>
<td>NFR-7</td>
<td>The system should be secured and restrict improper access.</td>
</tr>
<tr>
<td>NFR-8</td>
<td>The product should have a user-friendly interface.</td>
</tr>
</tbody>
</table>
5. Definitions, Acronyms and Abbreviations

The following table includes the list of definition, acronyms and abbreviations related to our project.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agent</td>
<td>An intelligent agent (IA) is a software agent that assists users and will act on their behalf, in performing non-repetitive computer-related task.[1]</td>
</tr>
<tr>
<td>Multi Agent System</td>
<td>A multi-agent system (MAS) is a system composed of multiple interacting intelligent agents. Multi-agent systems can be used to solve problems which are difficult or impossible for an individual agent or monolithic system to solve.[1]</td>
</tr>
<tr>
<td>GUI</td>
<td>Graphical User Interface</td>
</tr>
<tr>
<td>API</td>
<td>Application Programming Interfaces</td>
</tr>
</tbody>
</table>

6. References

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- http://www.eecs.harvard.edu/~rad/ssr/publications