
SOFTWARE REQUIREMENTS SPECIFICATION

for

Encost Smart Graph Project

Version 1.1 approved

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Revision History

Name	Date	Reason for Changes	Version
Sophia Brown	05/04/2023	Updated priorities	1.1

1 Introduction

1.1 Purpose

The purpose of this document is to specify the software requirements of a software system called Encost Smart Graph Project (ESGP). This document will explain the capabilities of the software, its interface requirements, and both its functional and nonfunctional requirements.

1.2 Document Conventions

This document uses the following conventions:

ESGP: Encost Smart Graph Project

1.3 Intended Audience and Reading Suggestions

This document is intended for any individual user, developer, tester, and project manager. Here are the potential uses for each of the reader types:

- Developer: The developer who wants to read, change, modify or add new requirements into the existing program, should firstly consult this document and update the requirements in an appropriate manner so as to not destroy the actual meaning of them and pass the information correctly to the next phases of the development process;

- User: The user of this program reviews the diagrams and the specifications presented in this document and determines if the software has all the suitable requirements and if the software developer has implemented all of them;
- Tester: The tester needs this document in order to develop tests which check that the requirements for this system, as given in this document, are *actually* met by any program which some developer *claims* meets the requirements.

This document contains the necessary requirements and some aspects of the analysis of the requirements and is organized based on the IEEE Standard for Software Requirements Specification (IEEE 830-1993).

1.4 Project Scope

Encost is a new and emerging Smart Home development company. They manufacture a series of Smart Home and IoT solutions, including Wifi Routers, Smart Hubs and Controllers, Smart Light Bulbs, Smart Appliances, and Smart Whiteware. Encost is interested in investigating how their smart devices are being used and connected within households across New Zealand. They have worked, in partnership with energy companies and their users, to gather information about the smart devices that have been in use in 100 New Zealand homes between April 2020 and April 2022 (called the Encost Smart Homes Dataset).

The Encost Smart Graph Project (ESGP) is a software system that enables the visualisation of Encost's devices using a graph data structure. When provided with the Encost Smart Homes Dataset, ESGP enables users to view all of the devices in the dataset, along with their connection to one another. It also provides verified users with summary statistics on device distribution, location, and connectivity.

2 Overall Description

2.1 Product Perspective

ESGP is a part of a larger mission for Encost to optimise the use of and connectivity between their devices. SoftFlux is responsible for the development of only the base version of the ESGP software. This involves the development of a local Java version of the application, including handling input and output, user login, graph visualisation, and data processing and statistics.

2.2 User Classes and Characteristics

ESGP has two types of users.

- Community users: Community users can view the graph visualisation for the Encost Smart Homes Dataset. Encost intends to distribute this version of the application to all users who opted to have their information recorded when Encost gathered information about the smart devices that have been in use in 100 New Zealand homes between April 2020 and April 2022;
- Encost users: Encost users can view graph visualisations for the Encost Smart Homes Dataset, or for any dataset that is formatted correctly. They can also access summary statistics on device distribution, device location, and device connectivity.

Roles	Custom datasets	Graph visualisations	Summary statistics
Community user	No	Yes	No
Encost user	Yes	Yes	Yes

2.3 Operating Environment

- Operating System: Windows 10
- Java: Version 1.8.0 or higher
- GraphStream: Version 1.3

2.4 Design and Implementation Constraints

- The software should be developed as an objected-oriented solution
- The software must make use of the GraphStream library.
- The software shall only be provided in English for this version.
- SoftFlux will be responsible for maintaining the software.

2.5 Assumptions and Dependencies

- SoftFlux assumes that the information provided in the Encost Smart Homes Dataset is anonymised;
- SoftFlux assumes that the information provided in the Encost Smart Homes Dataset is correct;
- SoftFlux assumes that the GraphStream library is available and correct.

3 External Interface Requirements

3.1 User Interfaces

ESGP is primarily a console application. Logging in, loading custom datasets, actioning a graph visualisation, and displaying summary statistics will all be facilitated through console prompts.

- **Welcome prompt:** When the application is started, a welcome message will be displayed along with a query about whether the user is a member of the community or a member of Encost. If the user indicates that they are a member of the community, then the ESGP Feature Options will be displayed. If the user indicates that they are a member of Encost, then the ESGP Account Login prompt will be displayed;
- **ESGP Account Login prompt:** Encost users will need to login in order to view their additional features. The ESGP Account Login prompt will first prompt the user to enter their username. It will then prompt the user to enter their password. If login is successful, users will be moved to the ESGP Feature Options;
- **ESGP Feature Options:** The ESGP Feature Options allows users to select which feature to access. The features available to a community user are: (1) visualising a graph representation of the data. The features available to an Encost user are: (1) loading a custom dataset; (2) visualising a graph representation of the data; and (3) viewing summary statistics;
- **Load custom dataset prompt:** If an Encost user elects to load a custom dataset, the custom dataset prompt will ask them to enter the full filepath for that dataset. If a file is found then ESGP will redisplay the ESGP Feature Options, updating the “load custom dataset” option to indicate that a dataset has been loaded;
- **View graph visualisation prompt:** If the user elects to view the graph visualisation, a UI window will open that displays the graph. The graph visualisation will show all devices as nodes and connections between devices as edges. It will also show a visualisation that represents whether each device has the ability to send and/or receive commands;
- **View summary statistics prompt:** If an Encost user elects to view summary statistics, then three summary statistics will be displayed in the console: (1) device distribution, (2) device location, (3) device connectivity.

3.2 Hardware Interface

ESGP does not integrate with any hardware interfaces

3.3 Software Interfaces

ESGP will integrate with the following software interfaces:

- GraphStream: GraphStream¹ is a Java library for building and visualising dynamic graphs. ESGP will use GraphStream to build and visualise a graph of Smart Home products and their connection and communication.

3.4 Communications Interfaces

ESGP will run locally. It does not require internet connection or communication protocols.

4 System Features

4.1 Categorizing Users

4.1.1 Description and Priority

Users should be able to indicate whether they are a Community User or an Encost User. Encost Users will have more features available to them than Community Users.

Priority: High

4.1.2 Stimulus/response Sequences

Stimulus: The application is started and the system prompts the user to indicate whether they are a Community User or an Encost User;

Response: The user provides their selection and the system stores the user-type (either “community” or “encost-unverified”) and outputs the ESGP Feature Options (for Community Users) or the ESGP Account Login prompt (for Encost Users).

¹<https://graphstream-project.org/>

4.1.3 Functional Requirements

- REQ-1 A prompt should be included that allows the user to indicate whether they are: (1) a member of the community; or (2) a member of Encost;
- REQ-2 The system should store the user-type that the user has selected (community or encost-unverified);
- REQ-3 Once the user has indicated which group they belong to, the system should provide them with the next prompt. For Community Users, the next prompt will be the ESGP Feature Options. For Encost Users, the next prompt will be the ESGP Account Login.

4.2 ESGP Account Login

4.2.1 Description and Priority

Encost employees should be able to login to the system to access additional features. A set number of login credentials will be created for this purpose.

Priority: High

4.2.2 Stimulus/response Sequences

Stimulus: An “encost-unverified” user logs into the system;

Response: The system updates the user-type to be “encost-verified” and provides the user with the ESGP Feature Options.

4.2.3 Functional Requirements

- REQ-1 The ESGP Account Login prompt should first prompt the user to enter their username. It should then prompt the user to enter their password;
- REQ-2 Once the username and password have been entered, the system should check that the inputs are valid;
- REQ-3 If the username and/or password are invalid, the system should inform the user that they have entered an invalid username and/or password and prompt them to enter their credentials again;
- REQ-4 If the username and password are valid, the system should update the user-type to be “encost-verified” and should provide the user with the ESGP Feature Options;
- REQ-5 Ten username and password pairs will be provided. The passwords should be encrypted before being stored in the application.

4.3 ESGP Feature Options

4.3.1 Description and Priority

Users should be able to select whether they want to (a) load a custom dataset; (b) visualise a graph representation of the data; or (c) view summary statistics.

Priority: High

4.3.2 Stimulus/response Sequences

Stimulus: The user selects a feature from the menu;

Response: The system moves to the next prompt, dependant on the feature that was selected.

4.3.3 Functional Requirements

REQ-1 The ESGP Feature Options prompt should provide the user with a selection of features that they can pick from. For a Community User there is only one feature available: visualising a graph representation of the data. For a verified Encost User there are three features: (a) loading a custom dataset; (b) visualising a graph representation of the data; or (c) viewing summary statistics;

REQ-2 Once the user has selected a feature, the system should provide them with the prompt/information for that feature.

4.4 Loading the Encost Smart Homes Dataset

4.4.1 Description and Priority

The system should be able to read and process the Encost Smart Homes Dataset.

Priority: High

4.4.2 Stimulus/response Sequences

Stimulus: A user elects to view a graph visualisation or summary statistics;

Response: The system opens, reads, and processes the Encost Smart Homes Dataset.

4.4.3 Functional Requirements

REQ-1 The Encost Smart Homes Dataset file should be located inside the system;

REQ-2 The system should know the default location of the Encost Smart Homes Dataset;

REQ-3 The system should be able to read the Encost Smart Homes Dataset line by line and extract the relevant device information (an example from the Encost Smart Homes Dataset is included below).

Device ID	Date Connected	Device name	Device type	Household ID	Router Connection	Sends	Receives
EWR-1234	01/04/22	Encost Router 360	Router	WKO-1234	-	Yes	Yes
ELB-4567	01/04/22	Encost Smart Bulb B22 (multi colour)	Light bulb	WKO-1234	EWR-1234	No	Yes
EK-9876	07/05/22	Encost Smart Jug	Kettle	WKO-1234	EWR-1234	No	Yes
EHC-2468	01/04/22	Encost Smart Hub 2.0	Hub/Controller	WKO-1234	EWR-1234	Yes	Yes

4.5 Loading Custom Datasets

4.5.1 Description and Priority

The system should be able to read and process custom datasets, so long as their format matches that of the Encost Smart Homes Dataset.

Priority: Low

4.5.2 Stimulus/response Sequences

Stimulus: A verified Encost User elects to load a custom dataset;

Response: The system opens, reads, and processes the custom dataset.

4.5.3 Functional Requirements

REQ-1 The system should prompt the user to enter the full file path for the custom dataset;

REQ-2 The system should attempt to read the custom dataset line by line and extract the relevant device information;

REQ-3 If the system fails to read and process the dataset (e.g. if the dataset is not formatted the same as the Encost Smart Homes Dataset) then the system should inform the user that the dataset is not compatible and allow them to (a) use the Encost Smart Homes Dataset or (b) enter a different file path.

4.6 Categorizing Smart Home Devices

4.6.1 Description and Priority

The system should be able to categorize each Encost Smart Device into one of five categories. These categories will be used for the graph visualisation and summary statistics.

Priority: High

4.6.2 Stimulus/response Sequences

Stimulus: The system opens, reads, and processes the Encost Smart Homes Dataset or a custom dataset;

Response: The system categorises each device and creates an object to store it in.

4.6.3 Functional Requirements

REQ-1 The system should determine the device category for each device, based on the information provided on each line of the Encost Smart Homes Dataset (or custom dataset). Device categories are shown in the table below;

REQ-2 The system should create an Object for each device. This object should hold all of the information for that device.

4.7 Building a Graph Data Type

4.7.1 Description and Priority

The system should create a graph data structure to store all of the Encost Smart Device Objects. This graph will be used to visualise the Encost Smart Devices and to generate summary statistics.

Priority: High

Device Category	Device types	Device Names
Encost Wifi Routers	Router, Extender	Encost Router 360, Encost Router Plus, Encost Wifi Range Extender 1.0, Encost Wifi Range Extender 2.0
Encost Hubs/- Controllers	Hub/Controller	Encost Smart Hub, Encost Smart Hub 2.0, Encost Smart Hub Mini
Encost Smart Lighting	Light Bulb, Strip Lighting, Other Lighting	Encost Smart Bulb B22 (white), Encost Smart Bulb B22 (multi colour), Encost Smart Bulb E26 (white), Encost Smart Bulb E26 (multi colour), Encost Strip Lighting (white), Encost Strip Lighting (multi colour), Encost Novelty Light (giraffe), Encost Novelty Light (lion), Encost Novelty Light (bear)
Encost Smart Appliances	Kettle, Toaster, Coffee Maker	Encost Smart Jug, Encost Smart Whistling Kettle, Encost Smart Toaster (2 slice), Encost Smart Toaster (4 slice), Encost Smart Coffee Maker, Encost Smart Coffee Maker Mini, Encost Smart Coffee Maker Pro
Encost Smart Whiteware	Washing Machine/Dryer, Refrigerator/Freezer, Dishwasher	Encost Smart Washer, Encost Smart Washer Pro, Encost Smart Dryer, Encost Smart Dryer Pro, Encost Smart Refrigerator, Encost Smart Freezer, Encost Smart Refrigerator/Freezer Combo, Encost Dishwasher, Encost Dishwasher Pro

4.7.2 Stimulus/response Sequences

Stimulus: The system categorises each device and creates an object to store it in;

Response: The system stores each object in a graph data structure.

4.7.3 Functional Requirements

REQ-1 Each Encost Smart Device Object should be stored in the graph data structure. The objects should be the nodes in the graph. The connection between objects should be the edges;

REQ-2 All unique datapoints should be included in the graph;

REQ-3 All households should be represented in the graph.

4.8 Graph Visualisation

4.8.1 Description and Priority

The system should allow the user to view a visualisation of the graph data structure.

Priority: High

4.8.2 Stimulus/response Sequences

Stimulus: The user selects “visualising a graph representation of the data” from the ESGP Feature Options;

Response: The system opens a UI window which shows a visualisation of the graph data structure.

4.8.3 Functional Requirements

REQ-1 The graph visualisation must be implemented using the GraphStream library;

REQ-2 The graph visualisation must show all nodes in the graph data structure;

REQ-3 The graph visualisation must show all connections between nodes (i.e. edges) in the graph data structure;

REQ-4 The graph visualisation must distinguish between different Device Categories. For example, Encost Smart Lighting nodes should be visually different to Encost Smart Appliances nodes, and so on;

REQ-5 The graph visualisation must, in some way, illustrate each device’s ability to send and receive commands from other devices. For example, it should be clear that an Encost Smart Hub 2.0 can both send and receive commands, while an Encost Smart Jug can receive commands but cannot send them.

4.9 Calculating Device Distribution

4.9.1 Description and Priority

The system should allow verified Encost Users to view the distribution of devices across category and type, based on the information stored in the graph data structure.

Priority: High

4.9.2 Stimulus/response Sequences

Stimulus: The user selects “viewing summary statistics” from the ESGP Feature Options;

Response: The system calculates the distribution of devices across category and type and displays the result to the user

4.9.3 Functional Requirements

REQ-1 The system should use the information stored in the graph data structure to calculate the number of devices that exist in each device category;

REQ-2 For each device category, the system should also calculate the number of devices that exist for each device type;

REQ-3 The system should output these figures to the console in a clear and concise manner.

4.10 Calculating Device Location

4.10.1 Description and Priority

The system should allow verified Encost Users to view the location of devices, both geographically and across households.

Priority: Medium

4.10.2 Stimulus/response Sequences

Stimulus: The user selects “viewing summary statistics” from the ESGP Feature Options;

Response: The system calculates the location of devices and displays the result to the user.

4.10.3 Functional Requirements

REQ-1 The system should use the information stored in the graph data structure to calculate the number of households that exist in each region in New Zealand. Names and codes are listed as in the ISO 3166-2 standard published by the ISO 3166 Maintenance Agency (ISO 3166/MA)¹;

REQ-2 The system should use the information stored in the graph data structure to calculate the number of devices that exist in each region in New Zealand;

REQ-3 The system should use the information stored in the graph data structure to calculate the number of devices that exist in each household, in each region in New Zealand;

REQ-4 The system should use the information stored in the graph data structure to calculate the number of devices in each category, for each household, in each region in New Zealand;

REQ-5 The system should use the information stored in the graph data structure to calculate the number of devices in each category, for each region in New Zealand;

¹https://en.wikipedia.org/wiki/ISO_3166-2:NZ

REQ-6 The system should output these figures to the console in a clear and concise manner.

4.11 Calculating Device Connectivity

4.11.1 Description and Priority

The system should allow verified Encost Users to view the connection and communication between devices.

Priority: Medium

4.11.2 Stimulus/response Sequences

Stimulus: The user selects “viewing summary statistics” from the ESGP Feature Options;

Response: The system calculates the connection and communication between devices and displays the result to the user

4.11.3 Functional Requirements

REQ-1 The system should use the information stored in the graph data structure to calculate the average number of devices that an Encost Wifi Router is connected to;

REQ-2 The system should use the information stored in the graph data structure to calculate the minimum number and maximum number of devices that an Encost Wifi Router is connected to;

REQ-3 The system should use the information stored in the graph data structure to calculate the average number of Encost Hubs/Controllers that an Encost Smart Device is receiving commands from;

REQ-4 The system should use the information stored in the graph data structure to calculate the minimum number and maximum number of Encost Hubs/Controllers that an Encost Smart Device is receiving commands from;

REQ-5 The system should use the information stored in the graph data structure to calculate the average number of Encost Smart devices that an Encost Hub/Controller is sending commands to;

REQ-6 The system should use the information stored in the graph data structure to calculate the minimum number and maximum number of Encost Smart devices that an Encost Hub/Controller is sending commands to;

REQ-7 The system should output these figures to the console in a clear and concise manner.

5 Other Nonfunctional Requirements

5.1 Performance Requirements

5.1.1 Response Times

- 5.1.1.a The Encost Smart Homes Dataset should take no more than 10 seconds to load and process. Should the process take more than one second, feedback should be given to the user;
- 5.1.1.b The graph visualisation should take no more than five seconds to display. Should the process take more than one second, feedback should be given to the user;
- 5.1.1.c Calculating device distribution should take no more than 10 seconds to load. Should the process take more than one second, feedback should be given to the user;
- 5.1.1.d Calculating device location should take no more than 10 seconds to load. Should the process take more than one second to load, feedback should be given to the user;
- 5.1.1.e Calculating device connectivity should take no more than 10 seconds to load. Should the process take more than one second, feedback should be given to the user.

5.2 Security Requirements

5.2.1 User Authentication

- 5.2.1.a Encost employees should be able to login to the system to access additional features;
- 5.2.1.b Ten username and password pairs will be provided for this purpose;
- 5.2.1.c The passwords should be encrypted before being stored in the application;
- 5.2.1.d Any passwords entered by Encost users during login should be encrypted and compared against the encrypted passwords stored in the system.

5.2.2 Data Anonymity

- 5.2.2.a The Encost Smart Homes Dataset will be anonymised before use with this system;
- 5.2.2.b All other custom datasets must be anonymised before they can be used with this system.

5.3 Software Quality Attributes

5.3.1 Reliability

- 5.3.2.a Data loss must be prevented as much as possible;
- 5.3.2.b Backups of the source code should be made daily.

5.3.2 Interoperability

- 5.2.1.a UTF8 encoding should be used;
- 5.2.1.b The product must be available on all operating systems specified in 2.3.

5.3.3 Usability

- 5.2.1.a Textual layout must be clear and readable;
- 5.2.1.b Language must be concise and easy to understand;
- 5.2.1.c User input options must be easy to understand;
- 5.2.1.d Error messages and feedback should be informative.

6 Other Requirements

No other requirements have been identified at this time. This document may be revised throughout the software engineering process. However, an entry must be added to the Revision History for any revision that occurs.