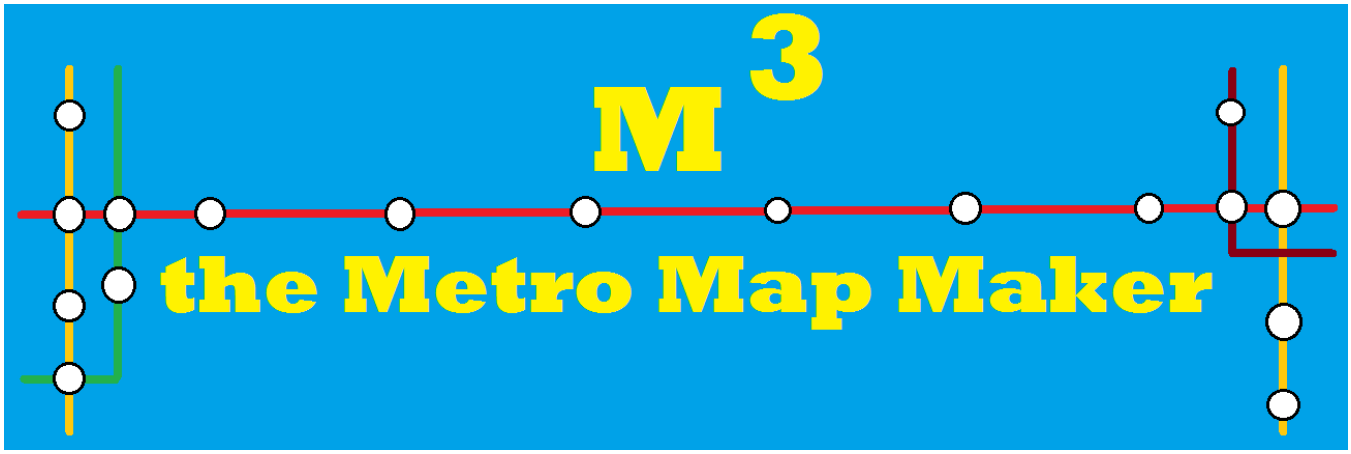
The *Metro Map Maker* TM0

Software Design Description



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Based on IEEE Std for IT - SDD (IEEE 1016-2009) document format

1 Introduction

The ***Metro Map Maker (i.e. M^3)*** application will provide a set of tools to build graphical representations of subway with named (intersecting) lines, stops and landmarks. It will also provide a calculating system, which gives the best route between two stations. Finally, it will provide an export feature such that it exports a generated map with related information which can be used by a corresponding Web application.

1.1 Purpose

The purpose of this software design document is to provide a low-level description of the Metro Map Maker (i.e M3) application, providing insight into the inner structure and design of each component described in the Software Requirements Specification. This document will cover class hierarchies and interactions, data flow and design, algorithmic models and user interface design.

1.2 Scope

For this project the goal is for users to provide functions that can be easily used to make and edit their own subway maps. Also, this application provides a common export format such that all maps can be used by a uniform application.

1.3 Definitions, acronyms, and abbreviations

Framework – In an object-oriented language, a collection of classes and interfaces that collectively provide a service for building applications or additional frameworks all with a common need.

GUI – Graphical User Interface, visual controls like buttons inside a window in a software application that collectively allow the user to operate the program.

IEEE– Institute of Electrical and Electronics Engineers, the "world's largest professional association for the advancement of technology".

Java– the default scripting language of the Web, Java is provided to pages in the form of text files with code that can be loaded and executed when a page loads so as to dynamically generate page content in the DOM.

Model View Controller– a software architectural pattern, which divides a given application into three interconnected parts (Model, View and Controller).

Stylesheet – a static text file employed by HTML pages that can control the colors, fonts, layout and other style components in a Web page.

UML – Unified Modeling Language, a standard set of document formats for designing software

graphically.

Use Case Diagram – A UML document format that specifies how a user will interact with a system.

User Interface – the space where user directly interact with an application through specific features.

1.4 References

IEEE Standard for Information Technology - Systems Design - Software Design Descriptions (IEEE 1016-2009)

1.5 Overview

This SDD will specify how the ***Metro Map Maker*** application will be constructed, through inner structure and design of each component, which contribute to building functions described in SRS. In this application, there are three major classes: Workspace class which is the user interface, EditController class that notifies Data class to make changes, and Data that implements specific methods to modify data. To sum up, the EditController class updates the Data class, which modifies the Workspace class. This document is organized in general-to-specific order: Section 2 of this document will provide the general description of application and its Java API Usage, with package-level design viewpoint. Section 3 will present how classes will be organized and interact between them. Section 4 will present how each method will be implemented to build specific function. Section 5 provides a Table of Contents, an Index, and References. To sum up, classes (Section 3) contain methods to build specific functions (Section 4), which are based on Java API(Section 2).

2 Package-Level Design Viewpoint

2.1 Metro Map Maker overview

The goal of ***Metro Map Maker*** is not only allowing users to make their own subway maps adapted to the personal needs, but also being a site where users can exchange their maps between them such that the entire community view the map and plot routes. Shape means lines and stations with corresponding JSON files describing the contents.

2.2 Java API Usage

This is the list of Java API used.

javafx
javafx.beans.value
- javafx.beans.value.ChangeListener;
- javafx.beans.value.ObservableValue;

javafx.collections.ObservableList

- javafx.collections.ObservableList;

javafx.scene
- javafx.scene.paint
- javafx.scene.shape
- javafx.scene.effect
- javafx.scene.layout
- javafx.scene.text
- javafx.scene.image
- javafx.scene.Node
- javafx.scene.Cursor
- javafx.scene.Scene
- javafx.scene.shape.Shape

javafx.stage
- javafx.stage.FileChooser;

java.io
- java.io.FileInputStream;
- java.io.FileOutputStream;
- java.io.IOException;
- java.io.InputStream;
- java.io.OutputStream;
- java.io.PrintWriter;
- java.io.StringWriter;
- java.io.BufferedReader;
- java.io.BufferedWriter;
- java.io.File;
- java.io.FileReader;
- java.io.FileWriter;

java.util
- java.util.HashMap
- java.util.Map
- java.util.ArrayList
- java.util.List;
- java.util.Optional;

javax
javax.imageio

javax.json
- javax.json.Json;
- javax.json.JsonArray;
- javax.json.JsonArrayBuilder;
- javax.json.JsonNumber;

- javax.json.JsonObject;
- javax.json.JsonReader;
- javax.json.JsonValue;
- javax.json.JsonWriter;
- javax.json.JsonWriterFactory;
- javax.json.stream.JsonGenerator;

2.3 Java API Usage Descriptions

javafx
javafx.beans.value
- ChangeListener and **ObservableValue** interfaces are used in CanvasController class to detect changes of choices in comboBox of user interface.

javafx.collections
- Contains the essential JavaFX collections and collection utilities. Used to store Node of shapes in ObservableList<Node>.

javafx.scene
- Provides the core set of base classes for the JavaFX Scene Graph API. Used to visualize UI throughout the application.

javafx.stage
-Provides the top-level container classes for JavaFX content. FileChooser is used to let user choose the image file to add in Workspace.

java.io
-Provides for system input and output through data streams, serialization and the file system. Used to read, modify and save shapes with details.

java.util
-Contains the collections framework, legacy collection classes, event model, date and time facilities, internationalization, and etc. Mainly, ArrayList is used in Workspace class to store language choices. HashMap is used in Files to store shapes using keys.

javax
javax.imageio
-Contains the basic classes and interfaces for describing the contents of image files, including metadata and thumbnails (IIOImage). In this application, this is used to control image writing process to process a snapshot in EditController class.

javax.json
-Provides immutable object models for JSON object and array structures. In this application, lines, stations with details are stored in JSON formats with JsonObject and JsonArray in Files class.

3 Class-Level Design Viewpoint

At first, the design with Line class and Stations class, interacting directly with Workspace class was considered. But the problem was that classes were too dependent to each other, with high coupling. To fix this problem of high coupling, classes are designed in Model View Controller structure (MVC), such that the controller updates the models, and the models modify the view (Figure 1). In addition, two interfaces Draggable and CoordinateTransformer allow the application to drag shapes, to zoom in/out and rotate the view (Figure 3). In this application, EditController class updates Data class, which modifies Workspace class (Figure 2). The dissociation of the data and the user interface makes the application more cohesive but difficult to implement. However, this architecture can be limited in terms of control and manipulation of data, such as stations or lines in this project.

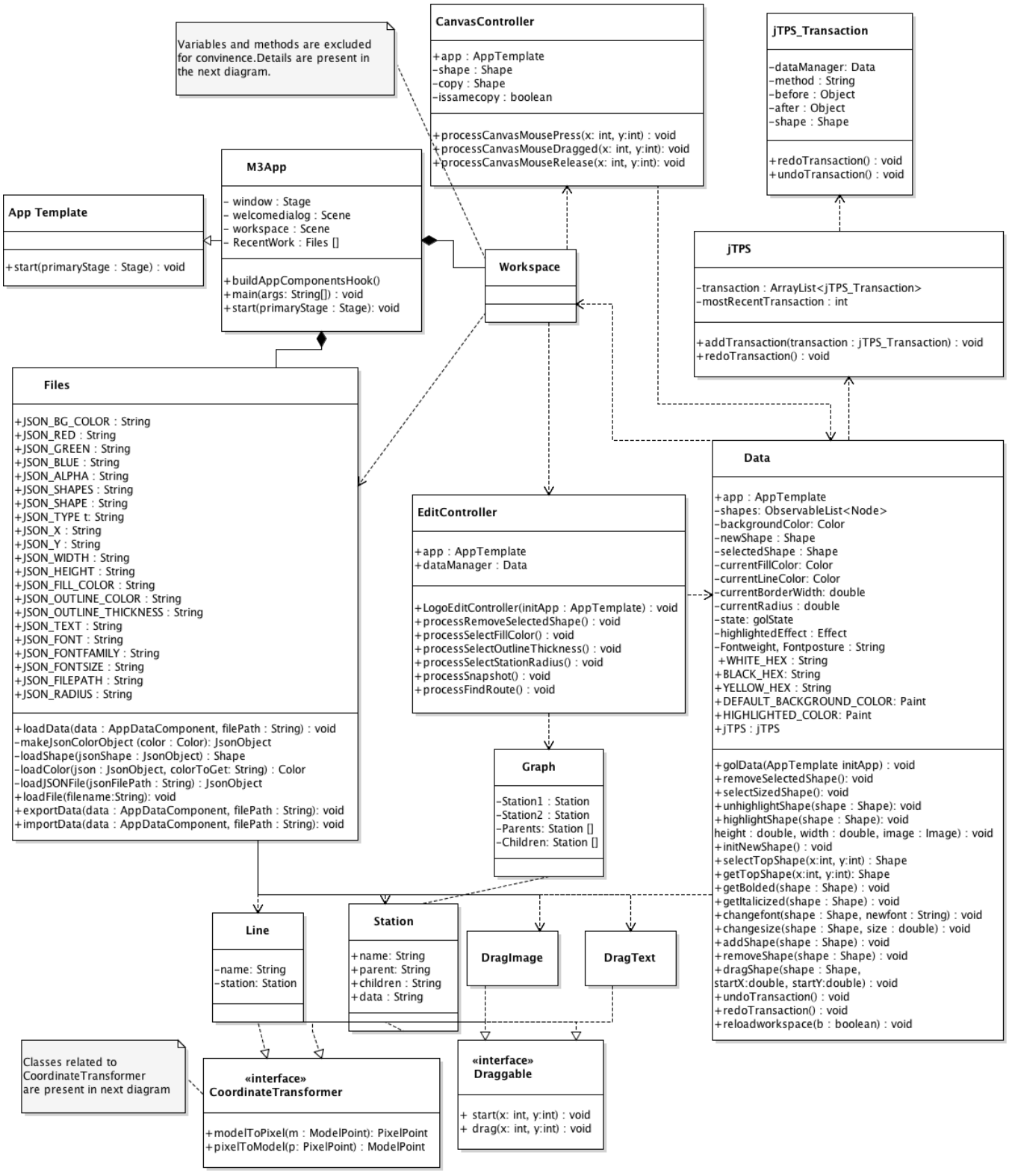

Figure 1. General Class Diagram

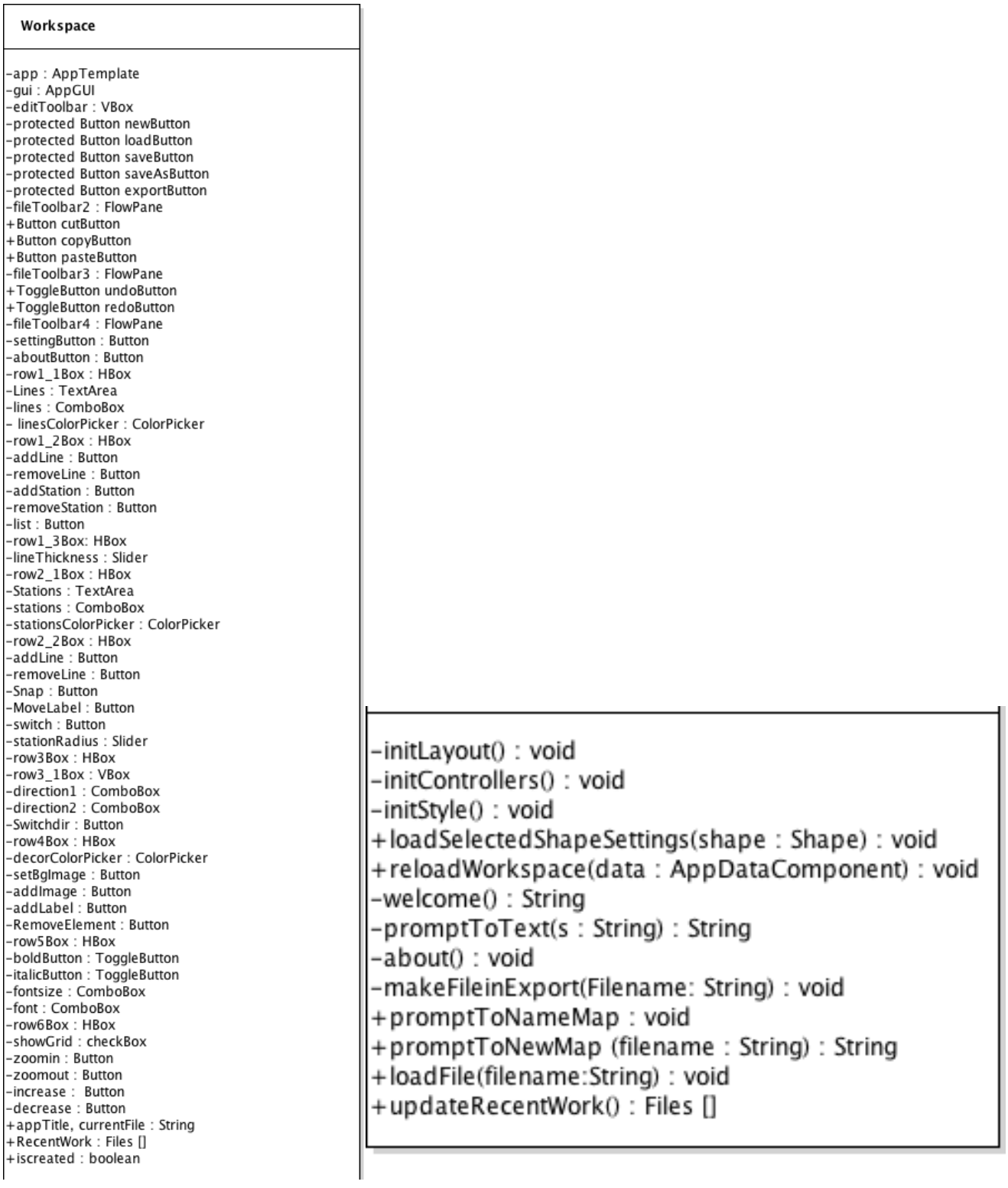

Figure 2. Workspace Class Diagram

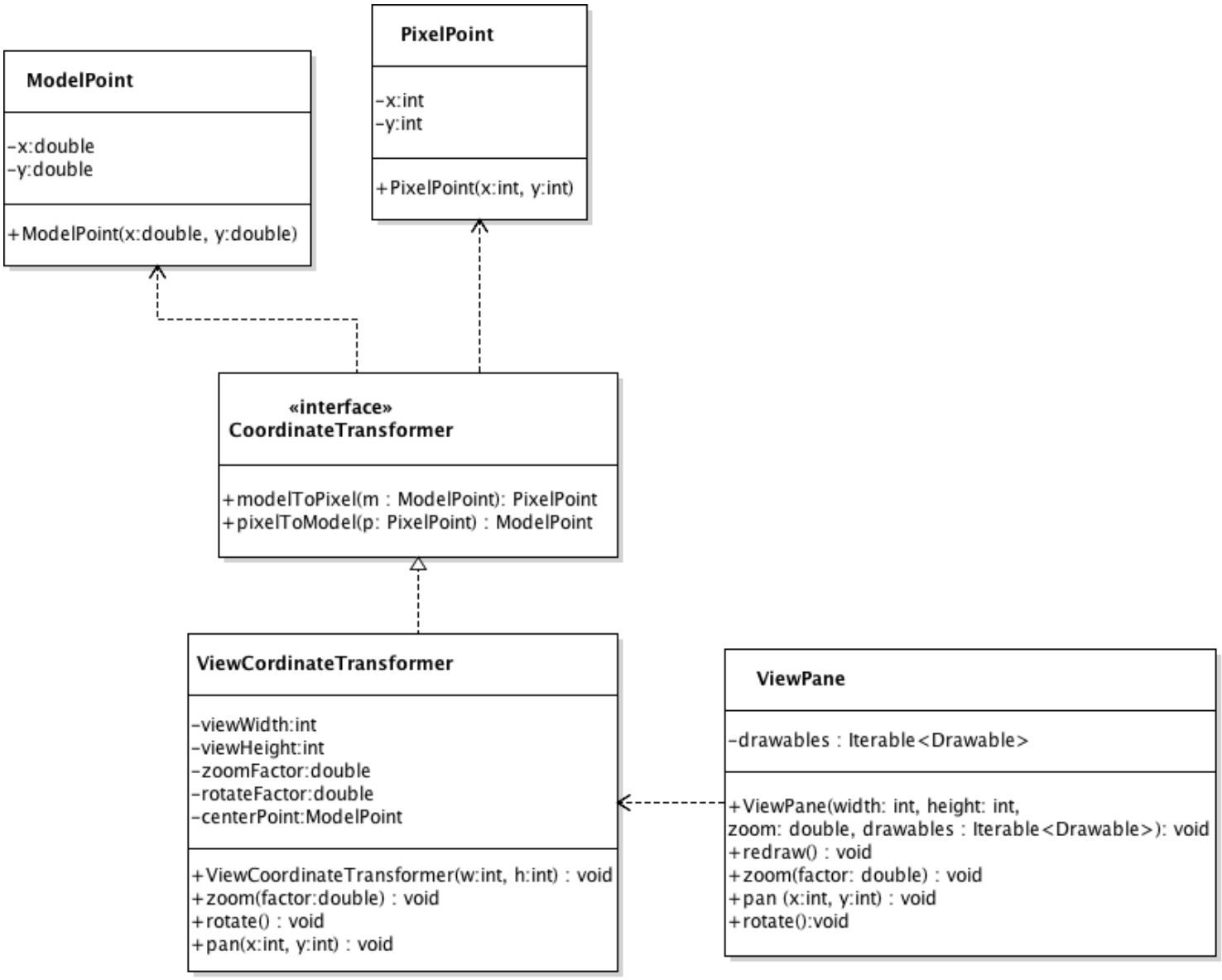

Figure 3. ViewCoordinateTransformer Class Diagram

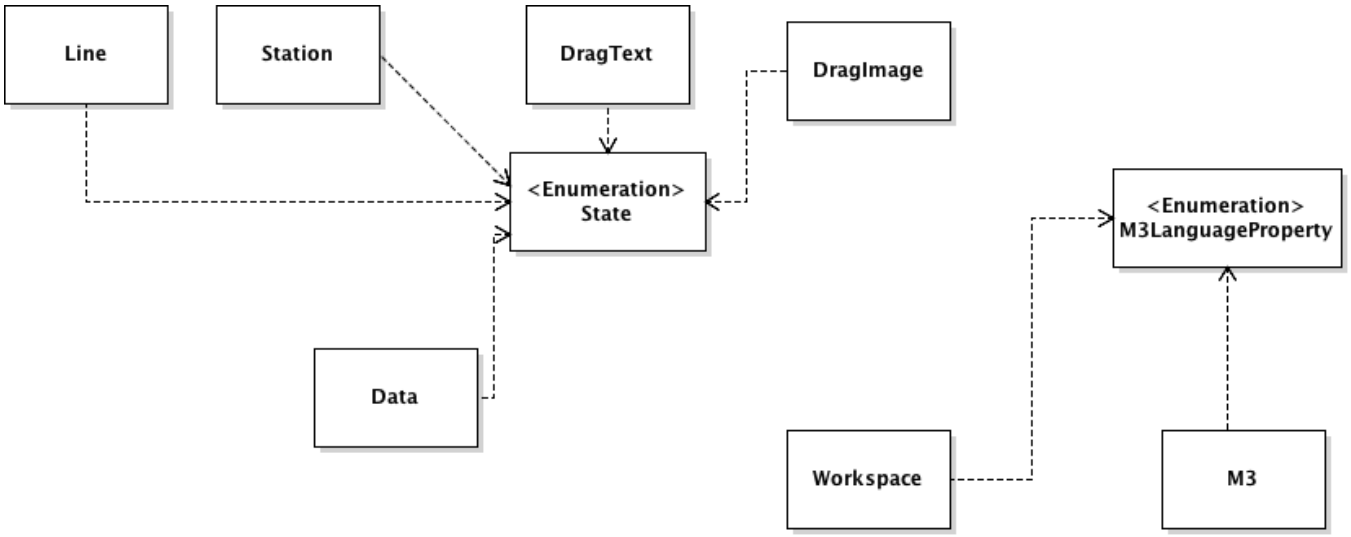

Figure 4. Enumeration Classes Diagram with simplified Classes

4 Method-Level Design Viewpoint

Overall, the goal of method level design is the high cohesion and low coupling. This design containing a lot of classes is easy to implement compared to other designs with less classes. However, the variability of data (text, shape etc) and types of file (png, json etc) makes lots of interaction between classes to make data and files convertible.

Following figures illustrate UML sequence diagrams for principle methods.

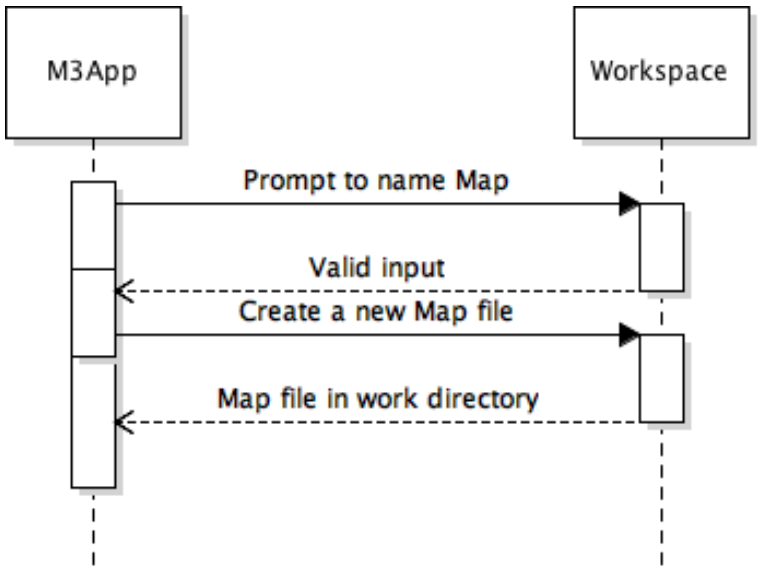

Figure 5. Sequence Diagram for Use case 2.1 Create New Map

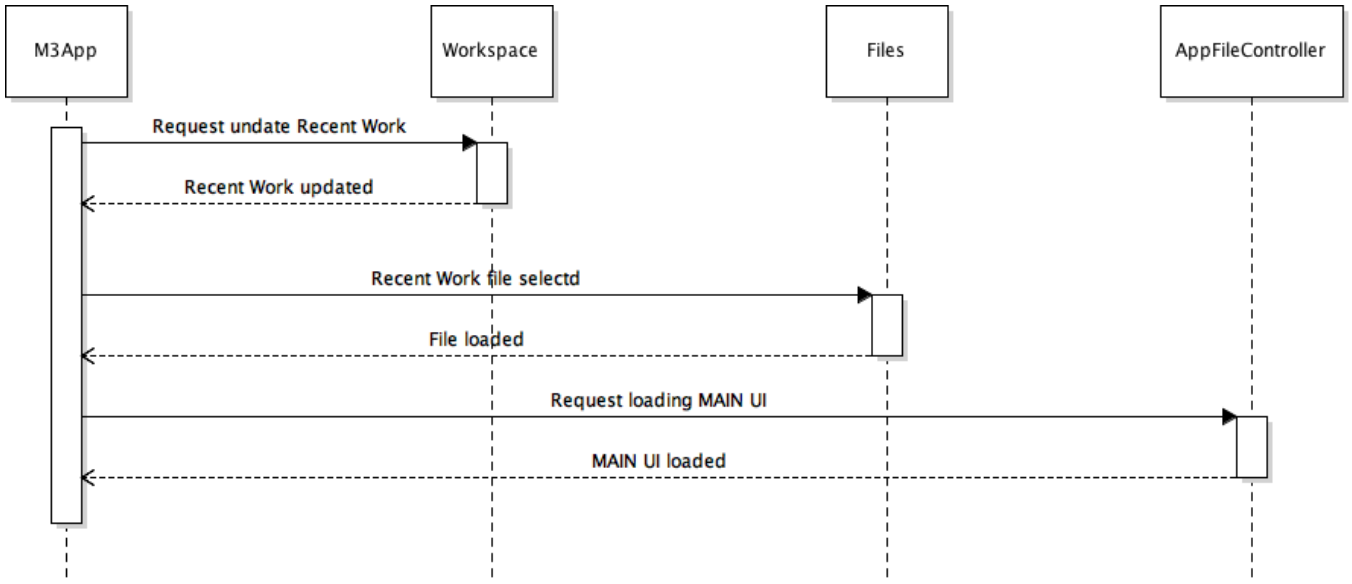

Figure 6. Sequence Diagram for Use case 2.2 Select Recent Map to Load

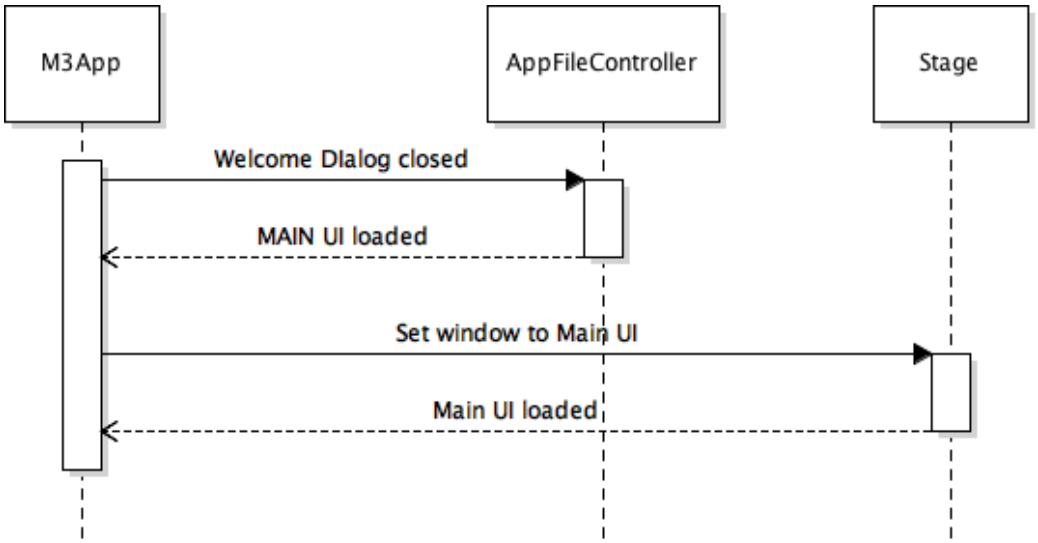

Figure 7. Sequence Diagram for Use case 2.3 Close Welcome Dialog

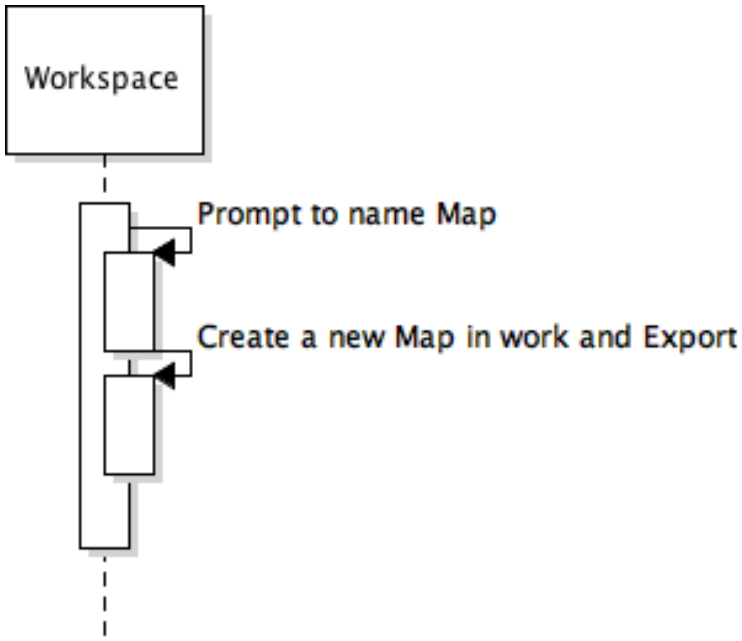

Figure 8. Sequence Diagram for Use case 2.4 Create New Map

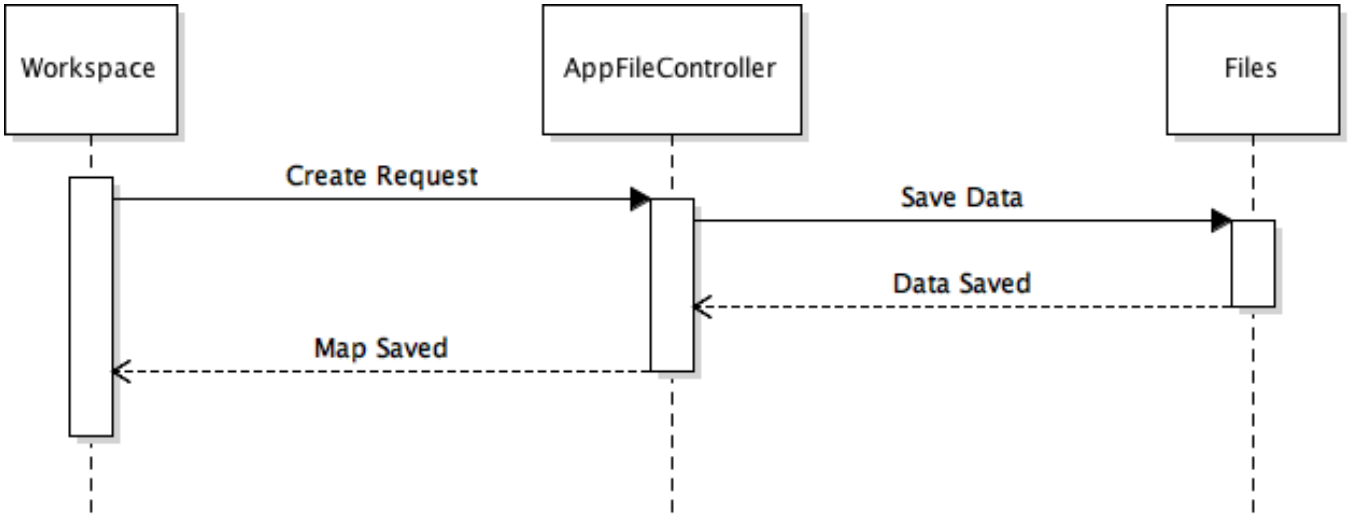

Figure 9. Sequence Diagram for Use case 2.6 Save Map

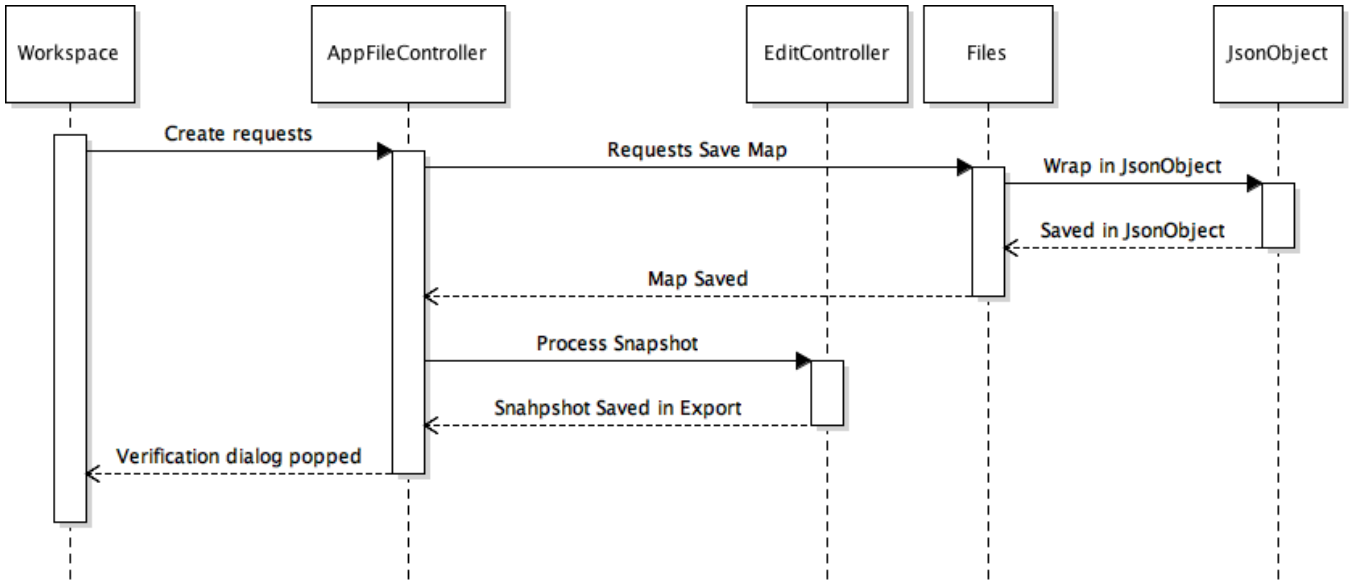

Figure 10. Sequence Diagram for Use case 2.8 Export Map

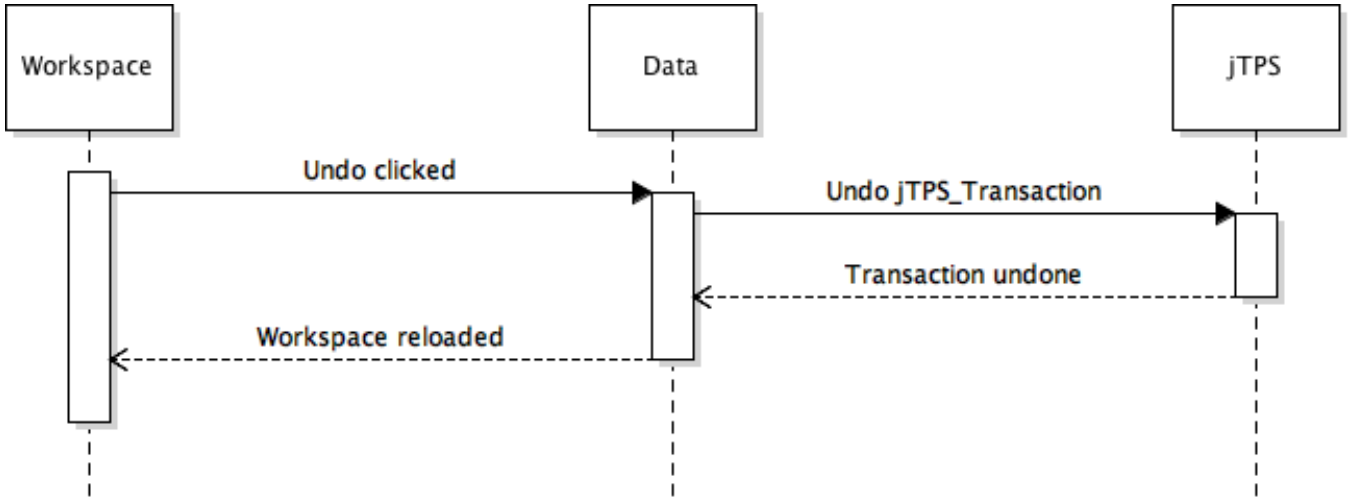

Figure 11. Sequence Diagram for Use case 2.9 Redo Edit

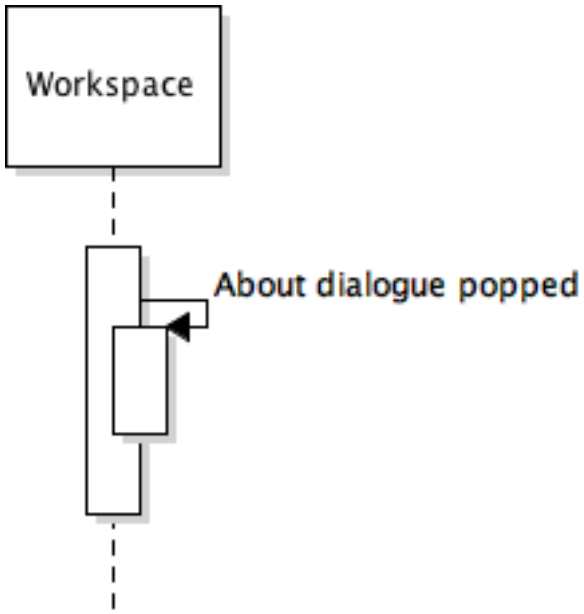

Figure 12. Sequence Diagram for Use case 2.11 Learn About Application

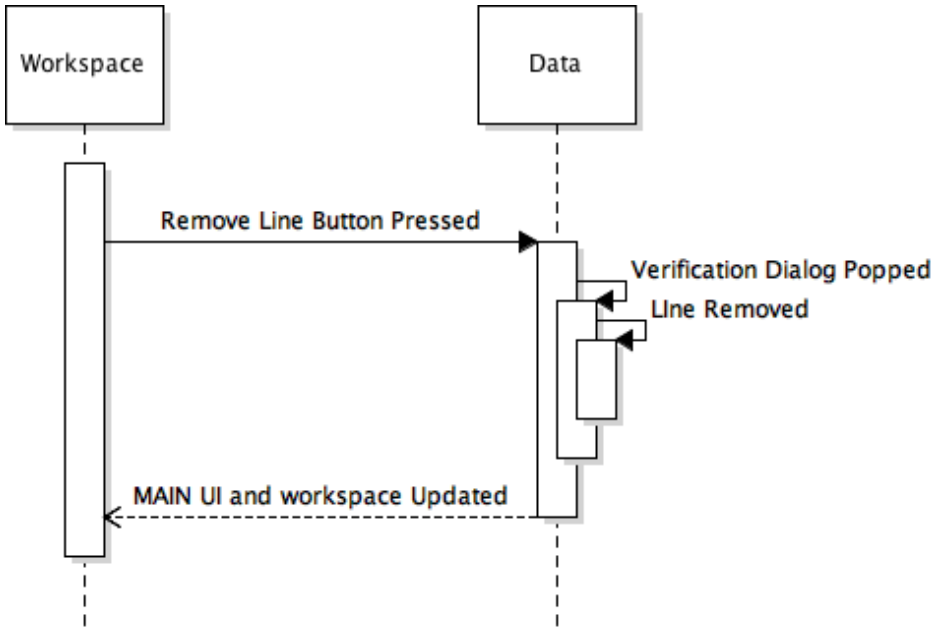

Figure 13. Sequence Diagram for Use case 2.13 Remove Line

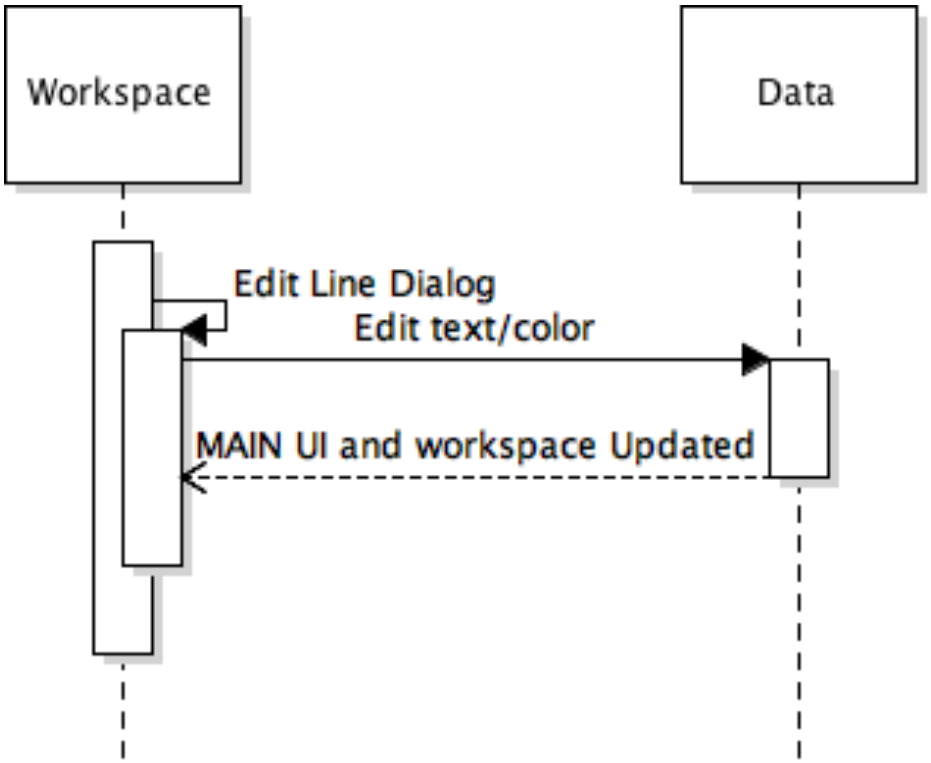

Figure 14. Sequence Diagram for Use case 2.14 Edit Line

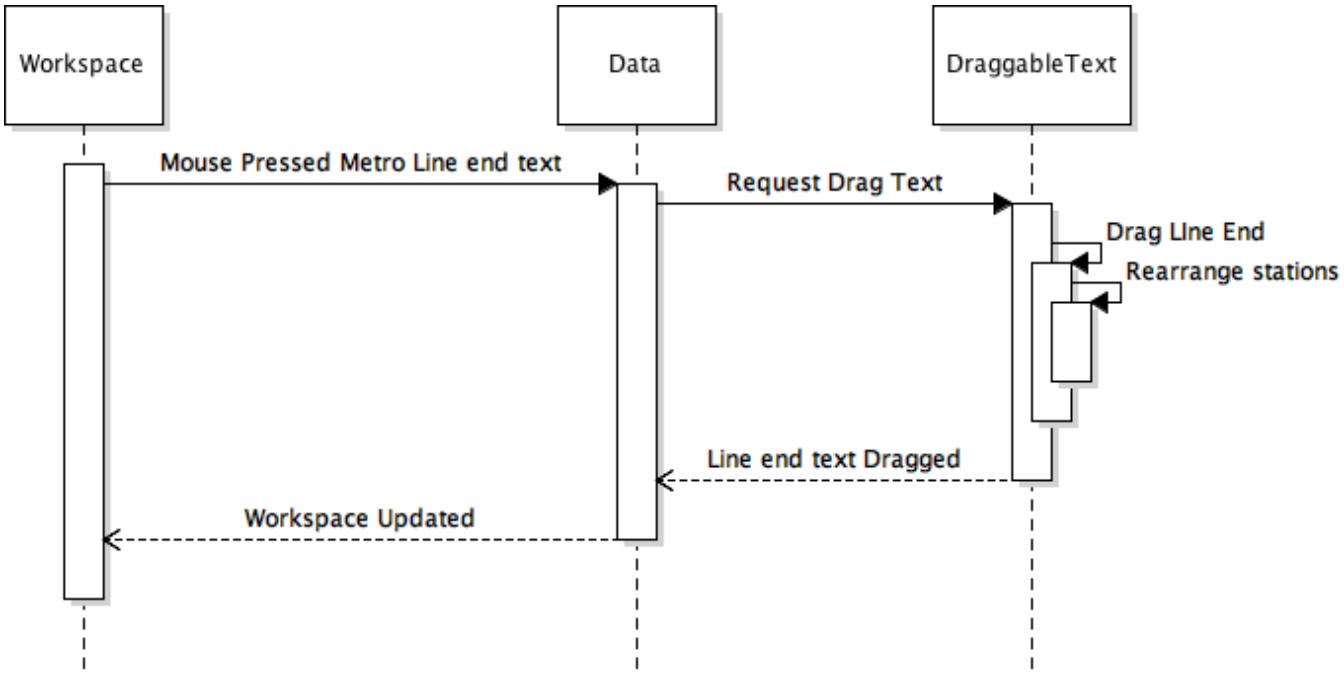

Figure 15. Sequence Diagram for Use case 2.15 Move Line End

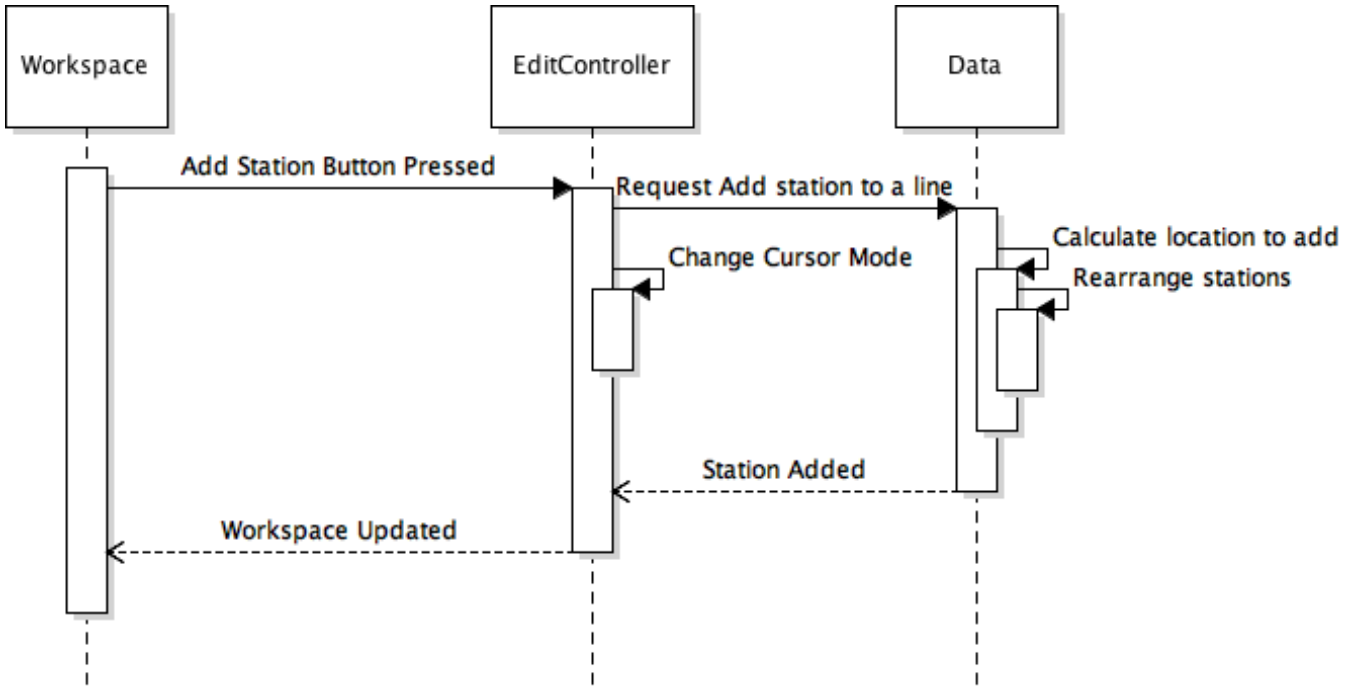

Figure 16. Sequence Diagram for Use case 2.16 Add Station to Line

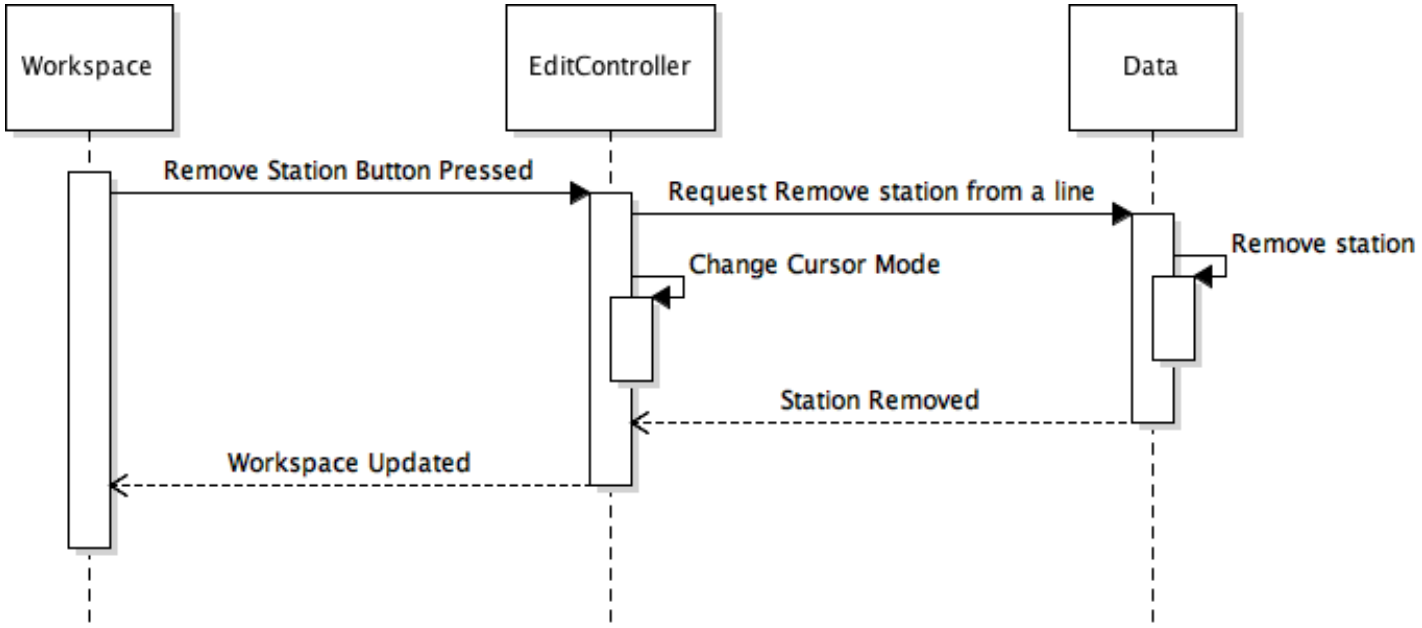

Figure 17. Sequence Diagram for Use case 2.17 Remove Station from Line

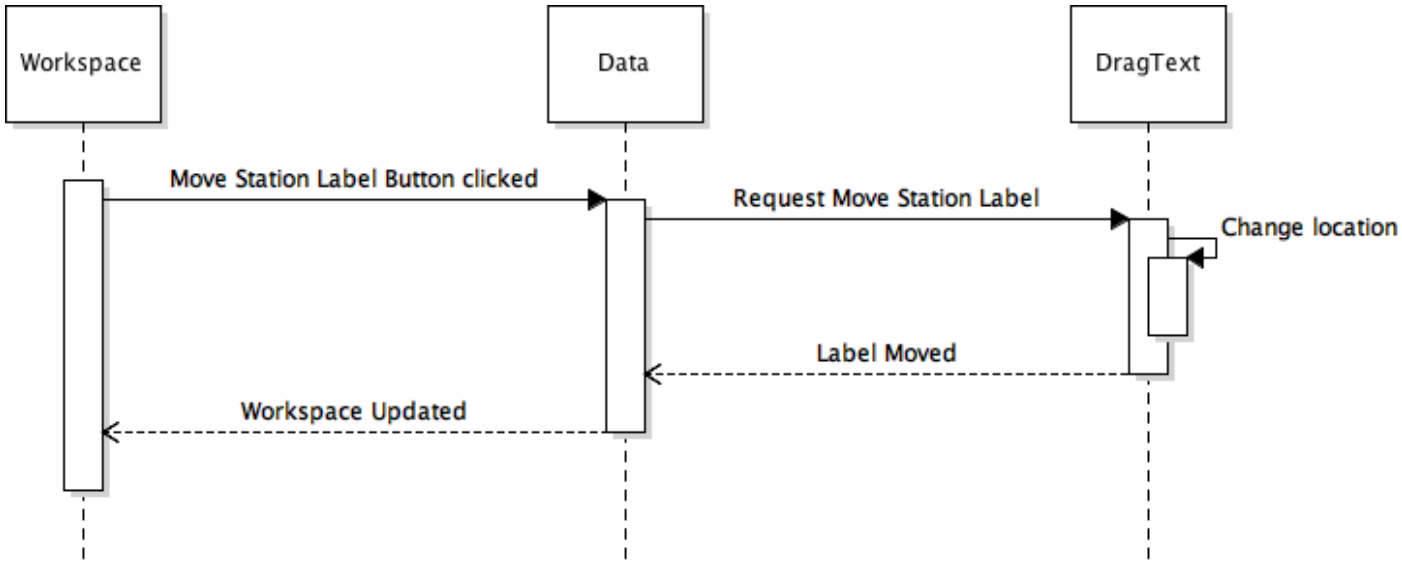

Figure 18. Sequence Diagram for Use case 2.23 Move Station Label

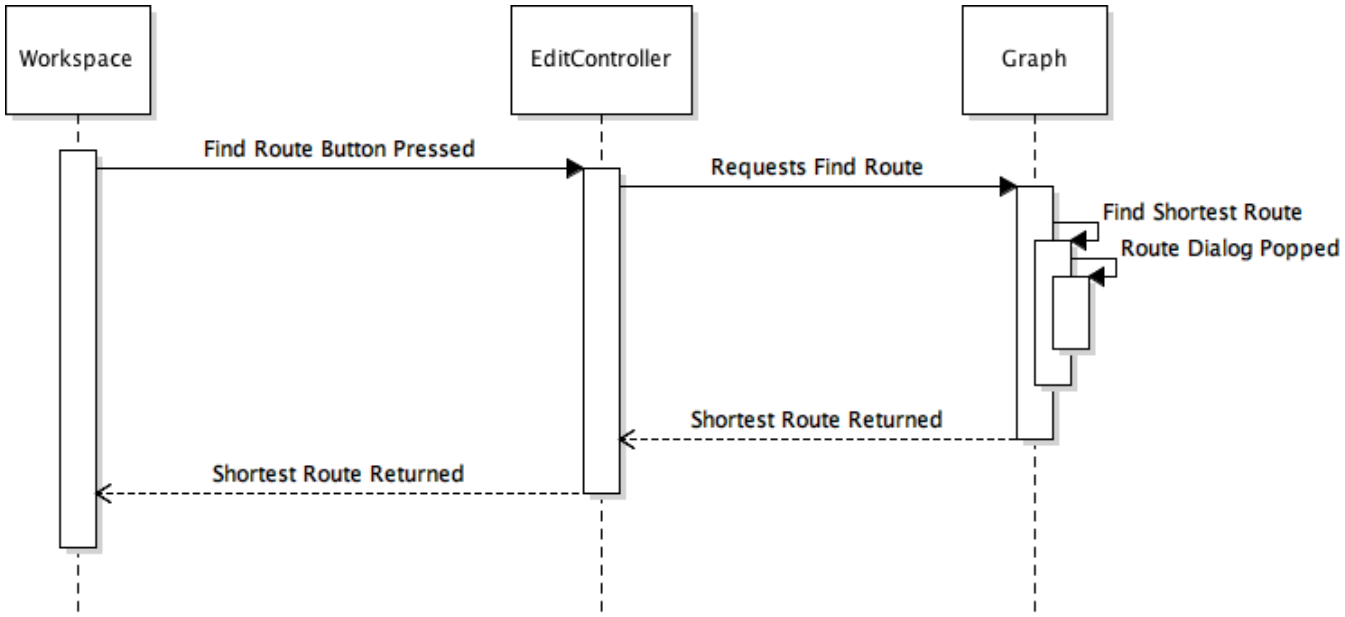

Figure 19. Sequence Diagram for Use case 2.27 Find Route

5 File Structure and Formats

In this application, files are stored in JSON format. Each data (type, font, text, size etc) is boxed in JSON Object using attributes, and stored in JsonArray with ObjectBuilder. To read data in JSON files,

the application uses JsonReader to read data by unboxing JSON Object in Files class. Writing and exporting JSON files works in the same way. To write and export JSON files, the application boxes data, creating JsonObject and storing it in JsonArray.
Following Figure is a sample of Map.json file.


```
{
    "background_color":{
        "red":0.0,
        "green":0.0,
        "blue":0.0,
        "alpha":1.0
    },
    "shapes":[
        {
            "type":"TEXT",
            "x":250.0,
            "y":400.0,
            "width":5.0,
            "height":200.0,
            "fill_color":{
                "red":1.0,
                "green":1.0,
                "blue":1.0,
                "alpha":1.0
            },
            "outline_color":{
                "red":0.0,
                "green":0.0,
                "blue":0.0,
                "alpha":1.0
            },
            "outline_thickness":6.0
        }
    ]
```


Figure 20. Sample file of Map.json

6 Supporting Information

Note that this document should serve as a base design for the software engineers to guide them in the future stages of the development process, so we'll provide a table of contents to help quickly find important sections.

6.1 Table of contents

Table of Contents

6.2 Appendixes

N/A