File Backup and Management System

Milestone 6

Submitted by:

Group 06

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Abstract

The *File Backup or Management System*, henceforth referred to as **FBMS**, is a system for backing up files while maintaining revisions. FBMS monitors the file operations that take place within the folder that the user wants to backup (called the "live directory"). Not only are file changes copied to the specified backup directory, but revisions (the instance of the file at a given time) are stored in a database, allowing the program to restore the file's state from any point of time.

FBMS works on all locally accessible drives, including external drives and network drives. The revisioning creates a patch file for plain text, keeping file size down. For binary files, the entire file is stored as the revision. This revisioning ensures not only are the user's files safe, but erroneous changes can be reverted.

FBMS has a focus on ease of use. A wizard guides the user through the setup, where the backup and live directories are chosen. With that complete, the program will run in the background and needs no user interaction until the use desires to restore or view files from the backup.

Contents

1 Introduction

1.1 System description

FBMS is an automated backup and revision program. The user specifies a folder that they want to keep backed up (the "live directory") and the location to store the backup (the "backup directory"). The program automatically copies changes in the live directory to the backup directory. Revisions are automatically created by creating "patch" files for every change.

Thus, not only is the user's data backed up, but older versions of the data are also backed up. FBMS can be thought of as a hybrid of a local-only Dropbox[1] and a version control system. While it's not as customizable as a version control system like SVN[2] or git[3], FBMS is easy to use and runs in the background without the need for user interaction.

FBMS backs up and revisions both plain text and binary files. A maximum file size to backup can be set. It's also possible to configure the system to remove revisions older than a certain date.

1.2 Business case

FBMS helps ensure the user's files are safely backed up without having to depend on limited cloud-based services or the complexity of programs like SVN[2]. Programs like Dropbox[1] keep revisions of files, but are limited in their ability to do so. FBMS removes these shackles, limiting you only by your hard drive capacity. FBMS currently supports multiple drive systems, including network drives, filling in the blanks of programs like Dropbox, which are online only.

FBMS differs itself from other backup systems in how it doesn't just backup files, but keeps revisions for safety. FBMS is targeted as the semi-casual audience, who know enough to understand the need for backups, but don't want to use a version control system (or perhaps don't like using such systems). The program is low effort to setup and requires no struggling with command line utilities. Once it's setup, it can run quietly in the background until you need it.

1.3 User-level goals for the system

A simple to use backup solution for a user's files.

1. Ability to back up a folder easily.
2. Iterative backup that allows specific versions to be restored.
3. User can specify any locally available drive (including external and network drives) to serve as the backup or live directory.

A file versioning and backup solution for their files.

1. User can recover deleted/lost files.
2. User can revert to a prior version of a file.
3. User can view a revision history of the file.

Gives users a lightweight multi-platform software solution.

1. Able to use this same software on various operating systems due to Java architecture.
2. Once setup, it runs in the background unobtrusively until needed.
3. Tested on Windows and Linux (no OS X support)

1.4 User scenarios

A user wants to backup files:

The user will start up the software. The first start wizard will guide the user through setting the live and backup directories. With that done, the system will perform a startup scan, grabbing any files not already in the backup directory. With this done, the software can monitor the file system for changes and act accordingly.

User has lost the live directory:

User can reinstall the software and specify the existing backup directory. From the GUI, the user can restore the entire backup directory and can set the live directory again.

User has accidentally deleted a file:

The user can bring up the user interface for our program. They then select the file in question which brings up a list of prior revisions that have been stored. The user can then select the revision they desire to restore and the program will restore it to its directory.

User wants to minimize file sizes:

The program offers two features to reduce the storage impact of the system. One is to set the maximum file size that is revisioned (defaults to 5 MB). Files larger than this will be backed up, but will not have versions stored. Another is to enable the trim features (disabled by default). Trim will remove all revisions older than a specified number of days. Both of these features are configured in the settings dialog, accessed via the GUI menus.

1.5 Scope document

- A front end GUI for the user to specify files to be watched or restored.
- File monitoring system that makes notes of changes including creation, deletion and renaming.
- Database that stores file change history and relevant details about the file.

- Patch creation and application engine (for handling revisions of text files).
- Ability to maintain a backup of the latest revision to a designated drive.
- Ability to restore a file from a specified revision. This includes deleted or renamed files.
- Option to restore all files from the backup.
- Ability to revision binary files (the full content of the file is stored).
- A settings dialog for managing configuration for the program.
- Ability to change the live and backup directories.
- Features for removing old revisions and not revisioning up large files.

1.6 Project plan / Rough estimates

Our plan for our project was to take a concurrent engineering approach with some agile methods, such as SCRUM-like meetings and iterative design. We split the project into stages based on the estimated priority of certain features. For example, the file patching was a high priority feature, since the system revolved that feature. With priority figured out, the project was further subdivided amongst our group members.

For the most part, group members worked alone. The assignment of components was made to try and balance familiarity with diversity. We wanted the group members to focus on some areas, allowing them to become proficient at that area. For example, Butler focused on the file change handlers, while Rizvi focused on the GUI. But to prevent the group members from being too specific (and thus blind to the other areas of the project), we also diversified our sections. For example, Butler also worked with the database and Rizvi also worked with the data retriever.

We only had initial estimates for version 1.0 of the program, which was our base goal. In that, we estimated approximately 25 hours of work per group member for a total of 125 man hours of work on the project.

However, we ended up adding many features to our project that were not originally planned. For example, we had not allocated time for the first run wizard, initially. These extra features caused the actual time spent on the project to well exceed the initial estimate. The rough estimate was a slight overestimate for the initially planned features.

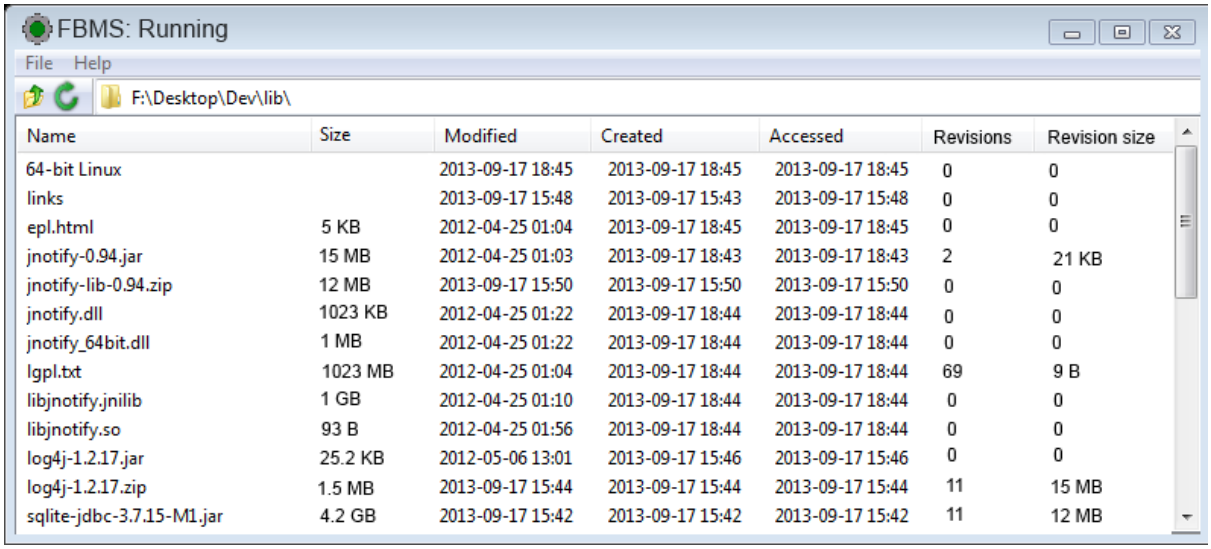
1.7 User involvement plan

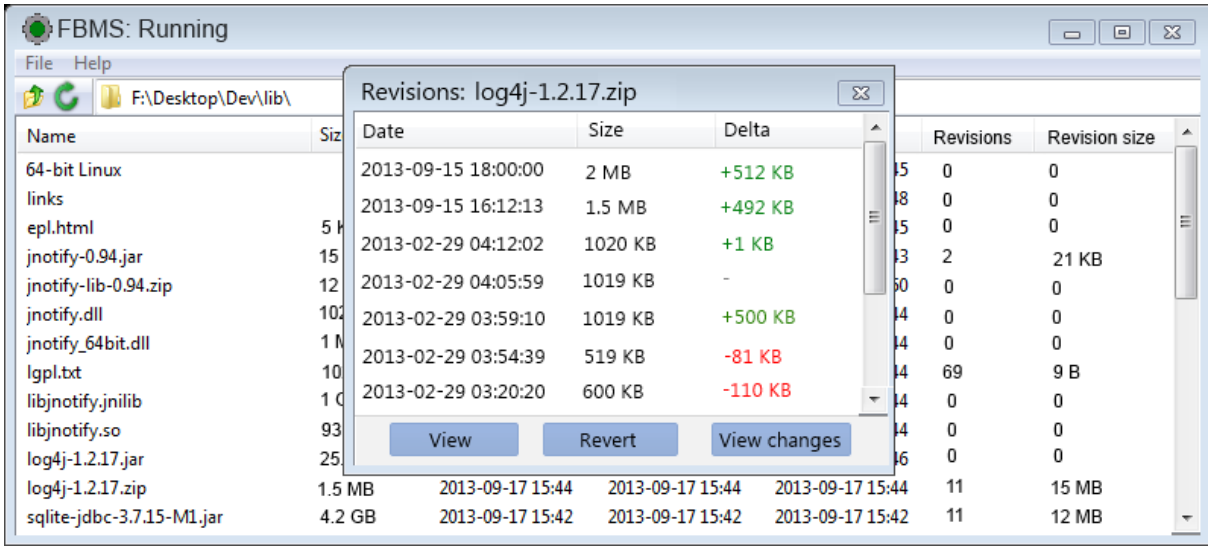
We designed the system with rational uses in mind. Thus, we are not just the system's creators, but also the system's users. This eliminates the need for a dedicated user. Planning was done both individually and together, collaborating on ideas for both the system's use cases and interior workings.

The time used from these users was heavily invested in the planning stage, going through several thousand words of planning. We also used user feedback heavily in revising the project. We made many changes to the project based on user feedback, including better display of errors, a wizard for the first run, and a greater deal of configuration.

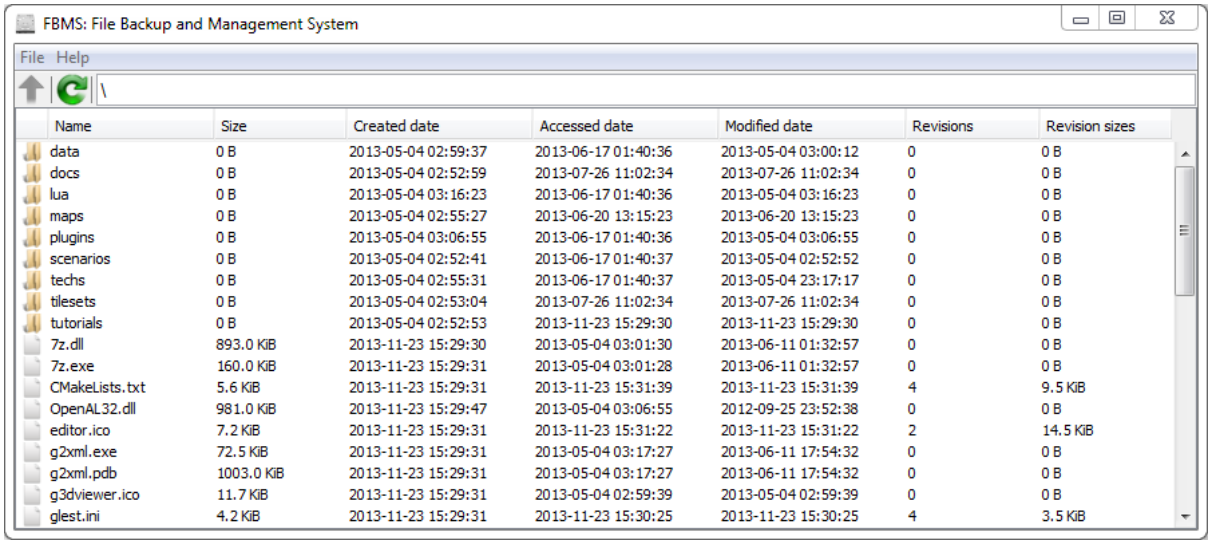
1.8 Low fidelity prototypes

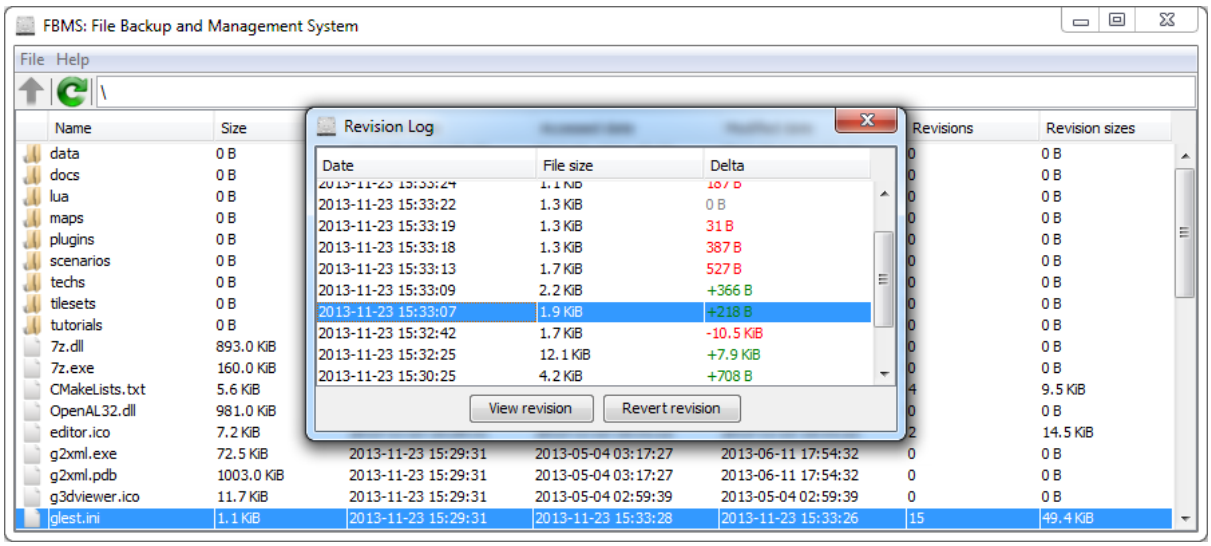
Our initial prototype was created by editing images of windows. With that, we obtained these early prototype:





Our final result is very similar to the mockups:





2 Requirements and early design

2.1 Summary use cases

2.1.1 List of all use cases

- **Create file**: A file is created. The file will be backed up.
- **Modify file**: A file is modified. The file will be backed up and revisioned.
- **Rename file**: A file is renamed. Any existing revisions will be renamed to the new name.
- **Delete file**: A file is deleted. No other operations will be done on that file.
- **Create folder**: A folder is created. Empty folders are not backed up. Folders are created automatically when files are backed up.

- **Rename folder**: A folder is renamed. Any existing revisions containing this folder in their path will be renamed to the new name.
- **Delete folder**: A folder is deleted. No other operations will be done on that folder.
- **Startup**: The program is started up. The location of the backup directory will be determined, database connection established, startup scan commenced, and file watcher initialized. If necessary, first run wizard will be run.
- **First run setup**: First run wizard is run if the program determines this is the first run (or regular startup cannot be commenced). Gets from the user the locations of the backup and live directories.
- **Change live directory**: The live directory is changed to a new, user specified location. The directory's files are scanned for differences from the backup and the watcher is reinitialized.
- **Change backup directory**: The backup directory is changed to a new, user specified location. The previous backup directory's contents are copied to the new location.
- **Change settings**: A settings window displays available settings. On close, the settings are saved.
- **View backed up files**: The main window is opened by double clicking the system tray icon. The window lists the contents of the backup directory, including files that were deleted or renamed in the live directory.
- **Go into folder**: A folder in the main window's file browser is double clicked. The main window's contents are replaced with the contents of that directory (in other words, the contents of a different directory are displayed).
- **Go up a directory**: The up button in the main window is clicked. The main window's contents are replaced with the contents of the directory "up" from the current folder. Cannot go up further than the backup directory.
- **Refresh the current directory**: The refresh button in the main window is clicked. The main window's contents are replaced with the contents of the current directory. This allows the user to see any updates to the contents of the directory.
- **Navigate to a user specified directory**: The file browser location bar is changed and the user presses enter. The entered path is parsed and navigated to as though the user went into that folder. If the path is invalid, the user is alerted.
- **View list of revisions for a file**: A file is double clicked in the main window's file browser. A modal displays all available revisions. The time stamp, file size, and difference in file size is shown.
- **View revision**: In the revisions dialog, the user double clicks on a revision or selects a revision and clicks the "view revision" button. The revision is obtained and opens in the user's default program for that file type.

- **Revert revision**: In the revisions dialog, the user double clicks on a revision or selects a revision and clicks the "view revision" button. The revision is obtained and is copied to the live directory. A revision is created for the revert operation.

2.1.2 Create file

Level
Summary

Actors
System

Goal
Add the file created by user to the system and backup it.

Activities
The system receives a file created notice from the watcher module, and put it in file created list.
The file change handler will process the list:

a) A file with the same name and location exists in the system:
The system will treat the file as a modified file, and make a diff file for it.

b) No file with the same name and location exists in the system:
The system just simply copies the file into the backup folder. Then a new record will be added in database stating a new file added.

Quality
This is a main use case in the system and must work to a very high standard.

Version
26 November 2013

2.1.3 Modify file

Level
Summary

Actors
User

Goal
Backup the modified file and make a revision for the change.

Activities
The watcher module notices the file has been modified and adds it to the modified files list. The file change handler for modified files will then handle the files in this list, making a revision for the changes and then copying the file to the correct folder in the backup directory.

Quality
This is a main use case in the system and must work to a very high standard.

Version
27 November 2013

2.1.4 Rename file

Level
Summary

Actors
System

Goal
Reflect the effect of renaming a file.

Activities
The system receives a file renamed notice from the watcher module, and put it in file renamed list.
The file change handler will process the list:
The system will either make a diff file or copy tdomaihe file to backup folder.

Quality
This is a main use case in the system and must work to a very high standard.

Version
26 November 2013

2.1.5 Rename folder

Level
Summary

Actors
User

Goal
When a folder is renamed, ensure that the revisions have the corrected path.

Activities
The watcher notices the folder has been renamed and adds it to the renamed list. The file change handler for renamed files will later handle the paths in this list, copying the folder in the backup directory to the new name and renaming revisions in the database to the new path.

Quality
This is a main use case in the system and must work to a very high standard.

Version
27 November 2013

2.1.6 Delete file

Level
Summary

Actors
System

Goal
Allows the user to delete a specified file

Activities
User scrolls over live directory and finds the file to be deleted. JNotify notices the file change and calls the watcher. The watcher notices a file has been deleted from the live directory and add to the list. The control reads the list and removes any other instances of the file in the other list.

Quality
This is a main use case in the system and must work to a very high standard.

Version
28 November 2013

2.1.7 Revert Revision

Level
Summary

Actors
User

Goal
Ability to revert a file to a prior version.

Activities
The file selects a revision using the GUI. Backend then uses FileHistory and FileOp to revert the file in such a way as not to interfere with versioning.

Quality
This part of the program is high priority, it is not critical to the backup functionality of the program but is necessary for the user to take advantage of the versioning information being created. To that end it is also a primary component to why a user would use our program.

Version
26 November 2013

2.1.8 View revision

Level
Summary

Actors
User

Goal
Ability to revert a file to a prior version.

Activities
The user selects whatever file he/she wants to view a specific revision for that file. With a selected file, the user is presented a list of revisions and options, which include view revision.

Quality
This is a main use case in the system and must work to a very high standard.

Version
26 November 2013

2.1.9 First run setup

Level
Summary

Actors
User

Goal
To setup the live and backup directories on the first time the program is run

Activities
The program determines if it is the first run by checking for the existence of the file which specifies the backup directory. If this file is not found or the backup directory is invalid, it is considered to be the first run. A GUI wizard is shown, and the user is asked if they wish to specify a new backup or if they wish to import an old backup. To create a new backup, the user is prompted for paths for a live and backup directory (which cannot be children of one or the other). To import an old backup, the user is prompted to provide a path to the backup folder (which contains a database file). If the user enters invalid paths, they will be prompted to enter a new one. The wizard also allows the user to go back and change previously made choices. On the final screen of the wizard, the program initializes the backup and live directories and creates the database connection.

Quality
This aspect of the program is top priority, as it is mandatory for the program to be used at all. Therefore, it must be completely stable and well designed. In

fact, this portion of the program is already complete in our prototype, as will be demonstrated in section 9.

Version
28 November 2013

2.1.10 Change live directory

Level
Summary

Actors
User

Goal
Change the folder system monitors.

Activities
User select "Change live directory" in main window.
The system changes configuration in database, removes the old watcher and adds a new watcher for new live folder.

Quality
This is a median use case in the system and should work to a high standard.

Version
26 November 2013

2.1.11 Change backup directory

Level
Summary

Actors
User

Goal
Change the folder for storing backups.

Activities
User select "Change backup directory" in main window.
The system changes configuration in database, and copies the old folder and its content to the new location.
The old backup folder still lives.

Quality
This is a median use case in the system and should work to a high standard.

Version
26 November 2013

2.2 Fully-dressed use cases

2.2.1 Create File

Scope
FBMS

Level
User goal

Primary actor
Main system

Stakeholders and interests
User: Want this new created file is automatically backed up.

Preconditions
The Watcher module is running normally.
There is enough space in backup folder.
System has read access to the newly created file. System has write access to backup folder.

Success Guarantee
The newly created file is backed up.
Records are added in database.
The history of this file is accessible from GUI.

Main Success scenario

(1) The system received a file created notice, and put it in file created list.

(2) The system determines whether a file with the same name and location has been existed in the backup folder.

(3a) If so, the system treated this file as a modified file.
Remove this file form file create list. Add it to file modified list.
Make a diff file for this file.

(3b) If not, copy this file to backup folder.

(4) Add a record in database.

Extensions
The file will be locked when being copied to backup folder.

Special Requirements
Privilege is possible required.

Technology and Data Variations List
The program flow changes based on whether a file with the same name and location has been existed in the system. If it exists, system will do additional steps to ensure no wrong overwriting occurs. If not, system will do it in regular way.

Frequency of Occurrence
Every time a new file is created in live folder.

2.2.2 First Run

Scope
Program is run for the first time

Level
User goal

Primary actor
User

Stakeholders and interests
User: Setup the program with the directories it will act on.

Preconditions
It is the program's first run or the program cannot startup normally.

Success Guarantee
The backup and live directories are configured to valid paths.

Main Success scenario

- Program determines that it is the first run because the file pointing to the backup location is missing, or the backup location is otherwise invalid (non-existent folder or missing necessary database file inside this folder).
- A GUI wizard is displayed, with buttons for navigating and exiting the wizard.
- The wizard prompts the user as to whether they wish to create a new backup or import an existing backup. If a new backup is chosen, the user is prompted to provide paths for both the live and backup directories (via file choosers). If the user chooses to import an existing backup, they are prompted to provide a path to this backup directory.
- The wizard finalizes, telling the user that setup was completed.
- The program establishes a connection with the database, setting it up in the specified backup directory by creating the file that points to the backup directory.

Extensions

- The user cannot specify live and backup directories that are children or parents of each other. This prevents infinite recursion. If the backup folder was inside

the live directory, every backup would be identified as a change to the live directory (and thus need to be backed up as well). If the live directory was inside the backup directory, then we run the risk of backed up files overwriting files in the live directory. The program will issue an error dialog if this occurs, and will not allow the user to continue until they specify valid directories.

- When importing an existing backup, the chosen directory must contain a database file which indicates that the directory has been used for backup before. This file contains the path of the live directory, which is necessary for the program to import an existing backup. The program will issue an error dialog if this occurs, and will not allow the user to continue until they specify a valid directory. If the user closes the dialog window, it will do nothing unless they are on the final panel of the wizard, which indicates a success.

Special Requirements

The program directory and the chosen live and backup directories must have write access.

Technology and Data Variations List

The program flow changes based on whether the user chose to import an existing backup or start a new one. If they chose to import an existing backup, the live directory is set when the program initializes the database. If they started a new backup, the wizard sets the live directory.

Frequency of Occurrence

Exactly once when the program starts for the first time May also occur if an error is encountered when the program starts up (such as if the backup directory is invalid)

2.2.3 Delete file

Scope

FBMS

Level

User goal

Primary actor

User

Stakeholders and interests

System: don't try and backup a deleted file

Preconditions

A file or folder is deleted

Success Guarantee

The deleted path will be removed from all other file handler lists

Main Success scenario

- A file or folder is deleted by the user.

- The watcher detects the deletion and adds it to the list of deleted files.
- The file change handler for deleted files fires before the other file change handlers.
- The handler removes the paths in the deleted files list from all the file change lists. This ensures that the other handlers won't try to act on deleted files.

Extensions
None

Special Requirements
None

Technology and Data Variations List
None

Frequency of Occurrence
Once for each deleted file

2.2.4 Revert file to revision

Scope
FBMS

Level
User goal

Primary actor
User

Stakeholders and interests
User: Revert the selected file to the selected version.

Preconditions

- System must be in a properly setup and running state.
- A file must be selected by the user.
- The file must be within the folder listing that is currently being backed up. .
- A version must be selected by the user.
- A version history must exist for the file.
- System has proper read/write access to the backup and the system file.

Success Guarantee

- The selected file is reverted to the proper revision.
- The previous version that was overwritten still remains in backup as a version.

Main Success scenario

- User prompts the program via the GUI that they wish to make a file revision.
- The user selects the file in question and then selects the revision they desire from the selection.
- The system then goes through file history to find the proper diff file referenced by the database.
- Temporary files are made where appropriate.
- The diff file is used to create a reverted version of the specified file.
- The file specified is now reverted and in the proper location.

Extensions

- Only files within the specified backup environment will have versions stored to revert to.
- Nothing will happen if the user selects the file and revision and exits the dialogue or otherwise does not hit 'Ok'.
- If the function fails due to system level issues, like permission conflicts, the function ends and the user is notified.

Special Requirements

Require write/read access to the file being modified.

Technology and Data Variations List

None

Frequency of Occurrence

Whenever specified by the user.

2.2.5 Rename file

Scope

FBMS

Level

User goal

Primary actor

User

Stakeholders and interests

User: Want this renamed file is automatically renamed in system.

Preconditions

- The Watcher module is running normally.

- The reversion is accessible.
- System has read access to the newly created file.
- System has write access to backup folder.

Success Guarantee

- The backups of file renamed are renamed.
- Records are renamed in database.

Main Success scenario

- System is notified for the renaming operation.
- System renames all the backups of the file.
- System add a rename record into the database.
- System changes all the records of the file.

Extensions

- The backups of file will be locked when being renamed.

Special Requirements

None

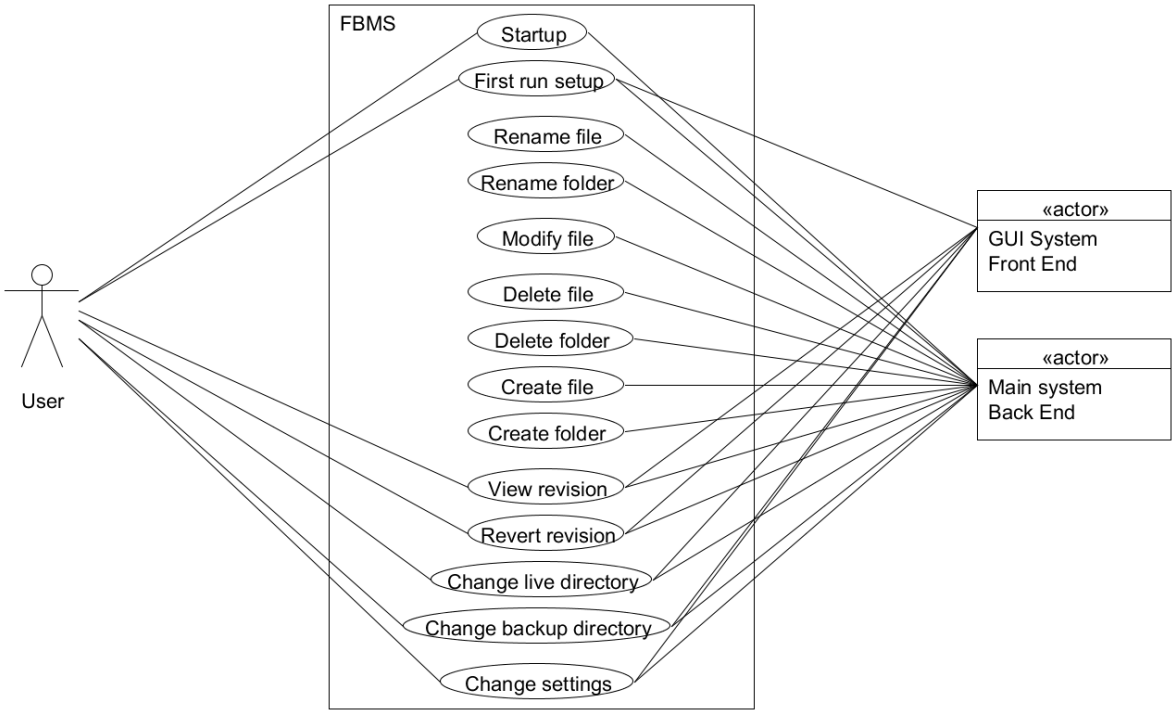
Technology and Data Variations List

None

Frequency of Occurrence

Every time a file is renamed in live folder.

2.3 Use case diagram



2.4 Domain model

The class diagram is too large to embed in this document, so has been included separately as the file `domain_diagram.png`.

2.5 Glossary

- **Live directory**: The directory that the program monitors for changes. In other words, the directory that is being backed up.
- **Backup directory**: The directory where the backed up files and revisions from the live directory are placed.
- **Revision**: A snapshot of a file at a given time.
- **Patch**: Data that details what changed from one revision of a file to another. Also called a "diff".
- **Raw data**: The contents of a file as bytes, without any kind of interpretation.
- **Revision database**: The database where revisions are stored as patch files (for plain text) or raw data (for binary).
- **File operations**: Operations that change a file's content, name, or location. This includes operations such as file creation, renaming, moving, or deletion.

- **Error alerts**: GUI dialogs that alert the user to an error. They are split into two branches:
  - **Fatal alerts**: Obtrusive dialogs that indicate that the program cannot proceed.
  - **Non-fatal alerts**: Non-obtrusive dialogs that appear in the bottom right corner of the screen and automatically disappear after some time. These indicate something has gone wrong and cannot be recovered, but do not halt the progress of the program. For example, a file that cannot be backed up (perhaps due to permission issues).
- **Front end**: The visible portions of the program, including the main GUI window, the toolbar icon, and dialogs.
  - **Main frame**: The large window that is opened by double clicking the program's system tray icon. It lists the files and folders inside the backup directory and offers actions on these files.
  - **Revisions dialog**: The modal opened by double clicking on a file in the main frame's list of files. It displays a list of revisions for that file, and offers actions on these revisions.
  - **Settings dialog**: The modal opened by from the "settings" option in the main frame's menus. It offers customization of some features such as trim, whether or not to perform the startup scan, and the display of errors.
- **Watcher**: The program component that watches the live directory for changes. It operates concurrently from the rest of the program.
- **File change handlers**: The section of the program that handles changes in files (file operations). Runs concurrently from the rest of the program.
- **Data retriever**: The program component that fetches data about revisions or the file system for the front end.
- **First start wizard**: A wizard that is shown on the first start (or if normal startup cannot occur). It guides the user in choosing the live and backup directories.
- **Trim**: A program feature that removes revisions older than a configured date.
- **Startup scan**: The one-time scan that occurs when starting the program up (or after the live directory is changed). This allows the backup of files that were changes when the system was not running, but is an unnecessary overhead if the system is always running. Can be disabled in the settings dialog.

2.6 Supplementary specification

2.6.1 Vision

FBMS is a multiplatform, self-contained automated backup and revision program. It does not require cloud services or any online access to function. It uses local resources and ideally secondary drive locations to backup critical data.

We chose this project as it fills a gap between cloud backup platforms and weighty software suites requiring considerable infrastructure and resources. Our program takes advantage of external drives or mapped network drives and consolidates folders specified by the user to a secure location. Joined with a redundant hardware solution like RAID, our software is a suitable replacement to cloud services.

Our design choices have lead to a cross platform utility that should be usable on any operating system supported by the Java run time. This frees it from the majority of dependencies that weigh down other software.

Using the data we backup we are able to run and operate a versioning system. This allows a user to revert unwanted file changes, restore corrupted files, or replace files accidentally deleted. It takes a step further then previous versions in windows, or other similar systems like svn. This gives more control over where versions are kept and is more straightforward then other versioning systems.

2.6.2 Interfaces

The interface consists of the GUI windowing system along with a minimizer tray icon. Closing the GUI minimizes the application to an icon in the system tray. This means that the application does not end simply by pressing the "x" button on the GUI but needs to be shut down from the system tray icon which has an "exit" option for closing the application entirely. We have tried to make the main GUI as simple as possible so that an average user could be able to handle the software. It comprises of a few simple areas namely a table, a toolbar, and a menubar.

Table: This is used to display the contents of the backup directory. This directory is specified by the user and shows detailed entries of the names of the files or the folder, the sizes, the modified and the created dates as well as the last date it was accessed on and finally the revision size and the number of current revisions. Interactive features of the table include a scrollbar, which the user can use to scroll up and down the list and selection, allowing the user to select a single file at a time. When a folder is selected the table refreshes the contents of the list by generating the contents of the folder. Selecting a file opens up a dialog box with information of the file revisions. Errors are handled by the means of dialog boxes.

Toolbar: This is located above the table and contains two buttons and a text field. One of the button is an up button enabling the user to navigate out of the current folder. However the button is disabled if the user is already in the backup directory. The second button is the refresh button which refreshes the directory to the latest version. The text

field is set to contain the current path of the directory and is also disabled if the user is already in the back up directory.

Menubar: At the very top is a menubar which consists of a file and a help item. The file item expands to options of:

- **View revisions**: It works in the same was a double clicking a file (eg, opens the revision dialog box; if no files are selected, do nothing). The dialog has options of view and revert which enables the user to view the revision of the file selected. This gives the information in the form of a JTable which shows the name of the file, its size and the modified size in bytes. The revert reversion removes any changes and changes to the file to the original state.
- **Copy-to**: Creates a dialog for selecting the folder to copy the selected file to. Like review revisions, this cannot be done if no file is selected. Restore all: Prompts the user (with a dialog box) if they're sure they want to continue. Upon approval, the directory is restored to the previous revision. Settings
- **Settings**: This has a number of interesting options like removing revisions older than a particular number of days, which the user can specify in a text box, and controlling the sizes of the files set for revision. Furthermore, a user can also enable or disable the scanning of the directories at start-up by the means of a check box. Lastly they can choose whether they want non fatal displayed or not.
- **Exit**: Closes the GUI window. However it can be brought back by clicking on the icon in the system tray.
- **Help**:The help menu has a single option to display the online help. This opens the website for the software in the users default browser.

2.6.3 Reliability

To maximize efficiency, the watcher module, which notices changes to files, adds these changes to lists. At specific intervals, the program handles the files in these lists. This reduces the program's use of system resources by allowing the program to frequently sleep instead of constantly looping while the program is running. It also drastically reduces the number of file operations. Some operating systems and programs will actually modify a file multiple times in just a few milliseconds (even if the file only appears to have been modified once from the user's perspective). The interval based system combines duplicate operations. So if the user modifies a file a dozen times within the interval, the program only stores one modification as a revision (with that revision being all the changes since the file was last modified).
Similarly, we use the JNotify library specifically because it binds with the operating systems for maximum performance. At one early point of time, we actually considered checking all the files in the live directory for changes in their CRC value, which would have been much slower.
The program also handles errors in a user-friendly way. Fatal errors are displayed as dialog boxes and also copied to the log (which helps find the source of errors). Non-fatal

errors use a non-obtrusive error pop-up message that appears in the bottom corner of the screen and disappears on its own after a few seconds. Finally, when file operations cannot be performed on a file (for reasons such as the file being open in another program or invalid permissions), the operation is retried after a short delay before informing the user of the error (which is a non-fatal error, as the file can simply be skipped).

2.6.4 Supportability

- **OS Compatibility**
  To adapt different OSes, we are storing a relative path in database. It solves the problem of changing backup folder.
- **Logging**
  Log is provided to diagnose problem when error occurs.
  Through analysing the log it is possible to give out a solution.
- **Import from old backup**
  It is possible to import backups from an old backup folder.
  This function is provided in first run wizard.
- **Configuration**
  Live folder and backup folder could be changed.

2.6.5 Third party components

The project uses third party components for several areas, allowing the project to be completed in a reasonable span of time, as well as assisting in functionality beyond our current skills. Currently, we use:

- **JNotify**: This library is used to detect changes in the live directory. It is capable of running event handlers when file changes occur. This allows us to efficiently find the changes in the directory. JNotify binds with the operating system (in which it supports all the major operating systems), allowing it to function similar to an interrupt-style listener. The program will then use a polling system to perform file operations on changes that occurred since the last poll. This makes spotting changes fast while minimizing file operations (which often occur in multiples even if the operation appeared atomic to the user).
- **Log4j**: The well known logging library is used to making logging efficient and configurable. Most importantly, it allows us to set levels to our logging. When the logging is set to DEBUG, the logging system is very verbose. This is useful when we need to know exactly what the program is doing, but for general usage, this slows the program down and floods the logs with irrelevant information. Normally, the user will have the logging set to either WARN or ERROR, which will limit the logging to things that are of actual use to the user.
- **Diff match patch**: This library is used to generate patch files, which is what our revisioning system is based on. The library is also used to apply the patches,

restoring the originals. To restore files several revisions old, the patch files are daisy-chained, restoring revisions until we get to the one we want.

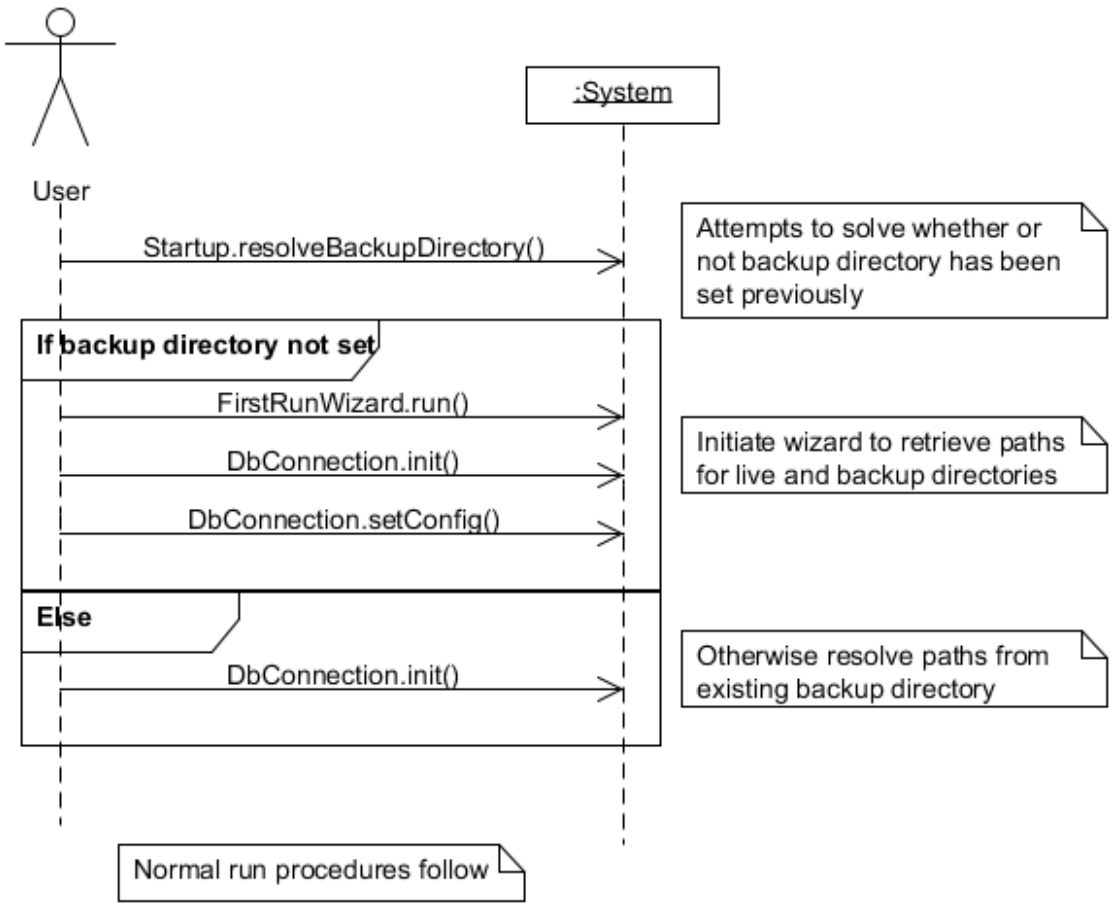
- **SQLite**: We use the SQLite JDBC driver to allow our databases to be well organized into an efficient, minimal file.
- **Java MIME Magic**: This library is used to maximize our ability to detect the difference between binary and text files (since they are revisioned differently).

We originally planned to use Java-diff-utils as the patching engine, but the library appears to be either bugged or the documentation is incorrect. We switched to the diff match patch library instead, which performed all the functionality we need and was better documented.

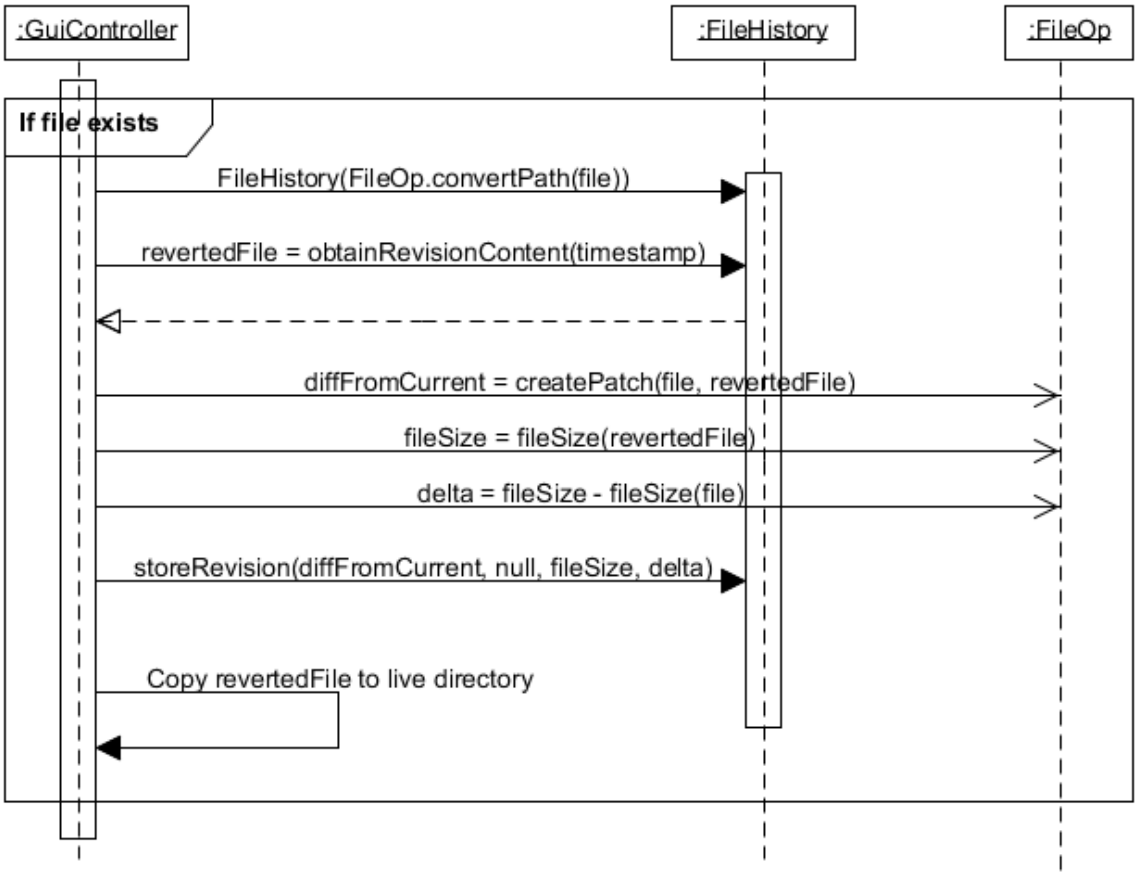
These components integrate with our program and were chosen with efficiency in mind.

2.7 System sequence diagrams

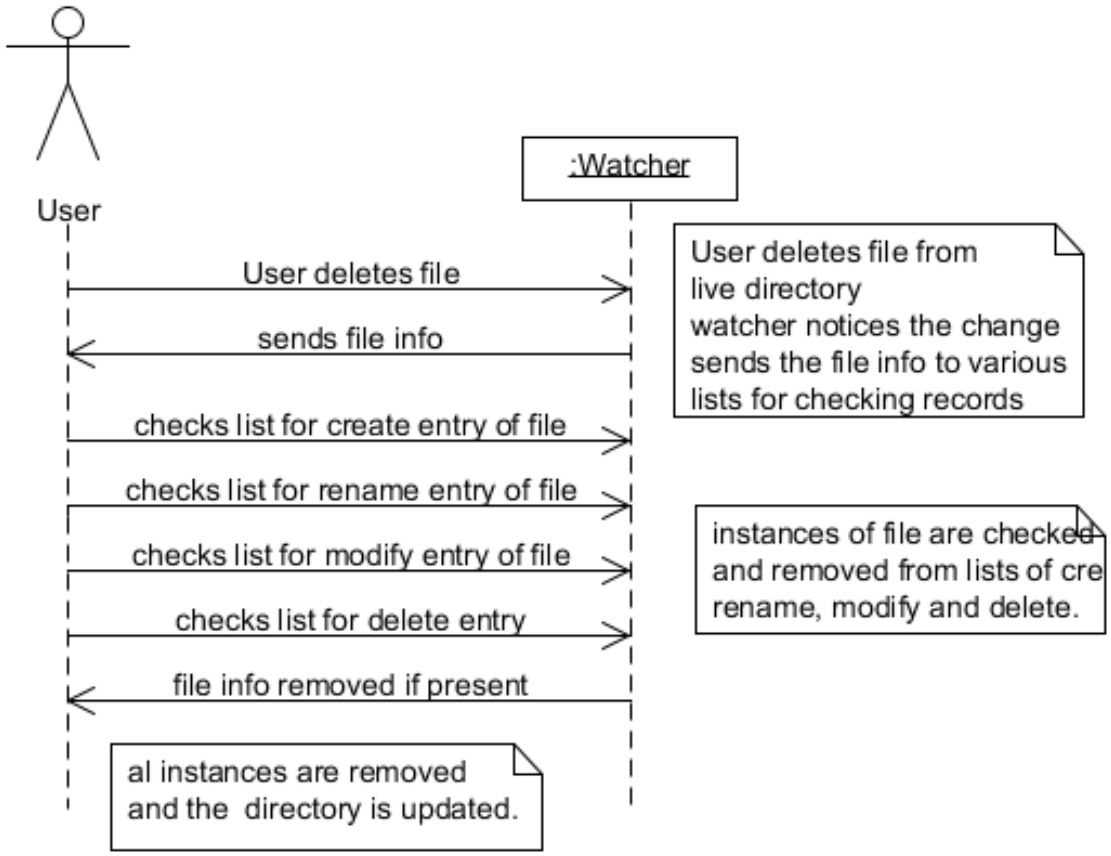
2.7.1 First run setup



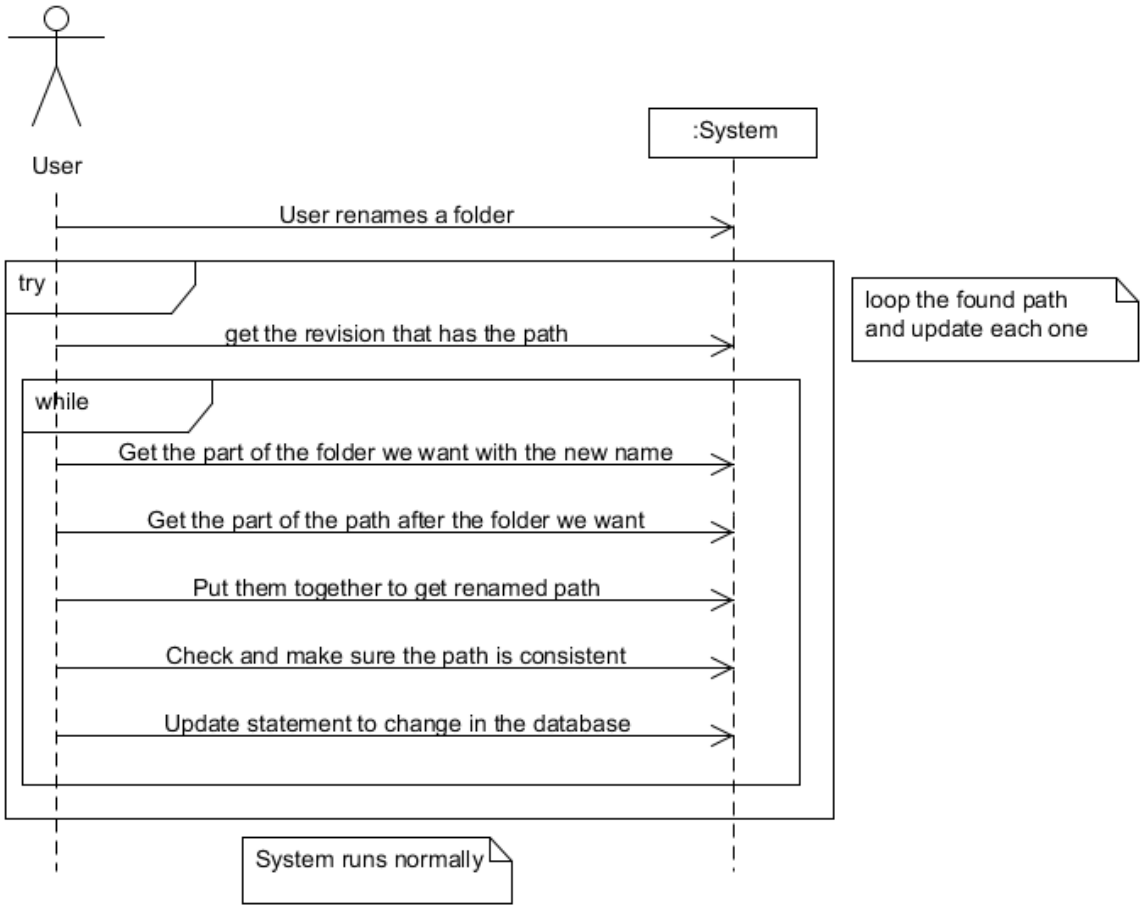
2.7.2 Revert to file revision



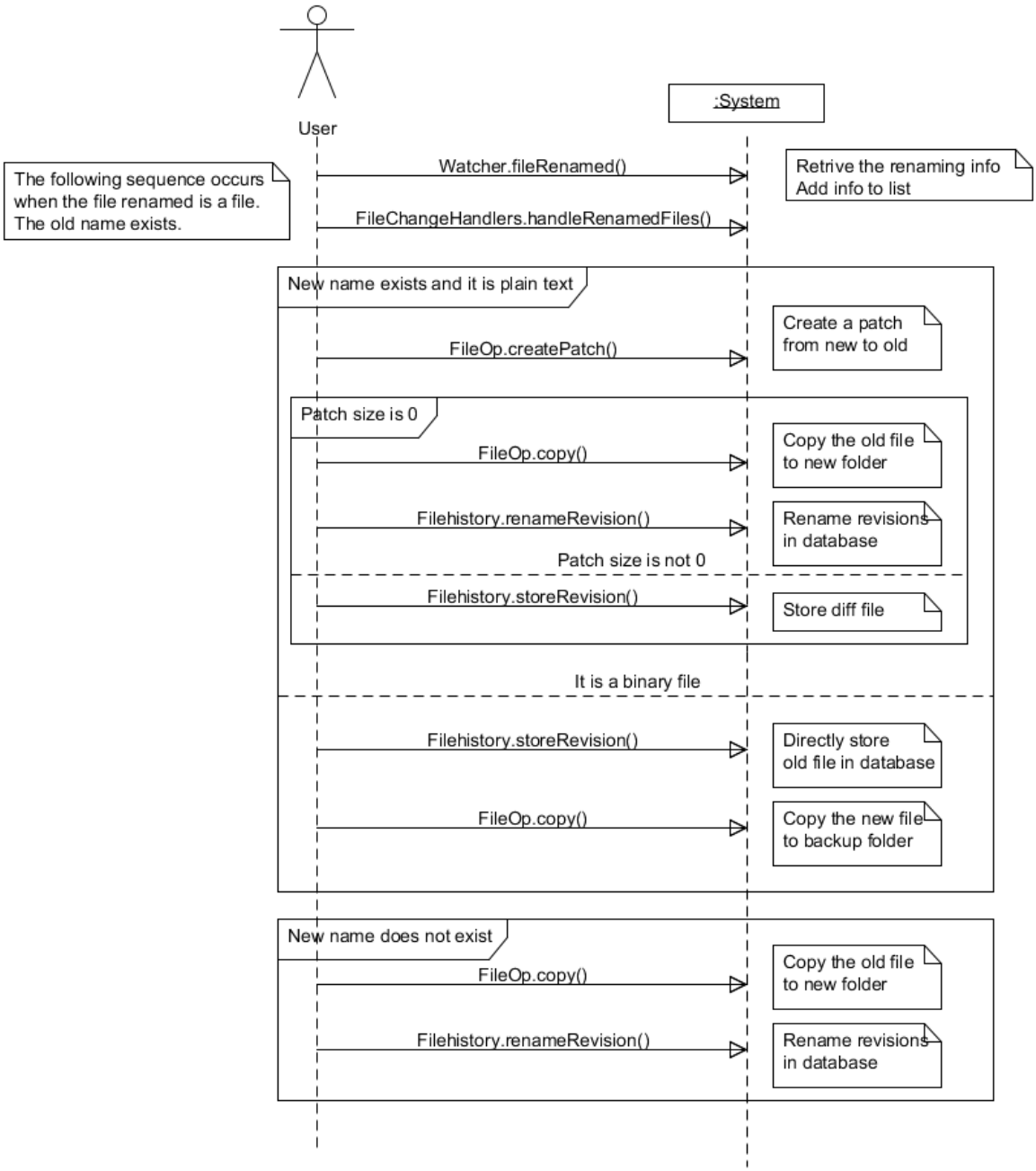
2.7.3 Delete file

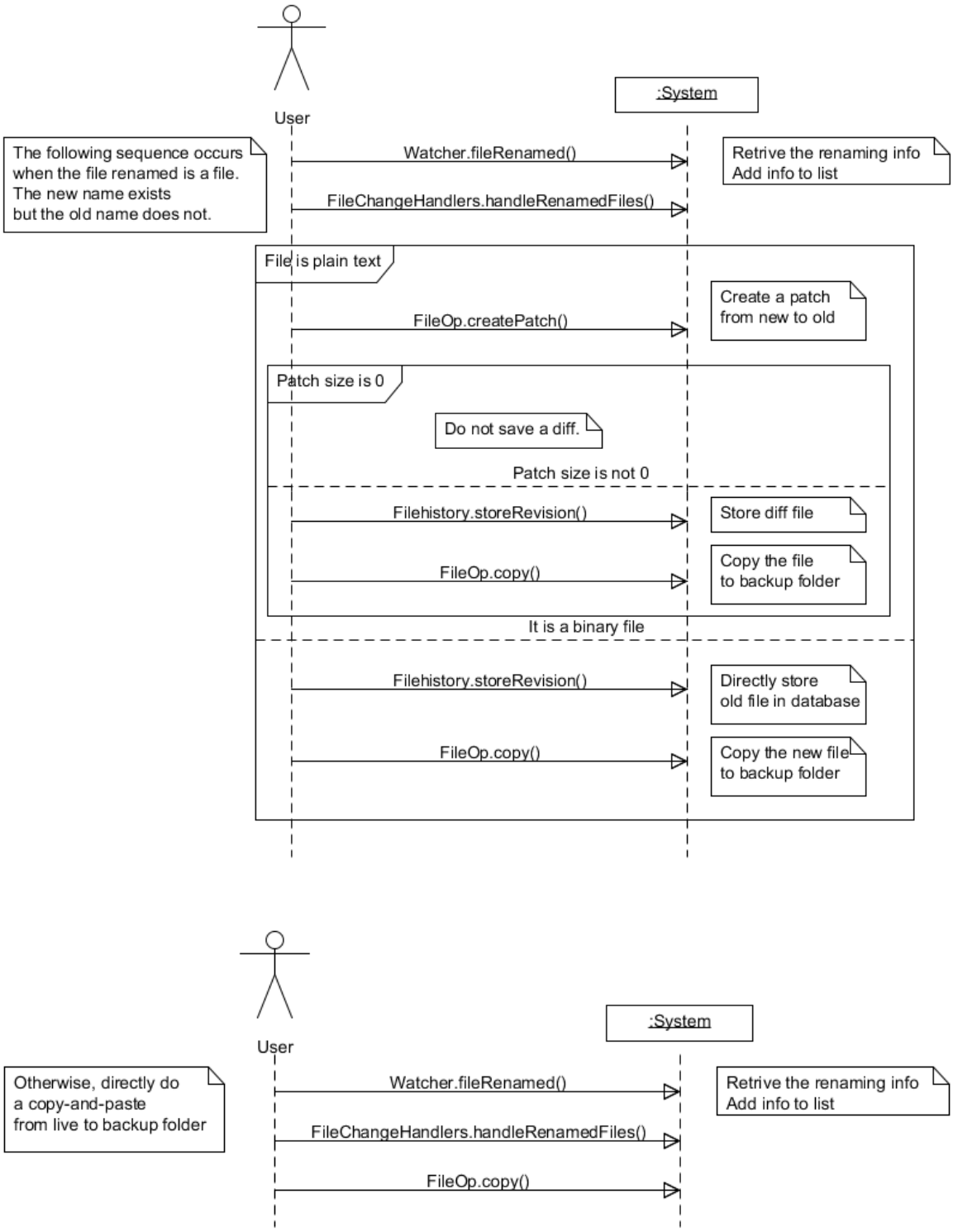


2.7.4 Rename folder



2.7.5 Rename file





2.8 Operation contracts

`FileOp.createPatch(Path oldRevision, Path currentRevision)`

Cross references:

Operation contracts:

`FileChangeHandlers.handleModifiedFiles()`,
`FileChangeHandlers.handleRenamedFiles()`,
`Startup.startupScan()`

Use cases:

`Startup`, `Rename file`, `Modify file`,
`View revision`, `Revert revision`

Precondition: `oldRevision` and `currentRevision` exist

Postconditions: A `Path` is created. It points to a temporary file containing the patch to patch `currentRevision` to `oldRevision`.

`FileOp.applyPatch(Path currentRevision, Path patchFile)`

Cross references:

Operation contracts:

`FileHistory.displayRevision(Path, long)`

Use cases:

`View revision`, `Revert revision`

Precondition: `currentRevision` and `patchFile` exist

Postconditions: Creates a temporary file, which contains the contents of the `currentRevision` with `patchFile` applied to it.

`DataRetriever.getFolderContents(Path folder)`

Cross references:

Operation contracts:

`Data.getTableData(Path)`

Use cases:

None

Precondition: Path `folder` exists

Postconditions: A `List<FileInfo>` is returned, containing the content of the `folder`

`GuiController.displayRevision(Path file, long timestamp)`

Cross references:

Operation contracts:

`RevisionTableSelectionListener.activateRow()`

Use cases:
`View revision`

Precondition: A revision exists in the database for the specified file and time stamp

Postconditions: A temporary file of the specific revision is created. System will open the file with default application for the file type

`GuiController.changeLiveDirectory(Path newDirectory)`

Cross references:

Operation contracts:
`MainMenu.initFileActions()`

Use cases:
`Change live directory`

Precondition: `newDirectory` exists and is valid (not a parent or child of backup directory)

Postconditions: `Main.liveDirectory` is changed to `newDirectory`. The previous file watcher is cancelled. A new file watcher is created for the new live directory. Files in the live directory are scanned once to backup

`Startup.resolveBackupDirectory()`

Cross references:

Operation contracts:
`Main.main(String[])`

Use cases:
`Startup`

Precondition: None

Postconditions: `Main.backupDirectory` is set to contents of `backup_location` file if it exists and is valid. First run will begin if backup directory cannot be resolved

`DbConnection.getFileRevisions(Path file)`

Cross references:

Operation contracts:
`DataRetriever.getFolderContents(Path)`,
`DataRetriever.getRevisionInfo(Path)`,
`FileHistory.obtainRevisionContent(Path, long)`

Use cases:
`View revision`, `Revert revision`

Precondition: `file` exists

Postconditions:
A `List<RevisionInfo>` is returned, containing revision infomation of `file`.

`DbConnection.setConfig(String settingName, String settingValue)`

Cross references:

Operation contracts:
`GuiController.changeLiveDirectory(Path)`,
`Startup.startup()`

Use cases:
`Startup`, `First run setup`, `Change live directory`

Precondition: The database exists.

Postconditions: The field `settingName` is set to `settingValue`

`FileOp.copy(Path file, Path destinationFolder)`

Cross references:

Operation contracts:
`GuiController.changeBackupDirectory(Path)`,
`GuiController.copyTo(Path, Path)`,
`FileChangeHandlers.handleCreatedFiles()`,
`FileChangeHandlers.handleModifiedFiles()`,
`FileChangeHandlers.handleRenamedFiles()`,
`GuiController.restoreBackup(Path)`,
`Startup.startupScan(Path)`

Use cases:
`Startup`, `Create file`, `Rename file`, `Modify file`, `Revert revision`,
`Change backup directory`

Precondition: `file` exists

Postconditions: `file` will be copied to the `destinationFolder`. If `destinationFolder` does not exist, it will be created. Any non-existant parent folders up to `destinationFolder` will be created.
Any existed file will be overwritten.

`FileHistory.storeRevision(Path file, Path diff, long filesize, long delta)`

Cross references:

Operation contracts:
`FileChangeHandlers.handleModifiedFiles()`,

`FileChangeHandlers.handleRenamedFiles()`,
`GuiController.revertRevision(Path, long)`

Use cases:
`Startup`, `Create file`, `Rename file`, `Modify file`

Precondition: `file` and `diff` exist

Postconditions: A row is inserted into the database containing information about the revision. In addition to the path of the file, the contents of the diff, the file size, and the delta (change in file size), the time will also be stored.

2.9 Obtaining user feedback

Most of our user-feedback stems from heavy testing. We have found several bugs by combining manual testing with logging. Features are also prioritized by user feedback. In version 1.0, for example, we had no support for binary revisions. They were backed up, but not revisioned. This was one of the biggest limitations at the time, and reflected by user feedback. In version 2.0, we introduced support for these binary revisions.

Another area where feedback was crucial was in the GUI development. We had to aim to make the GUI both natural and easy to use. For example, the table rows are activated via double clicking or the enter key. The default behavior of the enter key in a table, however, was to go to the next line, which is counter-intuitive for a file browser, and was overridden.

3 Updated design and unit testing

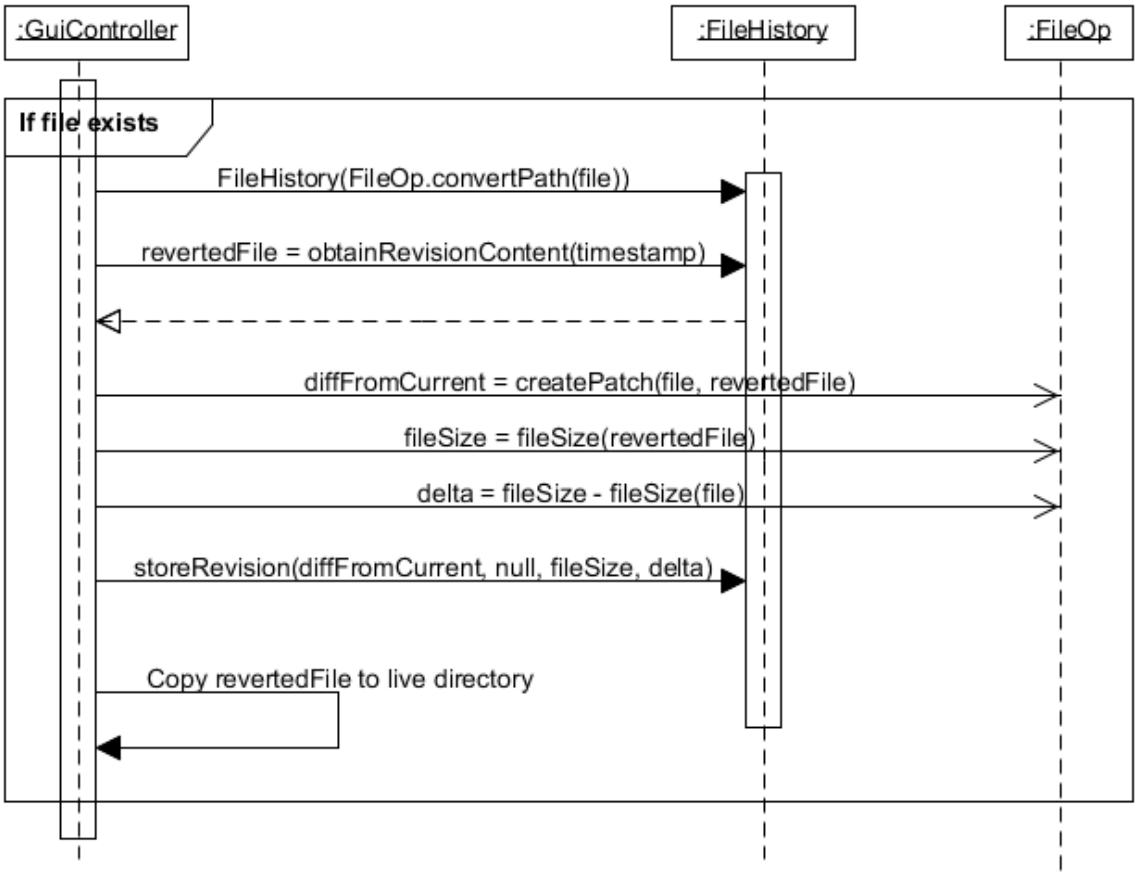
3.1 System operations

- `Startup.resolveBackupDirectory()`
- `DbConnection.insertRevision()`
- `DbConnection.getFileRevisions()`
- `DbConnection.getSpecificRevision()`
- `DbConnection.renameRevisions()`
- `DbConnection.setConfig()`
- `DbConnection.getConfig()`
- `FileOp.createPatch()`
- `FileOp.applyPatch()`
- `GuiController.revertRevision()`

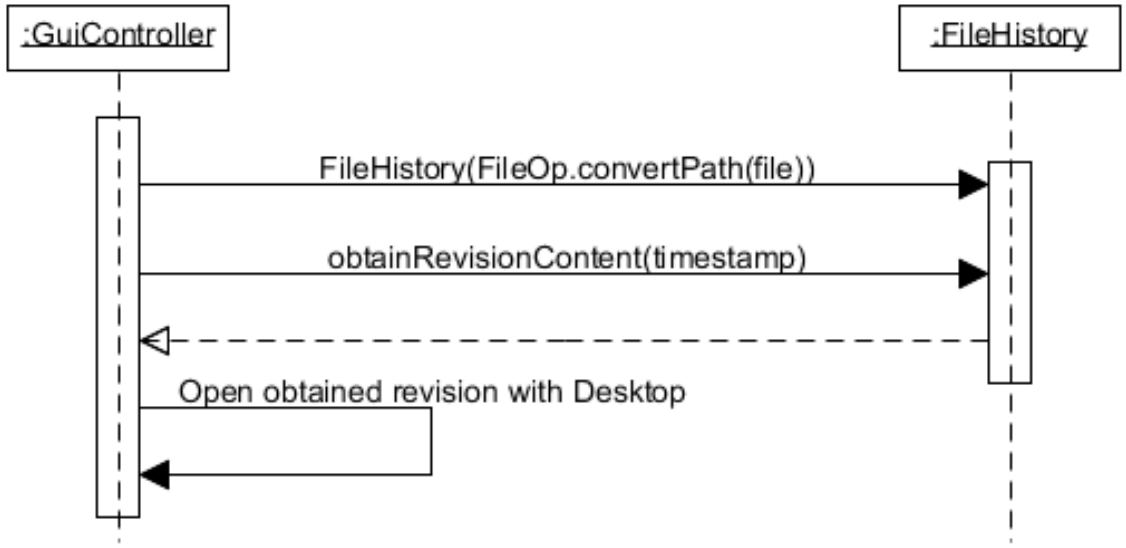
- `GuiController.viewRevision()`
- `GuiController.changeLiveDirectory()`
- `GuiController.changeBackupDirectory()`
- `FileChangeHandlers.handleRenamedFiles()`
- `FileChangeHandlers.handleCreatedFiles()`
- `FileChangeHandlers.handleModifiedFiles()`
- `FileChangeHandlers.handleDeletedFiles()`
- `FileHistory.getRevisionInfo()`
- `FileHistory.storeRevision()`
- `FileHistory.obtainRevision()`
- `FileHistory.renameRevision()`

3.2 Sequence or communication diagrams with GRASP patterns

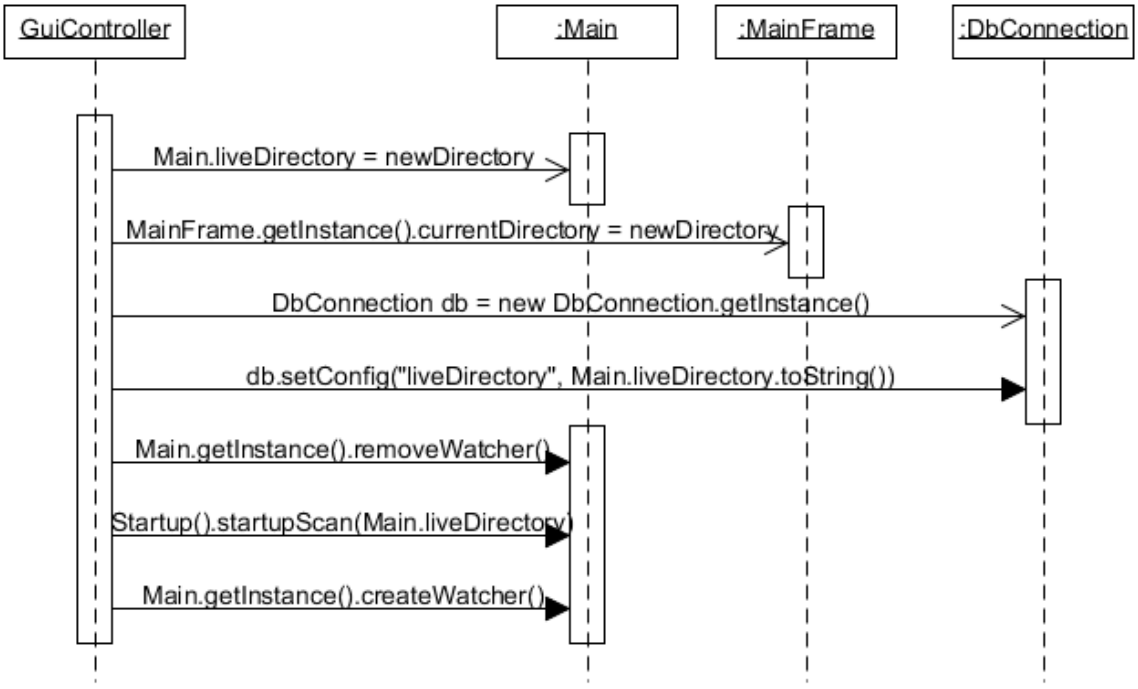
3.2.1 GuiController.revertRevision



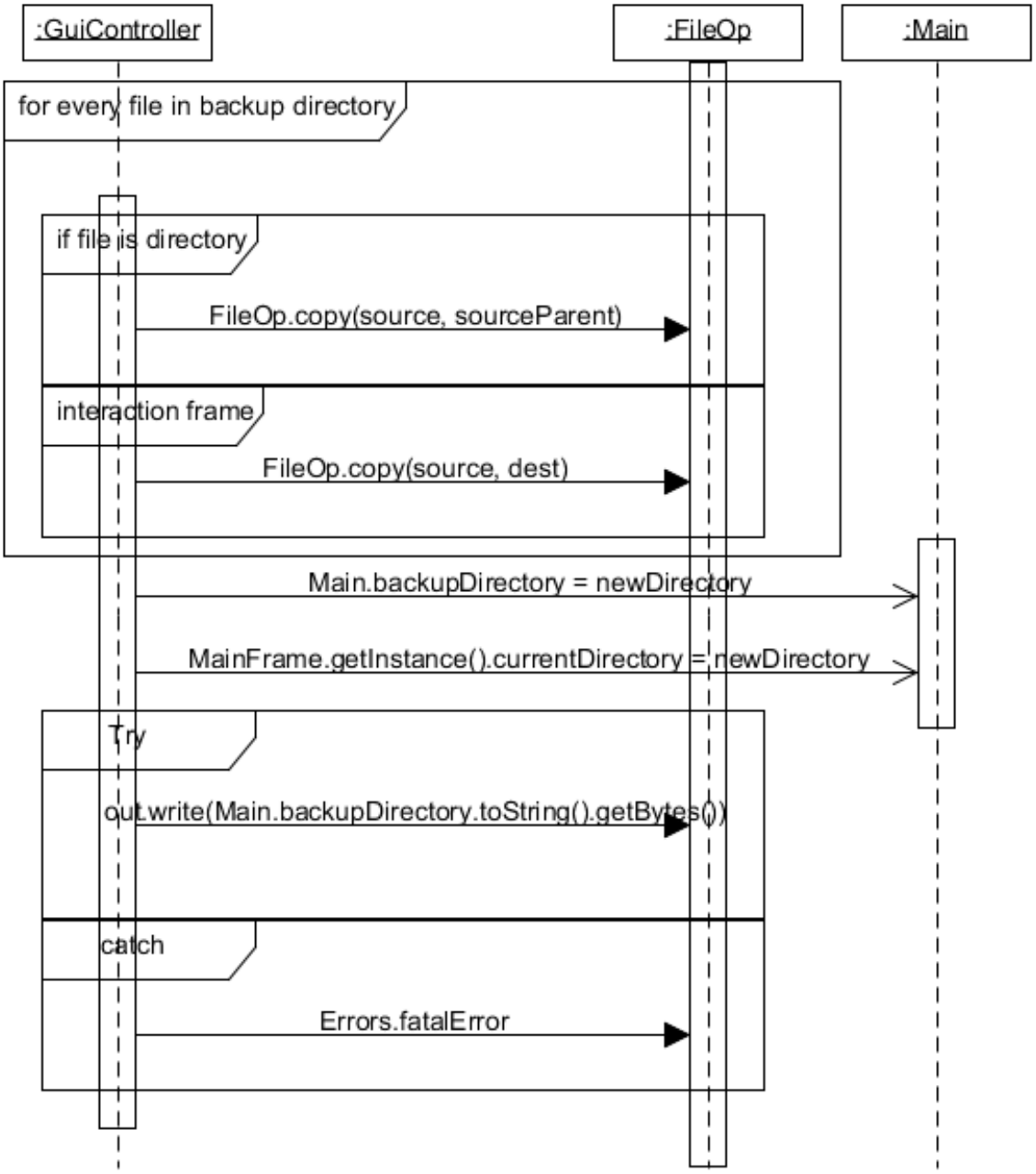
3.2.2 GuiController.displayRevision



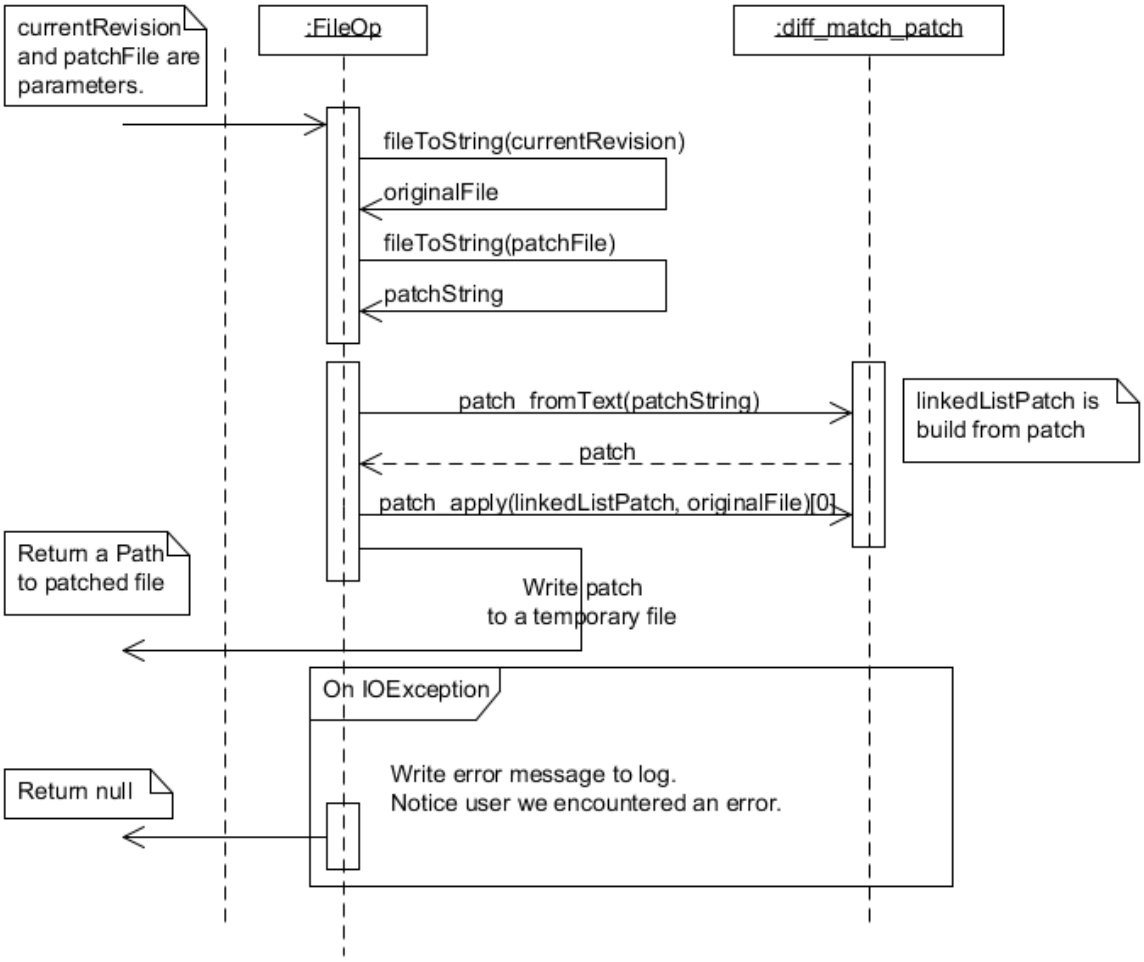
3.2.3 GuiController.changeLiveDirectory



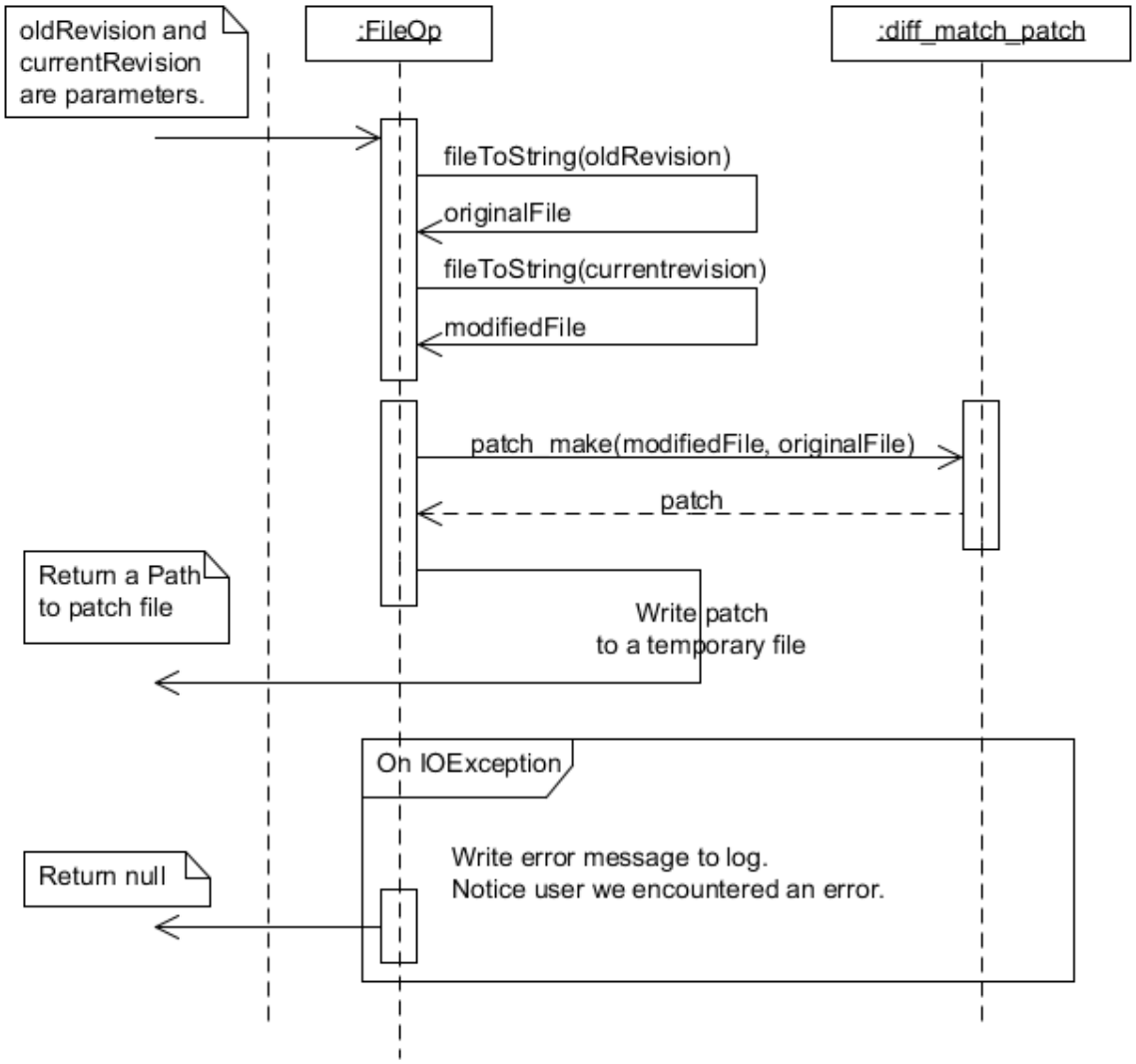
3.2.4 GuiController.changeBackupDirectory



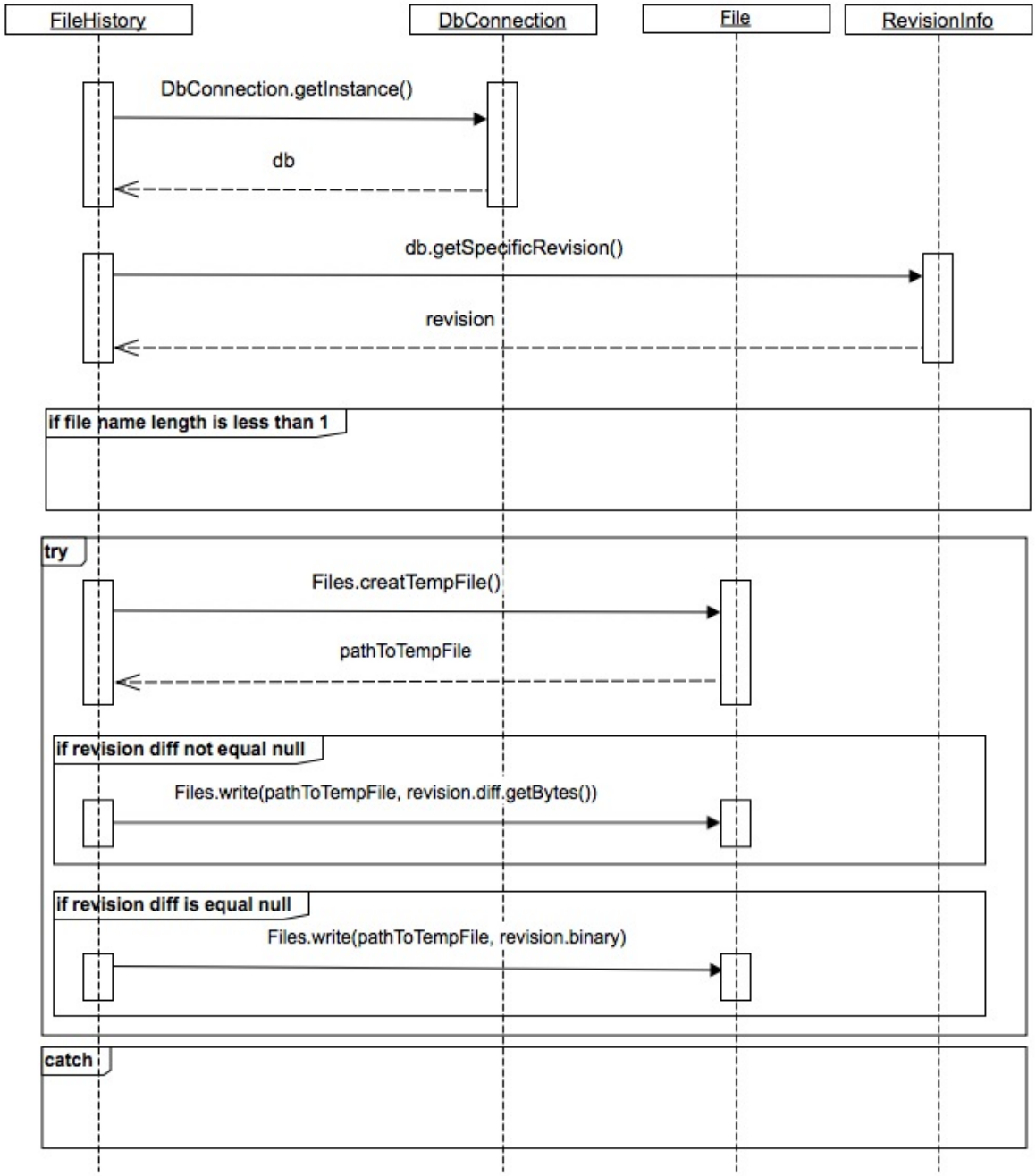
3.2.5 FileOp.applyPatch



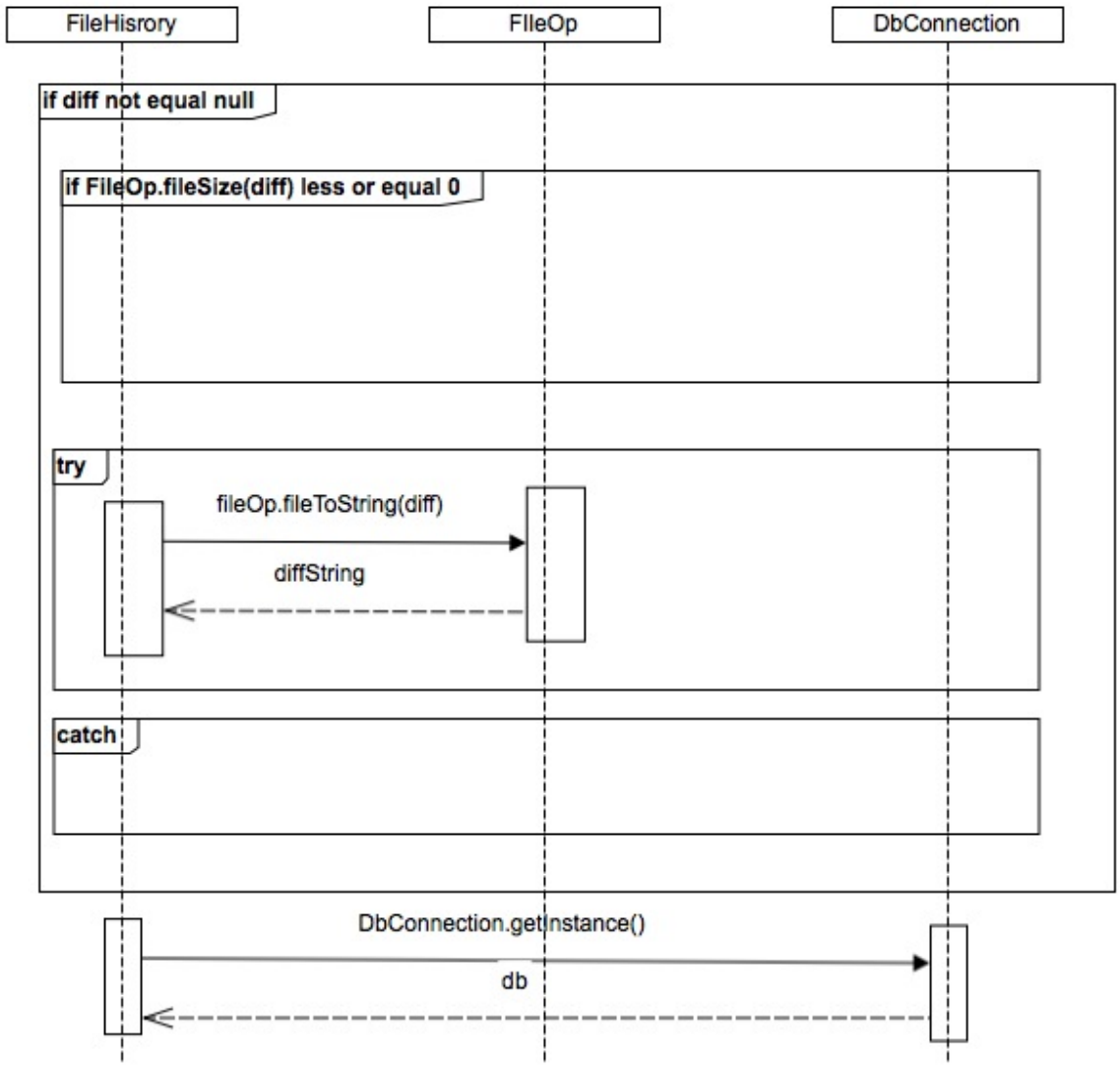
3.2.6 FileOp.createPatch



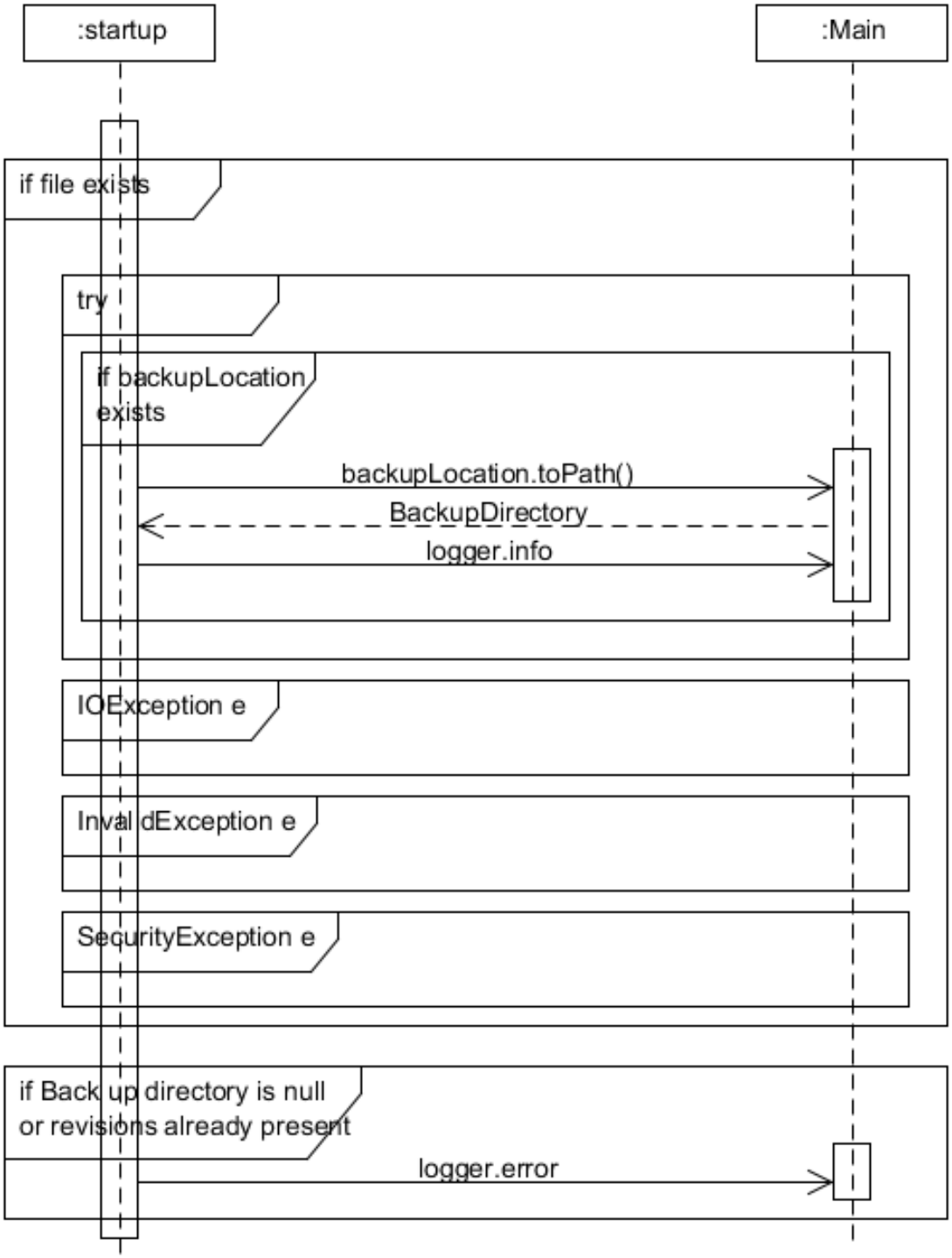
3.2.7 FileHistory.getRevisionInfo



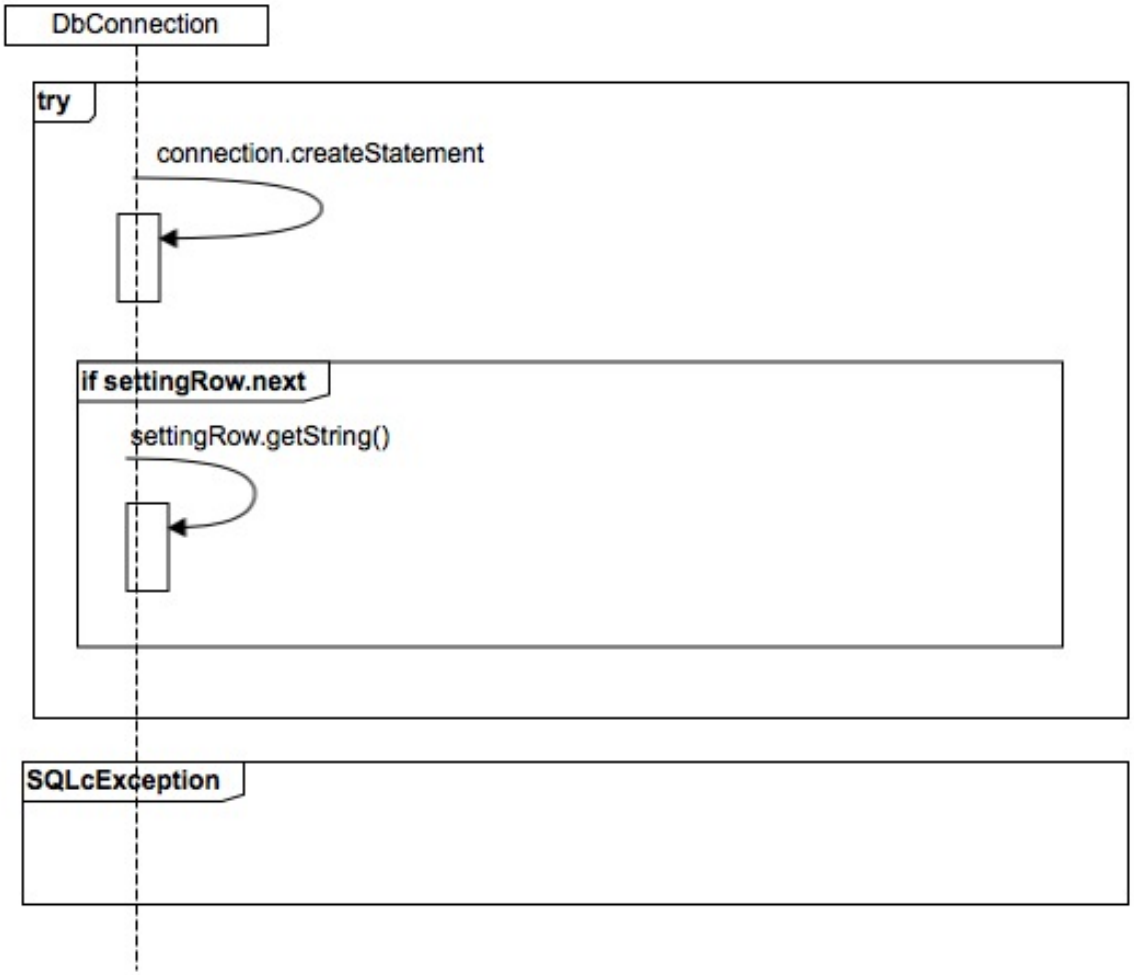
3.2.8 FileHistory.storeRevision



3.2.9 Startup.resolveBackupDirectory



3.2.10 DbConnection.getConfig



3.3 Class diagram

The class diagram is too large to embed in this document, so has been included separately as the file `class_diagram.png`.

3.4 Unit testing

- Test cases
  The test file is in `/trunk/main/src/cmpt370/fbms/test`. All test cases are in package `cmpt370.fbms.test` to keep other packages clean.
- What is tested
  FileOp, FileChangeHandlers, and parts of DbConnection, DataRetriever is tested

by JUnit. Some methods are tested in one test, since they have a close relationship. Some time-depended result needs human to check.
The GUI parts (`Errors`) are test by a special `TestCase` class, TesterVisual. Since GUI needs "look good", this test case always reports successful. However, you need to check the look and feel of the windows.

- JUnit is helpful
  With JUnit, it becomes easy to detect bugs in program. Besides, when the program evolves, The only thing is to add tests to test suite and test again. Less manpower is consumed by testing basic part.
  Some parts of the program used TDD. JUnit also speeds TDD. It clearly shows what passed test and what not, and gives a very distinct view of test results. Since it integrates with Eclipse, It is avoided to check output line by line at most time.

4 Re-engineering

4.1 Code smells

Our project was found to have only two clones (both blind, with the latter also being classified as consistent). Preventing poor practices like clones was kept in mind when designing our program (and indeed, we probably removed several clones before we reached this point). We have no need to guess on why these clones appeared: we know why they exist.

ID	**Root causes**	**Comments**
40 42	3.a(ii) 1.a(iv)	**FirstStartWizard.java lines 101-141 and 148-186** Main reason is that abstraction here creates complexity. The two functions generate panels for the first start wizard. They need two different logging methods, two of the buttons need different labels, the panel text is different, and the values passed into two other functions are different. The large number of differences would mean abstracting the problem into multiple functions would require a very large number of parameters, which ultimately ends up more confusing than the repetition.

101 102	3.a(ii) 3.a(iv)	**MainMenu.java lines 148-176 181-210** These two functions handle changing the backup and live directories, respectively. They're fairly similar except for the variables used to store the chosen path and the fact that they call different functions in their bodies. The latter is the reason for the clone. These small methods weren't deemed worth the bother of implementing callbacks to handle the difference in their implementation. They're too specific and they are easier to understand without the necessary callback.

There are **no** clones in our project that cannot be refactored. All of our clones could be removed, we merely have deemed them not worth removing, for the reasons mentioned in the table.

There are some areas in our code, however, that resemble clones (but were not picked up by the clone detection software) and cannot be removed. In particular, the `TableSelectionListener` and `RevisionTableSelectionListener` classes, located in `MainFrame.java` and `RevisionDialog.java`, respectfully, are quite similar at first look. With the exception of their constructors, they contain the same functions.

However, their behavior is quite different. They need to access variables in different ways to make all the necessary changes to the window (the table selector for the main frame, for example, has to disable menu options in the `MainMenu` object), one has to check if the selected row is a file or folder (whereas the other is selecting revisions which are assumed to exist in the database).

As an end result, there's a complicated network of dependencies and variances between those classes. They appear similar, but they just aren't compatible with each other and cannot be reliably merged while maintaining consistent functionality.

4.2 Refactoring

- We changed the static class `DbManager` into a singleton, and renamed it to `DbConnection`. In doing so, we set all the methods as non-static, added a private constructor, and added a `getInstance()` method.
- We added helper method to handlers, which is `validateLists()` for clearing the lists, which lets us remove a vital dependency from `GuiController`.
- `Main` has become a singleton. This allows us to objectify `Watcher` and `GuiController` better, and decoupling the lists, which are no longer static.
- `FileInfo` implemented `Comparible` to make comparisons between `FileInfo` objects considerably easier.

- We renamed the `FileHistory`'s `obtainRevision()` method to `obtainRevisionContent()`, which made the workings clearer and reduced confusion with the other methods in the class, which had similar names like `getRevision()` (which was renamed to `getRevisionInfo()`.
- The if clauses in `DbConnection` (line 115 and 129) and `Startup` (line 270) are reversed to enhance the readability.
- The nested classes in `FirstStartWizard`, `RevisionDialog` and `MainFrame` are not implementing `MouseListener`. They are extending `MouseAdapter` to reduce code length.
- Some excalmatory marks, `==true` in `FileChangeHandlers` are removed to enhance the readability.
- Removed and consolidated rudundant code in `FileChangeHandlers` including common `FileOp` and `FileHistory` method call patterns. Putting them instead into class internal helper functions.

4.3 Gang of Four design patterns

We used several Gang of Four design patterns in our project. One of the most notable is the use of a singleton for the `DbConnection` class. We used a singleton here because it's very slow to create and close connections at whim. The SQLite database manager we used supports serialized access, so the singleton is thread-safe.

The `FileOp` class, which performs file operations, is a facade. It provides easier access to modifications of the Java `Files` class and the libraries that we used. This makes the parameters and return values easier to work with and reduces the code present in other files. For example, we could copy a file with `Files.copy()`, but that doesn't handle directories well. `FileOp.copy()` cleanly handles both directories and files. It also allows us to just specify the directory to copy to, not the destination file name.

Or for another example, `isPlainText()` provides a simple way to get the MIME type from Java MIME magic and determine if the MIME type starts with "text". Without the use of `FileOp`, we'd be repeating a large block of code that is not as easily understood as "is plain text".

5 Complete implementation and product delivery

5.1 Naming conventions

In regards to naming conventions, our code roughly follows the *Code Conventions for the Java language*[4] as outlined by Sun.

5.2 Commenting

The FBMS project aims to be self documenting where possible. All functions and classes, however, are commented to explain their use, parameters, and return types.

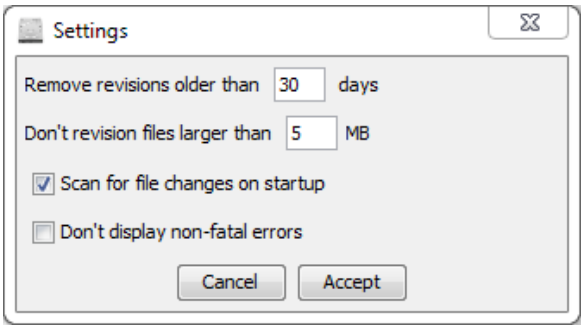
5.3 Pretty-printing of the source

Instead of using some additional tool for formatting the source, we use the formatter built into Eclipse[5]. We configured the formatter to use our agreed upon conventions (a modified version of the *Code Conventions for the Java language*[4]) upon save.

Some of the differences include using tabs instead of spaces (for numerous reasons including consistency between editors and ease of use) and having braces start on a new line (making the opening braces easier to see).

5.4 Usability engineering

We designed FBMS to be easy to use and intuitive. The bulk of the user accessible portion of the program (ie, the GUI) is largely a file browser, so we looked at existing file browsers (such as Windows Explorer[6] and Dolphin[7]) for design patterns. In particular, we changed the "default" behavior of the enter key in the file browser's table to activate the row instead of go to the next row. Similarly, rows are selected by single click and activated by double click.



The settings dialog tries to phrase the options in a naturally readable manner and uses tooltips.

In a number of places, we needed to prompt the user for paths (such as when choosing the live or backup directory). To make this more convenient, we supplied file chooser dialogs that only showed folders. We also skinned these dialogs to use the system dialog. So Windows users will see a Window-themed file chooser while Linx users would see an Linux themed file chooser.

The first run wizard was also intended to make the program much more usable. Instead of filling a configuration file or such, the user is guided through choosing the live and backup directories (or importing an existing backup) via a GUI wizard. This is not only more user friendly, but presents the opportunity to tell the user a bit about the program and how to use it.

To make the revision dialog more friendly, we added color based on whether a revision added or removed bytes. This dialog was inspired by the history pages of Wikipedia[8].

We also included an option in the program's menu that opens up the documentation in their web browser.

As per the marker's feedback in milestone 4, we implemented auto-refresh to the file browser and revisions dialog window. Now it is no longer necessary to re-open the revisions dialog to see changes to the revisions. We further added tooltips to all the menu options and toolbar icons, ensuring the user can easily find out what an option or feature does.

5.5 Complete implementation

We have included the implementation in "release" and "development" versions.

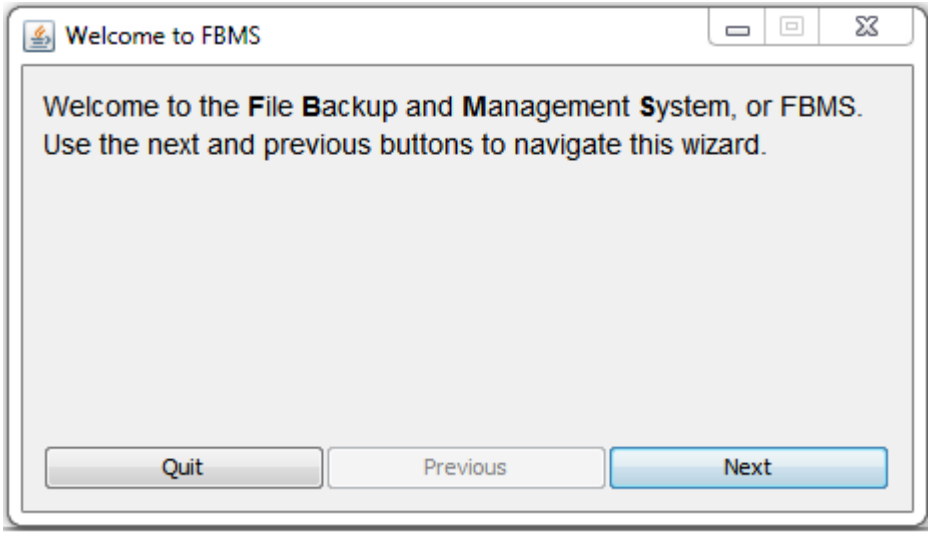
The release version is pre-built and easy to use: just run the batch file (Windows) or shell script (Linux). This version is intended to allow the program to be run in a straightforward manner (allowing easy testing) and with optimal performance.

The development version does not contain pre-built binaries, but has the full source code available. To compile this, you will need Eclipse[5] or Ant[9]. This version is intended to allow the source code to be examined. Running the development program will be slower than the release version, since debugging is enabled and logging uses slower, more exact methods.

The release version is located in the `release` folder, relative to the location of this file. The development version is located in the `development` folder.

5.6 User manual

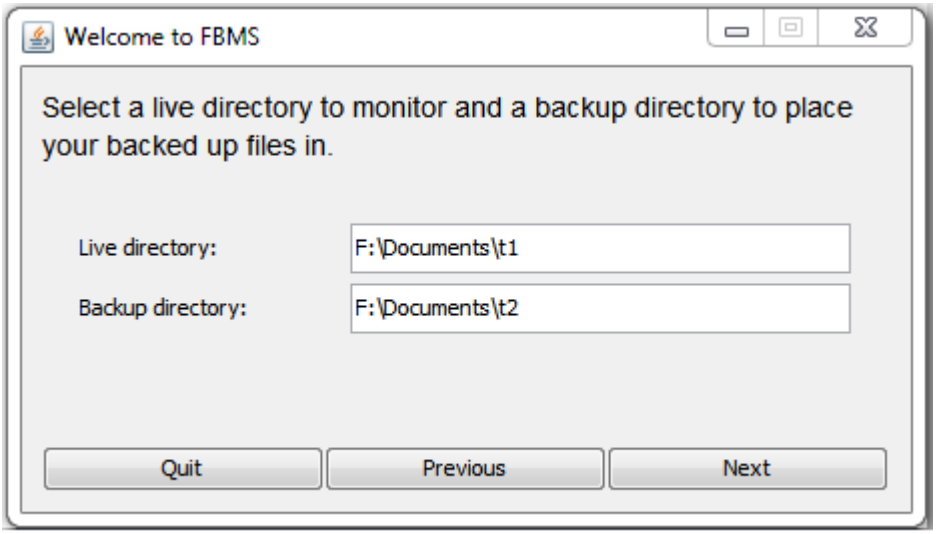
When the program is started for the first time, a wizard will guide you through selecting your live and backup directories.



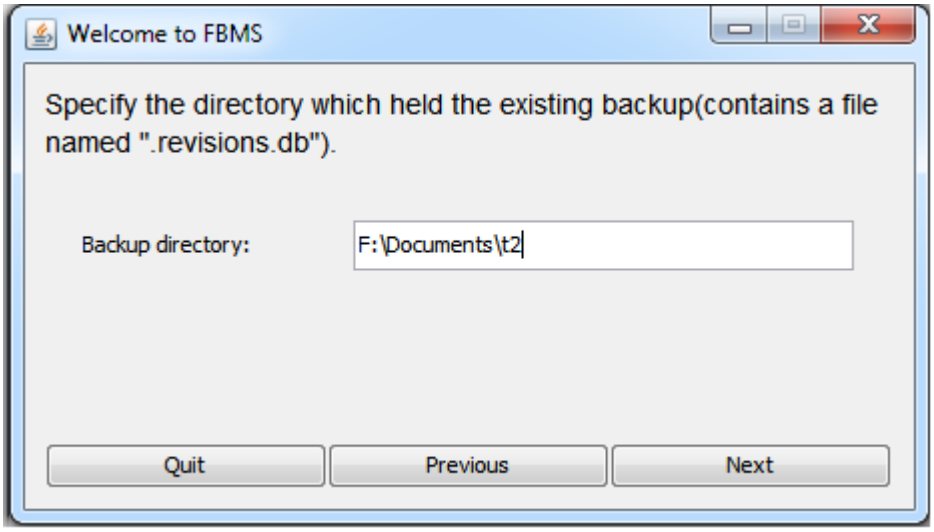
The first run wizard introduction panel

You can opt to start from scratch (specifying a backup and live directory), or import an existing backup directory (which will determine the live directory from previously saved settings).

- **Live directory:** The folder that you want to keep backed up and revisioned.
- **Backup directory:** The location to store the backup. Don't use an existing folder, or you risk losing your files.



Selecting new folder locations



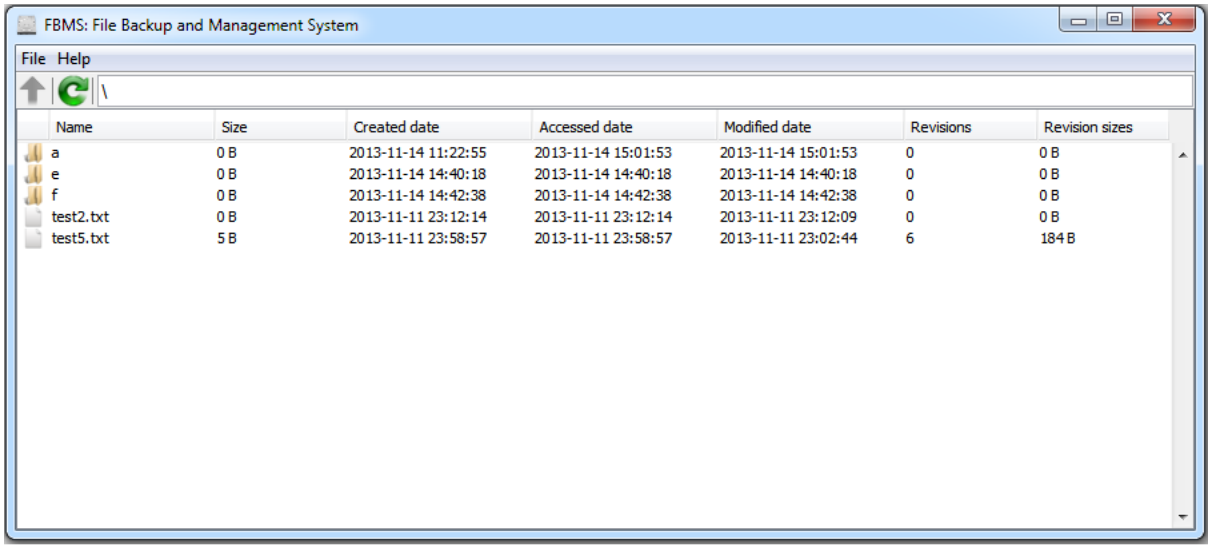
Selecting a previously created backup location

Once folders are chosen and the wizard is completed, the program will run quietly in the background. An icon will be created on the system tray. Double clicking this icon will open the program's interface.

Right clicking the system tray icon

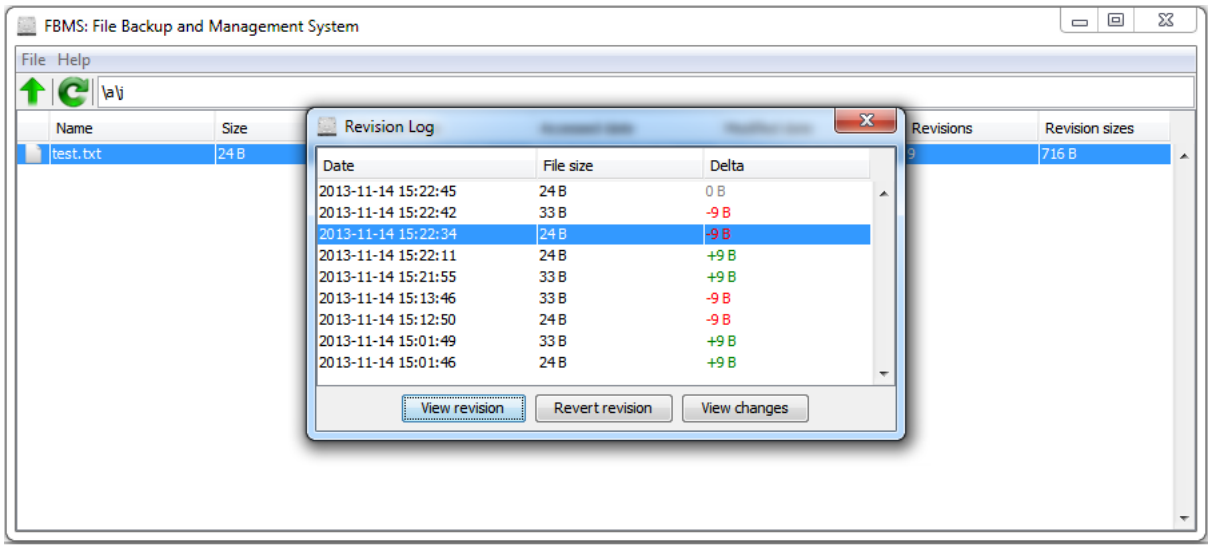
The interface shows a special file browser, which displays the contents of the backup

directory along with information such as the number of revisions stored. This file browser can be navigated with the keyboard or a mouse, and has functionality similar to other file browsers, such as Windows Explorer or Dolphin. It is, however, a specialized browser intended only to be able to restore files and view revisions.



The main program window

Double clicking a file will open the revisions dialog, displaying a list of past revisions (if there are any). These revisions can be viewed (which opens the revision in your default program) or reverted (which sets that file in your live directory to the specified revision). You can also view the changes introduced by a revision, which will open in your default web browser.



Viewing a file's revisions

The file browser is also able to:

- Copy the selected file to a chosen folder: From the "File" menu, choose "copy-to" while selecting a file. This will open a prompt for choosing the location you wish to copy the selected file to.

- Restore all files: From the "File" menu, choose "restore all". This will open a prompt for choosing the location you wish to restore all the files to.
- Change the live or backup directory: From the "File" menu, choose either "Change live directory" or 'Change backup directory". This will open a prompt for choosing the directory. The live and backup directories cannot be children of each other.

FBMS is also able to detect when files have changed since the last time you ran the program. When starting the program up, FBMS will perform a one time scan for file changes. This scan is slow, and can be disabled in the settings if FBMS is always running.

The settings dialog is accessed under the File menu of the GUI. It provides a few choices such as:

- Whether or not to display non-fatal error messages (which don't stop the program from running, but notify the user of issues).
- Whether or not to run the previously mentioned first run scan
- Whether or not to enable the trim feature, which removes revisions older than a specified date.

In terms of file operations, there's several operations that can occur:

- A file is created: if the file doesn't already exist, it is merely backed up. If the file does exist, this is treated like a modification.
- A file is modified: if the file already exists, it is backed up and revisioned. If it doesn't already exist, this is treated like a creation.
- A file is renamed: if the old name already exists, that is renamed, otherwise this is treated like a creation (under the new name). If the new name doesn't already exist, we rename the file. If the new name already exists, we treat this like a modification, backing up and revisioning the file. The current behavior of "renaming" a file is to make a copy and move the revisions to the new name. To allow the old name to be restored, it is not deleted. Therefore, we end up with copies (this will be improved in future versions of the software, which will keep track of name history).
- A file is deleted: The file is not removed from the backup directory, but files that no longer exist in the live directory will be marked with an exclamation mark in the file browser.

6 Project plan, budget justification, and performance evaluation

The following table breaks up the development of this milestone by group member. The time spent developing past milestones where contents was copied to this milestone is **not** included in this table.

List of tasks	Completed by	Comments

Abstract	Hoffert(0.1h)	
1. Introduction		
1.1. System description	Hoffert(0.1h)	
1.2. Business case	Hoffert(0.1h)	
1.3. User-level goals	Hoffert(0.1h)	
1.4. User scenarios	Hoffert(0.1h)	
1.5. Scope document	Hoffert(0.1h)	
1.6. Project plan	Hoffert(0.2h)	
1.7. User involvement plan	Hoffert(0.1h)	
1.8. Low fidelity prototypes	Hoffert(0.25h)	
2. Requirements and early design		
2.1. Summary use cases	Hoffert(2h) Tao(1.5h) Rizvi(2h) Alsharif(2h) Butler(2h)	
2.2. Fully-dressed use cases	Hoffert(0.5h) Tao(0.5h) Rizvi(1.5h) Alsharif (1.5h)) Butler(0.5h)	Adapted to current design.
2.3. Use case diagram	Tao(0.5h)	
2.4. Domain model	Butler(3h)	
2.5. Glossary	Hoffert(0.25h)	
2.6. Supplementary specification	Hoffert(0.25h) Tao(0.5h) Rizvi(1h) Alsharif(1.5h) Butler(0.5h)	
2.7. System sequence diagrams	Hoffert(0.5h) Rizvi(1.5h) Alsharif(1.5h) Butler(0.5h)	
2.8. Operation contracts	Hoffert(1.5h) Tao(1.5h)	References of use cases by Tao
2.9. Obtaining user feedback	Hoffert(0.25h)	
3. Updated design and unit testing		
3.1. System operations	Hoffert(0.25h)	
3.2. Sequence diagrams	Hoffert(2h) Tao(3h) Rizvi(3h) Alsharif(3h) Butler(3h)	
3.3. Class diagram	Hoffert(1.5h)	

3.4. Unit testing	Tao(5.0h)	Revamping included
4. Re-engineering		
4.1. Code smells	Hoffert(2h)	
4.2. Refactoring	Hoffert(0.25h) Tao(1h) Rizvi(1.5h) Alsharif(0.5h) Butler(0.5h)	
4.3. Gang of Four design patterns	Hoffert(0.5h)	
5. Complete implementation		These conventions were followed from the start
5.1. Naming conventions	Hoffert(0h)	
5.2. Commenting	Hoffert(0h)	
5.3. Pretty-printing	Hoffert(0.1h)	
5.4. Usability engineering	Hoffert(0.5h)	
5.5. Complete implementation	Hoffert(1h)	
5.6. User manual	Hoffert(0.5h)	
6. Project plan, evaluation	Hoffert(0.5h)	
7. Conclusion	Hoffert(0.25h)	
8. Acknowledgements	Hoffert(0.25h)	
References	Hoffert(0h)	
Total member contributions	**Hoffert**	15.5h
	Tao	13.5h
	Butler	11.5h
	Rizvi	9.0h
	Alsharif	10.0h
Grand total		59.5h

The next table summarizes the time spent by each member throughout the project (not including the time counted on the above table):

Group member	**Responsible for**	**Contributions**	**Comments**
Hoffert	Planning and documentation	5 hours	Almost entire technical details document
	Previous milestones	14 hours	
	Utility demo	8 hours	Used to test features and toy demo in M2
	Skeleton implementation and PoD classes	2 hours	
	Watcher class	1 hour	
	DbConnection.init()	3 hours	
	FirstRunWizard	6 hours	
	Data.getFolderContents()	2 hours	Later renamed “DataRetriever”

	Various Control code related to startup	5 hours	
	JUnit testing code	4 hours	Most later revamped by Tao
	Errors class	3 hours	
	MainFrame table	5 hours	Table and listener dominantly my work
	MainMenu functionality	2 hours	
	MainToolBar functionality	1 hour	
	RevisionDialog table	2 hours	
	SettingsDialog	3 hours	
	Redid FileOp.createPatch and FileOp.applyPatch	2 hours	Original library didn't work
	Data.getTableData and Data.getRevisionData	3 hours	
	Data number formatting	1 hour	With some third party code
	Trim database feature	3 hours	
	FileOp utility functions	2 hours	
	Refactoring	4 hours	Objectification, use of design patterns
	Binary revisioning feature	5 hours	Also lumped in bug fixes to file handlers
	MIME detection	3 hours	Getting Java MIME Magic to work
	Usability fixes	3 hours	As suggested by marker in M5
	Miscellaneous bug fixes	4 hours	Numerous smaller bug fixes
	Total for Hoffert	96 hours	62% of the commits from one person
Tao	Rough design of modules	1 hour	
	Rough design of functions	1 hour	
	Work on M1-M3	4 hours	
	Work on M4 text	5 hours	
	Work on M4 graph	2 hours	
	Work on FileOp	7 hours	
	Revamping test case	4 hours	
	FileOp test cases	2 hours	
	FileChangeHandlers test cases	5 hours	
	Work on FileHistory	6 hours	
	Redo operation contracts	1 hours	
	Build.xml and run script	4.5 hours	
	Work on M5 graph	5 hours	

	Miscellaneous bug fixes	3.5 hours	
	Total for Tao	51 hours	Preliminary design and library suggestion
Butler	Milestone 1-5	8 hours	
	getConfig()	3 hours	
	setConfig	3 hours	
	handleCreatedFiles	6 hours	
	handleDeletedFiles	2 hours	
	handleModifiedFiles	4 hours	
	handleRenamedFiles	3 hours	
	Refactoring	3.5 hours	File change handlers
	testing	4 hours	
	debugging/optimization	4 hours	
	Total for Butler	40.5 hours	
Rizvi	Milestone(1-4) documentation	7 hours	
	frontend implementation	4 hours	
	GUI brainstorm	7 hours	
	GUI implementation	10 hours	
	Testing and reporting	6 hours	
	Milestone 5	3 hours	
	Total for Rizvi	37 hours	
Alsharif	Milestone (1-4)	9 hours	
	work on presentation slides	3 hours	
	FileOp.creatPatch	4 hours	
	FileOp.fileToList	4 hours	
	Test FileOp.creatPatch	2 hours	
	Test FileOp.fileToList	3 hours	
	FileOp.applyPatch	6 hours	
	Milestone 5	4 hours	
	Total for Alsharif	35 hours	

Our initial estimate focused largely on the "basics", the features we absolutely needed. However, we finished those and managed to add many extra features that weren't originally planned. The introduction estimated 150 man hours of work to create the system. The features mentioned in the introduction took 147 man hours including planning, testing, and debugging time, but not including time spent on the milestones.

This indicates that our estimate was very close. If we include the time spent on past milestones (not including this one), the total time comes to over 200 man hours. Another 15 man hours was needed to bring the program up to version 2.0, which consisted entirely of "extra" features.

7 Conclusion

FBMS is a program that balances ease of use with power. It's geared at those wanting something inbetween the power of version control and the ease of use of online backup solutions. FBMS goes beyond most backup systems to store revisions of files. Monitoring the file system real time allowed efficiency for the system, which focuses on a single folder rather than an entire hard drive.

FBMS is best used for small projects where files change rapidly, where the system's live monitoring comes in handy. FBMS supports multi-drive systems, and works best when the backup and live directory are on different drives, decreasing the risk of losing both at the same time.

8 Acknowledgements

FBMS was created by:

- Mike Hoffert (mlh374)
- Da Tao (dat293)
- Michael Butler (mdb815)
- Ahsen Rizvi (sar457)
- Hattan Alsharif (haa775)

Some code derived from work by:

- aioobe <http://stackoverflow.com/users/276052/aioobe>
- erickson <http://stackoverflow.com/users/3474/erickson>

Resources:

- Program and refresh icons by oxygen (CC-BY-SA 3.0)
  http://www.oxygen-icons.org/
- Up icon by crystal (LGPL-2.1)
  http://www.everaldo.com/
- File and folder icons by nuovext2 (LGPL-2.1)
  http://nuovext.pwsp.net/

SQLite JDBC Driver is licensed under the Apache License v2:
https://bitbucket.org/xerial/sqlite-jdbc

JNotify is licensed under the LGPL v2:
http://jnotify.sourceforge.net/

google-diff-match-patch is licensed under the Apache License v2:
https://code.google.com/p/google-diff-match-patch/

Java MIME Magic is licensed under GPL v2:
https://github.com/arimus/jmimemagic

References

[1] Dropbox: https://www.dropbox.com/

[2] Subversion: https://subversion.apache.org/

[3] Git: http://git-scm.com/

[4] Code Conventions for the Java language: http://www.oracle.com/technetwork/java/javase/documentation/codeconvtoc-136057.html

[5] The Eclipse IDE: http://www.eclipse.org/

[6] Windows Explorer on Wikipedia: https://en.wikipedia.org/wiki/File_Explorer

[7] Dolphin File Manager: http://dolphin.kde.org/

[8] Example Wikipedia history page: https://en.wikipedia.org/w/index.php?title=Software_engineering&action=history

[9] Apache Ant: https://ant.apache.org/