

Module Guide for REACH

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1 Revision History

Date	Version	Notes
01/16/24	1.0	Add module decomposition
01/16/24	1.1	Add module descriptions for hardware hiding modules
01/17/24	1.2	Add module descriptions for behaviour hiding/decision hiding modules, and uses diagram
01/17/24	1.3	Finalize/cleanup module guide
04/04/2024	1.4	Update module guide to match current state of the project

2 Reference Material

This section records information for easy reference.

2.1 Abbreviations and Acronyms

symbol	description
AC	Anticipated Change
DAG	Directed Acyclic Graph
M	Module
MG	Module Guide
OS	Operating System
FR	Functional Requirement
SRS	Software Requirements Specification
Software Engineering	Explanation of program name
UC	Unlikely Change

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3 Introduction

Decomposing a system into modules is a commonly accepted approach to developing software. A module is a work assignment for a programmer or programming team (Parnas et al., 1984). We advocate a decomposition based on the principle of information hiding (Parnas, 1972). This principle supports design for change, because the “secrets” that each module hides represent likely future changes. Design for change is valuable in SC, where modifications are frequent, especially during initial development as the solution space is explored.

Our design follows the rules laid out by Parnas et al. (1984), as follows:

- System details that are likely to change independently should be the secrets of separate modules.
- Each data structure is implemented in only one module.
- Any other program that requires information stored in a module’s data structures must obtain it by calling access programs belonging to that module.

After completing the first stage of the design, the Software Requirements Specification (SRS), the Module Guide (MG) is developed (Parnas et al., 1984). The MG specifies the modular structure of the system and is intended to allow both designers and maintainers to easily identify the parts of the software. The potential readers of this document are as follows:

- New project members: This document can be a guide for a new project member to easily understand the overall structure and quickly find the relevant modules they are searching for.
- Maintainers: The hierarchical structure of the module guide improves the maintainers’ understanding when they need to make changes to the system. It is important for a maintainer to update the relevant sections of the document after changes have been made.
- Designers: Once the module guide has been written, it can be used to check for consistency, feasibility, and flexibility. Designers can verify the system in various ways, such as consistency among modules, feasibility of the decomposition, and flexibility of the design.

The rest of the document is organized as follows. Section 4 lists the anticipated and unlikely changes of the software requirements. Section 5 summarizes the module decomposition that was constructed according to the likely changes. Section 6 specifies the connections between the software requirements and the modules. Section 7 gives a detailed description of the modules. Section 8 includes two traceability matrices. One checks the completeness of the design against the requirements provided in the SRS. The other shows the relation between anticipated changes and the modules. Section 9 describes the use relation between modules.

4 Anticipated and Unlikely Changes

This section lists possible changes to the system. According to the likeliness of the change, the possible changes are classified into two categories. Anticipated changes are listed in Section 4.1, and unlikely changes are listed in Section 4.2.

4.1 Anticipated Changes

Anticipated changes are the source of the information that is to be hidden inside the modules. Ideally, changing one of the anticipated changes will only require changing the one module that hides the associated decision. The approach adapted here is called design for change.

AC1: The format of user data and how it is validated.

AC2: The format of profile data and how it is validated.

AC3: The format of trial data and how it is validated.

AC4: How trials are gathered from external, clinical trial repositories.

AC5: How trials are filtered after gathering trials from external, clinical trial repositories.

AC6: How email notifications are triggered and sent to users.

AC7: The format of the email templates.

AC8: The process of account creation.

AC9: The process of logging in to an account.

AC10: How the input data forms for user profiles are presented to the user.

AC11: How the registration forms will be presented to the user.

AC12: How the list user profiles are presented to the user.

AC13: How eligible trials are presented to the user.

AC14: The look/feel of general UI components, present on every page.

4.2 Unlikely Changes

The module design should be as general as possible. However, a general system is more complex. Sometimes this complexity is not necessary. Fixing some design decisions at the system architecture stage can simplify the software design. If these decision should later need to be changed, then many parts of the design will potentially need to be modified. Hence, it is not intended that these decisions will be changed.

- UC1:** The type of database used (type: relational).
- UC2:** The external repository for clinical trials (repository: clinicaltrials.gov).
- UC3:** The types of notifications sent to users (type: email).
- UC4:** Being able to create and search based on multiple profiles.
- UC5:** The device used to access the application (device: computer).
- UC6:** Cloud platform used to deploy the web application (platform: google cloud).
- UC7:** The operating system the application will run on (OS: linux).

5 Module Hierarchy

This section provides an overview of the module design. Modules are summarized in a hierarchy decomposed by secrets in Figure 1. The modules listed below, which are leaves in the hierarchy tree, are the modules that will actually be implemented.

Leaf modules:

- M1:** User data module
- M2:** Patient info module
- M3:** Trial data module
- M4:** Trial fetching module
- M5:** Trial filtering module
- M6:** Notification system module
- M7:** Email template module
- M8:** Registration module
- M9:** Login module
- M10:** Data collection module
- M11:** Registration visualization module
- M12:** User profile module
- M13:** Trial display module

M14: Base UI module

Non-Leaf modules:

M15: Database hiding module

M16: Concurrent execution hiding module

M17: Visualization hiding module

Module Hierarchy:

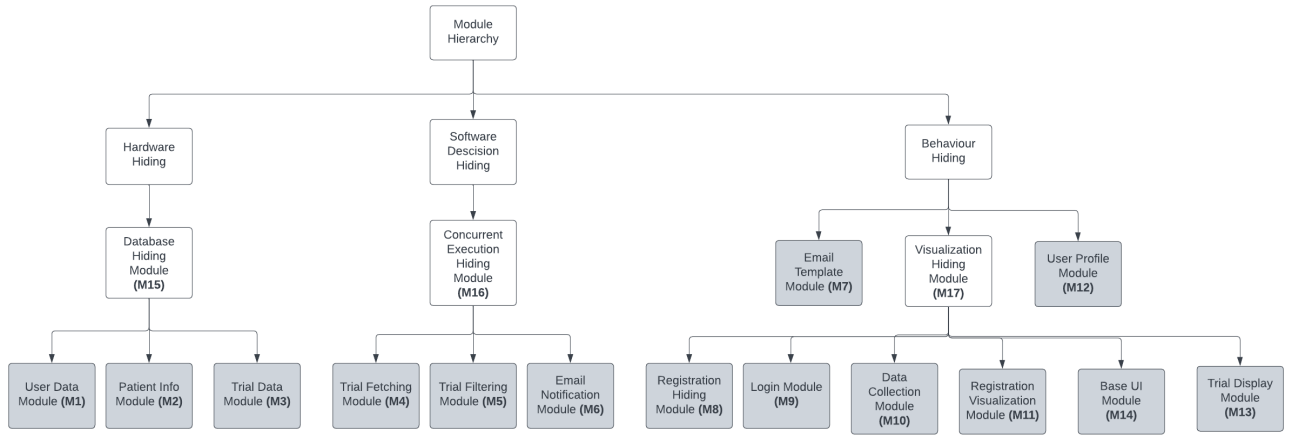


Figure 1: The module hierarchy for REACH.

6 Connection Between Requirements and Design

The design of the system is intended to satisfy the requirements developed in the SRS. In this stage, the system is decomposed into modules. The connection between requirements and modules is listed in Table 2.

7 Module Decomposition

Modules are decomposed according to the principle of “information hiding” proposed by Parnas et al. (1984). The *Secrets* field in a module decomposition is a brief statement of the design decision hidden by the module. The *Services* field specifies *what* the module will do without documenting *how* to do it. For each module, a suggestion for the implementing software is given under the *Implemented By* title. If the entry is *OS*, this means that the

module is provided by the operating system or by standard programming language libraries. *Software Engineering* means the module will be implemented by the Software Engineering software.

Only the leaf modules in the hierarchy have to be implemented. If a dash (–) is shown, this means that the module is not a leaf and will not have to be implemented.

7.1 Hardware Hiding Modules

7.1.1 Database Hiding Module (M15)

Secrets: How data is stored on the physical database machines.

Services: Organizes and stores data to be used by the software system in an efficient and effective manner.

Implemented By: -

7.1.2 User Data Module (M1)

Secrets: How user data is formatted, validated, and stored for future use by the system.

Services: Provides an interface/abstraction over all the user data that is currently available in the database, and any new data that needs to be stored.

Implemented By: REACH

7.1.3 Patient Info Module (M2)

Secrets: How patient information/profiles are formatted, validated, and stored for future use by the system.

Services: Provides an interface/abstraction over all the patient profiles that are currently available in the database, and any new profiles that need to be stored.

Implemented By: REACH

7.1.4 Trial Data Module (M3)

Secrets: How trial data is formatted, validated, and stored for future use by the system.

Services: Provides an interface/abstraction over all the trial data that is currently available in the database, and any new trial data that needs to be stored.

Implemented By: REACH

7.2 Software Decision Module

7.2.1 Concurrent Execution Hiding Module (M16)

Secrets: How jobs/tasks are assigned to different threads of execution, in order to run concurrently.

Services: Allows the user to execute multiple tasks (can be methods, functions, etc..) concurrently.

Implemented By: -

7.2.2 Trial Fetching Module (M4)

Secrets: How the trial API is accessed, how trials are received and exported.

Services: Retrieves a set of trials stored on the ClinicalTrials.gov database.

Implemented By: REACH

7.2.3 Trial Filtering Module (M5)

Secrets: Trial export format, how trials are filtered and sorted, how distances are computed.

Services: Filters and sorts a set of trials from the Trial Fetching module.

Implemented By: REACH

7.2.4 Email Notification Module (M6)

Secrets: Format of the email notification, query to retrieve user data and new trials.

Services: Retrieves new trials from the database and sends an email notification to users that may be interested in them.

Implemented By: REACH

7.3 Behaviour-Hiding Module

7.3.1 Visualization Hiding Module (M17)

Secrets: How program content is visualized.

Services: Allows the user to interact with the REACH system via a user interface.

Implemented By: -

7.3.2 Email Template Module (M7)

Secrets: Format of the email template.

Services: Provides the user with a template email to send to the trial coordinator.

Implemented By:

Type of Module: Abstract Object

7.3.3 Registration Module (M8)

Secrets: How user data is formatted, validated and stored, how the system creates new user profiles, how the system accesses external logon servers.

Services: Provides the user with the ability to create a new user profile.

Implemented By: -

Type of Module: Abstract Object

7.3.4 Login Module (M9)

Secrets: How user data is formatted, validated and stored, how the system creates new user profiles, how the system accesses external logon servers.

Services: Provides the user with the ability to log into and access their user profile.

Implemented By: -

Type of Module: Abstract Object

7.3.5 Data Collection Module (M10)

Secrets: How user data is formatted, validated and stored, how user input is collected.

Services: Collects user data to be stored for future use in searching for trials.

Implemented By: REACH

Type of Module: Abstract Object

7.3.6 Registration Visualization Module (M11)

Secrets: How the registration process is visualized.

Services: Allows user to interact with the registration system via a user interface.

Implemented By: -

Type of Module: Abstract Object

7.3.7 User Profile Module (M12)

Secrets: How user data is formatted, validated and stored.

Services: Provides a model of a user profile, including their basic information and saved trials.

Implemented By: REACH

Type of Module: Abstract Object

7.3.8 Trial Display Module (M13)

Secrets: How to visualize the trial data.

Services: Provides a visual representation of the retrieved trials.

Implemented By: REACH

Type of Module: Abstract Object

7.3.9 Base UI Module (M14)

Secrets: How to visualize the system data, layout and style of the user interface

Services: Provides the user with an interface through which they can interact with the system. Includes processes for displaying GUI elements and program related information, and for accepting user input.

Implemented By: REACH

Type of Module: Abstract Object

8 Traceability Matrix

This section shows two traceability matrices: between the modules and the requirements and between the modules and the anticipated changes.

Req.	Modules
FR1, FR2	M8, M11
FR3, FR4, FR5	M9, M11
FR6	M12, M14
FR7	M10, M14
FR8	M1, M2
FR9	M1, M2, M10
FR10	M7
FR11	M6
FR12	M14
FR13, FR14	M4, M5, M13, M14
FR15	M1, M2, M10
FR16	M1, M2, M12, M13, M14
FR17	M12, M14
FR18	M12, M14
FR19	M5, M12, M14
FR20	M13, M14
FR21	M1, M2, M5, M10

Table 1: Trace Between Functional Requirements and Modules

Req.	Modules
NFR1	M15
NFR2	M16
NFR3	M17
NFR4	M17
NFR5	M17
NFR6	M17
NFR7	M17
NFR8	M17
NFR9	M17
NFR10	M17
NFR11	M17
NFR12	M17
NFR13	M17
NFR14	M17
NFR15	M17
NFR16	M17
NFR17	M17
NFR18	M17

Table 2: Trace Between Non-Functional Requirements and Modules

AC	Modules
AC1	M1
AC2	M2
AC3	M3
AC4	M4
AC5	M5
AC6	M6
AC7	M7
AC8	M8
AC9	M9
AC10	M10
AC11	M11
AC12	M12
AC13	M13
AC14	M14

Table 3: Trace Between Anticipated Changes and Modules

9 Use Hierarchy Between Modules



Figure 2: Use hierarchy among modules

References

- David L. Parnas. On the criteria to be used in decomposing systems into modules. *Comm. ACM*, 15(2):1053–1058, December 1972.
- D.L. Parnas, P.C. Clement, and D. M. Weiss. The modular structure of complex systems. In *International Conference on Software Engineering*, pages 408–419, 1984.