

# Module Guide for 4TB6 - Mechatronics Capstone

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# 1 Revision History

Date	Version	Notes
Jan 2, 2023	1.0	Added Likely and Unlikely Changes

## 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
R	Requirement
SC	Scientific Computing
SRS	Software Requirements Specification
4TB6 - Mechatronics Capstone	Explanation of program name
UC	Unlikely Change
<a href="#">[etc. —SS]</a>	<a href="#">[... —SS]</a>

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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 (?). We advocate a decomposition based on the principle of information hiding (?). 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 layed out by ?, 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 (?). 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:** Depending on the battery life, showing battery percentage on the phone app, as required in FR11, might not be necessary. If the battery life is very long, then perhaps a warning that the battery is low is sufficient.
- AC2:** Having never created an app like this before, the amount of storage needed for the smartphone application is unknown. NFR3 ensures ample space is provided, if any change, this requirement might be revised so that it be required that the app takes up even less storage.
- AC3:** Even though aesthetics is a selling point of any product, it is not a priority for this product. As such, the requirement NFR4 regarding the visual appeal of the design is subject to change.
- AC4:** The degree of accuracy mentioned in NFR8, NFR9, and NFR10 is not possible for the scope of this project.
- AC5:** Given that we will likely not be maintaining the system, requirements regarding maintainability will be difficult to test and verify. While products should be designed with maintainability in mind, it is not a priority for this project. Thus, requirements NFR17, NFR18, NFR19, NFR20 and NFR21 are subject to change.
- AC6:** Requiring an iOS application as stated in NFR22 and NFR23 was chosen given the team's skillset; however, the product's nature does not require the application to be iOS based. Given different preferences and/or skillset, this application could be substituted or extended to an Android application. Note that NFR23 is dependent on NFR22.

### 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:** These requirements are core to the functionality of the product. The product would not accomplish its purpose without meeting these requirements. Thus, these requirements are unlikely to change: FR1, FR2, FR3, FR4, FR5, FR6, FR7, FR8, FR9 and FR13.

**UC2:** These requirements are key selling features of the system, and are therefore unlikely to change: FR10 and FR11.

**UC3:** These requirements are necessary to ensure accessibility for all users: NFR1 and NFR2.

**UC4:** Dependent on requirement FR10, that the lock can be mounted on the bike's frame, NFR5 that the design must not impede normal bike function is necessary for the bike to function at all, and, if the bike does not function, the SmartLock product is useless. As such, this requirement is unlikely to change.

**UC5:** To maintain usability in imperfect weather conditions, requirements NFR6 and NFR7 and are therefore unlikely to change.

**UC6:** The following requirements must be satisfied to maintain an edge over typical, manually engaged/disengaged bike locks, and are therefore unlikely to change: NFR11, NFR12, NFR13, NFR14, NFR15 and NFR16.

## 5 Module Hierarchy

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

**M1:** Hardware-Hiding Module

...

## 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.

Level 1	Level 2
Hardware-Hiding Module	
	?
	?
	?
Behaviour-Hiding Module	?
	?
	?
	?
	?
	?
Software Decision Module	?
	?

Table 1: Module Hierarchy

## 7 Module Decomposition

Modules are decomposed according to the principle of “information hiding” proposed by ?. 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. *4TB6 - Mechatronics Capstone* means the module will be implemented by the 4TB6 - Mechatronics Capstone 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 (M1)

**Secrets:** The data structure and algorithm used to implement the virtual hardware.

**Services:** Serves as a virtual hardware used by the rest of the system. This module provides the interface between the hardware and the software. So, the system can use it to display outputs or to accept inputs.

**Implemented By:** OS



## 7.2 Behaviour-Hiding Module

**Secrets:** The contents of the required behaviours.

**Services:** Includes programs that provide externally visible behaviour of the system as specified in the software requirements specification (SRS) documents. This module serves as a communication layer between the hardware-hiding module and the software decision module. The programs in this module will need to change if there are changes in the SRS.

**Implemented By:** –

### 7.2.1 Input Format Module (M??)

**Secrets:** The format and structure of the input data.

**Services:** Converts the input data into the data structure used by the input parameters module.

**Implemented By:** [Your Program Name Here]

**Type of Module:** [Record, Library, Abstract Object, or Abstract Data Type] [Information to include for leaf modules in the decomposition by secrets tree.]

### 7.2.2 Etc.

## 7.3 Software Decision Module

**Secrets:** The design decision based on mathematical theorems, physical facts, or programming considerations. The secrets of this module are *not* described in the SRS.

**Services:** Includes data structure and algorithms used in the system that do not provide direct interaction with the user.

**Implemented By:** –

### 7.3.1 Etc.

## 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
R1	M1, M??, M??, M??
R2	M??, M??
R3	M??
R4	M??, M??
R5	M??, M??, M??, M??, M??, M??
R6	M??, M??, M??, M??, M??, M??
R7	M??, M??, M??, M??, M??
R8	M??, M??, M??, M??, M??
R9	M??
R10	M??, M??, M??
R11	M??, M??, M??, M??

Table 2: Trace Between Requirements and Modules

AC	Modules
AC??	M1
AC??	M??
AC??	M??
AC??	M??
AC??	M??
AC??	M??
AC??	M??
AC??	M??
AC??	M??
AC??	M??
AC??	M??
AC??	M??

Table 3: Trace Between Anticipated Changes and Modules

## 9 Use Hierarchy Between Modules

In this section, the uses hierarchy between modules is provided. ? said of two programs A and B that A *uses* B if correct execution of B may be necessary for A to complete the task

described in its specification. That is, A *uses* B if there exist situations in which the correct functioning of A depends upon the availability of a correct implementation of B. Figure 1 illustrates the use relation between the modules. It can be seen that the graph is a directed acyclic graph (DAG). Each level of the hierarchy offers a testable and usable subset of the system, and modules in the higher level of the hierarchy are essentially simpler because they use modules from the lower levels.

Figure 1: Use hierarchy among modules

## Appendix — Reflection

The information in this section will be used to evaluate the team members on the graduate attribute of Lifelong Learning. Please answer the following questions:

- 1.
- 2.