

# Module Guide for Chess Connect

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# 1 Revision History

## Table of Revisions

Table 1: Revision History

Date	Developer(s)	Change
2023-01-16	Jonathan Cels, Rupinder Nagra	Web Application Modules
2023-01-17	Alexander Van Kralingen	Detailed Modules used by Arduino Mega 2560
2023-01-18	Jonathan Cels, Rupinder Nagra	Finalized Web Application Modules

## 2 Reference Material

This section records information for easy reference.

### 2.1 Abbreviations and Acronyms

symbol	description
AC	Anticipated Change
M	Module
MG	Module Guide
MIS	Module Interface Specification
OS	Operating System
R	Requirement
UC	Unlikely Change
<a href="#">FEN</a>	Forsyth-Edwards Notation

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## **3 Introduction**

### **3.1 Overview**

The Chess Connect project allows two users to play a game of chess on a physical board with the information being transmitted to an online web application over Bluetooth. Currently, there is no way for players to seamlessly switch between playing on a physical board and playing online, but Chess Connect intends to change this by creating a central platform that will provide flexibility and remove barriers for new players looking to learn the game.

### **3.2 Context**

This document is the Module Guide (MG), which is created after the Software Requirements Specification (SRS). The purpose of the Software Requirements Specification document is to present a description of the software system to be developed, including the functional and non-functional requirements for the project. The following MG has a different purpose, where it is instead providing a modular decomposition of the system, showing the modular structure of the application. The MG also describes how the requirements in the SRS are met with the modular structure that is described. Along with the MG, it is also necessary to create a Module Interface Specification (MIS) explaining the semantics and syntax of each module. Examples of such semantics and syntax includes the access routines, state variables, inputs/outputs, and exceptions of the modules. This document will further expand on the information provided in the MG.

### **3.3 Design Principles**

Information Hiding and Encapsulation are some of the design principles being used to build a modular structure of our application. The project should also assess the software metric of coupling and cohesion. Ideally, the project has high cohesion, and a low degree of coupling. Information Hiding is the process of hiding the details of an object or function. This process disassociates the calling code from the internal workings of the object or function being called. This makes it possible to change the hidden portions without having to also change the calling code. Encapsulation is a design principle that makes it easier to enforce information hiding. Encapsulation simply hides the states of an object of a class by preventing direct access to it. A high cohesion signifies that the methods and data within a module are closely related. Low coupling means that there is a low degree of interdependence between the modules of the system.

### **3.4 Document Structure**

The document structure is organised as follows:

- Section 4 lists Anticipated and Unlikely Changes to the system's implementation. This list is used for the Traceability Matrices later in the document.

- Section 5 presents the Module Hierarchy, listing all the modules and their hierarchy by levels.
- Section 6 describes the Connection Between Requirements and Design, which details how the software requirements are related to the modules.
- Section 7 describes the Module Decomposition, detailing the module secrets, services, and implementations.
- Section 8 provides the Traceability Matrices. The first matrix connects the functional and nonfunctional requirements to the modules. The second matrix connects anticipated changes from Section 2 to the modules.
- Section 9 presents the Uses Hierarchy diagram for the application. The model shows the uses relations 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

**AC1:** The format in which the data is passed from the hardware to the web application.

**AC2:** The implementation of the data structure that stores the game board state.

**AC3:** User options to change the font and board size.

**AC4:** The GUI and interface design.

**AC5:** The amount of time for a move to be reflected on the web application.

**AC6:** The pin configuration for Hall-effect sensors

**AC7:** The pin configuration for LEDs

**AC8:** Transition logic between the various game states

**AC9:** Handling different user actions

## 4.2 Unlikely Changes

**UC1** The user option to play against another user online.

**UC2** The interface functionality of the system.

**UC3** The rules and values related to the game itself.

**UC4** The purpose of the system to allow users to play a game of chess against an opponent.

**UC5:** Valid chess move logic.

**UC6:** Data type definition locations may be shifted between different modules.

## 5 Module Hierarchy

This section provides an overview of the module design. Modules are summarized in a hierarchy decomposed by secrets in Table 2. The modules listed below, which are leaves in the hierarchy tree, are the modules that will actually be implemented.

**M1:** Hardware-Hiding Module

**M2:** Arduino Controller Module

**M3:** Arduino Module

**M4:** Piece Identification Module

**M5:** Chess Board Module

**M6:** Communication Module

**M7:** Software Serial Module

**M8:** Web Application Input Module

**M9:** Display Module

**M10:** Web Application Output Module

**M11:** User Mode Module

**M12:** Board Module

**M13:** Web Application Game State Module

**M14:** Engine Module

The Hardware-Hiding module is implemented by the microcontroller as firmware that controls all of the hardware components. This is implemented by the kernel to also run embedded software loaded onto the controller. The Arduino and SoftwareSerial modules are present in the Arduino framework and will not be recreated for this project.



Level 1	Level 2
Hardware Hiding Module	Arduino Controller Module
	Arduino Module
	Software Serial Module
Behaviour-Hiding Module	Web Application Input Module
	Display Module
	Web Application Output Module
	Piece Identification Module
Software Decision Module	Communication Module
	User Mode Module
	Board Module
	Web Application Game State Module
	Engine Module
	Chess Board Module

Table 2: Module Hierarchy

## 6 Connection Between Requirements and Design

The design satisfies the system requirements developed in the SRS. The Web Application Input module will handle all interactions from the inputs provided by the user, such as the FEN String, the user mode, and whether the game has terminated. The Display module outputs the visual component of the interface, and this module will cover all requirements that have a component of the user directly interacting with the system. The Web Application Board and Game State modules cover the board setup and positions along with checking the end game conditions such as checkmate and stalemate. The look and feel requirements are satisfied by the input and output modules as they define the core areas of user interaction. The usability and humanity requirements are again satisfied by the input and output modules which define the user interaction. Performance requirements are to be satisfied by the combination of all modules, but the key modules that impact performance are software decision hiding modules. The operational and environmental requirements, and the maintainability and support requirements are achieved by all modules. This is because all modules are designed to be operational for the environment (the server and client) and maintained for a set time (end of semester). Security and legal requirements are covered by the entirety of the system. This is because the accessibility of the repository and the JavaScript standard in use affects all modules.

## 7 Module Decomposition

### 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

#### 7.1.1 Arduino Controller Module (M2)

**Secrets:** The logic for changing game state and reading user actions.

**Services:** Reads inputs from sensors and writes to outputs to turn on/off LED's. Main overarching module that runs and controls all other modules to coordinate the logic and messages with the game state.

**Implemented By:** Chess Connect(Arduino Mega 2560 Rev3 Controller)

#### 7.1.2 Arduino Module (M3)

**Secrets:** The Arduino API that allows access to the Hardware Abstraction Layer (HAL).

**Services:** Provides an interface to the hardware through pin assignments and hardware ID's.

**Implemented By:** Arduino.h library

#### 7.1.3 Piece Identification Module (M4)

**Secrets:** The values read by the Hall-effect sensors that are translated into the Piece data type.

**Services:** Translates sensor values into pieces and positions on the chess board. Provides Piece identification data types to the rest of the program.

**Implemented By:** Chess Connect(c++, Arduino)

#### 7.1.4 Chess Board Module (M5)

**Secrets:** Contained within this module are:

- the valid move logic for chess pieces;
- The translation of the piece configuration on the chess board into a [FEN string](#)

- Checking for checkmate

**Services:** Handles all of the logic used in the game of chess. This module processes commands received from the Web Application and Teensy Controller into actions to be implemented within the game and gives feedback related to valid moves and the game/board state.

**Implemented By:** Chess Connect(c++, Arduino)

### 7.1.5 Communication Module (M6)

**Secrets:** Message encoding string used to send board state, game mode and resignation signal. Message decoding string to interpret best moves, the check/mate/stalemate warning and commands from the Teensy controller.

**Services:** Reads and writes to the communication pins, processes and sends commands to various parts of the embedded software.

**Implemented By:** Chess Connect(c++, Arduino, Bluetooth)

### 7.1.6 Software Serial Module (M7)

**Secrets:** The methods in which the data is encoded, flags used to acknowledge connection, successful data transmission, incoming signal, etc.

**Services:** The Arduino API that allows for sending and receiving various data types through serial communication.

**Implemented By:** SoftwareSerial.h library

## 7.2 Behaviour-Hiding Modules

### 7.2.1 Web Application Input Module (M8)

**Secrets:** Input data.

**Services:** Takes in input data of current board state to provide to other modules.

**Implemented By:** Chess Connect (Node.js libraries, Bluetooth)

### 7.2.2 Display Module M9

**Secrets:** Graphics output data.

**Services:** Allows users to view the current board configuration of the system.

**Implemented By:** Chess Connect (React.js framework)

### 7.2.3 Web Application Output Module M10

**Secrets:** None.

**Services:** Takes game state and engine moves, encodes the data, and transmits it.

**Implemented By:** Chess Connect (React.js framework, Bluetooth)

## 7.3 Software Decision Modules

### 7.3.1 User Mode Module M11

**Secrets:** User mode logic and data.

**Services:** Handles switching between user modes and communicating with mode-specific modules.

**Implemented By:** Chess Connect (React.js framework)

### 7.3.2 Web Application Board Module M12

**Secrets:** Board data.

**Services:** Stores and modifies board state information.

**Implemented By:** Chess Connect (React.js framework)

### 7.3.3 Web Application Game State Module M13

**Secrets:** Game state and data.

**Services:** Handles checking the game state (none, check, checkmate, stalemate).

**Implemented By:** Chess Connect (React.js framework, Node.js libraries)

### 7.3.4 Engine Module M14

**Secrets:** Chess engine moves.

**Services:** Uses the board state to calculate 3 possible moves.

**Implemented By:** Chess Connect (Node.js libraries and Stockfish)

## 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, M8, M??, M??
R2	M8, M??
R3	M??
R4	M10, M??
R5	M10, M??, M??, M??, M??, M??
R6	M10, M??, M??, M??, M??, M??
R7	M10, M??, M??, M??, M??
R8	M10, M??, M??, M??, M??
R9	M??
R10	M10, M??, M??
R11	M10, M??, M??, M??

Table 3: Trace Between Requirements and Modules

AC	Modules
AC6	M2
AC7	M2
AC8	M2, M5
AC9	M2, M5, M6

Table 4: Trace Between Anticipated Changes and Modules

## 9 Use Hierarchy Between Modules

In this section, the uses hierarchy between modules is provided. Parnas (1978) 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

## References

FEN. Fen (forsyth-edwards notation) - chess terms. <https://www.chess.com/terms/fen-chess>. Accessed: 2023-01-18.

David L. Parnas. Designing software for ease of extension and contraction. In *ICSE '78: Proceedings of the 3rd international conference on Software engineering*, pages 264–277, Piscataway, NJ, USA, 1978. IEEE Press. ISBN none.