

# DHL WAREHOUSE AUTOMATION SYSTEM



# ROLES DISTRIBUTION



**BERNARD WIDJAJA**

- RESOURCE (BOX, AGV)
- STORAGE AREA
- UI



**MEGHANA HEMESH KUMAR**

- LOG MANAGER
- PROCESS (STORING AND RETRIEVING)



**RAJDEEP SHAW**

- CHARGING STATION
- BATTERY
- STORAGE SYSTEM



# DESCRIPTION OF THE DOMAIN

**DOMAIN:**  
**AUTOMATED WAREHOUSE MANAGEMENT**

**DESCRIPTION:**

- **HANDLING STORAGE AND RETRIEVAL OF BOXES EFFICIENTLY**
- **MANAGING AUTONOMOUS GUIDED VEHICLES (AGVS)**
- **MAINTAINING LOGS FOR AUDITING AND MONITORING**
- **ENSURING SAFE AND CONCURRENT OPERATIONS**
- **CHARGING THE AGVS WHEN THE BATTERY IS LOW**



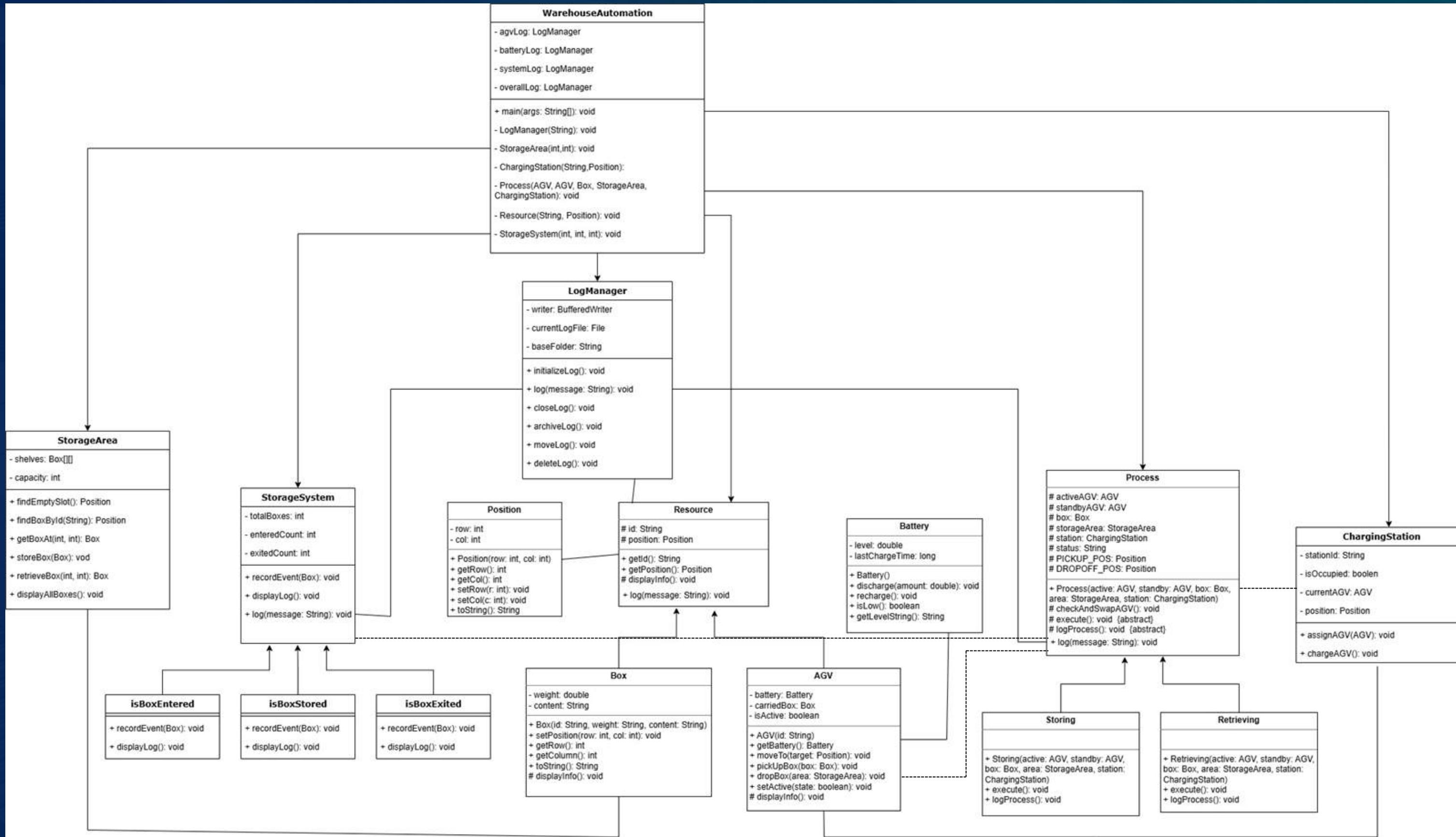
# REQUIREMENTS TO THE SYSTEM

## FUNCTIONAL REQUIREMENTS:

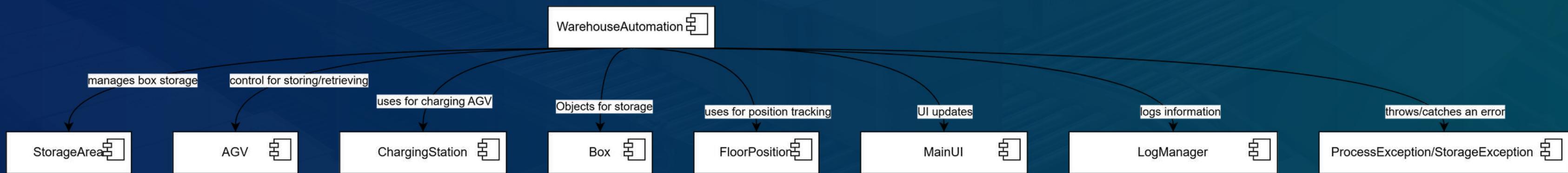
- **THE SYSTEM MUST ALLOW STORING AND RETRIEVING BOXES.**
- **AGVS SHOULD MOVE TO PICKUP AND DROP POSITIONS.**
- **EACH AGV MUST MONITOR ITS BATTERY LEVEL.**
- **CHARGING STATIONS MUST HANDLE THE AGV CHARGING PROCESS.**
- **IF A STATION IS UNAVAILABLE, THE AGV MUST EITHER WAIT OR THROW AN EXCEPTION AFTER TIMEOUT.**
- **THE SYSTEM SHOULD LOG IMPORTANT EVENTS.**
- **THE UI MUST ALLOW THE USER TO INTERACT WITH THE SYSTEM.**



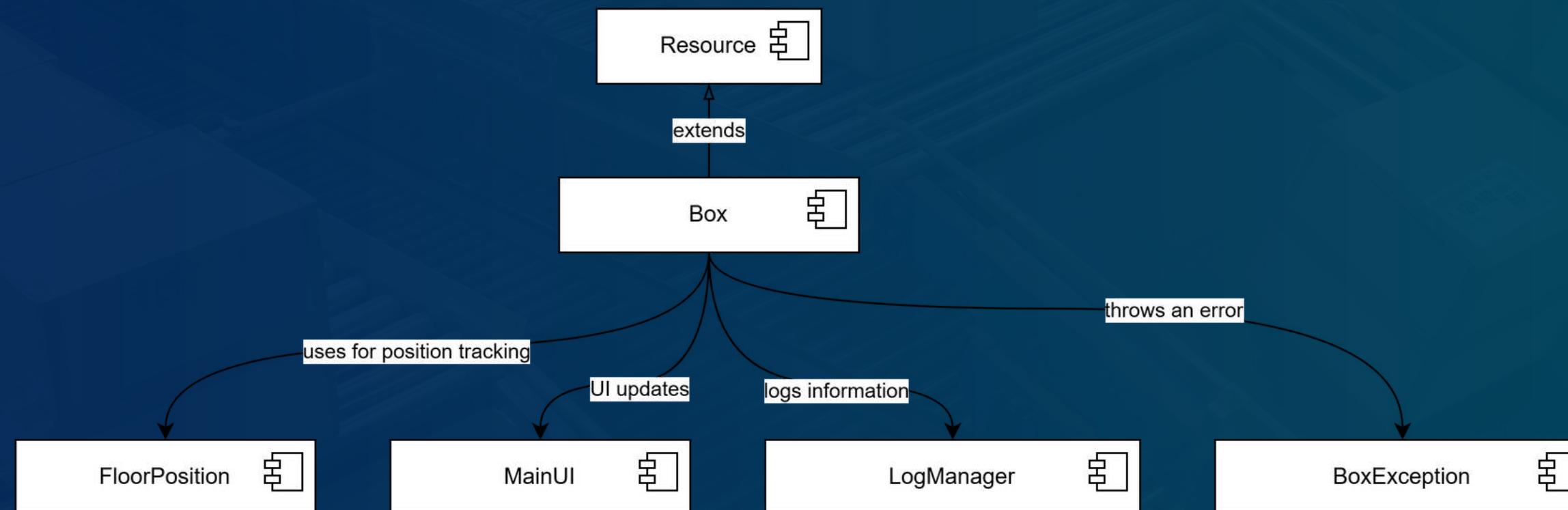
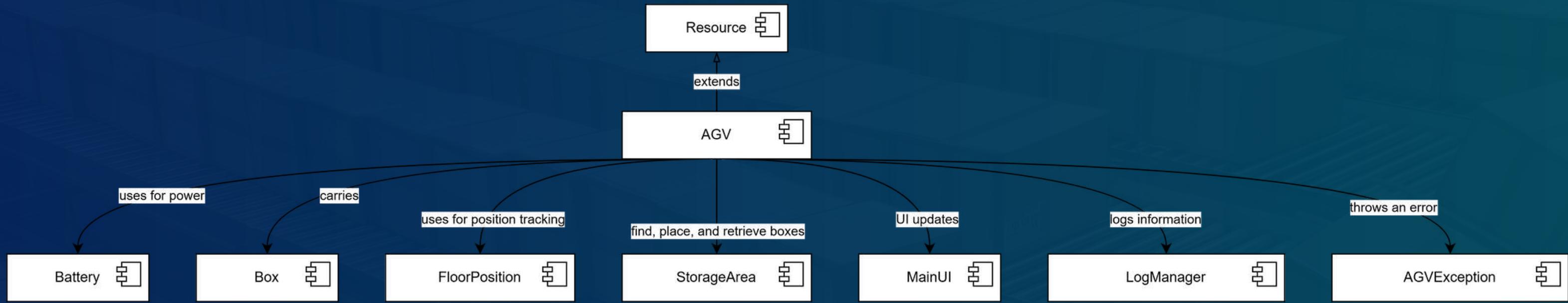
# UML CLASS DIAGRAM



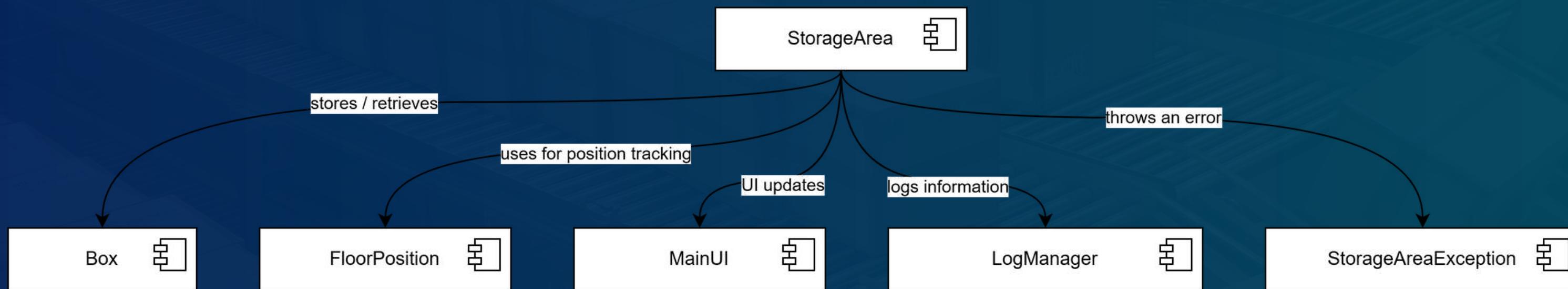
# WAREHOUSEAUTOMATION COMPONENT DIAGRAM



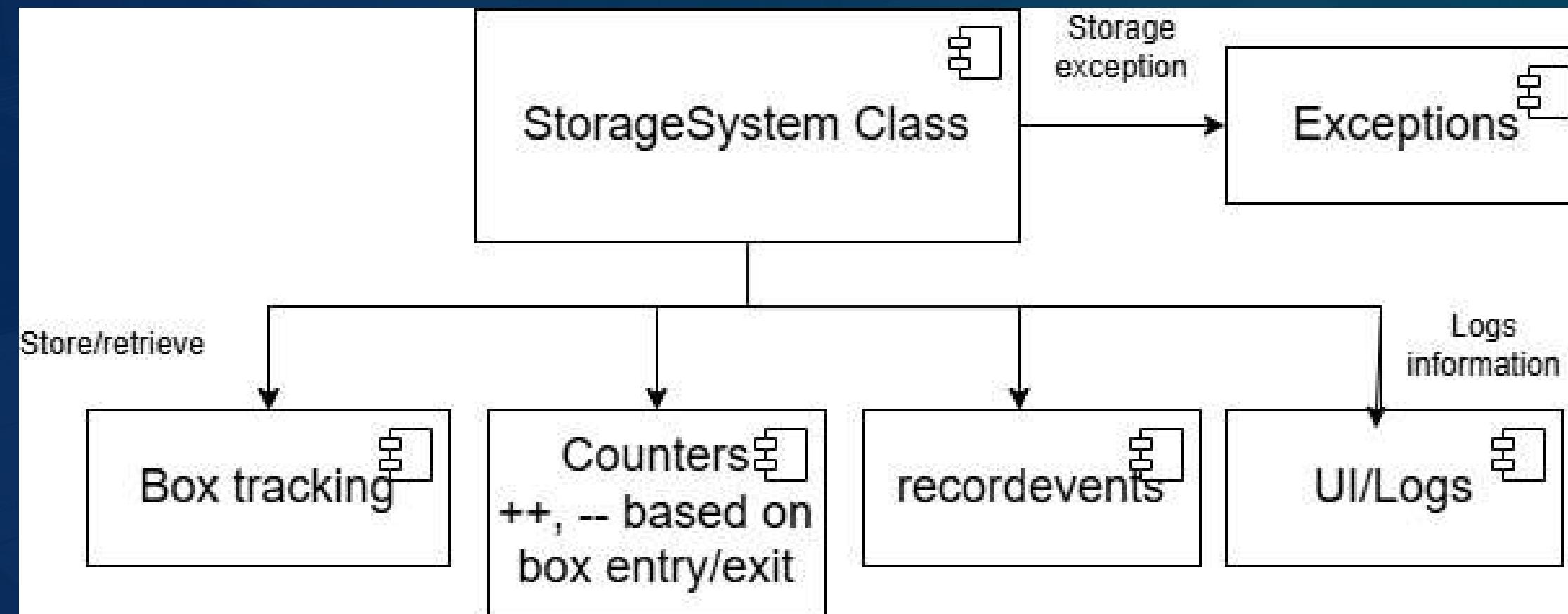
# AGV & BOX COMPONENT DIAGRAM



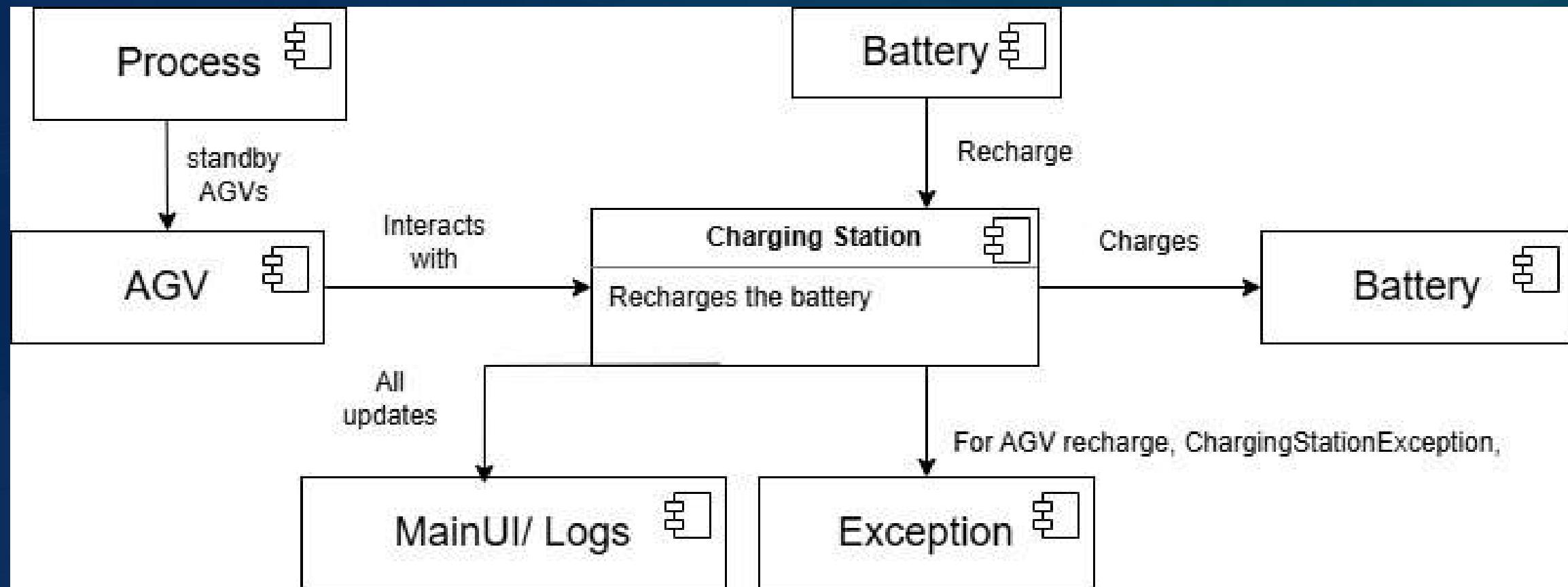
# STORAGEAREA COMPONENT DIAGRAM



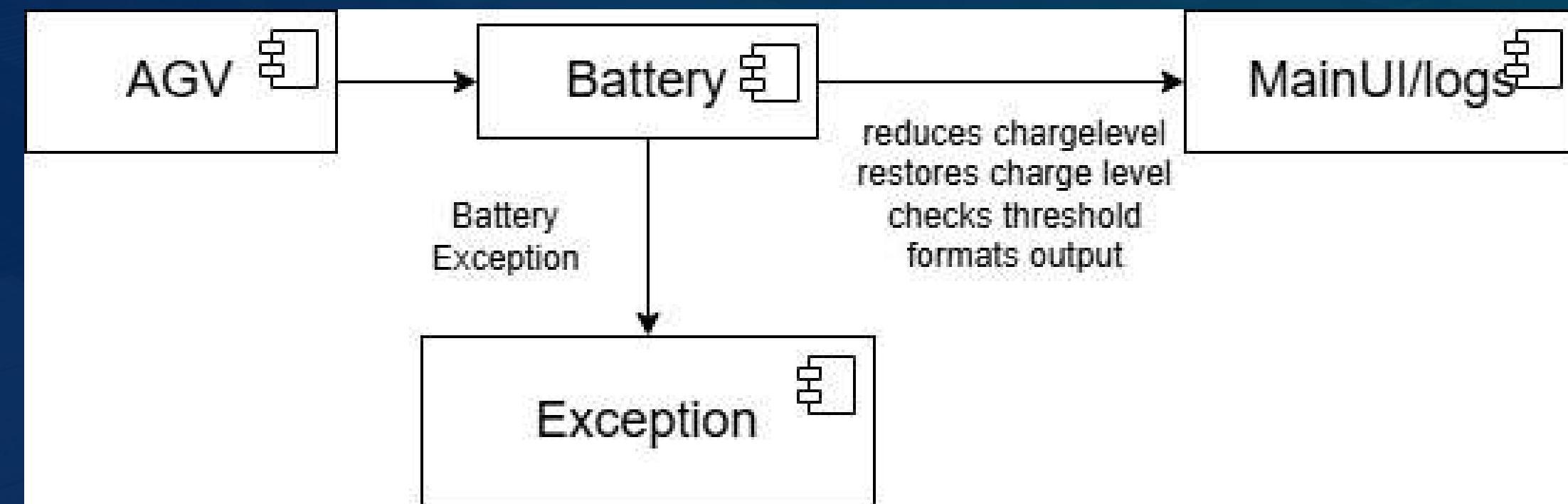
# STORAGE SYSTEM COMPONENT DIAGRAM



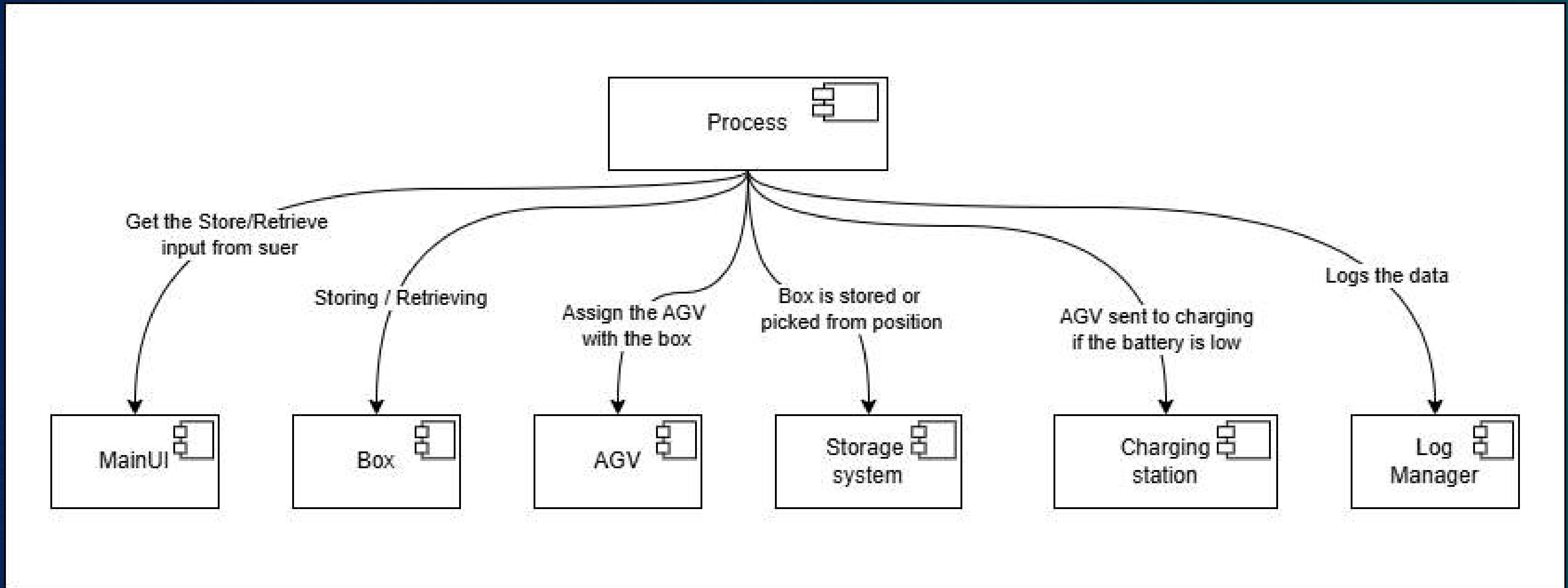
# CHARGING STATION COMPONENT DIAGRAM



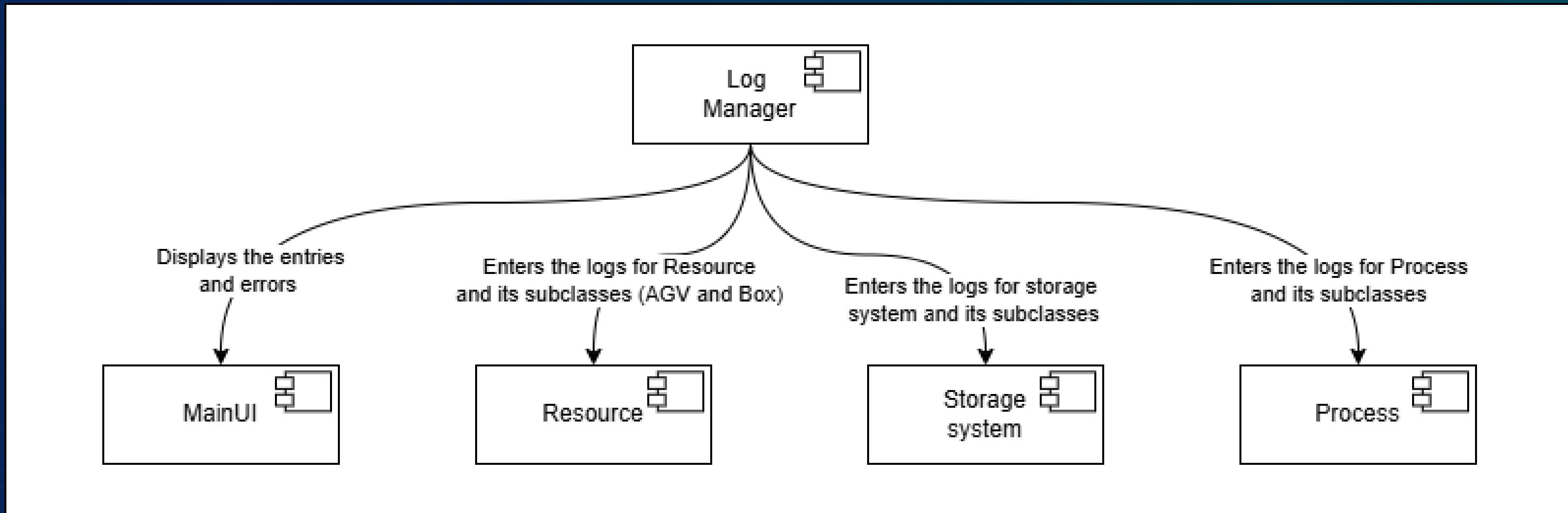
# BATTERY COMPONENT DIAGRAM



# PROCESS COMPONENT DIAGRAM



# LOG MANAGER COMPONENT DIAGRAM



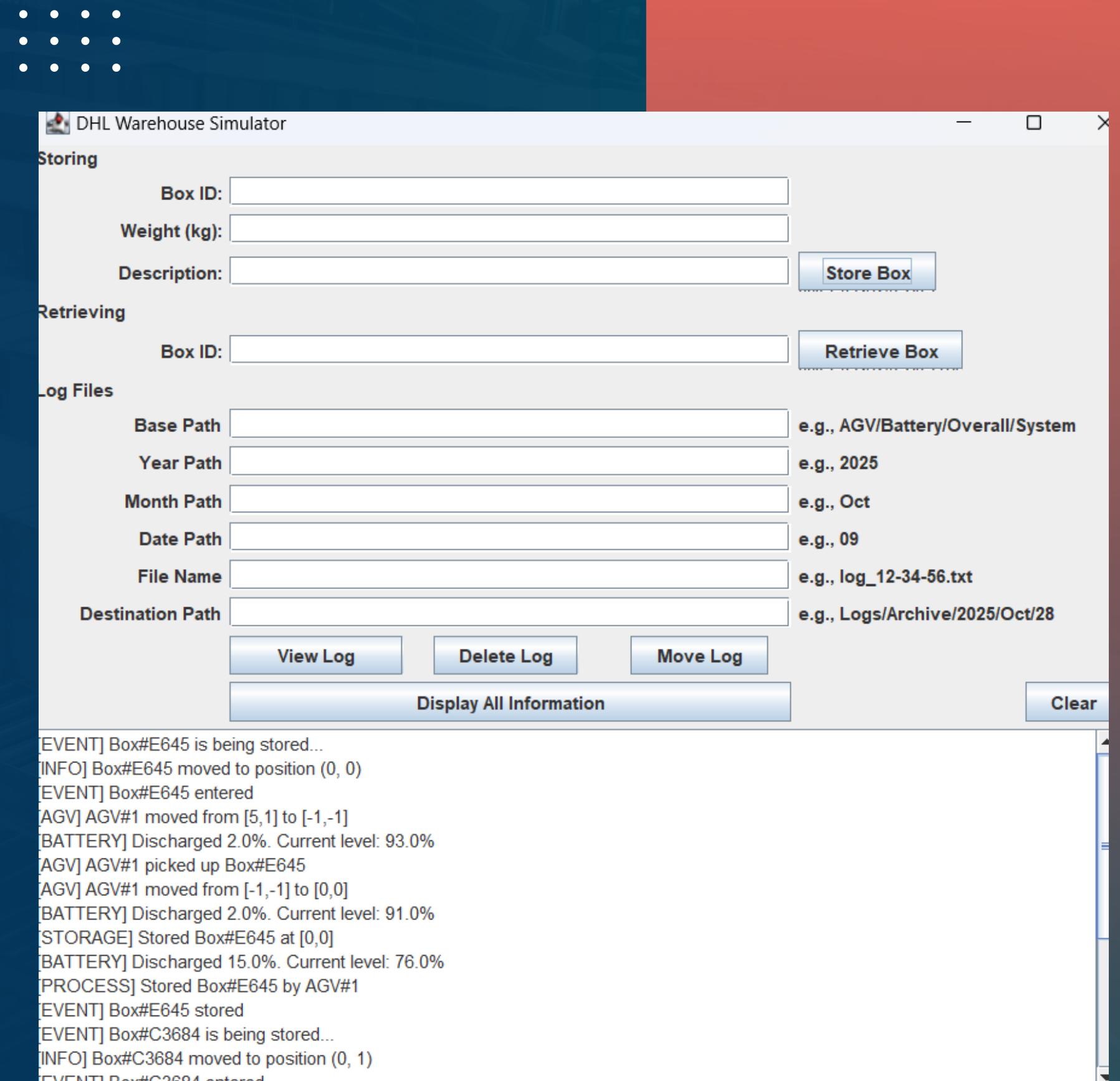
# MANAGEMENT I/O IN THE SYSTEM

## INPUTS:

- STORING: BOX ID, WEIGHT, DESCRIPTION
- RETRIEVING: BOX ID
- LOG FILES: BASE PATH, YEAR, MONTH, DATE AND FILE NAME
- VIEW LOG, DELETE LOG, MOVE LOG
- DISPLAY ALL INFORMATION AND CLEAR

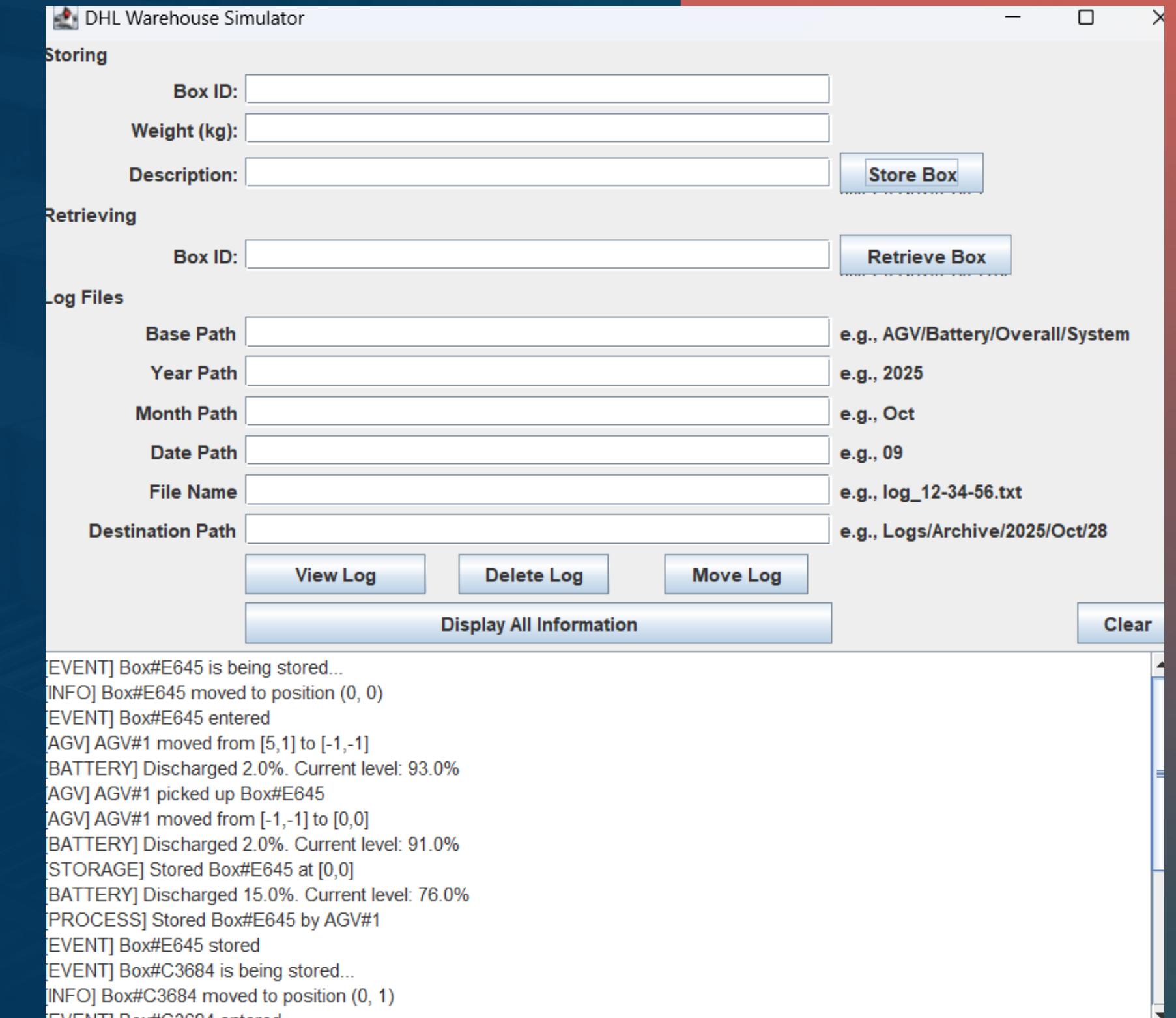
## OUTPUTS:

- MAINUI LOGS FOR USER
- SYSTEM LOGS FOR AUDITING (AGV, BATTERY, OVERALL, SYSTEM)



# USER INTERFACE

- DEVELOPED USING JAVA SWING FOR USER-FRIENDLY INTERACTION.
- ALLOWS THE USER TO STORE AND RETRIEVE BOXES WITH UNIQUE IDS.
- PROVIDES FIELDS FOR BOX ID, WEIGHT, DESCRIPTION, AND LOG MANAGEMENT
- INCLUDES FEATURES TO:
  - STORE / RETRIEVE BOXES
  - VIEW, DELETE, MOVE LOGS
  - DISPLAY ALL INFORMATION
  - CLEAR TEXT AREA
- DISPLAYS REAL-TIME SYSTEM EVENTS IN THE OUTPUT AREA — INCLUDING AGV MOVEMENT, STORAGE PROCESS, AND BATTERY UPDATES.



# THREADS IMPLEMENTATION



## AGV ASSIGNMENT TO CHARGING STATION

- When multiple AGVs want to charge, only one should get the station at a time.
- Code uses synchronization to ensure fair access.



## SWAP LOGIC WHEN BATTERY IS LOW

- If AGV1 is charging and AGV2's battery becomes low, AGV2 waits for 15 mins.
- This is controlled by threads and timers — a good example of concurrent behavior.



## STORING AND RETRIEVING SYNCHRONIZED

- The storeBox() and retrieveBox() methods are synchronized to perform at the same time.

# RESULTS OF THE UNIT TEST CASES

## TESTCASES FOR BATTERY:

1. NEW BATTERY INITIALISATION
2. DISCHARGING BATTERY WHEN AGV IS PERFORMING TASK
3. INDICATE LOW BATTERY (WHEN HEAVILY DISCHARGED)
4. CHARGE VALUE SHOULD NOT BE NEGATIVE
5. PROPER FORMATTING FOR BATTERY UPDATES
6. RECHARGING AFTER DRAINING BATTERY SHOULD NOT CAUSE ERROR.

```
[INFO] Running BatteryTest
[BATTERY ERROR] Discharge amount cannot be negative!
[BATTERY] Discharged 10.0%. Current level: 86.4%
[BATTERY] Discharged 50.0%. Current level: 40.7%
[BATTERY] Charging started...
[BATTERY] Battery level: 60.7%
[BATTERY] Battery level: 80.7%
[BATTERY] Battery level: 100.0%
[BATTERY] Battery fully charged!
[BATTERY] Discharged 90.0%. Current level: 8.7%
[INFO] Tests run: 6, Failures: 0, Errors: 0, Skipped: 0, Time elapsed: 6.077 s -- in BatteryTest
```

# RESULTS OF THE UNIT TEST CASES

## TESTCASES FOR CHARGING STATION:

1. TEST THAT A CHARGINGSTATION OBJECT CAN BE CREATED WITHOUT ERRORS
2. MAKING SURE ASSIGNING AGV MOVES IT TO THE STATION'S COORDINATES
3. THE STATION ONLY ACCEPTS ONE AGV AT A TIME; OTHER AGV STAYS PUT
4. CHARGING AN AGV AT THE STATION SHOULD NEARLY FIL THE BATTERY
5. BOTH AGVS SHOULD GET FULLY CHARGED WHEN ASSIGNED AND CHARGED OEN AFTER ANOTHER

```
[INFO] Running ChargingStationTest
[AGV] AGV#AGV-1 moved from [0,0] to [1,1]
[BATTERY] Discharged 2.0%. Current level: 92.0%
[AGV] AGV#AGV-1 assigned to Charging Station#CS-02
[AGV] AGV#AGV-1 moved from [0,0] to [4,4]
[BATTERY] Discharged 2.0%. Current level: 91.0%
[AGV] AGV#AGV-1 assigned to Charging Station#CS-05
[BATTERY] Charging started...
[BATTERY] Battery level: 100.0%
[BATTERY] Battery fully charged!
[AGV] AGV#AGV-1 fully charged at Station#CS-05
[AGV] AGV#AGV-2 moved from [0,0] to [4,4]
[BATTERY] Discharged 2.0%. Current level: 92.5%
[AGV] AGV#AGV-2 assigned to Charging Station#CS-05
[BATTERY] Charging started...
[BATTERY] Battery level: 100.0%
[BATTERY] Battery fully charged!
[AGV] AGV#AGV-2 fully charged at Station#CS-05
[AGV] AGV#AGV-1 moved from [0,0] to [2,3]
[BATTERY] Discharged 2.0%. Current level: 92.5%
[AGV] AGV#AGV-1 assigned to Charging Station#CS-03
[BATTERY] Charging started...
[BATTERY] Battery level: 100.0%
[BATTERY] Battery fully charged!
[AGV] AGV#AGV-1 fully charged at Station#CS-03
[AGV] AGV#AGV-1 moved from [0,0] to [3,3]
[BATTERY] Discharged 2.0%. Current level: 89.7%
[AGV] AGV#AGV-1 assigned to Charging Station#CS-04
[BATTERY] Charging started...
[BATTERY] Battery level: 100.0%
[BATTERY] Battery fully charged!
[AGV] AGV#AGV-1 fully charged at Station#CS-04
[INFO] Tests run: 5, Failures: 0, Errors: 0, Skipped: 0, Time elapsed: 10.58 s -- in ChargingStationTest
```

# RESULTS OF THE UNIT TEST CASES

## TESTCASES FOR STORAGESYSTEM:

1. EVERY BOX ENTRY SHOULD INCREASE BOTH COUNTERS BY 1
2. TWO BOX ENTRIES SHOULD PRODUCE COUNTS OF 2
3. RECORDING A 'STORED' EVENT SHOULD NOT CHANGE BOX COUNTS
4. BOX EXIT SHOULD DECREASE TOTAL BOXES AND INCREASE EXITED COUNT
5. DISPLAYING LOGS SHOULD NOT THROW ANY ERROS

```
[INFO] Running StorageSystemTest
[EVENT] Box#B1 exited
Test 4 Passed: Exiting updates counters properly
[EVENT] Box#B1 entered
[EVENT] Box#B2 entered
Test 2 Passed: Multiple entries tracked properly
[EVENT] Box#B1 stored
Test 3 Passed: Storing does not change counters
[INFO] Total boxes entered: 0
[INFO] Total boxes stored: 0
[INFO] Total boxes exited: 0
Test 5 Passed: displayLog() runs safely
[EVENT] Box#B1 entered
[EVENT] Box#B2 entered
[EVENT] Box#B1 stored
[EVENT] Box#B1 exited
[INFO] Total boxes entered: 2
[INFO] Total boxes stored: 1
[INFO] Total boxes exited: 1
[EVENT] Box#B1 entered
Test 1 Passed: Box entry updates counters properly
[INFO] Tests run: 6, Failures: 0, Errors: 0, Skipped: 0, Time elapsed: 0.066 s -- in StorageSystemTest
```

# RESULTS OF THE UNIT TEST CASES

## TESTCASES FOR PROCESS:

1. CHECK IF STORING BOX WORKS
2. CHECK IF STORING SAME BOX TWICE DOES NOT CRASH
3. CHECK RETRIEVE FUNCTION
4. TRY TO RETRIEVE WRONG BOX ID
5. SWAPPING AGV'S

```
[INFO] Running ProcessTest
Simulating storing box...
Test 1 Passed: Box stored successfully
Simulating AGV state swap...
Test 5 Passed: AGV swap simulated
Simulating storing box...
Simulating storing box...
Test 2 Passed: Duplicate handled
Simulating retrieving box...
Test 4 Passed: Handled missing box safely
Simulating retrieving box...
Test 3 Passed: Box retrieved properly
[INFO] Tests run: 5, Failures: 0, Errors: 0, Skipped: 0, Time elapsed: 0.022 s -- in ProcessTest
```

# RESULTS OF THE UNIT TEST CASES

## TESTCASES FOR LOG MANAGER:

1. CREATING A LOG IN VALID FOLDER SHOULD ACTUALLY CREATE A FILE
2. TRYING TO LOG TO AN INVALID PATH SHOULD NOT CRASH THE SYSTEM
3. LOGGING FILE CAN BE CLOSED SAFELY, EVEN IF ALREADY CLOSED
4. AFTER CLOSING A LOG, ITS FILE CAN BE MOVED TO ANOTHER LOCATION
5. LOGGING BEFORE CALLING INIT SHOULD NOT CRASH ANYTHING

```
[INFO] Running LogManagerTest
[LOG] Created folders: Logs/test_logs/513681090407900//2025/Nov/14
[LOG] Log file created: C:\Users\RAJDEEP SHAW\Downloads\FH Compact Programming Course\14_11_20
25_11.56_WarehouseAutomation\WarehouseAutomation\Logs\test_logs\513681090407900\2025\Nov\14\lo
g_12-28-44.txt
[LOG] Created folders: Logs/test_logs/513681115465500//2025/Nov/14
[LOG] Log file created: C:\Users\RAJDEEP SHAW\Downloads\FH Compact Programming Course\14_11_20
25_11.56_WarehouseAutomation\WarehouseAutomation\Logs\test_logs\513681115465500\2025\Nov\14\lo
g_12-28-44.txt
[LOG] Log file created: C:\Users\RAJDEEP SHAW\Downloads\FH Compact Programming Course\14_11_20
25_11.56_WarehouseAutomation\WarehouseAutomation\Logs\test_logs\2025\Nov\14\log_12-28-44.txt
[LOG] Created folders: Logs/test_logs/513681654818300//2025/Nov/14
[LOG] Log file created: C:\Users\RAJDEEP SHAW\Downloads\FH Compact Programming Course\14_11_20
25_11.56_WarehouseAutomation\WarehouseAutomation\Logs\test_logs\513681654818300\2025\Nov\14\lo
g_12-28-44.txt
Error writing to log: Stream closed
[INFO] Tests run: 5, Failures: 0, Errors: 0, Skipped: 0, Time elapsed: 0.608 s -- in LogManagerTest
```

# RESULTS OF THE UNIT TEST CASES

## TESTCASES FOR AGV:

1. TEST AGV INITIALIZATION
2. TEST MOVE TO VALID POSITION
3. TEST MOVE TO NULL POSITION
4. TEST PICKUP VALID BOX
5. TEST DROPBOX INTO STORAGEAREA

```
✓  AGVTest                                2 sec 98 ms
    ✓ testAGVInitialization()      29 ms
    ✓ testMoveToValidPosition()   1 sec 3 ms
    ✓ testPickUpValidBox()        512 ms
    ✓ testDropBoxIntoStorageArea() 534 ms
    ✓ testMoveToNullPosition()     20 ms

✓  5 tests passed  5 tests total, 2 sec 98 ms
"D:\Bernard_App\JetBrains\IntelliJ IDEA 2025.2.1\JDK\.jdks\openjdk-25\bin\java.exe" ...
Passed
[AGV] AGV#A1 moved from [10,10] to [20,30]
[LOG] Log file created: D:\Bernard_App\JetBrains\IntelliJ IDEA 2025.2
.1\IdeaProjects\WarehouseAutomation\Logs\AGV\2025\Nov\14\log_13-12-23.txt
[LOG] Log file created: D:\Bernard_App\JetBrains\IntelliJ IDEA 2025.2
.1\IdeaProjects\WarehouseAutomation\Logs\System\2025\Nov\14\log_13-12-23.txt
[LOG] Log file created: D:\Bernard_App\JetBrains\IntelliJ IDEA 2025.2
.1\IdeaProjects\WarehouseAutomation\Logs\Overall\2025\Nov\14\log_13-12-23.txt
[BATTERY] Discharged 2.0%. Current level: 93.5%
[LOG] Log file created: D:\Bernard_App\JetBrains\IntelliJ IDEA 2025.2
.1\IdeaProjects\WarehouseAutomation\Logs\Battery\2025\Nov\14\log_13-12-23.txt
Passed
[AGV] AGV#A1 picked up Box#B1
Passed
[INFO] Box#B1 moved to position (0, 0)
[AGV] AGV#A1 picked up Box#B1
[STORAGE] Stored Box#B1 at [0,0]
Passed
[ERROR] AGV#A1: Target position cannot be null!
Passed
```

# RESULTS OF THE UNIT TEST CASES

## TESTCASES FOR BOX:

1. TEST BOX INITIALIZATION
2. TEST SETPOSITION COORDINATES
3. TEST SETPOSITION NO THROW
4. TEST TOSTRING CONTAINS INFORMATION
5. TEST DISPLAYINFO RUNS WITHOUTERROR

```
BoxTest 563 ms
  ✓ testSetPositionCoor() 529 ms
  ✓ testSetPositionNoThrow() 9 ms
  ✓ testToStringContainsInfo() 4 ms
  ✓ testBoxInit() 4 ms
  ✓ testDisplayInfoRunsWithoutError() 17 ms

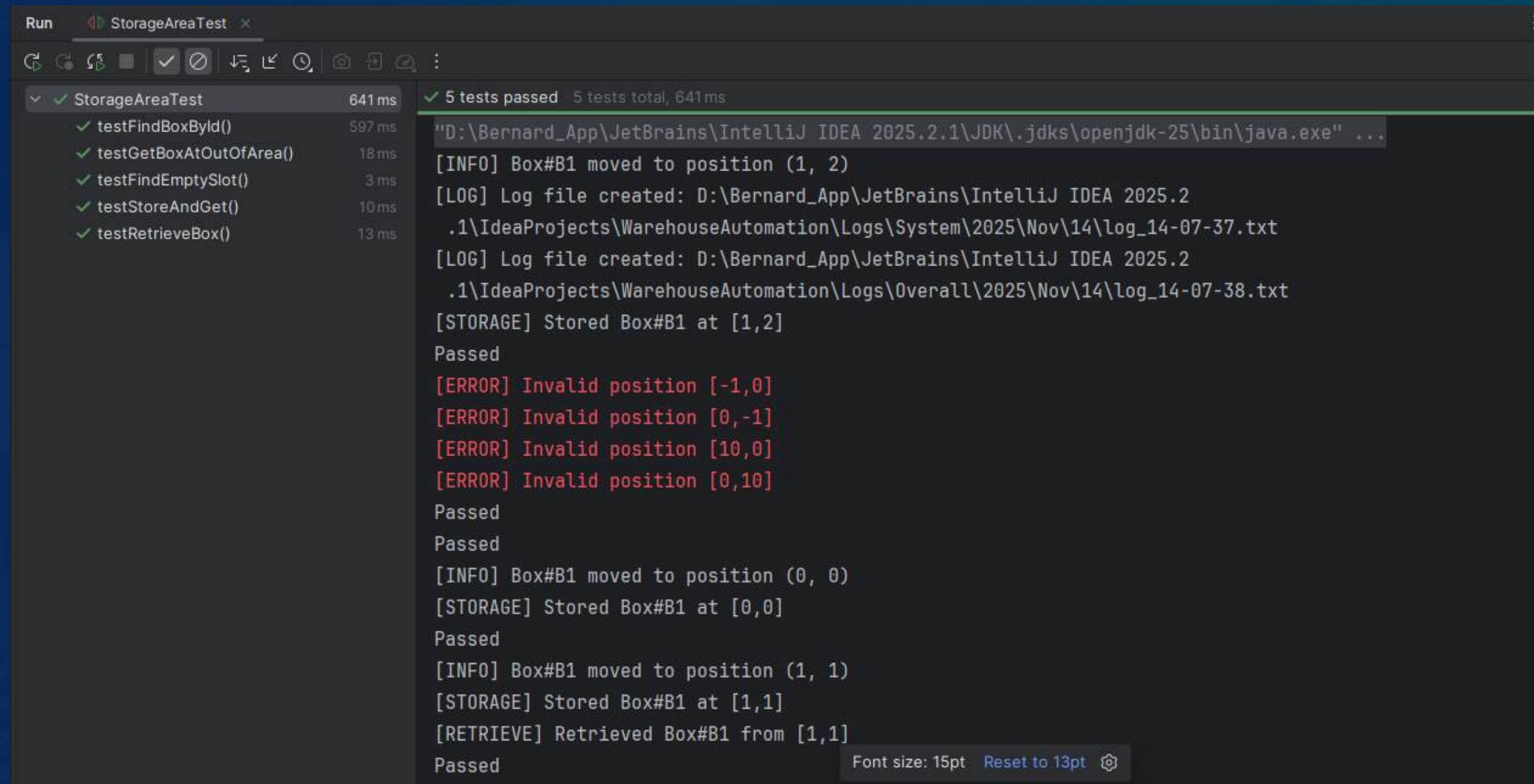
✓ 5 tests passed 5 tests total, 563 ms
D:\Bernard_App\JetBrains\IntelliJ IDEA 2025.2.1\JDK\.jdks\openjdk-25\bin\java.exe
[INFO] Box#B1 moved to position (5, 8)
[LOG] Log file created: D:\Bernard_App\JetBrains\IntelliJ IDEA 2025.2
.1\IdeaProjects\WarehouseAutomation\Logs\System\2025\Nov\14\log_14-06-27.txt
[LOG] Log file created: D:\Bernard_App\JetBrains\IntelliJ IDEA 2025.2
.1\IdeaProjects\WarehouseAutomation\Logs\Overall\2025\Nov\14\log_14-06-27.txt
testSetPositionCoor Passed
[INFO] Box#B1 moved to position (9, 9)
testSetPositionNoThrow Passed
testToStringContainsInfo Passed
testBoxInit Passed
[INFO] Box#B1 | TEST | Storage Pos: [-5,-5]
testDisplayInfoRunsWithoutError Passed

Process finished with exit code 0
```

# RESULTS OF THE UNIT TEST CASES

## TESTCASES FOR STORAGE AREA:

1. TEST FINDEMPTY SLOT
2. TEST STORE AND GET BOX
3. TEST FINDBOXBYID
4. TEST RETRIEVEBOX
5. TEST GETBOX AT OUT OF AREA



The screenshot shows the IntelliJ IDEA interface during a test run. The top bar indicates "Run" and the current test class "StorageAreaTest". The left sidebar lists the test methods: testFindBoxById(), testGetBoxAtOutOfArea(), testFindEmptySlot(), testStoreAndGet(), and testRetrieveBox(). All tests are marked as passed (green checkmark) and took a total of 641ms. The right pane displays the test output, which includes log messages and storage operations. Key log entries include:

- "D:\Bernard\_App\JetBrains\IntelliJ IDEA 2025.2.1\JDK\.jdks\openjdk-25\bin\java.exe" ...
- [INFO] Box#B1 moved to position (1, 2)
- [LOG] Log file created: D:\Bernard\_App\JetBrains\IntelliJ IDEA 2025.2 .1\IdeaProjects\WarehouseAutomation\Logs\System\2025\Nov\14\log\_14-07-37.txt
- [LOG] Log file created: D:\Bernard\_App\JetBrains\IntelliJ IDEA 2025.2 .1\IdeaProjects\WarehouseAutomation\Logs\Overall\2025\Nov\14\log\_14-07-38.txt
- [STORAGE] Stored Box#B1 at [1,2]
- Passed
- [ERROR] Invalid position [-1,0]
- [ERROR] Invalid position [0,-1]
- [ERROR] Invalid position [10,0]
- [ERROR] Invalid position [0,10]
- Passed
- Passed
- [INFO] Box#B1 moved to position (0, 0)
- [STORAGE] Stored Box#B1 at [0,0]
- Passed
- [INFO] Box#B1 moved to position (1, 1)
- [STORAGE] Stored Box#B1 at [1,1]
- [RETRIEVE] Retrieved Box#B1 from [1,1]
- Passed

At the bottom right, there is a font size setting: "Font size: 15pt Reset to 13pt".

# SIMULATION VIDEO

The screenshot shows a simulation software interface with the following sections:

- Storage:** Fields for Box ID, Weight (kg), and Description, followed by a **Store Box** button.
- Retrieval:** A field for Box ID followed by a **Retrieve Box** button.
- Log File:** Fields for Base Path, Year Path, Month Path, Date Path, and File Name, each with an example value (e.g., AGV/Battery/Overall/System, e.g., 2025). Below these are fields for Destination Path (e.g., Logs/Archive/2025/Oct/28) and buttons for **View Log**, **Delete Log**, and **Move Log**.
- Log Viewer:** A scrollable text area displaying simulation logs:

```
[EVENT] Box#1 is being stored...
[INFO] Box#1 moved to position (0, 0)
[EVENT] Box#1 entered
[AGV] AGV#1 moved from [5,1] to [-1,-1]
[BATTERY] Discharged 2.0%. Current level: 92.0%
[AGV] AGV#1 picked up Box#1
[AGV] AGV#1 moved from [-1,-1] to [0,0]
[BATTERY] Discharged 2.0%. Current level: 90.0%
[STORAGE] Stored Box#1 at [0,0]
[BATTERY] Discharged 15.0%. Current level: 75.0%
[PROCESS] Stored Box#1 by AGV#1
```

= THANK YOU =