SECURITY AUDIT REPORT

Mentie

DATE
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PREPARED BY

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Revision History & Version Control

Version	Date	Author(s)	Description
1.0	14 March 2025	D.Aditya M.Gowda	Initial Audit Report
2.0	21 March 2025	D.Aditya M.Gowda	Second Audit Report
3.0	27 Jan 2025	D.Aditya M.Gowda	Final Audit Report

0xTeam conducted a comprehensive Security Audit on the Mentie to ensure the overall code quality, security, and correctness. The review focused on ensuring that the code functions as intended, identifying potential vulnerabilities, and safeguarding the integrity of Mentie's operations against possible attacks.

Report Structure

The report is divided into two primary sections:

1. **Executive Summary** : Provides a high-level overview of the audit findings.
2. **Technical Analysis** : Offers a detailed examination of the Smart contracts code.

Note :
The analysis is static and exclusively focused on the Smart contracts code. The information provided in this report should be utilised to understand the security, quality, and expected behaviour of the code.

1.0 Disclaimer

This is a summary of our audit findings based on our analysis, following industry best practices as of the date of this report.However, it is important to understand that no security audit can guarantee complete protection against all possible security threats. The audit focuses on Smart contracts coding practices and any issues found in the code, as detailed in this report. For a complete understanding of our analysis, you should read the full report. We have made every effort to conduct a thorough analysis, but it's important to note that you should not rely solely on this report and cannot make claims against us based on its contents. We strongly advise you to perform your own independent checks before making any decisions. Please read the disclaimer below for more information.

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2.0 Executive Summary

2.1 Overview

0xTeam has meticulously audited the Mentie Smart contracts project from 14 March 2025 to 27 March 2025. The primary objective of this audit was to assess the security, functionality, and reliability of the Mentie's before their deployment on the blockchain. The audit focused on identifying potential vulnerabilities, evaluating the contract's adherence to best practices, and providing recommendations to mitigate any identified risks. The comprehensive analysis conducted during this period ensures that the Mentie is robust and secure, offering a reliable environment for its users.

2.2 Scope

The scope of this audit involved a thorough analysis of the Mentie Smart contracts, focusing on evaluating its quality, rigorously assessing its security, and carefully verifying the correctness of the code to ensure it functions as intended without any vulnerabilities.

Files in Examination:

Code Language	Smart contracts
In-Scope	• src/icon/RewardPoolController.sol • src/0x/TransformController.sol

OUT-OF-SCOPE: External Smart contracts code, other imported code.

2.3 Audit Summary

Name	Verified	Audited	Vulnerabilities
Mentie	Yes	Yes	Refer Section 5.0

2.4 Summary of Findings

ID	Title	Severity	Fixed
[H-01]	ICON token will not be accounted for in tokensIn	HIGH	✔
[L-01]	withdraw() and redeem() do not send any reward tokens	LOW	✔
[L-02]	If ETH is used as an input and output token to 0x, it will always revert	LOW	✔

2.5 Vulnerability Summary

High	Medium	Low	Informational
0	1	2	0

2.6 Recommendation Summary

Severity

Issues	High	Medium	Low	Informational
Open	0	1	2	0
Resolved		1	2	
Acknowledged				
Partially Resolved				

- **Open:** Unresolved security vulnerabilities requiring resolution.
- **Resolved:** Previously identified vulnerabilities that have been fixed.
- **Acknowledged:** Identified vulnerabilities noted but not yet resolved.
- **Partially Resolved:** Risks mitigated but not fully resolved.

3.0 Checked Vulnerabilities

We examined Smart contracts for widely recognized and specific vulnerabilities. Below are some of the common vulnerabilities considered.

Category	Check Items
Source Code Review	➔ Reentrancy Vulnerabilities ➔ Ownership Control ➔ Time-Based Dependencies ➔ Gas Usage in Loops ➔ Transaction Sequence Dependencies ➔ Style Guide Compliance ➔ EIP Standard Compliance ➔ External Call Verification ➔ Mathematical Checks ➔ Type Safety ➔ Visibility Settings ➔ Deployment Accuracy ➔ Repository Consistency
Functional Testing	➔ Business Logic Validation ➔ Feature Verification ➔ Access Control and Authorization ➔ Escrow Security ➔ Token Supply Management ➔ Asset Protection ➔ User Balance Integrity ➔ Data Reliability ➔ Emergency Shutdown Mechanism

4.0 Techniques , Methods & Tools Used

The following techniques, methods, and tools were used to review all the smart contracts

- **Structural Analysis:**
  EThis involves examining the overall design and architecture of the smart contract. We ensure that the contract is logically organised, scalable, and follows industry best practices. This step is crucial for identifying potential structural issues that could lead to vulnerabilities or maintenance challenges in the future.

- **Static Analysis:**
  Static analysis is conducted using automated tools to scan the contract's codebase for common vulnerabilities and security risks without executing the code. This process helps identify issues such as reentrancy, arithmetic errors, and potential denial-of-service (DOS) vulnerabilities early on, allowing for quick remediation.

- **Code Review / Manual Analysis:**
  A manual, in-depth review of the smart contract's code is performed to verify the logic and ensure it matches the intended functionality as described in the project's documentation. During this phase, we also confirm the findings from the static analysis and check for any additional issues that may not have been detected by automated tools.

- **Dynamic Analysis:**
  Dynamic analysis involves executing the smart contract in various controlled environments to observe its behaviour under different conditions. This step includes running comprehensive test cases, performing unit tests, and monitoring gas consumption to ensure the contract operates efficiently and securely in real-world scenarios.

- **Tools and Platforms Used for Audit:**
  Utilising tools such as Remix , Slither, Aderyn, Solhint for static analysis, and platforms like Hardhat and Foundry for dynamic testing and simulation.

Note: The following values for "Severity" mean:

- High: Direct and severe impact on the funds or the main functionality of the protocol.
- Medium: Indirect impact on the funds or the protocol's functionality.
- Low: Minimal impact on the funds or the protocol's main functionality.
- Informational: Suggestions related to good coding practices and gas efficiency.

5.0 Technical Analysis

HIGH

Issue#1 [Resolved]

[H-1] ICON token will not be accounted for in tokensIn

Severity

HIGH

Issue Description

The `canCallGetReward` function sets `tokensIn` by collecting the `rewardToken` of the target contract and all of its `extraRewards`. However, the `getReward()` function in the `BaseRewardPool` contract also indirectly results in minting **ICON** tokens via a call to `rewardClaimed()` in the `Booster` contract. This additional ICON token is not included in the `tokensIn` array.

```
function canCallGetReward(address target) internal view returns (bool, address[]
memory, address[] memory) {
    uint256 rewardLength = IRewards(target).extraRewardsLength();
    address[] memory tokensIn = new address[](rewardLength + 1);
    for (uint256 i = 0; i < rewardLength; i++) {
        tokensIn[i] = IRewards(IRewards(target).extraRewards(i)).rewardToken();
    }
    tokensIn[rewardLength] = IRewards(target).rewardToken();
    return (true, tokensIn, new address );
}
```

Issue Impact

Since the ICON token is not accounted for in `tokensIn`, the Sentiment protocol fails to recognize it as part of the user's balance. This discrepancy could lead to **unfair liquidations**, as users appear to have fewer assets than they actually do.

Recommended Mitigation Steps

Include the ICON token in the `tokensIn` array to ensure accurate balance representation. If the Arbitrum deployment mirrors Mainnet, the ICON token can be accessed via:

```
IBooster(IRewards(target).operator()).minter();
```

Low

Issue#2 [Resolved]

[L-1] **withdraw()** and **redeem()** do not send any reward tokens

Severity

Low

Issue Description

The `canCallWithdrawAndRedeem()` function currently adds the vault asset, the `rewardToken`, and all `extraRewards` tokens to the `tokensIn` array. The logic assumes that `withdraw()` or `redeem()` sends out these reward tokens:

```
function canCallWithdrawAndRedeem(address target)
    internal
    view
    returns (bool, address[] memory, address[] memory)
{
    uint256 rewardLength = IRewards(target).extraRewardsLength();
    address[] memory tokensIn = new address[](rewardLength + 2);
    for (uint256 i = 0; i < rewardLength; i++) {
        tokensIn[i] = IRewards(IRewards(target).extraRewards(i)).rewardToken();
    }
    tokensIn[rewardLength] = IERC4626(target).asset();
    tokensIn[rewardLength + 1] = IRewards(target).rewardToken();

    address ;
    tokensOut[0] = target;
    return (true, tokensIn, tokensOut);
}
```

However, reviewing the actual contract logic in ICON's `BaseRewardPool`, we can see that **no reward tokens are sent** during `withdraw()` or `redeem()`:

```
function _withdrawAndUnwrapTo(uint256 amount, address from, address receiver)
internal updateReward(from) returns(bool){
    for(uint i = 0; i < extraRewards.length; i++){
        IRewards(extraRewards[i]).withdraw(from, amount);  // This does NOT transfer
rewards
    }

    _totalSupply = _totalSupply.sub(amount);
    _balances[from] = _balances[from].sub(amount);
```

```
    IDeposit(operator).withdrawTo(pid, amount, receiver);
    emit Withdrawn(from, amount);
    emit Transfer(from, address(0), amount);

    return true;
}
```

Also, the `withdraw()` function in the `VirtualBalanceRewardPool` (used for `extraRewards`) only updates accounting via `updateReward()` and does **not actually transfer tokens**:

```
function withdraw(address _account, uint256 amount)
    public
    updateReward(_account)
{
    require(msg.sender == address(deposits), "!authorized");
    emit Withdrawn(_account, amount);
}
```

Issue Impact

This overestimates the actual tokens sent by `withdraw()` and `redeem()` functions. By including reward tokens in `tokensIn`, Sentiment assumes a user's balance has increased more than it actually has, which could lead to **incorrect accounting or liquidation logic**.

Recommendation

Simplify `canCallWithdrawAndRedeem()` to only include the vault's asset token as `tokensIn`:

```
function canCallWithdrawAndRedeem(address target)internal view
    returns (bool, address[] memory, address[] memory){
    address ;
    tokensIn[0] = IERC4626(target).asset();

    address ;
    tokensOut[0] = target;

    return (true, tokensIn, tokensOut);
}
```

Issue#3 [Resolved]

[L-2] If ETH is used as an input and output token to 0x, it will always revert

Severity

Low

Issue Description

When decoding data for a call to `transformERC20()` in the 0x protocol, the controller uses the following logic to determine `tokensIn` and `tokensOut`:

```
(address tokenOut, address tokenIn) = abi.decode(data[4:], (address, address));

if (tokenIn == ETH) {
    tokensOut = new address ;
    tokensOut[0] = tokenOut;
    return (true, new address , tokensOut);
}

if (tokenOut == ETH) {
    tokensIn = new address ;
    tokensIn[0] = tokenIn;
    return (true, tokensIn, new address );
}
```

The intent is to avoid including ETH in the `tokensIn`/`tokensOut` arrays, since:

- ETH is automatically accounted for in Sentiment balances, and
- The "ETH address" (`0xEeeeeEeeeEeEeeEeEeEeeEEEeeeeEeeeeeeeEEeE`) is a placeholder and **not a real token contract**—calls to it like `balanceOf()` will **revert**.

However, **if both `tokenIn` and `tokenOut` are ETH**, the first `if` condition matches, and the second is skipped. As a result, the function attempts to return `tokenOut = ETH`, leading to a downstream call like `ETH.balanceOf(account)` — which reverts, since ETH is not an ERC20 token.

Issue Impact

When **both input and output tokens are ETH**, the logic incorrectly includes the ETH pseudo-address in `tokensOut`. This causes:

- A call to `balanceOf()` on the ETH placeholder address.
- A **transaction revert**, breaking compatibility with legitimate ETH ↔ ETH transformERC20 calls.
- Unexpected behavior in systems relying on accurate balance updates from controller callbacks.

Recommendation

Update the first condition to handle the case where **both input and output tokens are ETH**. If both are ETH, return empty arrays for `tokensIn` and `tokensOut`:

```
if (tokenIn == ETH) {
    if (tokenOut == ETH) return (true, new address , new address );
    tokensOut = new address ;
    tokensOut[0] = tokenOut;
    return (true, new address , tokensOut);
}

// No need to handle tokenOut == ETH here again; already caught above
if (tokenOut == ETH) {
    tokensIn = new address ;
    tokensIn[0] = tokenIn;
    return (true, tokensIn, new address );
}
```

Proof of Concept

A minimal test demonstrating the bug:

```
function testEthOutIfAlsoIn() public {
    ITransformERC20Feature.Transformation ;
    bytes memory data = abi.encodeWithSelector(
        ITransformERC20Feature.transformERC20.selector, ETH, ETH, 0, 0,
transformations
    );
    (bool canCall, address[] memory tokensIn, address[] memory tokensOut) =
        controllerFacade.canCall(target, true, data);

    assert(tokensOut[0] == ETH); // ← This will cause a revert downstream
}
```

6.0 Auditing Approach and Methodologies Applied

The Solidity smart contract was audited using a comprehensive approach to ensure the highest level of security and reliability. Careful attention was given to the following key areas to ensure the overall quality of the code:

- **Code quality and structure**: We conducted a detailed review of the codebase to identify any potential issues related to code structure, readability, and maintainability. This included analysing the overall architecture of the Solidity smart contract and reviewing the code to ensure it follows best practices and coding standards.
- **Security vulnerabilities**: Our team used manual techniques to identify any potential security vulnerabilities that could be exploited by attackers. This involved a thorough analysis of the code to identify any potential weaknesses, such as buffer overflows, injection vulnerabilities, signatures, and deprecated functions.
- **Documentation and comments**: Our team reviewed the code documentation and comments to ensure they accurately describe the code's intended behaviour and logic. This helps developers to better understand the codebase and make modifications without introducing new issues.
- **Compliance with best practices**: We checked that the code follows best practices and coding standards that are recommended by the Solidity community and industry experts. This ensures that the Solidity smart contract is secure, reliable, and efficient.

Our audit team followed OWASP and Ethereum (Solidity) community security guidelines for this audit. As a result, we were able to identify potential issues and provide recommendations to improve the smart contract's security and performance.

Throughout the audit of the smart contracts, our team placed great emphasis on ensuring the overall quality of the code and the use of industry best practices. We meticulously reviewed the codebase to ensure that it was thoroughly documented and that all comments and logic aligned with the intended behaviour. Our approach to the audit was comprehensive, methodical, and aimed at ensuring that the smart contract was secure, reliable, and optimised for performance.

6.1 Code Review / Manual Analysis

Our team conducted a manual analysis of the Solidity smart contracts to identify new vulnerabilities or to verify vulnerabilities found during static and manual analysis. We carefully analysed every line of code and made sure that all instructions provided during the onboarding phase were followed. Through our manual analysis, we were able to identify potential vulnerabilities that may have been missed by automated tools and ensure that the smart contract was secure and reliable.

6.2 Tools Used for Audit

In the course of our audit, we leveraged a suite of tools to bolster the security and performance of our program. While our team drew on their expertise and industry best practices, we also integrated various tools into our development environment. Noteworthy among them are Remix,Slither, Aderyn, Solhint for Static Analysis and Hardhat & Foundry for Dynamic Analysis. This holistic approach ensures a thorough analysis, uncovering potential issues that automated tools alone might overlook. 0xTeam takes pride in utilising these tools, which significantly contribute to the quality, security, and maintainability of our codebase

7.0 Limitations on Disclosure and Use of this Report

This report contains information concerning potential details of the Mentie Project and methods for exploiting them. 0xTeam recommends that special precautions be taken to protect the confidentiality of both this document and the information contained herein. Security Assessment is an uncertain process, based on past experiences, currently available information, and known threats. All information security systems, which by their nature are dependent on human beings, are vulnerable to some degree. Therefore, while 0xTeam considers the major security vulnerabilities of the analysed systems to have been identified, there can be no assurance that any exercise of this nature will identify all possible vulnerabilities or propose exhaustive and operationally viable recommendations to mitigate those exposures. In addition, the analysis set forth herein is based on the technologies and known threats as of the date of this report. As technologies and risks change over time, the vulnerabilities associated with the operation of the Mentie Smart contracts Code Base described in this report, as well as the actions necessary to reduce the exposure to such vulnerabilities, will also change. 0xTeam makes no undertaking to supplement or update this report based on changed circumstances or facts of which 0xTeam becomes aware after the date hereof, absent a specific written agreement to perform the supplemental or updated analysis. This report may recommend that 0xTeam use certain software or hardware products manufactured or maintained by other vendors. 0xTeam bases these recommendations upon its prior experience with the capabilities of those products. Nonetheless, 0xTeam does not and cannot warrant that a particular product will work as advertised by the vendor, nor that it will operate in the manner intended. This report was prepared by 0xTeam for the exclusive benefit of Mentie and is proprietary information. The Non-Disclosure Agreement (NDA) in effect between 0xTeam and Mentie governs the disclosure of this report to all other parties including product vendors and suppliers.