CERTIK

Security Assessment

SaitaMask

Dec 25th, 2021

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Summary

This report has been prepared for SaitaMask to discover issues and vulnerabilities in the source code of the SaitaMask project as well as any contract dependencies that were not part of an officially recognized library. A comprehensive examination has been performed, utilizing Static Analysis and Manual Review techniques.

The auditing process pays special attention to the following considerations:

- Testing the smart contracts against both common and uncommon attack vectors.
- Assessing the codebase to ensure compliance with current best practices and industry standards.
- Ensuring contract logic meets the specifications and intentions of the client.
- Cross referencing contract structure and implementation against similar smart contracts produced by industry leaders.
- Thorough line-by-line manual review of the entire codebase by industry experts.

The security assessment resulted in findings that ranged from critical to informational. We recommend addressing these findings to ensure a high level of security standards and industry practices. We suggest recommendations that could better serve the project from the security perspective:

- Enhance general coding practices for better structures of source codes;
- Add enough unit tests to cover the possible use cases;
- Provide more comments per each function for readability, especially contracts that are verified in public;
- Provide more transparency on privileged activities once the protocol is live.

Overview

Project Summary

Project Name	SaitaMask
Platform	Ethereum
Language	Solidity
Codebase	git@gitlab.com:luismauricio/saitamask-v1-core.git git@gitlab.com:luismauricio/saitamask-v1-periphery.git
Commit	21ea25ea678827664af0caa8a3e04e710e067e52 82604f2f2414b9deb98a29ca6d32c86b29904244

Audit Summary

Delivery Date	Dec 25, 2021
Audit Methodology	Static Analysis, Manual Review
Key Components	

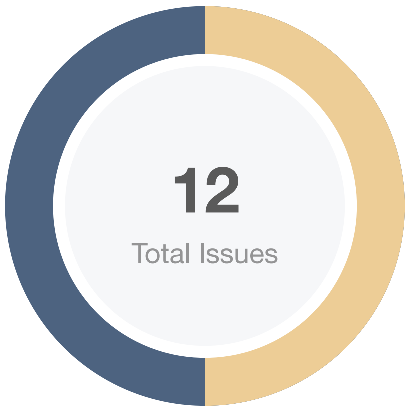
Vulnerability Summary

Vulnerability Level	Total	Pending	Declined	Acknowledged	Partially Resolved	Resolved
● Critical	0	0	0	0	0	0
● Major	0	0	0	0	0	0
● Medium	0	0	0	0	0	0
● Minor	6	0	0	2	0	4
● Informational	6	0	0	0	0	6
● Discussion	0	0	0	0	0	0

Audit Scope

ID	File	SHA256 Checksum
MSM	projects/SaitaMask/saitamask-v1-core/contracts/Migrations.sol	4fd6092bdfa8b42f19d535c5ac69c4323b0b894717c699e58d5552eeabd04cd4
SVE	projects/SaitaMask/saitamask-v1-core/contracts/SaitamaskV1ERC20.sol	6c3aa1127016c57f5a9292129636b16f33f805fcd6b90c1e11352fca3d21b2f0
SVF	projects/SaitaMask/saitamask-v1-core/contracts/SaitamaskV1Factory.sol	4dd15c2fbc8a9e837e5b36920a21219de20f08d79f126341cfc0c622f6870723
SVP	projects/SaitaMask/saitamask-v1-core/contracts/SaitamaskV1Pair.sol	d5a4ae472a3d07ae8b606cf8cd830400abf50d63d201472e0919d3e0a97abd24
BSM	projects/SaitaMask/saitamask-v1-periphery/contracts/libraries/Babylonian.sol	55f7f97f332b408835ff07a374bef0a8ef698abe282de76a259f2ea6b7d210b4
SVL	projects/SaitaMask/saitamask-v1-periphery/contracts/libraries/SaitamaskV1Library.sol	540b508bf172c6b78776d91fe70f4e9ac17c816c0d2ca07ae4c993555880633b
SVM	projects/SaitaMask/saitamask-v1-periphery/contracts/libraries/SaitamaskV1LiquidityMathLibrary.sol	8735ef8f74fd58a490f40cd5660ffb403fb997357f28765c9f7362fabccd0719
SVO	projects/SaitaMask/saitamask-v1-periphery/contracts/libraries/SaitamaskV1OracleLibrary.sol	e634ed159a1bf2ad9b8af0b6dcec3ec56bc2f28b16515a0ffa4ffde8fed78464
THS	projects/SaitaMask/saitamask-v1-periphery/contracts/libraries/TransferHelper.sol	22b87fd425d590e533ab7e52478cf72bdc4bde2672e0977c7eff7742e8f0737d
SVS	projects/SaitaMask/saitamask-v1-periphery/contracts/SaitamaskV1Migrator.sol	3fbbccd15b4fcf6324e61719a630fe06a048456dbc982879e0ac301598e79e76
SVR	projects/SaitaMask/saitamask-v1-periphery/contracts/SaitamaskV1Router01.sol	e89975e4a015bd2782977bc21ffbabe91cfcc59e7a4b6a6c503394cb28f5b402
SVC	projects/SaitaMask/saitamask-v1-periphery/contracts/SaitamaskV1Router02.sol	9cb30569401c20226d7096135b2036f4487e101cd5de6d4df2b4a1d646acbb75
WET	projects/SaitaMask/saitamask-v1-periphery/contracts/WETH.sol	a847d003c6497f43e244f4c2e2690a34313e96217e69db097ae839c573db1b7f

Findings



🟥	**Critical**	**0** (0.00%)
🟧	**Major**	**0** (0.00%)
🟨	**Medium**	**0** (0.00%)
🟨	**Minor**	**6** (50.00%)
🟦	**Informational**	**6** (50.00%)
🟩	**Discussion**	**0** (0.00%)

ID	Title	Category	Severity	Status
SVE-01	Missing Input Validation	Volatile Code	● Minor	✓ Resolved
SVE-02	Declaration Naming Convention	Coding Style	● Informational	✓ Resolved
SVF-01	Unnecessary Array as Counter	Gas Optimization	● Informational	✓ Resolved
SVF-02	Missing Emit Events	Coding Style	● Informational	✓ Resolved
SVP-01	Divide by Zero	Logical Issue	● Minor	✓ Resolved
SVR-01	Missing Input Validation	Volatile Code	● Minor	✓ Resolved
SVR-02	Proper Usage of `require` And `assert` Functions	Coding Style	● Informational	✓ Resolved
SVR-03	Incompatibility With Deflationary Tokens	Logical Issue	● Minor	ⓘ Acknowledged
SVS-01	Missing Input Validation	Volatile Code	● Minor	✓ Resolved
SVS-02	Proper Usage of `require` And `assert` Functions	Coding Style	● Informational	✓ Resolved
SVS-03	Incompatibility With Deflationary Tokens	Logical Issue	● Minor	ⓘ Acknowledged
WET-01	Declaration Naming Convention	Coding Style	● Informational	✓ Resolved

SVE-01 | Missing Input Validation

Category	Severity	Location	Status
Volatile Code	● Minor	projects/SaitaMask/saitamask-v1-core/contracts/SaitamaskV1ERC20.sol: 46, 52, 57	✓ Resolved

Description

The given input is missing the check for the non-zero address.

Recommendation

We advise adding the check for the passed-in values to prevent unexpected error as below:

```
46  function _burn(address from, uint value) internal {
47      require(from != address(0), "burn from zero address!");
48      balanceOf[from] = balanceOf[from].sub(value);
49      totalSupply = totalSupply.sub(value);
50      emit Transfer(from, address(0), value);
51  }
```

```
52  function _approve(address owner, address spender, uint value) private {
53      require(owner != address(0), "owner is zero address!");
54      require(spender != address(0), "spender is zero address!");
55      allowance[owner][spender] = value;
56      emit Approval(owner, spender, value);
57  }
```

```
57  function _transfer(address from, address to, uint value) private {
58      require(from != address(0), "from is zero address!");
59      require(to != address(0), "to is zero address!");
60      balanceOf[from] = balanceOf[from].sub(value);
61      balanceOf[to] = balanceOf[to].add(value);
62      emit Transfer(from, to, value);
63  }
```

Alleviation

As per commit `82604f2f2414b9deb98a29ca6d32c86b29904244`, the affected functions are now checking for the non-zero address.

SVE-02 | Declaration Naming Convention

Category	Severity	Location	Status
Coding Style	● Informational	projects/SaitaMask/saitamask-v1-core/contracts/SaitamaskV1ERC20.sol: 9~11	✓ Resolved

Description

The linked declarations do not conform to the Solidity style guide with regards to its naming convention.

Particularly:

- `camelCase`: Should be applied to function names, argument names, local and state variable names, modifiers
- `UPPER_CASE`: Should be applied to `constant` variables
- `CapWords`: Should be applied to contract names, struct names, event names and enums

Recommendation

We advise that the linked variable and function names are adjusted to properly conform to Solidity's naming convention.

Alleviation

As per commits `ba62ee0a2d481c171332c1664f52c82c370627ed` and `82604f2f2414b9deb98a29ca6d32c86b29904244`, the highlighted constants are now following the naming convention.

SVF-01 | Unnecessary Array as Counter

Category	Severity	Location	Status
Gas Optimization	● Informational	projects/SaitaMask/saitamask-v1-core/contracts/SaitamaskV1Factory.sol: 12, 20, 37, 38	✓ Resolved

Description

The usage of `allPairs` array is as a counter to maintain the number of created pairs.

Recommendation

We advise the client to replace the `allPairs` with a simple uint type counter to store the number of pairs created.

Alleviation

As per commit `82604f2f2414b9deb98a29ca6d32c86b29904244`, the `allPairs` array has been substituted by the `pairsCount` unsigned integer.

SVF-02 | Missing Emit Events

Category	Severity	Location	Status
Coding Style	● Informational	projects/SaitaMask/saitamask-v1-core/contracts/SaitamaskV1Factory.sol: 41, 46	✓ Resolved

Description

The function that affects the status of sensitive variables should be able to emit events as notifications.

- `setFeeTo()`
- `setFeeToSetter()`

Recommendation

We advise the client to consider adding events for sensitive actions, and emit them in the function.

Alleviation

As per commit `82604f2f2414b9deb98a29ca6d32c86b29904244`, the `setFeeTo()` and `setFeeToSetter()` functions are now emitting events.

SVP-01 | Divide by Zero

Category	Severity	Location	Status
Logical Issue	● Minor	projects/SaitaMask/saitamask-v1-core/contracts/SaitamaskV1Pair.sol: 143~145	✓ Resolved

Description

If the value of `totalSupply` is 0, the following two division operations will fail due to the divide by 0 error, which ultimately make the invocation to `burn()` function fail.

```
amount0 = liquidity.mul(balance0) / _totalSupply; // using balances ensures pro-rata distribution
amount1 = liquidity.mul(balance1) / _totalSupply; // using balances ensures pro-rata distribution
```

Recommendation

We advise the client to add the following validation in the function `burn()`

```
function burn(address to) external lock returns (uint amount0, uint amount1) {
   require(totalSupply != 0, "The value of totalSupply must not be 0");
    ...
}
```

Alleviation

As per commit `82604f2f2414b9deb98a29ca6d32c86b29904244`, the burn function is now checking whether the total supply is zero or not.

SVR-01 | Missing Input Validation

Category	Severity	Location	Status
Volatile Code	● Minor	projects/SaitaMask/saitamask-v1-periphery/contracts/SaitamaskV1Router01.sol: 21~22	✓ Resolved

Description

The given input is missing the check for the non-zero address.

Recommendation

We advise adding the check for the passed-in values to prevent unexpected error as below:

```
constructor(address _factory, address _WETH) public {
     require(_factory != address(0),"_factory should not be address(0)");
     require(_WETH != address(0),"_WETH should not be address(0)");
    factory = _factory;
    WETH = _WETH;
}
```

Alleviation

As per commit `ba62ee0a2d481c171332c1664f52c82c370627ed`, the constructor function is now making sure that the `_factory` and `_WETH` addresses are not equal to the zero address.

SVR-02 | Proper Usage of `require` And `assert` Functions

Category	Severity	Location	Status
Coding Style	● Informational	projects/SaitaMask/saitamask-v1-periphery/contracts/SaitamaskV1Router01.sol: 214, 256, 93, 52, 26	✓ Resolved

Description

The `assert()` function should only be used to test for internal errors, and to check invariants. The `require()` function should be used to ensure valid conditions, such as inputs, or contract state variables are met, or to validate return values from calls to external contracts.

Recommendation

We advise the client using the `require()` function, along with a custom error message when the condition fails, instead of the `assert()` function.

Alleviation

As per commit `ba62ee0a2d481c171332c1664f52c82c370627ed`, the `SaitamaskV1Router02.sol` is now using `require()` instead of `assert()`.

SVR-03 | Incompatibility With Deflationary Tokens

Category	Severity	Location	Status
Logical Issue	● Minor	projects/SaitaMask/saitamask-v1-periphery/contracts/SaitamaskV1Router01.sol: 70~71, 91, 109	ⓘ Acknowledged

Description

When users add or remove LP tokens into the router, and the `mint` and `burn` operations are performed. When transferring standard ERC20 deflationary tokens, the input amount may not be equal to the received amount due to the charged transaction fee. As a result, the amount inconsistency will occur and the transaction may fail due to the validation checks.

Recommendation

We advise the client to regulate the set of LP tokens supported and add necessary mitigation mechanisms to keep track of accurate balances if there is a need to support deflationary tokens.

SVS-01 | Missing Input Validation

Category	Severity	Location	Status
Volatile Code	● Minor	projects/SaitaMask/saitamask-v1-periphery/contracts/SaitamaskV1Router02.sol: 24~25	✓ Resolved

Description

The given input is missing the check for the non-zero address.

Recommendation

We advise adding the check for the passed-in values to prevent unexpected error as below:

```
constructor(address _factory, address _WETH) public {
     require(_factory != address(0),"_factory should not be address(0)");
     require(_WETH != address(0),"_WETH should not be address(0)");
     factory = _factory;
     WETH = _WETH;
}
```

Alleviation

As per commit `ba62ee0a2d481c171332c1664f52c82c370627ed`, the constructor function is now making sure that the `_factory` and `_WETH` addresses are not equal to the zero address.

SVS-02 | Proper Usage of `require` And `assert` Functions

Category	Severity	Location	Status
Coding Style	● Informational	projects/SaitaMask/saitamask-v1-periphery/contracts/SaitamaskV1Router02.sol: 29	Resolved

Description

The `assert()` function should only be used to test for internal errors, and to check invariants. The `require()` function should be used to ensure valid conditions, such as inputs, or contract state variables are met, or to validate return values from calls to external contracts.

Recommendation

We advise the client using the `require()` function, along with a custom error message when the condition fails, instead of the `assert()` function.

Alleviation

As per commit `ba62ee0a2d481c171332c1664f52c82c370627ed`, the `SaitamaskV1Router02.sol` is now using `require()` instead of `assert()`.

SVS-03 | Incompatibility With Deflationary Tokens

Category	Severity	Location	Status
Logical Issue	● Minor	projects/SaitaMask/saitamask-v1-periphery/contracts/SaitamaskV1Router02.sol: 73~74, 94, 113	ⓘ Acknowledged

Description

When users add or remove LP tokens into the router, and the `mint` and `burn` operations are performed. When transferring standard ERC20 deflationary tokens, the input amount may not be equal to the received amount due to the charged transaction fee. As a result, the amount inconsistency will occur and the transaction may fail due to the validation checks.

Recommendation

We advise the client to regulate the set of LP tokens supported and add necessary mitigation mechanisms to keep track of accurate balances if there is a need to support deflationary tokens.

WET-01 | Declaration Naming Convention

Category	Severity	Location	Status
Coding Style	● Informational	projects/SaitaMask/saitamask-v1-periphery/contracts/WETH.sol: 23~25	✓ Resolved

Description

The linked declarations do not conform to the Solidity style guide with regards to its naming convention.

Particularly:

- `camelCase`: Should be applied to function names, argument names, local and state variable names, modifiers
- `UPPER_CASE`: Should be applied to `constant` variables
- `CapWords`: Should be applied to contract names, struct names, event names and enums

Recommendation

We advise that the linked variable and function names are adjusted to properly conform to Solidity's naming convention.

Alleviation

As per commits `ba62ee0a2d481c171332c1664f52c82c370627ed` and `82604f2f2414b9deb98a29ca6d32c86b29904244`, the highlighted constants are now following the naming convention.

Appendix

Finding Categories

Gas Optimization

Gas Optimization findings do not affect the functionality of the code but generate different, more optimal EVM opcodes resulting in a reduction on the total gas cost of a transaction.

Logical Issue

Logical Issue findings detail a fault in the logic of the linked code, such as an incorrect notion on how block.timestamp works.

Volatile Code

Volatile Code findings refer to segments of code that behave unexpectedly on certain edge cases that may result in a vulnerability.

Coding Style

Coding Style findings usually do not affect the generated byte-code but rather comment on how to make the codebase more legible and, as a result, easily maintainable.

Checksum Calculation Method

The "Checksum" field in the "Audit Scope" section is calculated as the SHA-256 (Secure Hash Algorithm 2 with digest size of 256 bits) digest of the content of each file hosted in the listed source repository under the specified commit.

The result is hexadecimal encoded and is the same as the output of the Linux "sha256sum" command against the target file.

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