CERTIK

Security Assessment

SafeMoon

May 3rd, 2021

Summary

This report has been prepared for SafeMoon smart contracts, to discover issues and vulnerabilities in the source code of their Smart Contract as well as any contract dependencies that were not part of an officially recognized library. A comprehensive examination has been performed, utilizing Dynamic Analysis, 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 given they are currently missing in the repository;
- Provide more comments per each function for readability, especially contracts are verified in public;
- Provide more transparency on privileged activities once the protocol is live.

Overview

Project Summary

Project Name	SafeMoon
Description	The SafeMoon contract is a mixture of RFI tokenomics with the added function of an auto-liquidity generating protocol.
Platform	BSC
Language	Solidity
Codebase	https://github.com/safemoonprotocol/Safemoon.sol
Commits	a2a1b922b1260b618427183ec8d4475d70cf4daf

Audit Summary

Delivery Date	May 03, 2021
Audit Methodology	Static Analysis, Manual Review, Testnet Deployment
Key Components	Safemoon.sol

Vulnerability Summary

Total Issues	13
Critical	0
Major	1
Medium	1
Minor	4
Informational	7
Discussion	0

Audit Scope

ID	file	SHA256 Checksum
SSL	Safemoon.sol	2229e5c37d221aec4dd69a137ddc66e8addc971f0f84af2cfb756c11032f06ab

Understandings

Overview

The SafeMoon Protocol is a decentralized finance (DeFi) token deployed on the Binance smart chain (BSC). SafeMoon employs two novel features in its protocol; static rewards for each user as well as an LP acquisition mechanism. The static reward (also known as reflection) and LP acquisition mechanisms function as follows:

Each SafeMoon transaction is taxed two 5% fees totalling 10% of the transaction amount. The first fee is redistributed to all existing holders using a form of rebasing mechanism whilst the other 5% is accumulated internally until a sufficient amount of capital has been amassed to perform an LP acquisition. When this number is reached, the total tokens accumulated are split with half being converted to BNB and the total being supplied to the PancakeSwap contract as liquidity.

LP Acquisition

The LP acquisition mechanism can be indirectly triggered by any normal transaction of the token as all transfers evaluate the set of conditions that trigger the mechanism. The main conditions of the mechanism are whether the sender is different than the LP pair and whether the accumulation threshold has been breached. Should these conditions be satisfied, the `swapAndLiquify` function is invoked with the current contract's SafeMoon balance.

The `swapAndLiquify` function splits the contract's balance in two halves properly accounting for any truncation that may occur. The first half is swapped to BNB via the PancakeSwap Router using the SafeMoon-BNB pair and thus temporarily driving the price of the SafeMoon token down. Afterwards, the resulting BNB balance along with the remaining SafeMoon balance are supplied to the SafeMoon-BNB liquidity pool as liquidity via the Router. The recipient of the LP units is defined as the current `owner` of the SafeMoon contract, a characteristic outlined in more depth within finding SSL-01.

Static Reward (Reflection)

Balances in the SafeMoon token system are calculated in one of two ways. The first method, which most users should be familiar with, is a traditional fixed number of units being associated with a user's address. The second method, which is of interest to static rewards, represents a user's balance as a proportion of the total supply of the token. This method works similarly to how dynamic rebasing mechanisms work such as that of Ampleforth.

Whenever a taxed transaction occurs, the 5% meant to be re-distributed to token holders is deducted from the total "proportion" supply resulting in a user's percentage of total supply being increased. Within the system, not all users are integrated in this system and as such the 5% fee is rewarded to a

subset of the total users of the SafeMoon token. The `owner` of the contract is able to introduce and exclude users from the dynamic balance system at will.

Privileged Functions

The contract contains the following privileged functions that are restricted by the `onlyOwner` modifier. They are used to modify the contract configurations and address attributes. We grouped these functions below:

Account management functions for inclusion and exclusion in the fee and reward system:

- excludeFromReward(address account)
- includeInReward(address account)
- excludeFromFee(address account)
- includeInFee(address account)

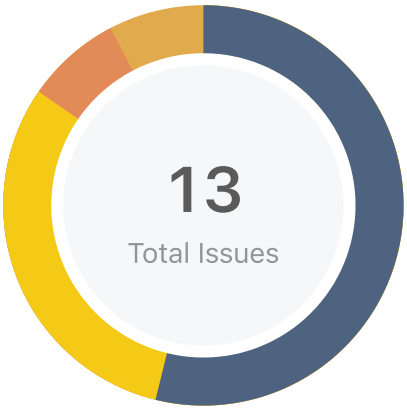
Modification of liquidation, tax and max transaction percents of the system:

- function setTaxFeePercent(uint256 taxFee)
- function setLiquidityFeePercent(uint256 liquidityFee)
- function setMaxTxPercent(uint256 maxTxPercent)

Toggle feature of the LP acquisition mechanism:

- function setSwapAndLiquifyEnabled(bool _enabled)

Findings



Critical	0 (0.00%)
Major	1 (7.69%)
Medium	1 (7.69%)
Minor	4 (30.77%)
Informational	7 (53.85%)
Discussion	0 (0.00%)

ID	Title	Category	Severity	Status
SSL-01	Incorrect error message	Logical Issue	Minor	Acknowledged
SSL-02	Redundant code	Logical Issue	Informational	Acknowledged
SSL-03	Contract gains non-withdrawable BNB via the `swapAndLiquify` function	Logical Issue	Medium	Acknowledged
SSL-04	Centralized risk in `addLiquidity`	**Centralization / Privilege**	**Major**	**Partially Resolved**
SSL-05	Variable could be declared as `constant`	Gas Optimization	Informational	Acknowledged
SSL-06	Return value not handled	Volatile Code	Informational	Acknowledged
SSL-07	3rd party dependencies	Control Flow	Minor	Acknowledged
SSL-08	Missing event emitting	Coding Style	Informational	Acknowledged
SSL-09	Function and variable naming doesn't match the operating environment	Coding Style	Informational	Acknowledged
SSL-10	Privileged ownership	**Centralization / Privilege**	**Minor**	**Partially Resolved**
SSL-11	Typos in the contract	Coding Style	Informational	Acknowledged
SSL-12	The purpose of function `deliver`	Control Flow	Informational	Acknowledged

ID	Title	Category	Severity	Status
SSL-13	Possible to gain ownership after renouncing the contract ownership	Logical Issue, Centralization / Privilege	Minor	Acknowledged

SSL-01 | Incorrect error message

Category	Severity	Location	Status
Logical Issue	Minor	Safemoon.sol: 869	Acknowledged

Description

The error message in `require(_isExcluded[account], "Account is already excluded")` does not describe the error correctly.

Recommendation

The message "Account is already excluded" can be changed to "Account is not excluded" .

Alleviation

The team acknowledged the finding, and given the deployed contract cannot be updated, decided to retain the code base unchanged.

SSL-02 | Redundant code

Category	Severity	Location	Status
Logical Issue	Informational	Safemoon.sol: 1123	Acknowledged

Description

The condition `!_isExcluded[sender] && !_isExcluded[recipient]` can be included in `else` .

Recommendation

The following code can be removed:

```
... else if (!_isExcluded[sender] && !_isExcluded[recipient]) {
    _transferStandard(sender, recipient, amount);
} ...
```

Alleviation

The team acknowledged the finding, and given the deployed contract cannot be updated, decided to retain the code base unchanged.

SSL-03 | Contract gains non-withdrawable BNB via the `swapAndLiquify` function

Category	Severity	Location	Status
Logical Issue	Medium	Safemoon.sol: 1057	Acknowledged

Description

The `swapAndLiquify` function converts half of the `contractTokenBalance` SafeMoon tokens to BNB. The other half of SafeMoon tokens and part of the converted BNB are deposited into the SafeMoon-BNB pool on pancakeswap as liquidity. For every `swapAndLiquify` function call, a small amount of BNB leftover in the contract. This is because the price of SafeMoon drops after swapping the first half of SafeMoon tokens into BNBs, and the other half of SafeMoon tokens require less than the converted BNB to be paired with it when adding liquidity. The contract doesn't appear to provide a way to withdraw those BNB, and they will be locked in the contract forever.

Recommendation

It's not ideal that more and more BNB are locked into the contract over time. The simplest solution is to add a `withdraw` function in the contract to withdraw BNB. Other approaches that benefit the SafeMoon token holders can be:

- Distribute BNB to SafeMoon token holders proportional to the amount of token they hold.
- Use leftover BNB to buy back SafeMoon tokens from the market to increase the price of SafeMoon.

Alleviation

The team acknowledged the finding, and given the deployed contract cannot be updated, decided to retain the code base unchanged.

SSL-04 | Centralized risk in `addLiquidity`

Category	Severity	Location	Status
Centralization / Privilege	Major	Safemoon.sol: 1108	Partially Resolved

Description

```
// add the liquidity
uniswapV2Router.addLiquidityETH{value: ethAmount}(
    address(this),
    tokenAmount,
    0, // slippage is unavoidable
    0, // slippage is unavoidable
    owner(),
    block.timestamp
);
```

The `addLiquidity` function calls the `uniswapV2Router.addLiquidityETH` function with the `to` address specified as `owner()` for acquiring the generated LP tokens from the `SafeMoon-BNB` pool. As a result, over time the `_owner` address will accumulate a significant portion of LP tokens.If the `_owner` is an EOA (Externally Owned Account), mishandling of its private key can have devastating consequences to the project as a whole.

Recommendation

We advise the `to` address of the `uniswapV2Router.addLiquidityETH` function call to be replaced by the contract itself, i.e. `address(this)`, and to restrict the management of the LP tokens within the scope of the contract's business logic. This will also protect the LP tokens from being stolen if the `_owner` account is compromised. In general, we strongly recommend centralized privileges or roles in the protocol to be improved via a decentralized mechanism or via smart-contract based accounts with enhanced security practices, f.e. Multisignature wallets.

Indicatively, here are some feasible solutions that would also mitigate the potential risk:

- Time-lock with reasonable latency, i.e. 48 hours, for awareness on privileged operations;
- Assignment of privileged roles to multi-signature wallets to prevent single point of failure due to the private key;
- Introduction of a DAO / governance / voting module to increase transparency and user involvement.

Alleviation

[SafeMoon Team]: In regards to owner control, we are a fair launch governed by a central board which is subject to governmental regulations and law. We are a legally registered entity in accordance to the law and jurisdictions in which we operate. SafeMoon is very different from other projects, and our differences provide more security for the community vs. anonymous teams and projects. Risks in regard to “rug-pulls” or anything else is mitigated due to the fact that every member of SafeMoon would be subject to litigation and likely a swift prison sentence. Additionally, outside of the law, our social lives would be in ruin, and we would not be able to show our faces in public again, let alone get another job. This should be taken into account when looking at the SafeMoon project as a whole.

Additionally, we have taken serious steps towards further risk mitigation by initially starting this project with a fair launch hosted on DxSale, where the LP being immediately locked out of the gate. SafeMoon quickly brought in a team willing to go public with their identities to build trust with the community and for the project. SafeMoon was quickly registered as a legal entity. We locked the 2nd, 3rd, 4th LP’s etc etc etc and will continue to do so when the LP is not needed. We locked $250 million recently via Unicrypt. We have publicly expressed our goals and intentions of why we will retain custody of the contract. The functions allow additional control for the SafeMoon team to make continued strategic plays in regards to long term growth of the community and the project.

Here is a list of the transactions associated with the locked LPs:

- https://unicrypt.network/amm/pancake/pair/0x9adc6fb78cefa07e13e9294f150c1e8c1dd566c0
- https://dxsale.app/app/pages/dxlockview?id=2&add=0xC95063D946242f26074A76C8A2E94c9D735dfc78&type=lplock&chain=BSC
- https://dxsale.app/app/pages/dxlockview?id=1&add=0xC95063D946242f26074A76C8A2E94c9D735dfc78&type=lplock&chain=BSC
- https://dxsale.app/app/pages/dxlockview?id=0&add=0xC95063D946242f26074A76C8A2E94c9D735dfc78&type=lplock&chain=BSC

SSL-05 | Variable could be declared as `constant`

Category	Severity	Location	Status
Gas Optimization	Informational	Safemoon.sol	Acknowledged

Description

Variables `_tTotal`, `numTokensSellToAddToLiquidity`, `_name`, `_symbol` and `_decimals` could be declared as `constant` since these state variables are never to be changed.

Recommendation

We recommend declaring those variables as `constant`.

Alleviation

The team acknowledged the finding, and given the deployed contract cannot be updated, decided to retain the code base unchanged.

SSL-06 | Return value not handled

Category	Severity	Location	Status
Volatile Code	Informational	Safemoon.sol: 1103~1110	Acknowledged

Description

The return values of function `addLiquidityETH` are not properly handled.

```
        uniswapV2Router.addLiquidityETH{value: ethAmount}(
            address(this),
            tokenAmount,
            0, // slippage is unavoidable
            0, // slippage is unavoidable
            owner(),
            block.timestamp
        );
```

Recommendation

We recommend using variables to receive the return value of the functions mentioned above and handle both success and failure cases if needed by the business logic.

Alleviation

The team acknowledged the finding, and given the deployed contract cannot be updated, decided to retain the code base unchanged.

SSL-07 | 3rd party dependencies

Category	Severity	Location	Status
Control Flow	Minor	Safemoon.sol	Acknowledged

Description

The contract is serving as the underlying entity to interact with third party PancakeSwap protocols. The scope of the audit would treat those 3rd party entities as black boxes and assume its functional correctness. However in the real world, 3rd parties may be compromised that led to assets lost or stolen.

Recommendation

We understand that the business logic of the SafeMoon protocol requires the interaction PancakeSwap protocol for adding liquidity to SafeMoon-BNB pool and swap tokens. We encourage the team to constantly monitor the statuses of those 3rd parties to mitigate the side effects when unexpected activities are observed.

Alleviation

[SafeMoon Team]: Renouncing ownership of the contract will result in an inability to adapt to 3rd party changes to include exchanges. The team had the foresight to understand this, as our understanding of the SafeMoon smart contract is the best. We already have contingency plans for likely upcoming 3rd party changes and growth.

SSL-08 | Missing event emitting

Category	Severity	Location	Status
Coding Style	Informational	Safemoon.sol	Acknowledged

Description

In contract `Safemoon`, there are a bunch of functions can change state variables. However, these function do not emit event to pass the changes out of chain.

Recommendation

Recommend emitting events, for all the essential state variables that are possible to be changed during runtime.

SSL-09 | Function and variable naming doesn't match the operating environment

Category	Severity	Location	Status
Coding Style	Informational	Safemoon.sol	Acknowledged

Description

The SafeMoon contract uses Pancakeswap for swapping and add liquidity to Pancakeswap pool, but naming it Uniswap. Function swapTokensForEth(uint256 tokenAmount) swaps SafeMoon token for BNB instead of ETH.

Recommendation

Change "Uniswap" and "ETH" to "Pancakeswap" and "BNB" in the contract respectively to match the operating environment and avoid confusion.

Alleviation

The team acknowledged the finding, and given the deployed contract cannot be updated, decided to retain the code base unchanged.

SSL-10 | Privileged ownership

Category	Severity	Location	Status
Centralization / Privilege	Minor	Safemoon.sol	Partially Resolved

Description

The owner of contract `Safemoon` has the permission to:

1. change the address that can receive LP tokens,
2. lock the contract,
3. exclude/include addresses from rewards/fees,
4. set `taxFee`, `liquidityFee` and `_maxTxAmount`,
5. enable `swapAndLiquifyEnabled`

without obtaining the consensus of the community.

Recommendation

Renounce ownership when it is the right timing, or gradually migrate to a timelock plus multisig governing procedure and let the community monitor in respect of transparency considerations.

Alleviation

[SafeMoon Team]: Consider the critical security concern about privileged ownership, the contract doesn't have an update function, thus it will be impossible to update directly. Our plan is to create a periphery multisig contract for contract owner functions and assign contract owner to it.

As of now, there will be no transfer of ownership, more of an extra check for security with keys split between the current board members. It will require 2/3 keys to do an action on the contract. Board Members are the individuals already disclosed and KYC'd by entities like exchanges we listed with, and they would not have listed SafeMoon if the team had not passed KYC. Additionally, The project and its team are subject to laws and regulations, meaning any action not done in good faith or illegal will result in a swift prison sentence. The MultiSig is underway and will be completed as soon as possible, and we are adding the multisig as an act of good faith.

SSL-11 | Typos in the contract

Category	Severity	Location	Status
Coding Style	Informational	Safemoon.sol: 746, 918	Acknowledged

Description

There are several typos in the code and comments.

1. In the following code snippet, `tokensIntoLiqudity` should be `tokensIntoLiquidity`.

```
event SwapAndLiquify(
        uint256 tokensSwapped,
        uint256 ethReceived,
        uint256 tokensIntoLiqudity
    );
```

2. `recieve` should be `receive` and `swaping` should be `swapping` in the line of comment `//to recieve ETH from uniswapV2Router when swaping`.

Recommendation

We recommend correcting all typos in the contract.

Alleviation

The team acknowledged the finding, and given the deployed contract cannot be updated, decided to retain the code base unchanged.

SSL-12 | The purpose of function `deliver`

Category	Severity	Location	Status
Control Flow	Informational	Safemoon.sol	Acknowledged

Description

The function `deliver` can be called by anyone. It accepts an uint256 number parameter `tAmount`. The function reduces the SafeMoon token balance of the caller by `rAmount`, which is `tAmount` reduces the transaction fee. Then, the function adds `tAmount` to variable `_tFeeTotal`, which represents the contract's total transaction fee. We wish the team could explain more on the purpose of having such functionality.

Alleviation

The team acknowledged the finding and had tested the functionality under different scenarios. Given the deployed contract cannot be updated, decided to retain the code base unchanged.

SSL-13 | Possible to gain ownership after renouncing the contract ownership

Category	Severity	Location	Status
Logical Issue, Centralization / Privilege	Minor	Safemoon.sol: (Ownable)	Acknowledged

Description

An owner is possible to gain ownership of the contract even if he calls function `renounceOwnership` to renounce the ownership. This can be achieved by performing the following operations:

1. Call `lock` to lock the contract. The variable `_previousOwner` is set to the current owner.
2. Call `unlock` to unlock the contract.
3. Call `renounceOwnership` to leave the contract without an owner.
4. Call `unlock` to regain ownership.

Recommendation

We advise updating/removing `lock` and `unlock` functions in the contract; or removing the `renounceOwnership` if such a privilege retains at the protocol level. If timelock functionality could be introduced, we recommend using the implementation of Compound finance as reference. Reference: https://github.com/compound-finance/compound-protocol/blob/master/contracts/Timelock.sol

Alleviation

The team acknowledged the finding, and given the deployed contract cannot be updated, decided to retain the code base unchanged.

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.

Mathematical Operations

Mathematical Operation findings relate to mishandling of math formulas, such as overflows, incorrect operations etc.

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.

Control Flow

Control Flow findings concern the access control imposed on functions, such as owner-only functions being invoke-able by anyone under certain circumstances.

Volatile Code

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

Data Flow

Data Flow findings describe faults in the way data is handled at rest and in memory, such as the result of a struct assignment operation affecting an in-memory struct rather than an in-storage one.

Language Specific

Language Specific findings are issues that would only arise within Solidity, i.e. incorrect usage of private or delete.

Centralization / Priviledge

Centralization / Priviledge findings refer to the logic or implementation of the code exposing to concerns or scenarios that would go against decentralized manners.

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.

Inconsistency

Inconsistency findings refer to functions that should seemingly behave similarly yet contain different code, such as a constructor assignment imposing different require statements on the input variables than a setter function.

Magic Numbers

Magic Number findings refer to numeric literals that are expressed in the codebase in their raw format and should otherwise be specified as constant contract variables aiding in their legibility and maintainability.

Compiler Error

Compiler Error findings refer to an error in the structure of the code that renders it impossible to compile using the specified version of the project.

Disclaimer

This report is subject to the terms and conditions (including without limitation, description of services, confidentiality, disclaimer and limitation of liability) set forth in the Services Agreement, or the scope of services, and terms and conditions provided to the Company in connection with the Agreement. This report provided in connection with the Services set forth in the Agreement shall be used by the Company only to the extent permitted under the terms and conditions set forth in the Agreement. This report may not be transmitted, disclosed, referred to or relied upon by any person for any purposes without CertiK's prior written consent.

This report is not, nor should be considered, an "endorsement" or "disapproval" of any particular project or team. This report is not, nor should be considered, an indication of the economics or value of any "product" or "asset" created by any team or project that contracts CertiK to perform a security assessment. This report does not provide any warranty or guarantee regarding the absolute bug-free nature of the technology analyzed, nor do they provide any indication of the technologies proprietors, business, business model or legal compliance.

This report should not be used in any way to make decisions around investment or involvement with any particular project. This report in no way provides investment advice, nor should be leveraged as investment advice of any sort. This report represents an extensive assessing process intending to help our customers increase the quality of their code while reducing the high level of risk presented by cryptographic tokens and blockchain technology.

Blockchain technology and cryptographic assets present a high level of ongoing risk. CertiK's position is that each company and individual are responsible for their own due diligence and continuous security. CertiK's goal is to help reduce the attack vectors and the high level of variance associated with utilizing new and consistently changing technologies, and in no way claims any guarantee of security or functionality of the technology we agree to analyze.

About

Founded in 2017 by leading academics in the field of Computer Science from both Yale and Columbia University, CertiK is a leading blockchain security company that serves to verify the security and correctness of smart contracts and blockchain-based protocols. Through the utilization of our world-class technical expertise, alongside our proprietary, innovative tech, we're able to support the success of our clients with best-in-class security, all whilst realizing our overarching vision; provable trust for all throughout all facets of blockchain.