Code Security Assessment

Swell Network

Mar 11th, 2022

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Disclaimer

About

Summary

This report has been prepared for Swell Network to discover issues and vulnerabilities in the source code of the Swell Network 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	Swell Network
Platform	Ethereum
Language	Solidity
Codebase	https://github.com/SwellNetwork/v2-core
Commit	① 6bb73be7ebc7bb8b8ca79bff61159aab66ce356f ② 1b67128b5c0b9904bebf596c32fa5040d72eb10f

Audit Summary

Delivery Date	Mar 11, 2022 UTC
Audit Methodology	Static Analysis, Manual Review

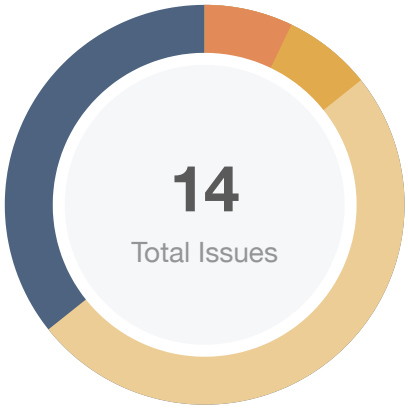
Vulnerability Summary

Vulnerability Level	Total	Pending	Declined	Acknowledged	Partially Resolved	Mitigated	Resolved
Critical	0	0	0	0	0	0	0
Major	1	0	0	1	0	0	0
Medium	1	0	0	1	0	0	0
Minor	7	0	0	2	0	0	5
Informational	5	0	0	3	0	0	2
Discussion	0	0	0	0	0	0	0

Audit Scope

ID	File	SHA256 Checksum
SCK	contracts/Strategy.sol	ca8fb2be2c83358351b75f7aaa1643ff356bbed7079cc77f1eea299d81133900
CKP	contracts/helpers.sol	0dc62ddc286b43e6c2e847631f0ae66489fab849557ed3fa77bab1c611b342e7
DAO	contracts/swDAO.sol	3acf343795b9a55785584f305761cdb1c0f929eccb217491bd0f1da071ae3819
ETH	contracts/swETH.sol	52ac6ce60108428af75b121967b979528c2109e70a5c7c7c3dde9b1a04f89ba9
NFT	contracts/swNFTUpgrade.sol	b5b1a71acde5a17bbb3d8bb7f99c550d1820fa3cd9ee17b3e0e46ef575f96d21

Findings



Critical	**0** (0.00%)
Major	**1** (7.14%)
Medium	**1** (7.14%)
Minor	**7** (50.00%)
Informational	**5** (35.71%)
Discussion	**0** (0.00%)

ID	Title	Category	Severity	Status
CKP-01	Missing Zero Address Validation	Volatile Code	Minor	Resolved
CKP-02	Centralization Related Risks	**Centralization / Privilege**	**Major**	Acknowledged
CKP-03	Variables That Could Be Declared as Immutable	Gas Optimization	Minor	Resolved
NFT-01	Third Party Dependencies	Volatile Code	Informational	Acknowledged
NFT-02	Missing Emit Events	Coding Style	Informational	Resolved
NFT-03	Incorrect `require` Statement	Logical Issue	Minor	Resolved
NFT-04	Potential Gas Exhaustion	Volatile Code	Minor	Acknowledged
NFT-05	Check Effect Interaction Pattern Violated	Logical Issue	Minor	Resolved
NFT-06	No Function to Withdraw Funds	Logical Issue	Informational	Acknowledged
NFT-07	Withdraw Tokens Without Reward	Logical Issue	Informational	Acknowledged
NFT-08	User Can Deposit More Tokens than The Position Value	Logical Issue	Medium	Acknowledged
NFU-01	Potential Gas Exhaustion On function `stake`	Gas Optimization	Minor	Acknowledged
NFU-02	Lack of Validation for `msg.value`	Logical Issue	Minor	Resolved
SCK-01	Missing Error Messages	Coding Style	Informational	Resolved

CKP-01 | Missing Zero Address Validation

Category	Severity	Location	Status
Volatile Code	Minor	contracts/Strategy.sol: 16 contracts/swETH.sol: 15	Resolved

Description

Addresses should be checked before assignment to make sure they are not zero addresses.

Recommendation

Recommend adding zero address checks in the functions.

Alleviation

The team heeded our advice and resolved this issue in commit `95b31eea33ef584a029f50508cea0509e58a7ae1`.

CKP-02 | Centralization Related Risks

Category	Severity	Location	Status
Centralization / Privilege	Major	contracts/Strategy.sol: 25, 33 contracts/swDAO.sol: 15, 19 contracts/swETH.sol: 24, 28 contracts/swNFTUpgrade.sol: 89, 96, 104, 115, 115	Acknowledged

Description

In the contract `Strategy`, the role `swNFT` has authority over the following functions:

- function enter(): to deposit `swETH` tokens to the `Strategy` contract.
- function exit(): to withdraw `swETH` tokens from the `Strategy` contract.

Any compromise to the `swNFT` account may allow a hacker to take advantage of this authority.

In the contract `SWDAO`, the role `_owner` has authority over the following functions:

- function burn(): to burn the `swDAO` tokens from the owner address.
- function mint(): to mint `swDAO` tokens to the owner address.

Any compromise to the `_owner` account may allow a hacker to take advantage of this authority.

In the contract `SWETH`, the role `minter` has authority over the following functions:

- function mint(): to mint `swETH` tokens to the minter address.
- function burn(): to burn `swETH` tokens from the minter address.

Any compromise to the `minter` account may allow a hacker to take advantage of this authority.

In the contract `SWNFTUpgrade`, the role `_owner` has authority over the following functions:

- function setswETHAddress(): to set the `swETH` token address.
- function addStrategy(): to add a new strategy.
- function removeStrategy(): to remove a strategy.
- function addWhiteList(): to add a new validator into whiteList.
- funciton setFeePool(): to set fee pool address.

Any compromise to the `_owner` account may allow a hacker to take advantage of this authority.

Recommendation

The risk describes the current project design and potentially makes iterations to improve in the security operation and level of decentralization, which in most cases cannot be resolved entirely at the present stage. We advise the client to carefully manage the privileged account's private key to avoid any potential risks of being hacked. In general, we strongly recommend centralized privileges or roles in the protocol be improved via a decentralized mechanism or smart-contract-based accounts with enhanced security practices, e.g., multi-signature wallets.

Indicatively, here are some feasible suggestions that would also mitigate the potential risk at a different level in terms of short-term, long-term and permanent:

Short Term:

Timelock and Multi sign (⅔, ⅗) combination *mitigate* by delaying the sensitive operation and avoiding a single point of key management failure.

- Time-lock with reasonable latency, e.g., 48 hours, for awareness on privileged operations;
  AND
- Assignment of privileged roles to multi-signature wallets to prevent a single point of failure due to the private key compromised;
  AND
- A medium/blog link for sharing the timelock contract and multi-signers addresses information with the public audience.

Long Term:

Timelock and DAO, the combination, *mitigate* by applying decentralization and transparency.

- Time-lock with reasonable latency, e.g., 48 hours, for awareness on privileged operations;
  AND
- Introduction of a DAO/governance/voting module to increase transparency and user involvement;
  AND
- A medium/blog link for sharing the timelock contract, multi-signers addresses, and DAO information with the public audience.

Permanent:

Renouncing the ownership or removing the function can be considered *fully resolved*.

- Renounce the ownership and never claim back the privileged roles;
  OR

- Remove the risky functionality.

Noted: Recommend considering the long-term solution or the permanent solution. The project team shall make a decision based on the current state of their project, timeline, and project resources.

Alleviation

The team acknowledged the issue and stated they will transfer the owner to Protocol DAO Gnosis multisign.

CKP-03 | Variables That Could Be Declared As Immutable

Category	Severity	Location	Status
Gas Optimization	Minor	contracts/swETH.sol: 11 contracts/Strategy.sol: 14	Resolved

Description

The linked variables assigned in the constructor can be declared as `immutable`. Immutable state variables can be assigned during contract creation but will remain constant throughout the lifetime of a deployed contract. A big advantage of immutable variables is that reading them is significantly cheaper than reading from regular state variables since they will not be stored in storage.

Recommendation

We recommend declaring these variables as immutable. Please note that the `immutable` keyword only works in Solidity version `v0.6.5` and up.

Alleviation

The team heeded our advice and resolved this issue in commit `95b31eea33ef584a029f50508cea0509e58a7ae1`.

NFT-01 | Third Party Dependencies

Category	Severity	Location	Status
Volatile Code	Informational	contracts/swNFTUpgrade.sol	Acknowledged

Description

The contract is serving as the underlying entity to interact with third-party `IDepositContract` protocols. The scope of the audit treats 3rd party entities as black boxes and assumes their functional correctness. However, in the real world, 3rd parties can be compromised and this may lead to lost or stolen assets. In addition, upgrades of 3rd parties can possibly create severe impacts, such as increasing fees of 3rd parties, migrating to new LP pools, etc.

Recommendation

We understand that the business logic of the contract requires interaction with the aforementioned protocols. We encourage the team to constantly monitor the status of 3rd parties to mitigate side effects when unexpected activities are observed.

Alleviation

The team acknowledged this issue and they stated the following:

"As IDepositContract is the official deposit contract, which is static code and address that is not going to change. And worst case as swNFT is an upgradable contract that we could still update from there".

NFT-02 | Missing Emit Events

Category	Severity	Location	Status
Coding Style	Informational	contracts/swNFTUpgrade.sol: 89	Resolved

Description

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

Recommendation

Consider adding events for sensitive actions, and emit them in the function.

Alleviation

The team heeded our advice and resolved this issue in commits `95b31eea33ef584a029f50508cea0509e58a7ae1` and `bc2756fb84a680c4630f0e8c1bb73f0d5c550b91`.

NFT-03 | Incorrect `require` Statement

Category	Severity	Location	Status
Logical Issue	Minor	contracts/swNFTUpgrade.sol: 105, 208, 231	Resolved

Description

The correct require check should ensure strategy index is in the range of the array `strategies` length.

Recommendation

We advise the client to recheck the function.

Alleviation

The team heeded our advice and resolved this issue in commit `bc2756fb84a680c4630f0e8c1bb73f0d5c550b91`.

NFT-04 | Potential Gas Exhaustion

Category	Severity	Location	Status
Volatile Code	Minor	contracts/swNFTUpgrade.sol: 246	Acknowledged

Description

The `for` loop in the function `batchAction()` takes the unbounded array's length as the maximum iteration times. If the size of the array `Action` grows large, iterating through the entire array could be an expensive operation considering there are external calls in the `for` loop. Even worse, if the computation for each iteration is extremely complex, it could lead to gas insufficiency.

Recommendation

We recommend setting constraints to the length of the array `Action`.

Alleviation

The team acknowledged this issue and they will leave it as it is for now.

NFT-05 | Check Effect Interaction Pattern Violated

Category	Severity	Location	Status
Logical Issue	Minor	contracts/swNFTUpgrade.sol: 173, 190, 206, 229	Resolved

Description

The order of external call/transfer and storage manipulation must follow the check-effect-interaction pattern.

Recommendation

It is recommended to follow checks-effects-interactions pattern for cases like this. It shields public functions from re-entrancy attacks. It's always a good practice to follow this pattern. `checks-effects-interaction` pattern also applies to ERC20 tokens as they can inform the recipient of a transfer in certain implementations.

Alleviation

The team heeded our advice and resolved this issue in commit `1b67128b5c0b9904bebf596c32fa5040d72eb10f`.

NFT-06 | No Function To Withdraw Funds

Category	Severity	Location	Status
Logical Issue	Informational	contracts/swNFTUpgrade.sol: 143~149	Acknowledged

Description

In the function `stake()`, ETH is deposited to the contract `IDepositContract`, however, there is no function provided in contract `SWNFTUpgrade` to withdraw ETHs, we would like to confirm with the client if the current implementation aligns with the original project design.

Recommendation

We advise the client to revisit the design and ensure it is intended.

Alleviation

The team acknowledged this issue and they stated that is intended and that's how Ethereum official POS works.

NFT-07 | Withdraw Tokens Without Reward

Category	Severity	Location	Status
Logical Issue	Informational	contracts/swNFTUpgrade.sol: 190, 229	Acknowledged

Description

In the contract `SWNFTUpgrade`, the users can deposit `swETH` to the contract, however, they do not receive any reward when withdrawing `swETH` from the contract. Similarly when the users exit the strategy they do not get any reward. We would like to confirm with the client if the current implementation aligns with the original project design.

Recommendation

We advise the client to revisit the design and ensure it is intended.

Alleviation

The team acknowledged this issue and stated they plan to convert it to a vault and provide reward in the next version.

NFT-08 | User Can Deposit More Tokens Than The Position Value

Category	Severity	Location	Status
Logical Issue	Medium	contracts/swNFTUpgrade.sol: 179, 215	Acknowledged

Description

In the function `deposit()`, the **require** check is used to ensure the total deposit amount is not more than the position value, however, does not consider the enter strategy amount. So the user still can deposit more tokens (transferred from other uses) than the position value if the user calls the function `enterStrategy()` to enter strategy before depositing `swETH` into position.

Recommendation

We recommend reviewing the logic again.

Alleviation

The team removed the **require** check in commit `1b67128b5c0b9904bebf596c32fa5040d72eb10f` and stated users could just deposit unlimited `swETH` but withdraw will still check the balance.

NFU-01 | Potential Gas Exhaustion On Function `stake`

Category	Severity	Location	Status
Gas Optimization	Minor	contracts/tests/swNFTUpgradeTestnet.sol	Acknowledged

Description

The `for` loop in the function `stake()` takes the unbounded array's length as the maximum iteration times. If the size of the array `Action` grows large, iterating through the entire array could be an expensive operation considering there are external calls in the `for` loop. Even worse, if the computation for each iteration is extremely complex, it could lead to gas insufficiency.

Recommendation

We recommend setting constraints to the length of the array `stakes`.

Alleviation

The team acknowledged this issue and they will leave it as it is for now.

NFU-02 | Lack Of Validation For `msg.value`

Category	Severity	Location	Status
Logical Issue	Minor	contracts/tests/swNFTUpgradeTestnet.sol	Resolved

Description

There is no validation to ensure `msg.value` equals the total stake amount of ETH.

```
  function stake(Stake[] calldata stakes) external payable returns (uint[] memory ids) {
      require(msg.value >= 1 ether, "Must send at least 1 ETH");
      require(msg.value % ETHER == 0, "stake value not multiple of Ether");
      ids = new uint[](stakes.length);
      uint totalAmount = msg.value;
      for(uint i = 0; i < stakes.length; i++){
          ids[i] = _stake(stakes[i].pubKey, stakes[i].signature,
stakes[i].depositDataRoot, stakes[i].amount);
          totalAmount -= stakes[i].amount;
      }
  }
```

Recommendation

Consider adding the validation to avoid the remaining ETH staying in the contract.

Alleviation

The team heeded our advice and resolved this issue in commit `bc2756fb84a680c4630f0e8c1bb73f0d5c550b91`.

SCK-01 | Missing Error Messages

Category	Severity	Location	Status
Coding Style	Informational	contracts/Strategy.sol: 21	Resolved

Description

The **require** can be used to check for conditions and throw an exception if the condition is not met. It is better to provide a string message containing details about the error that will be passed back to the caller.

Recommendation

We advise adding error messages to the linked **require** statements.

Alleviation

The team heeded our advice and resolved this issue in commit `ef2a10118b96224331976890967d2ffa55022f36`.

Appendix

Finding Categories

Centralization / Privilege

Centralization / Privilege findings refer to either feature logic or implementation of components that act against the nature of decentralization, such as explicit ownership or specialized access roles in combination with a mechanism to relocate funds.

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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