# Code Security Assessment

# Numbers Protocol-Audit

Jan 12th, 2022

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# Summary

This report has been prepared for Numbers Protocol-Audit to discover issues and vulnerabilities in the source code of the Numbers Protocol-Audit 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.

We are not sure the token contracts will be used in which scenarios. The issues caused by the external design logic are not included in the audit scope.

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** | Numbers Protocol-Audit |
| **Platform** | ethereum |
| **Language** | Solidity |
| **Codebase** | https://github.com/numbersprotocol/thunder_bridge/tree/feature-certik-auditing/contracts/flats |
| **Commit** | 3b6165f243e40e0ebf4da62e63141b730ed7cea1 |

## Audit Summary

| | |
|---|---|
| **Delivery Date** | Jan 12, 2022 |
| **Audit Methodology** | Static Analysis, Manual Review |

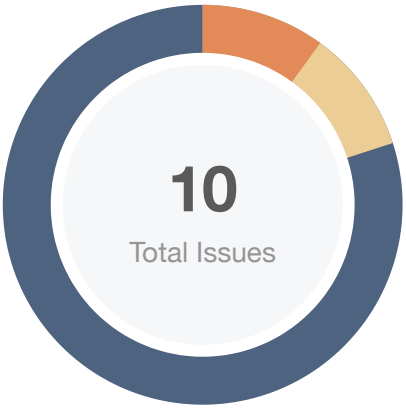
## Vulnerability Summary

| Vulnerability Level | Total | Pending | Declined | Acknowledged | Partially Resolved | Resolved |
|---|---|---|---|---|---|---|
| Critical | 0 | 0 | 0 | 0 | 0 | 0 |
| Major | 1 | 0 | 0 | 1 | 0 | 0 |
| Medium | 0 | 0 | 0 | 0 | 0 | 0 |
| Minor | 1 | 0 | 0 | 1 | 0 | 0 |
| Informational | 8 | 0 | 0 | 8 | 0 | 0 |
| Discussion | 0 | 0 | 0 | 0 | 0 | 0 |

# Audit Scope

| ID | File | SHA256 Checksum |
| --- | --- | --- |
| ERC | flats/ERC677InitializableToken.sol | ae635bcb4c42e4438fdea9e96908c26fa7ae024d387887abeeaf0994d72ad680 |
| ERM | flats/ERC677MultiBridgeToken.sol | 10a881ec3a19624d1cbe26ecb92fef8fe71987629f15526100f31a0a5d5d6042 |
| TPN | flats/TokenProxy.sol | 54fa34b2dcb5cb822ff95f1bbf0543cc63eee58dedbc5338137506493a094e9b |

# Findings




| | |
|---|---|
| **Critical** | **0** (0.00%) |
| **Major** | **1** (10.00%) |
| **Medium** | **0** (0.00%) |
| **Minor** | **1** (10.00%) |
| **Informational** | **8** (80.00%) |
| **Discussion** | **0** (0.00%) |

| ID | Title | Category | Severity | Status |
|---|---|---|---|---|
| GLOBAL-01 | Missing Error Messages | Coding Style | Informational | Acknowledged |
| **GLOBAL-02** | Centralization Related Risks | **Centralization / Privilege** | **Major** | Acknowledged |
| ERC-01 | Redundant Statements | Volatile Code | Informational | Acknowledged |
| ERC-02 | Code Optimization | Logical Issue | Informational | Acknowledged |
| ERM-01 | Missing BridgeContract Removing Function | Logical Issue | Informational | Acknowledged |
| NPC-01 | Unclear Purpose Of `fundReceiver()` | Logical Issue | Informational | Acknowledged |
| NPC-02 | Unlocked Compiler Version | Language Specific | Informational | Acknowledged |
| NPC-03 | Meaningless Function | Logical Issue | Informational | Acknowledged |
| NPC-04 | Mixed Complier Version | Compiler Error | Informational | Acknowledged |
| NPC-05 | Missing Input Validation | Volatile Code | Minor | Acknowledged |

# GLOBAL-01 | Missing Error Messages

| Category | Severity | Location | Status |
| --- | --- | --- | --- |
| Coding Style | Informational | Global | Acknowledged |

## 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 refactoring the linked codes as below:

For example:

```
function add(uint256 a, uint256 b) internal pure returns (uint256 c) {
    c = a + b;
    require(c >= a, ""SafeMath: addition overflow"");
}
```

## Alleviation

No alleviation.

# GLOBAL-02 | Centralization Related Risks

| Category | Severity | Location | Status |
| --- | --- | --- | --- |
| Centralization / Privilege | Major | Global | Acknowledged |

## Description

The role `owner` has the authority over the listed functions:

`ERC677MultiBridgeToken.sol:`

- `setFundingRules()`
- `setBridgeContract()`
- `renounceOwnership()`
- `claimTokens()`
- `transferOwnership()`
- `finishMinting()`
- `addBridgeContract()`

`ERC677InitializableToken.sol:`

- `setFundingRules()`
- `setBridgeContract()`
- `renounceOwnership()`
- `claimTokens()`
- `transferOwnership()`
- `mint()`

`TokenProxy.sol:`

- `changeAdmin()`
- `upgradeTo()`
- `upgradeToAndCall()`

Any compromise to the key role account may allow a potential hacker to take advantage of this and execute malicious acts.

## 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.

## Alleviation

No alleviation.

# ERC-01 | Redundant Statements

| Category | Severity | Location | Status |
| --- | --- | --- | --- |
| Volatile Code | Informational | flats/ERC677InitializableToken.sol: 606~609 | Acknowledged |

## Description

The linked statements do not affect the functionality of the codebase and appear to be either leftovers from test code or older functionality.

## Recommendation

We advise that they are removed to better prepare the code for production environments.

## Alleviation

No alleviation.

# ERC-02 | Code Optimization

| Category | Severity | Location | Status |
| --- | --- | --- | --- |
| Logical Issue | Informational | flats/ERC677InitializableToken.sol: 33~43, 645~648 | Acknowledged |

## Description

In the higher version Openzeppelin, the linked `initializer` modifier code is improved to be better suited to the following case:

- In the contract, the initialization function, which is modified by the liked `initializer` modifier, called its super contract initialization function also modified by the same `initializer` modifier.

## Recommendation

We advise refactoring the linked statements as below:

```
33  modifier initializer() {
34    require(initializing || isConstructor() || !initialized, "Contract instance has
already been initialized");
35
36    bool isTopLevelCall = !initializing;
37    if (isTopLevelCall) {
38      initializing = true;
39      initialized = true;
40    }
41
42    _;
43
44    if (isTopLevelCall) {
45      initializing = false;
46    }
47  }
```

## Alleviation

No alleviation.

# ERM-01 | Missing BridgeContract Removing Function

| Category | Severity | Location | Status |
| --- | --- | --- | --- |
| Logical Issue | Informational | flats/ERC677MultiBridgeToken.sol: 678~681 | Acknowledged |

## Description

The linked function only takes charge of adding bridge contract. However, in the codebase, there is no function for removing the added bridge contract. Does it meet the original design logic?

## Recommendation

Please provide us more information about the design logic.

## Alleviation

No alleviation.

## NPC-01 | Unclear Purpose Of `fundReceiver()`

| Category | Severity | Location | Status |
| --- | --- | --- | --- |
| Logical Issue | Informational | flats/ERC677InitializableToken.sol: 694~695, 667<br>flats/ERC677MultiBridgeToken.sol: 599~600, 599~600, 551 | Acknowledged |

### Description

Along with the `ERC677` token is transferred to the `_to` address, the `fundingRules.amount` of native tokens are transferred into the `_to` address. There is no fixed value rate between the transferred `ERC677` token and the transferred native token, so what's the purpose of the `fundReceiver()` function?

### Recommendation

Please provide us with more information about the design logic.

### Alleviation

The client gave the following response:

`The purpose of the` fundReceiver() `function is used for transferring a number of native tokens to the cross-bridge transfer recipient and helping the above recipient to pay the gas fee of other transactions.`

## NPC-02 | Unlocked Compiler Version

| Category | Severity | Location | Status |
| --- | --- | --- | --- |
| Language Specific | Informational | flats/ERC677InitializableToken.sol: 3<br>flats/ERC677MultiBridgeToken.sol: 3<br>flats/TokenProxy.sol: 3 | Acknowledged |

### Description

The contract has unlocked compiler version. An unlocked compiler version in the source code of the contract permits the user to compile it at or above a particular version. This, in turn, leads to differences in the generated bytecode between compilations due to differing compiler version numbers. This can lead to an ambiguity when debugging as compiler specific bugs may occur in the codebase that would be hard to identify over a span of multiple compiler versions rather than a specific one.

### Recommendation

We advise that the compiler version is instead locked at the lowest version possible that the contract can be compiled at. For example, for version `v0.6.2` the contract should contain the following line:

```
pragma solidity 0.6.2;
```

### Alleviation

No alleviation.

# NPC-03 | Meaningless Function

| Category | Severity | Location | Status |
| --- | --- | --- | --- |
| Logical Issue | Informational | flats/ERC677InitializableToken.sol: 756~762<br>flats/ERC677MultiBridgeToken.sol: 641~648 | Acknowledged |

## Description

The behavior of the linked functions is unchangeable no matter what the value of parameters.

## Recommendation

We advise removing the linked function.

## Alleviation

No alleviation.

# NPC-04 | Mixed Complier Version

| Category | Severity | Location | Status |
| --- | --- | --- | --- |
| Compiler Error | Informational | flats/ERC677InitializableToken.sol: 63, 3, 101, 170, 387, 420, 503, 547, 595, 604<br>flats/ERC677MultiBridgeToken.sol: 20, 75, 126, 160, 185, 311, 378, 440, 464, 477, 490, 499, 666<br>flats/TokenProxy.sol: 73, 186, 321, 109 | Acknowledged |

## Description

The using compiler version should satisfy each `pragma solidity VersionNum` declaration at the same time when multiple different compiler version declarations appear in a single `sol` file.

## Recommendation

We advise fixing the compiler version and removing the duplicated declarations.

## Alleviation

No alleviation.

# NPC-05 | Missing Input Validation

| Category | Severity | Location | Status |
| --- | --- | --- | --- |
| Volatile Code | Minor | flats/ERC677InitializableToken.sol: 645~648<br>flats/TokenProxy.sol: 234~238 | Acknowledged |

## 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 errors as below:

```
645  function initialize(string _name, string _symbol, uint8 _decimals, address _owner)
external initializer {
646      require(address(0) != _owner, "set owner to the zero address");
647      ERC20Mintable.initialize(_owner);
648      ERC20Detailed.initialize(_name, _symbol, _decimals);
649  }
```

```
234  constructor(address _implementation, address _admin, bytes _data)
UpgradeabilityProxy(_implementation, _data) public payable {
235    require(address(0) != _admin, "set admin to the zero address");
236    assert(ADMIN_SLOT == keccak256("org.zeppelinos.proxy.admin"));
237
238    _setAdmin(_admin);
239  }
```

## Alleviation

No alleviation.

# 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.

### 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.

### Language Specific

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

### 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.

### 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.

## 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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