CERTIK

Security Assessment

The Legend of Deification

Sept 8th, 2021

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Summary

This report has been prepared for The Legend of Deification to discover issues and vulnerabilities in the source code of the The Legend of Deification 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.

Additionally, this audit is based on a premise that all external smart contracts are implemented safely.

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	The Legend of Deification
Platform	Ethereum
Language	Solidity
Codebase	https://github.com/BWNFT/Legend-NFT
Commit	79ebad4cf1cb664a3268cfbf9bcd14292449d81b 1e7455cb2da55b1c1fdf781510e8f5647f81dae3

Audit Summary

Delivery Date	Sept 08, 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	1	0	0	1	0	0
Medium	2	0	0	1	0	1
Minor	0	0	0	0	0	0
Informational	1	0	0	0	0	1
Discussion	0	0	0	0	0	0

Audit Scope

ID	File	SHA256 Checksum
ATL	Auth.sol	c2f912ede3b59e6f805b66dac8410f5d8f77af27dbbf8408d1940af6c571ef91
CAR	CARD.sol	170528742cc475701ca3a9e3aaa83e97ed9d829e0bcb3c0df44da1114e61f248
ERC	ERC721.sol	88769222342a25637ce3ba053067927863eb3a2a551bfb5086e5494deae75796
ERT	ERC721Token.sol	42fca16971367503463df07343ccd332bf95cec77c6e25df4b2aa45cf48b9a1d
PAC	PACK.sol	7933d139337becae28c4d9c2b6fcadc1197585e2e895bcdb840128382dd6e8aa
SKI	SKILL.sol	4b52446eabc594e353b34a079e3d8015fb253b4f258d691095f7d3e3d7379cdf
TLO	TLOD.sol	886987bc39d46e57cefa1e35893b74185b197f6f859313f580d5f985679f1f69

Understandings

Overview

The Legend of Deification is an NFT project based on `ERC721 Non-Fungible Token Standard.` CARD`,` PACK`, and` SKILL`contracts are inherited from the`ERC721Token `contract which is inherited from the`ERC721` contract.

The `Auth` contract is responsible for access restriction. There are three different kinds of roles , `address(this)`, `_owner`, and `_authority`, can be authorized to access sensitive functions, such as `mint()`, `safeMint`, `burn()`, etc.

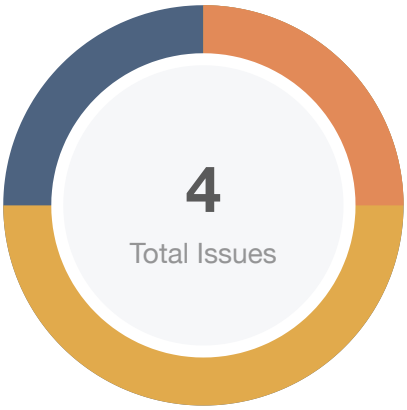
`TLOD` is an `ERC20` contract that mints the `_totalSupply` amount of token to a centralized address when it is deployed onto blockchain.

Privileged Functions

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

- `setOwner()` in `Auth.sol`
- `setAuthority()` in `Auth.sol`
- `setBaseURI()` in `ERC721Token.sol`
- `setTokenURI()` in `ERC721Token.sol`
- `mint()` in `ERC721Token.sol`
- `safeMint(address to, uint256 tokenId)` in `ERC721Token.sol`
- `safeMint(address to,uint256 tokenId,bytes memory _data)` in `ERC721Token.sol`
- `burn()` in `ERC721Token.sol`

Findings



Critical	**0** (0.00%)
Major	**1** (25.00%)
Medium	**2** (50.00%)
Minor	**0** (0.00%)
Informational	**1** (25.00%)
Discussion	**0** (0.00%)

ID	Title	Category	Severity	Status
GLOBAL-01	Unlocked Compiler Version	Language Specific	Informational	Resolved
GLOBAL-02	Centralization Risk	**Centralization / Privilege**	**Major**	Acknowledged
ATL-01	Missing Input Validation	Volatile Code	Medium	Resolved
TLO-01	Token Minted To Centralized Address	Logical Issue	Medium	Acknowledged

GLOBAL-01 | Unlocked Compiler Version

Category	Severity	Location	Status
Language Specific	Informational	Global	Resolved

Description

The contract utilizes an unlocked compiler version. An unlocked compiler version in the contract's source code 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 ambiguity when debugging as compiler-specific bugs may occur in the codebase that would be difficult to identify over a span of multiple compiler versions rather than a specific one.

Recommendation

We advise that the compiler version is alternatively locked at the lowest version possible that the contract can be compiled at. For example, for version `v0.8.0` the contract should contain the following line:

```
pragma solidity 0.8.0;
```

Alleviation

The development team resolved this issue in commit 1e7455cb2da55b1c1fdf781510e8f5647f81dae3.

GLOBAL-02 | Centralization Risk

Category	Severity	Location	Status
Centralization / Privilege	**Major**	**Global**	Acknowledged

Description

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

- `setOwner()` in `Auth.sol`
- `setAuthority()` in `Auth.sol`
- `setBaseURI()` in `ERC721Token.sol`
- `setTokenURI()` in `ERC721Token.sol`
- `mint()` in `ERC721Token.sol`
- `safeMint(address to, uint256 tokenId)` in `ERC721Token.sol`
- `safeMint(address to,uint256 tokenId,bytes memory _data)` in `ERC721Token.sol`
- `burn()` in `ERC721Token.sol`

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

Recommendation

We advise the client to carefully manage the role `owner` account's private key to avoid any potential risks of being hacked. In general, we strongly recommend centralized privileges or roles in the protocol to be improved via a decentralized mechanism or smart-contract-based accounts with enhanced security practices, e.g., Multisignature wallets.

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

- Time-lock with reasonable latency, e.g., 48 hours, for awareness on privileged operations;

- Assignment of privileged roles to multi-signature wallets to prevent a single point of failure due to the private key;
- Introduction of a DAO/governance/voting module to increase transparency and user involvement.

Alleviation

The client responded that they would use the recommended and their own methods to protect the private key of the `owner`.

ATL-01 | Missing Input Validation

Category	Severity	Location	Status
Volatile Code	Medium	new_version/Auth.sol: 28~31, 33~36	Resolved

Description

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

Recommendation

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

```
28 function setOwner(address owner) external onlyAuth {
29     require(address(0) != owner, "set owner to the zero address");
30     _owner = owner;
31     emit SetOwner(_owner);
32 }
```

```
33 function setAuthority(address authority) external onlyAuth {
34     require(address(0) != owner, "set authority to the zero address");
35     _authority = authority;
36     emit SetAuthority(_authority);
37 }
```

Alleviation

The development team resolved this issue in commit 1e7455cb2da55b1c1fdf781510e8f5647f81dae3.

TLO-01 | Token Minted To Centralized Address

Category	Severity	Location	Status
Logical Issue	Medium	new_version/TLOD.sol: 19	Acknowledged

Description

The `_totalSupply` amount of token is minted to a centralized address. This may raise community concerns about the centralized issue.

Recommendation

We advise the client to carefully manage the `ERC20` deployer account's private key and avoid any potential risks of being hacked. We also advise the client to adopt Multisig, Timelock, and/or DAO in the project to manage this specific account in this case.

Alleviation

The client responded that the tokens, which are minted when the contract is deployed, would be transferred to the address of the `Game Operation Department`. And the client would use the recommended and their own methods to protect the private key of the `ERC20` deployer account.

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.

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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