Blaize.Security

November 28th 2022 / V. 1.0

# SMART CONTRACT AUDIT

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# AUDIT RATING

LiquidAccess NFT contract's source code was taken from the repository provided by the Spectre LiquidAccess NFT team.

**SCORE** **9.6**/10

The scope of the project includes **LiquidAccess NFT** set of contracts**:**

LiquidAccess.sol:

Repository:
https://github.com/liquidaccess/nft/commits/master

Initial commit:

- 87b64635e54488db466424d883d62332ebc4f1ac

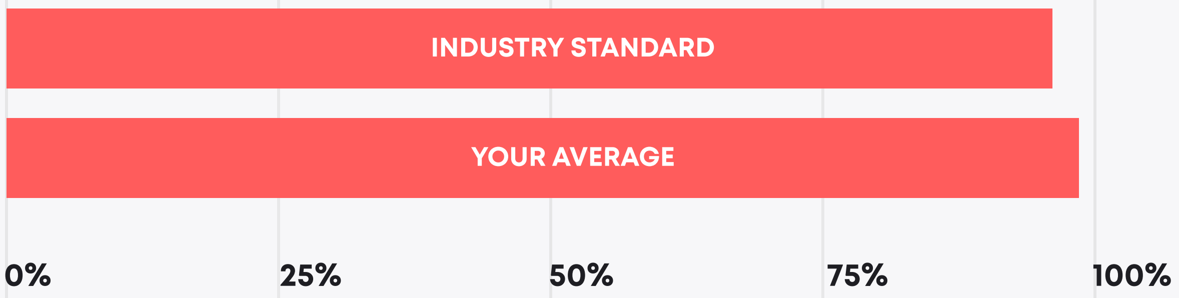
Last-audited commit:

- https://github.com/liquidaccess/nft/pull/1, 8ccc6eba28f1fae0a1b2459aa5eead6aa7ae4aca

# TECHNICAL SUMMARY

During the audit, we examined the security of smart contracts for the LiquidAccess NFT protocol. Our task was to find and describe any security issues in the smart contracts of the platform. This report presents the findings of the security audit of the **LiquidAccess NFT** smart contracts conducted during **November 21st, 2022 - November 25th, 2022.**

**Testable code**

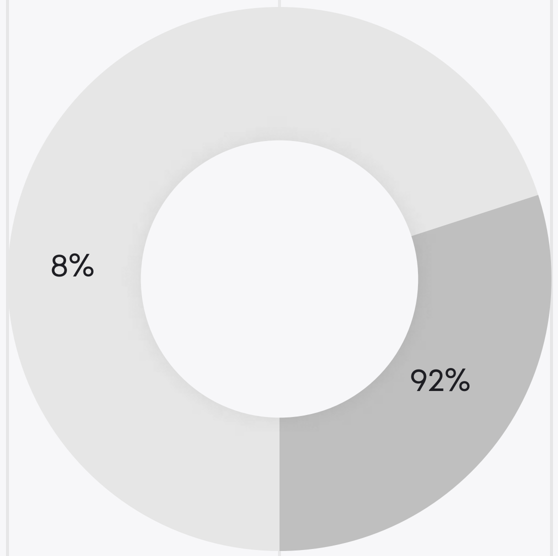


The testable code has sufficient coverage, which is above the industry standard of 95%.

The scope of the audit includes the unit test coverage, which is based on the smart contracts code, documentation, and requirements presented by the LiquidAccess NFT team. The coverage is calculated based on the set of the Hardhat framework tests and scripts from additional testing strategies. However, in order to ensure full security of the contract, the Blaize.Security team suggests the LiquidAccess NFT team launch a bug bounty program to encourage further active analysis of the smart contracts.

## THE GRAPH OF VULNERABILITIES DISTRIBUTION:

- 🟥 CRITICAL
- 🟥 HIGH
- 🟥 MEDIUM
- ⬜ LOW
- ⬜ LOWEST



The table below shows the number of the detected issues and their severity. A total of 12 problems were found. No critical issues were found. Most of the issues were fixed by the LiquidAccess NFT team.

| | FOUND | FIXED/VERIFIED |
|---|---|---|
| Critical | 0 | 0 |
| High | 0 | 0 |
| Medium | 0 | 0 |
| Low | 1 | 1 |
| Lowest | 11 | 7 |

## SEVERITY DEFINITION

🟥 **Critical**
The system contains several issues ranked as very serious and dangerous for users and the secure work of the system. Requires immediate fixes and a further check.

🟥 **High**
The system contains a couple of serious issues, which lead to unreliable work of the system and migh cause a huge data or financial leak. Requires immediate fixes and a further check.

🟥 **Medium**
The system contains issues that may lead to medium financial loss or users’ private information leak. Requires immediate fixes and a further check.

⬜ **Low**
The system contains several risks ranked as relatively small with the low impact on the users’ information and financial security. Requires fixes.

⬜ **Lowest**
The system does not contain any issues critical to the secure work of the system, but best practices should be implemented.

## AUDITING STRATEGY AND TECHNIQUES APPLIED/PROCEDURE

We have scanned this smart contract for commonly known and more specific vulnerabilities:

- Unsafe type inference;
- Timestamp Dependence;
- Reentrancy;
- Implicit visibility level;
- Gas Limit and Loops;
- Transaction-Ordering Dependence;
- Unchecked external call - Unchecked math;
- DoS with Block Gas Limit;
- DoS with (unexpected) Throw;
- Byte array vulnerabilities;
- Malicious libraries;
- Style guide violation;
- ERC20 API violation;
- Uninitialized state/storage/ local variables;
- Compile version not fixed.

### Procedure

We checked the contract for the following parameters:

- Whether the contract is secure;
- Whether the contract corresponds to the documentation;
- Whether the contract meets the best practices in the efficient use of gas, code readability.

### Automated analysis:

Scanning contract by several publicly available automated analysis tools such as Mythril, Solhint, Slither, and Smartdec. Manual verification of all the issues found with these tools.

### Manual audit:

Manual analysis of smart contracts for security vulnerabilities. We checked smart contract logic and compared it with the one described in the documentation.

## EXECUTIVE SUMMARY

During the audit, the Blaize security team carefully checked the core contract of LiquidAccess NFT - LiquidAccess.sol. The goal of the audit was to verify that the best Solidity practices are applied, the contract corresponds to the ERC721 standard. It was also required to ensure the safety of minting, transfering, and other standard processes of an NFT contract.

No critical issues were found in the contract. Though, one low and several informational problems were discovered. The low issue was connected to the absence of one validation parameter, during which tokens can't be transferred. The informational issues were connected to the violation of the Solidity code style, optimizations, and bussiness-logic features validations. Most of the issues were succesfully fixed by the LiquidAccess NFT team.

The overall security of the contract is high enough. The contract corresponds to the NFT standard in a secure way. The provided repository contains a sufficient tests coverage provided by the LiquidAccess NFT team. The Blaize security team has also prepared their own set of additional testing scenarios.

| | **RATING** |
|---|---|
| Security | 9.9 |
| Gas usage and logic optimization | 9.9 |
| Code quality | 9.0 |
| Test coverage* | 9.9 |
| Total | 9.6 |

## CONTRACT OVERVIEW

LiquidAccess.sol is an NFT contract that implements ERC721 NFT standard, ERC2981 royalty standard and ERC4906 Metadana Update Extension. During the deployment of the contract, token's name, symbol, merchant, and merchant ID are set in storage.

The minting flow of the contract contains the safeMint() function, which can be executed only by the owner of the contract. During minting, the owner can specify the receiver, subscription type, and expiration of the token. There are also setters, which allow owner to change the subscription type and expiration of the existing tokens. Also, the contract contains additional setters, which allows the owner to set the following information about the contract: royalty, lockup period, users and NFTs blacklist, NFT and contract's name, description, image.

There is also a blacklist for users and NFTs in the contract. The owner can add or remove users and NFTs in the blacklist. Blacklisted users are fobidden from transferring or receiving NFTs, while blacklisted tokens can't be transferred.

Additionally, there is a lockup period between transfers of the tokens. For example, if the lockup period is set to 1 day, each NFT can be transferred only once a day.

## COMPLETE ANALYSIS

**LOW-1** ✓ **Resolved**

**Lock period can be set to large values.**

LiquidAccess.sol: setLockupPeriod().
There is no validation in this function that the `period` parameter is not equal to large values. In case a large value is passed in this function, it can potentially block any other transfers of the NFT (since the lock up period of the NFT isn't updated when global `_lockupPeriod` is updated). The issue is marked as low since the owner should validate which value is passed in this function. Though it is still recommended to add a maximum limit which the `period` parameter could not exceed.

**Recommendation:**

Validate that the `period` parameter doesn't exceed a certain value.

**LOWEST-1** ✓ **Resolved**

**Blacklist mappings can use boolean values to indicate if the value is blacklisted.**

LiquidAccess.sol: lines 22, 23
Mapping `mapping(address => address)` can be changed to `mapping(address =>bool)`, and `mapping(uint256 => uint256)` to `mapping(uint256 => bool)`. Though the current solution works well and doesn't lead to any vulnerabilities, using booleans instead will improve readability and code clarity.

**Recommendation:**

Change mappings and relevant functions.

## LOWEST-2 ✓ Resolved

**Some variables are changed without an event.**

LiquidAccess.sol: functions setLockupPeriod(), addNFTToBlacklist(), removeNFTFromBlacklist(), addAddressToBlacklist(), removeAddressFromBlacklist(), setContractName(), setContractDescription(), setContractImage().
Mapping and variables inside the LiquidAccess contract can be changed without an event. Thus, it can be complicated to parse and update data related to this contract.

**Recommendation:**

Add events for every storage change. It is advised to indicate the previous and new values.

## LOWEST-3 Unresolved

**Explicit getters can be omitted in favor of the default ones.**

LiquidAccess.sol: lines 16-23, 121-122, 247-249
The variables can be set to public, so default getters will be created. Since this contract isn't inherited by any other contracts, there is no point of making these variables private. Thus, security is not a concern in this case.

**Recommendation:**

Remove explicit getters and make the variables public.

| LOWEST-4 | ✓ Resolved |
|---|---|

**Style guide violation.**

LiquidAccess.sol: 121-122, 247-249, etc
Solidity style guide (the order of layout) is violated, which makes the code harder to read.

**Recommendation:**

Change your contract so as to comply with the style guide (especially the order of layout). You can also split the contract into several parts to divide logic and variables for readability.

| LOWEST-5 | ✓ Resolved |
|---|---|

**Functions can be marked as external.**

LiquidAccess.sol: functions contractURI(), lockupLeftOf(), lockupPeriod(), isNFTBlacklisted(), isAddressBlacklisted(), merchantName(), merchantId(). In order to decrease gas spending, some of public functions that aren’t used within other functions can be marked as external.

**Recommendation:**

Mark the aforementioned functions as external.

## LOWEST-6 ✓ Resolved

**Conditions can be united in one if.`**

LiquidAccess.sol: function lockupLeftOf(), lines 126,129.
Since 0`value is returned in both branches, they can be united to improve code readability.

**Recommendation:**

Unite conditions of if's with || operator.

## LOWEST-7 Unresolved

**Personal NFT lock up is not updated in case global lock up period is updated. LiquidAccess.sol**

When `_lockupPeriod`is updated, the personal lockup of each NFT that is currently locked for transfers is not updated. The issue is marked as info since it doesn't expose any danger and might be a part of the bussiness logic.

**Recommendation:**

Verify that the personal lockup for each NFT should not be affected when the global lockup period is changed.

## LOWEST-8 ✓ Verified

**Users and NFTs can be blacklisted.**

Though such functionality is a part of the bussiness logic and isn't considered as security threat, it should be noted that the owner of the contract can blacklist any user and NFT so that such a user can't transfer or receive NFTs and such an NFT can't be transferred.
**Post-audit:** Verified to be a part of the bussiness logic in order to prevent any suspicous actions on the contract.

| LOWEST-9 | ✓ Resolved |
|---|---|

**The owner can blacklist a non-existing NFT.**

LiquidAccess.sol: function addNFTToBlacklist().
Though only the owner can execute this function and validate that an existing NFT is passed only, it is recommended to validate that a provided `_nft`exists.

**Recommendation:**

Validate that the `_nft` parameter exists before blacklisting.

| LOWEST-10 | Unresolved |
|---|---|

**Tokens cannot be burned.**

There is a comment in line 97 about burning tokens but in fact tokens cannot be burned.

**Recommendation:**

Add burn functionality if needed.

| LOWEST-11 | Unresolved |
|---|---|

**Unreachable branch at line 103.**

There is no need to check transfer to zero address because error “ERC721: transfer to the zero address” will be raised at ECR721 contract.
**Recommendation:**
Remove the unreachable branch.

| | | LiquidAccess.sol: |
|---|---|---|
| ✓ | Re-entrancy | Pass |
| ✓ | Access Management Hierarchy | Pass |
| ✓ | Arithmetic Over/Under Flows | Pass |
| ✓ | Delegatecall Unexpected Ether | Pass |
| ✓ | Default Public Visibility | Pass |
| ✓ | Hidden Malicious Code | Pass |
| ✓ | Entropy Illusion (Lack of Randomness) | Pass |
| ✓ | External Contract Referencing | Pass |
| ✓ | Short Address/Parameter Attack | Pass |
| ✓ | Unchecked CALL Return Values | Pass |
| ✓ | Race Conditions/Front Running | Pass |
| ✓ | General Denial Of Service (DOS) | Pass |
| ✓ | Uninitialized Storage Pointers | Pass |
| ✓ | Floating Points and Precision | Pass |
| ✓ | Tx.Origin Authentication | Pass |
| ✓ | Signatures Replay | Pass |
| ✓ | Pool Asset Security (backdoors in the underlying ERC-20) | Pass |

## CODE COVERAGE AND TEST RESULTS FOR ALL FILES BY THE BLAIZE.SECURITY TEAM

- ✓ supports interfaces (60ms)

**NFT transfer**

- ✓ user can transfer their NFT (77ms)
- ✓ NFT cannot be transfered to zero address (55ms)
- ✓ user cannot transfer their blacklisted NFT (74ms)
- ✓ user cannot transfer their blacklisted NFT by approve (85ms)
- ✓ NFT from blacklisted address cannot be sent by approve (65ms)
- ✓ user cannot transfer their NFT to blacklisted address (46ms)
- ✓ user cannot transfer their NFT if they are blacklisted (44ms)

**Setters**

- ✓ sets contract image (77ms)

**setExpirationDate**

- ✓ only the owner can set an expiration date (46ms)
- ✓ expiration date can be set only for existing token

**setSubscriptionType**

- ✓ only the owner can set subscription type (46ms)
- ✓ subscription type can be set only for existing token

**setContractImage**

- ✓ only the owner can set image

## TEST COVERAGE RESULTS

| FILE | % STMTS | % BRANCH | % FUNCS | % LINES |
|---|---|---|---|---|
| LiquidAccess.sol | 100 | 98.53 | 100 | 100 |

## CODE COVERAGE AND TEST RESULTS FOR ALL FILES BY THE LIQUIDACCESS NFT

**Contract: LiquidAccess**

Contract info
- ✓ should have the correct name (39ms)
- ✓ should have the correct symbol

Merchant info
- ✓ should return merchant name
- ✓ should return merchant id

Token minting
- ✓ should safeMint (39ms)
- ✓ shoud return correct tokenId (176ms)
- ✓ should emit Transfer event (42ms)
- ✓ should revert if not owner (58ms)

Token info
- ✓ should have the correct subscription type (49ms)
- ✓ should be able to change subscription type
- ✓ should have the correct expiration date
- ✓ should be able to change expiration date
- ✓ should revert if token does not exist

Transfer
- ✓ should emit TransferFrom event with transfer counter (79ms)
- ✓ should revert if not token owner (60ms)

SafeTransfer
- ✓ should emit TransferFrom event with transfer counter (86ms)
- ✓ should revert if not token owner

Approved transfer
- ✓ should be able to approve an address for a transfer
- ✓ should be able to transfer by approved address (93ms)

Transfer Lockup
- ✓ should be able to set lockup period
- ✓ should revert if not owner

✓ should lock transfers after each transfer (64ms)
✓ should be able to retrieve lockup period of a token (63ms)
✓ should unlock transfers after lockup period (77ms)
✓ should not revert if lockup period is 0 (59ms)
Royalty
✓ should return 5% royalty by default
✓ should be able to change royalty recipient
✓ should be able to change royalty fee
✓ should be able to remove royalty
✓ should revert if caller is not owner
NFT blacklisting
✓ should be able to blacklist NFT (100ms)
✓ should be able to remove NFT from blacklist (110ms)
✓ should revert if caller is not owner
✓ should not be able to transfer blacklisted NFT
Address blacklisting
✓ should be able to blacklist address (189ms)
✓ should be able to remove address from blacklist (113ms)
✓ should revert if caller is not owner
✓ should not be able to transfer NFT to blacklisted address
✓ should not be able to transfer NFT from blacklisted address
User tokens
✓ should be able to retrieve user tokens (114ms)
Metadata
✓ should be able to change NFT meta name (64ms)
✓ should be able to change NFT meta description (65ms)
✓ should be able to change NFT meta image (48ms)
✓ should have correct NFT meta attributes (47ms)
✓ should revert if caller is not owner
Contract metadata
✓ should be able to change contract meta name (45ms)
✓ should be able to change contract meta description (40ms)
✓ should use nft image as contract image
✓ should contain royalty info (40ms)
✓ should revert if caller is not owner

```
Interface support
  ✓ should support ERC165
  ✓ should support ERC721
  ✓ should support ERC721Metadata
  ✓ should support ERC721Enumerable
  ✓ should support ERC2981


  55 passing (8s)
```

## TEST COVERAGE RESULTS

| FILE | % STMTS | % BRANCH | % FUNCS | % LINES |
|---|---|---|---|---|
| LiquidAccess.sol | 100 | 88,24 | 97,06 | 98,65 |

# DISCLAIMER

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