



# SMART CONTRACT AUDIT REPORT

for

## Umbrella Network



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# 1 | Introduction

Given the opportunity to review the design document and related smart contract source code of the Umbrella Network protocol, we outline in the report our systematic approach to evaluate potential security issues in the smart contract implementation, expose possible semantic inconsistencies between smart contract code and design document, and provide additional suggestions or recommendations for improvement. Our results show that the given version of smart contracts can be further improved due to the presence of several issues related to either security or performance. This document outlines our audit results.

## 1.1 About Umbrella Network

Umbrella Network is a layer-2, decentralized oracle solution. Umbrella leverages Merkle trees to anchor data to layer-1 network to ensure that the data points Umbrella provides are cryptographically verifiable and the oracle itself is highly scalable. The basic information of the audited protocol is as follows:

Table 1.1: Basic Information of The Umbrella Network

Item	Description
Issuer	Umbrella Network
Website	<a href="https://www.umb.network/">https://www.umb.network/</a>
Type	EVM Smart Contract
Platform	Solidity
Audit Method	Whitebox
Latest Audit Report	June 14, 2022

In the following, we show the contract addresses of reviewed files that are deployed in BSC and Ethereum.

- <https://bscscan.com/address/0xb2c6c4162c0d2b6963c62a9133331b4d0359aa34#code> (ContractRegistry)
- <https://bscscan.com/address/0x5cb48b685e1d86f5d850ff8a55ba8c2bd6a74713#code> (Chain)

- <https://bscscan.com/address/0x648F235ec0C24fe170BD0822d2FEf442880A25EE#code> (StakingBank)
- <https://etherscan.io/address/0x01e7F40AdB183fa09849243a237A920C5ce509d4#code> (ForeignChain)

## 1.2 About PeckShield

PeckShield Inc. [7] is a leading blockchain security company with the goal of elevating the security, privacy, and usability of current blockchain ecosystems by offering top-notch, industry-leading services and products (including the service of smart contract auditing). We are reachable at Telegram (<https://t.me/peckshield>), Twitter (<http://twitter.com/peckshield>), or Email ([contact@peckshield.com](mailto:contact@peckshield.com)).

Table 1.2: Vulnerability Severity Classification

Impact	High	Critical	High	Medium
	Medium	High	Medium	Low
	Low	Medium	Low	Low
		High	Medium	Low
		Likelihood		

## 1.3 Methodology

To standardize the evaluation, we define the following terminology based on OWASP Risk Rating Methodology [6]:

- Likelihood represents how likely a particular vulnerability is to be uncovered and exploited in the wild;
- Impact measures the technical loss and business damage of a successful attack;
- Severity demonstrates the overall criticality of the risk.

Likelihood and impact are categorized into three ratings: *H*, *M* and *L*, i.e., *high*, *medium* and *low* respectively. Severity is determined by likelihood and impact and can be classified into four categories accordingly, i.e., *Critical*, *High*, *Medium*, *Low* shown in Table 1.2.

Table 1.3: The Full List of Check Items

Category	Check Item
Basic Coding Bugs	Constructor Mismatch
	Ownership Takeover
	Redundant Fallback Function
	Overflows & Underflows
	Reentrancy
	Money-Giving Bug
	Blackhole
	Unauthorized Self-Destruct
	Revert DoS
	Unchecked External Call
	Gasless Send
	Send Instead Of Transfer
	Costly Loop
	(Unsafe) Use Of Untrusted Libraries
	(Unsafe) Use Of Predictable Variables
	Transaction Ordering Dependence
	Deprecated Uses
Semantic Consistency Checks	Semantic Consistency Checks
Advanced DeFi Scrutiny	Business Logics Review
	Functionality Checks
	Authentication Management
	Access Control & Authorization
	Oracle Security
	Digital Asset Escrow
	Kill-Switch Mechanism
	Operation Trails & Event Generation
	ERC20 Idiosyncrasies Handling
	Frontend-Contract Integration
	Deployment Consistency
	Holistic Risk Management
Additional Recommendations	Avoiding Use of Variadic Byte Array
	Using Fixed Compiler Version
	Making Visibility Level Explicit
	Making Type Inference Explicit
	Adhering To Function Declaration Strictly
	Following Other Best Practices

To evaluate the risk, we go through a list of check items and each would be labeled with a severity category. For one check item, if our tool or analysis does not identify any issue, the contract is considered safe regarding the check item. For any discovered issue, we might further deploy contracts on our private testnet and run tests to confirm the findings. If necessary, we would additionally build a PoC to demonstrate the possibility of exploitation. The concrete list of check items is shown in Table 1.3.

In particular, we perform the audit according to the following procedure:

- Basic Coding Bugs: We first statically analyze given smart contracts with our proprietary static code analyzer for known coding bugs, and then manually verify (reject or confirm) all the issues found by our tool.
- Semantic Consistency Checks: We then manually check the logic of implemented smart contracts and compare with the description in the white paper.
- Advanced DeFi Scrutiny: We further review business logics, examine system operations, and place DeFi-related aspects under scrutiny to uncover possible pitfalls and/or bugs.
- Additional Recommendations: We also provide additional suggestions regarding the coding and development of smart contracts from the perspective of proven programming practices.

To better describe each issue we identified, we categorize the findings with Common Weakness Enumeration (CWE-699) [5], which is a community-developed list of software weakness types to better delineate and organize weaknesses around concepts frequently encountered in software development. Though some categories used in CWE-699 may not be relevant in smart contracts, we use the CWE categories in Table 1.4 to classify our findings.

## 1.4 Disclaimer

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Note that this security audit is not designed to replace functional tests required before any software release, and does not give any warranties on finding all possible security issues of the given smart contract(s) or blockchain software, i.e., the evaluation result does not guarantee the nonexistence of any further findings of security issues. As one audit-based assessment cannot be considered comprehensive, we always recommend proceeding with several independent audits and a public bug bounty program to ensure the security of smart contract(s). Last but not least, this security audit should not be used as investment advice.

Table 1.4: Common Weakness Enumeration (CWE) Classifications Used in This Audit



Category	Summary
<b>Configuration</b>	Weaknesses in this category are typically introduced during the configuration of the software.
<b>Data Processing Issues</b>	Weaknesses in this category are typically found in functionality that processes data.
<b>Numeric Errors</b>	Weaknesses in this category are related to improper calculation or conversion of numbers.
<b>Security Features</b>	Weaknesses in this category are concerned with topics like authentication, access control, confidentiality, cryptography, and privilege management. (Software security is not security software.)
<b>Time and State</b>	Weaknesses in this category are related to the improper management of time and state in an environment that supports simultaneous or near-simultaneous computation by multiple systems, processes, or threads.
<b>Error Conditions, Return Values, Status Codes</b>	Weaknesses in this category include weaknesses that occur if a function does not generate the correct return/status code, or if the application does not handle all possible return/status codes that could be generated by a function.
<b>Resource Management</b>	Weaknesses in this category are related to improper management of system resources.
<b>Behavioral Issues</b>	Weaknesses in this category are related to unexpected behaviors from code that an application uses.
<b>Business Logics</b>	Weaknesses in this category identify some of the underlying problems that commonly allow attackers to manipulate the business logic of an application. Errors in business logic can be devastating to an entire application.
<b>Initialization and Cleanup</b>	Weaknesses in this category occur in behaviors that are used for initialization and breakdown.
<b>Arguments and Parameters</b>	Weaknesses in this category are related to improper use of arguments or parameters within function calls.
<b>Expression Issues</b>	Weaknesses in this category are related to incorrectly written expressions within code.
<b>Coding Practices</b>	Weaknesses in this category are related to coding practices that are deemed unsafe and increase the chances that an exploitable vulnerability will be present in the application. They may not directly introduce a vulnerability, but indicate the product has not been carefully developed or maintained.



## 2 | Findings

### 2.1 Summary

Here is a summary of our findings after analyzing the `Umbrella Network` protocol implementation. During the first phase of our audit, we study the smart contract source code and run our in-house static code analyzer through the codebase. The purpose here is to statically identify known coding bugs, and then manually verify (reject or confirm) issues reported by our tool. We further manually review business logics, examine system operations, and place DeFi-related aspects under scrutiny to uncover possible pitfalls and/or bugs.

Severity	# of Findings	
Critical	0	
High	0	
Medium	1	
Low	1	
Informational	1	
Total	2	

We have so far identified a list of potential issues: some of them involve subtle corner cases that might not be previously thought of, while others refer to unusual interactions among multiple contracts. For each uncovered issue, we have therefore developed test cases for reasoning, reproduction, and/or verification. After further analysis and internal discussion, we determined a few issues of varying severities that need to be brought up and paid more attention to, which are categorized in the above table. More information can be found in the next subsection, and the detailed discussions of each of them are in [Section 3](#).

## 2.2 Key Findings

Overall, these smart contracts are well-designed and engineered, though the implementation can be improved by resolving the identified issues (shown in Table 2.1), including 1 medium-severity vulnerability and 1 informational suggestion.

Table 2.1: Key Umbrella Network Audit Findings

ID	Severity	Title	Category	Status
PVE-001	Informational	Meaningful Events For Important State Changes	Coding Practices	Confirmed
PVE-002	Medium	Trust Issue of Admin Keys	Security Features	Mitigated

Besides recommending specific countermeasures to mitigate these issues, we also emphasize that it is always important to develop necessary risk-control mechanisms and make contingency plans, which may need to be exercised before the mainnet deployment. The risk-control mechanisms need to kick in at the very moment when the contracts are being deployed in mainnet. Please refer to Section 3 for details.

## 3 | Detailed Results

### 3.1 Meaningful Events For Important State Changes

- ID: PVE-001
- Severity: Informational
- Likelihood: N/A
- Impact: N/A
- Target: StakingBank
- Category: Coding Practices [4]
- CWE subcategory: CWE-563 [2]

#### Description

In Ethereum, the `event` is an indispensable part of a contract and is mainly used to record a variety of runtime dynamics. In particular, when an `event` is emitted, it stores the arguments passed in transaction logs and these logs are made accessible to external analytics and reporting tools. Events can be emitted in a number of scenarios. One particular case is when system-wide parameters or settings are being changed. Another case is when tokens are being minted, transferred, or burned.

In the following, we use the `StakingBank` contract as an example. While examining the event that reflect the `StakingBank` dynamics, we notice there is a lack of emitting related events to reflect important state changes. Specifically, when the `stake()/receiveApproval()/withdraw()/exit()` are being called, there are no corresponding events being emitted to reflect the occurrence of `stake()/receiveApproval()/withdraw()/exit()`.

```
70     function stake(uint256 _value) external nonReentrant {
71         _stake(msg.sender, _value);
72     }
73
74     function receiveApproval(address _from) override external nonReentrant returns (bool
       success) {
75         uint256 allowance = token.allowance(_from, address(this));
76
77         _stake(_from, allowance);
78
79         return true;
80     }
```

```

81
82     function withdraw(uint256 _value) override external nonReentrant returns (bool
      success) {
83         uint256 balance = balanceOf(msg.sender);
84         require(balance >= _value, "can't withdraw more than balance");
85         require(balance - _value >= minAmountForStake, "minAmountForStake must be
          available, use exit to withdraw all");
86
87         _unstake(msg.sender, _value);
88         return true;
89     }
90
91     function exit() external nonReentrant returns (bool success) {
92         uint256 balance = balanceOf(msg.sender);
93         _unstake(msg.sender, balance);
94         return true;
95     }

```

Listing 3.1: StakingBank::stake()/receiveApproval()/withdraw()/exit()

**Recommendation** Properly emit the related events when the above-mentioned functions are being invoked.

**Status** This issue has been confirmed.

## 3.2 Trust Issue of Admin Keys

- ID: PVE-002
- Severity: Medium
- Likelihood: Medium
- Impact: Medium
- Target: Multiple contracts
- Category: Security Features [3]
- CWE subcategory: CWE-287 [1]

### Description

In the Umbrella Network protocol, there is a privileged account, i.e., `owner`. The `owner` account plays a critical role in governing and regulating the system-wide operations (e.g., configure key parameters, execute privileged operations, etc.). Our analysis shows that this privileged account needs to be scrutinized. In the following, we use the `StakingBank` contract as an example and show the representative functions potentially affected by the privileges of the `owner` account.

```

55     function setMinAmountForStake(uint256 _minAmountForStake) external onlyOwner {
56         _setMinAmountForStake(_minAmountForStake);
57     }
58
59     ...
60

```

```

61     function create(address _id, string calldata _location) override external onlyOwner
62     {
63         Validator storage validator = validators[_id];
64
65         require validator.id == address(0x0), "validator exists";
66         validator.id = _id;
67         validator.location = _location;
68
69         addresses.push(validator.id);
70
71         emit LogValidatorRegistered(validator.id);
72     }
73
74     function remove(address _id) external onlyOwner {
75         require(validators[_id].id != address(0x0), "validator NOT exists");
76
77         delete validators[_id];
78         emit LogValidatorRemoved(_id);
79
80         uint256 balance = balanceOf(_id);
81         if (balance > 0) {
82             _unstake(_id, balanceOf(_id));
83         }
84
85         if (addresses.length == 1) {
86             addresses.pop();
87             return;
88         }
89
90         for (uint256 i = 0; i < addresses.length; i++) {
91             if (addresses[i] == _id) {
92                 addresses[i] = addresses[addresses.length - 1];
93                 addresses.pop();
94                 return;
95             }
96         }
97     }
98
99     function update(address _id, string calldata _location) override external onlyOwner
100     {
101         Validator storage validator = validators[_id];
102
103         require(validator.id != address(0x0), "validator does not exist");
104
105         validator.location = _location;
106
107         LogValidatorUpdated(validator.id);
108     }

```

Listing 3.2: StakingBank.sol

We understand the need of the privileged functions for contract maintenance, but at the same

time the extra power to the owner may also be a counter-party risk to the protocol users. It is worrisome if the privileged `owner` account is a plain EOA account. Note that a multi-sig account could greatly alleviate this concern, though it is still far from perfect. Specifically, a better approach is to eliminate the administration key concern by transferring the role to a community-governed DAO.

**Recommendation** Promptly transfer the privileged account to the intended DAO-like governance contract. All changed to privileged operations may need to be mediated with necessary timelocks. Eventually, activate the normal on-chain community-based governance life-cycle and ensure the intended trustless nature and high-quality distributed governance.

**Status** This issue has been mitigated as the team confirms that multi-sig will be adopted for the privileged account.



## 4 | Conclusion

In this audit, we have analyzed the `Umbrella Network` design and implementation. `Umbrella Network` is a Layer-2, decentralized oracle solution. The current code base is well structured and neatly organized. Those identified issues are promptly confirmed and addressed.

Meanwhile, we need to emphasize that `Solidity`-based smart contracts as a whole are still in an early, but exciting stage of development. To improve this report, we greatly appreciate any constructive feedbacks or suggestions, on our methodology, audit findings, or potential gaps in scope/coverage.



## References

- [1] MITRE. CWE-287: Improper Authentication. <https://cwe.mitre.org/data/definitions/287.html>.
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- [3] MITRE. CWE CATEGORY: 7PK - Security Features. <https://cwe.mitre.org/data/definitions/254.html>.
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- [5] MITRE. CWE VIEW: Development Concepts. <https://cwe.mitre.org/data/definitions/699.html>.
- [6] OWASP. Risk Rating Methodology. [https://www.owasp.org/index.php/OWASP\\_Risk\\_Rating\\_Methodology](https://www.owasp.org/index.php/OWASP_Risk_Rating_Methodology).
- [7] PeckShield. PeckShield Inc. <https://www.peckshield.com>.