SMART CONTRACT AUDIT REPORT

for

SGNv2 Governance

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1 Introduction

Given the opportunity to review the design document and related smart contract source code of the SGNv2 Governance, 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 SGNv2 Governance

Celer Network is an Internet-scale, trust-free, and privacy-preserving platform where everyone can quickly build, operate, and use highly scalable decentralized applications. Celer Network provides unprecedented performance and flexibility through innovation in off-chain scaling techniques and incentive-aligned crypto-economics. SGNv2 is an important part of Celer Network, which supports cross-chain transaction between different blockchains. In particular, the audited Governance module is designed as the governance-based owner for various contracts of Celer Network.

Table 1.1: Basic Information of SGNv2 Governance

Item	Description
Target	SGNv2 Governance
Type	EVM Smart Contract
Language	Solidity
Audit Method	Whitebox
Latest Audit Report	June 20, 2022

In the following, we show the Git repository of reviewed files and the commit hash value used in this audit. Please note that this audit only covers the contracts/governed-owner/SimpleGovernance.sol contract.

- https://github.com/celer-network/sgn-v2-contracts.git (2889dd3)

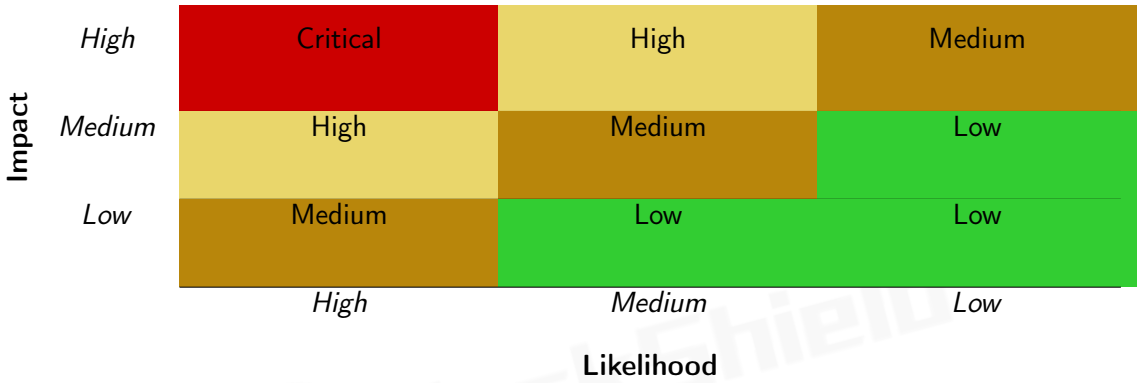
And this is the commit ID after all fixes for the issues found in the audit have been checked in:

- https://github.com/celer-network/sgn-v2-contracts.git (3835a96)

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).

Table 1.2: Vulnerability Severity Classification



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

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
Configuration	Weaknesses in this category are typically introduced during the configuration of the software.
Data Processing Issues	Weaknesses in this category are typically found in functionality that processes data.
Numeric Errors	Weaknesses in this category are related to improper calculation or conversion of numbers.
Security Features	Weaknesses in this category are concerned with topics like authentication, access control, confidentiality, cryptography, and privilege management. (Software security is not security software.)
Time and State	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.
Error Conditions, Return Values, Status Codes	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.
Resource Management	Weaknesses in this category are related to improper management of system resources.
Behavioral Issues	Weaknesses in this category are related to unexpected behaviors from code that an application uses.
Business Logics	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.
Initialization and Cleanup	Weaknesses in this category occur in behaviors that are used for initialization and breakdown.
Arguments and Parameters	Weaknesses in this category are related to improper use of arguments or parameters within function calls.
Expression Issues	Weaknesses in this category are related to incorrectly written expressions within code.
Coding Practices	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 `SGNv2 Governance` 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 logic, 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	0	
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 low-severity vulnerability and 1 informational recommendation.

Table 2.1: Key SGNv2 Governance Audit Findings

ID	Severity	Title	Category	Status
PVE-001	Low	Improved Logic Of executeProposal()	Business Logic	Fixed
PVE-002	Informational	Suggested Event Generation For Key Operations	Coding Practices	Confirmed

Beside the identified issues, we emphasize that for any user-facing applications and services, 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 should kick in at the very moment when the contracts are being deployed on mainnet. Please refer to Section 3 for details.

3 Detailed Results

3.1 Improved Logic Of executeProposal()

- ID: PVE-001
- Severity: Low
- Likelihood: Low
- Impact: Low
- Target: `SimpleGovernance`
- Category: Business Logic [4]
- CWE subcategory: CWE-841 [2]

Description

The `SimpleGovernance` contract implements a simple governance mechanism, which allows `proposers` to commit the proposal for community governance. If the voting power for a proposal exceeds the pre-configured threshold, the proposal can be carried out. In particular, we observe the special `ExternalFastPass` proposal type requires a lower voting power than other proposal types. While examining the logic of threshold update for different proposal types, we notice current implementation can be improved.

To elaborate, we show below the related code snippet of the `SimpleGovernance` contract. By design, there is an implicit condition where the threshold of the special `ExternalFastPass` proposal type should be lower than other normal proposal types. However, in the `executeProposal()` routine, we observe there is no necessary sanity check to guarantee it when the threshold of different proposal types are updated (lines 192-195).

```
169     function executeProposal(
170         uint256 _proposalId,
171         ProposalType _type,
172         address _target,
173         bytes calldata _data
174     ) external {
175         require(voterPowers[msg.sender] > 0, "only voter can execute a proposal");
176         Proposal storage p = proposals[_proposalId];
177         require(block.timestamp < p.deadline, "deadline passed");
178         require(keccak256(abi.encodePacked(_type, _target, _data)) == p.dataHash, "data
                hash not match");
```

```
179         p.deadline = 0;
180
181         p.votes[msg.sender] = true;
182         (, , bool pass) = countVotes(_proposalId, _type);
183         require(pass, "not enough votes");
184
185         if (_type == ProposalType.ExternalDefault  _type == ProposalType.
                ExternalFastPass) {
186             (bool success, bytes memory res) = _target.call(_data);
187             require(success, _getRevertMsg(res));
188         } else if (_type == ProposalType.InternalParamChange) {
189             (ParamName name, uint256 value) = abi.decode((_data), (ParamName, uint256));
190             if (name == ParamName.ActivePeriod) {
191                 require(value <= MAX_ACTIVE_PERIOD && value >= MIN_ACTIVE_PERIOD, "
                        invalid active period");
192             } else if (name == ParamName.QuorumThreshold  name == ParamName.
                    FastPassThreshold) {
193                 require(value < THRESHOLD_DECIMAL && value > 0, "invalid threshold");
194             }
195             params[name] = value;
196         }
197         ...
198     }
```

Listing 3.1: `SimpleGovernance::executeProposal()`

Recommendation Improve the implementation of the `executeProposal()` routine to ensure that the threshold of the special `ExternalFastPass` proposal type is lower than other normal proposal types.

Status The issue has been addressed by the following commit: `3835a96`.

3.2 Suggested Event Generation For Key Operations

- ID: PVE-002
- Severity: Informational
- Likelihood: N/A
- Impact: N/A
- Target: `SimpleGovernance`
- Category: Coding Practices [3]
- CWE subcategory: CWE-563 [1]

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.

While examining the events that reflect the protocol dynamics, we notice there are several key operations that lack meaningful events to reflect their changes in the `executeProposal()` routine. In the following, we show below the code snippet.

```
169     function executeProposal(
170         uint256 _proposalId,
171         ProposalType _type,
172         address _target,
173         bytes calldata _data
174     ) external {
175         require(voterPowers[msg.sender] > 0, "only voter can execute a proposal");
176         Proposal storage p = proposals[_proposalId];
177         require(block.timestamp < p.deadline, "deadline passed");
178         require(keccak256(abi.encodePacked(_type, _target, _data)) == p.dataHash, "data
                hash not match");
179         p.deadline = 0;
180 
181         p.votes[msg.sender] = true;
182         (, , bool pass) = countVotes(_proposalId, _type);
183         require(pass, "not enough votes");
184 
185         if (_type == ProposalType.ExternalDefault  _type == ProposalType.
                ExternalFastPass) {
186             (bool success, bytes memory res) = _target.call(_data);
187             require(success, _getRevertMsg(res));
188         } else if (_type == ProposalType.InternalParamChange) {
189             (ParamName name, uint256 value) = abi.decode((_data), (ParamName, uint256));
190             if (name == ParamName.ActivePeriod) {
191                 require(value <= MAX_ACTIVE_PERIOD && value >= MIN_ACTIVE_PERIOD, "
                        invalid active period");
192             } else if (name == ParamName.QuorumThreshold  name == ParamName.
                    FastPassThreshold) {
193                 require(value < THRESHOLD_DECIMAL && value > 0, "invalid threshold");
194             }
195             params[name] = value;
196         } else if (_type == ProposalType.InternalVoterUpdate) {
197             (address[] memory addrs, uint256[] memory powers) = abi.decode((_data), (
                    address[], uint256[]));
198             for (uint256 i = 0; i < addrs.length; i++) {
199                 if (powers[i] > 0) {
200                     _addVoter(addrs[i], powers[i]);
201                 } else {
202                     _removeVoter(addrs[i]);
203                 }
204             }
205         } else if (_type == ProposalType.InternalProxyUpdate) {
206             (address[] memory addrs, bool[] memory ops) = abi.decode((_data), (address
                    [], bool[]));
207             for (uint256 i = 0; i < addrs.length; i++) {
208                 if (ops[i]) {
209                     proposerProxies[addrs[i]] = true;
210                 } else {
```

```
211                     delete proposerProxies[addrs[i]];
212                 }
213             }
214         } else if (_type == ProposalType.InternalTransferToken) {
215             (address receiver, address token, uint256 amount) = abi.decode((_data), (
                    address, address, uint256));
216             _transfer(receiver, token, amount);
217         }
218         emit ProposalExecuted(_proposalId);
219     }
```

Listing 3.2: `SimpleGovernance::executeProposal()`

With that, we suggest to emit meaningful events for these key operations. Also, the key event information is better `indexed`. Note each emitted event is represented as a topic that usually consists of the signature (from a `keccak256` hash) of the event name and the types (`uint256`, `string`, etc.) of its parameters. Each indexed type will be treated like an additional topic. If an argument is not indexed, it will be attached as data (instead of a separate topic). Considering that the key information is typically queried, it is better treated as a topic, hence the need of being `indexed`.

Recommendation Properly emit the above-mentioned events with accurate information to timely reflect state changes. This is very helpful for external analytics and reporting tools.

Status The issue has been confirmed by the team.

4 Conclusion

In this audit, we have analyzed the SGNv2 Governance design and implementation. Celer Network is an Internet-scale, trust-free, and privacy-preserving platform where everyone can quickly build, operate, and use highly scalable decentralized applications. Celer Network provides unprecedented performance and flexibility through innovation in off-chain scaling techniques and incentive-aligned crypto-economics. SGNv2 is an important part of Celer Network, which supports cross-chain transaction between different blockchains. In particular, the audited Governance module is designed as the governance-based owner for various contracts of Celer Network. The current code base is well structured and neatly organized. Those identified issues are promptly confirmed and addressed.

Meanwhile, we need to emphasize that 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-563: Assignment to Variable without Use. https://cwe.mitre.org/data/definitions/563.html.

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