SMART CONTRACT AUDIT REPORT

for

Tranchess Protocol

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PeckShield

December 24, 2021

Document Properties

Client	Tranchess Protocol
Title	Smart Contract Audit Report
Target	TranchessV2
Version	1.0
Author	Xuxian Jiang
Auditors	Stephen Bie, Yiqun Chen, Xuxian Jiang
Reviewed by	Yiqun Chen
Approved by	Xuxian Jiang
Classification	Public

Version Info

Version	Date	Author(s)	Description
1.0	December 24, 2021	Xuxian Jiang	Final Release
1.0-rc1	December 18, 2021	Xuxian Jiang	Release Candidate #1

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1 | Introduction

Given the opportunity to review the **TranchessV2** design document and related smart contract source code, 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 Tranchess

`Tranchess` is a yield enhancing asset tracker with varied risk-return solutions. Inspired by tranches fund that caters investors with different risk appetite, `Tranchess` aims to provide different risk/return matrix out of a single main fund that tracks a specific underlying asset (e.g. `BTC`). Meanwhile, it also shares some of the popular DeFi features such as: single-asset yield farming, borrowing and lending, trading, etc. `Tranchess` consists of three tranche tokens (`M`, aka `QUEEN`; `A`, aka `BISHOP`; and `B`, aka `ROOK`) and its governance token `CHESS`. Each of the three tranches is designed to solve the need of a different group of users: stable return yielding (`Tranche A`), leveraged crypto-asset trading (`Tranche B`), and long-term crypto-asset holding (`Tranche M`). This audit covers the latest enhancements on the strategy support for improved capital efficiency as well as new `TWAP` oracles.

The basic information of TranchessV2 is as follows:

Table 1.1: Basic Information of TranchessV2

Item	Description
Name	Tranchess Protocol
Website	https://tranchess.com/
Type	Ethereum Smart Contract
Platform	Solidity
Audit Method	Whitebox
Latest Audit Report	December 24, 2021

In the following, we show the Git repository of reviewed files and the commit hash value used in this audit.

- https://github.com/tranchess/contract-core.git (f557f5a)

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

- https://github.com/tranchess/contract-core.git (80c97f4)

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

Impact \ Likelihood	*High*	*Medium*	*Low*
High	Critical	High	Medium
Medium	High	Medium	Low
Low	Medium	Low	Low

1.3 Methodology

To standardize the evaluation, we define the following terminology based on the 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.

To evaluate the risk, we go through a checklist of 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. Moreover, in case there is an issue that may affect an active protocol that has been deployed, the public version of this report may omit such issue, but will be amended with full details right after the affected protocol is upgraded with respective fixes.

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

Table 1.3: The Full Audit Checklist

Category	Checklist Items
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

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 Logic	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.

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.

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2 Findings

2.1 Summary

Here is a summary of our findings after analyzing the implementation of the Tranchess protocol. 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	1	
Low	1	
Informational	0	
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 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 low-severity vulnerability.

Table 2.1: Key TranchessV2 Audit Findings

ID	Severity	Title	Category	Status
PVE-001	Low	Meaningful Events For Important States Change	Coding Practices	Fixed
PVE-002	Medium	Trust Issue of Admin Keys	Security Features	Mitigated

Besides 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.

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3 | Detailed Results

3.1 Meaningful Events For Important States Change

- ID: PVE-001
- Severity: Low
- Likelihood: Low
- Impact: Low
- Target: PrimaryMarketV2
- Category: Coding Practices [4]
- CWE subcategory: CWE-1126 [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.

In the following, we use the PrimaryMarketV2 contract as an example. This contract is designed to create new markets for Tranchess. While examining the events that reflect the PrimaryMarketV2 dynamics, we notice there is a lack of emitting important events that reflect important state changes. Specifically, when various fee parameters are being updated, there are no respective events being emitted to reflect the dynamics.

```
    function updateFundCap(uint256 newCap) external onlyOwner {
        fundCap = newCap;
    }

    function updateRedemptionFeeRate(uint256 newRedemptionFeeRate) external onlyOwner {
        require(newRedemptionFeeRate <= MAX_REDEMPTION_FEE_RATE, "Exceed max redemption
            fee rate");
        redemptionFeeRate = newRedemptionFeeRate;
    }

    function updateSplitFeeRate(uint256 newSplitFeeRate) external onlyOwner {
        require(newSplitFeeRate <= MAX_SPLIT_FEE_RATE, "Exceed max split fee rate");
```

```
        splitFeeRate = newSplitFeeRate;
    }
```

Listing 3.1: `PrimaryMarketV2::_mint()/_burn()`

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

Status The issue has been fixed by the following commit: `80c97f4`.

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 [2]

Description

In the `Tranchess` protocol, there is a privileged `owner` account that plays a critical role in governing and regulating the protocol-wide operations (e.g., configuring various system parameters). It also has the privilege to control or govern the flow of assets managed by this protocol. Our analysis shows that the privileged account needs to be scrutinized. In the following, we examine the privileged account and their related privileged accesses in current contracts.

```
    function updateFundCap(uint256 newCap) external onlyOwner {
        fundCap = newCap;
    }

    function updateRedemptionFeeRate(uint256 newRedemptionFeeRate) external onlyOwner {
        require(newRedemptionFeeRate <= MAX_REDEMPTION_FEE_RATE, "Exceed max redemption fee rate");
        redemptionFeeRate = newRedemptionFeeRate;
    }

    function updateSplitFeeRate(uint256 newSplitFeeRate) external onlyOwner {
        require(newSplitFeeRate <= MAX_SPLIT_FEE_RATE, "Exceed max split fee rate");
        splitFeeRate = newSplitFeeRate;
    }

    function updateMergeFeeRate(uint256 newMergeFeeRate) external onlyOwner {
        require(newMergeFeeRate <= MAX_MERGE_FEE_RATE, "Exceed max merge fee rate");
        mergeFeeRate = newMergeFeeRate;
    }

```

```
    function updateMinCreationUnderlying(uint256 newMinCreationUnderlying) external onlyOwner {
        minCreationUnderlying = newMinCreationUnderlying;
    }
```

Listing 3.2: Example `Setters` in the `PrimaryMarketV2` Contract

In addition, we notice the `owner` account that is able to adjust various protocol-wide risk parameters. Apparently, if the privileged `owner` account is a plain EOA account, this may be worrisome and pose counter-party risk to the protocol users. 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. In the meantime, a timelock-based mechanism can also be considered as mitigation.

Moreover, it should be noted that if current contracts need to be deployed behind a proxy, there is a need to properly manage the proxy-admin privileges as they fall in this trust issue as well.

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 confirmed and partially mitigated. Especially, for all admin-level operations, the current mitigation is to adopt the standard `Timelock` with multi-sig `Tranchess` account as the proposer, and a minimum delay of 1 days. In the future, the team further plans to transfer the proposer role to DAO with transparent governance process similar to `Compound`.

4 Conclusion

In this audit, we have analyzed the design and implementation of the `Tranchess` protocol. The system presents a unique, robust offering as a decentralized yield enhancing asset tracker with varied risk-return solutions which caters to investors with different risk appetite. This audit covers the latest enhancements on the strategy support for improved capital efficiency as well as new `TWAP` oracles. The current code base is well structured and neatly organized. Those identified issues are promptly confirmed and fixed.

Moreover, 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.

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References

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[2] MITRE. CWE-287: Improper Authentication. https://cwe.mitre.org/data/definitions/287.html.

[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.

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