

SMART CONTRACT AUDIT REPORT

for

SynFutures V2

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PeckShield July 1, 2022

Document Properties

Client	SynFutures
Title	Smart Contract Audit Report
Target	SynFutures V2
Version	1.0
Author	Shulin Bie
Auditors	Shulin Bie, Xuxian Jiang
Reviewed by	Xiaomi Huang
Approved by	Xuxian Jiang
Classification	Public

Version Info

Version	Date	Author(s)	Description
1.0	July 1, 2022	Shulin Bie	Final Release
1.0-rc	June 16, 2022	Shulin Bie	Release Candidate

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Contents

1	Intro	oduction	4
	1.1	About SynFutures V2	4
	1.2	About PeckShield	5
	1.3	Methodology	5
	1.4	Disclaimer	7
2	Find	lings	9
	2.1	Summary	9
	2.2	Key Findings	10
3	Deta	ailed Results	11
	3.1	Incompatibility With Deflationary/Rebasing Tokens	11
	3.2	Accommodation of Non-ERC20-Compliant Tokens	12
	3.3	Suggested Addition Of rescueToken() To SynFuturesV2Underlying	15
	3.4	Suggested Reentrancy Protection In Current Implementation	16
	3.5	Trust Issue Of Admin Keys	17
4	Con	clusion	19
Re	ferer	ices	20

1 Introduction

Given the opportunity to review the design document and related smart contract source code of the SynFutures V2 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 SynFutures V2

SynFutures V2 is a decentralized derivatives platform. In comparison to SynFutures V1, SynFutures V2 provides a more streamlined, easier-to-navigate user experience for both traders and liquidity providers, as well as more trading products and features designed with increased capital efficiency. For traders, SynFutures V2 introduces Perpetual Futures, which is a never-ending futures contract with native permissionless listing, guaranteed price convergence to spot index, and a forward-looking funding mechanism. For LPs, SynFutures V2 will be the first AMM-based derivatives protocol to natively incorporate ranged liquidity provision and limit orders, in addition to the vanilla AMM liquidity provision.

Table 1.1:	Basic	Information	of	SynFutures	V2
------------	-------	-------------	----	------------	----

ltem	Description
Target	SynFutures V2
Туре	EVM Smart Contract
Language	Solidity
Audit Method	Whitebox
Latest Audit Report	July 1, 2022

In the following, we show the Git repository of reviewed files and the commit hash values used

in this audit.

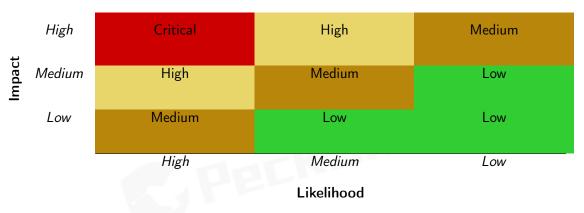
• https://github.com/SynFutures/v2-contracts.git (d6df565)

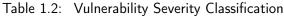
And this is the commit ID after all fixes for the issues found in the audit have been checked in:

• https://github.com/SynFutures/v2-contracts.git (ff28a81)

1.2 About PeckShield

PeckShield Inc. [12] 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).





1.3 Methodology

To standardize the evaluation, we define the following terminology based on OWASP Risk Rating Methodology [11]:

- <u>Likelihood</u> 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;
- <u>Severity</u> demonstrates the overall criticality of the risk.

Category	Check Item			
	Constructor Mismatch			
	Ownership Takeover			
	Redundant Fallback Function			
	Overflows & Underflows			
	Reentrancy			
	Money-Giving Bug			
	Blackhole			
	Unauthorized Self-Destruct			
Basic Coding Bugs	Revert DoS			
Dasie Counig Dugs	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			
	Business Logics Review			
	Functionality Checks			
	Authentication Management			
	Access Control & Authorization			
	Oracle Security			
Advanced DeFi Scrutiny	Digital Asset Escrow			
	Kill-Switch Mechanism			
	Operation Trails & Event Generation			
	ERC20 Idiosyncrasies Handling			
	Frontend-Contract Integration			
	Deployment Consistency			
	Holistic Risk Management			
	Avoiding Use of Variadic Byte Array			
	Using Fixed Compiler Version			
Additional Recommendations	Making Visibility Level Explicit			
	Making Type Inference Explicit			
	Adhering To Function Declaration Strictly			
	Following Other Best Practices			

Table 1.3:	The Full	List of	Check Items
------------	----------	---------	-------------

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 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:

- <u>Basic Coding Bugs</u>: 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.
- <u>Semantic Consistency Checks</u>: We then manually check the logic of implemented smart contracts and compare with the description in the white paper.
- <u>Advanced DeFi Scrutiny</u>: We further review business logics, examine system operations, and place DeFi-related aspects under scrutiny to uncover possible pitfalls and/or bugs.
- <u>Additional Recommendations</u>: 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) [10], 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.

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 functional-
	ity that processes data.
Numeric Errors	Weaknesses in this category are related to improper calcula-
	tion 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 man-
	agement of time and state in an environment that supports
	simultaneous or near-simultaneous computation by multiple
	systems, processes, or threads.
Error Conditions,	Weaknesses in this category include weaknesses that occur if
Return Values,	a function does not generate the correct return/status code,
Status Codes	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 manage-
	ment of system resources.
Behavioral Issues	Weaknesses in this category are related to unexpected behav-
	iors 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
Initialization and Cleanup	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 and Farameters	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 ex-
	ploitable 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.
	product has not been calciumy developed of maintained.

2 Findings

2.1 Summary

Here is a summary of our findings after analyzing the SynFutures V2 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	1
Low	3
Undetermined	1
Total	5

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, 3 low-severity vulnerabilities, and 1 undetermined issue.

ID	Severity	Title	Category	Status
PVE-001	Low	Incompatibility With Deflation-	Business Logic	Fixed
		ary/Rebasing Tokens		
PVE-002	Low	Accommodation Of Non-ERC20-	Coding Practices	Fixed
		Compliant Tokens		
PVE-003	Low	Suggested Addition Of rescueTo-	Coding Practices	Confirmed
		ken() To SynFuturesV2Underlying		
PVE-004	Undetermined	Suggested Reentrancy Protection In	Time and State	Fixed
		Current Implementation		
PVE-005	Medium	Trust Issue Of Admin Keys	Security Features	Confirmed

Table 2.1: Key SynFutures V2 Audit Findings

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 Incompatibility With Deflationary/Rebasing Tokens

- ID: PVE-001
- Severity: Low
- Likelihood: Low
- Impact: Low

- Target: SynFuturesV2Router
- Category: Business Logic [9]
- CWE subcategory: CWE-841 [5]

Description

In the SynFutures V2 implementation, the SynFuturesV2Router contract is one of the main entries for interaction with users. In particular, one entry routine, i.e., deposit(), accepts the deposits of the supported assets. While examining its logic, we observe the incoming token (i.e., quoteInfo.quote) is transferred to the SynFuturesV2Router contract and then transferred to the SynFuturesV2Underlying contract. This is reasonable under the assumption that these transfers will always result in full transfer. Otherwise, the transaction will be reverted.

```
197
        function deposit (address underlying, address trader, uint amount) public payable
             nonReentrant {
198
            Types.QuoteInfo memory quoteInfo = IUnderlying(underlying).quoteInfo();
199
             _deposit(underlying, quoteInfo, trader, amount);
200
             return;
201
        }
202
203
        function _deposit(
204
             address underlying, Types.QuoteInfo memory quoteInfo, address trader, uint
                 amount
205
        ) internal returns (uint) {
206
             require(msg.value == 0, "invalid msg.value");
207
             uint tokenAmount = amount / quoteInfo.scaler;//10**(18 - token decimals)
208
             IERC20(quoteInfo.quote).safeTransferFrom(msg.sender, address(this), tokenAmount)
                 ;
209
210
             amount = tokenAmount * quoteInfo.scaler;
211
             IUnderlying(underlying).deposit(trader, amount);
```

212 return amount; 213 }

Listing 3.1: SynFuturesV2Router::deposit()

However, there exist other ERC20 tokens that may make certain customizations to their ERC20 contracts. One type of these tokens is deflationary tokens that charge certain fee for every transfer() or transferFrom(). (Another type is rebasing tokens such as YAM.) As a result, this may not meet the assumption behind these routines related to token transfer.

One possible mitigation is to measure the asset change right before and after the asset-transferring routines. In other words, instead of bluntly assuming the amount parameter in transfer() or transferFrom() will always result in full transfer, we need to ensure the increased or decreased amount in the SynFuturesV2Router contract before and after the transfer() or transferFrom() is expected and aligned well with our operation. Though these additional checks cost additional gas usage, we consider they are necessary to deal with deflationary tokens or other customized ones if their support is deemed necessary.

Another mitigation is to regulate the set of ERC20 tokens that are permitted into SynFutures V2. In SynFutures V2 protocol, it is indeed possible to effectively regulate the set of tokens that can be supported. Keep in mind that there exist certain assets (e.g., USDT) that may have control switches that can be dynamically exercised to suddenly become one.

Recommendation If current codebase needs to support possible deflationary tokens, it is better to check the balance before and after the transfer()/transferFrom() call to ensure the book-keeping amount is accurate. This support may bring additional gas cost. Also, keep in mind that certain tokens may not be deflationary for the time being. However, they could have a control switch that can be exercised to turn them into deflationary tokens. One example is the widely-adopted USDT.

Status The issue has been addressed by the following commit: 2fe40d9.

3.2 Accommodation of Non-ERC20-Compliant Tokens

- ID: PVE-002
- Severity: Low
- Likelihood: Low
- Impact: Low

- Target: SynFuturesV2Router
- Category: Coding Practices [8]
- CWE subcategory: CWE-1126 [2]

Description

Though there is a standardized ERC-20 specification, many token contracts may not strictly follow the specification or have additional functionalities beyond the specification. In this section, we examine

the approve() routine and analyze possible idiosyncrasies from current widely-used token contracts. In particular, we use the popular stablecoin, i.e., USDT, as our example. We show the related code snippet below.

```
194
195
        * @dev Approve the passed address to spend the specified amount of tokens on behalf
            of msg.sender.
196
        * @param _spender The address which will spend the funds.
197
        * Cparam _value The amount of tokens to be spent.
198
        */
199
        function approve(address spender, uint value) public onlyPayloadSize(2 * 32) {
201
            // To change the approve amount you first have to reduce the addresses '
202
            // allowance to zero by calling 'approve(_spender, 0)' if it is not
203
            // already 0 to mitigate the race condition described here:
204
            // https://github.com/ethereum/EIPs/issues/20#issuecomment-263524729
205
             require(!(( value != 0) && (allowed[msg.sender][ spender] != 0)));
207
            allowed [msg.sender] [ _spender] = _value;
208
             Approval (msg. sender, spender, value);
209
```



It is important to note that the approve() function does not have a return value. However, the IERC20 interface has defined the following approve() interface with a bool return value: function approve(address spender, uint256 amount)external returns (bool). As a result, the call to approve() may expect a return value. With the lack of return value of USDT's approve(), the call will be unfortunately reverted.

Because of that, a normal call to approve() is suggested to use the safe version, i.e., safeApprove (). In essence, it is a wrapper around ERC20 operations that may either throw on failure or return false without reverts. Moreover, the safe version also supports tokens that return no value (and instead revert or throw on failure). Note that non-reverting calls are assumed to be successful.

In the following, we show the internal _createUnderlying() routine in the SynFuturesV2Router contract. If the USDT token is supported as quoteInfo.quote, the unsafe version of IERC20(quoteInfo.quote).approve(underlying, LibMathUnsigned.POSITIVE_INT256_MAX()) (line 142) may revert as there is no return value in the USDT token contract's approve() implementation (but the IERC20 interface expects a return value)!

```
118
                 bytes32 index;
119
                 address expectedUnderlying;
120
                 // deployData varies as market, but should always contains the expected
                     deployed pair address(which is
121
                 // used as the feeders' mapping key), to check the deployed one use the
                     correct feeder.
122
                 (parameters, index, expectedUnderlying) = IMarket(market).newUnderlying(
                     deployData);
123
                 // check whether the same pair exists
124
                 require(underlyings[index] == address(0), "underlying exists");
126
                 address beacon = beacons[marketType];
                 underlying = address(new SynFuturesV2UnderlyingProxy{salt : index}(beacon));
127
128
                 // check whether the pair deployed is the same as specified in deployData
129
                 require(underlying == expectedUnderlying, "underlying addr mismatch");
131
                 delete parameters;
132
                 underlyings[index] = underlying;
133
                 underlyingsIndex.push(index);
135
                 IObserver(observer).addUnderlying(underlying);
             }
136
138
             Types.QuoteInfo memory quoteInfo = IUnderlying(underlying).quoteInfo();
139
             ſ
140
                 (uint amount) = abi.decode(initializeData, (uint));
141
                 // approve underlying as underlying is created
142
                 IERC20(quoteInfo.quote).approve(underlying, LibMathUnsigned.
                     POSITIVE_INT256_MAX());
143
                 . . .
144
             }
146
             . . .
147
```

Listing 3.3: SynFuturesV2Router::_createUnderlying()

Recommendation Accommodate the above-mentioned idiosyncrasy about ERC20-related approve().

Status The issue has been addressed by the following commit: 2fe40d9.

3.3 Suggested Addition Of rescueToken() To SynFuturesV2Underlying

- ID: PVE-003
- Severity: Low
- Likelihood: Low
- Impact: Low

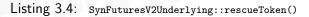
- Target: SynFuturesV2Underlying
- Category: Coding Practices [8]
- CWE subcategory: CWE-1099 [1]

Description

By design, the SynFutures V2 protocol supports multiple SynFuturesV2Underlying contracts and holds various types of underlying tokens. From past experience with current popular DeFi protocols, e.g., YFI/Curve, we notice that there is always non-trivial possibilities that non-related tokens may be accidentally sent to the contract(s). To avoid unnecessary loss of protocol users, we suggest to add the support of rescuing remaining tokens. This is a design choice for the benefit of protocol users.

Recommendation Add the support of rescuing remaining tokens in SynFuturesV2Underlying. An example addition is shown below:

```
function rescueToken(address _token, address _to, uint256 _amount) external
    onlyOwner {
    require(_token != quoteInfo.quote, "Should not withdraw staking Token");
    IERC20(_token).safeTransfer(_to, _amount);
    emit Recovered(_token, _to, _amount);
}
```



Status The issue has been confirmed by the team.

3.4 Suggested Reentrancy Protection In Current Implementation

- ID: PVE-004
- Severity: Undetermined
- Likelihood: Undetermined
- Impact: Undetermined

- Target: SynFuturesV2Router/SynFuturesV2Underlying
- Category: Time and State [7]
- CWE subcategory: CWE-362 [4]

Description

In the SynFuturesV2Router contract, we notice the deposit() routine is used to deposit the supported assets into the SynFutures V2 protocol, and the trade() routine is used to buy Long or Short positions. While examining their logic, we notice the deposit() routine is under the reentrancy protection, however, the trade() routine is not.

To elaborate, we show below the related code snippet of the SynFuturesV2Router contract. Within the internal _deposit() routine (which is called inside the deposit() routine), we notice IERC20(quoteInfo.quote).safeTransferFrom(msg.sender, address(this), tokenAmount) (line 208) is called to transfer the token into the SynFuturesV2Router contract. If the quoteInfo.quote faithfully implements the ERC777-like standard, then the trade() routine is exposed to potential reentrancy vulnerability and this risk needs to be properly mitigated. Although we also do not know how a malicious actor can exploit this vulnerability to earn profit. After internal discussion, we consider it is necessary to bring this vulnerability up to the team. We suggest to use the ReentrancyGuard::nonReentrant modifier to protect all the public routines at the whole protocol level.

```
187
         function trade(address underlying, uint expiry, int size, uint limitPrice, uint
             deadline) public payable {
             IUnderlying(underlying).trade(msg.sender, expiry, size, limitPrice, deadline);
188
189
         }
190
191
         . . .
192
193
         function deposit(address underlying, address trader, uint amount) public payable
             nonReentrant {
194
             Types.QuoteInfo memory quoteInfo = IUnderlying(underlying).quoteInfo();
195
             _deposit(underlying, quoteInfo, trader, amount);
196
             return;
197
         }
198
199
         . . .
200
201
```

```
202
203
        function _deposit(
204
            address underlying, Types.QuoteInfo memory quoteInfo, address trader, uint
                 amount
205
        ) internal returns (uint) {
206
            require(msg.value == 0, "invalid msg.value");
207
             uint tokenAmount = amount / quoteInfo.scaler;//10**(18 - token decimals)
208
             IERC20(quoteInfo.quote).safeTransferFrom(msg.sender, address(this), tokenAmount)
                 ;
209
210
             amount = tokenAmount * quoteInfo.scaler;
211
             IUnderlying(underlying).deposit(trader, amount);
212
             return amount;
213
```

Listing 3.5: SynFuturesV2Router::trade()&&deposit()

Recommendation Apply the non-reentrancy protection in all public routines.

Status The issue has been addressed by the following commit: 72e9f18.

3.5 Trust Issue Of Admin Keys

- ID: PVE-005
- Severity: Medium
- Likelihood: Medium
- Impact: Medium

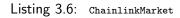
- Target: Multiple Contracts
- Category: Security Features [6]
- CWE subcategory: CWE-287 [3]

Description

In the SynFutures V2 protocol, there is a privileged owner account that plays a critical role in governing and regulating the protocol-wide operations (e.g., configuring the price oracle related parameters). In the following, we show the representative functions potentially affected by the privilege of the owner account.

```
305
        function setQuoteParam(address _quote, Types.QuoteParam calldata _param) public
             onlyOwner {
306
             quotes[_quote] = _param;
307
             emit SetQuoteParam(_quote, _param);
308
        }
309
310
        function setUnderlyingInfo(address _underlying, UnderlyingInfo calldata _info)
            public onlyOwner {
311
            _setUnderlyingInfo(_underlying, _info);
312
        }
313
```

314	<pre>function _setUnderlyingInfo(address _underlying, UnderlyingInfo memory _info)</pre>
	internal {
315	
315	<pre>require(_info.underlyingType <= 3, "unsupported underlyingType");</pre>
316	<pre>require(address(_info.feeder.aggregator0) != address(0), "invalid feeder");</pre>
510	require (address (_info.reeder.aggregatoro) :- address (0), invalid reeder),
317	underlyingsInfo[_underlying] = _info;
318	<pre>emit SetUnderlyingInfo(_underlying, _info);</pre>
210	
319	}
319	}



We emphasize that the privilege assignment may be necessary and consistent with the protocol design. However, it is worrisome if the owner is not governed by a DAD-like structure. Note that a compromised account would allow the attacker to modify a number of sensitive system parameters, which directly undermines the assumption of the protocol design.

Recommendation Promptly transfer the privileged account to the intended DAD-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 The issue has been confirmed by the team.



4 Conclusion

In this audit, we have analyzed the SynFutures V2 design and implementation. SynFutures V2 is a decentralized derivatives platform. In comparison to SynFutures V1, SynFutures V2 provides a more streamlined, easier-to-navigate user experience for both traders and liquidity providers, as well as more trading products and features designed with increased capital efficiency. For traders, SynFutures V2 introduces Perpetual Futures, which is a never-ending futures contract with native permissionless listing, guaranteed price convergence to spot index, and a forward-looking funding mechanism. For LPs, SynFutures V2 will be the first AMM-based derivatives protocol to natively incorporate ranged liquidity provision and limit orders, in addition to the vanilla AMM liquidity provision. 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

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- [3] MITRE. CWE-287: Improper Authentication. https://cwe.mitre.org/data/definitions/287.html.
- [4] MITRE. CWE-362: Concurrent Execution using Shared Resource with Improper Synchronization ('Race Condition'). https://cwe.mitre.org/data/definitions/362.html.
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