SMART CONTRACT AUDIT REPORT

for

Automata ConveyorV2

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1 Introduction

Given the opportunity to review the `Automata ConveyorV2` 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 branch of `Automata ConveyorV2` 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 ConveyorV2

`Automata ConveyorV2` is an independent DEX which allows the tokens to be traded in the `ConveyorV2` liquidity pools separated from existing DEXes. The users need to sign an `EIP712` message to authorize the protocol to submit a transaction on the user's behalf. Users would enjoy the benefit of gas-less trading with an acceptable service fee in the form of certain `ERC20` tokens, such as `DAI`, `USDC` or `ATA` tokens.

The basic information of `Automata ConveyorV2` is as follows:

Table 1.1: Basic Information of ConveyorV2

Item	Description
Name	Automata
Type	Ethereum and BSC Smart Contract
Platform	Solidity
Audit Method	Whitebox
Latest Audit Report	October 07, 2021

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

- https://github.com/automata-network/conveyor-v2.git (c4102e2)

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

- https://github.com/automata-network/conveyor-v2.git (f86d15b)

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 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 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

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

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 `Automata ConveyorV2` 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	2	■ ■
Low	1	■
Informational	0	
Total	3	

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 2 medium-severity vulnerabilities and 1 low-severity vulnerability.

Table 2.1: Key ConveyorV2 Audit Findings

ID	Severity	Title	Category	Status
PVE-001	Medium	Improved Logic of ConveyorV2Router01::getAmountIn()	Business Logic	Fixed
PVE-002	Low	Incompatibility With Deflationary Tokens	Business Logic	Fixed
PVE-003	Medium	Trust Issue of Admin Keys	Security Features	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 ConveyorV2Router01::getAmountIn()

- ID: PVE-001
- Severity: Medium
- Likelihood: Medium
- Impact: Medium
- Target: `ConveyorV2Router01`
- Category: Business Logic [4]
- CWE subcategory: CWE-841 [2]

Description

In `ConveyorV2Router01`, the `getAmountIn()` routine is defined to calculate the required input amount of an asset when given an output amount of the other asset. During the analysis of this function, we notice that the calculation of `amountIn` is routed to `ConveyorV2Library.getAmountOut()`(line 195) which is not correct.

```
190     function getAmountIn(
191         uint256 amountOut,
192         uint256 reserveIn,
193         uint256 reserveOut
194     ) public pure override returns (uint256 amountIn) {
195         return ConveyorV2Library.getAmountOut(amountOut, reserveIn, reserveOut);
196     }
```

Listing 3.1: `ConveyorV2Router01::getAmountIn()`

Recommendation Correct the above `getAmountIn()` routine by calling the right helper function, i.e., `ConveyorV2Library.getAmountIn()`.

Status The issue has been fixed by this commit: `3c0fa33`.

3.2 Incompatibility With Deflationary Tokens

- ID: PVE-002
- Severity: Low
- Likelihood: Low
- Impact: Medium
- Target: ConveyorV2Router01
- Category: Business Logic [4]
- CWE subcategory: CWE-841 [2]

Description

In the ConveyorV2Router01 contract, there are several routines designed to facilitate the swap between tokens. For example, the swapExactTokensForTokens() routine is used to swap an exact amount of input tokens for as many output tokens as possible, according to the swap route determined by the path.

```
function swapExactTokensForTokens(ConveyorV2Types.SWAP_TYPE memory swap)
        external
        override
        ensure(swap.deadline)
        metaOnly
        returns (uint256[] memory amounts)
{
    address to = !metaDisabled ? swap.user : msg.sender;
    amounts = ConveyorV2Library.getAmountsOut(factory, swap.amount0, swap.path);
    require(amounts[amounts.length - 1] >= swap.amount1, "ConveyorV2Router:
        INSUFFICIENT_OUTPUT_AMOUNT");
    TransferHelper.safeTransferFrom(
        swap.path[0],
        to,
        ConveyorV2Library.pairFor(factory, swap.path[0], swap.path[1]),
        amounts[0]
    );
    _swap(amounts, swap.path, to);
}
```

Listing 3.2: ConveyorV2Router01::swapExactTokensForTokens()

However, in the cases of deflationary tokens, the swapExactTokensForTokens() may fail. In order to supports tokens that take a fee on transfer, the UniswapV2 introduces another helper routine, i.e., swapExactTokensForTokensSupportingFeeOnTransferTokens().

Recommendation If there is a need to support deflationary tokens, we suggest to make use of another helper routine, i.e., swapExactTokensForTokensSupportingFeeOnTransferTokens() as the swapExactTokensForTokens() replacement.

Status The issue has been fixed by this commit: f86d15b.

3.3 Trust Issue of Admin Keys

- ID: PVE-003
- Severity: Medium
- Likelihood: Low
- Impact: High
- Target: ERC20Forwarder
- Category: Security Features [3]
- CWE subcategory: CWE-287 [1]

Description

In the Automata ConveyorV2 protocol, there is a special administrative account, i.e., owner. This owner account plays a critical role in governing and regulating the protocol-wide operations (e.g., setting various 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 owner account and its related privileged accesses in current contract.

To elaborate, we show below several functions which are provided to set system parameters. These functions allow the owner account to change the constantFee, transferFee, relayers and feeHolder, which could affect how much fees should be charged from the user and where the fees would flow to for the execution of the meta-transactions.

```
    function setConstantFee(uint256 _newConstantFee) public onlyOwner {
        constantFee = _newConstantFee;
    }

    function setTransferFee(uint256 _newTransferFee) public onlyOwner {
        transferFee = _newTransferFee;
    }

    function setRelayer(address _relayer, bool _trusted) public onlyOwner {
        relayers[_relayer] = _trusted;
    }

    function setFeeHolder(address _feeHolder) public onlyOwner {
        feeHolder = _feeHolder;
    }
```

Listing 3.3: Example Setters in ERC20Forwarder

We understand the need of the privileged functions for contract maintenance, but 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 The issue has been confirmed by the team.

4 Conclusion

In this audit, we have analyzed the `Automata ConveyorV2` design and implementation. `Automata ConveyorV2` is an independent DEX which allows the tokens to be traded in the `ConveyorV2` liquidity pools separated from existing DEXes. 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-287: Improper Authentication. https://cwe.mitre.org/data/definitions/287.html.

[2] MITRE. CWE-841: Improper Enforcement of Behavioral Workflow. https://cwe.mitre.org/data/definitions/841.html.

[3] MITRE. CWE CATEGORY: 7PK - Security Features. https://cwe.mitre.org/data/definitions/254.html.

[4] MITRE. CWE CATEGORY: Business Logic Errors. https://cwe.mitre.org/data/definitions/840.html.

[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.

[7] PeckShield. PeckShield Inc. https://www.peckshield.com.