1inch

Router & RFQ v4

SMART CONTRACT AUDIT

24.09.2021

Made in Germany by Chainsulting.de

Table of contents

1. Disclaimer 3
2. About the Project and Company 4
   2.1 Project Overview 5
3. Vulnerability & Risk Level 6
4. Auditing Strategy and Techniques Applied 7
   4.1 Methodology 7
   4.2 Used Code from other Frameworks/Smart Contracts 8
   4.3 Tested Contract Files 9
   4.4 Metrics / CallGraph 10
   4.5 Metrics / Source Lines & Risk 11
   4.6 Metrics / Capabilities 12
5. Scope of Work 14
   5.1 Manual and Automated Vulnerability Test 15
   5.1.1 Extensive owner rights 16
   5.2. SWC Attacks 17
6. Executive Summary 21
7. Deployed Smart Contract 21

1. Disclaimer

The audit makes no statements or warrantees about utility of the code, safety of the code, suitability of the business model, investment advice, endorsement of the platform or its products, regulatory regime for the business model, or any other statements about fitness of the contracts to purpose, or their bug free status. The audit documentation is for discussion purposes only.

The information presented in this report is confidential and privileged. If you are reading this report, you agree to keep it confidential, not to copy, disclose or disseminate without the agreement of 1Inch Exchange. If you are not the intended receptor of this document, remember that any disclosure, copying or dissemination of it is forbidden.

Major Versions / Date	Description
0.1 (16.09.2021)	Layout
0.2 (17.09.2021)	Test Deployment
0.5 (18.09.2021)	Automated Security Testing Manual Security Testing
0.6 (19.09.2021)	Testing SWC Checks
0.7 (20.09.2021)	Verify Claims
0.9 (20.09.2021)	Summary and Recommendation
1.0 (23.09.2021)	Final document
1.1 (TBA)	Adding deployed contract address

2. About the Project and Company

Company address:

1Inch Limited
Quijano Chambers, P.O. Box 3159, Road Town
Tortola, British Virgin Islands

Sergej Kunz Co-Founder & Chief Executive Officer
Anton Bukov Co-Founder & Chief Technology Officer

Discord: https://discord.gg/FZADkCZ

Blog: https://blog.1inch.io

Medium: https://medium.com/@1inch.exchange

Website: https://app.1inch.io

Twitter: https://twitter.com/1inchExchange

Reddit: https://www.reddit.com/r/1inch_exchange

Telegram: https://t.me/OneInchExchange

Forum: https://gov.1inch.io

2.1 Project Overview

The 1inch Network unites decentralized protocols whose synergy enables the most lucrative, fastest and protected operations in the DeFi space. The initial protocol of the 1inch Network is a DEX aggregator solution that searches deals across multiple liquidity sources, offering users better rates than any individual exchange.

This protocol incorporates the Pathfinder algorithm which finds the best paths among different markets over 50+ liquidity sources on Ethereum, 20+ liquidity sources on Binance Smart Chain and 8+ liquidity sources on Polygon. In just two years the 1inch DEX aggregator surpassed $50B in overall volume on the Ethereum network alone. The 1inch Aggregation Protocol facilitates cost-efficient and secure swap transactions across multiple liquidity sources.

The 1inch Liquidity Protocol is a next-generation automated market maker that protects users from front-running attacks and offers attractive opportunities to liquidity providers. The 1inch Limit Order Protocol facilitates the most innovative and flexible limit order swap opportunities in DeFi. The protocol's features, such as dynamic pricing, conditional orders and extra RFQ support, power various implementations, including stop-loss and trailing stop orders, as well as auctions.

1inch limit order protocol is a set of smart contracts, that can work on any EVM based blockchains (Ethereum, Binance Smart Chain, Polygon, etc.). Key features of the protocol is extreme flexibility and high gas efficiency that achieved by using two different order types - regular Limit Order and RFQ Order. Smart Contract allows users to place limit orders and RFQ Orders, that later could be filled on-chain. Both type of orders is a data structure created off-chain and signed according to EIP-712.

3. Vulnerability & Risk Level

Risk represents the probability that a certain source-threat will exploit vulnerability, and the impact of that event on the organization or system. Risk Level is computed based on CVSS version 3.0.

Level	Value	Vulnerability	Risk (Required Action)
Critical	9 – 10	A vulnerability that can disrupt the contract functioning in a number of scenarios, or creates a risk that the contract may be broken.	Immediate action to reduce risk level.
High	7 – 8.9	A vulnerability that affects the desired outcome when using a contract, or provides the opportunity to use a contract in an unintended way.	Implementation of corrective actions as soon as possible.
Medium	4 – 6.9	A vulnerability that could affect the desired outcome of executing the contract in a specific scenario.	Implementation of corrective actions in a certain period.
Low	2 – 3.9	A vulnerability that does not have a significant impact on possible scenarios for the use of the contract and is probably subjective.	Implementation of certain corrective actions or accepting the risk.
Informational	0 – 1.9	A vulnerability that have informational character but is not effecting any of the code.	An observation that does not determine a level of risk

4. Auditing Strategy and Techniques Applied

Throughout the review process, care was taken to evaluate the repository for security-related issues, code quality, and adherence to specification and best practices. To do so, reviewed line-by-line by our team of expert pentesters and smart contract developers, documenting any issues as there were discovered.

4.1 Methodology

The auditing process follows a routine series of steps:

1. Code review that includes the following:
   i. Review of the specifications, sources, and instructions provided to Chainsulting to make sure we understand the size, scope, and functionality of the smart contract.
   ii. Manual review of code, which is the process of reading source code line-by-line in an attempt to identify potential vulnerabilities.
   iii. Comparison to specification, which is the process of checking whether the code does what the specifications, sources, and instructions provided to Chainsulting describe.
2. Testing and automated analysis that includes the following:
   i. Test coverage analysis, which is the process of determining whether the test cases are actually covering the code and how much code is exercised when we run those test cases.
   ii. Symbolic execution, which is analysing a program to determine what inputs causes each part of a program to execute.
3. Best practices review, which is a review of the smart contracts to improve efficiency, effectiveness, clarify, maintainability, security, and control based on the established industry and academic practices, recommendations, and research.
4. Specific, itemized, actionable recommendations to help you take steps to secure your smart contracts.

4.2 Used Code from other Frameworks/Smart Contracts (direct imports)

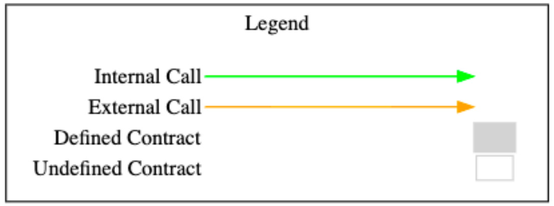
Dependency / Import Path	Source
@openzeppelin/contracts/access/Ownable.sol	https://github.com/OpenZeppelin/openzeppelin-contracts/tree/v3.4.2-solc-0.7/contracts/access/Ownable.sol
@openzeppelin/contracts/cryptography/ECDSA.sol	https://github.com/OpenZeppelin/openzeppelin-contracts/tree/v3.4.2-solc-0.7/contracts/cryptography/ECDSA.sol
@openzeppelin/contracts/drafts/ERC20Permit.sol	https://github.com/OpenZeppelin/openzeppelin-contracts/tree/v3.4.2-solc-0.7/contracts/drafts/ERC20Permit.sol
@openzeppelin/contracts/math/SafeMath.sol	https://github.com/OpenZeppelin/openzeppelin-contracts/tree/v3.4.2-solc-0.7/contracts/math/SafeMath.sol
@openzeppelin/contracts/token/ERC20/IERC20.sol	https://github.com/OpenZeppelin/openzeppelin-contracts/tree/v3.4.2-solc-0.7/contracts/token/ERC20/IERC20.sol
@openzeppelin/contracts/token/ERC20/SafeERC20.sol	https://github.com/OpenZeppelin/openzeppelin-contracts/tree/v3.4.2-solc-0.7/contracts/token/ERC20/SafeERC20.sol
@openzeppelin/contracts/utils/Address.sol	https://github.com/OpenZeppelin/openzeppelin-contracts/tree/v3.4.2-solc-0.7/contracts/utils/Address.sol

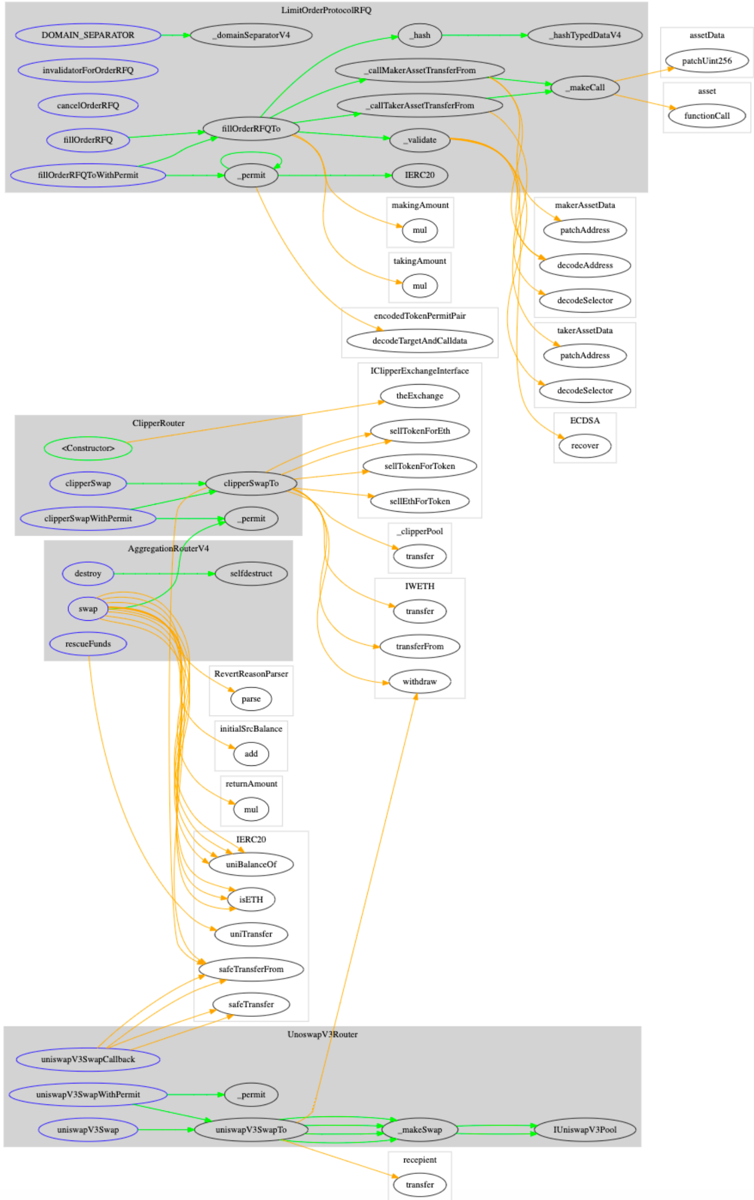
4.3 Tested Contract Files

The following are the MD5 hashes of the reviewed files. A file with a different MD5 hash has been modified, intentionally or otherwise, after the security review. You are cautioned that a different MD5 hash could be (but is not necessarily) an indication of a changed condition or potential vulnerability that was not within the scope of the review

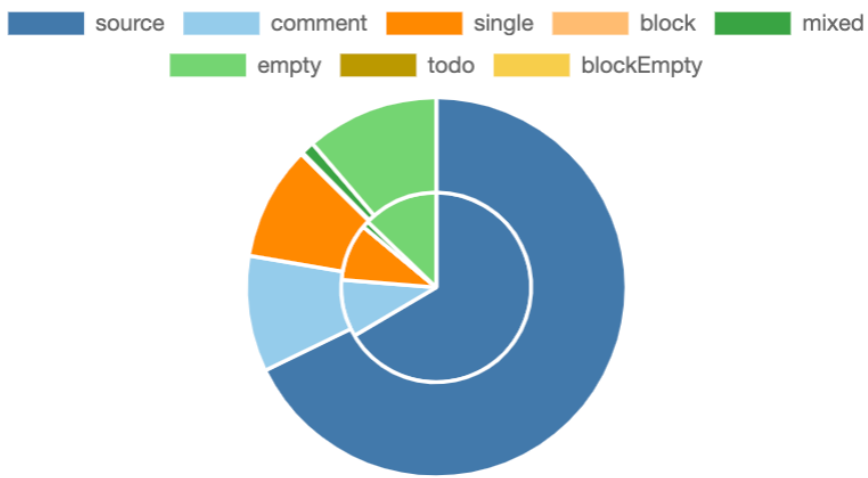
File	Fingerprint (MD5)
./AggregatonRouterV4.sol	eeb4529c7e5f0ffa4e3abf96a24c5ddb
./ClipperRouter.sol	2aa9ae75eff5594a8b9b8878e435ad91
./LimitOrderProtocolRFQ.sol	9248db1b4e0a74c925483eabf0a5aa0d
./UnoswapV3Router.sol	838d77c3b6b2ca37dd97a5482efcfb99

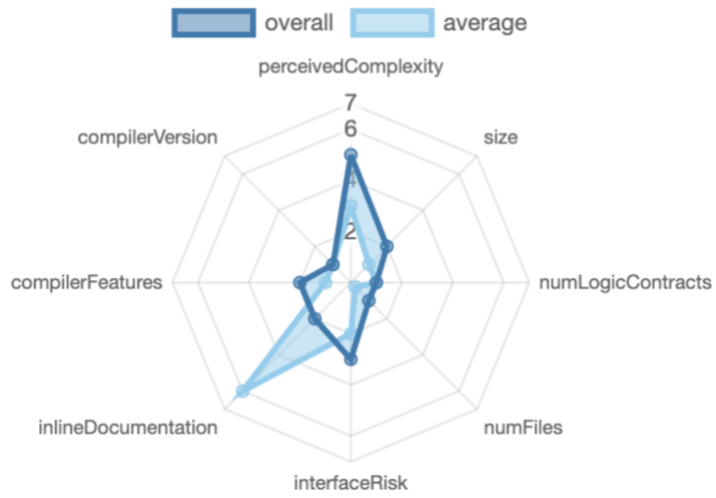
4.4 Metrics / CallGraph





4.5 Metrics / Source Lines & Risk





4.6 Metrics / Capabilities

Solidity Versions observed	🧪 Experimental Features	💰 Can Receive Funds	🖥 Uses Assembly	💣 Has Destroyable Contracts
`^0.7.6`		`yes`	`yes` (1 asm blocks)	`yes`

📤 Transfers ETH	⚡ Low-Level Calls	👥 DelegateCall	🧮 Uses Hash Functions	🔖 ECRecover	🌀 New/Create/Create2
`yes`			`yes`		

Exposed Functions

This section lists functions that are explicitly declared public or payable. Please note that getter methods for public stateVars are not included.

🌐Public	💰Payable
16	7

External	Internal	Private	Pure	View
13	14	7	1	3

StateVariables

Total	🌐Public
23	1

4.7 Metrics / Source Unites in Scope

Type	File	Logic Contracts	Interfaces	Lines	nLines	nSLOC	Comment Lines	Complex. Score	Capabilities
📝	contracts/ClipperRouter.sol	1		85	67	57	1	55	💰📤
📝	contracts/AggregationRouterV4.sol	1		158	142	87	39	66	💰💣
📝	contracts/LimitOrderProtocolRFQ.sol	1		197	178	131	23	86	🧮
📝	contracts/UnoswapV3Router.sol	1		182	162	140	7	272	🖥️💰📤
📝	**Totals**	**4**		**622**	**549**	**415**	**70**	**479**	🖥️💰💣📤🧮

Legend: [➖]

- **Lines**: total lines of the source unit
- **nLines**: normalized lines of the source unit (e.g. normalizes functions spanning multiple lines)
- **nSLOC**: normalized source lines of code (only source-code lines; no comments, no blank lines)
- **Comment Lines**: lines containing single or block comments
- **Complexity Score**: a custom complexity score derived from code statements that are known to introduce code complexity (branches, loops, calls, external interfaces, ...)

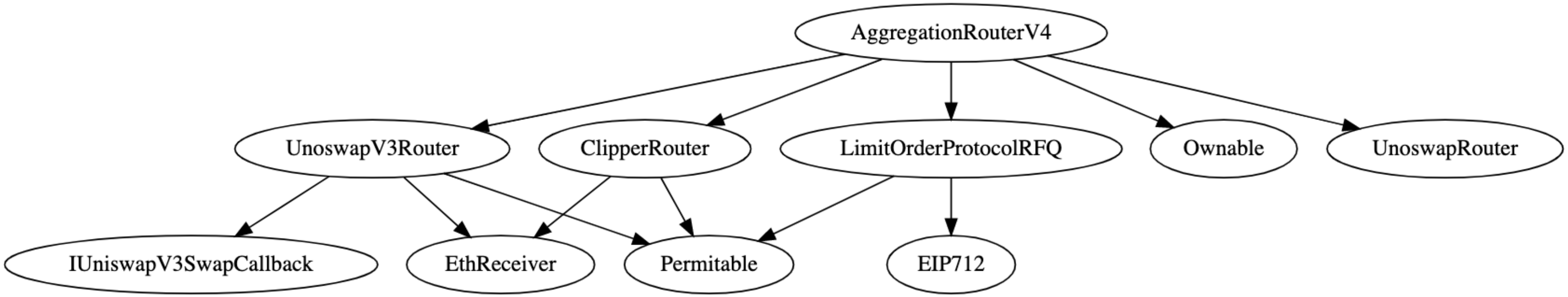
5. Scope of Work

The 1inch Team provided us with the files that needs to be tested. The scope of the audit is the updated Aggregation Router v4 and the imported contracts.

The team put forward the following assumptions regarding the security, usage of the contracts:

- The smart contract is coded according to the newest standards and in a secure way.

The main goal of this audit was to verify these claims. The auditors can provide additional feedback on the code upon the client's request.



5.1 Manual and Automated Vulnerability Test

CRITICAL ISSUES

During the audit, Chainsulting‘s experts found **no Critical issues** in the code of the smart contract.

HIGH ISSUES

During the audit, Chainsulting’s experts found **no High issues** in the code of the smart contract.

MEDIUM ISSUES

During the audit, Chainsulting’s experts found **no Medium issues** in the code of the smart contract

LOW ISSUES

During the audit, Chainsulting’s experts found **no Low issues** in the code of the smart contract

INFORMATIONAL ISSUES

5.1.1 Extensive owner rights
Severity: INFORMATIONAL
Status: ACKNOWLEDGED
File(s) affected: AggregationRouterV4.sol

Attack / Description	Code Snippet	Result/Recommendation

The owner has extensive rights, which can lead to a vulnerability once the private key got lost or hacked. This is the case if the access to the owner wallet is not a multi-sig.	Line: 151 – 158
	`function rescueFunds(IERC20 token, uint256 amount) external onlyOwner {`
	`token.uniTransfer(msg.sender, amount);`
	`}`
	
	`function destroy() external onlyOwner {`
	`selfdestruct(msg.sender);`
	`}`
	`}`
		The owner has rights to rescue funds and destruct. If the owner wallet is not a multi-sig, this can cause problems in the future if the contract owner's wallet gets hacked. We recommend using multi-sig for onlyOwner modifier.

5.2. SWC Attacks

ID	Title	Relationships	Test Result
SWC-131	Presence of unused variables	CWE-1164: Irrelevant Code	✅
SWC-130	Right-To-Left-Override control character (U+202E)	CWE-451: User Interface (UI) Misrepresentation of Critical Information	✅
SWC-129	Typographical Error	CWE-480: Use of Incorrect Operator	✅
SWC-128	DoS With Block Gas Limit	CWE-400: Uncontrolled Resource Consumption	✅
SWC-127	Arbitrary Jump with Function Type Variable	CWE-695: Use of Low-Level Functionality	✅
SWC-125	Incorrect Inheritance Order	CWE-696: Incorrect Behavior Order	✅
SWC-124	Write to Arbitrary Storage Location	CWE-123: Write-what-where Condition	✅
SWC-123	Requirement Violation	CWE-573: Improper Following of Specification by Caller	✅

ID	Title	Relationships	Test Result
[SWC-122]()	Lack of Proper Signature Verification	[CWE-345: Insufficient Verification of Data Authenticity]()	✅
[SWC-121]()	Missing Protection against Signature Replay Attacks	[CWE-347: Improper Verification of Cryptographic Signature]()	✅
[SWC-120]()	Weak Sources of Randomness from Chain Attributes	[CWE-330: Use of Insufficiently Random Values]()	✅
[SWC-119]()	Shadowing State Variables	[CWE-710: Improper Adherence to Coding Standards]()	✅
[SWC-118]()	Incorrect Constructor Name	[CWE-665: Improper Initialization]()	✅
[SWC-117]()	Signature Malleability	[CWE-347: Improper Verification of Cryptographic Signature]()	✅
[SWC-116]()	Timestamp Dependence	[CWE-829: Inclusion of Functionality from Untrusted Control Sphere]()	✅
[SWC-115]()	Authorization through tx.origin	[CWE-477: Use of Obsolete Function]()	✅
[SWC-114]()	Transaction Order Dependence	[CWE-362: Concurrent Execution using Shared Resource with Improper Synchronization ('Race Condition')]()	✅

ID	Title	Relationships	Test Result
SWC-113	DoS with Failed Call	CWE-703: Improper Check or Handling of Exceptional Conditions	✓
SWC-112	Delegatecall to Untrusted Callee	CWE-829: Inclusion of Functionality from Untrusted Control Sphere	✓
SWC-111	Use of Deprecated Solidity Functions	CWE-477: Use of Obsolete Function	✓
SWC-110	Assert Violation	CWE-670: Always-Incorrect Control Flow Implementation	✓
SWC-109	Uninitialized Storage Pointer	CWE-824: Access of Uninitialized Pointer	✓
SWC-108	State Variable Default Visibility	CWE-710: Improper Adherence to Coding Standards	✓
SWC-107	Reentrancy	CWE-841: Improper Enforcement of Behavioral Workflow	✓
SWC-106	Unprotected SELFDESTRUCT Instruction	CWE-284: Improper Access Control	✓
SWC-105	Unprotected Ether Withdrawal	CWE-284: Improper Access Control	✓
SWC-104	Unchecked Call Return Value	CWE-252: Unchecked Return Value	✓

ID	Title	Relationships	Test Result
SWC-103	Floating Pragma	CWE-664: Improper Control of a Resource Through its Lifetime	X
SWC-102	Outdated Compiler Version	CWE-937: Using Components with Known Vulnerabilities	✅
SWC-101	Integer Overflow and Underflow	CWE-682: Incorrect Calculation	✅
SWC-100	Function Default Visibility	CWE-710: Improper Adherence to Coding Standards	✅

6. Executive Summary

Two (2) independent Chainsulting experts performed an unbiased and isolated audit of the smart contract codebase. The final debriefs took place on the September 23, 2021.

The main goal of the audit was to verify the claims regarding the security of the smart contract and the functions. During the audit, no critical issues were found after the manual and automated security testing and the claims been successfully verified.

7. Deployed Smart Contract

PENDING