PUBLIC

Code Assessment

of the Franchiser Smart Contracts

September 13, 2024

Produced for

UNISWAP FOUNDATION

by

CHAINSECURITY

Contents

1 Executive Summary

Dear Uniswap Foundation,

Thank you for trusting us to help Uniswap Foundation with this security audit. Our executive summary provides an overview of subjects covered in our audit of the latest reviewed contracts of Franchiser according to Scope to support you in forming an opinion on their security risks.

Uniswap Foundation implements a Franchiser system, that allows multi-level delegation of UNI tokens' voting power.

The most critical subjects covered in our audit are asset solvency and front-running resistance. Security regarding all the aforementioned subjects is high.

The general subjects covered are gas efficiency, code complexity, and documentation. Security regarding all the aforementioned subjects is satisfactory, but can be improved, see Franchiser.subDelegateMany() Modifier Called in a Loop and Inaccurate NatSpec.

In summary, we find that the codebase provides a high level of security. No issues were identified that would pose a significant risk to the system.

It is important to note that security audits are time-boxed and cannot uncover all vulnerabilities. They complement but don't replace other vital measures to secure a project.

The following sections will give an overview of the system, our methodology, the issues uncovered and how they have been addressed. We are happy to receive questions and feedback to improve our service.

Sincerely yours,

ChainSecurity

1.1 Overview of the Findings

Below we provide a brief numerical overview of the findings and how they have been addressed.

Critical-Severity Findings	0
High-Severity Findings	0
Medium-Severity Findings	0
Low-Severity Findings	0

2 Assessment Overview

In this section, we briefly describe the overall structure and scope of the engagement, including the code commit which is referenced throughout this report.

2.1 Scope

The assessment was performed on the source code files inside the `src` folder of Franchiser repository:

```
Franchiser.sol
FranchiserFactory.sol
FranchiserLens.sol
base:
    FranchiserImmutableState.sol
interfaces:
    Franchiser:
        IFranchiser.sol
        IFranchiserErrors.sol
        IFranchiserEvents.sol
    FranchiserFactory:
        IFranchiserFactory.sol
        IFranchiserFactoryErrors.sol
    IFranchiserImmutableState.sol
    IFranchiserLens.sol
    IVotingToken.sol
```

The table below indicates the code versions relevant to this report and when they were received.

V	Date	Commit Hash	Note
1	07 Spetember 2024	a9cd24d12ec2c390807a148d9b07ee6e2728aa05	Initial Version

For the solidity smart contracts, the compiler version `0.8.15` was chosen.

2.1.1 *Excluded from scope*

Imported dependencies are not in the scope of this assessment.

2.2 System Overview

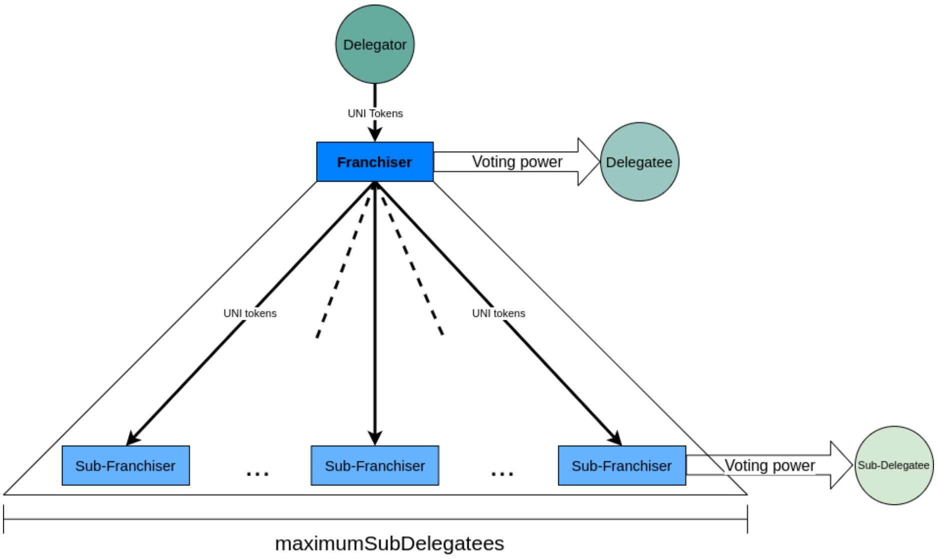
This system overview describes the initially received version (Version 1) of the contracts as defined in the Assessment Overview.

Furthermore, in the findings section, we have added a version icon to each of the findings to increase the readability of the report.

2.2.1 High-level Overview

Uniswap Foundation offers a Franchiser system that allows a token holder to give the voting power of their tokens to a delegatee. The delegatee can further delegate the voting power to a sub-delegatee. The sub-delegatee can then further delegate the voting power. Note that the initial token holder can retrieve their tokens at any time.

The contract is intended to be used with the UNI token on Ethereum mainnet.



Franchiser contract visualization

A single Franchiser contract can be visualized as shown in the figure above.

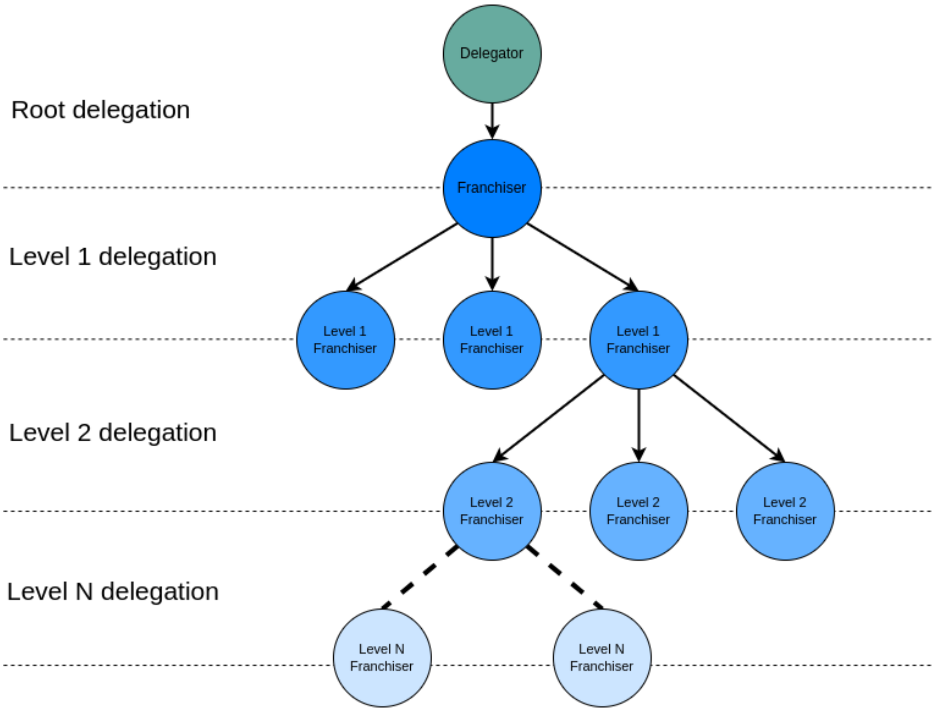
The `Delegator` is the token owner who supplies UNI tokens to the `Franchiser` contract.

The `Delegatee` is the address that receives the voting power from the tokens held by the `Franchiser` contract. The `Delegatee` can choose to further sub-delegate this voting power to multiple `Sub-Delegatees`. For each sub-delegation, the delegatee's `Franchiser` contract deploys a new `Franchiser` contract (Sub-Franchiser) and transfers the corresponding UNI tokens.

The per-address aggregation of delegated voting tokens happens directly in the UNI token contract. Voting mechanics are also handled by the UNI token contract, independently of the Franchiser system.

At any time, the `Delegator` can retrieve their tokens from the `Franchiser` contract and all its sub-delegations. In this context, the `Franchiser` contract acts as the `Delegator` for its `Sub-Franchiser` contracts.

By layering multiple `Franchiser` contracts, a tree-like delegation structure can be created.



Delegations

2.2.2 Nested Delegation Structure

To ensure that the token `recall` operation performed by the token owner does not exceed the gas limit, each `Franchiser` contract has a limited number of sub-delegatees, defined by `maximumSubDelegatees`.

The root `Franchiser` contract has a maximum of 8 sub-delegatees. Each subsequent level of sub-delegatees can have at most half the maximum number of sub-delegatees of the previous level. This is controlled by the `INITIAL_MAXIMUM_SUBDELEGATEES` and `DECAY_FACTOR` constants, which by default are set to 8 and 2, respectively. With these default parameters, the maximum depth of delegation is 5 levels (including the root level).

For a single initial delegation, the number of `Franchiser` contracts for each level in the delegation tree can be:

- 1 `Franchiser` contract for the initial token owner
- 8 `Franchiser` contracts for the first level of delegation
- 8 * 4 = 32 `Franchiser` contracts for the second level of delegation
- 8 * 4 * 2 = 64 `Franchiser` contracts for the third level of delegation
- 8 * 4 * 2 * 1 = 64 `Franchiser` contracts for the fourth level of delegation

This results in a maximum of 169 `Franchiser` contracts for one initial delegation.

2.2.3 Smart Contracts Overview

The system consists of the following contracts:

1. `FranchiserFactory`
2. `Franchiser`
3. `FranchiserLens`

2.2.3.1 FranchiserFactory

The FranchiserFactory contract has a constant variable, franchiserImplementation, which stores the address of the Franchiser contract reference implementation. Whenever a user calls FranchiserFactory.fund(), the FranchiserFactory deploys a minimal proxy (ERC-1167; OZ: cloneDeterministic) of the Franchiser contract implementation, unless a contract has already been deployed for that specific user (delegator) and delegatee pair. The fund() function then transfers UNI tokens to the newly created Franchiser contract. The INITIAL_MAXIMUM_SUBDELEGATEES constant is used to set the maximum number of sub-delegatees for the root-level Franchiser.

The root-level delegator can call the recall() function of the FranchiserFactory contract to retrieve the tokens held by the first-level Franchiser contract and all of its sub-delegations.

Both the fund() and recall() functions have multi-action versions, that allow multiple actions to be performed in a single transaction: fundMany() and recallMany().

Since the FranchiserFactory needs to transfer UNI tokens from the user to the newly created Franchiser contract, the user must approve the transfer of UNI tokens to the FranchiserFactory contract.

The user can call the Uni.approve() function to approve the transfer of UNI tokens to the FranchiserFactory contract. Alternatively, to bundle approval and funding in a single transaction, the user can produce a signature for the Uni.permit() function and utilize the following functions of the FranchiserFactory contract:

- permit()
- permitAndFund()
- permitAndFundMany()

2.2.3.2 Franchiser

The main functionality of the Franchiser contract is provided by the following functions:

- subDelegate() and subDelegateMany() - Delegates voting power to one or more sub-delegatees. When these functions are called, an ERC-1167 minimal proxy of the Franchiser contract is deployed (if it does not already exist) and the specified amount of UNI tokens is transferred to it. Each sub-delegatee's Franchiser contract is owned by the parent Franchiser contract and is initialized with maximumSubDelegatees set to the parent's maximumSubDelegatees divided by the DECAY_FACTOR. The addresses of the Franchiser's active sub-delegatees are stored in the _subDelegatees set.
- unSubDelegate() and unSubDelegateMany() - Removes one or more sub-delegatees from the _subDelegatees set and recalls the UNI tokens back to the parent Franchiser contract.
- recall() - Recalls the UNI tokens from the Franchiser contracts of the _subDelegatees set and transfers all of the tokens back to the delegator.

2.2.3.3 FranchiserLens

The FranchiserLens contract is a read-only utility contract that provides a way to retrieve data from the Franchiser contract. It is intended to be used by frontend applications and websites.

It has the following functions:

- getRootDelegation() - Retrieves information about the root delegation.
- getVerticalDelegations(Franchiser) - Traverses the delegation graph up to the root delegation and returns a list of all delegations along the path.
- getHorizontalDelegations(Franchiser) - Returns a list of all sub-delegations of the given Franchiser contract.

- getVotes() - Returns the amount of votes for a given Franchiser, along with delegation information.
- getAllDelegations() - Returns the entire delegation tree as a list of lists.

2.2.4 Roles and Trust Model

The system does not have explicit role-based access control. No addresses can change the system parameters in a way that would affect the behavior of all Franchiser contracts.

Each Franchiser contract has an owner. Only the owner can call the recall() function to retrieve the tokens from the contract and its sub-delegations. For the root level Franchiser, the owner is the FranchiserFactory contract. For sub-delegatee Franchiser contracts, the owner is the parent Franchiser contract.

3 Limitations and use of report

Security assessments cannot uncover all existing vulnerabilities; even an assessment in which no vulnerabilities are found is not a guarantee of a secure system. However, code assessments enable the discovery of vulnerabilities that were overlooked during development and areas where additional security measures are necessary. In most cases, applications are either fully protected against a certain type of attack, or they are completely unprotected against it. Some of the issues may affect the entire application, while some lack protection only in certain areas. This is why we carry out a source code assessment aimed at determining all locations that need to be fixed. Within the customer-determined time frame, ChainSecurity has performed an assessment in order to discover as many vulnerabilities as possible.

The focus of our assessment was limited to the code parts defined in the engagement letter. We assessed whether the project follows the provided specifications. These assessments are based on the provided threat model and trust assumptions. We draw attention to the fact that due to inherent limitations in any software development process and software product, an inherent risk exists that even major failures or malfunctions can remain undetected. Further uncertainties exist in any software product or application used during the development, which itself cannot be free from any error or failures. These preconditions can have an impact on the system's code and/or functions and/or operation. We did not assess the underlying third-party infrastructure which adds further inherent risks as we rely on the correct execution of the included third-party technology stack itself. Report readers should also take into account that over the life cycle of any software, changes to the product itself or to the environment in which it is operated can have an impact leading to operational behaviors other than those initially determined in the business specification.

4 Terminology

For the purpose of this assessment, we adopt the following terminology. To classify the severity of our findings, we determine the likelihood and impact (according to the CVSS risk rating methodology).

- *Likelihood* represents the likelihood of a finding to be triggered or exploited in practice
- *Impact* specifies the technical and business-related consequences of a finding
- *Severity* is derived based on the likelihood and the impact

We categorize the findings into four distinct categories, depending on their severity. These severities are derived from the likelihood and the impact using the following table, following a standard risk assessment procedure.

Likelihood	Impact		
	High	Medium	Low
High	Critical	High	Medium
Medium	High	Medium	Low
Low	Medium	Low	Low

As seen in the table above, findings that have both a high likelihood and a high impact are classified as critical. Intuitively, such findings are likely to be triggered and cause significant disruption. Overall, the severity correlates with the associated risk. However, every finding's risk should always be closely checked, regardless of severity.

5 Findings

In this section, we describe our findings. The findings are split into these different categories:

Below we provide a numerical overview of the identified findings, split up by their severity.

Critical-Severity Findings	0
High-Severity Findings	0
Medium-Severity Findings	0
Low-Severity Findings	0

6 Informational

We utilize this section to point out informational findings that are less severe than issues. These informational issues allow us to point out more theoretical findings. Their explanation hopefully improves the overall understanding of the project's security. Furthermore, we point out findings which are unrelated to security.

6.1 Dangling Franchisers With Tokens

Informational Version 1

CS-UNIFND-FRNC-001

Assume the following delegation chain:

Alice -> Bob -> Charlie.

Alice decides to send 100 tokens to Charlie, effectively giving more voting power to Charlie, while still keeping control over the tokens. Bob can front-run this transaction and `unSubDelegate()` Charlie. When Alice's transaction is processed, Charlie's Franchiser will get 100 tokens, but Alice will not be able to recall them anymore unless Bob calls `subDelegate()` on Charlie again.

Sending tokens to a Franchiser's address is unorthodox and should be avoided.

6.2 Inaccurate NatSpec

Informational Version 1

CS-UNIFND-FRNC-002

Some of the NatSpec comments in the code can be improved:

1. The `@notice` of the function `IFranchiserFactory.permitAndFundMany` describes that the function calls `permitAndFund` many times. However, the implementation makes no calls to `permitAndFund`. Instead, it calls `permit` once on the sum of amounts and then calls `fund` many times.
2. The `@dev` of the function `IFranchiser.subDelegate` is inaccurate. If the Franchiser associated with the `subDelegatee` is already active the `amount` of `votingTokens` will also be delegated to `subDelegatee`.

6.3 `Franchiser.subDelegateMany()` Modifier Called in a Loop

Informational Version 1

CS-UNIFND-FRNC-003

The `subDelegateMany()` function calls the `subDelegate()` function multiple times. The `subDelegate()` function has the `onlyDelegatee` modifier which checks if the caller is the delegatee. Calling the `onlyDelegatee` modifier multiple times in a loop is a redundant check.

7 Notes

We leverage this section to highlight further findings that are not necessarily issues. The mentioned topics serve to clarify or support the report, but do not require an immediate modification inside the project. Instead, they should raise awareness in order to improve the overall understanding.

7.1 Later Solidity Compiler Version Can Be Used to Avoid Unchecked Blocks

Note Version 1

In version 0.8.22, the Solidity compiler does not use safe math checks for loop increments by default. If the project were to be updated to use this version, the unchecked block would no longer be necessary. Currently 0.8.15 is used.

More info: https://soliditylang.org/blog/2023/10/25/solidity-0.8.22-release-announcement/

7.2 Theoretical Hash Collision Attack

Note Version 1

Sub-delegatees have the ability to deploy new Franchiser contracts via sub-delegation. The address of the new Franchiser can be arbitrarily chosen by the sub-delegatee.

Assume the following scenario:

Alice is the Delegator, that delegates tokens to Bob. Bob deploys a Factory contract, that can create an arbitrary number of contracts that are able to sweep UNI tokens. Let's call these "Sweeper" contracts. Bob can as well pre-compute the set of sub-Franchiser addresses that will be used to deploy Franchiser contracts (within Alice's delegation tree). Let's call this the "Franchiser" set of contracts.

If both sets of addresses are large enough, there is a chance that some of the sub-Franchiser address will collide with the Sweeper addresses.

In this case, Bob can:

1. Deploy a Sweeper contract
2. `subDelegate()` to the Sweeper contract, so Alice's delegated tokens are transferred to the Sweeper contract. Due to address collision, the Franchiser contract creation will be skipped.
3. Sweep the tokens from the Sweeper contract.

This is a highly theoretical attack, as it requires a lot of resources to pre-compute the addresses. A 50% chance of address collision is reached after 2^81 addresses (2^80 in each set). With the current cost of hardware, such an attack is in the order of 400 billion USD.

However, in ~50 years, this attack might become feasible.