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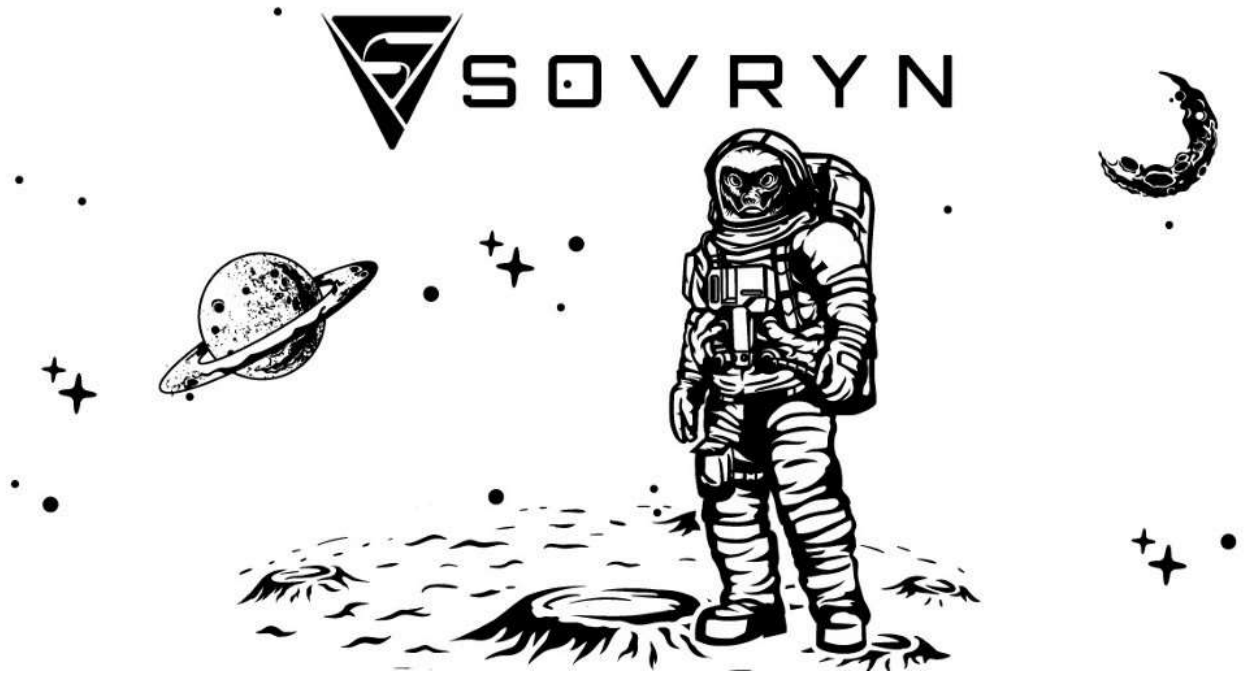

Sovryn Smart Contract Audit

Coinspect Security Feb 12 · 12 min read

Executive Summary

In October 2020, Sovryn engaged Coinspect to perform a source code review of their new decentralized Bitcoin trading and lending platform. The objective of the audit was to evaluate the security of their smart contracts.

The code reviewed was found to be clear, well written, and properly documented. The modifications performed to the forked projects did not introduce any vulnerabilities. However, Coinspect observed the oracle integration implementation weakens the system security and could be abused by attackers to manipulate the price feeds.

platform. The oracles are trusted by Sovryn and are a single point of failure for the whole system.

The following issues were identified during the assessment:

High Risk	Medium Risk	Low Risk	Informational
1	0	4	3

During December 2020 Coinspect verified the fixes developed by the Sovryn team were correct. Detailed information regarding these fixes and the current status for each finding can be found in the Remmediations section.

Introduction

Sovryn's goal is to enable lending, borrowing and margin trading in the RSK blockchain.

The project architecture is composed of the following components:

1. **Core protocol:** The Core protocol is a bZx — A Protocol For Tokenized Margin Trading and Lending protocol fork. The most important change introduced by Sovryn is the switch to using their **oracle-based AMM** instead of Kyber. Also, some protocol parameters were modified, such as: rollover rewards and minimum utilization rate on interest calculation. This component can be found in https://github.com/DistributedCollective/Sovryn-smart-contracts.

2. **Oracle-based Automated Market Maker:** This component is a Bancor Network liquidity protocol fork. The most important modification introduced by Sovryn is the switch from Chainlink oracles to the Money on Chain ones. This component is located in https://github.com/DistributedCollective/oracle-based-amm

3. **Watcher:** this off-chain component is responsible for the liquidation and rollover of open positions. It reads all open positions from the Sovryn smart contracts and continuously monitors for changes, then triggers transaction submissions when appropriate. This component can be found in https://github.com/DistributedCollective/Sovryn-Watcher/tree/audit-coinspect

The whole engagement was structured in phases:

3. **Phase 3**: review of the lending, borrowing and trading flows.

This report documents phases 1 and 3 of the audit.

The audit started on October 27th and was conducted on the following Git repositories:

1. https://github.com/DistributedCollective/Sovryn-smart-contracts as of commit 86008054558bd7ce02e6b3b0547c681b62ecd4fc of **October 26th.**
2. https://github.com/DistributedCollective/oracle-based-amm as of commit 8b6504406b89ad24bf4e0f5ff97037bf798b59c8 of **October 9th.**

The scope of the audit's **Phase 1** was limited to the following pull requests as requested by Sovryn:

- https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/12
- https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/13
- https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/24
- https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/28
- https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/30
- https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/31
- https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/34
- https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/35
- https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/42
- https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/44
- https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/52
- https://github.com/DistributedCollective/oracle-based-amm/pull/1
- https://github.com/DistributedCollective/oracle-based-amm/pull/4
- https://github.com/DistributedCollective/oracle-based-amm/pull/8

Neither the upstream projects' security nor the Money on Chain oracle infrastructure were evaluated during this audit.

Assessment

Phase 1: Review of all changes introduced to upstream projects bZx and Bancor

The following list including all modifications introduced by Sovryn to the forked repositories was provided by the team and were reviewed during this phase of the engagement:

Sovryn Protocol:

1. Replaced the Kyber connector with a connector to Sovryn Swap

2. Use MoC as oracle for the price feed instead of Chainlink / Kyber

3. Disabled flash loans

4. LoanId creation refactoring

5. Removal of hard coded addresses

6. Changed the rollover reward

7. Lowered the minimum utilization rate on interest calculation

8. Introduced a multisig owner

Sovryn Swap:

9. Split up the factory function which deploys the liquidity pool v2 converter

10. Use MoC as oracle instead of Chainlink

Additionally, the new wrapped RBTC and the RBTCWrapperProxy contracts were added during the audit and were reviewed as per the client's request.

The following sections explore each of these code modifications, and provide a brief description and audit notes for each of them.

1. Replaced the Kyber connector with a connector to Sovryn Swap

Sovryn created a new connector contract, which connects to Sovryn's oracle-based AMM and replaces the existing Kyber swap connector.

The new SwapsImplSovrynSwap contract implements the ISwapsImpl interface and is responsible for token swapping, these are its most relevant characteristics:

1. Uses OpenZeppelin's SafeERC20 for token transfers.
2. The source token estimation was improved to account for rounding in the AMM.
3. Source code documentation was improved.
4. It keeps a reference to the Sovryn Swap Network contract, only the connector contract owner is allowed to modify it.
5. Relies on the Sovryn Swap Network to perform token conversions and calculate exchange rates.
6. Bubbling of errors from Sovryn Swap network is allowed (this differs from the Kyber connector implementation which does not allow it)
7. If the returnToSenderAddress parameter is not the protocol itself, any source token remaining after the swap are sent back to this address

Because the oracle-based AMM does not have the option to pass a maximum amount of destination tokens, the rollover function in LoanClosings was adapted. After the interest was swapped, the excess gets swapped back in the new function _swapBackExcess. Sovryn optimized the LoanClosings contract to swap back excess (from the rollover and the borrower scenarios) only if the amount is big enough to justify the swap transaction, usually the excess is a fraction of a cent and not worth the extra gas cost. The hard coded 0.00001 RBTC is used as the threshold value for borrower excess. The new function worthTheTransfer is responsible for obtaining the exchange rate from the priceFeeds contract and comparing the resulting value with the threshold. In the _coverPrincipalWithSwap scenario, when the excess is under the threshold limit, it is always sent back to the lender. But in the _rollover scenario, excess under threshold is kept as a protocol lending fee.

Coinspect reviewed the following pull requests:

- https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/30

2. Use MoC as oracle for the price feed instead of Chainlink / Kyber

The following modifications were introduced:

1. Added a price feed contract PriceFeedsMoC which connects to the MoC oracle: https://github.com/money-on-chain/Amphiraos-Oracle/blob/master/contracts/medianizer/medianizer.sol, replacing Kyber and Chainlink as price feed sources.
2. The value retrieved from the price feed contract latestAnswer function is uint256 instead of int256.
3. Added a base token parameter to the price feed constructor.
4. Removed gas price retrieval function getFastGasPrice.

Coinspect observed that in the current implementation, the feed contract lacks the ability to know when was the last time the oracle was updated because the MoC oracle does not provide that information back to the consumer contract. This issue is fully described in Price feed oracle fake timestamp.

Coinspect verified only the PriceFeedMoC contract owner can set the MoC oracle contract address.

Coinspect reviewed the following pull requests:

1. https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/28
2. https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/42

3. Disabled flash loans

Sovryn commented out the function flashBorrow in order to disable the flash loan functionality for the MVP release. Also, the reentrancyGuard modifier was re-enabled for the marginTrade and borrow functions. This modifier will have to be removed again once the flash loans are enabled.

It is worth noting that even if flash loans are disabled in the Sovryn platform, they could still be offered by another platform enabling attackers to utilize them in order to exploit Sovryn.

- https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/13

4. loanId creation refactoring

Sovryn modified the way the loanId is calculated when a new loan is opened. A per user nonce is used instead of the block timestamp, in addition to the lender, borrower and loanParamsLocal.id.

Coinspect reviewed this change and concluded that making the loanId deterministic does not represent a risk to the platform's security.

This change is introduced in the following pull request:

- https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/24

5. Removal of hardcoded addresses

Sovryn moved WETH and the protocol token addresses from Constants.sol to State.sol; setters were added to the price feed contracts. The LoanToken constructor is now passed the sovrynContractAddress and wbtcTokenAddress parameters which were previously hard coded.

Coinspect verified that only the contract owner is able to access the new configuration setters.

This change is implemented in the following pull request:

- https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/12

6. Changed the rollover reward

The GasTokenUser contract was removed together with all the existing gas rebate logic. The loan rollover reward which was before based on the transaction gas cost is now replaced with the following calculation instead:

```
uint256 public rolloverBaseReward = 16800000000000;

// Rollover transaction costs around 0.0000168 rBTC, it is denominated in wRBTC

uint256 public rolloverFlexFeePercent = 0.1 ether; // 0.1%
```

```
.add(positionSizeInCollateralToken.mul(rolloverFlexFeePercent).div(10**20));

// flexFee = 0.1% of position size
```

Note the new RewardHelper contract relies on the priceFeeds oracle contract in order to calculate the reward in the corresponding collateral token.

This change is introduced by the following pull request:

- https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/31

7. Lowered the minimum utilization rate on interest calculation

Previously, a minimum utilization rate of 80% was hardcoded and could not be adjusted as needed, now it can be parametrized together with targetLevel, kinkLevel and the maxScaleRate parameters using the new function setDemandCurve. The interest calculation logic in function _nextBorrowInterestRate2 was updated to use the parameterized values instead of hardcoded ones. This change was merged from the bZx repository.

This change is introduced by the following pull requests:

- https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/34
- https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/44

8. Introduced a multisig owner

In order to replace the single address that owned all the Sovryn protocol contracts, a 2of3 multisig wallet was introduced. This multisig is intended to be used while the governance model is being developed. The deployment script was modified to transfer ownership of the Sovryn protocol contract to the multisig.

This change was introduced by the following pull request:

- https://github.com/DistributedCollective/Sovryn-smart-contracts/pull/35

9. Split up the factory function which deploys the liquidity pool v2 converter

The function newConverter in the ConverterRegistry contract needed to be split in order to be able to deploy it on RSK because of the network's gas limit of 6.8M. A new

PR8 correctly fixed an issue found by a previous security audit performed by a different team by checking the user finishing the contract deployment is the same that initiated it.

This change was introduced by the following pull requests:

- https://github.com/DistributedCollective/oracle-based-amm/pull/1
- https://github.com/DistributedCollective/oracle-based-amm/pull/8

10. Use MoC as oracle instead of Chainlink

Sovryn modified the AMM to utilize the Money on Chain oracle infrastructure running in the RSK network instead of Chainlink as the source for off-chain price feeds.

Even though the change is straightforward implementation-wise, Coinspect observed the latestTimestamp function does not return a value obtained from the oracle as expected, but the block timestamp. This behavior prevents the oracle consumer from using this information in order to make a decision regarding the validity of the off-chain data and is fully documented in Price feed oracle fake timestamp.

Additionally, Coinspect verified only the contract owner can set the MoC oracle contract address.

This change was introduced by the following pull request:

- https://github.com/DistributedCollective/oracle-based-amm/pull/4

11. Wrapped RBTC and RBTCWrapperProxy

Sovryn added the new RBTCWrapperProxy and WRBTC contracts. The wrapped RBTC contract gives depositors one WRBTC token per each RBTC sent to it. In the same way, it allows withdrawing one RBTC for each WRBTC token burned.

The RBTCWrapperProxy enables users to:

1. Add liquidity to the pools reserves in exchange for pool tokens
2. Remove liquidity
3. Convert their tokens

The convertByPath function can:

1. Receive RBTC as value, which gets wrapped and swapped
2. Convert any token to WRBTC

This change was introduced by the following pull request:

- https://github.com/DistributedCollective/oracle-based-amm/pull/10

Phase 3: General review of the lending, trading and borrowing processes

During this phase of the engagement, Coinspect reviewed how all Sovryn components integrate, reviewed the deployment procedures, and tested user-Sovryn interactions.

This process focused on the following contracts and entry points as requested by the Sovryn team:

1. LoanTokenLogicStandard.sol
2. marginTrade
3. borrow
4. mint
5. burn
6. LoanTokenLogicWrbtc.sol:
7. mintWithBTC
8. burnToBTC
9. LoanClosing.sol
10. closeWithSwap
11. closeWithDeposit
12. liquidate
13. rollover

1. Upgrading all Sovryn protocol smart contracts.
2. Withdrawing all funds.
3. Pausing/unpausing the protocol.
4. Changing all protocol parameters (interest curve, AMM connector, oracles, etc).

Coinspect recommends splitting administrative roles in order to minimize damage in case one role is compromised.

The tests included in the https://github.com/DistributedCollective/Sovryn-smart-contracts repository were reviewed. These tests have been developed using the brownie framework, and are currently being migrated to the truffle framework. Besides some sporadic errors related to the brownie framework, all tests included pass. The tests are intended to verify the basic functionality of the protocol is correct, and no complex scenarios are included. For example: all tests consist of one lender and one borrower.

Coinspect auditors were unable to obtain a valid coverage report, when coverage is enabled most tests fail. The Sovryn team is aware of this fact and this is one of the reasons why the brownie framework is being abandoned. It is important that the ability to evaluate the tests coverage is recovered in order to obtain a clear view of what execution paths are being exercised and which tests need to be improved or created.

Coinspect auditors found not all the platform's entry points enforce the same security limits for maximum transaction amount and slippage. This is detailed in Transaction size and slippage limits not enforced for external swaps.

Regarding slippage, there is a hardcoded slippage limit of 5%, enforced by the function checkPriceDisagreement in the PriceFeeds contract, for all borrowing, lending and margin trading originated swaps performed in the Sovryn exchange:

```
uint256 public maxDisagreement = 5 * 10**18;

// % disagreement between swap rate and reference rate
```

This means all operations in the Sovryn exchange are subject to losing up to 5% from the internal swap performed.

and this maximum liquidity pool size is enforced by the addLiquidity function. This limit is not hardcoded though, and depends on the deployment and configuration actions performed by the contract owner for each pool. *By default, new pools are created with unlimited staked balance.*

Conclusions and Recommendations

In respect to the smart contracts reviewed, the changes introduced to the forked projects did not introduce any security vulnerabilities and were well documented. The oracle integration did weaken the platform overall security by voiding the last update timestamp checks that were in place.

The following list sums up the most important recommendations from this audit:

1. Continue Improving the oracle integration as this could be seen as the weakest link in the platform.
2. Add tests for oracle's worst case scenarios.
3. Improve end to end testing to include complex scenarios (e.g., chain reorganizations, network congestion, multiple lenders and borrowers, trade operations with sizes around maximum limits, slippage).
4. Fix testing coverage reporting.
5. Create administrative roles with different sets of privileges.
6. Clearly document the upgradable nature of the protocol and the operations accessible by the contract's owners.
7. Constantly monitor vulnerabilities reported in the upstream projects and backport the changes as needed.

Summary of Findings

During December 2020 Coinspect verified the findings that Sovryn decided to address had been correctly fixed.

The following table lists the findings that were fixed and the corresponding pull requests:

SVN-001 has been mitigated by adding a new price source, an oracle contract provided by the RSK team, for the WRBTC price. This oracle in the Sovryn Protocol will be used to check price divergence between this new feed and the exchange rate obtained from the AMM component. This change will not affect transactions performed directly in the AMM. Additionally, code in the AMM repository was modified to use the latest publication block number (that will be provided by the MoC oracle in the future) to calculate the latest oracle update timestamp. This fix is not currently deployed and has only been tested using a mock contract. Coinspect has not reviewed the recently introduced RSK oracle infrastructure.

Regarding SVN-011, the vulnerable contract has not been deployed so Sovryn is currently not exposed to any risk related to this finding. The Sovryn team will implement a price divergente check in the contract before it is deployed. The limit check is considered unnecessary for this contract as funds are never stored in it.

The Sovryn team decided not to fix SVN-002 and is considering if SVN-003 and SVN-004 will be fixed; these are all low risk findings.

Click here for the full report.