Tempest Bridge Oracle

SECURITY ASSESSMENT REPORT

11 February, 2025

Prepared for

Contents

1 About CODESPECT **2**

2 Disclaimer **2**

3 Risk Classification **3**

4 Executive Summary **4**

5 Audit Summary **5**
5.1 Scope - Audited Files . . . 5
5.2 Findings Overview . . . 5

6 System Overview **6**

7 Issues **7**
7.1 [Low] `GUARDIAN_ROLE` is not transferrable . . . 7
7.2 [Info] Initially `isSequencerDown` is false which may incorrectly allow price feed calls . . . 7

8 Evaluation of Provided Documentation **8**

9 Test Suite Evaluation **9**
9.1 Compilation Output . . . 9
9.2 Tests Output . . . 9
9.3 Notes about Test suite . . . 10

1 About CODESPECT

CODESPECT is a specialized smart contract security firm dedicated to ensure the safety, reliability, and success of blockchain projects. Our services include comprehensive smart contract audits, secure design and architecture consultancy, and smart contract development across leading blockchain platforms such as Ethereum (Solidity), Starknet (Cairo), and Solana (Rust).

At CODESPECT, we are committed to build secure, resilient blockchain infrastructures. We provide strategic guidance and technical expertise, working closely with our partners from concept development through deployment. Our team consists of blockchain security experts and seasoned engineers who apply the latest auditing and security methodologies to help prevent exploits and vulnerabilities in your smart contracts.

Smart Contract Auditing: Security is at the core of everything we do at CODESPECT. Our auditors conduct thorough security assessments of smart contracts written in Solidity, Cairo, and Rust, ensuring that they function as intended without vulnerabilities. We specialize in providing tailored security solutions for projects on EVM-compatible chains and Starknet. Our audit process is highly collaborative, keeping clients involved every step of the way to ensure transparency and security. Our team is also dedicated to cutting-edge research, ensuring that we stay ahead of emerging threats.

Secure Design & Architecture Consultancy: At CODESPECT, we believe that secure development begins at the design phase. Our consultancy services offer deep insights into secure smart contract architecture and blockchain system design, helping you build robust, secure, and scalable decentralized applications. Whether you're working with Ethereum, Starknet, or other blockchain platforms, our team helps you navigate the complexity of blockchain development with confidence.

Tailored Cybersecurity Solutions: CODESPECT offers specialized cybersecurity solutions designed to minimize risks associated with traditional attack vectors, such as phishing, social engineering, and Web2 vulnerabilities. Our solutions are crafted to address the unique security needs of blockchain-based applications, reducing exposure to attacks and ensuring that all aspects of the system are fortified.

With a focus on the intersection of security and innovation, CODESPECT strives to be a trusted partner for blockchain projects at every stage of development and for each aspect of security.

2 Disclaimer

Limitations of this Audit: This report is based solely on the materials and documentation provided to CODESPECT for the specific purpose of conducting the security review outlined in the Summary of Audit and Files. The findings presented in this report may not be comprehensive and may not identify all possible vulnerabilities. CODESPECT provides this review and report on an "as-is" and "as-available" basis. You acknowledge that your use of this report, including any associated services, products, protocols, platforms, content, and materials, is entirely at your own risk.

Inherent Risks of Blockchain Technology: Blockchain technology is still evolving and is inherently subject to unknown risks and vulnerabilities. This review focuses exclusively on the smart contract code provided and does not cover the compiler layer, underlying programming language elements beyond the reviewed code, or any other potential security risks that may exist outside of the code itself.

Purpose and Reliance of this Report: This report should not be viewed as an endorsement of any specific project or team, nor does it guarantee the absolute security of the audited smart contracts. Third parties should not rely on this report for any purpose, including making decisions related to investments or purchases.

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Further Recommendations: We advise clients to schedule a re-audit after any significant changes to the codebase to ensure ongoing security and reduce the risk of newly introduced vulnerabilities. Additionally, we recommend implementing a bug bounty program to incentivize external developers and security researchers to identify and disclose potential vulnerabilities safely and responsibly.

Disclaimer of Advice: FOR AVOIDANCE OF DOUBT, THIS REPORT, ITS CONTENT, AND ANY ASSOCIATED SERVICES OR MATERIALS SHOULD NOT BE CONSIDERED OR RELIED UPON AS FINANCIAL, INVESTMENT, TAX, LEGAL, REGULATORY, OR OTHER PROFESSIONAL ADVICE.

3 Risk Classification

Severity Level	Impact: High	Impact: Medium	Impact: Low
Likelihood: High	Critical	High	Medium
Likelihood: Medium	High	Medium	Low
Likelihood: Low	Medium	Low	Low

Table 1: Risk Classification Matrix based on Likelihood and Impact

3.1 Impact

- **High** - Results in a substantial loss of assets (more than 10%) within the protocol or causes significant disruption to the majority of users.
- **Medium** - Losses affect less than 10% globally or impact only a portion of users, but are still considered unacceptable.
- **Low** - Losses may be inconvenient but are manageable, typically involving issues like griefing attacks that can be easily resolved or minor inefficiencies such as gas costs.

3.2 Likelihood

- **High** - Very likely to occur, either easy to exploit or difficult but highly incentivized.
- **Medium** - Likely only under certain conditions or moderately incentivized.
- **Low** - Unlikely unless specific conditions are met, or there is little-to-no incentive for exploitation.

3.3 Action Required for Severity Levels

- **Critical** - Must be addressed immediately if already deployed.
- **High** - Must be resolved before deployment (or urgently if already deployed).
- **Medium** - It is recommended to fix.
- **Low** - Can be fixed if desired but is not crucial.

In addition to High, Medium, and Low severity levels, CODESPECT utilizes two other categories for findings: **Informational** and **Best Practices**.

a) **Informational** findings do not pose a direct security risk but provide useful information the audit team wants to communicate formally.

b) **Best Practices** findings indicate that certain portions of the code deviate from established smart contract development standards.

4 Executive Summary

This document presents the security assessment conducted by CODESPECT for the smart contracts of Tempest. Tempest is the Large Liquidity Model for Ambient Finance, enabling users to manage liquidity in a non-custodial and automated manner.

This audit focuses on the small changes implemented in `BridgeOracle` contract. It introduces an arbitrary control mechanism for sequencer downtime in chains that lack a Chainlink sequencer uptime oracle.

The audit was performed using:

a) Manual analysis of the codebase.

b) Dynamic analysis of smart contracts, execution testing.

c) Creation of test cases.

CODESPECT found 2 points of attention, one classified as `Low` and one classified as `Info`. All of the issues are summarised in Table 2.

Organization of the document is as follows:

- **Section 5** summarizes the audit.
- **Section 6** describes the system overview.
- **Section 7** presents the issues.
- **Section 8** discusses the documentation provided by the client for this audit.
- **Section 9** presents the compilation and tests.

Issues found:

Severity	Unresolved	Fixed	Acknowledged
Low	0	1	0
Informational	0	1	0
Total	**0**	**2**	**0**

Table 2: Summary of Unresolved, Fixed, and Acknowledged Issues

5 Audit Summary

Audit Type	Security Review
Project Name	Tempest
Type of Project	Oracle
Duration of Engagement	1 Day
Duration of Fix Review Phase	1 Day
Draft Report	Feb 11, 2025
Final Report	Feb 11, 2025
Repository 1	tempest_smart_contract
Commit (Audit)	f9da49e15ea8f8f66670cb269814c9dd9fde875c
Commit (Final)	7af4beaa4d5b011334333e21283eca60f46f9e52
Documentation Assessment	High
Test Suite Assessment	High
Auditors	Kalogerone, Talfao, 0xMrjory

Table 3: Summary of the Audit

5.1 Scope - Audited Files

	Contract	LoC
1	BridgeOracle.sol	113
	Total	**113**

5.2 Findings Overview

	Finding	Severity	Update
1	`GUARDIAN_ROLE` is not transferrable	Low	Fixed
2	Initially `isSequencerDown` is false which may incorrectly allow price feed calls	Info	Fixed

6 System Overview

Tempest upgraded the Bridge Oracle contract which introduces enhancements for handling sequencer downtime, particularly for chains that lack a Chainlink sequencer uptime oracle. The key improvements include:

a. **Sequencer Downtime Handling via Off-Chain Keeper**

- Introduced the `isSequencerDown` boolean to track the sequencer's status when no on-chain oracle is available.
- Added the `setIsSequencerDown(bool value)` function, allowing an off-chain keeper with `GUARDIAN_ROLE` to manually update the sequencer's status.
- Emitted the `IsSequencerDownSet(bool value)` event to provide visibility into status changes.

b. **Improved Sequencer Downtime Validation**

- Modified `_checkSequencerDowntime()` to handle cases where `sequencerUptimeOracle` is unavailable.
- If no oracle is set (`address(0)`), the function falls back to `isSequencerDown` for downtime validation.
- If an oracle exists, the function queries `latestRoundData()` and verifies `startedAt != 0` to prevent reliance on uninitialized oracle data.

These enhancements ensure that the contract is more flexible and robust, particularly in environments where a sequencer uptime oracle is not available.

7 Issues

7.1 [Low] GUARDIAN_ROLE is not transferrable

File(s): BridgeOracle.sol

Description: The new GUARDIAN_ROLE cannot be transferred to other addresses because an admin role for this role hasn't been set, unlike the GOVERNANCE_ROLE which other governors have been allowed to grantRole and revokeRole from other addresses. As shown below, _setRoleAdmin(...) for the GUARDIAN_ROLE is missing.

```
constructor(
  address _baseUsdOracle,
  address _quoteUsdOracle,
  address _sequencerUptimeOracle,
  uint64 _baseOracleTimeLimit,
  uint64 _quoteOracleTimeLimit,
  uint64 _sequencerDowntimeLimit,
  bool _isL2,
  string memory _name,
  address governor
) {
  // ...
  _setRoleAdmin(GOVERNANCE_ROLE, GOVERNANCE_ROLE);
  _grantRole(GOVERNANCE_ROLE, governor);
  _grantRole(GUARDIAN_ROLE, governor);
}
```

Impact: The GUARDIAN_ROLE which is granted to the address, which updates the isSequencerDown for L2 networks without a Chainlink Sequencer Uptime Feed, can't be transferred and is stuck to the initial governor forever.

Recommendation(s): Like the GOVERNANCE_ROLE, also set an admin role for the GUARDIAN_ROLE.

Status: Fixed

Update from the Tempest: Fixed in 7af4beaa4d5b011334333e21283eca60f46f9e52

7.2 [Info] Initially isSequencerDown is false which may incorrectly allow price feed calls

File(s): BridgeOracle.sol

Description: During contract construction, the isSequencerDown is not initialized, meaning it is initially set to false. Contract deployment may happen at a time that the sequencer is down at the L2 chain without a Chainlink Sequencer Uptime Feed. For a short time, until the off-chain keeper is set up to call setIsSequencerDown(...) with the correct value, all calls for the latestAnswer() and numeraireLatestAnswer() will incorrectly go through.

Impact: After contract deployment, the BridgeOracle contract will return prices for any latestAnswer() and numeraireLatestAnswer() calls even if the sequencer is actually down.

Recommendation(s): Set the isSequencerDown variable to equal to true in the constructor until the off-chain keeper is fully set up.

Status: Fixed

Update from the Tempest: Fixed in da18fc4f0f642926e53890833c268c83ce1a829d

8 Evaluation of Provided Documentation

The Tempest documentation was provided in four forms:

- **Official Documentation Website:** The Gitbook contains high-level use cases for each vault type, providing an overview of the protocol's purpose for both users and auditors.
- **Natspec Comments:** Most of the code included Natspec comments, which explained the purpose of complex functionality in detail and facilitated understanding of individual functions. However, some functionalities lacked comments, and expanding documentation coverage would enhance the overall comprehensibility of the code.
- **Inheritance and Interaction Diagrams:** Non-public inheritance and high-level interaction diagrams were provided. These effectively clarified the contracts' complex inheritance structures and interactions, aiding CODESPECT's analysis significantly.
- **Mathematical Equations:** The Tempest team provided the mathematical equations used within the protocol. These equations were instrumental in understanding the protocol's calculations and logic.

The documentation provided by Tempest offered valuable insights into the protocol, significantly aiding CODESPECT's understanding. However, the public technical documentation could be further improved to better present the protocol's overall functionality and facilitate the understanding of each component.

Additionally, the Tempest team was consistently available and responsive, promptly addressing all questions raised by CODESPECT during the evaluation process.

9 Test Suite Evaluation

9.1 Compilation Output

```
> forge compile
[] Compiling...
[] Compiling 123 files with Solc 0.8.23
[] Solc 0.8.23 finished in 46.07s
Compiler run successful!
```

9.2 Tests Output

```
> forge test
[] Compiling...
No files changed, compilation skipped

Ran 1 test for test/RswETHClaimTestToken.t.sol:RswClaimTestToken
[PASS] test_ClaimCmd() (gas: 77995)
Suite result: ok. 1 passed; 0 failed; 0 skipped; finished in 373.00ms (17.57ms CPU time)

Ran 1 test for test/WstETHClaimTestToken.t.sol:LSTClaimTestToken
[PASS] test_ClaimCmd() (gas: 77994)
Suite result: ok. 1 passed; 0 failed; 0 skipped; finished in 389.41ms (10.17ms CPU time)

Ran 2 tests for test/FeeCollection.t.sol:FeeCollectionTest
[PASS] testFuzz_FeeCollection() (gas: 2259345)
[PASS] testFuzz_SetFee() (gas: 2091634)
Suite result: ok. 2 passed; 0 failed; 0 skipped; finished in 636.13ms (271.33ms CPU time)

Ran 7 tests for test/DepositSymTestToken1.t.sol:DepositSymTestToken1
[PASS] testFuzz_Deposit1(uint256) (runs: 1003, : 724373, ~: 732984)
[PASS] testFuzz_DepositAndUpdateWidth(uint256) (runs: 1003, : 1121428, ~: 1148752)
[PASS] testFuzz_DepositSymAndRebalance1(uint256) (runs: 1003, : 1115605, ~: 1136055)
[PASS] testFuzz_FeeCollection() (gas: 1827893)
[PASS] testFuzz_SetFee() (gas: 1641005)
[PASS] testFuzz_deposit1MultipeUser(uint256,uint256) (runs: 1003, : 1236483, ~: 1236488)
[PASS] testFuzz_depositAndWithdraw(uint256) (runs: 1003, : 931534, ~: 944492)
Suite result: ok. 7 passed; 0 failed; 0 skipped; finished in 77.99s (127.72s CPU time)

Ran 5 tests for test/DepositTestToken1.t.sol:DepositTestToken1
[PASS] testFuzz_Deposit1(uint256) (runs: 1003, : 864295, ~: 905522)
[PASS] testFuzz_DepositAndRebalance1(uint256) (runs: 1003, : 1163246, ~: 1193866)
[PASS] testFuzz_deposit1MultipeUser(uint256,uint256) (runs: 1003, : 1407356, ~: 1407356)
[PASS] testFuzz_depositAndWithdraw(uint256) (runs: 1003, : 1205835, ~: 1304280)
[PASS] testSimple1() (gas: 835444)
Suite result: ok. 5 passed; 0 failed; 0 skipped; finished in 81.07s (135.79s CPU time)

Ran 4 tests for test/DepositTestToken0.t.sol:DepositTestToken0
[PASS] testFuzz_Deposit0(uint256) (runs: 1003, : 709259, ~: 775044)
[PASS] testFuzz_deposit0AndWithdraw(uint256) (runs: 1003, : 918227, ~: 1012681)
[PASS] testFuzz_depositMultipeUser(uint256,uint256) (runs: 1003, : 1240367, ~: 1291733)
[PASS] testSimple0() (gas: 685074)
Suite result: ok. 4 passed; 0 failed; 0 skipped; finished in 88.27s (87.73s CPU time)
```

```
Ran 13 tests for test/WstETHTestToken.t.sol:WstETHTestToken
[PASS] testFuzz_DepositAndRebalanceLST(uint256,uint256[3]) (runs: 1003, : 1421094, ~: 1421150)
[PASS] testFuzz_DepositLST(uint256) (runs: 1003, : 1058690, ~: 1058690)
[PASS] testFuzz_WithdrawAllFromLido(uint256) (runs: 1003, : 2654790, ~: 2654790)
[PASS] testFuzz_WithdrawFromLido(uint256) (runs: 1003, : 3717252, ~: 3717268)
[PASS] testFuzz_claimFromLido(uint256) (runs: 1003, : 3169226, ~: 3169237)
[PASS] testFuzz_depositLSTAndRedeem(uint256) (runs: 1003, : 1197288, ~: 1194419)
[PASS] testFuzz_depositLSTAndWithdraw(uint256) (runs: 1003, : 1398339, ~: 1398350)
[PASS] testFuzz_depositLSTInvestAndWithdraw(uint256) (runs: 1003, : 1050969, ~: 1050124)
[PASS] testFuzz_depositLSTMultipeUser(uint256,uint256) (runs: 1003, : 1302450, ~: 1302511)
[PASS] testFuzz_getWithdrawalDatas(uint256) (runs: 1003, : 2290412, ~: 2290424)
[PASS] test_depositWstWhenVaultHavingKnockedOutPositions() (gas: 2359159)
[PASS] test_totalAssetsWithIdle() (gas: 1407974)
[PASS] test_unstake() (gas: 1521331)
Suite result: ok. 13 passed; 0 failed; 0 skipped; finished in 109.37s (463.44s CPU time)

Ran 9 tests for test/DepositSymTestToken0.t.sol:DepositSymTestToken0
[PASS] testFuzz_DepositSym0(uint256) (runs: 1003, : 583672, ~: 592289)
[PASS] testFuzz_DepositSymAndUpdateWidth0(uint256) (runs: 1003, : 1176374, ~: 1176374)
[PASS] testFuzz_FeeCollection() (gas: 1892790)
[PASS] testFuzz_SetFee() (gas: 1706928)
[PASS] testFuzz_depositSym0AndWithdraw(uint256) (runs: 1003, : 784121, ~: 787739)
[PASS] testFuzz_depositSymMultipeUser(uint256,uint256) (runs: 1003, : 2996066, ~: 3031880)
[PASS] test_Deposits() (gas: 658405)
[PASS] test_Deposits2() (gas: 658387)
[PASS] test_DepositsAndWithdraw() (gas: 804900)
Suite result: ok. 9 passed; 0 failed; 0 skipped; finished in 114.88s (120.18s CPU time)

Ran 12 tests for test/RswETHTestToken.t.sol:RswTestToken
[PASS] testFuzz_DepositAndRebalanceRsw(uint256,uint256[3]) (runs: 1003, : 1303288, ~: 1303418)
[PASS] testFuzz_DepositRsw(uint256) (runs: 1003, : 904809, ~: 904809)
[PASS] testFuzz_WithdrawAllFromSwell(uint256) (runs: 1003, : 4714244, ~: 4714244)
[PASS] testFuzz_WithdrawFromSwell(uint256) (runs: 1003, : 5324710, ~: 5324710)
[PASS] testFuzz_claimFromSwell(uint256) (runs: 1003, : 6247818, ~: 6247831)
[PASS] testFuzz_depositRswAndRedeem(uint256) (runs: 1003, : 1047654, ~: 1038952)
[PASS] testFuzz_depositRswAndWithdraw(uint256) (runs: 1003, : 1339446, ~: 1339460)
[PASS] testFuzz_depositRswInvestAndWithdraw(uint256) (runs: 1003, : 928067, ~: 923725)
[PASS] testFuzz_depositRswMultipeUser(uint256,uint256) (runs: 1003, : 1113578, ~: 1113634)
[PASS] testFuzz_getWithdrawalDatas(uint256) (runs: 1003, : 5161314, ~: 5161314)
[PASS] test_depositRswWhenVaultHavingKnockedOutPositions() (gas: 2074096)
[PASS] test_unstake() (gas: 1407910)
Suite result: ok. 12 passed; 0 failed; 0 skipped; finished in 150.66s (660.68s CPU time)

Ran 9 test suites in 150.69s (623.64s CPU time): 54 tests passed, 0 failed, 0 skipped (54 total tests)
```

9.3 Notes about Test suite

The Tempest team delivered a robust and comprehensive test suite, showcasing a well-structured approach to ensuring the protocol's correctness and resilience. Key highlights of the test suite include:

- **Fuzzing Tests:** The extensive use of fuzzing tests enabled coverage of numerous edge cases, particularly for core functionalities such as deposits, withdrawals, and fee collection. These tests validate the behaviour of the system under a wide range of inputs, uncovering potential vulnerabilities or inconsistencies that could emerge in unexpected conditions.
- **Complex Scenarios:** Beyond basic operations, the test suite included sophisticated scenarios such as rebalancing positions across vaults. These tests verified the correctness and stability of the system in handling advanced operational flows, reinforcing confidence in the protocol's ability to operate effectively under dynamic conditions.
- **Coverage of Multiple Functional Areas:** Separate test cases targeted specific vault types (e.g., LST and Symmetric strategy vaults), token interactions, and withdrawal mechanics. This segmented testing approach helped isolate issues and provided clear insights into how different components of the system operate and interact.

Overall, the test suite reflects a mature development process and significantly enhances the reliability of the protocol. While the suite's depth is commendable, ongoing improvements, such as extending fuzzing ranges and incorporating even more complex operational scenarios, could further solidify its effectiveness.

CODESPECT also recommends explicitly defining strict invariants that the protocol must uphold. Incorporating tests to validate these invariants would ensure that critical assumptions about the system's behaviour are consistently maintained across all functionalities, further bolstering the protocol's security and stability.