BEOSIN
Blockchain Security

hydra-bridge

Smart Contract Security Audit

V1.0

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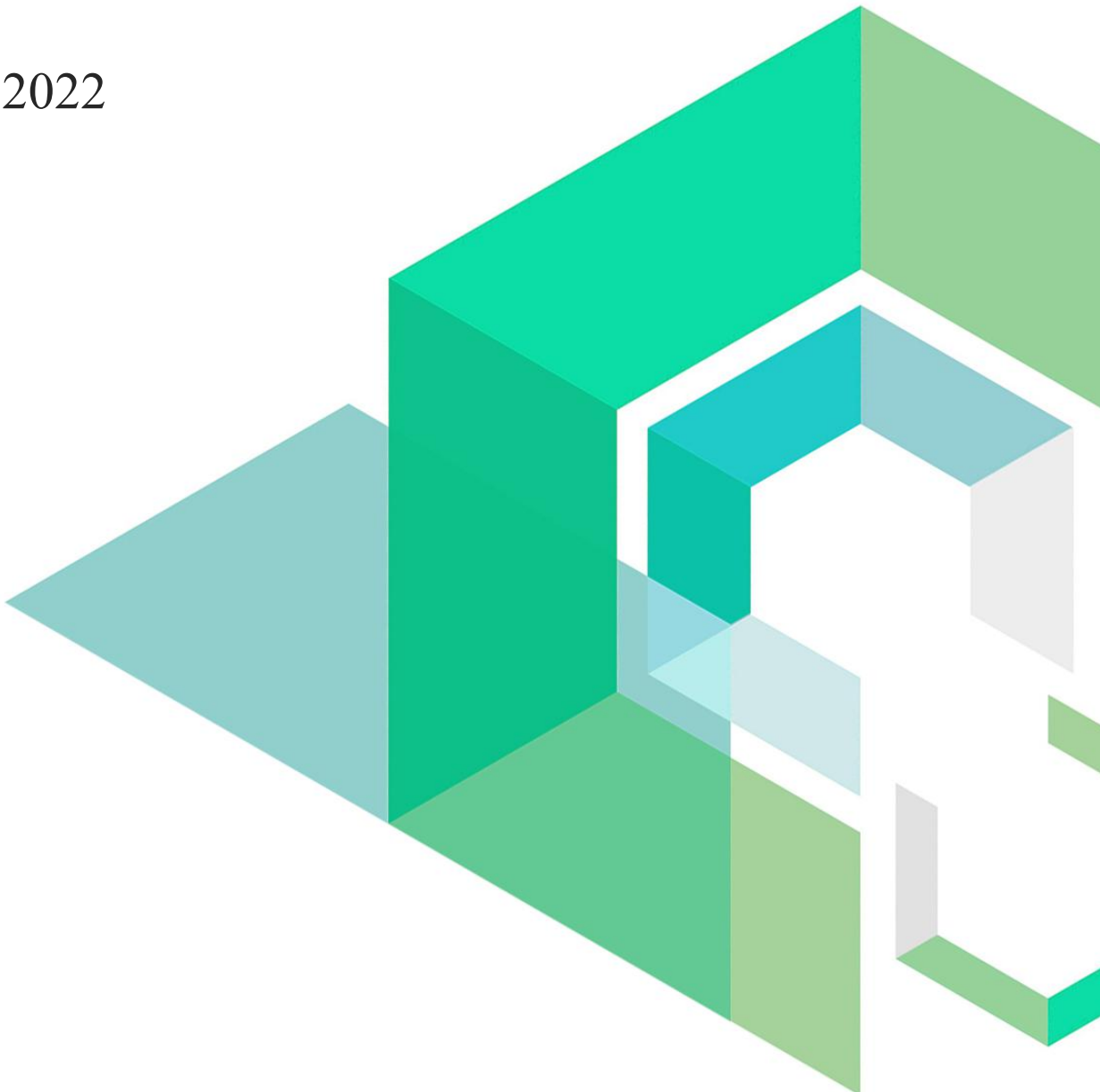
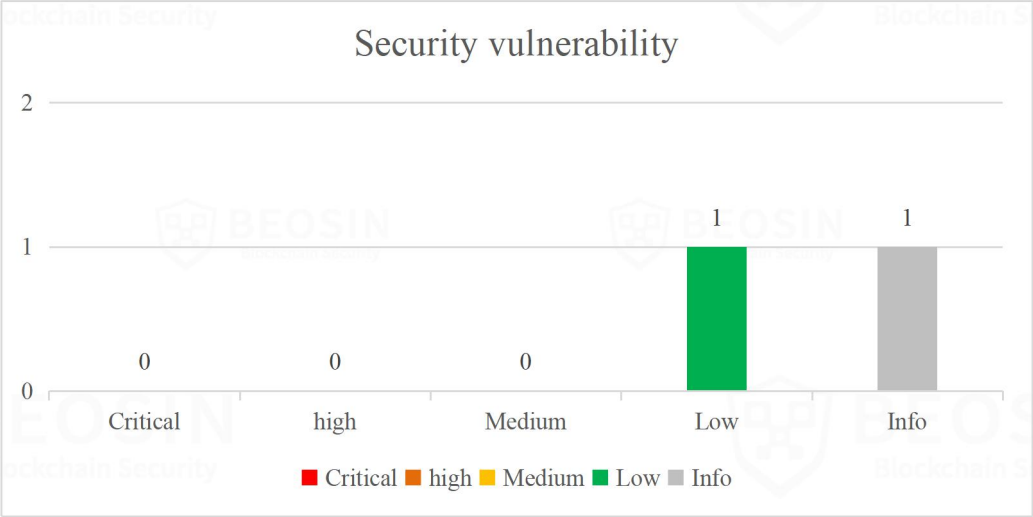


Contents

Summary of audit results

After auditing, 1 Low-risk and 1 Info items were identified in the hydra-bridge project. Specific audit details will be presented in the **Findings section**. Users should pay attention to the following aspects when interacting with this project：



*Notes：

- **Risk Description:**

1. In some special cases, some observers cannot vote normally, and some observers may vote repeatedly.
2. If the user sends ETH to the ERC20DefaultVault contract by mistake, this part of ETH will be permanently lost.
3. At the contract level, there is no direct connection between user deposit and observer voting, and the core logic of this project is mainly controlled by the contract owner. Users who participate in this project are requested to pay attention to the permission changes and key operations of the contract administrator.
4. In the last step of cross chain, users need to send tokens to the target address corresponding to the vault contract. If the tokens corresponding to the vault contract are insufficient, the sending of tokens will fail, and there is no relevant interface to cancel the cross chain operation at present.

- **Project Description:**

1. Business overview

This project implements a cross-chain bridge through observer voting. The user can send the token to the bridge contract(vault contract) for locking (partial handling fee is required), and the contract will record it; at the same time, the observer of the target chain will obtain the lock record of the user, and vote on the

corresponding bridge contract on the target chain. Once the vote is passed, the vault contract of the target chain will send tokens to the address specified by the user.

1 Overview

1.1 Project Overview

Project Name	hydra-bridge
Platform	Ethereum
Audit scope	https://github.com/Hydra-Chain/hydra-bridge
Commit Hash	358a3ebc9b7cc9027253b858c4fffe47351c528c (Original) 3333e87455936a5e5f6af6424677fe75458620dc (Final)

1.2 Audit Overview

Audit work duration：January 01, 2022 – March 18, 2022

Audit methods: Formal Verification, Static Analysis, Typical Case Testing and Manual Review.

Audit team: Beosin Technology Co. Ltd.

2 Findings

Index	Risk description	Severity level	Status
Bridge-1	After removing the observer, the observer voting function may be abnormal	**Low**	Acknowledged
Vault-1	ERC20DefaultVault can receive ETH, but lacks the corresponding withdrawal interface	**Info**	Acknowledged

Risk Details Description：

1. Item **Bridge-1** is not fixed. In some special cases, some observers cannot vote normally, and some observers may vote repeatedly.

2. Item **Vault-1** is not fixed. This may cause the ERC20DefaultVault contract to not be able to withdraw the ETH sent to this contract by mistake.

[Bridge-1] After removing the observer, the observer voting function may be abnormal

Severity Level	**Low**
Type	Business Security
Lines	HydraAccessControl.sol #L41 https://github.com/OpenZeppelin/openzeppelin-contracts/blob/v4.2.0/contracts/utils/structs/EnumerableSet.sol #L71 - #L103
Description	In the voting logic of HydraBridge contract, the contract will record whether to vote through the index of the corresponding observer, but in the *removeObserver* function, when removing the observer, its index will be exchanged with the last observer in the list. Therefore, there is an exception may occur: the observer is removed after voting, resulting in the last observer in the original list being recorded as 'already voted' and unable to vote normally. Or, the last Observer in the list has finished voting, but when the index is changed, the address can vote again.

```
function _remove(Set storage set, bytes32 value) private returns (bool) {
    // We read and store the value's index to prevent multiple reads from the same storage slot
    uint256 valueIndex = set._indexes[value];

    if (valueIndex != 0) {
        // Equivalent to contains(set, value)
        // To delete an element from the _values array in O(1), we swap the element to delete with the last one in
        // the array, and then remove the last element (sometimes called as 'swap and pop').
        // This modifies the order of the array, as noted in {at}.

        uint256 toDeleteIndex = valueIndex - 1;
        uint256 lastIndex = set._values.length - 1;

        if (lastIndex != toDeleteIndex) {
            bytes32 lastvalue = set._values[lastIndex];

            // Move the last value to the index where the value to delete is
            set._values[toDeleteIndex] = lastvalue;
            // Update the index for the moved value
            set._indexes[lastvalue] = valueIndex; // Replace lastvalue's index to valueIndex
        }

        // Delete the slot where the moved value was stored
        set._values.pop();

        // Delete the index for the deleted slot
        delete set._indexes[value];

        return true;
    } else {
        return false;
    }
}
```

Figure 1 Processing logic for removing the observer

Recommendations	It is recommended to use mapping to store whether the Observer has voted.
Status	**Acknowledged.**

[Vault-1] ERC20DefaultVault can receive ETH, but lacks the corresponding withdrawal interface	
Severity Level	Info
Type	Business Security
Lines	ERC20DefaultVault.sol #L50 - #L81
Description	As shown in the figure below, the *lock* function in the ERC20DefaultVault of the main branch declares the payable keyword, and then the Bridge contract will send the excess handling fee (ETH) to this contract. However, this contract lacks the interface to withdraw this part of the ETH, and this part of tokens will be locked in this contract.

```
function lock(
    bytes32 _assetId,
    uint8 _destinationChainId,
    uint64 _lockNonce,
    address _user,
    bytes calldata _data
) external payable override onlyBridge {
    bytes memory recipientAddress;

    (uint256 amount, uint256 recipientAddressLength) = abi.decode(_data, (uint256, uint256));
    recipientAddress = bytes(_data[64:64 + recipientAddressLength]);

    address tokenAddress = assetIdToTokenAddress[_assetId];
    require(tokenAllowlist[tokenAddress], "Vault: token is not in the allowlist");

    if (tokenBurnList[tokenAddress]) {
        // burn on destination chain
        ERC20Burnable(tokenAddress).burnFrom(_user, amount);
    } else {
        // lock on source chain
        ERC20Burnable(tokenAddress).safeTransferFrom(_user, address(this), amount);
    }

    lockRecords[_destinationChainId][_lockNonce] = LockRecord(
        tokenAddress,
        _destinationChainId,
        _assetId,
        recipientAddress,
        _user,
        amount
    );
}
```

Figure 2 Source code of function *lock*

Recommendations	Provides an interface for withdrawing platform tokens.
Status	**Acknowledged.**

3 Appendix

3.1 Vulnerability Assessment Metrics and Status in Smart Contracts

3.1.1 Metrics

In order to objectively assess the severity level of vulnerabilities in blockchain systems, this report provides detailed assessment metrics for security vulnerabilities in smart contracts with reference to CVSS 3.1 (Common Vulnerability Scoring System Ver 3.1).

According to the severity level of vulnerability, the vulnerabilities are classified into four levels: "critical", "high", "medium" and "low". It mainly relies on the degree of impact and likelihood of exploitation of the vulnerability, supplemented by other comprehensive factors to determine of the severity level.

Likelihood \ Impact	Severe	High	Medium	Low
Probable	Critical	High	Medium	Low
Possible	High	High	Medium	Low
Unlikely	Medium	Medium	Low	Info
Rare	Low	Low	Info	Info

3.1.2 Degree of impact

- **Severe**

Severe impact generally refers to the vulnerability can have a serious impact on the confidentiality, integrity, availability of smart contracts or their economic model, which can cause substantial economic losses to the contract business system, large-scale data disruption, loss of authority management, failure of key functions, loss of credibility, or indirectly affect the operation of other smart contracts associated with it and cause substantial losses, as well as other severe and mostly irreversible harm.

- **High**

High impact generally refers to the vulnerability can have a relatively serious impact on the confidentiality, integrity, availability of the smart contract or its economic model, which can cause a greater economic loss, local functional unavailability, loss of credibility and other impact to the contract business system.

- **Medium**

Medium impact generally refers to the vulnerability can have a relatively minor impact on the confidentiality, integrity, availability of the smart contract or its economic model, which can cause a small amount of economic loss to the contract business system, individual business unavailability and other impact.

- **Low**

Low impact generally refers to the vulnerability can have a minor impact on the smart contract, which can pose certain security threat to the contract business system and needs to be improved.

3.1.4 Likelihood of Exploitation

- **Probable**

Probable likelihood generally means that the cost required to exploit the vulnerability is low, with no special exploitation threshold, and the vulnerability can be triggered consistently.

- **Possible**

Possible likelihood generally means that exploiting such vulnerability requires a certain cost, or there are certain conditions for exploitation, and the vulnerability is not easily and consistently triggered.

- **Unlikely**

Unlikely likelihood generally means that the vulnerability requires a high cost, or the exploitation conditions are very demanding and the vulnerability is highly difficult to trigger.

- **Rare**

Rare likelihood generally means that the vulnerability requires an extremely high cost or the conditions for exploitation are extremely difficult to achieve.

3.1.5 Fix Results Status

Status	Description
Fixed	The project party fully fixes a vulnerability.
Partially Fixed	The project party did not fully fix the issue, but only mitigated the issue.
Acknowledged	The project party confirms and chooses to ignore the issue.

3.2 Audit Categories

No.	Categories	Subitems
1	Coding Conventions	Compiler Version Security
		Deprecated Items
		Redundant Code
		require/assert Usage
		Gas Consumption
2	General Vulnerability	Integer Overflow/Underflow
		Reentrancy
		Pseudo-random Number Generator (PRNG)
		Transaction-Ordering Dependence
		DoS (Denial of Service)
		Function Call Permissions
		call/delegatecall Security
		Returned Value Security
		tx.origin Usage
		Replay Attack
		Overriding Variables
		Third-party Protocol Interface Consistency
3	Business Security	Business Logics
		Business Implementations
		Manipulable Token Price
		Centralized Asset Control
		Asset Tradability
		Arbitrage Attack

Beosin classified the security issues of smart contracts into three categories: Coding Conventions, General Vulnerability, Business Security. Their specific definitions are as follows:

- **Coding Conventions**

Audit whether smart contracts follow recommended language security coding practices. For example, smart contracts developed in Solidity language should fix the compiler version and do not use deprecated keywords.

- **General Vulnerability**

General Vulnerability include some common vulnerabilities that may appear in smart contract projects. These vulnerabilities are mainly related to the characteristics of the smart contract itself, such as integer overflow/underflow and denial of service attacks.

- **Business Security**

Business security is mainly related to some issues related to the business realized by each project, and has a relatively strong pertinence. For example, whether the lock-up plan in the code match the white paper, or the flash loan attack caused by the incorrect setting of the price acquisition oracle.

*Note that the project may suffer stake losses due to the integrated third-party protocol. This is not something Beosin can control. Business security requires the participation of the project party. The project party and users need to stay vigilant at all times.

3.3 Disclaimer

The Audit Report issued by Beosin is related to the services agreed in the relevant service agreement. The Project Party or the Served Party (hereinafter referred to as the "Served Party") can only be used within the conditions and scope agreed in the service agreement. Other third parties shall not transmit, disclose, quote, rely on or tamper with the Audit Report issued for any purpose.

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The Audit Report issued by Beosin in no way provides investment advice on any project, nor should it be utilized as investment suggestions of any type. This report represents an extensive evaluation process designed to help our customers improve code quality while mitigating the high risks in Blockchain.

3.4 About BEOSIN

Affiliated to BEOSIN Technology Pte. Ltd., BEOSIN is the first institution in the world specializing in the construction of blockchain security ecosystem. The core team members are all professors, postdocs, PhDs, and Internet elites from world-renowned academic institutions.BEOSIN has more than 20 years of research in formal verification technology, trusted computing, mobile security and kernel security, with overseas experience in studying and collaborating in project research at well-known universities. Through the security audit and defense deployment of more than 2,000 smart contracts, over 50 public blockchains and wallets, and nearly 100 exchanges worldwide, BEOSIN has accumulated rich experience in security attack and defense of the blockchain field, and has developed several security products specifically for blockchain.

BEOSIN
Blockchain Security

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