CERTIK

Security Assessment

TARS Protocol

Apr 30th, 2022

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Summary

This report has been prepared for TARS Protocol to discover issues and vulnerabilities in the source code of the TARS Protocol project as well as any contract dependencies that were not part of an officially recognized library. A comprehensive examination has been performed, utilizing Static Analysis and Manual Review techniques.

The auditing process pays special attention to the following considerations:

- Testing the smart contracts against both common and uncommon attack vectors.
- Assessing the codebase to ensure compliance with current best practices and industry standards.
- Ensuring contract logic meets the specifications and intentions of the client.
- Cross referencing contract structure and implementation against similar smart contracts produced by industry leaders.
- Thorough line-by-line manual review of the entire codebase by industry experts.

Additionally, this audit is based on a premise that all external contracts were implemented safely.

The security assessment resulted in findings that ranged from critical to informational. We recommend addressing these findings to ensure a high level of security standards and industry practices. We suggest recommendations that could better serve the project from the security perspective:

- Enhance general coding practices for better structures of source codes;
- Add enough unit tests to cover the possible use cases;
- Provide more comments per each function for readability, especially contracts that are verified in public;
- Provide more transparency on privileged activities once the protocol is live.

Overview

Project Summary

Project Name	TARS Protocol
Platform	Ethereum
Language	Solidity
Codebase	https://github.com/Tars-Protocol/tars_protocol
Commit	c9573fa39115aa2873c08f6ab5e13c1428a57259

Audit Summary

Delivery Date	Apr 30, 2022 UTC
Audit Methodology	Static Analysis, Manual Review

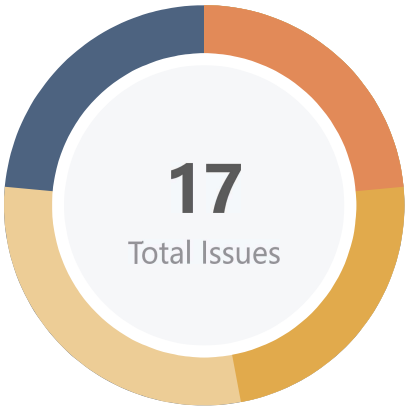
Vulnerability Summary

Vulnerability Level	Total	Pending	Declined	Acknowledged	Mitigated	Partially Resolved	Resolved
Critical	0	0	0	0	0	0	0
Major	4	0	0	1	0	0	3
Medium	4	0	0	1	0	0	3
Minor	5	0	0	3	0	1	1
Informational	4	0	0	3	0	0	1
Discussion	0	0	0	0	0	0	0

Audit Scope

ID	File	SHA256 Checksum
CSI	CoinSalesIDO.sol	cd8d2415a75364d4473c7774403ee697cf6b575094861dc53ebc5d64bb772eee
ALT	AssemblyLine.sol	52b0b2ab0e134dad04dfab7834b827f340fc8b03b9c5e4b5bf3b0ff06f81168e
VNT	token/VoucherNft.sol	d6f6f43ab261c2986193396dc988353001280a002b730f67998ccca341470247
FID	FactoryIDO.sol	7a5dec9eae43ca4dcf43de9ac53397e9f6ad143847507a228b9be08ba5475556
ITP	Insurance.sol	75c2b0a6ff5cd277083e605249fc4973dcb18c8da4961edfa05cb53a1c796cc0

Findings



Critical	**0** (0.00%)
Major	**4** (23.53%)
Medium	**4** (23.53%)
Minor	**5** (29.41%)
Informational	**4** (23.53%)
Discussion	**0** (0.00%)

ID	Title	Category	Severity	Status
GLOBAL-01	Centralization Related Risks	**Centralization / Privilege**	**Major**	Acknowledged
CSI-01	Missing Validation	Logical Issue	Major	Resolved
CSI-02	Missing Input Validation	Volatile Code	Minor	Resolved
CSI-03	Lack Of Reasonable Boundary	Volatile Code	Minor	Partially Resolved
CSI-04	Missing Input Validation	Volatile Code	Minor	Acknowledged
CSI-05	LockWarehouse Can Be Added After User Investment	Logical Issue	Minor	Acknowledged
CSI-06	Condition Can Be Simplified	Volatile Code	Informational	Resolved
FID-01	Incorrect Logic In Function `customProductionIDO`	Logical Issue	Medium	Acknowledged
ITP-01	Possible Loss Of Accuracy In Function `joinInsurance`	Logical Issue	Medium	Resolved
ITP-02	Incorrect Operator Used	Logical Issue	Medium	Resolved
ITP-03	Inadequate Validation	Logical Issue	Medium	Resolved
TPC-01	Permission Issues For Super Admin	Logical Issue	Major	Resolved
TPC-02	Missing Input Validation	Volatile Code	Minor	Acknowledged

ID	Title	Category	Severity	Status
TPC-03	Unlocked Compiler Version	Language Specific	Informational	Acknowledged
TPC-04	Missing Emit Events	Coding Style	Informational	Acknowledged
TPC-05	Variables That Could Be Declared As Immutable	Gas Optimization	Informational	Acknowledged
VNT-01	Missing Creation In Function `queryUserAllNft`	Language Specific	Major	Resolved

GLOBAL-01 | Centralization Related Risks

Category	Severity	Location	Status
Centralization / Privilege	**Major**	**Global**	Acknowledged

Description

In the contract `CoinSalesIDO`, the role `superAdmin` has the authority over the following function:

1. function adminSafeTransfer()
2. function updateInsuranceAddress()
3. function updateIsPrivate()
4. function updateTime()
5. function updatePoolQuota()
6. function updateQuantitySold()
7. function updateWhiteListQuota()
8. function addWhiteList()
9. function addLockWarehouse()
10. function updateSellingToken()
11. function updateSellingTokenName()
12. function cancelProject()
13. function identification()
14. function transferCoin()

In the contract `CoinSalesIDO`, the role `secondParty` has the authority over the following function:

1. function addWhiteList()
2. function addLockWarehouse()
3. function updateSellingToken()
4. function updateSellingTokenName()
5. function cancelProject()
6. function secondPartyClaim()

In the contract `CoinSalesIDO`, the role `firstParty` has the authority over the following function:

1. function identification()
2. function transferCoin()
3. function firstPartyClaim()

In the contract `FactoryIDO`, the role `superAdmin` has the authority over the following function:

1. function adminSafeTransfer()
2. function updateAdmin()
3. function updateInsurance()
4. function updateAssemblyLine()
5. function addAssemblyLine()
6. function deleteAssemblyLine()

In the contract `FactoryIDO`, the role `voucherBoss` has the authority over the following function:

1. function updateProxyInvestment()
2. function foundCoinSalesIdo()
3. function customProductionIDO()

In the contract `FactoryIDO`, the role `operator` has the authority over the following function:

1. function updatePayee()
2. function updateBusinessToken()
3. function updatePrice()
4. function updateClosePrice()
5. function addFundRaisingToken()
6. function deleteFundRaisingToken()
7. function poolAuthentication()

In the contract `Insurance`, the role `superAdmin` has the authority over the following function:

1. function adminSafeTransfer()
2. function updateAdmin()
3. function setFactoryIdoAddress()

In the contract `Insurance`, the role `operator` has the authority over the following function:

1. function adminAllSafeTransfer()
2. function updateInsuranceRate()
3. function settlementOfClaims()

In the contract `VoucherNft`, the role `operator` has the authority over the following function:

1. function setNftUri()
2. function mintNft()

Any compromise to the accounts may allow a hacker to take advantage of this authority and causes security problems.

Recommendation

The risk describes the current project design and potentially makes iterations to improve in the security operation and level of decentralization, which in most cases cannot be resolved entirely at the present stage. We advise the client to carefully manage the privileged account's private key to avoid any potential risks of being hacked. In general, we strongly recommend centralized privileges or roles in the protocol be improved via a decentralized mechanism or smart-contract-based accounts with enhanced security practices, e.g., multi-signature wallets.

Indicatively, here are some feasible suggestions that would also mitigate the potential risk at a different level in terms of short-term, long-term and permanent:

Short Term:

Timelock and Multi sign (⅔, ⅗) combination *mitigate* by delaying the sensitive operation and avoiding a single point of key management failure.

- Time-lock with reasonable latency, e.g., 48 hours, for awareness on privileged operations;
  AND
- Assignment of privileged roles to multi-signature wallets to prevent a single point of failure due to the private key compromised;
  AND
- A medium/blog link for sharing the timelock contract and multi-signers addresses information with the public audience.

Long Term:

Timelock and DAO, the combination, *mitigate* by applying decentralization and transparency.

- Time-lock with reasonable latency, e.g., 48 hours, for awareness on privileged operations;
  AND
- Introduction of a DAO/governance/voting module to increase transparency and user involvement;
  AND
- A medium/blog link for sharing the timelock contract, multi-signers addresses, and DAO information with the public audience.

Permanent:

Renouncing the ownership or removing the function can be considered *fully resolved*.

- Renounce the ownership and never claim back the privileged roles;
  OR
- Remove the risky functionality.

Noted: Recommend considering the long-term solution or the permanent solution. The project team shall make a decision based on the current state of their project, timeline, and project resources.

Alleviation

The team response: Some permissions have been cancelled, and the remaining permissions are due to business needs.

CSI-01 | Missing Validation

Category	Severity	Location	Status
Logical Issue	Major	CoinSalesIDO.sol: 418~427, 429~431	Resolved

Description

The `sellingToken` can be changed after `startTime`. So `sellingToken` can be changed after the user has made a purchase. The user may not get the `sellingToken` that he wanted to buy.

Recommendation

We recommend adding a check to ensure the `sellingToken` can only be changed before `startTime`.

Alleviation

The development team has resolved this issue in commit `a38539d19c200c900888315ad35dcd9acf938470`.

CSI-02 | Missing Input Validation

Category	Severity	Location	Status
Volatile Code	Minor	CoinSalesIDO.sol: 264~265	Resolved

Description

The `userFloor` means the minimum amount of tokens one user can buy. The `userQuota` means the maximum amount of tokens one user can buy. So the `userFloor` should be less than `userQuota`.

Recommendation

Consider adding a check as below:

```
1     require(intArr[7] > intArr[8], "userQuota should be greater than userFloor!");
```

Alleviation

The development team has resolved this issue in commit `a38539d19c200c900888315ad35dcd9acf938470`.

CSI-03 | Lack Of Reasonable Boundary

Category	Severity	Location	Status
Volatile Code	Minor	CoinSalesIDO.sol: 277, 372~416	Partially Resolved

Description

1. The variable `yield` means the percentage a second party can get from a `CoinSalesIDO`. Its current range of values is `yield<=100`. We think its range of values should be more reasonable.
2. If `_isLockWarehouse == 2`, the selling token may be locked for a certain period of time. This time should be within a reasonable range.

Recommendation

We recommend adding reasonable upper and lower boundaries to all the configuration variables.

Alleviation

1. The range of values changed to `0<yield<100`.
2. The final unlock time limit is 10 years after the current time.

Code was applied in commit `a38539d19c200c900888315ad35dcd9acf938470`.

CSI-04 | Missing Input Validation

Category	Severity	Location	Status
Volatile Code	Minor	CoinSalesIDO.sol: 317~335	Acknowledged

Description

According to the logic, `startTime` should be less than `endTime`, `endTime` should be less than `claimTime` and `closeTime`. So there need a check before updating the variables `startTime`, `endTime`, `claimTime` and `closeTime`.

Recommendation

Consider adding a check to ensure the variables mentioned above have a reasonable value.

Alleviation

The team response: Because of the needs of business needs, there is no need to solve them.

CSI-05 | LockWarehouse Can Be Added After User Investment

Category	Severity	Location	Status
Logical Issue	Minor	CoinSalesIDO.sol: 372~416	Acknowledged

Description

The `LockWarehouse` can be added after user investment, so users may not know the lockdown program when they participate exchange.

Recommendation

It's best to add `LockWarehouse` before users participate exchange.

Alleviation

The team response: Because of the needs of business needs, there is no need to solve them.

CSI-06 | Condition Can Be Simplified

Category	Severity	Location	Status
Volatile Code	Informational	CoinSalesIDO.sol: 481	Resolved

Description

In Line481, `_amount` <= `investment.add(_amount)`. So Line481 can be simplied.

Recommendation

Consider modifying as below:

```
1      require(investment.add(_amount) <= quota, "Err_46");
```

Alleviation

The development team has resolved this issue in commit `a38539d19c200c900888315ad35dcd9acf938470`.

FID-01 | Incorrect Logic In Function `customProductionIDO`

Category	Severity	Location	Status
Logical Issue	Medium	FactoryIDO.sol: 403~435	Acknowledged

Description

function `foundCoinSalesIdo`:

```
    _addressArray[3] = msg.sender;
    _addressArray[4] = superAdmin;
    _addressArray[5] = insurance;
    _addressArray[6] = address(this);

    require(isInsuranceToken(_addressArray[1]), "Illegal token!");
    _intArray[9] = uint256(ERC20(_addressArray[1]).decimals());
```

function `customProductionIDO`:

```
    _addressArray[0] = msg.sender;
    _addressArray[1] = superAdmin;
    _addressArray[2] = insurance;
    _addressArray[3] = address(this);
    _addressArray[4] = _assemblyLine;

    require(isInsuranceToken(_addressArray[5]), "Illegal token!");
    _intArray[0] = uint256(ERC20(_addressArray[5]).decimals());
```

The functions `foundCoinSalesIdo` and `customProductionIDO` have similar features. So the parameters passed to `assemblyLine` should be the same. But the real parameters shown above are different. The parameters in `customProductionIDO` are incorrect. Please correct the parameters.

Additionally, The newly created `ido` is not added to the `firstPartyPoolArray` in function `customProductionIDO`, like in `foundCoinSalesIdo`.

Recommendation

We recommend to correct the logic in function `customProductionIDO`.

Alleviation

The team response: `customProductionIDO` is a later reserved extension function and does not correspond to the `productionIdo` function in `AssemblyLine`, it is a reserved interface for the new `AssemblyLine` later.

ITP-01 | Possible Loss Of Accuracy In Function `joinInsurance`

Category	Severity	Location	Status
Logical Issue	Medium	Insurance.sol: 169, 172	Resolved

Description

Variables `totalInsuredAmount`, `userInsuredTotal` are without precision. The default value of `insuranceRate` is 1%. When the investment amount is not an integer multiple of 100, `totalInsuredAmount` and `userInsuredTotal` will have a loss of precision.

For example: _investedAmount = 99 * 10 ** decimals; _amount = 0.99 * 10 ** decimals; _amount.div(10 ** decimals) = 0;

Recommendation

We recommend retaining the precision of `totalInsuredAmount` and `userInsuredTotal`.

Alleviation

The development team has resolved this issue in commit `a38539d19c200c900888315ad35dcd9acf938470`.

ITP-02 | Incorrect Operator Used

Category	Severity	Location	Status
Logical Issue	Medium	Insurance.sol: 169, 172	Resolved

Description

```
1     totalInsuredAmount = totalInsuredAmount.add(_amount.div(10 * decimals));
2
3     userInsuredTotal[_user] = userInsuredTotal[_user].add(_amount.div(10 * decimals));
```

The operator in Line169 and Line172 should be **, but not *.

Recommendation

We recommend using the correct operator.

Alleviation

The development team has resolved this issue in commit `a38539d19c200c900888315ad35dcd9acf938470`.

ITP-03 | Inadequate Validation

Category	Severity	Location	Status
Logical Issue	Medium	Insurance.sol: 150~179	Resolved

Description

The validation in `Insurance.joinInsurance` is not sufficient. Users can forge their own contracts into `CoinSalesIDO` to mint themselves NFT.

Recommendation

We recommend using of more adequate calibration `FactoryIDO.isVoucherIdo(msg.sender)` to ensure the `CoinSalesIDO` is a valid one.

Alleviation

The development team has resolved this issue in commit `a38539d19c200c900888315ad35dcd9acf938470`.

TPC-01 | Permission Issues For Super Admin

Category	Severity	Location	Status
Logical Issue	Major	FactoryIDO.sol: 150~154 Insurance.sol: 111~116	Resolved

Description

The function `updateAdmin` can only be called by the `superAdmin`. The functions `removeAuth` and `addAuth` can only be called by the `owner`. But the `superAdmin` is set in `constructor`, maybe not the `owner`. So the `superAdmin` may not have the permission to call the functions `removeAuth` and `addAuth`.

Recommendation

We recommend assigning `owner` to `superAdmin` in constructor.

Alleviation

The development team has resolved this issue in commit `a38539d19c200c900888315ad35dcd9acf938470`.

TPC-02 | Missing Input Validation

Category	Severity	Location	Status
Volatile Code	Minor	AssemblyLine.sol: 20, 25 CoinSalesIDO.sol: 420 FactoryIDO.sol: 99, 102~106, 152 Insurance.sol: 61~63	Acknowledged

Description

The given input is missing the check for the non-zero address.

Recommendation

We advise adding the check for the passed-in values to prevent unexpected error as below:
For example:

```
1     require(_lineLeader != address(0), "lineLeader can not be zero address!");
```

Alleviation

The team response: No need to resolve.

TPC-03 | Unlocked Compiler Version

Category	Severity	Location	Status
Language Specific	Informational	AssemblyLine.sol: 2 token/VoucherNft.sol: 2 CoinSalesIDO.sol: 2 Insurance.sol: 2 FactoryIDO.sol: 2	Acknowledged

Description

The contract has unlocked compiler version. An unlocked compiler version in the source code of the contract permits the user to compile it at or above a particular version. This, in turn, leads to differences in the generated bytecode between compilations due to different compiler versions. This can lead to an ambiguity when debugging as compiler specific bugs may occur in the codebase that would be hard to identify over a span of multiple compiler versions rather than a specific one.

Recommendation

We advise that the compiler version is instead locked at the lowest version possible that the contract can be compiled at. For example, for version `v0.6.2` the contract should contain the following line:

```
pragma solidity 0.6.2;
```

Alleviation

The team response: No need to resolve.

TPC-04 | Missing Emit Events

Category	Severity	Location	Status
Coding Style	Informational	AssemblyLine.sol: 23, 28 CoinSalesIDO.sol: 228, 300, 308, 313, 317, 337, 341, 345, 356, 372, 418, 429, 433, 438, 452, 515, 530 Insurance.sol: 88, 111, 118 FactoryIDO.sol: 142, 150, 176, 181, 215, 222, 252, 295	Acknowledged

Description

There should always be events emitted in the sensitive functions that are controlled by centralization roles.

Recommendation

It is recommended emitting events for the sensitive functions that are controlled by centralization roles.

Alleviation

The team response: No need to resolve.

TPC-05 | Variables That Could Be Declared As Immutable

Category	Severity	Location	Status
Gas Optimization	Informational	AssemblyLine.sol: 11 CoinSalesIDO.sol: 27 Insurance.sol: 20, 22 FactoryIDO.sol: 19	Acknowledged

Description

The linked variables assigned in the constructor can be declared as `immutable`. Immutable state variables can be assigned during contract creation but will remain constant throughout the lifetime of a deployed contract. A big advantage of immutable variables is that reading them is significantly cheaper than reading from regular state variables since they will not be stored in storage.

Recommendation

We recommend declaring these variables as immutable. Please note that the `immutable` keyword only works in Solidity version `v0.6.5` and up.

Alleviation

The team response: No need to resolve.

VNT-01 | Missing Creation In Function `queryUserAllNft`

Category	Severity	Location	Status
Language Specific	Major	token/VoucherNft.sol: 74~79	Resolved

Description

In function `queryUserAllNft`, `nftArray` is not created. When this method be called there will be an error.

Recommendation

Consider modifying as below:

```
    nftArray = new NftInfo[](_ids.length);
    for (uint256 i = 0; i < _ids.length; i++) {
        nftArray[i] = nftInfo[_ids[i]];
    }
    return nftArray;
```

Alleviation

The development team has resolved this issue in commit `a38539d19c200c900888315ad35dcd9acf938470`.

Appendix

Finding Categories

Centralization / Privilege

Centralization / Privilege findings refer to either feature logic or implementation of components that act against the nature of decentralization, such as explicit ownership or specialized access roles in combination with a mechanism to relocate funds.

Gas Optimization

Gas Optimization findings do not affect the functionality of the code but generate different, more optimal EVM opcodes resulting in a reduction on the total gas cost of a transaction.

Logical Issue

Logical Issue findings detail a fault in the logic of the linked code, such as an incorrect notion on how block.timestamp works.

Volatile Code

Volatile Code findings refer to segments of code that behave unexpectedly on certain edge cases that may result in a vulnerability.

Language Specific

Language Specific findings are issues that would only arise within Solidity, i.e. incorrect usage of private or delete.

Coding Style

Coding Style findings usually do not affect the generated byte-code but rather comment on how to make the codebase more legible and, as a result, easily maintainable.

Checksum Calculation Method

The "Checksum" field in the "Audit Scope" section is calculated as the SHA-256 (Secure Hash Algorithm 2 with digest size of 256 bits) digest of the content of each file hosted in the listed source repository under the specified commit.

The result is hexadecimal encoded and is the same as the output of the Linux "sha256sum" command against the target file.

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