BLOCKSEC

Security Audit
Report for Avalon Contracts

Date: October 22, 2024 **Version:** 1.1

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Contents

Report Manifest

Item	Description
Client	Avalon
Target	Avalon Contracts

Version History

Version	Date	Description
1.0	October 11, 2024	First release
1.1	October 22, 2024	Add two new repositories

Signature

Digitally signed by: BlockSec (https://blocksec.com)

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Date: 2024-10-24 04:31:02+0000

About BlockSec BlockSec focuses on the security of the blockchain ecosystem and collaborates with leading DeFi projects to secure their products. BlockSec is founded by top-notch security researchers and experienced experts from both academia and industry. They have published multiple blockchain security papers in prestigious conferences, reported several zero-day attacks of DeFi applications, and successfully protected digital assets that are worth more than 14 million dollars by blocking multiple attacks. They can be reached at Email, Twitter and Medium.

Chapter 1 Introduction

1.1 About Target Contracts

Information	Description
Type	Smart Contract
Language	Solidity
Approach	Semi-automatic and manual verification

Avalon is a set of contracts that issues the `USDA` stablecoin, which is pegged 1:1 to the stablecoin `USDT`. Borrowers can supply `FBTC` tokens to the `PoolManager` contract as collateral to mint `USDA` tokens, while lenders can provide `USDT` tokens in the `LendingPool` contract to benefit from a fixed reward rate.

The audit scope includes smart contracts from the following three repositories:

- USDA [1]: Contains the implementation of the `USDA` token.
- USDA-OFT [2]: Contains the `USDa` and the `USDaOFTAdapter` for Avalon.
- AALoan [3]: Contains the `PoolManager` contract.
- USDAPool [4]: Contains the `LendingPool` for Avalon.
- Saving-account [5]: Contains the `SavingAccount` for Avalon.

Additionally, all dependencies of the smart contracts within the audit scope are considered reliable in terms of functionality and security, and are therefore not included in the audit scope.

The auditing process is iterative. Specifically, we would audit the commits that fix the discovered issues. If there are new issues, we will continue this process. The commit SHA values during the audit are shown in the following table. Our audit report is responsible for the code in the initial version (`Version 1`), as well as new code (in the following versions) to fix issues in the audit report.

Project	Version	Commit Hash
AALoan	Version 1	18928e521f0e84d5602e5911841d228870b1d08e
	Version 2	13f633c5dbccd57c514ad7c3b594e58aad59beaf
USDA	Version 1	71d69f9a966bd9d594bf7046a2adfea53ad629a2
USDAPool	Version 1	2d94d64e1fdd66e9b078965c0ba970f7bbc9e458
	Version 2	65d3fb8fc1a54d2ce2a517b48596a576d5a05c46
Saving-account	Version 1	3806530473d4ec9775c2664577c6744f9109b734
	Version 2	f513db33ab1d669fdd66dfe365003ebb6233f91b
USDA-OFT	Version 1	393349344296c03bf4d5512c8ede7daf2b83cf24
	Version 2	15ee68086919de24c6d39d27b84bb5e7f55a160b

[1] https://github.com/avalonfinancexyz/USDA

[2] https://github.com/avalonfinancexyz/USDa-oft

[3] https://github.com/avalonfinancexyz/AALoan/tree/v2.0

[4] https://github.com/avalonfinancexyz/USDAPool

[5] https://github.com/avalonfinancexyz/saving-account

1.2 Disclaimer

This audit report does not constitute investment advice or a personal recommendation. It does not consider, and should not be interpreted as considering or having any bearing on, the potential economics of a token, token sale or any other product, service or other asset. Any entity should not rely on this report in any way, including for the purpose of making any decisions to buy or sell any token, product, service or other asset.

This audit report is not an endorsement of any particular project or team, and the report does not guarantee the security of any particular project. This audit does not give any warranties on discovering all security issues of the smart contracts, i.e., the evaluation result does not guarantee the nonexistence of any further findings of security issues. As one audit cannot be considered comprehensive, we always recommend proceeding with independent audits and a public bug bounty program to ensure the security of smart contracts.

The scope of this audit is limited to the code mentioned in Section 1.1. Unless explicitly specified, the security of the language itself (e.g., the solidity language), the underlying compiling toolchain and the computing infrastructure are out of the scope.

1.3 Procedure of Auditing

We perform the audit according to the following procedure.

- **Vulnerability Detection** We first scan smart contracts with automatic code analyzers, and then manually verify (reject or confirm) the issues reported by them.
- **Semantic Analysis** We study the business logic of smart contracts and conduct further investigation on the possible vulnerabilities using an automatic fuzzing tool (developed by our research team). We also manually analyze possible attack scenarios with independent auditors to cross-check the result.
- **Recommendation** We provide some useful advice to developers from the perspective of good programming practice, including gas optimization, code style, and etc.

We show the main concrete checkpoints in the following.

1.3.1 Software Security

* Reentrancy
* DoS
* Access control
* Data handling and data flow
* Exception handling
* Untrusted external call and control flow
* Initialization consistency
* Events operation
* Error-prone randomness
* Improper use of the proxy system

1.3.2 DeFi Security

* Semantic consistency
* Functionality consistency
* Permission management
* Business logic
* Token operation
* Emergency mechanism
* Oracle security
* Whitelist and blacklist
* Economic impact
* Batch transfer

1.3.3 NFT Security

* Duplicated item
* Verification of the token receiver
* Off-chain metadata security

1.3.4 Additional Recommendation

* Gas optimization
* Code quality and style

Note *The previous checkpoints are the main ones. We may use more checkpoints during the auditing process according to the functionality of the project.*

1.4 Security Model

To evaluate the risk, we follow the standards or suggestions that are widely adopted by both industry and academy, including OWASP Risk Rating Methodology [6] and Common Weakness Enumeration [7]. The overall *severity* of the risk is determined by *likelihood* and *impact*. Specifically, likelihood is used to estimate how likely a particular vulnerability can be uncovered and exploited by an attacker, while impact is used to measure the consequences of a successful exploit.

In this report, both likelihood and impact are categorized into two ratings, i.e., *high* and *low* respectively, and their combinations are shown in Table 1.1.

Accordingly, the severity measured in this report are classified into three categories: **High**, **Medium**, **Low**. For the sake of completeness, **Undetermined** is also used to cover circumstances when the risk cannot be well determined.

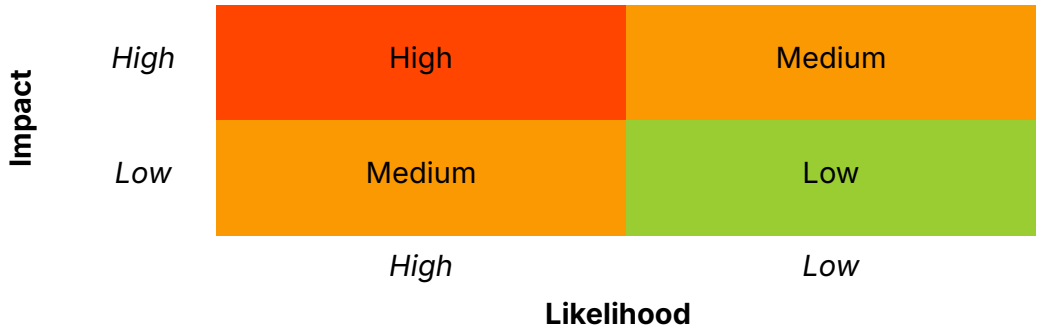
Furthermore, the status of a discovered item will fall into one of the following four categories:

- **Undetermined** No response yet.

[6] https://owasp.org/www-community/OWASP_Risk_Rating_Methodology

[7] https://cwe.mitre.org/

Table 1.1: Vulnerability Severity Classification



- **Acknowledged** The item has been received by the client, but not confirmed yet.
- **Confirmed** The item has been recognized by the client, but not fixed yet.
- **Fixed** The item has been confirmed and fixed by the client.

Chapter 2 Findings

In total, we found **three** potential security issues. Besides, we have **six** recommendations and **two** notes.

- High Risk: 1
- Medium Risk: 1
- Low Risk: 1
- Recommendation: 6
- Note: 2

ID	Severity	Description	Category	Status
1	Medium	Precision loss in the `redeemUSDT` function	Software Security	Fixed
2	Low	Inconsistent usage and calculation of the underlying asset	Software Security	Fixed
3	High	Invalid maximum borrow amount check	DeFi Security	Fixed
4	-	Avoid multiplication following division to prevent precision loss	Recommendation	Fixed
5	-	Avoid redundant state updates	Recommendation	Fixed
6	-	Avoid using the deprecated library function	Recommendation	Fixed
7	-	Ensure that addresses are not zero in constructors	Recommendation	Fixed
8	-	Remove unused variables	Recommendation	Acknowledged
9	-	Remove the redundant check	Recommendation	Fixed
10	-	Potential centralization risks	Note	-
11	-	Stealing the distributing rewards are not profitable	Note	-

The details are provided in the following sections.

2.1 Software Security

2.1.1 Precision loss in the `redeemUSDT` function

Severity Medium

Status Fixed in `Version 2` (USDAPool)

Introduced by `Version 1` (USDAPool)

Description In the `redeemUSDT` function of the `LendingPool` contract, there is a precision loss issue in calculating the shares redeemable by the user. Specifically, `totalDepositedUSDT` can exceed `totalDepositedUSDTShares` because the interest on deposited `USDT` tokens accumulates in `totalDepositedUSDT`, while `totalDepositedUSDTShares` only increases when users deposit `USDT` tokens.

This precision loss could allow the `LENDER_ROLE` to manipulate the `_amount`, resulting in `redeemShares` being zero and enabling them to redeem `USDT` without reducing their shares.

However, the rate of increase for `totalDepositedUSDT` is slow enough that executing such attacks would be too costly to yield a profit.

```
131   function redeemUSDT(
132       uint256 _amount
133   ) external onlyRole(LENDER_ROLE) realizeInterests {
134       uint256 redeemShares = (_amount * totalDepositedUSDTShares) /
135           totalDepositedUSDT;
136       require(
137           usdtDepositedShares[msg.sender] >= redeemShares,
138           "redeem amount exceeds balance"
139       );
140       usdtDepositedShares[msg.sender] -= redeemShares;
141       totalDepositedUSDTShares -= redeemShares;
142       totalDepositedUSDT -= _amount;
143       USDT.safeTransfer(msg.sender, _amount);
144       emit RedeemUSDT(msg.sender, redeemShares, _amount);
145   }
```

Listing 2.1: contracts/LendingPool.sol

Impact Malicious actors can redeem a small amount of `USDT` tokens without decreasing shares.

Suggestion Use ceiling division, or require that redeeming shares are not zero.

2.1.2 Inconsistent usage and calculation of the underlying asset

Severity Low

Status Fixed in `Version 2` (Saving-account)

Introduced by `Version 1` (Saving-account)

Description In the `SavingAccount` contract, there are two functions, `getSharesByAmount` and `getAmountByShares`, that allow users to calculate the conversion ratio between shares and underlying tokens. However, the minting and redeeming processes are inconsistent with these two functions.

Specifically, users deposit tokens to earn interest in this contract, with the interest accumulated in `unpaidInterest` and distributed when the admin invokes the `distributeInterests` function. The two calculation functions treat `unpaidInterest` as part of the underlying asset, while the minting and redeeming processes do not, leading to inconsistency.

```
286   function distributeInterests()
287       external
288       realizeReward
289       onlyRole(POOL_MANAGER_ROLE)
290   {
291       IERC20(usda).safeTransferFrom(
292           msg.sender,
293           address(this),
294           unpaidInterest
295       );
296       totalUnderlying += unpaidInterest;
297       unpaidInterest = 0;
```

```
298    }
```

Listing 2.2: saving-account/contracts/SavingAccount.sol

```
286    function distributeInterests()
287        external
288        realizeReward
289        onlyRole(POOL_MANAGER_ROLE)
290    {
291        IERC20(usda).safeTransferFrom(
292            msg.sender,
293            address(this),
294            unpaidInterest
295        );
296        totalUnderlying += unpaidInterest;
297        unpaidInterest = 0;
298    }
```

Listing 2.3: saving-account/contracts/SavingAccount.sol

```
122    function getTotalUnderlying() public view returns (uint256) {
123        // need include manager fee
124        uint256 totalInterest = getRPS() * (block.timestamp - lastCheckpoint);
125        return totalUnderlying + totalInterest;
126    }
127
128    /**
129     * @dev get amount of shares by underlying amount
130     * @param _amount the amount of underlying
131     */
132    function getSharesByAmount(uint256 _amount) public view returns (uint256) {
133        uint256 sTokenTotalSupply = susda.totalSupply();
134        if (sTokenTotalSupply == 0) {
135            return 0;
136        } else {
137            return (_amount * sTokenTotalSupply) / getTotalUnderlying();
138        }
139    }
140
141    /**
142     * @dev get amount by shares
143     * @param _shares the amount of cToken
144     */
145    function getAmountByShares(uint256 _shares) public view returns (uint256) {
146        uint256 sTokenTotalSupply = susda.totalSupply();
147        if (sTokenTotalSupply == 0) {
148            return 0;
149        } else {
150            return (_shares * getTotalUnderlying()) / (sTokenTotalSupply);
151        }
152    }
```

Listing 2.4: saving-account/contracts/SavingAccount.sol

```
196   function _mintFor(
197       uint256 amount,
198       address receiver
199   ) internal realizeReward nonReentrant whenNotPaused{
200       usda.safeTransferFrom(msg.sender, address(this), amount);
201
202       uint256 cTokenAmount;
203       uint256 sTokenTotalSupply = susda.totalSupply();
204       if (sTokenTotalSupply == 0 || totalUnderlying == 0) {
205           cTokenAmount = amount;
206       } else {
207           cTokenAmount = (amount * sTokenTotalSupply) / totalUnderlying;
208       }
209
210       susda.mint(receiver, cTokenAmount);
211
212       totalUnderlying = totalUnderlying + amount;
213   }
214
215   /**
216    * @dev redeem susda
217    * @param amount the amount of sToken, 1 sToken = 10**18, which eaquals to 1 usda (if not
           interest).
218    * error code
219    * 100: redeem is less than the balance
220    * 101: totalUnderlying should be greater than 0
221    * 102:
222    */
223   function redeem(uint256 amount) external realizeReward nonReentrant whenNotPaused{
224       require(amount <= susda.balanceOf(msg.sender), "less than balance");
225       require(totalUnderlying > 0, "totalUnderlying = 0");
226       require(susda.totalSupply() > 0, "susda total is 0");
227       require(amount >= 1e18, "redeem amount is too small");
228
229       uint256 sTokenTotalSupply = susda.totalSupply();
230
231       uint256 underlyingAmount = (amount * totalUnderlying) /
232           sTokenTotalSupply;
233
234       susda.burn(msg.sender, amount);
235
236       totalUnderlying = totalUnderlying - underlyingAmount;
237
238       redeemIndex++;
239       redeemDetails[redeemIndex] = RedeemDetail({
240           id: redeemIndex,
241           timestamp: block.timestamp,
242           user: msg.sender,
243           underlyingAmount: underlyingAmount,
244           isDone: false
245       });
246
```

```
247         emit RedeemRequested(
248             redeemIndex,
249             block.timestamp,
250             msg.sender,
251             underlyingAmount
252         );
253     }
```

Listing 2.5: saving-account/contracts/SavingAccount.sol

Impact Inconsistent usage may lead to unexpected miscalculations for users of the view functions.

Suggestion Refactor the code accordingly.

2.2 DeFi Security

2.2.1 Invalid maximum borrow amount check

Severity High

Status Fixed in `Version 2` (AALoan)

Introduced by `Version 1` (AALoan)

Description In the `PoolManager` contract, users deposit `FBTC` token collateral to borrow `USDA` tokens. The protocol employs an over-collateralization mechanism, requiring that the maximum borrow amount does not exceed the collateral value multiplied by the `loanToValue` configuration variable.

```
550     function calculateMaxBorrowAmount(
551         uint256 loanToValue,
552         uint256 collateral,
553         uint256 debt,
554         uint256 FBTCOPrice,
555         uint256 USDADecimal,
556         uint256 FBTCODecimal,
557         uint256 oracleDecimal
558     ) public view returns (uint256) {
559         return
560             (((collateral * FBTCOPrice * 10 ** USDADecimal) /
561                 (10 ** FBTCODecimal * 10 ** oracleDecimal)) * loanToValue) /
562             DENOMINATOR -
563             debt;
564     }
```

Listing 2.6: AALoan/src/protocol/PoolManager.sol

Additionally, the `PoolManager` provides a liquidation mechanism specifying that once the collateral value multiplied by the `liquidationThreshold` configuration variable is less than the debt value, the user becomes liquidatable. The `loanToValue` variable is set lower than the `liquidationThreshold` to ensure the protocol maintains a buffer, preventing users from being liquidated immediately after borrowing.

```
599   function checkLiquidateCondition(
600       uint256 liquidationThreshold,
601       uint256 collateral,
602       uint256 debt,
603       uint256 FBTCOPrice,
604       uint256 USDADecimal,
605       uint256 FBTCODecimal,
606       uint256 oracleDecimal
607   ) public view returns (bool) {
608       return
609           collateral <
610               (debt *
611                   10 ** (oracleDecimal + FBTCODecimal - USDADecimal) *
612                   DENOMINATOR) /
613                   (FBTCOPrice * liquidationThreshold)
614               ? true
615               : false;
616   }
```

Listing 2.7: AALoan/src/protocol/PoolManager.sol

However, users can still withdraw their collateral to get to reach the liquidation threshold. The withdrawal progress only requires that the user will not be liquidatable after the withdrawal. As a result, users can easily bypass the maximum borrow amount check.

```
572   function calculateMaxWithdrawAmount(
573       uint256 liquidationThreshold,
574       uint256 collateral,
575       uint256 debt,
576       uint256 FBTCOPrice,
577       uint256 USDADecimal,
578       uint256 FBTCODecimal,
579       uint256 oracleDecimal
580   ) public view returns (uint256) {
581       if (debt == 0) {
582           return collateral;
583       } else {
584           return
585               collateral >
586                   (debt *
587                       10 ** (oracleDecimal + FBTCODecimal - USDADecimal) *
588                       DENOMINATOR) /
589                       (FBTCOPrice * liquidationThreshold)
590                   ? collateral -
591                       (debt *
592                           10 ** (oracleDecimal + FBTCODecimal - USDADecimal) *
593                           DENOMINATOR) /
594                       (FBTCOPrice * liquidationThreshold)
595                   : 0;
596       }
597   }
```

Listing 2.8: AALoan/src/protocol/PoolManager.sol

Impact Users can reach the liquidation line by withdrawing from the protocol, rendering the maximum borrow amount check invalid.

Suggestion Refactor the logic of the `calculateMaxWithdrawAmount` function.

2.3 Additional Recommendation

2.3.1 Avoid multiplication following division to prevent precision loss

Status Fixed in `Version 2` (USDAPool)

Introduced by `Version 1` (USDAPool)

Description In the `realizeInterests` function, there is an issue with multiplication occurring after division, which can amplify the precision loss from the division. It is recommended to switch the order of calculations to avoid this precision loss.

```
229   modifier realizeInterests() {
230       if (totalBorrowedUSDT != 0) {
231           uint256 totalInterest = ((apr * totalBorrowedUSDT) /
232               365 days /
233               APR_COEFFICIENT) * (block.timestamp - lastCheckpoint);
234           totalBorrowedUSDT += totalInterest;
235           totalDepositedUSDT += totalInterest;
236           unpaidInterestUSDT += totalInterest;
237       }
238       lastCheckpoint = block.timestamp;
239       _;
240   }
```

Listing 2.9: USDAPool/contracts/LendingPool.sol

Impact This may lead to unexpected results.

Suggestion Switch the calculation order to avoid precision loss.

2.3.2 Avoid redundant state updates

Status Fixed in `Version 2` (USDAPool)

Introduced by `Version 1` (USDAPool)

Description The `realizeInterests` function updates the state regardless of whether it is already the latest. Adding a check for `lastCheckpoint == block.timestamp` could help determine whether to perform the calculation and state update, thereby optimizing gas consumption.

```
229   modifier realizeInterests() {
230       if (totalBorrowedUSDT != 0) {
231           uint256 totalInterest = ((apr * totalBorrowedUSDT) /
232               365 days /
233               APR_COEFFICIENT) * (block.timestamp - lastCheckpoint);
234           totalBorrowedUSDT += totalInterest;
235           totalDepositedUSDT += totalInterest;
236           unpaidInterestUSDT += totalInterest;
```

```
237         }
238         lastCheckpoint = block.timestamp;
239         _;
240     }
```

Listing 2.10: USDAPool/contracts/LendingPool.sol

Impact N/A

Suggestion Add checks to prevent unnecessary state updates.

2.3.3 Avoid using the deprecated library function

Status Fixed in `Version 2` (USDAPool)

Introduced by `Version 1` (USDAPool)

Description The code uses an outdated version of the OpenZeppelin library that employs the deprecated function `_setupRole`.

```
56    constructor(address _admin, address _usda, address _usdt) {
57        require(_admin != address(0), "!_admin");
58        _setupRole(DEFAULT_ADMIN_ROLE, _admin);
59        _setRoleAdmin(ADMIN_ROLE, ADMIN_ROLE);
60        _setRoleAdmin(MANAGER_ROLE, ADMIN_ROLE);
61        _setRoleAdmin(LENDER_ROLE, ADMIN_ROLE);
62        _setRoleAdmin(BORROWER_ROLE, ADMIN_ROLE);
63
64        _setupRole(ADMIN_ROLE, _admin);
65        _setupRole(MANAGER_ROLE, _admin);
66
67        USDA = IERC20(_usda);
68        USDT = IERC20(_usdt);
69    }
```

Listing 2.11: USDAPool/contracts/LendingPool.sol

Impact N/A

Suggestion Avoid using the deprecated function.

2.3.4 Ensure that addresses are not zero in constructors

Status Fixed in `Version 2` (USDAPool)

Introduced by `Version 1` (USDAPool)

Description When setting critical address parameters, it is recommended to check that the addresses are not zero to avoid misconfiguration.

```
56    constructor(address _admin, address _usda, address _usdt) {
57        require(_admin != address(0), "!_admin");
58        _setupRole(DEFAULT_ADMIN_ROLE, _admin);
59        _setRoleAdmin(ADMIN_ROLE, ADMIN_ROLE);
60        _setRoleAdmin(MANAGER_ROLE, ADMIN_ROLE);
61        _setRoleAdmin(LENDER_ROLE, ADMIN_ROLE);
```

```
62        _setRoleAdmin(BORROWER_ROLE, ADMIN_ROLE);
63
64        _setupRole(ADMIN_ROLE, _admin);
65        _setupRole(MANAGER_ROLE, _admin);
66
67        USDA = IERC20(_usda);
68        USDT = IERC20(_usdt);
69    }
```

Listing 2.12: USDAPool/contracts/LendingPool.sol

Impact The lack of non-zero address checks may lead to misconfiguration.

Suggestion Add proper checks.

2.3.5 Remove unused variables

Status Acknowledged

Introduced by `Version 1` (USDA-OFT)

Description In the `USDa` contract, the `mintVault` and `burnVault` variables are not used.

Impact N/A

Suggestion Remove the unused variables.

2.3.6 Remove the redundant check

Status Fixed in `Version 2` (Saving-account)

Introduced by `Version 1` (Saving-account)

Description When users redeem their shares in the `SavingAccount` contract, the contract checks that the redeeming amount is less than the user's `susda` balance. However, since the burning process of `susda` already verifies this condition, the check is redundant.

```
223    function redeem(uint256 amount) external realizeReward nonReentrant whenNotPaused{
224        require(amount <= susda.balanceOf(msg.sender), "less than balance");
225        require(totalUnderlying > 0, "totalUnderlying = 0");
226        require(susda.totalSupply() > 0, "susda total is 0");
227        require(amount >= 1e18, "redeem amount is too small");
228
229        uint256 sTokenTotalSupply = susda.totalSupply();
230
231        uint256 underlyingAmount = (amount * totalUnderlying) /
232            sTokenTotalSupply;
233
234        susda.burn(msg.sender, amount);
```

Listing 2.13: saving-account/contracts/SavingAccount.sol

Impact N/A

Suggestion Remove the redundant check.

2.4 Note

2.4.1 Potential centralization risks

Introduced by `Version 1`

Description Avalon Contracts include several critical functions, such as upgrading contracts, setting key parameters, and modifying user states, which can only be executed by privileged roles. Misconfigurations of these parameters can significantly impact the functionality of the contracts, potentially rendering them unusable. Consequently, if the private keys of these privileged roles were compromised, the entire protocol could be incapacitated, leading to potential centralization risks.

2.4.2 Stealing the distributing rewards are not profitable

Introduced by `Version 1` (Saving-account)

Description In the `SavingAccount` contract, the interests are distributed periodically by the admin. If a malicious user deposits in the contract before the distribution, he may receive rewards that don't come from his deposit. However, since the interests are calculated on an annual basis APR and as long as the reward distribution is frequent enough, stealing the distributing rewards is not profitable.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