Cyberscope

Audit Report

Digits DAO

December 2022

SHA256 26af32b963c49cc65df5e3450489caba9394cdd92de86f2aefd2c43e13567146

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Review

Contract Name	MultiRewards
Compiler Version	v0.5.17
Optimization	200 runs
Testing Deploy	https://testnet.bscscan.com/address/0xc2D5B5011Bd033593b911E6d4BF67629Ef863F59
Address	0xc2D5B5011Bd033593b911E6d4BF67629Ef863F59
Network	BSC_TESTNET
Total Supply	0

Audit Updates

Initial Audit	19 Dec 2022

Source Files

Filename	SHA256
MultiRewards.sol	26af32b963c49cc65df5e3450489caba9394cdd92de86f2aefd2c43e13567146

Introduction

Digits DAO consists of four contracts:

- Digits
- DividendTracker
- TokenStorage
- MultiRewards

This audit report is referring to the MultiRewards contract. The audit report for the first three contracts can be found at https://github.com/cyberscope-io/audits/tree/main/digits-dao/audit.pdf.

Roles

The contract has two roles, the USER role, and the OWNER role.

The OWNER role has the authority to

- Add a new reward.
- Set the distributor of a reward.
- Pause the staking functionality.

The USER role has the authority to

- Stake tokens.
- Withdraw tokens.
- Get rewards.

Diagnostics

Critical Medium Minor / Informative

Severity	Code	Description	Status
●	RDM	Require Descriptive Message	Unresolved
●	PTAI	Potential Transfer Amount Inconsistency	Unresolved
●	PSE	Potential Side Effect	Unresolved
●	AAO	Accumulated Amount Overflow	Unresolved
●	PAI	Potential Amount Inconsistency	Unresolved
●	DPI	Decimals Precision Inconsistency	Unresolved
●	IRRC	Inaccurate Reward Rate Calculation	Unresolved
●	L02	State Variables could be Declared Constant	Unresolved
●	L04	Conformance to Solidity Naming Conventions	Unresolved
●	L09	Dead Code Elimination	Unresolved
●	L14	Uninitialized Variables in Local Scope	Unresolved
●	L16	Validate Variable Setters	Unresolved
●	L17	Usage of Solidity Assembly	Unresolved
●	L20	Succeeded Transfer Check	Unresolved

RDM - Require Descriptive Message

Criticality	Minor / Informative
Location	MultiRewards.sol#L525
Status	Unresolved

Description

The `require()` function is used to check a condition in a contract and revert any changes made to the contract's state. The contract does not provide a descriptive message to the `require()` function.

```
require(rewardData[_rewardsToken].rewardsDuration == 0);
```

Recommendation

The team is suggested to provide a descriptive message to the require function. This message can be used to provide additional context about the error that occurred or to explain why the contract execution was halted. This can be useful for debugging and for providing more information to users that interact with the contract.

PTAI - Potential Transfer Amount Inconsistency

Criticality	Minor / Informative
Location	MultiRewards.sol#L629,641
Status	Unresolved

Description

The transfer and transferFrom functions are used to transfer a specified amount of tokens to an address. The fee or tax is an amount that is charged to the sender of an ERC20 token when tokens are transferred to another address. According to the specification, the transferred amount could potential be less than the expected amount. This may produce inconsistency between the expected and the actual behavior.

The following example depicts the diversion between the expected and actual amount.

Tax	Amount	Expected	Actual
No Tax	100	100	100
10% Tax	100	100	90

```
stakingToken.safeTransferFrom(msg.sender, address(this), amount);
...
stakingToken.safeTransfer(msg.sender, amount);
```

Recommendation

The team is advised to take into consideration the actual amount that has transferred instead of the expected. It is important to note that an ERC20 transfer tax is not a standard feature of the ERC20 specification, and it is not universally implemented by all ERC20 contracts. Therefore, the contract could calculate the actual amount by deducting the amount after from the amount before the transfer.

PSE - Potential Side Effect

Criticality	Minor / Informative
Location	MultiRewards.sol#L769
Status	Unresolved

Description

The contract uses the `transfer` method to trigger dividend distribution. This can lead to unexpected side effects since the `transfer` method executes additional business logic that is unrelated to the dividend tracker.

```
stakingToken.transfer(address(stakingToken), 0);
```

Recommendation

The team is advised to implement another mechanism for triggering dividend distribution to avoid any potential side effects that may occur.

AAO - Accumulated Amount Overflow

Criticality	Minor / Informative
Location	MultiRewards.sol#L555
Status	Unresolved

Description

The contract is using variables to accumulate values. The contract could lead to an overflow when the total value of a variable exceeds the maximum value that can be stored in that variable's data type. This can happen when an accumulated value is updated repeatedly over time, and the value grows beyond the maximum value that can be represented by the data type.

```
function rewardPerToken(address _rewardsToken) public view returns (uint256)
{
  if (_totalSupply == 0) {
    return rewardData[_rewardsToken].rewardPerTokenStored;
  }
  return
    rewardData[_rewardsToken].rewardPerTokenStored.add(
      lastTimeRewardApplicable(_rewardsToken)
        .sub(rewardData[_rewardsToken].lastUpdateTime)
        .mul(rewardData[_rewardsToken].rewardRate)
        .mul(1e18)
        .div(_totalSupply)
    );
}
```

Recommendation

The team is advised to carefully investigate the usage of the variables that accumulate value. A suggestion is to add checks to the code to ensure that the value of a variable does not exceed the maximum value that can be stored in its data type.

PAI - Potential Amount Inconsistency

Criticality	Minor / Informative
Location	MultiRewards.sol#L772
Status	Unresolved

Description

The result that is being returned from the `withdrawableDividendOf` function can potentially be different than the one being transferred at `claim` function. As a result, the values may diverge.

```
uint256 reflection = _digits.withdrawableDividendOf(address(this));
if (reflection > 0) {
  _digits.claim();
  _reflectionPerToken = reflection.mul(1e32).div(_totalSupply).add(
    _reflectionPerToken
  );
}
```

Recommendation

The team is advised to take into consideration the actual amount that has transferred instead of the expected.

DPI - Decimals Precision Inconsistency

Criticality	Minor / Informative
Location	MultiRewards.sol#L555,664
Status	Unresolved

Description

The variable `rewardRate` is calculated based on the decimal places of the `rewardToken`, when the `notifyRewardAmount` function is called. In contrast, the `rewardPerToken` function uses the `rewardRate` variable with the decimal places of the contract. As a result, this can cause inconsistency between values.

```
IERC20(_rewardsToken).safeTransferFrom(msg.sender, address(this), reward);

if (block.timestamp >= rewardData[_rewardsToken].periodFinish) {
  rewardData[_rewardsToken].rewardRate = reward.div(
    rewardData[_rewardsToken].rewardsDuration
  );
} else {
  uint256 remaining = rewardData[_rewardsToken].periodFinish.sub(
    block.timestamp
  );
  uint256 leftover = remaining.mul(
    rewardData[_rewardsToken].rewardRate
  );
  rewardData[_rewardsToken].rewardRate = reward.add(leftover).div(
    rewardData[_rewardsToken].rewardsDuration
  );
}
...
rewardData[_rewardsToken].rewardPerTokenStored.add(
  lastTimeRewardApplicable(_rewardsToken)
    .sub(rewardData[_rewardsToken].lastUpdateTime)
    .mul(rewardData[_rewardsToken].rewardRate)
    .mul(1e18)
    .div(_totalSupply)
);
```

Recommendation

To avoid these issue, it is important to carefully review the implementation of the decimals field of the underlying tokens. The team is advised to normalize each decimal to one single source of truth. A recommended way is to check the difference of decimal places between the `rewardToken` and the `staking` token, after the reward is transferred on `notifyRewardAmount` function and normalize it.

IRRC - Inaccurate Reward Rate Calculation

Criticality	Minor / Informative
Location	MultiRewards.sol#L696
Status	Unresolved

Description

The contract calculates the `rewardRate` based on the remaining period of a user's last staking, but it can lead to inaccurate values. An example might be the following:

- A user stakes 100 tokens, then the values are being calculated.
- Before the time period finishes, he stakes again the same amount.
- Then the `rewardRate` is being calculated again with the last's staking reward and time period, without taking into consideration the first one. As a result `rewardRate` resolves to an inaccurate number.

```
uint256 remaining = rewardData[_rewardsToken].periodFinish.sub(
  block.timestamp
);
uint256 leftover = remaining.mul(
  rewardData[_rewardsToken].rewardRate
);
rewardData[_rewardsToken].rewardRate = reward.add(leftover).div(
  rewardData[_rewardsToken].rewardsDuration
);
```

Recommendation

The team is advised to recoinsider all possible scenarios and rewrite the `notifyRewardAmount` function to avoid any potential miscalculations.

L02 - State Variables could be Declared Constant

Criticality	Minor / Informative
Location	MultiRewards.sol#L478
Status	Unresolved

Description

State variables can be declared as constant using the constant keyword. This means that the value of the state variable cannot be changed after it has been set. Additionally, the constant variables decreases gas consumption of the corresponding transaction.

```
uint256 private MAXUINT256 = 2**256 - 1
```

Recommendation

Constant state variables can be useful when you want to ensure that the value of a state variable cannot be changed by any function in the contract. This can be useful for storing values that are important to the contract's behavior, such as the contract's address or the maximum number of times a certain function can be called. The team is advices to add the constant keyword to state variables that never change.

L04 - Conformance to Solidity Naming Conventions

Criticality	Minor / Informative
Location	MultiRewards.sol#L151,196,478,521,522,523,546,555,573,600,614,615,664,725
Status	Unresolved

Description

The Solidity style guide is a set of guidelines for writing clean and consistent Solidity code. Adhering to a style guide can help improve the readability and maintainability of your Solidity code, making it easier for others to understand and work with.

The followings are few key points from the Solidity style guide:

1. Use camelCase for function and variable names, with the first letter in lowercase (e.g., myVariable, updateCounter).
2. Use PascalCase for contract, struct, and enum names, with the first letter in uppercase (e.g., MyContract, UserStruct, ErrorEnum).
3. Use uppercase for constant variables and enums (e.g., MAX_VALUE, ERROR_CODE).
4. Use indentation to improve readability and structure.
5. Use spaces between operators and after commas.
6. Use comments to explain the purpose and behavior of your code.
7. Keep lines short (around 120 characters) to improve readability.

```
address _owner
bool _paused
uint256 private MAXUINT256 = 2**256 - 1
address _rewardsToken
address _rewardsDistributor
uint256 _rewardsDuration
address _rewardsToken
address _rewardsToken
address _rewardsToken
address _rewardsToken
address _rewardsToken
address _rewardsDistributor
address _rewardsToken
uint256 _rewardsDuration

...
```

Recommendation

By following the Solidity naming convention guidelines, the codebase increased the readability, maintainability, and makes it easier to work with.

You can find more information on the Solidity documentation https://docs.soliditylang.org/en/v0.8.17/style-guide.html#naming-convention.

L09 - Dead Code Elimination

Criticality	Minor / Informative
Location	MultiRewards.sol#L120,135,280,299,317
Status	Unresolved

Description

In Solidity, dead code is code that is written in the contract, but is never executed or reached during normal contract execution. Dead code can occur for a variety of reasons, such as:

- Conditional statements that are always false.
- Functions that are never called.
- Unreachable code (e.g., code that follows a return statement).

Dead code can make a contract more difficult to understand and maintain, and can also increase the size of the contract and the cost of deploying and interacting with it.

```
function max(uint256 a, uint256 b) internal pure returns (uint256) {
        return a >= b ? a : b;
    }

function average(uint256 a, uint256 b) internal pure returns (uint256) {
        // (a + b) / 2 can overflow, so we distribute
        return (a / 2) + (b / 2) + (((a % 2) + (b % 2)) / 2);
    }

...
```

Recommendation

To avoid creating dead code, it's important to carefully consider the logic and flow of the contract and to remove any code that is not needed or that is never executed. This can help improve the clarity and efficiency of the contract.

L14 - Uninitialized Variables in Local Scope

Criticality	Minor / Informative
Location	MultiRewards.sol#L646
Status	Unresolved

Description

Using an uninitialized local variable can lead to unpredictable behavior and potentially cause errors in your contract. It's important to always initialize local variables with appropriate values before using them.

```
uint256 i
```

Recommendation

By initializing local variables before using them, you can help ensure that your contract functions behave as expected and avoid potential issues.

L16 - Validate Variable Setters

Criticality	Minor / Informative
Location	MultiRewards.sol#L152
Status	Unresolved

Description

The contract performs operations on variables that have been configured on user-supplied input. These variables are missing of proper check for the case where a value is zero. This can lead to problems when the contract is executed, as certain actions may not be properly handled when the value is zero.

```
nominatedOwner = _owner
```

Recommendation

By adding the proper check, the contract will not allow the variables to be configured with zero value. This will ensure that the contract can handle all possible input values and avoid unexpected behavior or errors. Hence, it can help to prevent the contract from being exploited or operating unexpectedly.

L17 - Usage of Solidity Assembly

Criticality	Minor / Informative
Location	MultiRewards.sol#L25
Status	Unresolved

Description

Using assembly can be useful for optimizing code, but it can also be error-prone. It's important to carefully test and debug assembly code to ensure that it is correct and does not contain any errors. Some common types of errors that can occur when using assembly in Solidity include Syntax, Type, Out-of-bounds, Stack and Revert.

```
assembly {
            size := extcodesize(account)
        }
```

Recommendation

It is recommended to use assembly sparingly and only when necessary, as it can be difficult to read and understand compared to Solidity code.

L20 - Succeeded Transfer Check

Criticality	Minor / Informative
Location	MultiRewards.sol#L769
Status	Unresolved

Description

According to the ERC20 specification, the transfer methods should be checked if the result is successful. Otherwise, the contract may wrongly assume that the transfer has been established.

```
stakingToken.transfer(address(stakingToken), 0)
```

Recommendation

The contract should check if the result of the transfer methods is successful. The team is advised to check the SafeERC20 library from the Openzeppelin library.

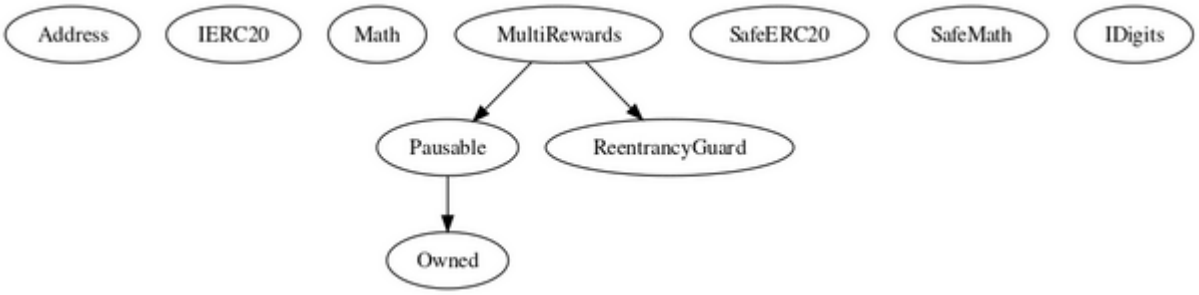
Functions Analysis

Contract	Type	Bases		
	Function Name	**Visibility**	**Mutability**	**Modifiers**
Address	Library			
	isContract	Internal		
IERC20	Interface			
	totalSupply	External		-
	balanceOf	External		-
	transfer	External	✓	-
	allowance	External		-
	approve	External	✓	-
	transferFrom	External	✓	-
Math	Library			
	max	Internal		
	min	Internal		
	average	Internal		
Owned	Implementation			
		Public	✓	-
	nominateNewOwner	External	✓	onlyOwner
	acceptOwnership	External	✓	-
	_onlyOwner	Private		
Pausable	Implementation	Owned		
		Internal	✓	

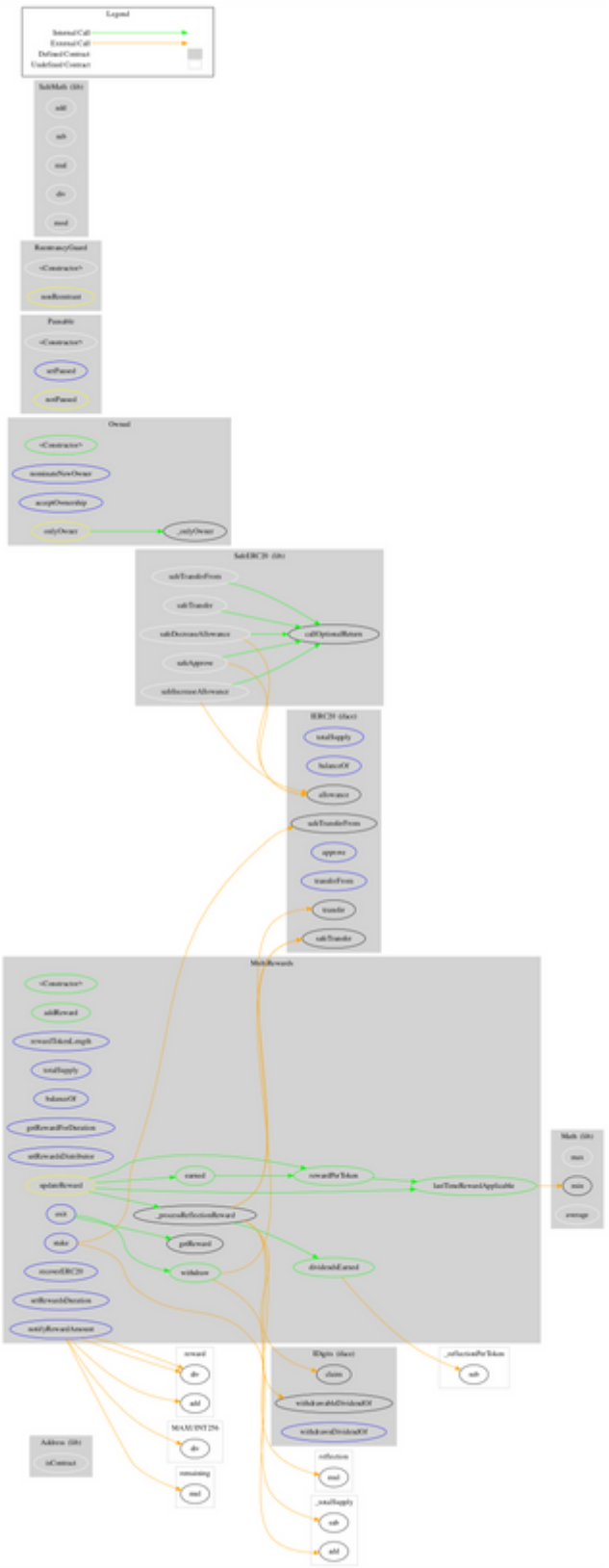
	setPaused	External	✓	onlyOwner
ReentrancyGuard	Implementation			
		Internal	✓	
SafeERC20	Library			
	safeTransfer	Internal	✓	
	safeTransferFrom	Internal	✓	
	safeApprove	Internal	✓	
	safeIncreaseAllowance	Internal	✓	
	safeDecreaseAllowance	Internal	✓	
	callOptionalReturn	Private	✓	
SafeMath	Library			
	add	Internal		
	sub	Internal		
	mul	Internal		
	div	Internal		
	mod	Internal		
IDigits	Interface			
	claim	External	✓	-
	withdrawableDividendOf	External		-
	withdrawnDividendOf	External		-
MultiRewards	Implementation	Reentrancy Guard, Pausable		
		Public	✓	Owned
	addReward	Public	✓	onlyOwner

	rewardTokenLength	External		-
	totalSupply	External		-
	balanceOf	External		-
	lastTimeRewardApplicable	Public		-
	rewardPerToken	Public		-
	earned	Public		-
	dividendsEarned	Public		-
	getRewardForDuration	External		-
	setRewardsDistributor	External	✓	onlyOwner
	stake	External	✓	nonReentrant notPaused updateReward
	withdraw	Public	✓	nonReentrant updateReward
	getReward	Public	✓	nonReentrant updateReward
	exit	External	✓	-
	notifyRewardAmount	External	✓	updateReward
	recoverERC20	External	✓	onlyOwner
	setRewardsDuration	External	✓	-
	_processReflectionReward	Private	✓	

Inheritance Graph



Flow Graph



Summary

Digits DAO contract implement a staking mechanism. This audit investigates security issues, business logic concerns and potential improvements.

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The Cyberscope team

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