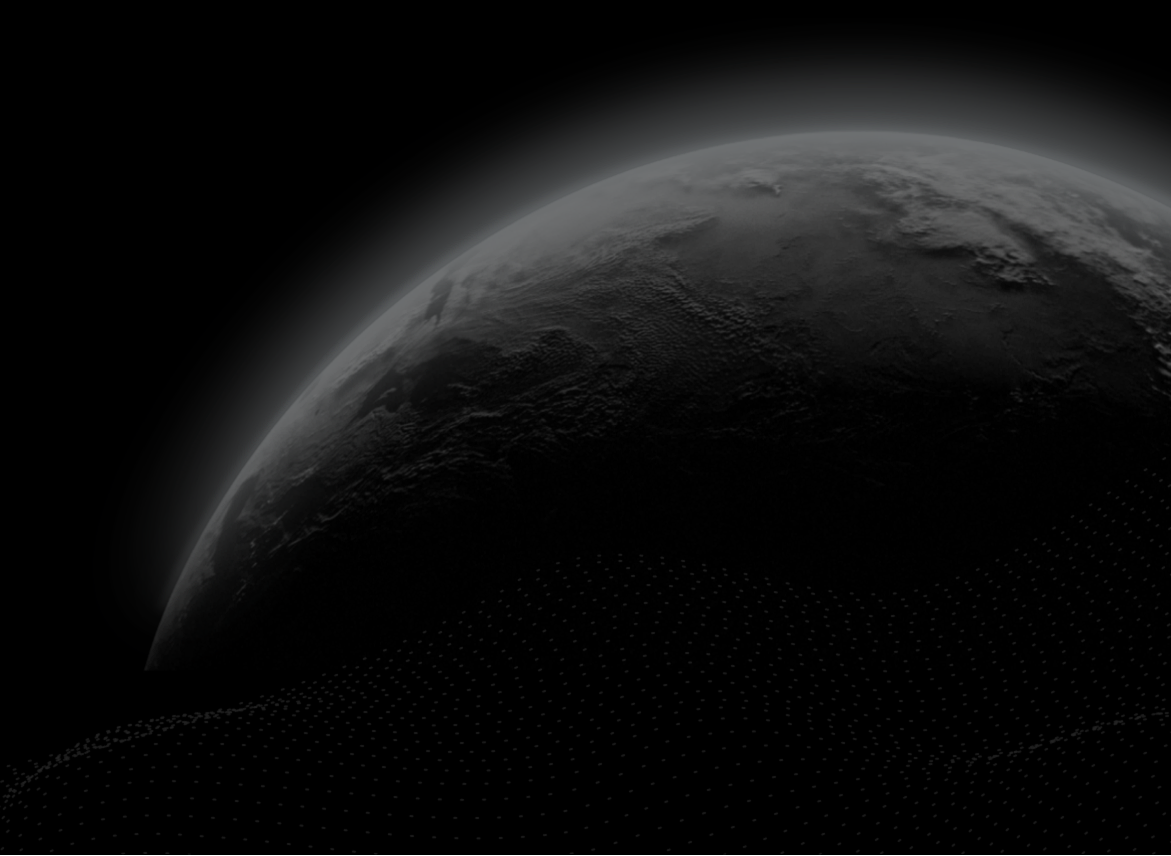
Economic Assessment

T.I.M.E. Dividend(TIME) - Polygon

CertiK Assessed on Dec 8th, 2023



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The economic assessment was prepared by CertiK, the leader in Web3.0 security.

Executive Summary

TYPES	ECOSYSTEM	METHODS
DeFi	Polygon (MATIC)	Manual Review, Static Analysis
LANGUAGE	**TIMELINE**	**KEY COMPONENTS**
Solidity	Delivered on 12/08/2023	N/A

CODEBASE

https://polygonscan.com/token/0x9F42bcA1A579fCf9Efc165a0244B129
37e18C6A5

View All in Codebase Page

Vulnerability Summary

Total Findings	Resolved	Mitigated	Partially Resolved	Acknowledged	Declined
0	0	0	0	0	0

Count	Severity	Description
0	Critical	Critical risks are those that impact the safe functioning of a platform and must be addressed before launch. Users should not invest in any project with outstanding critical risks.
0	Major	Major risks can include centralization issues and logical errors. Under specific circumstances, these major risks can lead to loss of funds and/or control of the project.
0	Medium	Medium risks may not pose a direct risk to users' funds, but they can affect the overall functioning of a platform.
0	Minor	Minor risks can be any of the above, but on a smaller scale. They generally do not compromise the overall integrity of the project, but they may be less efficient than other solutions.
0	Informational	Informational errors are often recommendations to improve the style of the code or certain operations to fall within industry best practices. They usually do not affect the overall functioning of the code.

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CODEBASE | T.I.M.E. DIVIDEND(TIME) - POLYGON

Repository

https://polygonscan.com/token/0x9F42bcA1A579fCf9Efc165a0244B12937e18C6A5

AUDIT SCOPE | T.I.M.E. DIVIDEND(TIME) - POLYGON

1 file audited ● 1 file without findings

ID	Repo	File	SHA256 Checksum
● TIM	mainnet	contracts/TIMEDividend.sol	610663a652d489d47d40e682cd0e794827ea6a4617b0297c9dc688bc85090d2d

APPROACH & METHODS | T.I.M.E. DIVIDEND(TIME) - POLYGON

This report has been prepared for T.I.M.E. Dividend to discover issues and vulnerabilities in the source code of the T.I.M.E. Dividend(TIME) - Polygon project as well as any contract dependencies that were not part of an officially recognized library. A comprehensive examination has been performed, utilizing Manual Review and Static Analysis 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.

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:

- Testing the smart contracts against both common and uncommon attack vectors;
- 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.

INTRODUCTION | T.I.M.E. DIVIDEND(TIME) - POLYGON

The `TIMEDividend` contract allows for the distribution of dividends to token holders. The dividends are paid out in native coins (MATIC), with the amount distributed based on the number of tokens held by each address after delta correction. The delta correction moves opposite to the token flow of token transferring, such that in general, the dividend distribution is aligned with the initial token holding status. Generally we do not recommend the token distribution to have more than half of the total supply held by one user, given that the initial token distribution takes place before the contract is ready and allowed to work.

The contract uses a unique approach to calculate dividends, where `magnifiedDividendPerShare` and `magnifiedDividendCorrections` of each address are to ensure that the dividend payouts/claims are maintained over time.

A core value of the calculation if the state variable `magnitude`, which is a constant value used to convert amounts to scaling magnitudes. It used to maintaining the resolution of payouts to be accurately calculated for very small amounts. It is hardcoded to 2^{128} in the contract.

The contract contains two key mappings, `cumulativeDividendClaimed` and `magnifiedDividendCorrections`. `cumulativeDividendClaimed` is used to track the cumulative amount of dividend claimed by each address, ensuring that double payouts are not made. `magnifiedDividendCorrections` is used to track corrections made to the magnified dividend per share as tokens are transferred between accounts.

The `receive()` function is aim to receive fees generated from the swap operations, which is not implemented in the TIMEDividend contract. In fact the `receive` function does not specify which address is the source of the fees, such that it allows any addresses to send native coin (MATIC) to itself. The function requires that the minting process is complete and the ownership has been renounced, which can also be seen as a status that the whole contract is ready to start functioning.

PROTOCOL DESCRIPTION | T.I.M.E. DIVIDEND(TIME) - POLYGON

State Variables

```
uint256 public constant magnitude = 2**128;
uint256 public magnifiedDividendPerShare;

mapping(address => int256) public magnifiedDividendCorrections;
mapping(address => uint256) public cumulativeDividendClaimed;
```

Functions

receive()

Let a_b be the native coins (MATIC) transfer amount, which is also known as `msg.value` in Solidity. For each function call, we have

$$magnifiedDividendPerShare += \frac{a_b}{totalSupply} \times magnitude$$

If the receive function is called for n times, we have

$$magnifiedDividendPerShare_n = \sum_{i=1}^{n} \frac{a_{bi}}{totalSupply} \times magnitude$$

$$\implies magnifiedDividendPerShare_n = 2^{128} * \sum_{i=1}^{n} \frac{a_{bi}}{totalSupply}$$

where `totalSupply` cannot be increased since the require statement of the `receive` function checks that the contract ownership is already renounced.

_beforeTokenTransfer()

Let's say there is a transfer transaction, where u_s is the sender's address, u_r is the recepient address, and a_t is the token transfer amount. Let `magnifiedDividendCorrections` be mdc. If this function is called for n times, we have

$$mdc[u_s] = \sum_{i=1}^{n} magnifiedDividendPerShare \times a_t$$

and

$$mdc[u_r] = -\sum_{i=1}^{n} magnifiedDividendPerShare \times a_t$$

divideFrom()

$$product = magDividendPerShare * balance + correction$$

$$return_1 = product/magnitude$$

$$\implies return_1 = (magDividendPerShare * balance + correction) \div magnitude$$

$$return_2 = product \mod magnitude$$

$$\implies return_2 = (magDividendPerShare * balance + correction) \mod magnitude$$

accumulativeDividendOf()

Let `magnifiedDividendCorrections` be mdc, and `account` be the input address. Also since there are two parts of the return value, let the former value be $return_1$ and the latter value be $return_2$.

$$return_1 = product/magnitude$$

$$\implies return_1 = (magDividendPerShare * balanceOf(account) + mdc[account]) \div magnitude$$

$$return_2 = product \mod magnitude$$

$$\implies return_2 = (magDividendPerShare * balanceOf(account) + mdc[account]) \mod magnitude$$

claimableDividendOf()

Let `magnifiedDividendCorrections` be mdc, `account` be the input address, and `cumulativeDividendClaimed` be cdc, we have

$$return = (return_1 \ of \ dividendFrom) - cdc[account]$$

$$\implies return = \frac{magDividendPerShare*balanceOf(account)+mdc[account]}{magnitude} - cdc[account]$$

claimDividend()

Let `magnifiedDividendCorrections` be mdc, and let `cumulativeDividendClaimed` be cdc.

$$claimable = \frac{magDividendPerShare*balanceOf(account)+mdc[account]}{magnitude} - cdc[account]_{old}$$

$$recipent \ balance += claimable \text{ , where currency MATIC}$$

$$cdc[account] += claimable$$

distributeAll()

This function is removed in commit hash `d6c89e5dac14b6db95f9dc67af54bd76103805fe`.

~~Called function `distributeAll()` from interface `IInternetMoneySwapRouter`. The function sends all fees, the input `amount` of native coins and/or WETH tokens, to the `destination` address defined in the contract behind the `IInternetMoneySwapRouter`.~~

PROTOCOL ANALYSIS | T.I.M.E. DIVIDEND(TIME) - POLYGON

The smart contract and its functions don't maintain any time-related variables, so the length of time a user holds TIME tokens doesn't affect the final dividend amount. We thoroughly examined the state and local variables of the TIMEDividend contract and found that it doesn't store or use any external data related to a locking time period. Therefore, the only variables that influence a user's dividend/reward are the `magnifiedDividendPerShare` , the amount of TIME tokens held by the user's address, and the `magnifiedDividendCorrections` (mdc) of the user's address.

Claimable Dividend

Within the four state variables, `magnitude` is declared to be `constant` .

`magnifiedDividendPerShare` is a variable that keeps track of the magnified dividend per share. It is calculated by dividing the total amount of dividend received by the `<total supply of tokens>` , and then multiplying by `magnitude` (2^{128}).

The `magnifiedDividendCorrections` mapping keeps track of the magnified dividend corrections for each account. Magnified dividend corrections are used to adjust the claimable dividend of an account based on its transfer history.

The `cumulativeDividendClaimed` mapping keeps track of the cumulative dividend claimed for each account. It is used to calculate the total claimable dividend for an account.

Here we would like to summarize a general math expression of the claimable dividend of a user. For the n-th time the function `claimDividend` is being called by an address, define the follow variables:

- `msg.sender` , the function caller address: u
- `magnifiedDividendPerShare` : `mdps`
- the previous claimed dividend summation: cdc_{n-1}
- the number of function calls of `claimDividend` before this call : n_c
- the number of function calls of `receive` : n_{nc}
  - the received MATIC amount of the i_{nc} time with the total n_{nc} time:$amount_{i_{nc}}$
- the number of function calls of `transfer` as a sender: n_{ts}
  - the sent token amount of the i_{ts} time with the total n_{ts} time: $amount_{i_{ts}}$
- the number of function calls of `transfer` as a receiver: n_{tr}
  - the received token amount of the i_{tr} time with the total n_{tr} time: $amount_{i_{tr}}$
- the number of function calls of `burn` : n_b
  - the burnt token amount of the i_b time with the total n_b time: $amount_{i_b}$
- initial token balance of the user: $initBal$

- current token balance of the user: $currBal$, at the n-th call of `claimDividend`

From the above function description, we have

$$claimable_n = \frac{magDividendPerShare_{n_{nc}} * balanceOf(account) + mdc[account]}{magnitude} - cdc_{old}$$

Here for the balance of u at the n-th call of `claimDividend`, the current token balance is

$$currBal = initBal - <\text{all sent amount}> + <\text{all received amount}> - <\text{all burnt amount}>$$

$$\implies currBal = initBal - \sum_{i_{ts}=1}^{n_{ts}} amount_{i_{tr}} + \sum_{i_{ts}=1}^{n_{tr}} amount_{i_{tr}} - \sum_{i_b=1}^{n_b} amount_{i_b}$$

Similarly, we have the `magnifiedDividendCorrections` be

$$mdc = mdps * (<\text{all sent amount}> - <\text{all received amount}> + <\text{all burnt amount}>)$$

$$\implies mdc = mdps * (\sum_{i_{ts}=1}^{n_{ts}} amount_{i_{tr}} - \sum_{i_{ts}=1}^{n_{tr}} amount_{i_{tr}} + \sum_{i_b=1}^{n_b} amount_{i_b})$$

In the meanwhile, `magnifiedDividendPerShare` is monotonically increasing controlled by the `receive` function. From the above function description of `receive`, we have

$$magnifiedDividendPerShare_{n_{nc}} = \sum_{i_{nc}=1}^{n_{nc}} \frac{amount_{i_{nc}}}{totalSupply} \times magnitude$$

Also, for the previous claimed dividend summation, we have $cdc_{n-1} = \sum_{i=1}^{n-1} claimable_i$

Therefore, for $claimable_n$, we have

$$claimable_n = \frac{magDividendPerShare_{n_{nc}} * balanceOf(account) + mdc[account]}{magnitude} - cdc_{old}$$

Substitute the variable names and make them fit the latest definition in the analysis.

$$claimable_n = \frac{mdps_{n_{nc}} * currBal + mdc}{magnitude} - cdc_{n-1}$$

Since $mdc == mdps * (<\text{transfer amount delta}>)$, we can extract $\frac{mdps}{magnitude}$, and then we have

$$claimable_n = \frac{mdps}{magnitude} * (currBal + \frac{mdc}{mdps}) - \sum_{i=1}^{n-1} claimable_i$$

Substitute $currBal$ and mdc, we have the expression with the detailed amount summation based on the times of different functions being called for the current `receiver` function caller.

$$\implies claimable_n = \frac{mdps}{magnitude} * (initBal - \sum_{i_{ts}=1}^{n_{ts}} amount_{i_{tr}} + \sum_{i_{ts}=1}^{n_{tr}} amount_{i_{tr}} - \sum_{i_b=1}^{n_b} amount_{i_b} + \sum_{i_{ts}=1}^{n_{ts}} amount_{i_{tr}} - \sum_{i_{ts}=1}^{n_{tr}} amount_{i_{tr}} + \sum_{i_b=1}^{n_b} amount_{i_b}) - \sum_{i=1}^{n-1} claimable_i$$

$$= \frac{mdps}{magnitude} * initBal - \sum_{i=1}^{n-1} claimable_i$$

$$= \frac{\sum_{i_{nc}=1}^{n_{nc}} \frac{amount_{i_{nc}}}{totalSupply} \times magnitude}{magnitude} - \sum_{i=1}^{n-1} claimable_i$$

$$= \sum_{i_{nc}=1}^{n_{nc}} \frac{amount_{i_{nc}}}{totalSupply} - \sum_{i=1}^{n-1} claimable_i$$

Here when $i = 1$, the base case gives that the $claimable_1 = 0$, and the first time claimable dividend is the sum of quotient of each native coin (MATIC) deposit divided by the total supply at that time.

APPENDIX | T.I.M.E. DIVIDEND(TIME) - POLYGON

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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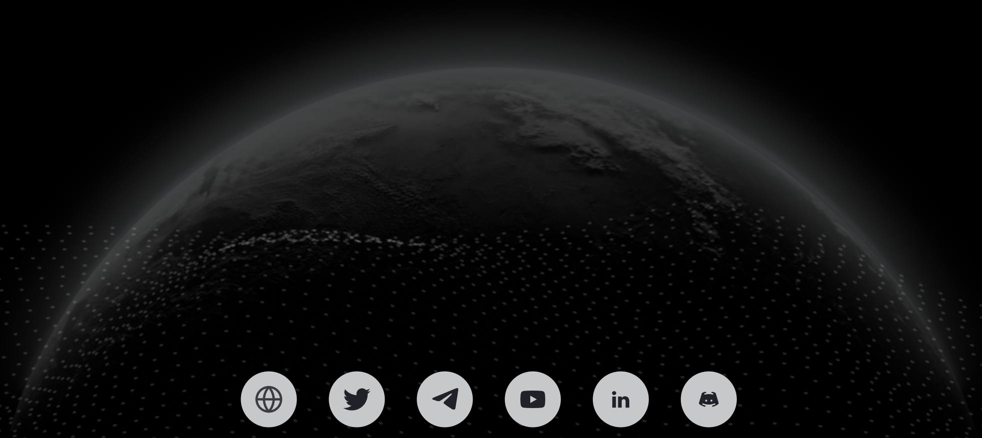

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