RT-Pay

Security Assessment

CertiK Assessed on Jul 7th, 2025

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RT-Pay

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

Executive Summary

TYPES	ECOSYSTEM	METHODS
ERC-20	Tron (TRX)	Formal Verification, Manual Review, Static Analysis
LANGUAGE	**TIMELINE**	**KEY COMPONENTS**
Solidity	Delivered on 07/07/2025	N/A
CODEBASE		**COMMITS**
source View All in Codebase Page		150008c33aa18a1682afc6bf32a233fa7828bfd1 View All in Codebase Page

Highlighted Centralization Risks

- Privileged role can remove users' tokens
- Transfers can be paused
- Privileged role can mint tokens
- Has blacklist/whitelist

Vulnerability Summary

5	3	0	2	0
Total Findings	Resolved	Partially Resolved	Acknowledged	Declined

2	Centralization	2 Acknowledged	Centralization findings highlight privileged roles & functions and their capabilities, or instances where the project takes custody of users' assets.
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 may include logical errors that, under specific circumstances, could result in fund losses or loss of project control.
1	Medium	1 Resolved	Medium risks may not pose a direct risk to users' funds, but they can affect the overall functioning of a platform.
1	Minor	1 Resolved	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.

1	Informational	1 Resolved	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 | RT-PAY

Repository

source

Commit

150008c33aa18a1682afc6bf32a233fa7828bfd1

AUDIT SCOPE | RT-PAY

2 files audited ● 2 files with Acknowledged findings

ID	Repo	File	SHA256 Checksum
● MSW	rt-pay/tkn	MultiSigWallet.sol	8904f653f4e94cc2450c7131b0aec5e882c6e743ed6447413331f3ac4fc79f74
● TKN	rt-pay/tkn	TKN.sol	ff1c3693dada46fe9e20d34b903c05bd66d5b31fd23117a5f1892212fdf478d1

APPROACH & METHODS | RT-PAY

This report has been prepared for RT-Pay to discover issues and vulnerabilities in the source code of the RT-Pay 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, Formal Verification, 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.

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.

FINDINGS | RT-PAY

5	0	2	0	1	1	1
Total Findings	Critical	Centralization	Major	Medium	Minor	Informational

This report has been prepared to discover issues and vulnerabilities for RT-Pay. Through this audit, we have uncovered 5 issues ranging from different severity levels. Utilizing the techniques of Static Analysis, Formal Verification & Manual Review to complement rigorous manual code reviews, we discovered the following findings:

ID	Title	Category	Severity	Status
RTP-02	**Centralized Balance Manipulation**	**Centralization**	**Centralization**	**Acknowledged**
RTP-03	**Centralization Risks**	**Centralization**	**Centralization**	**Acknowledged**
RTP-07	Weak Constraint On `numConfirmationsRequired`	Logical Issue	Medium	Resolved
RTP-05	Missing 0 Address Check In `replaceOwner()` Function	Volatile Code, Inconsistency	Minor	Resolved
RTP-06	Missing Emit Events	Coding Style	Informational	Resolved

RTP-02 | CENTRALIZED BALANCE MANIPULATION

Category	Severity	Location	Status
Centralization	**Centralization**	**TKN.sol: 50, 54**	**Acknowledged**

Description

In the contract `RUBx` , the role `MINTER_ROLE` has the authority to update the token balance of an arbitrary account without sanity restriction.

Any compromise to the `MINTER_ROLE` account or the `DEFAULT_ADMIN_ROLE` which can set `MINTER_ROLE` may allow a hacker to take advantage of this authority and manipulate users' balances. For example, The hacker could also update his/her balance to a large number, sell these tokens, and cause the token price to drop.

Recommendation

We recommend the team makes efforts to restrict access to the private key of the privileged account. A strategy of multi-signature (⅔, ⅗) wallet can be used to prevent a single point of failure due to a private key compromise. In addition, the team should be transparent and notify the community in advance whenever they plan to mint more tokens or engage in similar balance-related operations.
Here are some feasible short-term and long-term suggestions that would mitigate the potential risk to a different level and suggestions that would permanently *fully* resolve the risk:

Short Term:

A multi signature (⅔, ⅗) wallet *mitigate* the risk by avoiding a single point of key management failure.

- Assignment of privileged roles to multi-signature wallets to prevent a single point of failure due to a private key compromised;
  AND
- A medium/blog link for sharing the time-lock contract and multi-signers' addresses information with the community.

For remediation and mitigated status, please provide the following information:

- Provide the **gnosis** address with **ALL** the multi-signer addresses for the verification process.
- Provide a link to the **medium/blog** with all of the above information included.

Long Term:

A DAO for controlling the operation *mitigate* the risk by applying transparency and decentralization.

- Introduction of a DAO, governance, or voting module to increase decentralization, transparency, and user involvement;
  AND
- A medium/blog link for sharing the multi-signers' addresses, and DAO information with the community.

For remediation and mitigated status, please provide the following information:

- Provide the **gnosis** address with **ALL** the multi-signer addresses for the verification process.
- Provide a link to the **medium/blog** with all of the above information included.

Permanent:

The following actions can *fully* resolve the risk:

- Renounce the ownership and never claim back the privileged role.
  OR
- Remove the risky functionality.
  OR
- Add minting logic (such as a vesting schedule) to the contract instead of allowing the owner account to call the sensitive function directly.

Note: we recommend the project team consider 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

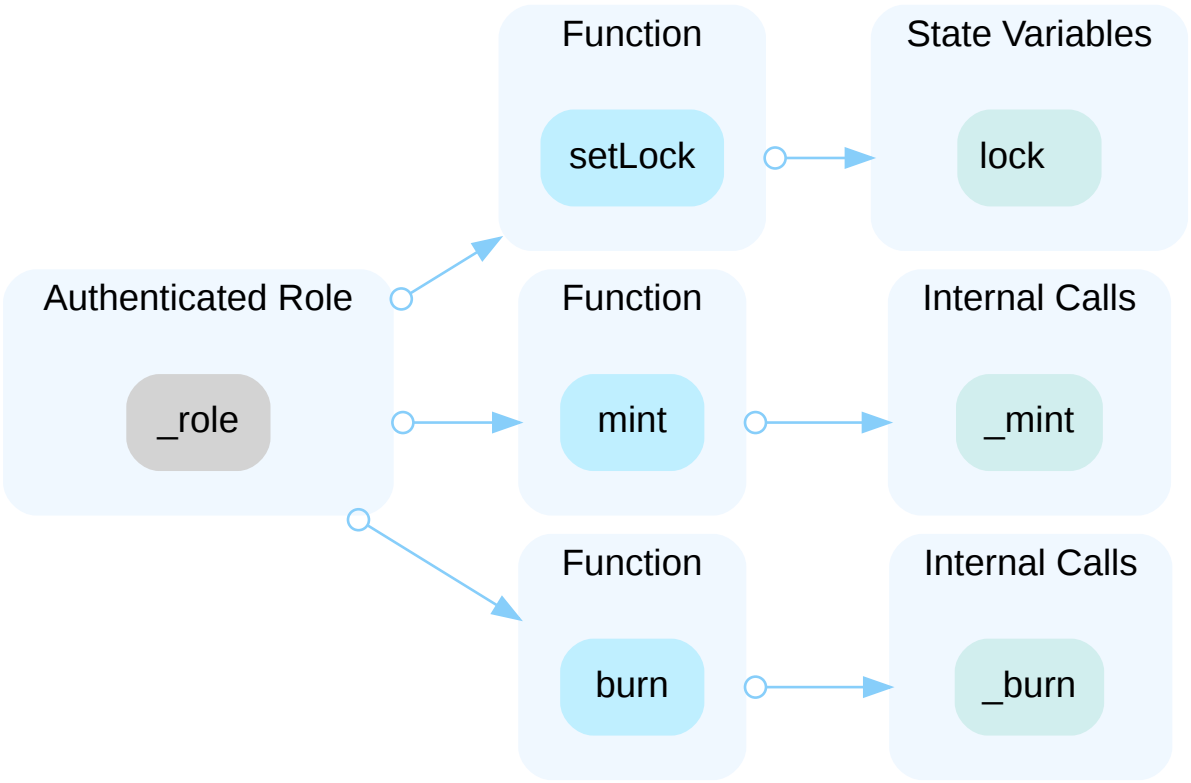
[RT-Pay, 07/10/2025]: Issue acknowledged. I won't make any changes for the current version.

RTP-03 | CENTRALIZATION RISKS

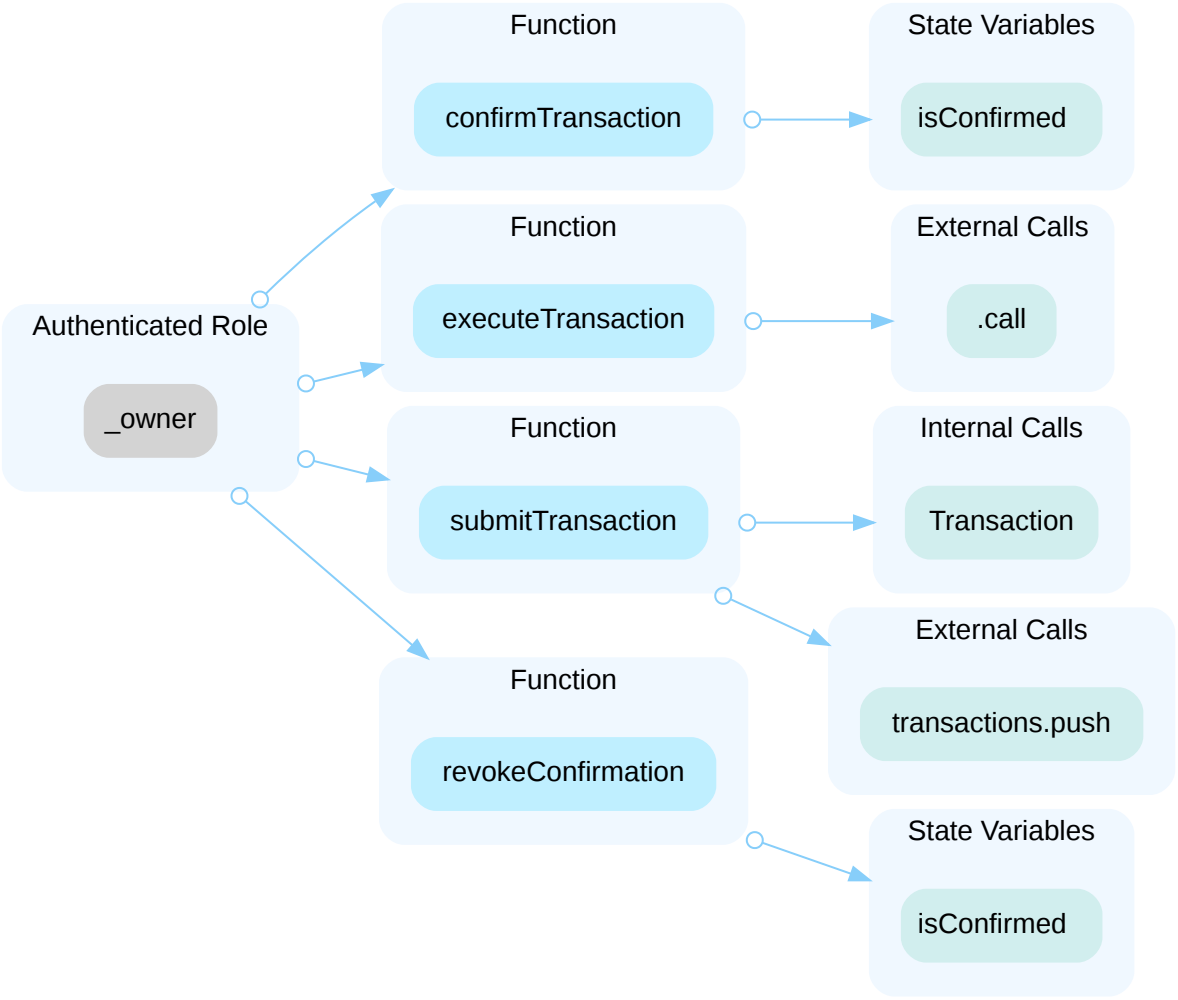
Category	Severity	Location	Status
Centralization	Centralization	MultiSigWallet.sol: 79, 98, 112, 134, 218, 236, 249, 267; TKN.sol: 46, 50, 54	Acknowledged

Description

In the contract `RUBx` , the role `MINTER_ROLE` / `LOCK_ROLE` has authority over the functions shown in the diagram below. Additionally, the `DEFAULT_ADMIN_ROLE` has the authority to set or revoke `MINTER_ROLE` / `LOCK_ROLE` / `BLACKLIST` . Any compromise to the `DEFAULT_ADMIN_ROLE` / `MINTER_ROLE` / `LOCK_ROLE` account may allow the hacker to take advantage of this authority and set the lock status, mint tokens to a specified address, and burn a specified amount of token from an arbitrary address.



In the contract `MultiSigWallet` , the role `_owner` has authority over the functions shown in the diagram below. Any compromise to the `_owner` account may allow the hacker to take advantage of this authority and confirm a transaction, add a new transaction to the transactions array, revoke a transaction confirmation, or execute a specified transaction. Note that this contract being a multisig wallet already partially mitigates the risk.



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., multisignature 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.

Alleviation

[RT-Pay, 07/10/2025]: Issue acknowledged. I won't make any changes for the current version.

RTP-07 | WEAK CONSTRAINT ON `numConfirmationsRequired`

Category	Severity	Location	Status
Logical Issue	Medium	MultiSigWallet.sol: 57~58	Resolved

Description

The only constraint on the `numConfirmationsRequired` in the `MultiSigWallet` contract is that it is greater than 0 and no greater than the number of owners. Generally, an effective multisig would require signatures from more than half of all owners, such as a 2/3 or 3/5 multisig. There's no such enforcement in the `MultiSigWallet` contract.

Recommendation

Consider including additional constraint on the `numConfirmationsRequired` to be more than half of the owner count.

Alleviation

[RT-Pay, 07/10/2025]: Issue acknowledged. Changes have been reflected in the commit hash: https://github.com/rt-pay/rubx/commit/a331f477bd8dcdab3740c1d4b66433277420547f

RTP-05 MISSING 0 ADDRESS CHECK IN `replaceOwner()` FUNCTION

Category	Severity	Location	Status
Volatile Code, Inconsistency	Minor	MultiSigWallet.sol: 218~232, 240	Resolved

Description

The `addOwner()` function has a `notNull(owner)` condition to ensure that the owner being added is not `address(0)`. However, there's no such check in the `replaceOwner()` function, which makes it possible to replace a non-zero address owner with a zero-address owner, thus breaking the intended design.

Recommendation

We recommend adding the `notNull(newOwner)` check in the `replaceOwner()` function.

Alleviation

[RT-Pay, 07/10/2025]: Issue acknowledged. Changes have been reflected in the commit hash: https://github.com/rt-pay/rubx/commit/a331f477bd8dcdab3740c1d4b66433277420547f

RTP-06 | MISSING EMIT EVENTS

Category	Severity	Location	Status
Coding Style	Informational	MultiSigWallet.sol: 218, 236, 249, 267; TKN.sol: 46	Resolved

Description

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

Recommendation

It is recommended to emit events in sensitive functions that are controlled by centralization roles.

Alleviation

[RT-Pay, 07/10/2025]: Issue acknowledged. Changes have been reflected in the commit hash: https://github.com/rt-pay/rubx/commit/a331f477bd8dcdab3740c1d4b66433277420547f

OPTIMIZATIONS | RT-PAY

ID	Title	Category	Severity	Status
RTP-01	Cache Array Length	Coding Issue	Optimization	Resolved

RTP-01 | CACHE ARRAY LENGTH

Category	Severity	Location	Status
Coding Issue	Optimization	MultiSigWallet.sol: 224	Resolved

Description

The for loop uses the length of the `owners` storage array in each loop iteration, which costs more gas due to repeated storage reads.

Recommendation

Cache the lengths of storage arrays if they are used and not modified in for loops.

Alleviation

[RT-Pay, 07/10/2025]: Issue acknowledged. Changes have been reflected in the commit hash: https://github.com/rt-pay/rubx/commit/a331f477bd8dcdab3740c1d4b66433277420547f

FORMAL VERIFICATION | RT-PAY

Formal guarantees about the behavior of smart contracts can be obtained by reasoning about properties relating to the entire contract (e.g. contract invariants) or to specific functions of the contract. Once such properties are proven to be valid, they guarantee that the contract behaves as specified by the property. As part of this audit, we applied formal verification to prove that important functions in the smart contracts adhere to their expected behaviors.

Considered Functions And Scope

In the following, we provide a description of the properties that have been used in this audit. They are grouped according to the type of contract they apply to.

Verification of ERC-20 Compliance

We verified properties of the public interface of those token contracts that implement the ERC-20 interface. This covers

- Functions `transfer` and `transferFrom` that are widely used for token transfers,
- functions `approve` and `allowance` that enable the owner of an account to delegate a certain subset of her tokens to another account (i.e. to grant an allowance), and
- the functions `balanceOf` and `totalSupply`, which are verified to correctly reflect the internal state of the contract.

The properties that were considered within the scope of this audit are as follows:

Property Name	Title
erc20-transfer-never-return-false	`transfer` Never Returns `false`
erc20-allowance-change-state	`allowance` Does Not Change the Contract's State
erc20-balanceof-change-state	`balanceOf` Does Not Change the Contract's State
erc20-transferfrom-fail-exceed-balance	`transferFrom` Fails if the Requested Amount Exceeds the Available Balance
erc20-transferfrom-fail-exceed-allowance	`transferFrom` Fails if the Requested Amount Exceeds the Available Allowance
erc20-transferfrom-correct-allowance	`transferFrom` Updated the Allowance Correctly
erc20-transferfrom-correct-amount	`transferFrom` Transfers the Correct Amount in Transfers
erc20-transfer-correct-amount	`transfer` Transfers the Correct Amount in Transfers
erc20-totalsupply-change-state	`totalSupply` Does Not Change the Contract's State
erc20-allowance-correct-value	`allowance` Returns Correct Value

Property Name	Title
erc20-approve-succeed-normal	`approve` Succeeds for Valid Inputs
erc20-allowance-succeed-always	`allowance` Always Succeeds
erc20-totalsupply-succeed-always	`totalSupply` Always Succeeds
erc20-balanceof-correct-value	`balanceOf` Returns the Correct Value
erc20-transferfrom-never-return-false	`transferFrom` Never Returns `false`
erc20-transfer-revert-zero	`transfer` Prevents Transfers to the Zero Address
erc20-transferfrom-revert-zero-argument	`transferFrom` Fails for Transfers with Zero Address Arguments
erc20-transfer-exceed-balance	`transfer` Fails if Requested Amount Exceeds Available Balance
erc20-approve-correct-amount	`approve` Updates the Approval Mapping Correctly
erc20-transfer-false	If `transfer` Returns `false`, the Contract State Is Not Changed
erc20-totalsupply-correct-value	`totalSupply` Returns the Value of the Corresponding State Variable
erc20-balanceof-succeed-always	`balanceOf` Always Succeeds
erc20-approve-revert-zero	`approve` Prevents Approvals For the Zero Address
erc20-transferfrom-false	If `transferFrom` Returns `false`, the Contract's State Is Unchanged
erc20-approve-false	If `approve` Returns `false`, the Contract's State Is Unchanged
erc20-approve-never-return-false	`approve` Never Returns `false`

Verification Results

For the following contracts, formal verification established that each of the properties that were in scope of this audit (see scope) are valid:

Detailed Results For Contract RUBx (contracts/TKN.sol) In Commit 150008c33aa18a1682afc6bf32a233fa7828bfd1

Verification of ERC-20 Compliance

Detailed Results for Function `transfer`

Property Name	Final Result	Remarks
erc20-transfer-never-return-false	True	
erc20-transfer-correct-amount	True	
erc20-transfer-revert-zero	True	
erc20-transfer-exceed-balance	True	
erc20-transfer-false	True	

Detailed Results for Function `allowance`

Property Name	Final Result	Remarks
erc20-allowance-change-state	True	
erc20-allowance-correct-value	True	
erc20-allowance-succeed-always	True	

Detailed Results for Function `balanceOf`

Property Name	Final Result	Remarks
erc20-balanceof-change-state	True	
erc20-balanceof-correct-value	True	
erc20-balanceof-succeed-always	True	

Detailed Results for Function `transferFrom`

Property Name	Final Result	Remarks
erc20-transferfrom-fail-exceed-balance	True	
erc20-transferfrom-fail-exceed-allowance	True	
erc20-transferfrom-correct-allowance	True	
erc20-transferfrom-correct-amount	True	
erc20-transferfrom-never-return-false	True	
erc20-transferfrom-revert-zero-argument	True	
erc20-transferfrom-false	True	

Detailed Results for Function `totalSupply`

Property Name	Final Result	Remarks
erc20-totalsupply-change-state	True	
erc20-totalsupply-succeed-always	True	
erc20-totalsupply-correct-value	True	

Detailed Results for Function `approve`

Property Name	Final Result	Remarks
erc20-approve-succeed-normal	True	
erc20-approve-correct-amount	True	
erc20-approve-revert-zero	True	
erc20-approve-false	True	
erc20-approve-never-return-false	True	

APPENDIX | RT-PAY

Finding Categories

Categories	Description
Coding Style	Coding Style findings may not affect code behavior, but indicate areas where coding practices can be improved to make the code more understandable and maintainable.
Coding Issue	Coding Issue findings are about general code quality including, but not limited to, coding mistakes, compile errors, and performance issues.
Inconsistency	Inconsistency findings refer to different parts of code that are not consistent or code that does not behave according to its specification.
Volatile Code	Volatile Code findings refer to segments of code that behave unexpectedly on certain edge cases and may result in vulnerabilities.
Logical Issue	Logical Issue findings indicate general implementation issues related to the program logic.
Centralization	Centralization findings detail the design choices of designating privileged roles or other centralized controls over the code.

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.

Details on Formal Verification

Some Solidity smart contracts from this project have been formally verified. Each such contract was compiled into a mathematical model that reflects all its possible behaviors with respect to the property. The model takes into account the semantics of the Solidity instructions found in the contract. All verification results that we report are based on that model.

The following assumptions and simplifications apply to our model:

- Certain low-level calls and inline assembly are not supported and may lead to a contract not being formally verified.
- We model the semantics of the Solidity source code and not the semantics of the EVM bytecode in a compiled contract.

Formalism for property specifications

All properties are expressed in a behavioral interface specification language that CertiK has developed for Solidity, which allows us to specify the behavior of each function in terms of the contract state and its parameters and return values, as well as contract properties that are maintained by every observable state transition. Observable state transitions occur when the contract's external interface is invoked and the invocation does not revert, and when the contract's Ether balance is changed by the EVM due to another contract's "self-destruct" invocation. The specification language has the usual Boolean connectives, as well as the operator `\old` (used to denote the state of a variable before a state transition), and several types of specification clause:

Apart from the Boolean connectives and the modal operators "always" (written `[]`) and "eventually" (written `<>`), we use the following predicates to reason about the validity of atomic propositions. They are evaluated on the contract's state whenever a discrete time step occurs:

- `requires [cond]` - the condition `cond`, which refers to a function's parameters, return values, and contract state variables, must hold when a function is invoked in order for it to exhibit a specified behavior.
- `ensures [cond]` - the condition `cond`, which refers to a function's parameters, return values, and both `\old` and current contract state variables, is guaranteed to hold when a function returns if the corresponding requires condition held when it was invoked.
- `invariant [cond]` - the condition `cond`, which refers only to contract state variables, is guaranteed to hold at every observable contract state.
- `constraint [cond]` - the condition `cond`, which refers to both `\old` and current contract state variables, is guaranteed to hold at every observable contract state except for the initial state after construction (because there is no previous state); constraints are used to restrict how contract state can change over time.

Description of the Analyzed ERC-20 Properties

Properties related to function `transfer`

erc20-transfer-correct-amount

All non-reverting invocations of `transfer(recipient, amount)` that return `true` must subtract the value in `amount` from the balance of `msg.sender` and add the same value to the balance of the `recipient` address.

Specification:

```
requires recipient != msg.sender;
requires balanceOf(recipient) + amount <= type(uint256).max;
ensures \result ==> balanceOf(recipient) == \old(balanceOf(recipient) + amount)
&& balanceOf(msg.sender) == \old(balanceOf(msg.sender) - amount);
  also
requires recipient == msg.sender;
ensures \result ==> balanceOf(msg.sender) == \old(balanceOf(msg.sender));
```

erc20-transfer-exceed-balance

Any transfer of an amount of tokens that exceeds the balance of `msg.sender` must fail.

Specification:

```
requires amount > balanceOf(msg.sender);
ensures !\result;
```

erc20-transfer-false

If the `transfer` function in contract `RUBx` fails by returning `false`, it must undo all state changes it incurred before returning to the caller.

Specification:

```
ensures !\result ==> \assigned (\nothing);
```

erc20-transfer-never-return-false

The transfer function must never return `false` to signal a failure.

Specification:

```
ensures \result;
```

erc20-transfer-revert-zero

Any call of the form `transfer(recipient, amount)` must fail if the recipient address is the zero address.

Specification:

```
ensures \old(recipient) == address(0) ==> !\result;
```

Properties related to function `allowance`

erc20-allowance-change-state

Function `allowance` must not change any of the contract's state variables.

Specification:

```
assignable \nothing;
```

erc20-allowance-correct-value

Invocations of `allowance(owner, spender)` must return the allowance that address `spender` has over tokens held by address `owner`.

Specification:

```
ensures \result == allowance(\old(owner), \old(spender));
```

erc20-allowance-succeed-always

Function `allowance` must always succeed, assuming that its execution does not run out of gas.

Specification:

```
reverts_only_when false;
```

Properties related to function `balanceOf`

erc20-balanceof-change-state

Function `balanceOf` must not change any of the contract's state variables.

Specification:

```
assignable \nothing;
```

erc20-balanceof-correct-value

Invocations of `balanceOf(owner)` must return the value that is held in the contract's balance mapping for address `owner`.

Specification:

```
ensures \result == balanceOf(\old(account));
```

erc20-balanceof-succeed-always

Function `balanceOf` must always succeed if it does not run out of gas.

Specification:

```
reverts_only_when false;
```

Properties related to function `transferFrom`

erc20-transferfrom-correct-allowance

All non-reverting invocations of `transferFrom(from, dest, amount)` that return `true` must decrease the allowance for address `msg.sender` over address `from` by the value in `amount`.

Specification:

```
ensures \result ==> allowance(\old(sender), msg.sender) == \old(allowance(sender,
msg.sender)) - \old(amount)
                  || (allowance(\old(sender), msg.sender) == \old(allowance(sender,
msg.sender)) && \old(allowance(sender, msg.sender)) == type(uint256).max);
```

erc20-transferfrom-correct-amount

All invocations of `transferFrom(from, dest, amount)` that succeed and that return `true` subtract the value in `amount` from the balance of address `from` and add the same value to the balance of address `dest`.

Specification:

```
requires recipient != sender;
requires balanceOf(recipient) + amount <= type(uint256).max;
ensures \result ==> balanceOf(\old(recipient)) == \old(balanceOf(recipient) +
amount)
                  && balanceOf(\old(sender)) == \old(balanceOf(sender) - amount);
  also
requires recipient == sender;
ensures \result ==> balanceOf(\old(recipient)) == \old(balanceOf(recipient));
```

erc20-transferfrom-fail-exceed-allowance

Any call of the form `transferFrom(from, dest, amount)` with a value for `amount` that exceeds the allowance of address `msg.sender` must fail.

Specification:

```
requires msg.sender != sender;
requires amount > allowance(sender, msg.sender);
ensures !\result;
```

erc20-transferfrom-fail-exceed-balance

Any call of the form `transferFrom(from, dest, amount)` with a value for `amount` that exceeds the balance of address `from` must fail.

Specification:

```
requires amount > balanceOf(sender);
ensures !\result;
```

erc20-transferfrom-false

If `transferFrom` returns `false` to signal a failure, it must undo all incurred state changes before returning to the caller.

Specification:

```
ensures !\result ==> \assigned (\nothing);
```

erc20-transferfrom-never-return-false

The `transferFrom` function must never return `false`.

Specification:

```
ensures \result;
```

erc20-transferfrom-revert-zero-argument

All calls of the form `transferFrom(from, dest, amount)` must fail for transfers from or to the zero address.

Specification:

```
ensures \old(sender) == address(0) ==> !\result;
also
ensures \old(recipient) == address(0) ==> !\result;
```

Properties related to function `totalSupply`

erc20-totalsupply-change-state

The `totalSupply` function in contract RUBx must not change any state variables.

Specification:

```
assignable \nothing;
```

erc20-totalsupply-correct-value

The `totalSupply` function must return the value that is held in the corresponding state variable of contract RUBx.

Specification:

```
ensures \result == totalSupply();
```

erc20-totalsupply-succeed-always

The function `totalSupply` must always succeeds, assuming that its execution does not run out of gas.

Specification:

```
reverts_only_when false;
```

Properties related to function `approve`

erc20-approve-correct-amount

All non-reverting calls of the form `approve(spender, amount)` that return `true` must correctly update the allowance mapping according to the address `msg.sender` and the values of `spender` and `amount`.

Specification:

```
requires spender != address(0);
ensures \result ==> allowance(msg.sender, \old(spender)) == \old(amount);
```

erc20-approve-false

If function `approve` returns `false` to signal a failure, it must undo all state changes that it incurred before returning to the caller.

Specification:

```
ensures !\result ==> \assigned (\nothing);
```

erc20-approve-never-return-false

The function `approve` must never returns `false`.

Specification:

```
ensures \result;
```

erc20-approve-revert-zero

All calls of the form `approve(spender, amount)` must fail if the address in `spender` is the zero address.

Specification:

```
ensures \old(spender) == address(0) ==> !\result;
```

erc20-approve-succeed-normal

All calls of the form `approve(spender, amount)` must succeed, if

- the address in `spender` is not the zero address and
- the execution does not run out of gas.

Specification:

```
requires spender != address(0);
ensures \result;
reverts_only_when false;
```

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