CERTIK

Security Assessment

StarChain - Token

CertiK Assessed on Sept 18th, 2024

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StarChain - Token

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

Executive Summary

TYPES	ECOSYSTEM	METHODS
ERC-20	Ethereum (ETH)	Formal Verification, Manual Review, Static Analysis

LANGUAGE	TIMELINE	KEY COMPONENTS
Solidity	Delivered on 09/18/2024	N/A

CODEBASE
https://github.com/starchaindev/strc-token
View All in Codebase Page

COMMITS
d71c7912292a3e86a9ce5decf0954572a01df3e1
9b6e76710bf951fd81e816693a7607313af11276
bdff55f292ca0c714519c0597064921dbb52eab1
View All in Codebase Page

Vulnerability Summary

2	1	1	0	0	0
Total Findings	Resolved	Mitigated	Partially Resolved	Acknowledged	Declined

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.
1	Major	1 Mitigated	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.
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.
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 | STARCHAIN - TOKEN

Repository

https://github.com/starchaindev/strc-token

Commit

d71c7912292a3e86a9ce5decf0954572a01df3e1

9b6e76710bf951fd81e816693a7607313af11276

bdff55f292ca0c714519c0597064921dbb52eab1

56b5052e96619c5ad1e6d5b00f30ded5223779cc

AUDIT SCOPE | STARCHAIN - TOKEN

1 file audited ● 1 file with Acknowledged findings

ID	Repo	File	SHA256 Checksum
● TTB	starchaindev /strc-token	Token/contracts/Token.sol	107880045901eb5dd0fe894a363d644744142778ceceb471144cd85303396737

APPROACH & METHODS | STARCHAIN - TOKEN

This report has been prepared for StarChain to discover issues and vulnerabilities in the source code of the StarChain - Token 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.

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 | STARCHAIN - TOKEN

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

This report has been prepared to discover issues and vulnerabilities for StarChain - Token. Through this audit, we have uncovered 2 issues ranging from different severity levels. Utilizing the techniques of Static Analysis & Manual Review to complement rigorous manual code reviews, we discovered the following findings:

ID	Title	Category	Severity	Status
TTB-05	Initial Token Distribution	Centralization	Major	**Mitigated**
TTB-03	State Variable Shadowing	Coding Style	Minor	**Resolved**

TTB-05 | INITIAL TOKEN DISTRIBUTION

Category	Severity	Location	Status
Centralization	**Major**	**Token/contracts/Token.sol (base): 364~365, 413~414, 493~494**	**Mitigated**

Description

All of the `5 *10 ** 8 * 10 ** 18` `STRC` tokens are sent to the contract deployer or one or several externally-owned account (EOA) addresses. This is a centralization risk because the deployer or the owner(s) of the EOAs can distribute tokens without obtaining the consensus of the community. Any compromise to these addresses may allow a hacker to steal and sell tokens on the market, resulting in severe damage to the project.

Recommendation

It is recommended that the team be transparent regarding the initial token distribution process. The token distribution plan should be published in a public location that the community can access. The team should make efforts to restrict access to the private keys of the deployer account or EOAs. A multi-signature (⅔, ⅗) wallet can be used to prevent a single point of failure due to a private key compromise. Additionally, the team can lock up a portion of tokens, release them with a vesting schedule for long-term success, and deanonymize the project team with a third-party KYC provider to create greater accountability.

Alleviation

`[CertiK, 07/17/2024]`: The team shared token distribution information in https://github.com/paris-florian/strc-token/blob/9b6e76710bf951fd81e816693a7607313af11276/StarChain%20Token%20Distribution%20Information.pdf.

The Gnosis Safe multisig wallet deployment proxy is https://polygonscan.com/address/0x36c4cfDd2E8ea7c64e59B65320842aCe6e5EdE2F, and its implementation deployment is https://polygonscan.com/address/0x3E5c63644E683549055b9Be8653de26E0B4CD36E

Any transaction requires the confirmation of 5 out of 6 following signers:

- 0xE06735C9ab25C8d0d1682B56bF273D087B413CDC
- 0xb7CE491C60FfAAC51802121C2011140edC34DD7D
- 0x64353ABB04F94a1D27E08824039d4aF6fB2F240B
- 0x92dDAB647045ff980C034a257112DC83147bfD2c
- 0xB5D99434E6D16eB767650FD504e6876eF2bB4E64
- 0x51d5A5D604fb1c4Ba58A2b43c986968207817B6B

The finding status is marked Acknowledge according to the fact:

1. The multisig wallet address does not hold the undistributed `STRC` tokens.

The finding will be revisited once the team provides the token deployment address and the transaction that mints initial tokens to the multisig wallet address outlined in the recommendation section.

`[StarChain, 09/12/2024]` : Token Distribution to multiple multi-sig wallets (per tokenomics allocation) will now happen on mint

So "Token Distribution risks exist if tokens are distributed to a single party (whale), this could lead to centralization risk as the deployer can then distribute tokens without obtaining the consensus of the community." no longer applies

`[CertiK, 09/12/2024]` : according to the modification made in the https://github.com/paris-florian/strc-token/blob/bdff55f292ca0c714519c0597064921dbb52eab1/Token/contracts/Token.sol, a fraction of the `_tTotal` tokens, in total of `5 * 100000 * 10 ** 18` , will be distributed to following addresses.

- **Presale** 0x601f414E25840125A84988039E542A0840c6B7Da receives 175 * 100000 * 10 ** 18 tokens:
    - The address is a Gnosis multi-signature address with transactions that need the signature of 2 out of 3 of the following addresses:
        - 0x67C794b610Eafe81c0f7A79c9d7DEaABC99fD403
        - 0xB0B4a0dca9283e5C749d2E0c3f084D9d5e2a7C15
        - 0xdE23463ae5583ac78ed1d4f725b0454BB2D7eE56

- **Contribution Incentives (Rewards)** 0x10250D559FEfc8A56649C7E25363f5fe814e671b receives 75 * 100000 * 10 ** 18 tokens:
    - The address is a Gnosis multi-signature address with transactions that need the signature of 2 out of 3 of the following addresses:
        - 0x212808A6690A90Bd50F4BF6DA635Fd7F6F4af886
        - 0xEb2960B9d70BC30ea02a1f5C02c70722eB9cD0D5
        - 0xeF600838D5A0135Af1163c219af973bc4381102e

- **Marketing and Development** 0x06E08944C1F423eFf5B0F71158DF3144c94ACBb5 receives 70 * 100000 * 10 ** 18 tokens:
    - The address is a Gnosis multi-signature address with transactions that need the signature of 2 out of 3 of the following addresses:
        - 0xe47b9bD4E5CD5674F5874c01125d931CFa600a4A
        - 0xBD47Fb46C06AC992Ced602c0Ddd08eAc6f0230F3

        - 0x1e1133949Ee5e03533736090e8fAB9AA3f880f01

- **Treasury** 0x0EF7D59F319999F978956c3bD906e026F74d355D receives 70 * 100000 * 10 ** 18 tokens:
    - The address is a Gnosis multi-signature address with transactions that need the signature of 2 out of 3 of the following addresses:
        - 0xAC10dbB46ea84BbB55615aa709aE426A01c4A0f3
        - 0xDBEdfceE7622f294720C4F1b9BD5B660D78c89F5
        - 0x4f89c5Add839D13194bde16c476B4EbE3d93Ee07

- **DEX Liquidity** 0x376ff99bbfe42432d5B53E3Cf9D0C0826D85F345 receives 50 * 100000 * 10 ** 18 tokens:
    - The address is a Gnosis multi-signature address with transactions that need the signature of 2 out of 3 of the following addresses:
        - 0x8D08e9Ea4CA302ceDE4591094A94369E22ADeb90
        - 0x70D72D069864398E6CAAb15E0313d37B2A26fc43
        - 0xE7BD8B23d07cc16Def7d729624490d35CB5Cddc6

- **Team and Advisors** 0xe6775c00BC6F06Cd15Ea90aF581C095306fE8C32 receives 35 * 100000 * 10 ** 18 tokens:
    - The address is a Gnosis multi-signature address with transactions that need the signature of 2 out of 3 of the following addresses:
        - 0x746f3d5609ad553827911c375a70688BC89E70D3
        - 0x87F81d4De49d33d5fe4554743aAd736CCfc9D18B
        - 0x2d8f0193AC951bb95eaabcCf5f30ae37B3065f75

- **CEX Listings** 0x2c84f0384138B3C1dD8ef1C8E2cd10B4b331f03a receives 25 * 100000 * 10 ** 18 tokens:
    - The address is a Gnosis multi-signature address with transactions that need the signature of 2 out of 3 of the following addresses:
        - 0xFFbb98C403bCb82b9Aa8a52Ff9F6dFA90382Aa52
        - 0x64D6b059329F1d2D5B53eceB4ac0CFf4C88968A1
        - 0x17D17C286666F65935ce8D4a649557C4C7edC3Fb

The token distribution information is shared at https://github.com/paris-florian/strc-token/blob/bdff55f292ca0c714519c0597064921dbb52eab1/StarChain%20Token%20Distribution%20Information.md.

`[CertiK, 09/18/2024]`: according to the modification made in the https://github.com/paris-florian/strc-token/tree/56b5052e96619c5ad1e6d5b00f30ded5223779cc/Token/contracts/Token.sol, a fraction of the `_tTotal` tokens, in total of `50000000 * (10 ** uint256(18))`, will be distributed to above addresses.

TTB-03 | STATE VARIABLE SHADOWING

Category	Severity	Location	Status
Coding Style	Minor	Token/contracts/Token.sol (base): 171, 490	Resolved

Description

A state variable in a derived contract is shadowing a similarly named component in a parent contract. This means that when the derived contract accesses the state variable by its name, it will use the one defined in the derived contract, not the one in the parent contract.

Variable `_totalSupply` in `StarChainToken` shadows the variable `_totalSupply` in `ERC20` .

```
490     uint256 _totalSupply ;
```

```
171     uint256 private _totalSupply;
```

Recommendation

It is suggested to remove or rename the state variable that shadows another definition.

Alleviation

`[CertiK, 07/17/2024]` : The team heeded the advice and resolved the finding in the commit bd10c54789dbbd6f432a60924d6008aac0a844e9

OPTIMIZATIONS | STARCHAIN - TOKEN

ID	Title	Category	Severity	Status
TTB-04	Variables That Could Be Declared As Immutable	Gas Optimization	Optimization	Acknowledged

TTB-04 | VARIABLES THAT COULD BE DECLARED AS IMMUTABLE

Category	Severity	Location	Status
Gas Optimization	Optimization	Token/contracts/Token.sol (base): 490	Acknowledged

Description

The linked variable, `_totalSupply`, assigned in the constructor can be declared as `immutable`. Immutable state variable can be assigned during contract creation but will remain constant throughout the lifetime of a deployed contract. A big advantage of immutable variable is that reading them is significantly cheaper than reading from regular state variable 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

`[CertiK, 09/12/2024]`: The `_totalSupply` variable is renamed to `_tTotal` in the commit bdff55f292ca0c714519c0597064921dbb52eab1. The finding is marked as Acknowledged as `_tTotal` can be declared as `immutable` to optimize the code

FORMAL VERIFICATION | STARCHAIN - TOKEN

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-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-transfer-exceed-balance	`transfer` Fails if Requested Amount Exceeds Available Balance
erc20-approve-false	If `approve` Returns `false`, the Contract's State Is Unchanged
erc20-approve-revert-zero	`approve` Prevents Approvals For the Zero Address
erc20-allowance-correct-value	`allowance` Returns Correct Value
erc20-approve-never-return-false	`approve` Never Returns `false`

Property Name	Title
erc20-approve-succeed-normal	`approve` Succeeds for Valid Inputs
erc20-balanceof-succeed-always	`balanceOf` Always Succeeds
erc20-transferfrom-fail-recipient-overflow	`transferFrom` Prevents Overflows in the Recipient's Balance
erc20-totalsupply-correct-value	`totalSupply` Returns the Value of the Corresponding State Variable
erc20-totalsupply-succeed-always	`totalSupply` Always Succeeds
erc20-allowance-succeed-always	`allowance` Always Succeeds
erc20-transferfrom-never-return-false	`transferFrom` Never Returns `false`
erc20-allowance-change-state	`allowance` Does Not Change the Contract's State
erc20-transfer-recipient-overflow	`transfer` Prevents Overflows in the Recipient's Balance
erc20-approve-correct-amount	`approve` Updates the Approval Mapping Correctly
erc20-balanceof-correct-value	`balanceOf` Returns the Correct Value
erc20-transferfrom-revert-zero-argument	`transferFrom` Fails for Transfers with Zero Address Arguments
erc20-transfer-never-return-false	`transfer` Never Returns `false`
erc20-transfer-false	If `transfer` Returns `false`, the Contract State Is Not Changed
erc20-transferfrom-false	If `transferFrom` Returns `false`, the Contract's State Is Unchanged
erc20-transfer-revert-zero	`transfer` Prevents Transfers to the Zero Address
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

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 ERC20 (Token/contracts/Token.sol) In Commit d71c7912292a3e86a9ce5decf0954572a01df3e1

Verification of ERC-20 Compliance

Detailed Results for Function `transferFrom`

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

Detailed Results for Function `transfer`

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

Detailed Results for Function `approve`

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

Detailed Results for Function `allowance`

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

Detailed Results for Function `balanceOf`

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

Detailed Results for Function `totalSupply`

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

Detailed Results For Contract StarChainToken (Token/contracts/Token.sol) In Commit d71c7912292a3e86a9ce5decf0954572a01df3e1

Verification of ERC-20 Compliance

Detailed Results for Function `totalSupply`

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

Detailed Results for Function `transferFrom`

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

Detailed Results for Function `transfer`

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

Detailed Results for Function `balanceOf`

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

Detailed Results for Function `approve`

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

Detailed Results for Function `allowance`

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

APPENDIX | STARCHAIN - TOKEN

Finding Categories

Categories	Description
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.
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.
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 `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-fail-recipient-overflow

Any call of `transferFrom(from, dest, amount)` with a value in `amount` whose transfer would cause an overflow of the balance of address `dest` must fail.

Specification:

```
requires recipient != sender;
requires balanceOf(recipient) + amount > type(uint256).max;
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 `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 `ERC20` fails by returning `false`, it must undo all state changes it incurred before returning to the caller.

Specification:

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

erc20-transfer-false

If the `transfer` function in contract `StarChainToken` 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-recipient-overflow

Any invocation of `transfer(recipient, amount)` must fail if it causes the balance of the `recipient` address to overflow.

Specification:

```
requires recipient != msg.sender;
requires balanceOf(recipient) + amount > type(uint256).max;
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 `totalSupply`

erc20-totalsupply-change-state

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

Specification:

```
assignable \nothing;
```

erc20-totalsupply-change-state

The `totalSupply` function in contract ERC20 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 ERC20.

Specification:

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

erc20-totalsupply-correct-value

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

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;
```

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;
```

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