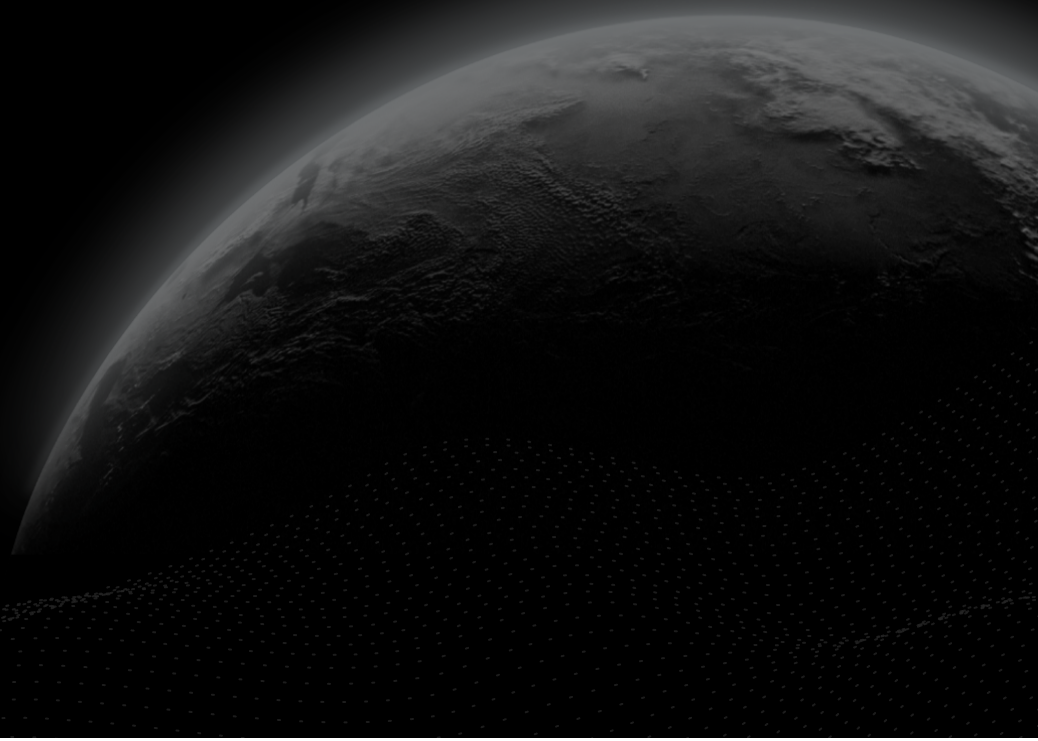
CERTIK

Security Assessment

INRx - Audit

CertiK Verified on Nov 1st, 2022



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

Executive Summary

TYPES	ECOSYSTEM	METHODS
ERC-20	BSC	Manual Review, Static Analysis

LANGUAGE	TIMELINE	KEY COMPONENTS
Solidity	Delivered on 11/01/2022	N/A

CODEBASE

https://github.com/inrxstablecoin/inrxtoken/tree/main/contracts

...View All

COMMITS

- 55e7b159832d5c870fd14c209253cd9976b27772
- 1579f9db009a9e6c1cc604e542a7db2275aa524e

...View All

Vulnerability Summary

4	3	1	0	0	0	0
Total Findings	Resolved	Mitigated	Partially Resolved	Acknowledged	Declined	Unresolved

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.
2	Informational	2 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 | INRX - AUDIT

Repository

https://github.com/inrxstablecoin/inrxtoken/tree/main/contracts

Commit

- 55e7b159832d5c870fd14c209253cd9976b27772
- 1579f9db009a9e6c1cc604e542a7db2275aa524e

AUDIT SCOPE | INRX - AUDIT

1 file audited ● 1 file with Mitigated findings

ID	Repo	File	SHA256 Checksum
● INT	CertiKProject/certik-audit-projects	INRxToken.sol	316193ff46ad552a0dac0bc14889b084ec7f45ad93efdb152d05f6142e7bc1b5

APPROACH & METHODS | INRX - AUDIT

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

REVIEW NOTES | INRX - AUDIT

Overview

The **INRx** contract is an ERC20 token `INRx`, whose owner has the ability to configure the minters, and pause/unpause the contract.

Privileged Roles

In the **INRx** contract, the owner and the minters are adopted to ensure a good runtime behavior in the contract, which was specified in the finding *Centralization Risks in INRxToken.sol*.

The advantage of those privileged roles in the codebase is that the client reserves the ability to configure the minters, and pause/unpause the contract according to the runtime. It is also worth noting the potential drawbacks of these functions, which should be clearly stated through the client's action/plan. Additionally, if the private keys of the privileged accounts are compromised, the project could have devastating consequences.

FINDINGS | INRX - AUDIT

4	0	1	0	1	2
Total Findings	Critical	Major	Medium	Minor	Informational

This report has been prepared to discover issues and vulnerabilities for INRx - Audit. Through this audit, we have uncovered 4 issues ranging from different severity levels. Utilizing the techniques of Manual Review & Static Analysis to complement rigorous manual code reviews, we discovered the following findings:

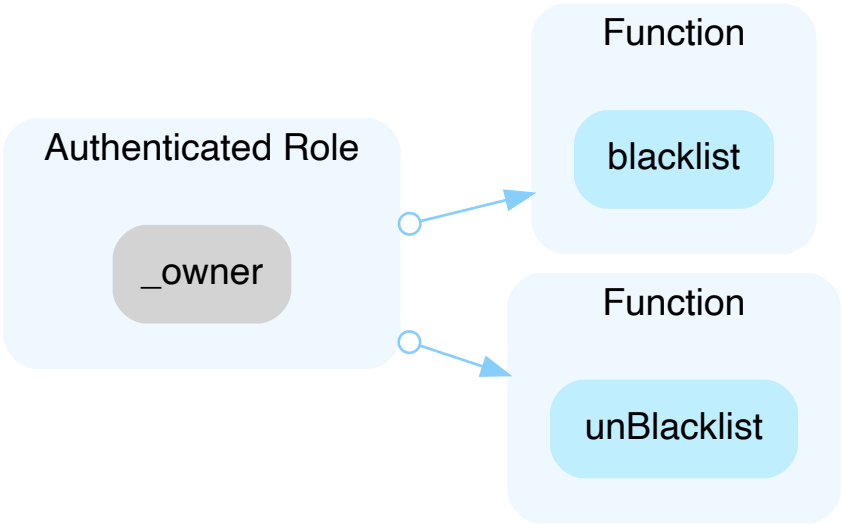
ID	Title	Category	Severity	Status
INT-01	**Centralization Risks In INRxToken.Sol**	**Centralization / Privilege**	**Major**	**Mitigated**
INT-02	Double-Spending Allowance To Mint Token	Logical Issue	Minor	Resolved
INT-03	Dead Code	Coding Style	Informational	Resolved
INT-04	Unused Event	Coding Style	Informational	Resolved

INT-01 | CENTRALIZATION RISKS IN INRXTOKEN.SOL

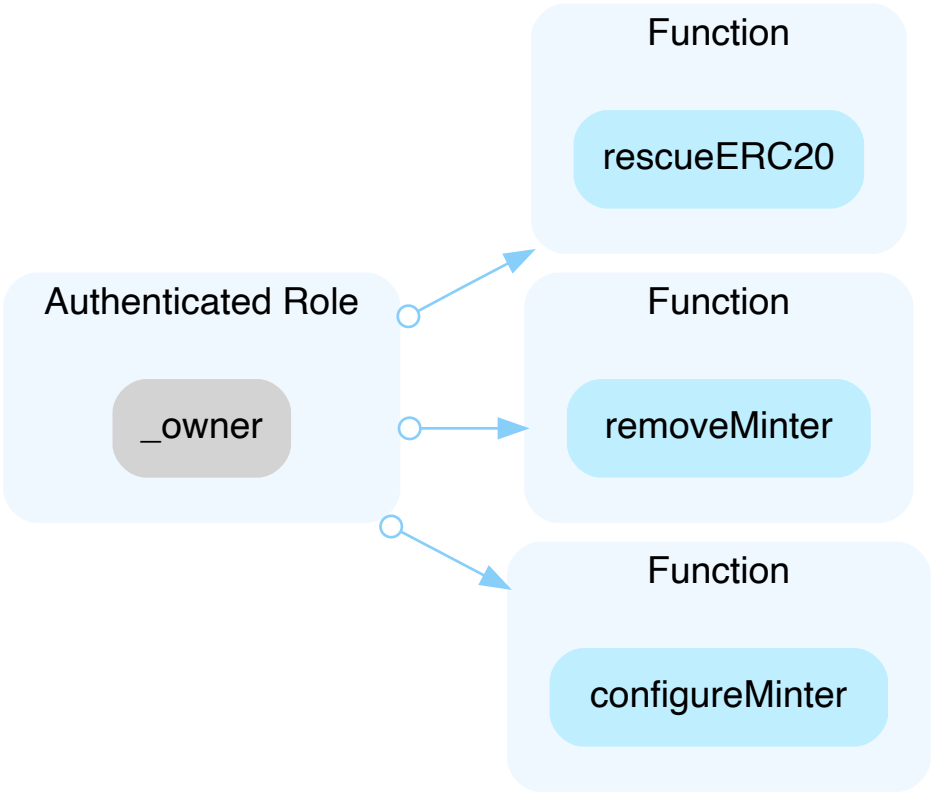
Category	Severity	Location	Status
Centralization / Privilege	**Major**	**INRxToken.sol: 280, 300, 306, 331, 336, 709, 713, 784, 791**	**Mitigated**

Description

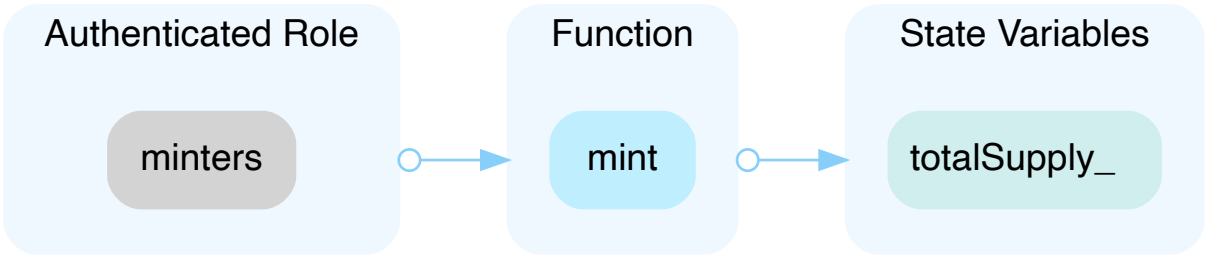
In the contract `Blacklistable` the role `_owner` has authority over the functions shown in the diagram below. Any compromise to the `_owner` account may allow the hacker to take advantage of this authority.



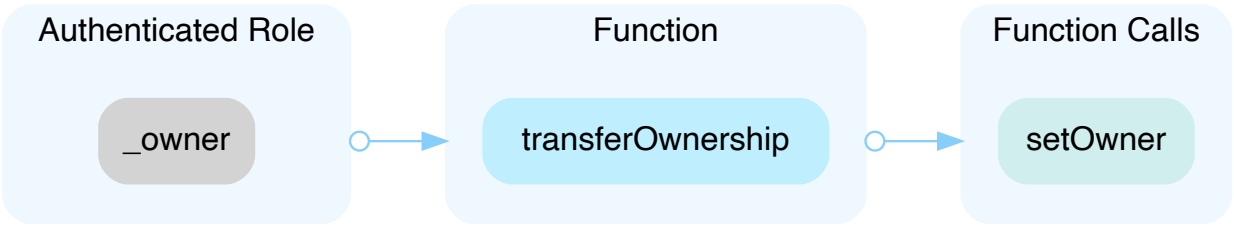
In the contract `INRxToken` the role `_owner` has authority over the functions shown in the diagram below. Any compromise to the `_owner` account may allow the hacker to take advantage of this authority.



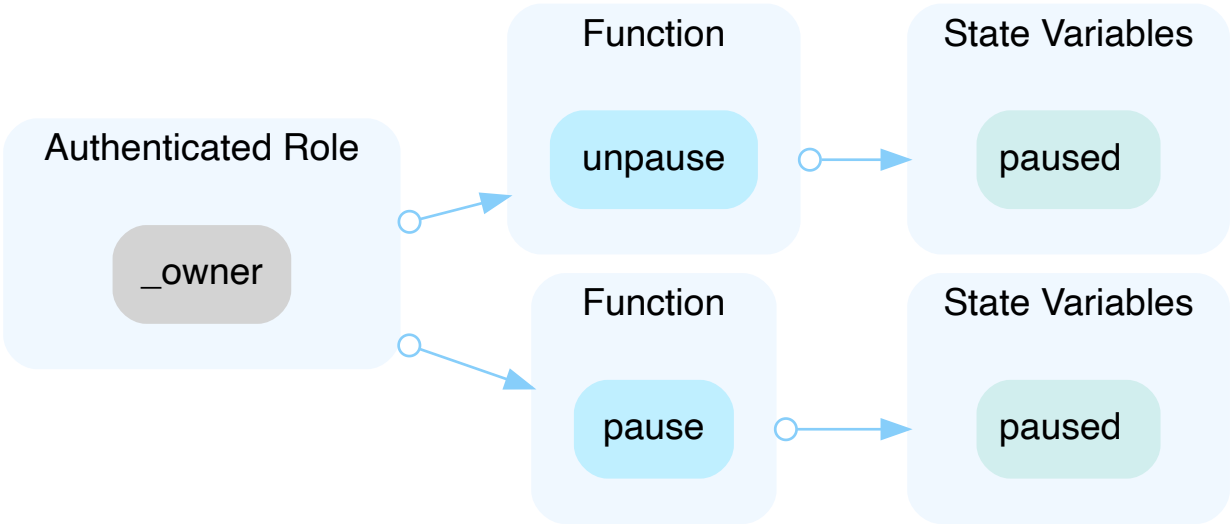
In the contract `INRxToken` the role `minters` has authority over the functions shown in the diagram below. Any compromise to the `minters` account may allow the hacker to take advantage of this authority.



In the contract `Ownable` 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.



In the contract `Pausable` 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.



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

[INRx]: The contract `Blacklistable` and its corresponding code is removed in the commit 1579f9db009a9e6c1cc604e542a7db2275aa524e.

Furthermore, for the deployed contract 0xcD6970d5211EfDF2516A4fc73163db7bA812B212 | BSC the ownership was transferred to the gnosis-safe contract(0xbf5dbafdd31a487129fdb94057f84a0979838055) in the transaction 0xf0c3a8c114039010464d91effdb8fe8fdf665b8a0424a43b46f16c007a54d368.

The gnosis-safe contract requires 3 of 5 owners to confirm the transaction. Here are the 5 owners:

- 0x25AE640f362AeC6b105cD069dB1e09b25cFc5c31
- 0x710973C65277AFD47aC354F5f29E82135Ed19739
- 0x8e4A89e494d7d66046171eD234B1d6211EaD1434
- 0x90Aa066B6c101Bbb5C5585b88C3B35EDC3dc2593
- 0xce0b9307cE30Fe0e98Cf6Fc4fb147eb59310b6E4

INT-02 | DOUBLE-SPENDING ALLOWANCE TO MINT TOKEN

Category	Severity	Location	Status
Logical Issue	Minor	INRxToken.sol: 784	Resolved

Description

A minter may double-spending his/her allowance being authorized by the owner.

Example:

- The owner, Alice, configures the minter, Bob, 100 allowances to mint tokens.
- One day, Alice decides to decrease the allowance to Bob from 100 to 50.
- Before Alice decreases the allowance, Bob spends the 100 allowances by front-running.
- Alice continues to configure the minter, Bob, 50 allowances to mint tokens.
- Bob spends another 50 allowances to mint tokens.

From the above example, we noticed that Bob spends a total of 150 allowances, instead of 50 allowances, even though Alice changed her mind to only give Bob 50 allowances.

Recommendation

Consider adding a check, in the `configureMinter()` function, to ensure that the minter is not a minter before.
Example:

```
require(!minters[minter],"should not be a minter before");
```

Alleviation

[INRx]: The team resolved this issue by adding a check on the `minter` parameter in commit 55e7b159832d5c870fd14c209253cd9976b27772.

INT-03 | DEAD CODE

Category	Severity	Location	Status
Coding Style	Informational	INRxToken.sol: 104, 243, 252, 257, 373, 387, 400, 446, 479 , 492, 507, 574, 588	Resolved

Description

One or more internal functions are not used.

```
104     function reset(Counter storage counter) internal {
```

```
243     function _disableInitializers() internal virtual {
```

```
252     function _getInitializedVersion() internal view returns (uint8) {
```

```
257     function _isInitializing() internal view returns (bool) {
```

```
373     function toHexString(uint256 value) internal pure returns (string memory)
{
```

```
387     function toHexString(uint256 value, uint256 length) internal pure returns
(string memory) {
```

```
400     function toHexString(address addr) internal pure returns (string memory) {
```

```
446     function tryRecover(bytes32 hash, bytes memory signature) internal pure
returns (address, RecoverError) {
```

```
479     function recover(bytes32 hash, bytes memory signature) internal pure
returns (address) {
```

```
492     function tryRecover(
```

```
507     function recover(
```

```
574     function toEthSignedMessageHash(bytes32 hash) internal pure returns
(bytes32) {
```

```
588     function toEthSignedMessageHash(bytes memory s) internal pure returns
(bytes32) {
```

Recommendation

We recommend removing those unused functions.

Alleviation

[INRx]: The team resolved this issue by removing the unused functions in commit 55e7b159832d5c870fd14c209253cd9976b27772.

INT-04 | UNUSED EVENT

Category	Severity	Location	Status
Coding Style	Informational	INRxToken.sol: 290, 319	Resolved

Description

```
290     event PauserChanged(address indexed newAddress);
```

- `PauserChanged` is declared in `Pausable` but never emitted.

```
319     event BlacklisterChanged(address indexed newBlacklister);
```

- `BlacklisterChanged` is declared in `Blacklistable` but never emitted.

Recommendation

We advise removing the unused events or emitting them in the intended functions.

Alleviation

[INRx]: The team resolved this issue by removing the unused events in commit 55e7b159832d5c870fd14c209253cd9976b27772.

OPTIMIZATIONS | INRX - AUDIT

ID	Title	Category	Severity	Status
INT-05	Unnecessary Use Of SafeMath	Gas Optimization	Optimization	Resolved
INT-06	Unused State Variable	Gas Optimization	Optimization	Resolved

INT-05 | UNNECESSARY USE OF SAFEMATH

Category	Severity	Location	Status
Gas Optimization	Optimization	INRxToken.sol: 5, 720, 721, 722, 765, 779, 780, 803, 804, 820, 824	Resolved

Description

The `SafeMath` library is used unnecessarily. With Solidity compiler versions 0.8.0 or newer, arithmetic operations will automatically revert in case of integer overflow or underflow.

```
5  library SafeMath {
```

- An implementation of `SafeMath` library is found.

```
671      using SafeMath for uint256;
```

- `SafeMath` library is used for `uint256` type in `INRxToken` contract.

```
720          totalSupply_ = totalSupply_.add(_amount);
```

- `SafeMath.add` is called in `mint` function of `INRxToken` contract.

Note: Only a sample of 2 `SafeMath` library usage in this contract (out of 11) are shown above.

Recommendation

We advise removing the usage of `SafeMath` library and using the built-in arithmetic operations provided by the Solidity programming language.

Alleviation

[INRx]: The team resolved this issue by removing the usage of `SafeMath` library in commit 55e7b159832d5c870fd14c209253cd9976b27772.

INT-06 | UNUSED STATE VARIABLE

Category	Severity	Location	Status
Gas Optimization	Optimization	INRxToken.sol: 688	Resolved

Description

One or more state variables are never used in the codebase.

Variable `_PERMIT_TYPEHASH_DEPRECATED_SLOT` in `INRxToken` is never used in `INRxToken`.

```
688     bytes32 private _PERMIT_TYPEHASH_DEPRECATED_SLOT;
```

```
670  contract INRxToken is  Ownable, Pausable, Blacklistable,Initializable,
IERC20Permit, EIP712  {
```

Recommendation

We advise removing the unused variables.

Alleviation

[INRx]: The team resolved this issue by removing the unused variables in commit 55e7b159832d5c870fd14c209253cd9976b27772.

FORMAL VERIFICATION | INRX - AUDIT

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 automated formal verification (symbolic model checking) to prove that well-known functions in the smart contracts adhere to their expected behavior.

Considered Functions And Scope

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-revert-zero	Function `transfer` Prevents Transfers to the Zero Address
erc20-transfer-succeed-normal	Function `transfer` Succeeds on Admissible Non-self Transfers
erc20-transfer-succeed-self	Function `transfer` Succeeds on Admissible Self Transfers
erc20-transfer-correct-amount	Function `transfer` Transfers the Correct Amount in Non-self Transfers
erc20-transfer-correct-amount-self	Function `transfer` Transfers the Correct Amount in Self Transfers
erc20-transfer-change-state	Function `transfer` Has No Unexpected State Changes
erc20-transfer-exceed-balance	Function `transfer` Fails if Requested Amount Exceeds Available Balance
erc20-transfer-recipient-overflow	Function `transfer` Prevents Overflows in the Recipient's Balance

Property Name	Title
erc20-transfer-false	If Function `transfer` Returns `false`, the Contract State Has Not Been Changed
erc20-transfer-never-return-false	Function `transfer` Never Returns `false`
erc20-transferfrom-revert-from-zero	Function `transferFrom` Fails for Transfers From the Zero Address
erc20-transferfrom-revert-to-zero	Function `transferFrom` Fails for Transfers To the Zero Address
erc20-transferfrom-succeed-normal	Function `transferFrom` Succeeds on Admissible Non-self Transfers
erc20-transferfrom-succeed-self	Function `transferFrom` Succeeds on Admissible Self Transfers
erc20-transferfrom-correct-amount	Function `transferFrom` Transfers the Correct Amount in Non-self Transfers
erc20-transferfrom-correct-amount-self	Function `transferFrom` Performs Self Transfers Correctly
erc20-transferfrom-correct-allowance	Function `transferFrom` Updated the Allowance Correctly
erc20-transferfrom-change-state	Function `transferFrom` Has No Unexpected State Changes
erc20-transferfrom-fail-exceed-allowance	Function `transferFrom` Fails if the Requested Amount Exceeds the Available Allowance
erc20-transferfrom-fail-exceed-balance	Function `transferFrom` Fails if the Requested Amount Exceeds the Available Balance
erc20-transferfrom-fail-recipient-overflow	Function `transferFrom` Prevents Overflows in the Recipient's Balance
erc20-transferfrom-false	If Function `transferFrom` Returns `false`, the Contract's State Has Not Been Changed
erc20-transferfrom-never-return-false	Function `transferFrom` Never Returns `false`
erc20-totalsupply-succeed-always	Function `totalSupply` Always Succeeds
erc20-totalsupply-correct-value	Function `totalSupply` Returns the Value of the Corresponding State Variable
erc20-totalsupply-change-state	Function `totalSupply` Does Not Change the Contract's State

Property Name	Title
erc20-balanceof-succeed-always	Function `balanceOf` Always Succeeds
erc20-balanceof-correct-value	Function `balanceOf` Returns the Correct Value
erc20-allowance-succeed-always	Function `allowance` Always Succeeds
erc20-balanceof-change-state	Function `balanceOf` Does Not Change the Contract's State
erc20-allowance-correct-value	Function `allowance` Returns Correct Value
erc20-allowance-change-state	Function `allowance` Does Not Change the Contract's State
erc20-approve-revert-zero	Function `approve` Prevents Giving Approvals For the Zero Address
erc20-approve-succeed-normal	Function `approve` Succeeds for Admissible Inputs
erc20-approve-correct-amount	Function `approve` Updates the Approval Mapping Correctly
erc20-approve-change-state	Function `approve` Has No Unexpected State Changes
erc20-approve-false	If Function `approve` Returns `false`, the Contract's State Has Not Been Changed
erc20-approve-never-return-false	Function `approve` Never Returns `false`

Verification Results

In the remainder of this section, we list all contracts where model checking of at least one property was not successful. There are several reasons why this could happen:

- Model checking reports a counterexample that violates the property. Depending on the counterexample,this occurs if
    - The specification of the property is too generic and does not accurately capture the intended behavior of the smart contract. In that case, the counterexample does not indicate a problem in the underlying smart contract. We report such instances as being "inapplicable".
    - The property is applicable to the smart contract. In that case, the counterexample showcases a problem in the smart contract and a correspond finding is reported separately in the Findings section of this report. In the following tables, we report such instances as "invalid". The distinction between spurious and actual counterexamples is done manually by the auditors.
- The model checking result is inconclusive. Such a result does not indicate a problem in the underlying smart contract. An inconclusive result may occur if

- The model checking engine fails to construct a proof. This can happen if the logical deductions necessary are beyond the capabilities of the automated reasoning tool. It is a technical limitation of all proof engines and cannot be avoided in general.
- The model checking engine runs out of time or memory and did not produce a result. This can happen if automatic abstraction techniques are ineffective or of the state space is too big.

Contract INRx (Source File projects/inrx/contracts/INRxToken.sol)

Detailed results for function `transfer`

Property Name	Final Result	Remarks
erc20-transfer-revert-zero	Inconclusive	
erc20-transfer-succeed-normal	Inconclusive	
erc20-transfer-succeed-self	Inconclusive	
erc20-transfer-correct-amount	Inconclusive	
erc20-transfer-correct-amount-self	Inconclusive	
erc20-transfer-change-state	Inconclusive	
erc20-transfer-exceed-balance	Inconclusive	
erc20-transfer-recipient-overflow	Inconclusive	
erc20-transfer-false	Inconclusive	
erc20-transfer-never-return-false	Inconclusive	

Detailed results for function `transferFrom`

Property Name	Final Result	Remarks
erc20-transferfrom-revert-from-zero	Inconclusive	
erc20-transferfrom-revert-to-zero	Inconclusive	
erc20-transferfrom-succeed-normal	Inconclusive	
erc20-transferfrom-succeed-self	Inconclusive	
erc20-transferfrom-correct-amount	Inconclusive	
erc20-transferfrom-correct-amount-self	Inconclusive	
erc20-transferfrom-correct-allowance	Inconclusive	
erc20-transferfrom-change-state	Inconclusive	
erc20-transferfrom-fail-exceed-allowance	Inconclusive	
erc20-transferfrom-fail-exceed-balance	Inconclusive	
erc20-transferfrom-fail-recipient-overflow	Inconclusive	
erc20-transferfrom-false	Inconclusive	
erc20-transferfrom-never-return-false	Inconclusive	

Detailed results for function `totalSupply`

Property Name	Final Result	Remarks
erc20-totalsupply-succeed-always	True	
erc20-totalsupply-correct-value	True	
erc20-totalsupply-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 `allowance`

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

Detailed results for function `approve`

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

APPENDIX | INRX - AUDIT

Finding Categories

Categories	Description
Centralization / Privilege	Centralization / Privilege findings refer to either feature logic or implementation of components that act against the nature of decentralization, such as explicit ownership or specialized access roles in combination with a mechanism to relocate funds.
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.
Logical Issue	Logical Issue findings detail a fault in the logic of the linked code, such as an incorrect notion on how block.timestamp works.
Coding Style	Coding Style findings usually do not affect the generated byte-code but rather comment on how to make the codebase more legible and, as a result, easily maintainable.

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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This report should not be used in any way to make decisions around investment or involvement with any particular project. This report in no way provides investment advice, nor should be leveraged as investment advice of any sort. This report represents an extensive assessing process intending to help our customers increase the quality of their code while reducing the high level of risk presented by cryptographic tokens and blockchain technology.

Blockchain technology and cryptographic assets present a high level of ongoing risk. CertiK's position is that each company and individual are responsible for their own due diligence and continuous security. CertiK's goal is to help reduce the attack vectors and the high level of variance associated with utilizing new and consistently changing technologies, and in no way claims any guarantee of security or functionality of the technology we agree to analyze.

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