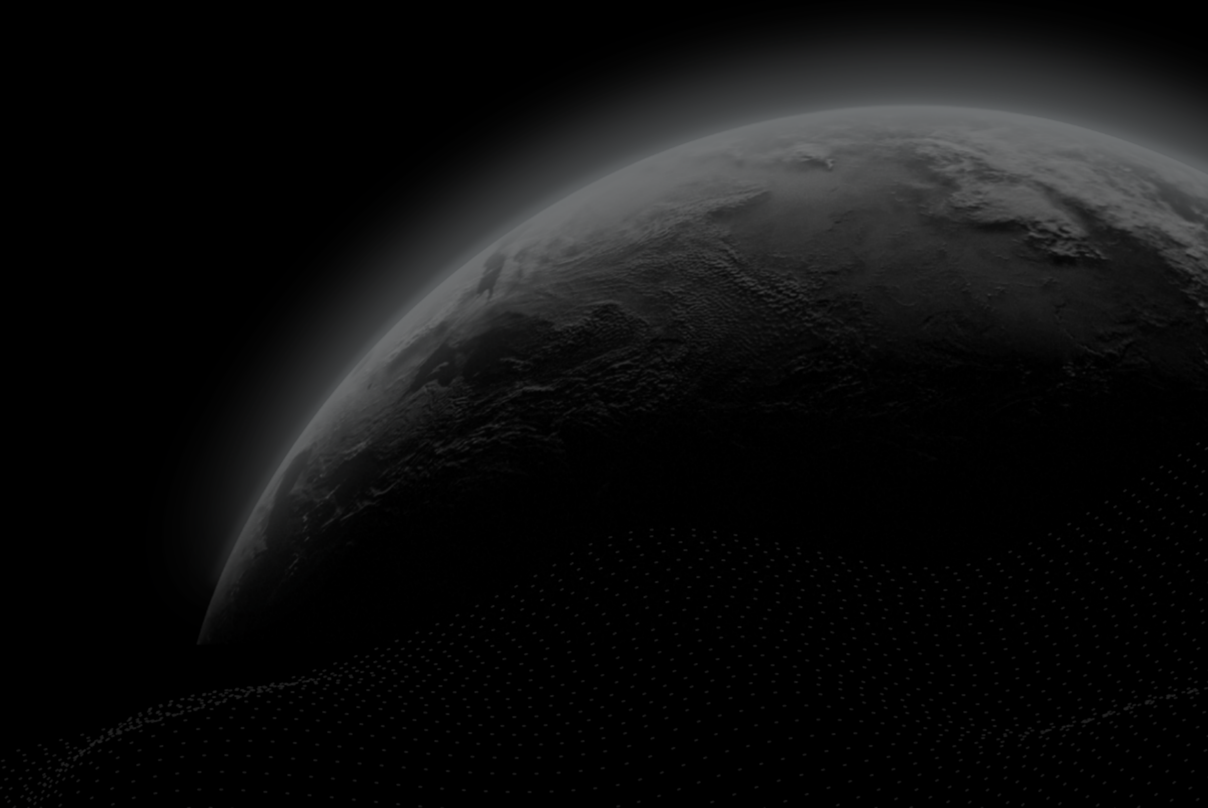
CERTIK

Security Assessment

VIDT DAO

CertiK Verified on Sept 27th, 2022



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VIDT DAO

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

Executive Summary

TYPES	ECOSYSTEM	METHODS
DeFi	Ethereum	Manual Review, Static Analysis

LANGUAGE	TIMELINE	KEY COMPONENTS
Solidity	Delivered on 09/27/2022	N/A

CODEBASE

https://rinkeby.etherscan.io/address/0xa236a6668a484e9dfd3dac18b48a697aa42679e3
https://etherscan.io/address/0x3be7bf1a5f23bd8336787d0289b70602f1
...View All

Vulnerability Summary

Total Findings	Resolved	Mitigated	Partially Resolved	Acknowledged	Declined	Unresolved
12	6	1	0	5	0	0

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.
3	Major	1 Mitigated, 2 Acknowledged	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.
2	Medium	1 Resolved, 1 Acknowledged	Medium risks may not pose a direct risk to users' funds, but they can affect the overall functioning of a platform.
2	Minor	2 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.
5	Informational	3 Resolved, 2 Acknowledged	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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Repository

https://rinkeby.etherscan.io/address/0xa236a6668a484e9dfd3dac18b48a697aa42679e3

https://etherscan.io/address/0x3be7bf1a5f23bd8336787d0289b70602f1940875#code

https://bscscan.com/address/0x9c4a515cd72D27A4710571Aca94858a53D9278D5

AUDIT SCOPE | VIDT DAO

1 file audited ● 1 file with Acknowledged findings

ID	File	SHA256 Checksum
● VID	VIDT.sol	16dec05df1574c86173be5279feefef23401c745ffc1328f1e970233fcc21460

APPROACH & METHODS | VIDT DAO

This report has been prepared for VIDT DAO to discover issues and vulnerabilities in the source code of the VIDT DAO 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.

FINDINGS | VIDT DAO

12	0	3	2	2	5
Total Findings	Critical	Major	Medium	Minor	Informational

This report has been prepared to discover issues and vulnerabilities for VIDT DAO. Through this audit, we have uncovered 12 issues ranging from different severity levels. Utilizing Static Analysis techniques to complement rigorous manual code reviews, we discovered the following findings:

ID	Title	Category	Severity	Status
VID-01	**Centralization Risks In VIDT.Sol**	**Centralization / Privilege**	**Major**	**Mitigated**
VID-02	**Initial Token Distribution**	**Centralization / Privilege**	**Major**	**Acknowledged**
VID-03	Potential Risk Of `delegatecall`	Logical Issue	Major	Acknowledged
VID-04	The Same Hash Can Validate Twice	Volatile Code	Medium	Resolved
VID-05	Third Party Dependencies	Volatile Code	Medium	Acknowledged
VID-06	Usage Of `transfer()` For Sending Ether	Volatile Code	Minor	Resolved
VID-07	Lack Of Input Validation	Volatile Code	Minor	Resolved
VID-10	Hardcode Address	Logical Issue	Informational	Acknowledged
VID-11	Redundant Code	Logical Issue	Informational	Resolved
VID-12	Redundant Modifier `payable`	Logical Issue	Informational	Resolved

ID	Title	Category	Severity	Status
VID-13	Missing Emit Events	Coding Style	Informational	Resolved
VID-14	Discussion For Contract	Logical Issue	Informational	Acknowledged

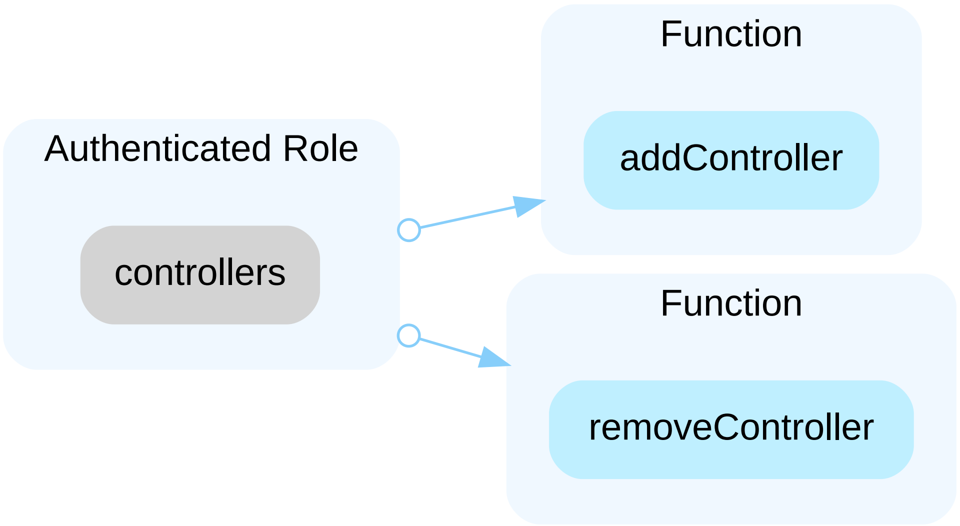
VID-01 | CENTRALIZATION RISKS IN VIDT.SOL

Category	Severity	Location	Status
Centralization / Privilege	Major	VIDT.sol: 65, 70, 145, 426, 431, 436, 442, 449, 465	Mitigated

Description

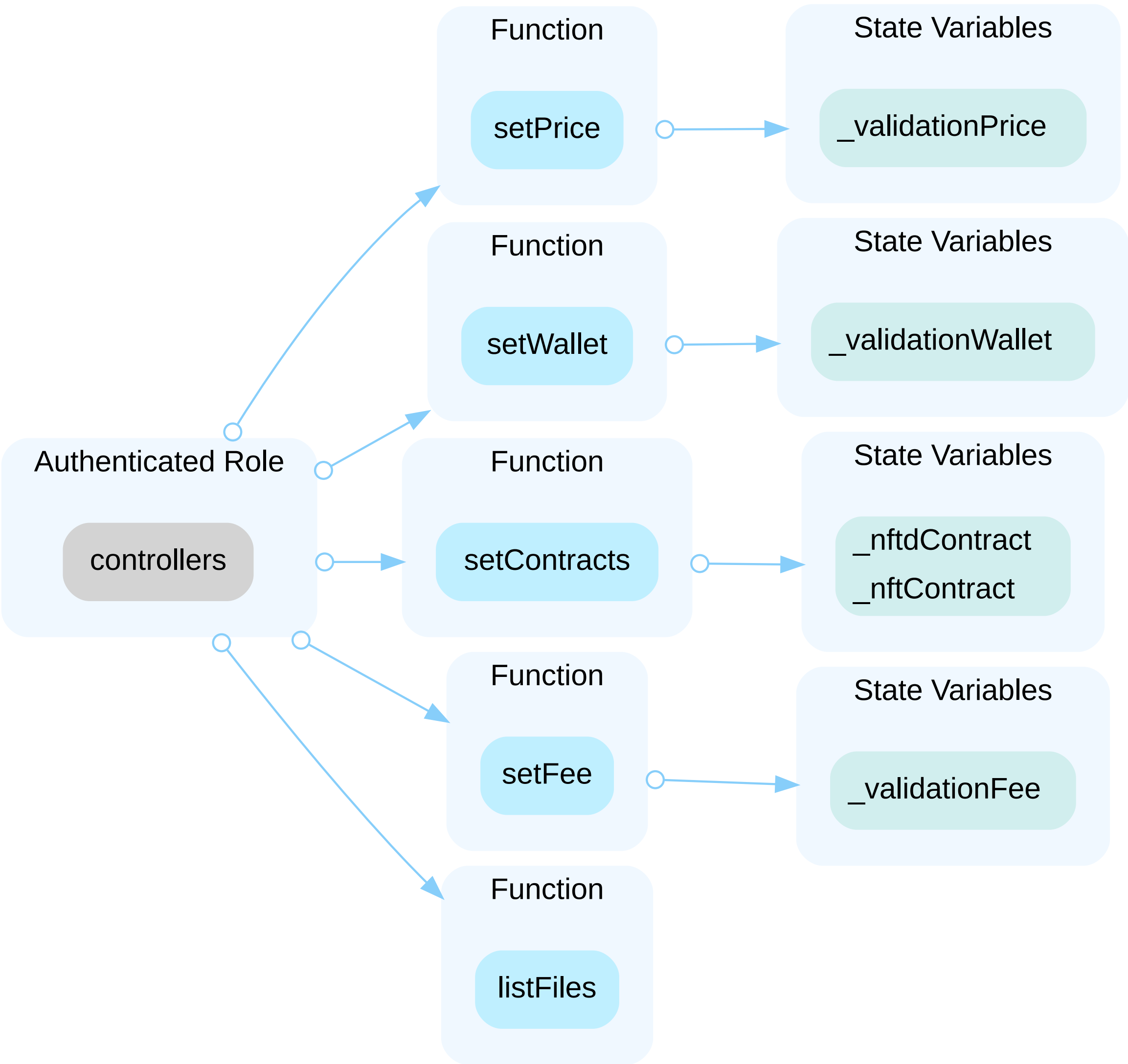
In the contract `Controllable` the role `controllers` has authority over the functions shown in the diagram below. Any compromise to the `controllers` account may allow the hacker to take advantage of this authority and

- add a controller to controllers through `addController()`
- remove a controller from controllers through `removeController()`



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

- set validation price through `setPrice()`
- set validation fee through `setFee()`
- set validation wallet through `setWallet()`
- set the address of `_nftContract` and `_nftdContract` through `setContracts()`
- list files through `listFiles()`



In the contract `VIDT` the role `_validationWallet` account can withdraw all arbitrary tokens and BNBs of the contract through `transferToken()` and `withdraw()`.

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

[VIDT Team]:

Multi-sign proxy address: https://etherscan.io/address/0x756B4e5be9517dC9b75f9b267010f4a577029F36

Control privilege added to Gnosis safe in
https://etherscan.io/tx/0xdf50ec9fdc5bf654cf1953714ca616b516686dfd9654f3335c29e811030de245

and removed privilege from deployer in

https://etherscan.io/tx/0x5e69ae8d483321ac6a5cb73debafef63bd11008a9bfeedff73849e89afd08bbb

VID-02 | INITIAL TOKEN DISTRIBUTION

Category	Severity	Location	Status
Centralization / Privilege	**Major**	**VIDT.sol: 117**	**Acknowledged**

Description

`1e27` tokens are sent to `msg.sender` when deploying the contract. This could be a centralization risk as the deployer can distribute tokens without obtaining the consensus of the community.

Recommendation

We recommend the team to be transparent regarding the initial token distribution process, and the team shall make enough efforts to restrict the access of the private key.

Alleviation

[VIDT Team]:

Issue acknowledged. I won't make any changes for the current version.

Tokens will be manually distributed to exchanges and a swap smart contract will be deployed on both ETH and BSC.

VID-03 | POTENTIAL RISK OF `delegatecall`

Category	Severity	Location	Status
Logical Issue	Major	VIDT.sol: 253, 319, 321	Acknowledged

Description

DelegateCall, as the name implies, is a calling mechanism of how caller contract calls target contract function but when target contract executed its logic, the context is not on the user who executes caller contract but on caller contract. So all developers should be aware of the risk that the `target` address may do harm to the current contract, such as calling the `selfdestruct()` or modifying the storage. In addition, it may also cause function clashing. Refer to https://forum.openzeppelin.com/t/beware-of-the-proxy-learn-how-to-exploit-function-clashing/1070.

Recommendation

We advise the client to be careful with the function and only use it on credible contracts. We would like to know why the contract needs to use a delegate call.

Alleviation

[VIDT Team]:

Issue acknowledged. I won't make any changes for the current version.

The NFT contracts will not be deployed by third parties.

VID-04 | THE SAME HASH CAN VALIDATE TWICE

Category	Severity	Location	Status
Volatile Code	Medium	VIDT.sol: 239, 243, 289, 293	Resolved

Description

According to the logic, the index of `fileHashes` starts from 0, but the logic for detecting the presence of a hash is based on whether the index is 0 or not. This will result in the first hash being able to be verified twice.

Recommendation

We advise the client to start the indexing from 1.

Alleviation

The client revised the code and resolved the issue in this commit.

VID-05 | THIRD PARTY DEPENDENCIES

Category	Severity	Location	Status
Volatile Code	Medium	VIDT.sol: 253, 319, 321, 382	Acknowledged

Description

The contract is serving as the underlying entity to interact with third-party protocols, including:

- `LEGACY_CONTRACT`
- `_nftContract`
- `_nftdContract`

Recommendation

We understand that the business logic requires interaction with the aforementioned protocols. We encourage the team to constantly monitor the status of 3rd parties to mitigate side effects when unexpected activities are observed.

Alleviation

[VIDT Team]:

Issue acknowledged. I won't make any changes for the current version.

VID-06 | USAGE OF `transfer()` FOR SENDING ETHER

Category	Severity	Location	Status
Volatile Code	Minor	VIDT.sol: 466	Resolved

Description

After EIP-1884 was included in the Istanbul hard fork, it is not recommended to use `.transfer()` or `.send()` for transferring ether as these functions have a hard-coded value for gas costs making them obsolete as they are forwarding a fixed amount of gas, specifically `2300`. This can cause issues in case the linked statements are meant to be able to transfer funds to other contracts instead of EOAs.

Recommendation

We advise that the linked `.transfer()` and `.send()` calls are substituted with the utilization of the `sendValue()` function from the `Address.sol` implementation of OpenZeppelin either by directly importing the library or copying the linked code.

Alleviation

The client revised the code and resolved the issue in this commit.

VID-07 | LACK OF INPUT VALIDATION

Category	Severity	Location	Status
Volatile Code	Minor	VIDT.sol: 344	Resolved

Description

The parameter `Data` is not validated, however it's checked in the function `validateFile()` .

Recommendation

We advise the client to add a validation.

Alleviation

The client revised the code and resolved the issue in this commit.

VID-10 | HARDCODE ADDRESS

Category	Severity	Location	Status
Logical Issue	Informational	VIDT.sol: 103	Acknowledged

Description

There is a hardcode address in this codebase.

Recommendation

We advise double check the addresses before the contract is deployed onto the blockchain.

Alleviation

[VIDT Team]:

Issue acknowledged. I won't make any changes for the current version. As this is intended as a token swap, the previous smart contract address is hard coded.

VID-11 | REDUNDANT CODE

Category	Severity	Location	Status
Logical Issue	Informational	VIDT.sol: 165, 175	Resolved

Description

The function `increaseAllowance()` has the same implementation logic as the function `increaseApproval()` , the function `decreaseAllowance()` has the same issue.

Recommendation

We advise the client to remove the functions.

Alleviation

The client revised the code and resolved the issue in this commit.

VID-12 | REDUNDANT MODIFIER `payable`

Category	Severity	Location	Status
Logical Issue	● Informational	VIDT.sol: 344	● Resolved

Description

The function that is declared `payable` can receive ether. The function `simpleValidateFile()` seems not designed for receiving ether, so it is redundant to have the `payable` modifier.

Recommendation

We recommend removing the `payable` modifier from function at the aforementioned line.

Alleviation

The client revised the code and resolved the issue in this commit.

VID-13 | MISSING EMIT EVENTS

Category	Severity	Location	Status
Coding Style	Informational	VIDT.sol: 354	Resolved

Description

The function `simpleValidateFile()` emits the event `Transfer` , but the function `covertValidateFile()` does not.

Recommendation

We advise the client to add events for sensitive actions and emit them in the function.

Alleviation

The client revised the code and resolved the issue by removing the function `covertValidateFile()` .

VID-14 | DISCUSSION FOR CONTRACT

Category	Severity	Location	Status
Logical Issue	Informational	VIDT.sol: 82	Acknowledged

Description

1. Creating an NFT in the function `validateNFT()` is based on whether it is divisible or not, but the function `validateFile()` is not.
2. The function `validateFile()` supports token or BNB payments, there is no strict restriction to only one kind of payment, so that the user may pay both at the same time. The functions `memoryValidateFile`, `validateNFT()` and `covertValidateFile()` have the same issue. If both `cStore` and `NFT` are `false`, the logic is similar to the function `covertValidateFile()`.
3. The functions `simpleValidateFile()` and `covertValidateFile()` do not support `allowances` and have inconsistent function names and logic. What is the purpose of these two functions?

Recommendation

We would like to confirm with the client if the current implementation aligns with the original project design.

Alleviation

[VIDT Team]:

1. That is as intended as it is not about file ownership or co-ownership of any file data other than NFT's.
2. This is correct, overpayment is allowed. Function covertValidateFile has been removed.
3. Correct, the purpose is optimal gas efficiency only for simpleValidateFile(). Function covertValidateFile has been removed.

OPTIMIZATIONS | VIDT DAO

ID	Title	Category	Severity	Status
VID-08	Variables That Could Be Declared As `constant`	Gas Optimization	Optimization	Resolved
VID-09	Loop Optimization	Gas Optimization	Optimization	Resolved

VID-08 | VARIABLES THAT COULD BE DECLARED AS `constant`

Category	Severity	Location	Status
Gas Optimization	Optimization	VIDT.sol: 96	Resolved

Description

The linked variables could be declared as `constant` since these state variables are never modified.

Recommendation

We recommend to declare these variables as `constant`.

Alleviation

The client revised the code and resolved the issue in this commit.

VID-09 | LOOP OPTIMIZATION

Category	Severity	Location	Status
Gas Optimization	Optimization	VIDT.sol: 374~378	Resolved

Description

In the function `verifyFile()`, the loop that checks for byte inequality would be more efficient if it aborted the loop as soon as it found a match.

Recommendation

We advise the client to add a `break` statement if a match was found.

Alleviation

The client revised the code and resolved the issue in this commit.

APPENDIX | VIDT DAO

Details on Formal Verification

Technical description

Some Solidity smart contracts from this project have been formally verified using symbolic model checking. Each such contract was compiled into a mathematical model which 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 model also formalizes a simplified execution environment of the Ethereum blockchain and a verification harness that performs the initialization of the contract and all possible interactions with the contract. Initially, the contract state is initialized non-deterministically (i.e. by arbitrary values) and over-approximates the reachable state space of the contract throughout any actual deployment on chain. All valid results thus carry over to the contract's behavior in arbitrary states after it has been deployed.

Assumptions and simplifications

The following assumptions and simplifications apply to our model:

- Gas consumption is not taken into account, i.e. we assume that executions do not terminate prematurely because they run out of gas.
- The contract's state variables are non-deterministically initialized before invocation of any of those functions. That ignores contract invariants and may lead to false positives. It is, however, a safe over-approximation.
- The verification engine reasons about unbounded integers. Machine arithmetic is modeled as operations on the congruence classes arising from the bit-width of the underlying numeric type. This ensures that over- and underflow characteristics are faithfully represented.
- Certain low-level calls and inline assembly are not supported and may lead to an ERC-20 token 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 definitions

All properties are expressed in linear temporal logic (LTL). For that matter, we treat each invocation of and each return from a public or an external function as a discrete time steps. Our analysis reasons about the contract's state upon entering and upon leaving public or external functions.

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:

- `started(f, [cond])` Indicates an invocation of contract function `f` within a state satisfying formula `cond`.

- `willSucceed(f, [cond])` Indicates an invocation of contract function `f` within a state satisfying formula `cond` and considers only those executions that do not revert.
- `finished(f, [cond])` Indicates that execution returns from contract function `f` in a state satisfying formula `cond`. Here, formula `cond` may refer to the contract's state variables and to the value they had upon entering the function (using the `old` function).
- `reverted(f, [cond])` Indicates that execution of contract function `f` was interrupted by an exception in a contract state satisfying formula `cond`.

The verification performed in this audit operates on a harness that non-deterministically invokes a function of the contract's public or external interface. All formulas are analyzed w.r.t. the trace that corresponds to this function invocation.

Description of ERC-20 Properties

The specifications are designed such that they capture the desired and admissible behaviors of the ERC-20 functions `transfer`, `transferFrom`, `approve`, `allowance`, `balanceOf`, and `totalSupply`.

In the following, we list those property specifications.

Properties for ERC-20 function `transfer`

erc20-transfer-revert-zero

Function `transfer` Prevents Transfers to the Zero Address.

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

Specification:

```
[](started(contract.transfer(to, value), to == address(0))
   ==> <>(reverted(contract.transfer) || finished(contract.transfer(to, value),
          !return)))
```

erc20-transfer-succeed-normal

Function `transfer` Succeeds on Admissible Non-self Transfers.

All invocations of the form `transfer(recipient, amount)` must succeed and return `true` if

- the `recipient` address is not the zero address,
- `amount` does not exceed the balance of address `msg.sender`,
- transferring `amount` to the `recipient` address does not lead to an overflow of the recipient's balance, and
- the supplied gas suffices to complete the call.

Specification:

```
[](started(contract.transfer(to, value), to != address(0)
          && to != msg.sender && value >= 0 && value <= _balances[msg.sender]
          && _balances[to] + value <= type(uint256).max && _balances[to] >= 0
          && _balances[msg.sender] <= type(uint256).max)
          ==> <>(finished(contract.transfer(to, value), return)))
```

erc20-transfer-succeed-self

Function `transfer` Succeeds on Admissible Self Transfers.

All self-transfers, i.e. invocations of the form `transfer(recipient, amount)` where the `recipient` address equals the address in `msg.sender` must succeed and return `true` if

- the value in `amount` does not exceed the balance of `msg.sender` and
- the supplied gas suffices to complete the call.

Specification:

```
[](started(contract.transfer(to, value), to != address(0)
          && to == msg.sender && value >= 0 && value <= _balances[msg.sender]
          && _balances[msg.sender] >= 0
          && _balances[msg.sender] <= type(uint256).max)
          ==> <>(finished(contract.transfer(to, value), return)))
```

erc20-transfer-correct-amount

Function `transfer` Transfers the Correct Amount in Non-self Transfers.

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:

```
[](willSucceed(contract.transfer(to, value), to != msg.sender
   && _balances[to] >= 0 && value >= 0
   && _balances[to] + value <= type(uint256).max
   && _balances[msg.sender] >= 0 && _balances[msg.sender] <= type(uint256).max)
      ==> <>(finished(contract.transfer(to, value), return
             ==> _balances[msg.sender] == old(_balances[msg.sender]) - value
                 && _balances[to] == old(_balances[to]) + value)))
```

erc20-transfer-correct-amount-self

Function `transfer` Transfers the Correct Amount in Self Transfers.

All non-reverting invocations of `transfer(recipient, amount)` that return `true` and where the `recipient` address equals `msg.sender` (i.e. self-transfers) must not change the balance of address `msg.sender`.

Specification:

```
[](willSucceed(contract.transfer(to, value), to == msg.sender
  && _balances[to] >= 0 && _balances[to] <= type(uint256).max)
     ==> <>(finished(contract.transfer(to, value), return
         ==> _balances[to] == old(_balances[to]))))
```

erc20-transfer-change-state

Function `transfer` Has No Unexpected State Changes.

All non-reverting invocations of `transfer(recipient, amount)` that return `true` must only modify the balance entries of the `msg.sender` and the `recipient` addresses.

Specification:

```
[](willSucceed(contract.transfer(to, value), p1 != msg.sender && p1 != to)
  ==> <>(finished(contract.transfer(to, value), return
      ==> (_totalSupply == old(_totalSupply) && _allowances == old(_allowances)
           && _balances[p1] == old(_balances[p1])  ))))
```

erc20-transfer-exceed-balance

Function `transfer` Fails if Requested Amount Exceeds Available Balance.

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

Specification:

```
[](started(contract.transfer(to, value), value > _balances[msg.sender]
   && _balances[msg.sender] >= 0 && value <= type(uint256).max)
   ==> <>(reverted(contract.transfer) || finished(contract.transfer(to, value),
          !return)))
```

erc20-transfer-recipient-overflow

Function `transfer` Prevents Overflows in the Recipient's Balance.

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

Specification:

```
[](started(contract.transfer(to, value), to != msg.sender
   && _balances[to] + value > type(uint256).max
   && _balances[to] >= 0 && _balances[to] <= type(uint256).max
   && _balances[msg.sender] <= type(uint256).max
   && value > 0 && value <= _balances[msg.sender])
   ==> <>(reverted(contract.transfer) || finished(contract.transfer(to, value),
          !return) || finished(contract.transfer(to, value), _balances[to]
                      > old(_balances[to]) + value - type(uint256).max - 1)))
```

erc20-transfer-false

If Function `transfer` Returns `false` , the Contract State Has Not Been Changed.

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

Specification:

```
[](willSucceed(contract.transfer(to, value))
   ==> <>(finished(contract.transfer(to, value), !return]
   ==> (_balances == old(_balances) && _totalSupply == old(_totalSupply)
                                 && _allowances == old(_allowances)  ))))
```

erc20-transfer-never-return-false

Function `transfe` Never Returns `false` .

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

Specification:

```
[](!(finished(contract.transfer, !return)))
```

Properties for ERC-20 function `transferFrom`

erc20-transferfrom-revert-from-zero

Function `transferFrom` Fails for Transfers From the Zero Address.

All calls of the form `transferFrom(from, dest, amount)` where the `from` address is zero, must fail.

Specification:

```
[](started(contract.transferFrom(from, to, value), from == address(0))
   ==> <>(reverted(contract.transferFrom) || finished(contract.transferFrom,
          !return)))
```

erc20-transferfrom-revert-to-zero

Function `transferFrom` Fails for Transfers To the Zero Address.

All calls of the form `transferFrom(from, dest, amount)` where the `dest` address is zero, must fail.

Specification:

```
[](started(contract.transferFrom(from, to, value), to == address(0))
   ==> <>(reverted(contract.transferFrom) || finished(contract.transferFrom,
          !return)))
```

erc20-transferfrom-succeed-normal

Function `transferFrom` Succeeds on Admissible Non-self Transfers. All invocations of `transferFrom(from, dest, amount)` must succeed and return `true` if

- the value of `amount` does not exceed the balance of address `from` ,
- the value of `amount` does not exceed the allowance of `msg.sender` for address `from` ,
- transferring a value of `amount` to the address in `dest` does not lead to an overflow of the recipient's balance, and
- the supplied gas suffices to complete the call.

Specification:

```
[](started(contract.transferFrom(from, to, value), from != address(0)
   && to != address(0) && from != to && value <= _balances[from]
   && value <= _allowances[from][msg.sender]
   && _balances[to] + value <= type(uint256).max
   && value >= 0 && _balances[to] >= 0 && _balances[from] >= 0
   && _balances[from] <= type(uint256).max
   && _allowances[from][msg.sender] >= 0
   && _allowances[from][msg.sender] <= type(uint256).max)
      ==> <>(finished(contract.transferFrom(from, to, value), return)))
```

erc20-transferfrom-succeed-self

Function `transferFrom` Succeeds on Admissible Self Transfers.

All invocations of `transferFrom(from, dest, amount)` where the `dest` address equals the `from` address (i.e. self-transfers) must succeed and return `true` if:

- The value of `amount` does not exceed the balance of address `from` ,
- the value of `amount` does not exceed the allowance of `msg.sender` for address `from` , and
- the supplied gas suffices to complete the call.

Specification:

```
[](started(contract.transferFrom(from, to, value), from != address(0)
   && from == to && value <= _balances[from]
   && value <= _allowances[from][msg.sender]
   && value >= 0 && _balances[from] <= type(uint256).max
   && _allowances[from][msg.sender] <= type(uint256).max)
     ==> <>(finished(contract.transferFrom(from, to, value), return)))
```

erc20-transferfrom-correct-amount

Function `transferFrom` Transfers the Correct Amount in Non-self Transfers.

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:

```
[](willSucceed(contract.transferFrom(from, to, value), from != to && value >= 0
&& _balances[from] >= 0 && _balances[from] <= type(uint256).max
&& _balances[to] >= 0 && _balances[to] + value <= type(uint256).max)
   ==> <>(finished(contract.transferFrom(from, to, value), return
          ==> _balances[from] == old(_balances[from]) - value
              && _balances[to] == old(_balances[to] + value))))
```

erc20-transferfrom-correct-amount-self

Function `transferFrom` Performs Self Transfers Correctly.

All non-reverting invocations of `transferFrom(from, dest, amount)` that return `true` and where the address in `from` equals the address in `dest` (i.e. self-transfers) do not change the balance entry of the `from` address (which equals `dest`).

Specification:

```
[](willSucceed(contract.transferFrom(from, to, value), from == to
   && value >= 0 && value <= type(uint256).max && _balances[from] >= 0
   && _balances[from] <= type(uint256).max)
      ==> <>(finished(contract.transferFrom(from, to, value), return
             ==> _balances[from] == old(_balances[from]))))
```

erc20-transferfrom-correct-allowance

Function `transferFrom` Updated the Allowance Correctly.

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:

```
[](willSucceed(contract.transferFrom(from, to, value), value >= 0
   && value <= type(uint256).max && _balances[from] >= 0
   && _balances[from] <= type(uint256).max && _balances[to] >= 0
   && _balances[to] <= type(uint256).max && _allowances[from][msg.sender] >= 0
   && _allowances[from][msg.sender] <= type(uint256).max)
      ==> <>(finished(contract.transferFrom(from, to, value), return
          ==> ((_allowances[from][msg.sender]
                == old(_allowances[from][msg.sender]) - value)
                 || (_allowances[from][msg.sender]
                     == old(_allowances[from][msg.sender])
                        && (from == msg.sender
                             || old(_allowances[from][msg.sender])
                                == type(uint256).max))))))
```

erc20-transferfrom-change-state

Function `transferFrom` Has No Unexpected State Changes.

All non-reverting invocations of `transferFrom(from, dest, amount)` that return `true` may only modify the following state variables:

- The balance entry for the address in `dest` ,
- The balance entry for the address in `from` ,
- The allowance for the address in `msg.sender` for the address in `from` . Specification:

```
[](willSucceed(contract.transferFrom(from, to, amount), p1 != from && p1 != to
   && (p2 != from || p3 != msg.sender))
    ==> <>(finished(contract.transferFrom(from, to, amount), return
     ==> (_totalSupply == old(_totalSupply) && _balances[p1] == old(_balances[p1])
         && _allowances[p2][p3] == old(_allowances[p2][p3])  ))))
```

erc20-transferfrom-fail-exceed-balance

Function `transferFrom` Fails if the Requested Amount Exceeds the Available 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:

```
[](started(contract.transferFrom(from, to, value), value > _balances[from]
   && _balances[from] >= 0 && _balances[from] <= type(uint256).max)
       ==> <>(reverted(contract.transferFrom)
              || finished(contract.transferFrom, !return)))
```

erc20-transferfrom-fail-exceed-allowance

Function `transferFrom` Fails if the Requested Amount Exceeds the Available 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:

```
[](started(contract.transferFrom(from, to, value), value > _allowances[from]
[msg.sender]
     && _allowances[from][msg.sender] >= 0 && value <= type(uint256).max)
     ==> <>(reverted(contract.transferFrom)
           || finished(contract.transferFrom(from, to, value), !return)
           || finished(contract.transferFrom(from, to, value), return
              && (msg.sender == from
                  || _allowances[from][msg.sender] == type(uint256).max))))
```

erc20-transferfrom-fail-recipient-overflow

Function `transferFrom` Prevents Overflows in the Recipient's Balance.

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:

```
[](started(contract.transferFrom(from, to, value), from != to
   && _balances[to] + value > type(uint256).max && value <= type(uint256).max
   && _balances[to] >= 0 && _balances[to] <= type(uint256).max)
      ==> <>(reverted(contract.transferFrom)
          || finished(contract.transferFrom(from, to, value), !return)
          || finished(contract.transferFrom(from, to, value), _balances[to]
              > old(_balances[to]) + value - type(uint256).max - 1)))
```

erc20-transferfrom-false

If Function `transferFrom` Returns `false`, the Contract's State Has Not Been Changed.

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

Specification:

```
[](willSucceed(contract.transfer(to, value))
   ==> <>(finished(contract.transfer(to, value), !return
   ==> (_balances == old(_balances) && _totalSupply == old(_totalSupply)
                                    && _allowances == old(_allowances)  ))))
```

erc20-transferfrom-never-return-false

Function `transferFrom` Never Returns `false`.

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

Specification:

```
[](!(finished(contract.transferFrom, !return)))
```

Properties related to function `totalSupply`

erc20-totalsupply-succeed-always

Function `totalSupply` Always Succeeds.

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

Specification:

```
[](started(contract.totalSupply) ==> <>(finished(contract.totalSupply)))
```

erc20-totalsupply-correct-value

Function `totalSupply` Returns the Value of the Corresponding State Variable.

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

Specification:

```
[](willSucceed(contract.totalSupply)
   ==> <>(finished(contract.totalSupply, return == _totalSupply)))
```

erc20-totalsupply-change-state

Function `totalSupply` Does Not Change the Contract's State.

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

Specification:

```
[](willSucceed(contract.totalSupply)
   ==> <>(finished(contract.totalSupply, _totalSupply == old(_totalSupply)
          && _balances == old(_balances) && _allowances == old(_allowances)  )))
```

Properties related to function `balanceOf`

erc20-balanceof-succeed-always

Function `balanceOf` Always Succeeds.

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

Specification:

```
[](started(contract.balanceOf) ==> <>(finished(contract.balanceOf)))
```

erc20-balanceof-correct-value

Function `balanceOf` Returns the Correct Value.

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

Specification:

```
[](willSucceed(contract.balanceOf)
   ==> <>(finished(contract.balanceOf(owner), return == _balances[owner])))
```

erc20-balanceof-change-state

Function `balanceOf` Does Not Change the Contract's State.

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

Specification:

```
[](willSucceed(contract.balanceOf)
   ==> <>(finished(contract.balanceOf(owner), _totalSupply == old(_totalSupply)
          && _balances == old(_balances)
          && _allowances == old(_allowances)  )))
```

Properties related to function `allowance`

erc20-allowance-succeed-always

Function `allowance` Always Succeeds.

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

Specification:

```
[](started(contract.allowance) ==> <>(finished(contract.allowance)))
```

erc20-allowance-correct-value

Function `allowance` Returns Correct Value.

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

Specification:

```
[](willSucceed(contract.allowance(owner, spender))
   ==> <>(finished(contract.allowance(owner, spender),
           return == _allowances[owner][spender])))
```

erc20-allowance-change-state

Function `allowance` Does Not Change the Contract's State.

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

Specification:

```
[](willSucceed(contract.allowance(owner, spender))
   ==> <>(finished(contract.allowance(owner, spender),
   _totalSupply == old(_totalSupply) && _balances == old(_balances)
                && _allowances == old(_allowances)  )))
```

Properties related to function `approve`

erc20-approve-revert-zero

Function `approve` Prevents Giving Approvals For the Zero Address.

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

Specification:

```
[](started(contract.approve(spender, value), spender == address(0))
   ==> <>(reverted(contract.approve)
          || finished(contract.approve(spender, value), !return)))
```

erc20-approve-succeed-normal

Function `approve` Succeeds for Admissible Inputs.

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:

```
[](started(contract.approve(spender, value), spender != address(0))
   ==> <>(finished(contract.approve(spender, value), return)))
```

erc20-approve-correct-amount

Function `approve` Updates the Approval Mapping Correctly.

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:

```
[](willSucceed(contract.approve(spender, value), spender != address(0)
   && value >= 0 && value <= type(uint256).max)
       ==> <>(finished(contract.approve(spender, value), return
              ==> _allowances[msg.sender][spender] == value)))
```

erc20-approve-change-state

Function `approve` Has No Unexpected State Changes.

All calls of the form `approve(spender, amount)` must only update the allowance mapping according to the address `msg.sender` and the values of `spender` and `amount` and incur no other state changes.

Specification:

```
[](willSucceed(contract.approve(spender, value), spender != address(0)
   && (p1 != msg.sender || p2 != spender))
       ==> <>(finished(contract.approve(spender, value), return
              ==> _totalSupply == old(_totalSupply) && _balances == old(_balances)
                  && _allowances[p1][p2] == old(_allowances[p1][p2])  )))
```

erc20-approve-false

If Function `approve` Returns `false`, the Contract's State Has Not Been Changed.

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

Specification:

```
[](willSucceed(contract.approve(spender, value))
   ==> <>(finished(contract.approve(spender, value), !return
          ==> (_balances == old(_balances) && _totalSupply == old(_totalSupply)
               && _allowances == old(_allowances)  ))))
```

erc20-approve-never-return-false

Function `approve` Never Returns `false`.

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

Specification:

```
[](!(finished(contract.approve, !return)))
```

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.
Volatile Code	Volatile Code findings refer to segments of code that behave unexpectedly on certain edge cases that may result in a vulnerability.
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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