CERTIK

Code Security Assessment

Shentu Security Oracle

Oct 11th, 2020

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Summary

This report has been prepared for Shentu Security Oracle to discover issues and vulnerabilities in the source code of the Shentu Security Oracle 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:

- 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.

Overview

Project Summary

Project Name	Shentu Security Oracle
Platform	Ethereum
Language	Solidity
Codebase	
Commit	

Audit Summary

Delivery Date	Oct 11, 2020
Audit Methodology	Static Analysis, Manual Review

Vulnerability Summary

Vulnerability Level	Total	Pending	Declined	Acknowledged	Partially Resolved	Mitigated	Resolved
● Critical	0	0	0	0	0	0	0
● Major	0	0	0	0	0	0	0
● Medium	0	0	0	0	0	0	0
● Minor	0	0	0	0	0	0	0
● Informational	14	0	0	2	0	0	12
● Discussion	0	0	0	0	0	0	0

Audit Scope

ID	File	SHA256 Checksum

Executive Summary

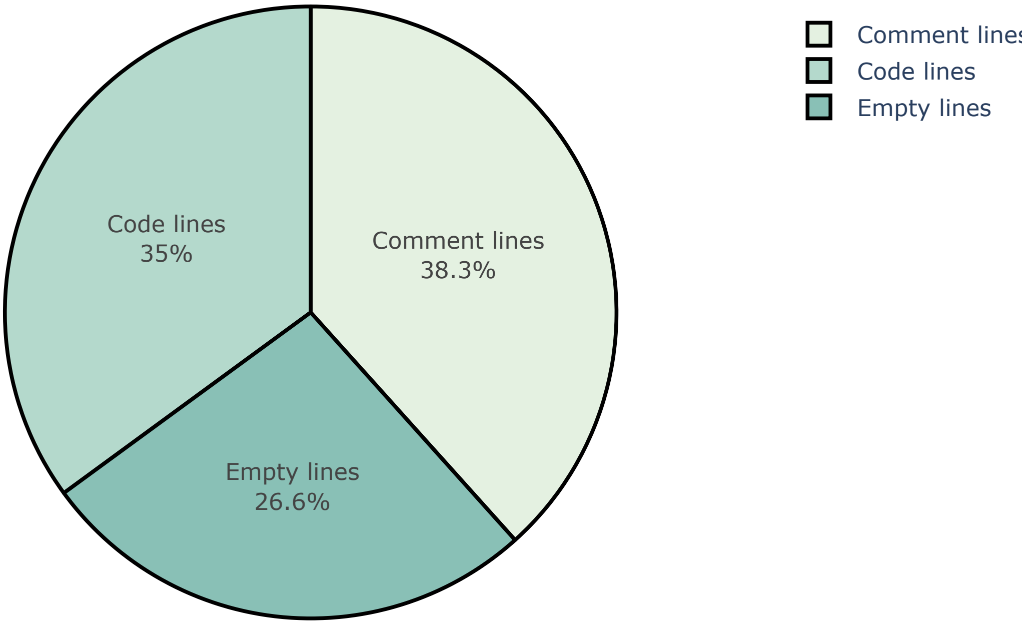
The report represents the results of our engagement with the Shentu Chain on their Security Oracle

The high severity exhibits stem from the different compiler versions that the codebase allowed and one referenced vulnerability, which were immediately refactored. In contrast, the lower severity ones mainly refer to optimization and Solidity coding standards.

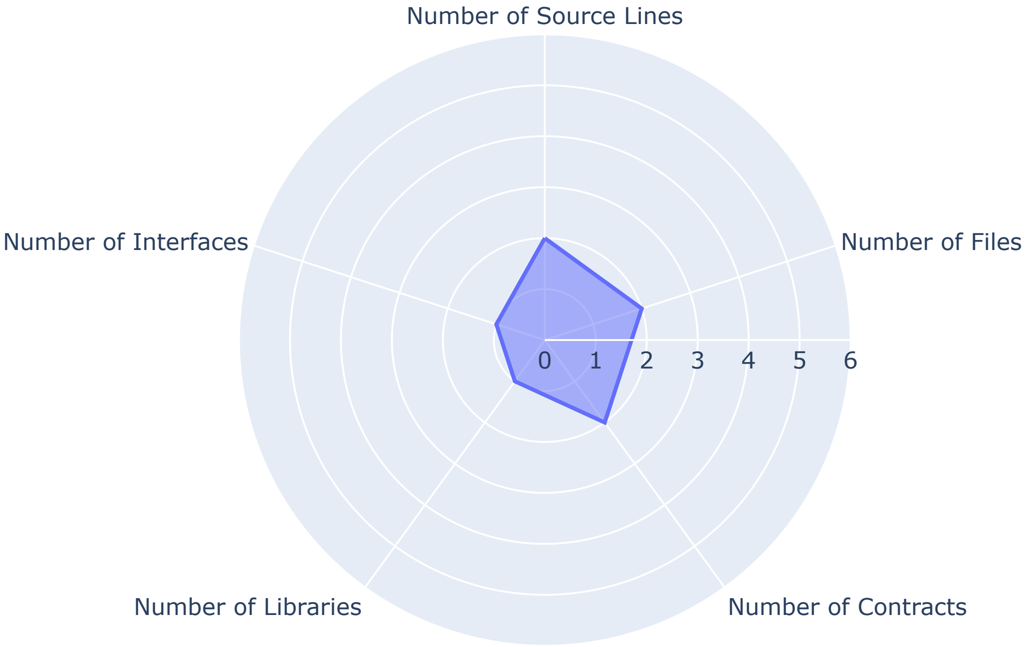
Hence the codebase can be deemed to be of high security and quality.

Diagrams

Source Line Chart



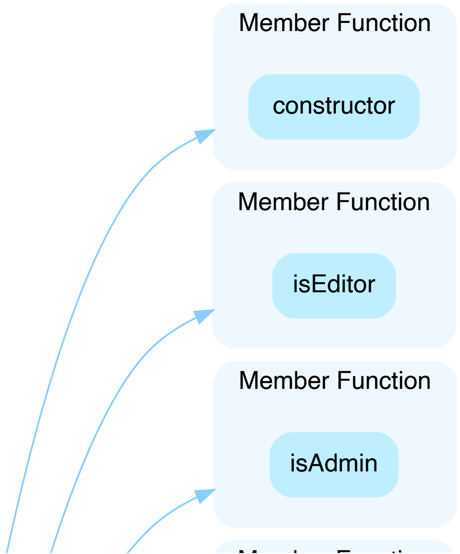
Summary Chart

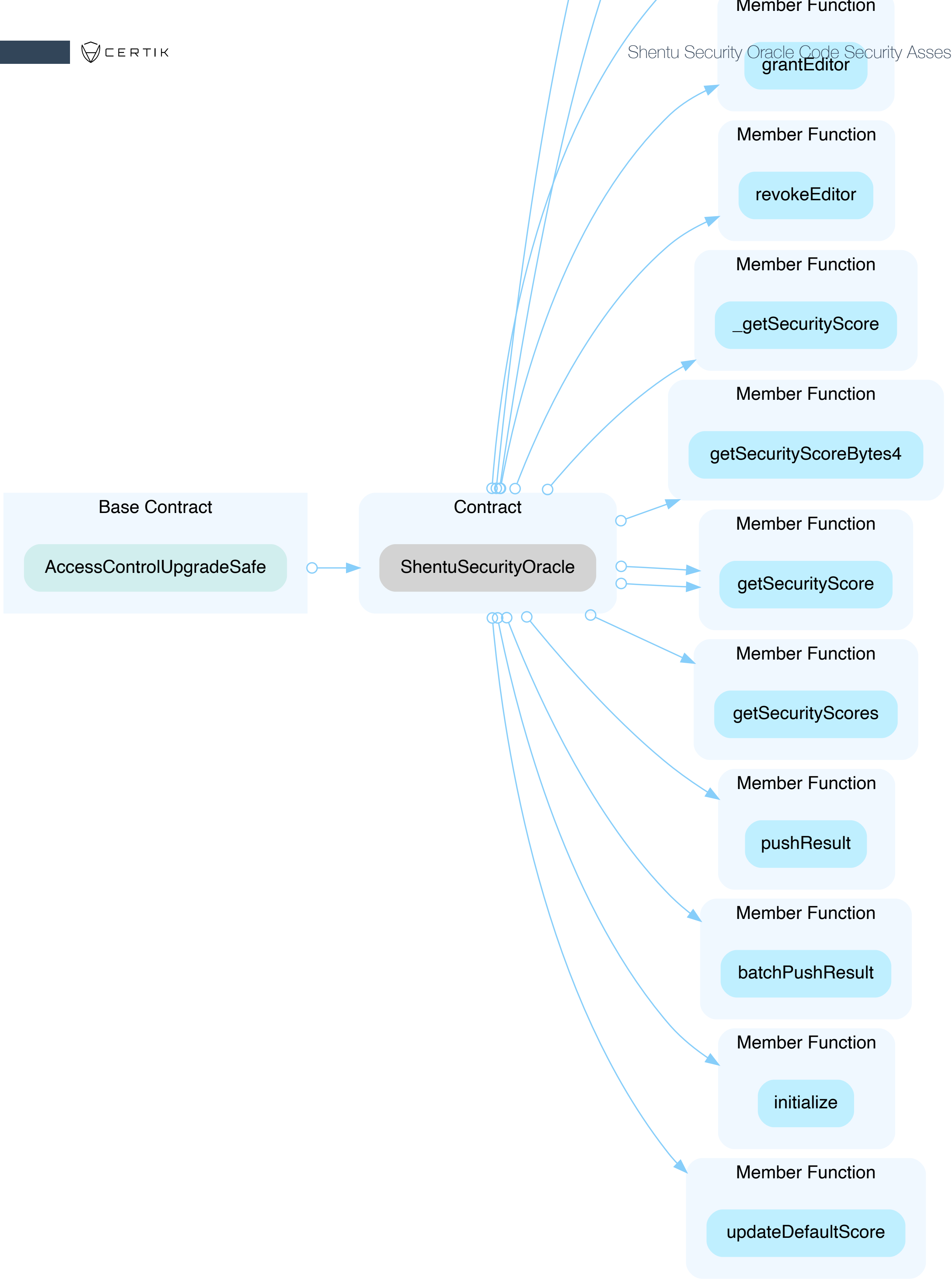


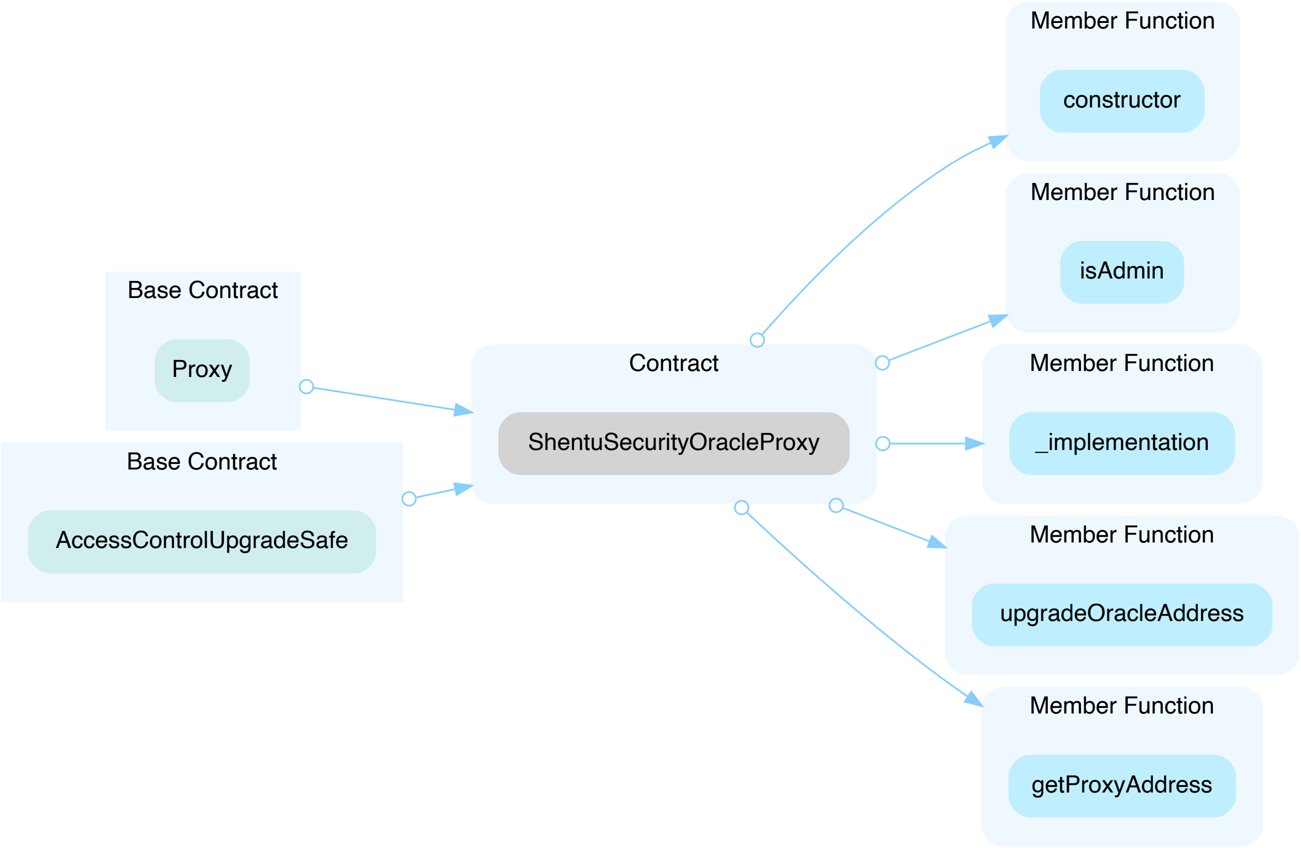
Function	*# of Invocations*	*Invocation Location*
isEditor	5	ShentuSecurityOracle.sol: 50, ShentuSecurityOracle.sol: 54, openzeppelin/AccessControl.sol: 133, openzeppelin/AccessControl.sol: 148, ShentuSecurityOracleProxy.sol: 29
isAdmin	2	ShentuSecurityOracle.sol: 38, ShentuSecurityOracle.sol: 45
_getSecurityScore	2	ShentuSecurityOracle.sol: 89, ShentuSecurityOracle.sol: 109
getSecurityScoreBytes4	2	ShentuSecurityOracle.sol: 97, ShentuSecurityOracle.sol: 126
pushResult	2	openzeppelin/EnumerableSet.sol: 55, openzeppelin/EnumerableSet.sol: 220
initialize	2	openzeppelin/Proxy.sol: 64, openzeppelin/Proxy.sol: 72
_add	2	ShentuSecurityOracle.sol: 30, ShentuSecurityOracleProxy.sol: 11
_remove	2	openzeppelin/AccessControl.sol: 135, openzeppelin/AccessControl.sol: 190
_contains	2	openzeppelin/AccessControl.sol: 150, openzeppelin/AccessControl.sol: 170
_length	1	ShentuSecurityOracle.sol: 38
_at	1	ShentuSecurityOracle.sol: 164
isConstructor	1	ShentuSecurityOracle.sol: 33
_delegate	1	openzeppelin/EnumerableSet.sol: 203
_implementation	1	openzeppelin/EnumerableSet.sol: 213
_fallback	1	openzeppelin/EnumerableSet.sol: 227
_beforeFallback	1	openzeppelin/EnumerableSet.sol: 241
__AccessControl_init_unchained	1	openzeppelin/Initializable.sol: 34
hasRole	1	openzeppelin/Proxy.sol: 56
grantRole	1	openzeppelin/Proxy.sol: 56
revokeRole	1	openzeppelin/Proxy.sol: 55
_setupRole	1	openzeppelin/AccessControl.sol: 44
_setRoleAdmin	1	ShentuSecurityOracle.sol: 58
_grantRole	1	ShentuSecurityOracle.sol: 62
_revokeRole	1	ShentuSecurityOracle.sol: 31
__Context_init_unchained	1	openzeppelin/Context.sol: 21
isAdmin	1	ShentuSecurityOracleProxy.sol: 22

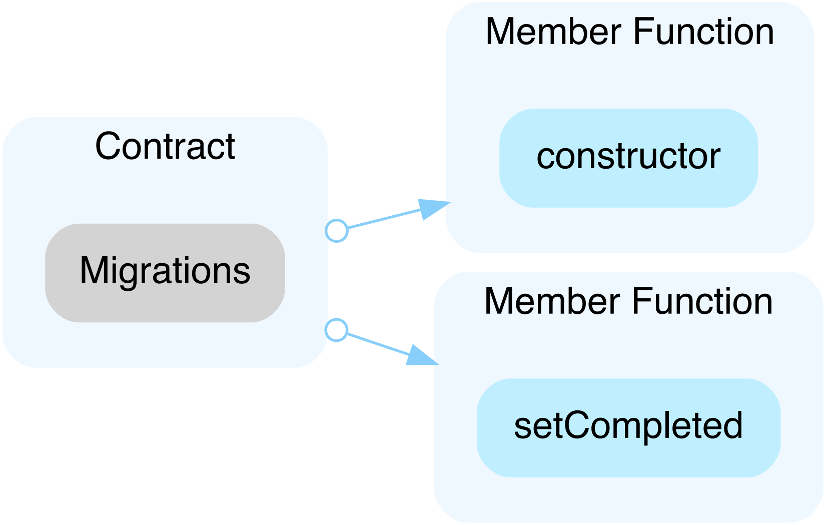
Contract	*# of Invocations*	*Invocation Location*
ShentuSecurityOracle	0	
Migrations	0	
EnumerableSet	0	
Initializable	0	
Proxy	0	
AccessControlUpgradeSafe	0	
ContextUpgradeSafe	0	
Address	0	
ShentuSecurityOracleProxy	0	
SecurityOracle	0	
DeFiExample	0	

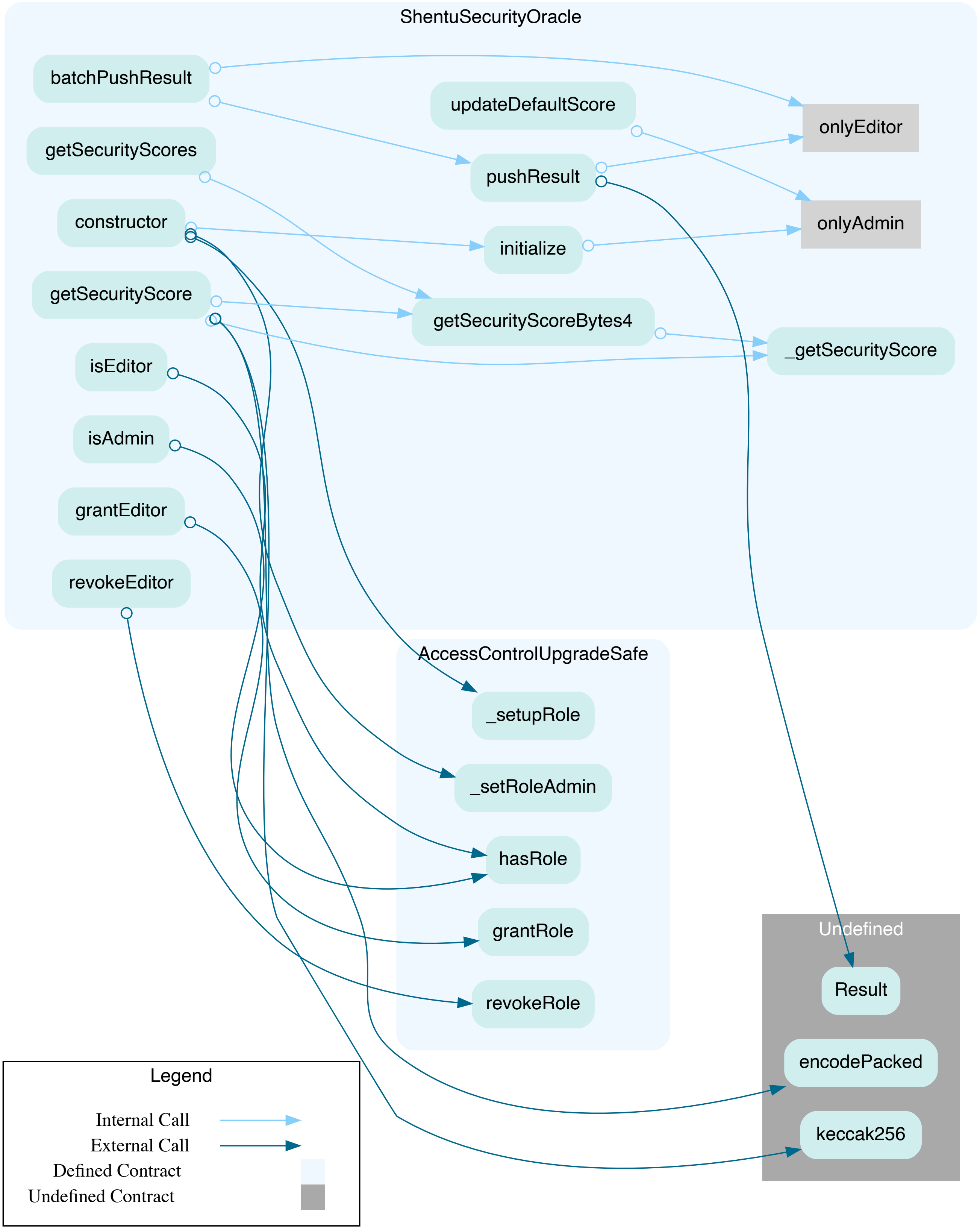
Function	*# of Invocations*	*Invocation Location*
constructor	0	
grantEditor	0	
revokeEditor	0	
getSecurityScore	0	
getSecurityScore	0	
getSecurityScores	0	
batchPushResult	0	
updateDefaultScore	0	
constructor	0	
setCompleted	0	
add	0	
remove	0	
contains	0	
length	0	
at	0	
fallback	0	
receive	0	
__AccessControl_init	0	
getRoleMemberCount	0	
getRoleMember	0	
getRoleAdmin	0	
renounceRole	0	
__Context_init	0	
_msgSender	0	
_msgData	0	
isContract	0	
sendValue	0	
constructor	0	
_implementation	0	
upgradeOracleAddress	0	
getProxyAddress	0	
getSecurityScore	0	
getSecurityScore	0	
getSecurityScoreBytes4	0	
getSecurityScores	0	
constructor	0	
callGetSecurityScore	0	
callGetSecurityScoreBytes4	0	
callGetSecurityScores	0	

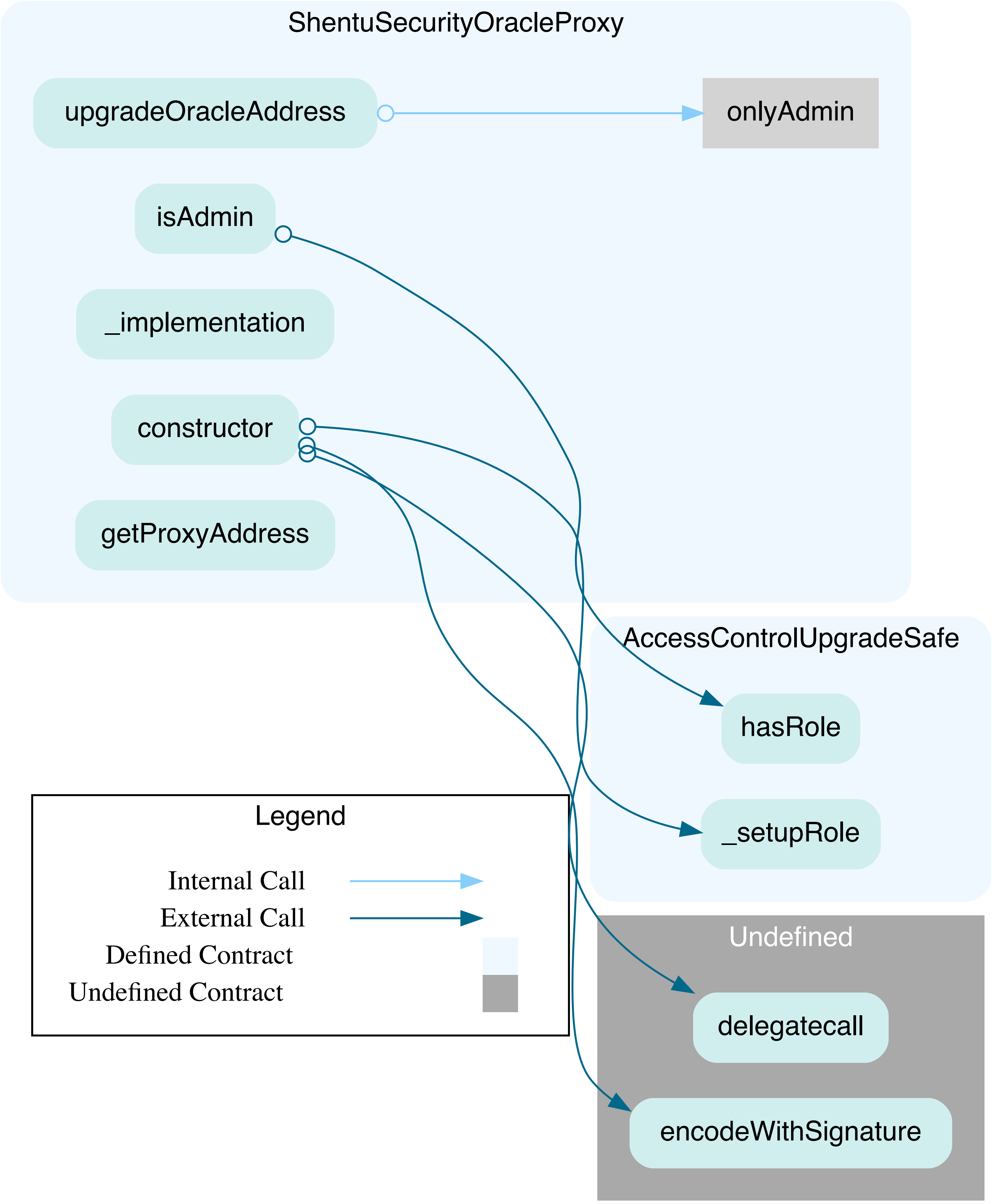


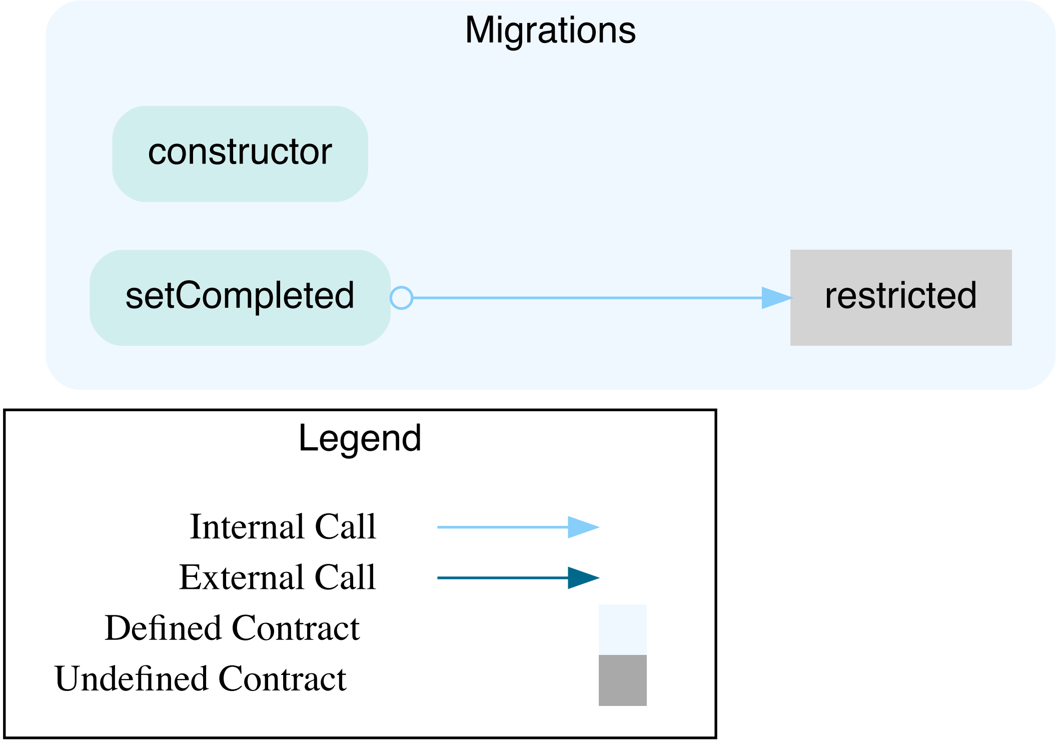

Member Function
grantEditor
Member Function
revokeEditor
Member Function
_getSecurityScore
Member Function
getSecurityScoreBytes4
Base Contract
AccessControlUpgradeSafe
Contract
ShentuSecurityOracle
Member Function
getSecurityScore
Member Function
getSecurityScores
Member Function
pushResult
Member Function
batchPushResult
Member Function
initialize
Member Function
updateDefaultScore

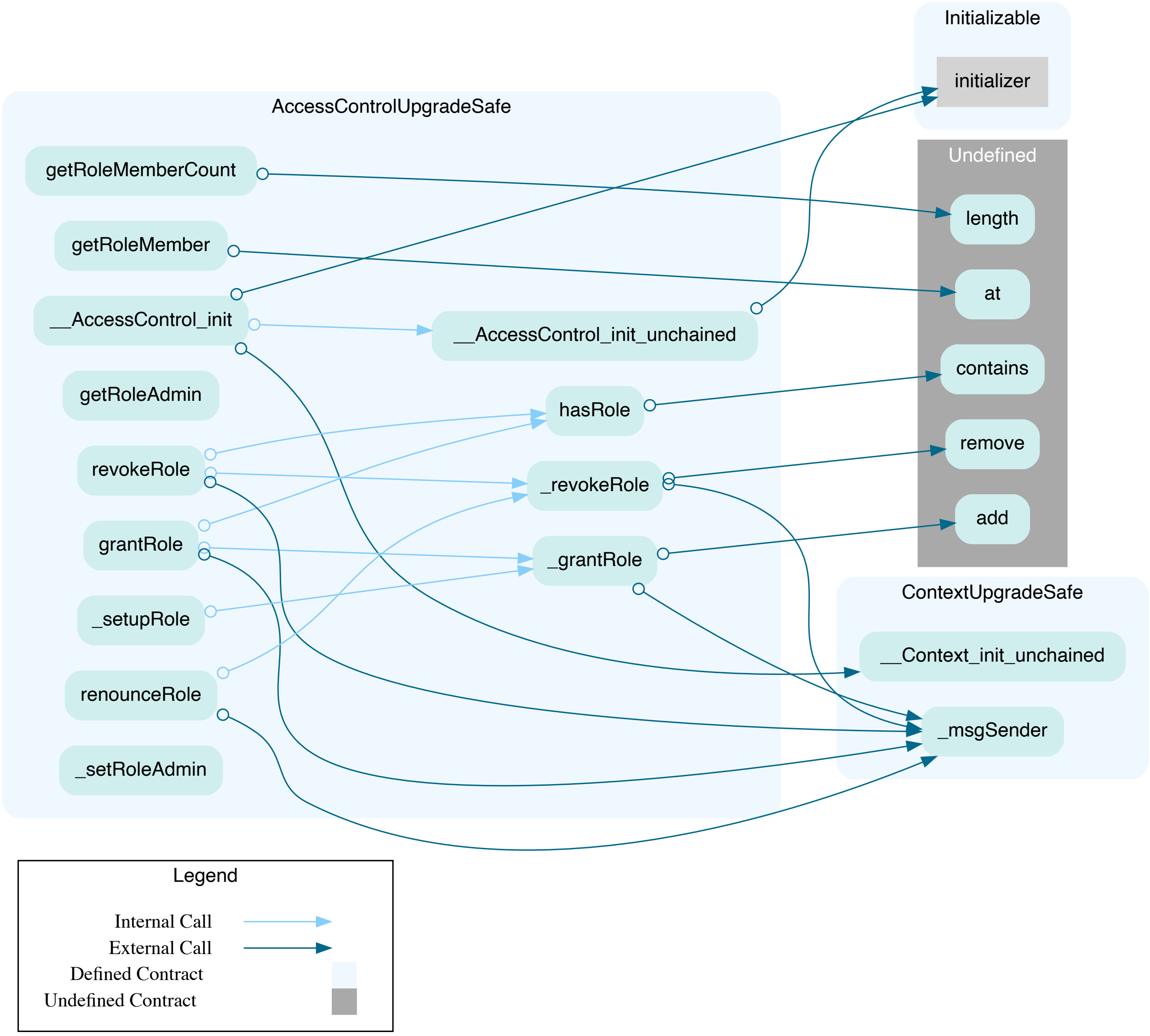

Base Contract
Proxy
Base Contract
AccessControlUpgradeSafe
Contract
ShentuSecurityOracleProxy
Member Function
constructor
Member Function
isAdmin
Member Function
_implementation
Member Function
upgradeOracleAddress
Member Function
getProxyAddress


Contract
Migrations
Member Function
constructor
Member Function
setCompleted


ShentuSecurityOracle
batchPushResult
updateDefaultScore
onlyEditor
getSecurityScores
pushResult
onlyAdmin
constructor
initialize
getSecurityScore
getSecurityScoreBytes4
_getSecurityScore
isEditor
isAdmin
grantEditor
revokeEditor
AccessControlUpgradeSafe
_setupRole
_setRoleAdmin
hasRole
grantRole
revokeRole
Undefined
Result
encodePacked
keccak256
Legend
Internal Call
External Call
Defined Contract
Undefined Contract


ShentuSecurityOracleProxy
upgradeOracleAddress
onlyAdmin
isAdmin
_implementation
constructor
getProxyAddress
AccessControlUpgradeSafe
hasRole
_setupRole
Undefined
delegatecall
encodeWithSignature
Legend
Internal Call
External Call
Defined Contract
Undefined Contract


Migrations
constructor
setCompleted
restricted
Legend
Internal Call
External Call
Defined Contract
Undefined Contract



Function api table for contract ShentuSecurityOracle

Function Name	***Visibility***	***State Variable Modification***	***Modifier***
isEditor_1	public	-	-
isAdmin_1	public	-	-
grantEditor_1	public	-	-
revokeEditor_1	public	-	-
getSecurityScoreBytes4_2	public	-	-
getSecurityScore_2	public	-	-
getSecurityScore_1	public	-	-
getSecurityScores_2	public	-	-
pushResult_4	public	_results	onlyEditor
batchPushResult_4	public	-	onlyEditor
initialize_0	public	defaultScore	onlyAdmin
updateDefaultScore_1	public	defaultScore	onlyAdmin

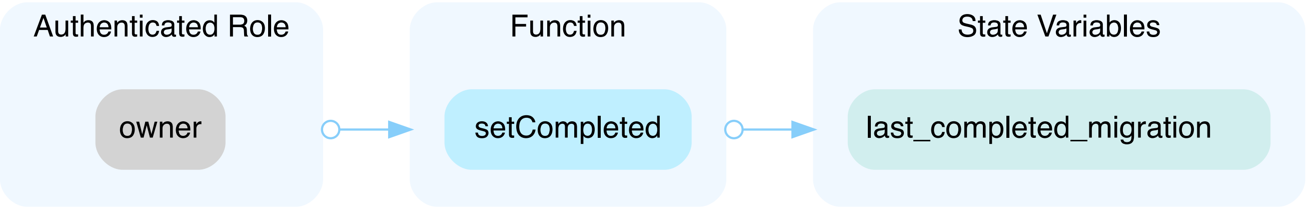
Function api table for contract ShentuSecurityOracleProxy

Function Name	***Visibility***	***State Variable Modification***	***Modifier***
isAdmin_1	public	-	-
upgradeOracleAddress_1	public	currentOracleAddress	onlyAdmin
getProxyAddress_0	public	-	-

Function api table for contract SecurityOracle

Function Name	***Visibility***	***State Variable Modification***	***Modifier***
getSecurityScore_1	external	-	-
getSecurityScore_2	external	-	-
getSecurityScoreBytes4_2	external	-	-
getSecurityScores_2	external	-	-

State Variable	***Variable Visibility***	***Functions Modifying the Variable***
_results	private	pushResult_4 (public, ShentuSecurityOracle.sol)
defaultScore	public	initialize_0 (public, ShentuSecurityOracle.sol)
defaultScore	public	updateDefaultScore_1 (public, ShentuSecurityOracle.sol)
owner	public	constructor (public, Migrations.sol)
last_completed_migration	public	setCompleted_1 (public, Migrations.sol)
currentOracleAddress	public	constructor (public, ShentuSecurityOracleProxy.sol)
currentOracleAddress	public	upgradeOracleAddress_1 (public, ShentuSecurityOracleProxy.sol)
_securityOracleAddress	private	constructor (public, DeFiExample.sol)



Findings

14
Total Issues

🟥	**Critical**	**0** (0.00%)
🟧	**Major**	**0** (0.00%)
🟨	**Medium**	**0** (0.00%)
🟨	**Minor**	**0** (0.00%)
🟦	**Informational**	**14** (100.00%)
🟩	**Discussion**	**0** (0.00%)

ID	Title	Category	Severity	Status
GLOBAL-01	Unlocked Compiler Version	Language Specific	● Informational	✓ Resolved
DFE-01	Unlocked Compiler Versions	Language Specific	● Informational	✓ Resolved
DFE-02	Different Compiler Versions	Language Specific	● Informational	✓ Resolved
SSO-01	Unlocked Compiler Version	Language Specific	● Informational	✓ Resolved
SSO-02	`struct` Optimization	Optimization	● Informational	✓ Resolved
SSO-03	Uncommon Naming Convention	Coding Style	● Informational	✓ Resolved
SSO-04	Use of `memory` Over `storage`	Optimization	● Informational	✓ Resolved
SSO-05	Potential High `gas` Operation	Optimization	● Informational	ⓘ Acknowledged
SSO-06	Check Against the Zero Address	Volatile Code	● Informational	✓ Resolved
SSO-07	Different Compiler Versions	Language Specific	● Informational	✓ Resolved
SSO-08	Malicious Hash Collision	Language Specific	● Informational	✓ Resolved
SSO-09	`initialize` Paradigm	Language Specific	● Informational	ⓘ Acknowledged
SSP-01	Uncommon Naming Convention	Coding Style	● Informational	✓ Resolved
SSP-02	Different Compiler Versions	Language Specific	● Informational	✓ Resolved

GLOBAL-01 | Unlocked Compiler Version

Category	Severity	Location	Status
Language Specific	● Informational	Global	✓ Resolved

Description

If the compiler version is between `0.4.21` and `0.4.26`, then the contract raises a compilation error due to the keyword `payable`.

Recommendation

We advise that compiler versions below `0.5.0` should be avoided

Alleviation

The team opted to consider our references and changed to compiler version `0.5.17`.

DFE-01 | Unlocked Compiler Versions

Category	Severity	Location	Status
Language Specific	● Informational	projects/ShentuSecurityOracle/DeFiExample.sol (a09e939): 2	✓ Resolved

Description

An unlocked compiler version in the source code of the contract permits the user to compile it at or above a particular version. This, in turn, leads to differences in the generated bytecode between compilations due to differing compiler version numbers. This can lead to an ambiguity when debugging as compiler specific bugs may occur in the codebase that would be hard to identify over a span of multiple compiler versions rather than a specific one.

Recommendation

We advise that the compiler version is instead locked at the lowest version possible that the full project can be compiled at.

Alleviation

The team opted to consider our references and changed to compiler version 0.5.17 .

DFE-02 | Different Compiler Versions

Category	Severity	Location	Status
Language Specific	● Informational	projects/ShentuSecurityOracle/DeFiExample.sol (a09e939): 2	✓ Resolved

Description

If the compiler version is between `0.4.21` and `0.4.26`, then the contract raises a compilation error.

Recommendation

We advise that compiler versions below `0.5.0` should be avoided.

Alleviation

The team opted to consider our references and changed to compiler version `0.5.17`.

SSO-01 | Unlocked Compiler Version

Category	Severity	Location	Status
Language Specific	● Informational	projects/ShentuSecurityOracle/ShentuSecurityOracle.sol (a09e939)	✓ Resolved

Description

An unlocked compiler version in the source code of the contract permits the user to compile it at or above a particular version. This, in turn, leads to differences in the generated bytecode between compilations due to differing compiler version numbers.This can lead to an ambiguity when debugging as compiler specific bugs may occur in the codebase that would be hard to identify over a span of multiple compiler versions rather than a specific one.

Recommendation

We advise that the compiler version is instead locked at the lowest version possible that the full project can be compiled at.

Alleviation

The team opted to consider our references and changed to compiler version `0.5.17`.

SSO-02 | `struct` Optimization

Category	Severity	Location	Status
Optimization	● Informational	projects/ShentuSecurityOracle/ShentuSecurityOracle.sol (a09e939): 17 ~20	✓ Resolved

Description

Each struct packs its members in 256-bit chunks. The Result struct contains the score (uint8) and the expiration (uint256) members, thus reserving two 256-bit chunks in storage.

Recommendation

We advise that the data type of the expiration member of the Result struct is changed to `uint248`, as the maximum bit-size that a datetime variable reserves are 64-bit, resulting in a one chuck storage reservation for the struct.

Alleviation

The team opted to consider our references and changed the data type of the expiration member of the Result struct to `uint248`.

SSO-03 | Uncommon Naming Convention

Category	Severity	Location	Status
Coding Style	● Informational	projects/ShentuSecurityOracle/ShentuSecurityOracle.sol (a09e939): 25	✓ Resolved

Description

The linked variable is prefixed with an underscore yet is declared as public .

Recommendation

We advise that the underscore is omitted per the Solidity style guide.

Alleviation

The team opted to consider our references and removed the underscore from the public variable.

SSO-04 | Use Of `memory` Over `storage`

Category	Severity	Location	Status
Optimization	● Informational	projects/ShentuSecurityOracle/ShentuSecurityOracle.sol (a09e939): 35	✓ Resolved

Description

The linked variable is redundantly stored in `storage` , as `storage` look-ups make the gas price higher.

Recommendation

We advise the team to store the result variable in `memory` instead of the `storage`.

Alleviation

The team opted to consider our references and stored the result variable in `memory` instead of the `storage`.

SSO-05 | Potential High `gas` Operation

Category	Severity	Location	Status
Optimization	● Informational	projects/ShentuSecurityOracle/ShentuSecurityOracle.sol (a09e939): 72~74, 105~112	ⓘ Acknowledged

Description

The linked functions iteratively assign values to a `mapping` in `storage`, based on the length of an input array

Recommendation

We advise the team to set upper boundary to the input array length.

Alleviation

The case was a situational and no alleviations were applied.

SSO-06 | Check Against The Zero Address

Category	Severity	Location	Status
Volatile Code	● Informational	projects/ShentuSecurityOracle/ShentuSecurityOracle.sol (a09e939): 31~42, 79~88	✓ Resolved

Description

The linked functions should check the value of their respective `contractAddress` parameter.

Recommendation

We advise the team to add a `require` statement to check against the zero address.

```
require(contractAddress != address(0), "Error Message");
```

Alleviation

The team opted to consider our references and added a `require` statement to check against the zero address, as recommended.

SSO-07 | Different Compiler Versions

Category	Severity	Location	Status
Language Specific	● Informational	projects/ShentuSecurityOracle/ShentuSecurityOracle.sol (a09e939): 2	✓ Resolved

Description

If the compiler version is between `0.4.21` and `0.4.26`, then the contract raises a compilation error due to the keyword `payable` .

Recommendation

We advise that compiler versions below `0.5.0` should be avoided

Alleviation

The team opted to consider our references and changed to compiler version `0.5.17`.

SSO-08 | Malicious Hash Collision

Category	Severity	Location	Status
Language Specific	● Informational	projects/ShentuSecurityOracle/ShentuSecurityOracle.sol (a09e939) : 44~53	✓ Resolved

Description

Since an empty `bytes4` variable, i.e. 0, points to the default score of a contract, it is possible to have the same score applied to a function of the contract as well. The "identifier" of a contract is simply the first 4 bytes of the `keccak256` hash of the signature, meaning that an attacker would simply need to generate a function signature that results in a `keccak256` hash with 4 leading zeroes which is not an impossible achievement.

Recommendation

We advise that the default grade of a contract is either stored in a different data structure or a sanity check is put in place.

Alleviation

The team opted to consider our references and changed the codebase to cover the edge case, as pointed in this exhibit.

SSO-09 | `initialize` Paradigm

Category	Severity	Location	Status
Language Specific	● Informational	projects/ShentuSecurityOracle/ShentuSecurityOracle.sol (a09e939): 117~121	ⓘ Acknowledged

Description

The `initialize` function of a contract should be invokable only once via sanity checks. Here, it is possible to subsequently call it multiple times.

Recommendation

We advise that a sanity check is imposed whereby the value of `_defaultScore` is ensured to be `0`. Additionally, we would advise a sanity check on the `updateDefaultScore` function that ensures the new `score` is not `0`.

Alleviation

The case was a situational and no alleviations were applied.

SSP-01 | Uncommon Naming Convention

Category	Severity	Location	Status
Coding Style	● Informational	projects/ShentuSecurityOracle/ShentuSecurityOracleProxy.sol (a09e939): 8	✓ Resolved

Description

The linked variable is prefixed with an underscore yet is declared as public.

Recommendation

We advise that the underscore is omitted per the Solidity style guide.

Alleviation

The team opted to consider our references and removed the underscore from the public variable.

SSP-02 | Different Compiler Versions

Category	Severity	Location	Status
Language Specific	● Informational	projects/ShentuSecurityOracle/ShentuSecurityOracleProxy.sol (a09e939): 2	✓ Resolved

Description

If the compiler version is above `0.6.0`, then the contract raises a compilation error due to the `fallback()` function in the Proxy.sol file.

Recommendation

We advise that compiler versions above `0.6.0` should be avoided or change the following function of the Proxy.sol file:

```
function() external payable {
_fallback();
}
```

to

```
fallback () external payable {
_fallback();
}
```

Alleviation

The team opted to consider our references and changed to compiler version `0.5.17`.

Appendix

Finding Categories

Volatile Code

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

Language Specific

Language Specific findings are issues that would only arise within Solidity, i.e. incorrect usage of private or delete.

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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Founded in 2017 by leading academics in the field of Computer Science from both Yale and Columbia University, CertiK is a leading blockchain security company that serves to verify the security and correctness of smart contracts and blockchain-based protocols. Through the utilization of our world-class technical expertise, alongside our proprietary, innovative tech, we're able to support the success of our clients with best-in-class security, all whilst realizing our overarching vision; provable trust for all throughout all facets of blockchain.