Mar 14, 2024

ZAN

Security Assessment hebao_v3

—

Professional Service

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1. Overview

1.1. Executive Summary

Hebao Smart Wallet Contracts is the smart contracts underpinning *Loopring*'s advanced smart-wallet deployment.

The security assessment encompassed the `base` directory for project core logic, the `connectors` directory for various defi protocol integration and the `price` directory for onchain price oracle from other DEX protocols, alongside any contract dependencies external to officially accredited libraries. The remaining parts of the project fall outside the scope of current audit, as they are directly derived from other projects which have undergone audits by third-party entities.

Our comprehensive analysis employed a triad of methodologies: *Static Analysis*, *Formal Verification*, and *Manual Review*. Upon scrutinizing the contract, we identified **1 medium**, **4 low** and **13 informational** issues.

In commit 49167c6, **the project team has resolved the code security and business security issues stated in M-01, L-03, and L-04. Regarding the issues mentioned in L-02 and L-05, the project team has confirmed that there are no security risks, and therefore, no changes have been made.** In addition, the project team has partially applied the optimization suggestions.

1.2. Project Summary

Project Name	hebao_v3
Platform	Ethereum
Language	Solidity
Codebase	Audit 1: • https://github.com/Loopring/protocols/tree/1a6952c522c95789fc276df29e83a9d21c83974a Final Audit: • https://github.com/Loopring/protocols/tree/49167c6b6748ac43f473dc321d8ebf62475a38c3

1.3. Assessment Summary

Delivery Date	Mar 13, 2024
Audit Methodology	Static Analysis, Formal Verification, Manual Review

1.4. Assessment Scope

ID	File	File Hash
1	/hebao_v3/contracts/base/ConnectorRegistry.sol	f07731f732f513144c169ced4d984760
2	/hebao_v3/contracts/base/DelayedImplementationManager.sol	4a95aef3ed628a4eb26ea3bbb5254c0d
3	/hebao_v3/contracts/base/ForwardProxy.sol	4b2cc3cb1f6d5395ec64c9cfdb155490
4	/hebao_v3/contracts/base/libwallet/ApprovalLib.sol	dee6323747576b7a9f1b514a6f4f6cdc
5	/hebao_v3/contracts/base/libwallet/AutomationLib.sol	dc89ce1ca14cff9de82bddc79d3c9e85
6	/hebao_v3/contracts/base/libwallet/ERC1271Lib.sol	bcb16dc0e1e3f2c3a461df8f58668535
7	/hebao_v3/contracts/base/libwallet/ERC20Lib.sol	5173ac2029eb9f75dc0dfe71c57ed981
8	/hebao_v3/contracts/base/libwallet/GuardianLib.sol	f5adbd0dd18c2b73234eb1e20510c2fb
9	/hebao_v3/contracts/base/libwallet/InheritanceLib.sol	373a00b97ce6b59e652257860faf5676
10	/hebao_v3/contracts/base/libwallet/LockLib.sol	c33e5cf4f97af39bc808b3e65ab1eab
11	/hebao_v3/contracts/base/libwallet/QuotaLib.sol	f84074af6b6e23d6a1d0f90729d84aa9
12	/hebao_v3/contracts/base/libwallet/RecoverLib.sol	e0a882b3b2daab51cb3b266d912495dc
13	/hebao_v3/contracts/base/libwallet/UpgradeLib.sol	fb318137b74ac0af5d48534f03a21f93
14	/hebao_v3/contracts/base/libwallet/Utils.sol	aca248edfc447ecc9f319941f3b2ff3e
15	/hebao_v3/contracts/base/libwallet/WalletData.sol	dfaf71a9a4353d26b015cc4e02f72e2c
16	/hebao_v3/contracts/base/libwallet/WhitelistLib.sol	9dd16fbba45b0f21dbb1a6999a447033

ID	File	File Hash
17	/hebao_v3/contracts/base/LoopringCreate2Deployer.sol	ee3f87e30f2654e03841dfa2dc0994a9
18	/hebao_v3/contracts/base/LoopringPaymaster.sol	bd811ba963b69dad37e4cd54218a0ac2
19	/hebao_v3/contracts/base/OfficialGuardian.sol	b1600a7cd89d9bd4c1884100fa17359f
20	/hebao_v3/contracts/base/SmartWallet.sol	778d81c7d617184d39b6a22715723be4
21	/hebao_v3/contracts/base/SmartWalletV3.sol	7bfe48032453f8da810b8343e0cb2d35
22	/hebao_v3/contracts/base/WalletDeploymentLib.sol	2b79f54caa2b09d5e004281868281f53
23	/hebao_v3/contracts/base/WalletFactory.sol	4458717bce7288b638e21ce96df24130
24	/hebao_v3/contracts/connectors/aavev3.sol	961d304ab3ccfdd7d54356f174ae63f5
25	/hebao_v3/contracts/connectors/base_connector.sol	c724b28ddf716a1ca604718dadfdd744
26	/hebao_v3/contracts/connectors/compound.sol	be02f14ecb2e33856da696b90a271257
27	/hebao_v3/contracts/connectors/flashloan/BalancerFlashloan.sol	ae3de20a4b89d9bf52990618e797ba34
28	/hebao_v3/contracts/connectors/flashloan/flashloan_connector.sol	ce837e2e4bb0723323a2305bcec8cd00
29	/hebao_v3/contracts/connectors/flashloan/IFlashLoanRecipient.sol	d4001230eff57d5834438904bae4352d
30	/hebao_v3/contracts/connectors/flashloan/IVault.sol	fdf8948b29cd4ac4e5fcdd6efcb9a3c8
31	/hebao_v3/contracts/connectors/lido.sol	c9d82f5ebaf4174276c6cd6e2bc0abd5
32	/hebao_v3/contracts/connectors/memory.sol	329ded52e90711f77608d85b9a59b160
33	/hebao_v3/contracts/connectors/uniswap.sol	e89ced41c1341f2f1e89943ccb52099e

ID	File	File Hash
34	/hebao_v3/contracts/connectors/weth.sol	32d4da50b4b61e5318130f6a16face83
35	/hebao_v3/contracts/price/AggregationalPriceOracle.sol	1cd109767d30dc526351eacac6c18989
36	/hebao_v3/contracts/price/CachedPriceOracle.sol	852c9533bfc9e349490f54caa6a7dc78
37	/hebao_v3/contracts/price/KyberNetworkPriceOracle.sol	b502f6a11a3b24fd032125804754b2a5
38	/hebao_v3/contracts/price/UniswapV2PriceOracle.sol	d6982295d884b080cb1d64423256060e

2. Checklist

2.1. Code Security

Reentrancy	DelegateCall	Integer Overflow
Input Validation	Unchecked this.call	Frozen Money
Arbitrary External Call	Unchecked Owner Transfer	Do-while Continue
Right-To-Left-Override Character	Unauthenticated Storage Access	Risk For Weak Randomness
TxOrigin	Missing Checks for Return Values	Diamond Inheritance
ThisBalance	VarType Deduction	Array Length Manipulation
Uninitialized Variable	Shadow Variable	Divide Before Multiply
Affected by Compiler Bug		

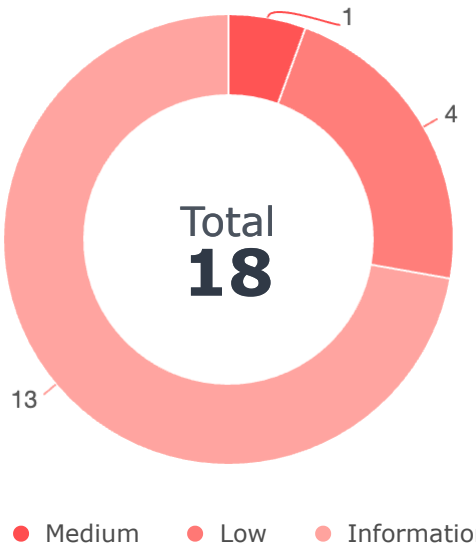
2.2. Optimization Suggestion

Compiler Version	Improper State Variable Modification
Function Visibility	Deprecated Function
Externally Controlled Variables	Code Style
Constant Specific	Event Specific
Return Value Unspecified	Inexistent Error Message
State Variable Defined Without Storage Location	Import Issue
Compare With Timestamp/Block Number/Blockhash	Constructor in Base Contract Not Implemented
Delete Struct Containing the Mapping Type	Usage of '=+'
Paths in the Modifier Not End with "_" or Revert	Non-payable Public Functions Use msg.value
Lack of SafeMath	Compiler Error/Warning
Tautology Issue	Loop Depends on Array Length
Redundant/Duplicated/Dead Code	Code Complexity/Code Inefficiency
Undeclared Resource	Optimizable Return Statement
Unused Resource	

2.3. Business Security

The Code Implementation is Consistent With Comments, Project White Papers and Other Materials
Permission Check
Address Check

3. Findings



Code Security

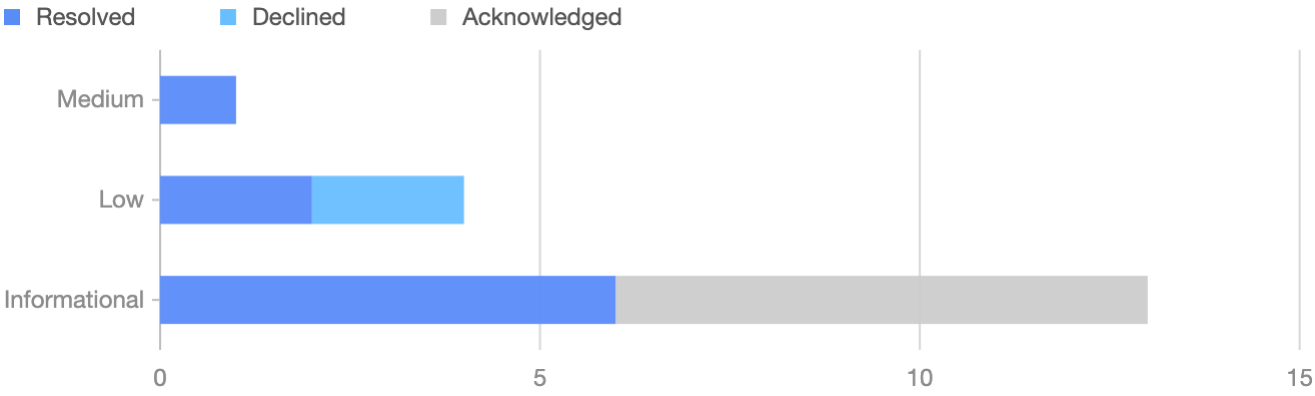
Low: 2

Optimization Suggestion

Low: 1, Informational: 13

Business Security

Medium: 1, Low: 1



ID	Title	Category	Severity	Status
M-01	Wallet Can Be Locked Permanently	Business Security	Medium	Resolved
L-02	Using Trusted Price Oracle	Business Security	Low	Declined
L-03	Use Safer Functions	Code Security	Low	Resolved
L-04	Clarify Return Value	Optimization Suggestion	Low	Resolved
L-05	Initialization Can Be Front-run	Code Security	Low	Declined
I-06	Unnecessary Approval	Optimization Suggestion	Informational	Resolved
I-07	Laggard Validity Check	Optimization Suggestion	Informational	Resolved
I-08	Unnecessary Experimental Pragma	Optimization Suggestion	Informational	Resolved
I-09	Use CustomError Instead of String	Optimization Suggestion	Informational	Acknowledged
I-10	No Check of Address Params with Zero Address	Optimization Suggestion	Informational	Acknowledged

ID	Title	Category	Severity	Status
I-11	Unused Imported Contract	Optimization Suggestion	Informational	Acknowledged
I-12	Unused Internal Function	Optimization Suggestion	Informational	Acknowledged
I-13	Parameters Should Be Declared as Calldata	Optimization Suggestion	Informational	Acknowledged
I-14	Variables Can Be Declared as Immutable	Optimization Suggestion	Informational	Acknowledged
I-15	No Need To Use SafeMath in Solidity Contract of Version 0.8.0 and Above	Optimization Suggestion	Informational	Resolved
I-16	Unused Events	Optimization Suggestion	Informational	Resolved
I-17	Set the Constant to Private	Optimization Suggestion	Informational	Acknowledged
I-18	Interface Defined Not Inherited	Optimization Suggestion	Informational	Resolved

M-01: Wallet Can Be Locked Permanently

Medium: Business Security

File Location: /hebao_v3/contracts/base/libwallet/GuardianLib.sol:119

Description

A wallet may become permanently locked due to the incorrect removal of the wallet's guardians.

Impact

The wallet can be locked permanently.

Proof of Concept

Here is a brief Proof of Concept (PoC):

1. The wallet's owner calls the `resetGuardians` function to clear the wallet's guardians.
2. The wallet's owner calls the `lock` function to lock the wallet.

At this point, unlocking the wallet must be done through the EntryPoint. However, the signature verification prior to the call will check if the invocation includes authorization from more than half of the guardians. Since the guardians have been cleared by the user at this stage, the call to the `requireMajority` function will fail. Therefore, the wallet will be permanently locked in this scenario. The only possibility for unlocking is if the user had previously set an inheritor and, after the waiting period ends, uses the inheritor to reset the owner and guardians.

/hebao_v3/contracts/base/libwallet/GuardianLib.sol

```
107      function requireMajority(
108          Wallet storage wallet,
109          address[] memory signers,
110          SigRequirement requirement
111      ) internal view returns (bool) {
112          // We always need at least one signer
113          if (signers.length == 0) {
114              return false;
115          }
116
117          // Calculate total group sizes
118          Guardian[] memory allGuardians = guardians(wallet, false);
119          _require(allGuardians.length > 0, Errors.NO_GUARDIANS);
```

Recommendation

When involving external calls to remove or modify Guardians, ensure that the wallet has at least one Guardian remaining after any such calls are completed.

Alleviation

Resolved in commit 49167c6. The project team addressed the issue by ensuring that the number of guardians is greater than zero when locking the wallet.

L-02: Using Trusted Price Oracle

Low: Business Security

File Location: /hebao_v3/contracts/price/UniswapV2PriceOracle.sol:24

Description

Liquidity pools based on a constant product formula, such as *Uniswap V2*, are susceptible to price manipulation through flash loans, leading to discrepancies in oracle outputs from actual market prices. This discrepancy might compromise the quota management features of wallets.

/hebao_v3/contracts/price/UniswapV2PriceOracle.sol

```
24      function tokenValue(
25          address token,
26          uint amount
27      ) public view override returns (uint) {
28          if (amount == 0) return 0;
29          if (token == address(0) || token == wethAddress) return amount;
30
31          address pair = factory.getPair(token, wethAddress);
32          if (pair == address(0)) {
33              return 0;
34          }
35
36          (uint112 reserve0, uint112 reserve1, ) = IUniswapV2Pair(pair)
37              .getReserves();
38
39          if (reserve0 == 0 || reserve1 == 0) {
40              return 0;
41          }
42
43          if (token < wethAddress) {
44              return amount.mul(reserve1) / reserve0;
45          } else {
46              return amount.mul(reserve0) / reserve1;
47          }
48      }
49  }
```

Recommendation

1. Avoid relying on easily manipulated data sources such as *Uniswap V2* pools directly as price oracles.
2. Calculate the *TWAP (Time-Weighted Average Price)* or use price oracles based on *TWAP*, e.g. *Uniswap V3*.

Alleviation

The project team has confirmed that the oracle's intended use is for daily quota management, which is not a highly security sensitive operation that heavily depends on the real-time accuracy of the oracle to run. Therefore, no changes will be made to this issue.

L-03: Use Safer Functions

Low: Code Security

File Location:
/hebao_v3/contracts/connectors/aavev3.sol:173,277
/hebao_v3/contracts/connectors/base_connector.sol:124
/hebao_v3/contracts/connectors/compound.sol:105,224,266,378
/hebao_v3/contracts/connectors/uniswap.sol:186,247,299,300,337

Description

When calling the `transfer`, `transferFrom`, and `approve` functions in the ERC20 contract, there are some contracts that are not fully implemented in accordance with the ERC20 standard. In order to more comprehensively judge whether the call result meets expectations or to be compatible with different ERC20 contracts, it is recommended to use the `safeTransfer`, `safeTransferFrom`, `safeApprove` function.

/hebao_v3/contracts/connectors/aavev3.sol

```
171         }
172
173         tokenContract.approve(address(aave), _amt);
174
175         aave.supply(_token, _amt, address(this), REFERRAL_CODE);
```

/hebao_v3/contracts/connectors/aavev3.sol

```
275         if (isEth) convertEthToWeth(isEth, tokenContract, _amt);
276
277         tokenContract.approve(address(aave), _amt);
278
279         aave.repay(_token, _amt, rateMode, address(this));
```

/hebao_v3/contracts/connectors/base_connector.sol

```
122     ) internal {
123         if (isEth) {
124             token.approve(address(token), amount);
125             token.withdraw(amount);
126         }
```

/hebao_v3/contracts/connectors/compound.sol

```
103                 ? tokenContract.balanceOf(address(this))
104                 : _amt;
105             tokenContract.approve(cToken, _amt);
106             require(CTokenInterface(cToken).mint(_amt) == 0,
                "deposit-failed");
107         }
```

/hebao_v3/contracts/connectors/compound.sol

```
222                 "not-enough-token"
223             );
224             tokenContract.approve(cToken, _amt);
225             require(cTokenContract.repayBorrow(_amt) == 0, "repay-failed.
                ");
226         }
```

/hebao_v3/contracts/connectors/compound.sol

```
264                 ? tokenContract.balanceOf(address(this))
265                 : _amt;
266             tokenContract.approve(cToken, _amt);
267             require(ctokenContract.mint(_amt) == 0,
                "deposit-ctoken-failed.");
268         }
```

/hebao_v3/contracts/connectors/compound.sol

```
376                 "not-enough-token"
377             );
378             tokenContract.approve(cTokenPay, _amt);
379             require(
380                 cTokenContract.liquidateBorrow(borrower, _amt,
                    cTokenColl) == 0,
```

/hebao_v3/contracts/connectors/uniswap.sol

```
184         bool isEth = address(_sellAddr) == WETH_ADDR;
185         convertEthToWeth(isEth, _sellAddr, _expectedAmt);
186         _sellAddr.approve(address(ROUTER), _expectedAmt);
187 
188         uint _sellAmt = ROUTER.swapTokensForExactTokens(
```

/hebao_v3/contracts/connectors/uniswap.sol

```
245         bool isEth = address(_sellAddr) == WETH_ADDR;
246         convertEthToWeth(isEth, _sellAddr, _sellAmt);
247         _sellAddr.approve(address(ROUTER), _sellAmt);
248 
249         uint _buyAmt = ROUTER.swapExactTokensForTokens(
```

/hebao_v3/contracts/connectors/uniswap.sol

```
297         convertEthToWeth(isEth, _tokenB, _amtB);
298 
299         _tokenA.approve(address(ROUTER), _amtA);
300         _tokenA.approve(address(ROUTER), _amtB);
301 
```

/hebao_v3/contracts/connectors/uniswap.sol

```
298
299         _tokenA.approve(address(ROUTER), _amtA);
300         _tokenA.approve(address(ROUTER), _amtB);
301
302         uint minAmtA = getMinAmount(_tokenA, _amtA, slippage);
```

/hebao_v3/contracts/connectors/uniswap.sol

```
335             ? uniToken.balanceOf(address(this))
336             : _amt;
337         uniToken.approve(address(ROUTER), _uniAmt);
338
339         {
```

Recommendation

It is recommended to use the `safeTransfer`, `safeTransferFrom`, and `safeApprove` functions in SafeERC20 to call the `transfer`, `transferFrom`, and `approve` functions in the ERC20 contract.

Alleviation

Resolved in commit 49167c6.

L-04: Clarify Return Value

Low: Optimization Suggestion

File Location:
/hebao_v3/contracts/base/LoopringPaymaster.sol:164,176
/hebao_v3/contracts/base/SmartWallet.sol:415

Description

In function `_validatePaymasterUserOp` of `LoopringPaymaster` contract and function `callContractWA` of `SmartWallet` contract, the returned variable is specified in the function signature, but it still calls the return statement to return a local variable defined in the function body or state variable. It is necessary to clarify whether the returned value meets expectations.

/hebao_v3/contracts/base/LoopringPaymaster.sol

```
162         //don't revert on signature failure: return SIG_VALIDATION_FAILED
163         if (!hasRole(SIGNER, hash.recover(signature))) {
164             return (
165                 "",
166                 _packValidationData(
```

/hebao_v3/contracts/base/LoopringPaymaster.sol

```
174         //no need for other on-chain validation: entire UserOp should
            have been checked
175         // by the external service prior to signing it.
176         return (
177             abi.encode(
178                 userOpHash,
```

/hebao_v3/contracts/base/SmartWallet.sol

```
413         bytes calldata data
414     ) external onlyFromEntryPoint returns (bytes memory returnData) {
415         return ERC20Lib.callContractWA(to, value, data);
416     }
417
```

Recommendation

It is recommended to be clear whether the returned value is as expected, and only use one way to return the value.

Alleviation

Resolved in commit 49167c6.

L-05: Initialization Can Be Front-run

Low: Code Security

File Location: /hebao_v3/contracts/base/OfficialGuardian.sol:16

Description

The function `initOwner` of `OfficialGuardian` contract has no access control. A malicious attacker could front-run the `initOwner` transaction to gain ownership of the contract. This can be repeated as a Denial Of Service (DOS) type of attack, effectively preventing contract deployment, leading to unrecoverable gas expenses.

/hebao_v3/contracts/base/OfficialGuardian.sol

```
15      /// @dev init owner for proxy contract:
16      function initOwner(address _owner) external {
17          require(owner == address(0), "INITIALIZED_ALREADY");
18          owner = _owner;
19      }
```

Recommendation

Ensure the deployment and initialization of contracts are in the same transaction or add onlyOwner or other authentication checking in initialize function.

Alleviation

The project team confirmed that the permission check for the `initOwner` function is implemented in the proxy contract. Therefore, no changes will be made to this issue.

I-06: Unnecessary Approval

Informational: Optimization Suggestion

File Location: /hebao_v3/contracts/connectors/weth.sol:26

Description

Obtaining approval prior to extracting *ETH* from *WETH* is unnecessary.

/hebao_v3/contracts/connectors/weth.sol

```
20      function withdraw(uint amt, uint getId, uint setId) public payable {
21          uint _amt = getUint(getId, amt);
22
23          _amt = _amt == type(uint256).max
24              ? WETH_CONTRACT.balanceOf(address(this))
25              : _amt;
26          WETH_CONTRACT.approve(WETH_ADDR, _amt);
27          WETH_CONTRACT.withdraw(_amt);
28          setUint(setId, _amt);
29      }
```

Recommendation

Eliminate the redundnat invocation of the function `approve`.

Alleviation

Resolved in commit 49167c6. The unnecessary approval is removed.

I-07: Laggard Validity Check

Informational: Optimization Suggestion

File Location: /hebao_v3/contracts/base/LoopringPaymaster.sol:297

Description

Positioning validity checks at the commencement of functions can save gas in the event of failure.

/hebao_v3/contracts/base/LoopringPaymaster.sol

```
290     function addDepositFor(
291         address token,
292         address account,
293         uint256 amount
294     ) external {
295         //(sender must have approval for the paymaster)
296         IERC20(token).safeTransferFrom(msg.sender, address(this),
            amount);
297         require(registeredToken[token], "LoopringPaymaster: unsupported
            token");
298         balances[token][account] += amount;
299         if (msg.sender == account) {
300             lockTokenDeposit();
301         }
302     }
```

Recommendation

Relocate all validity checks to the foremost positions within functions wherever feasible.

Alleviation

Resolved in commit 49167c6. The project team relocates the validity check to the beginning of function `addDepositFor`.

I-08: Unnecessary Experimental Pragma

Informational: Optimization Suggestion

File Location:

Description

For contracts utilizing *Solidity version 0.7.4* and subsequent versions, the inclusion of the experimental pragma `pragma experimental ABIEncoderV2;` to activate the `ABI coder v2` is rendered unnecessary.

Recommendation

Eliminate all instances of the experimental pragma `pragma experimental ABIEncoderV2;` within the contracts.

Alleviation

Resolved in commit 49167c6. The unnecessary experimental pragma is removed.

I-09: Use CustomError Instead of String

Informational: Optimization Suggestion

File Location:

Description

When using `require` or `revert`, `CustomError` is more gas efficient than string description, as the error message described using `CustomError` is only compiled into four bytes. Especially when string exceeds 32 bytes, more gas will be consumed. Generally, around 250-270 gas can be saved for one `CustomError` replacement when compiler optimization is turned off, 60-80 gas can be saved even if compiler optimization is turned on.

This issue is prevalent in almost all contracts that use `require` and `revert` statements.

Recommendation

Use `CustomError` instead of string for `require` or `revert` description.

Alleviation

Acknowledged and partially applied in commit 49167c6. To ensure that external `EntryPoints` can correctly parse error messages returned by `LoopringPaymaster`, some checks still use revert strings instead of custom errors.

I-10: No Check of Address Params with Zero Address

Informational: Optimization Suggestion

File Location:
/hebao_v3/contracts/base/LoopringPaymaster.sol:49,50,270,275
/hebao_v3/contracts/base/OfficialGuardian.sol:16,31
/hebao_v3/contracts/base/SmartWallet.sol:117,118,119,120,341,347,352,491,498
/hebao_v3/contracts/base/SmartWalletV3.sol:69
/hebao_v3/contracts/base/WalletDeploymentLib.sol:17
/hebao_v3/contracts/base/WalletFactory.sol:57,63
/hebao_v3/contracts/base/libwallet/WhitelistLib.sol:27,34,38
/hebao_v3/contracts/connectors/base_connector.sol:83
/hebao_v3/contracts/connectors/flashloan/BalancerFlashloan.sol:33
/hebao_v3/contracts/connectors/flashloan/flashloan_connector.sol:25,26
/hebao_v3/contracts/connectors/memory.sol:62,102

Description

The input parameter of the `address` type in the function does not use the zero address for verification. This might lead to loss of fund, particularly in scenarios where low-level calls to the zero address will not revert.

/hebao_v3/contracts/base/LoopringPaymaster.sol

```
48      constructor(
49          IEntryPoint _entryPoint,
50          address paymasterOwner
```

/hebao_v3/contracts/base/LoopringPaymaster.sol

```
270     function addToken(address token) external onlyOwner {
271         require(!registeredToken[token], "registered already");
272         registeredToken[token] = true;
273     }
274
275     function removeToken(address token) external onlyOwner {
276         require(registeredToken[token], "unregistered already");
277         registeredToken[token] = false;
278     }
```

/hebao_v3/contracts/base/OfficialGuardian.sol

```
16      function initOwner(address _owner) external {
17          require(owner == address(0), "INITIALIZED_ALREADY");
18          owner = _owner;
```

/hebao_v3/contracts/base/OfficialGuardian.sol

```
31      function transact(
32          address target,
33          uint value,
```

/hebao_v3/contracts/base/SmartWallet.sol

```
116     constructor(
117         PriceOracle _priceOracle,
118         address _blankOwner,
119         IEntryPoint entryPointInput,
120         address _connectorRegistry
121     ) {
```

/hebao_v3/contracts/base/SmartWallet.sol

```
341     function addToWhitelist(
342         address addr
343     ) external onlyFromEntryPointOrWalletOrOwnerWhenUnlocked {
344         wallet.addToWhitelist(addr);
345     }
346
347     function addToWhitelistWA(address addr) external onlyFromEntryPoint {
348         wallet.addToWhitelistWA(addr);
349     }
350
351     function removeFromWhitelist(
352         address addr
353     ) external onlyFromEntryPointOrWalletOrOwnerWhenUnlocked {
354         wallet.removeFromWhitelist(addr);
355     }
```

/hebao_v3/contracts/base/SmartWallet.sol

```
490     function approveExecutor(
491         address executor,
492         uint256 validUntil
493     ) external onlyFromEntryPointOrWalletOrOwnerWhenUnlocked {
494         return AutomationLib.approveExecutor(wallet, executor,
            validUntil);
495     }
496
497     function unApproveExecutor(
498         address executor
499     ) external onlyFromEntryPointOrWalletOrOwnerWhenUnlocked {
500         return AutomationLib.unApproveExecutor(wallet, executor);
501     }
```

/hebao_v3/contracts/base/SmartWalletV3.sol

```
68      function withdrawDepositTo(
69          address payable withdrawAddress,
70          uint256 amount
```

/hebao_v3/contracts/base/WalletDeploymentLib.sol

```
17      constructor(address _walletImplementation) {
18          walletImplementation = _walletImplementation;
19      }
```

/hebao_v3/contracts/base/WalletFactory.sol

```
55      /// @dev Adds a new operator.
56      /// @param operator The new address to add.
57      function addOperator(address operator) public onlyOwner {
58          addOperatorInternal(operator);
59      }
60
61      /// @dev Removes a operator.
62      /// @param operator The operator to remove.
63      function removeOperator(address operator) public onlyOwner {
64          removeAddressFromSet(OPERATOR, operator);
65          emit OperatorRemoved(operator);
66      }
```

/hebao_v3/contracts/base/libwallet/WhitelistLib.sol

```
27      function addToWhitelist(Wallet storage wallet, address addr)
        external {
28          wallet._addToWhitelist(
29              addr,
30              block.timestamp.add(WHITELIST_PENDING_PERIOD)
31          );
32      }
33
34      function addToWhitelistWA(Wallet storage wallet, address addr)
        external {
35          wallet._addToWhitelist(addr, block.timestamp);
36      }
37
38      function removeFromWhitelist(Wallet storage wallet, address addr)
        external {
39          wallet._removeFromWhitelist(addr);
40      }
```

/hebao_v3/contracts/connectors/base_connector.sol

```
83      constructor(address _instaMemory) {
84          instaMemory = MemoryInterface(_instaMemory);
85      }
```

/hebao_v3/contracts/connectors/flashloan/BalancerFlashloan.sol

```
33      constructor(address _vault) {
34          vault = _vault;
35      }
```

/hebao_v3/contracts/connectors/flashloan/flashloan_connector.sol

```
24      constructor(
25          address _instaMemory,
26          address _flashLoanPool
```

/hebao_v3/contracts/connectors/memory.sol

```
62      function setAddr(uint _id, address _addr) public {
63          maddr[msg.sender][_id] = _addr;
64      }
```

/hebao_v3/contracts/connectors/memory.sol

```
102     function setBroadcastAddr(uint _id, address _addr) public isMaster {
103         maddr[BROADCAST_ADDR][_id] = _addr;
104     }
```

Recommendation

It is recommended to perform zero address verification on the input parameters of the `address` type. Alternatively, verify the transaction calldata and result meticulously when dealing with privileged functions, such as the `initialize` function, `constructor`, and similar critical functions.

Alleviation

Acknowledged and partially applied in commit 49167c6. Functions without a zero-address check can only be called by privileged accounts or will not affect the contract's execution logic.

I-11: Unused Imported Contract

Informational: Optimization Suggestion

File Location:
/hebao_v3/contracts/base/SmartWallet.sol:12
/hebao_v3/contracts/base/libwallet/Utils.sol:6

Description

Unused imported contract will increase gas consumption.

/hebao_v3/contracts/base/SmartWallet.sol

```
10  import "../lib/EIP712.sol";
11  import "../lib/ERC1271.sol";
12  import "@openzeppelin/contracts/security/ReentrancyGuard.sol";
13  import "../thirdparty/erc165/IERC165.sol";
14  import "../thirdparty/erc1155/ERC1155Holder.sol";
```

/hebao_v3/contracts/base/libwallet/Utils.sol

```
4   pragma experimental ABIEncoderV2;
5
6   import "./WalletData.sol";
7   import "../../lib/AddressUtil.sol";
8
```

Recommendation

It is recommended to delete unused imported contracts.

Alleviation

Resolved in commit 49167c6.

I-12: Unused Internal Function

Informational: Optimization Suggestion

File Location:

Description

The following internal functions in `DSMath` contract is defined but not used, which will add gas consumption:

- `function add(uint x, uint y)`
- `function div(uint x, uint y)`
- `function wdiv(uint x, uint y)`
- `function rdiv(uint x, uint y)`
- `function rmul(uint x, uint y)`
- `function toInt(uint x)`
- `function toUint(int256 x)`
- `function toRad(uint wad)`

Recommendation

It is recommended to delete functions that are not called.

Alleviation

Acknowledged and partially applied in commit 49167c6.

I-13: Parameters Should Be Declared as Calldata

Informational: Optimization Suggestion

File Location:
/hebao_v3/contracts/base/LoopringCreate2Deployer.sol:9
/hebao_v3/contracts/base/OfficialGuardian.sol:23
/hebao_v3/contracts/base/SmartWallet.sol:193
/hebao_v3/contracts/base/libwallet/ERC1271Lib.sol:22
/hebao_v3/contracts/base/libwallet/ERC20Lib.sol:237,261,286,319
/hebao_v3/contracts/base/libwallet/GuardianLib.sol:44,445,465,485
/hebao_v3/contracts/base/libwallet/LockLib.sol:46
/hebao_v3/contracts/base/libwallet/RecoverLib.sol:67
/hebao_v3/contracts/base/libwallet/UpgradeLib.sol:32
/hebao_v3/contracts/base/libwallet/WhitelistLib.sol:74
/hebao_v3/contracts/connectors/flashloan/BalancerFlashloan.sol:17,38,39,40,41,70
/hebao_v3/contracts/connectors/flashloan/IFlashLoanRecipient.sol:32,33,34,35
/hebao_v3/contracts/connectors/flashloan/IVault.sol:10,11,12
/hebao_v3/contracts/connectors/flashloan/flashloan_connector.sol:40

Description

When the compiler parses the `external` or `public` function, it can directly read the function parameters from calldata. Setting it to other storage locations may waste gas. About 300-400 gas can be saved with optimization turned off while 120-150 gas can be saved vice versa.

/hebao_v3/contracts/base/LoopringCreate2Deployer.sol

```
7       event Deployed(address addr, uint256 salt);
8
9       function deploy(bytes memory code, uint256 salt) public {
10          address addr;
11          // solhint-disable-next-line no-inline-assembly
```

/hebao_v3/contracts/base/OfficialGuardian.sol

```
21      function isValidSignature(
22          bytes32 _signHash,
23          bytes memory _signature
24      ) public view override returns (bytes4) {
25          return
```

/hebao_v3/contracts/base/SmartWallet.sol

```
191     function isValidSignature(
192         bytes32 signHash,
193         bytes memory signature
194     ) public view override returns (bytes4 magicValue) {
195         return wallet.isValidSignature(ERC1271_MAGICVALUE, signHash,
            signature);
```

/hebao_v3/contracts/base/libwallet/ERC1271Lib.sol

```
20          bytes4 erc1271MagicValue,
21          bytes32 signHash,
22          bytes memory signature
23      ) public view returns (bytes4 magicValue) {
24          if (wallet.locked) {
```

/hebao_v3/contracts/base/libwallet/ERC20Lib.sol

```
235
236     function encodeApprovalForTransferToken(
237         bytes memory data,
238         bytes32 domainSeparator,
239         uint256 validUntil
```

/hebao_v3/contracts/base/libwallet/ERC20Lib.sol

```
259
260     function encodeApprovalForApproveToken(
261         bytes memory data,
262         bytes32 domainSeparator,
263         uint256 validUntil
```

/hebao_v3/contracts/base/libwallet/ERC20Lib.sol

```
284
285     function encodeApprovalForCallContract(
286         bytes memory callData,
287         bytes32 domainSeparator,
288         uint256 validUntil
```

/hebao_v3/contracts/base/libwallet/ERC20Lib.sol

```
317
318     function encodeApprovalForApproveThenCallContract(
319         bytes memory callData,
320         bytes32 domainSeparator,
321         uint256 validUntil
```

/hebao_v3/contracts/base/libwallet/GuardianLib.sol

```
42      function addGuardiansImmediately(
43          Wallet storage wallet,
44          address[] memory _guardians
45      ) external {
46          address guardian = address(0);
```

/hebao_v3/contracts/base/libwallet/GuardianLib.sol

```
443
444     function encodeApprovalForAddGuardian(
445         bytes memory data,
446         bytes32 domainSeparator,
447         uint256 validUntil
```

/hebao_v3/contracts/base/libwallet/GuardianLib.sol

```
463
464     function encodeApprovalForRemoveGuardian(
465         bytes memory data,
466         bytes32 domainSeparator,
467         uint256 validUntil
```

/hebao_v3/contracts/base/libwallet/GuardianLib.sol

```
483
484     function encodeApprovalForResetGuardians(
485         bytes memory data,
486         bytes32 domainSeparator,
487         uint256 validUntil
```

/hebao_v3/contracts/base/libwallet/LockLib.sol

```
44
45     function encodeApprovalForUnlock(
46         bytes memory,
47         bytes32 domainSeparator,
48         uint256 validUntil
```

/hebao_v3/contracts/base/libwallet/RecoverLib.sol

```
65     function encodeApprovalForRecover(
66         address newOwner,
67         address[] memory newGuardians,
68         bytes32 domainSeparator,
69         uint256 validUntil
```

/hebao_v3/contracts/base/libwallet/UpgradeLib.sol

```
30
31     function encodeApprovalForChangeMasterCopy(
32         bytes memory data,
33         bytes32 domainSeparator,
34         uint256 validUntil
```

/hebao_v3/contracts/base/libwallet/WhitelistLib.sol

```
72
73      function encodeApprovalForAddToWhitelist(
74          bytes memory data,
75          bytes32 domainSeparator,
76          uint256 validUntil
```

/hebao_v3/contracts/connectors/flashloan/BalancerFlashloan.sol

```
15          address token,
16          uint256 amount,
17          bytes memory userData
18      ) external;
19  }
```

/hebao_v3/contracts/connectors/flashloan/BalancerFlashloan.sol

```
36
37      function receiveFlashLoan(
38          IERC20[] memory tokens,
39          uint256[] memory amounts,
40          uint256[] memory /*feeAmounts*/,
41          bytes memory userData
42      ) external override {
43          // check msg.sender
```

/hebao_v3/contracts/connectors/flashloan/BalancerFlashloan.sol

```
68          address token,
69          uint256 amount,
70          bytes memory data
71      ) external {
72          IERC20[] memory tokens = new IERC20[](1);
```

/hebao_v3/contracts/connectors/flashloan/IFlashLoanRecipient.sol

```
30       */
31      function receiveFlashLoan(
32          IERC20[] memory tokens,
33          uint256[] memory amounts,
34          uint256[] memory feeAmounts,
35          bytes memory userData
36      ) external;
37  }
```

/hebao_v3/contracts/connectors/flashloan/IVault.sol

```
 8      function flashLoan(
 9          IFlashLoanRecipient recipient,
10          IERC20[] memory tokens,
11          uint256[] memory amounts,
12          bytes memory userData
13      ) external;
14  }
```

/hebao_v3/contracts/connectors/flashloan/flashloan_connector.sol

```
38          address token,
39          uint amt,
40          bytes memory data
41      ) external payable {
42          (address[] memory targets, bytes[] memory callDatas) = abi.decode
            (
```

Recommendation

In `external` or `public` functions, the storage location of function parameters should be set to `calldata` to save gas.

Alleviation

Acknowledged and partially applied in commit 49167c6.

I-14: Variables Can Be Declared as Immutable

Informational: Optimization Suggestion

File Location:
/hebao_v3/contracts/base/SmartWallet.sol:64
/hebao_v3/contracts/connectors/memory.sol:77
/hebao_v3/contracts/price/UniswapV2PriceOracle.sol:15

Description

The solidity compiler of version 0.6.5 introduces `immutable` to modify state variables that are only modified in the constructor. Using `immutable` can save gas.

/hebao_v3/contracts/base/SmartWallet.sol

```
62      address internal masterCopy;
63
64      bool internal isImplementationContract;
65
66      Wallet public wallet;
```

/hebao_v3/contracts/connectors/memory.sol

```
75
76  contract OwnedMemory is Memory {
77      address public master;
78      address public constant BROADCAST_ADDR = address(0);
79
```

/hebao_v3/contracts/price/UniswapV2PriceOracle.sol

```
13      using SafeMath for uint;
14
15      IUniswapV2Factory public factory;
16      address public immutable wethAddress;
17
```

Recommendation

For contracts compiled with compiler of versions 0.6.5 and above, if the state variable is only modified in the constructor, it is recommended to modify the variable with `immutable` to save gas.

Alleviation

Acknowledged and partially applied in commit 49167c6.

I-15: No Need To Use SafeMath in Solidity Contract of Version 0.8.0 and Above

Informational: Optimization Suggestion

File Location:
/hebao_v3/contracts/base/libwallet/ERC20Lib.sol:19
/hebao_v3/contracts/base/libwallet/QuotaLib.sol:17
/hebao_v3/contracts/price/UniswapV2PriceOracle.sol:12

Description

In solidity 0.8.0 and above, the compiler has its own overflow checking function, so there is no need to use the SafeMath library to prevent overflow.

/hebao_v3/contracts/base/libwallet/ERC20Lib.sol

```
17  /// @author Brecht Devos - <brecht@loopring.org>
18  /// @author Daniel Wang - <daniel@loopring.org>
19  library ERC20Lib {
20      using AddressUtil for address;
21      using BytesUtil for bytes;
```

/hebao_v3/contracts/base/libwallet/QuotaLib.sol

```
15  /// @dev This store maintains daily spending quota for each wallet.
16  ///      A rolling daily limit is used.
17  library QuotaLib {
18      using SafeCast for uint;
19      using SafeMath for uint;
```

/hebao_v3/contracts/price/UniswapV2PriceOracle.sol

```
10  /// @title Uniswap2PriceOracle
11  /// @dev Returns the value in Ether for any given ERC20 token.
12  contract UniswapV2PriceOracle is PriceOracle {
13      using SafeMath for uint;
14
```

Recommendation

It is recommended to abandon the use of the SafeMath library to prevent overflow, which can save gas in versions 0.8.0 and above, unless you want to specify the error message when overflowing or you are using the openzeppelin library of version 0.4 and above.

Alleviation

Resolved in commit 49167c6.

I-16: Unused Events

Informational: Optimization Suggestion

File Location: /hebao_v3/contracts/base/libwallet/InheritanceLib.sol:24,35

Description

The `InheritorChanged` event is currently not being used. An event notification for `InheritorChanged` should be emitted when the `setInheritor` function is called, to allow off-chain tools to monitor changes to the inheritor.

/hebao_v3/contracts/base/libwallet/InheritanceLib.sol

```
22      event Inherited(address inheritor, address newOwner);
23
24      event InheritorChanged(address inheritor, uint32 waitingPeriod);
25
26      function touchLastActiveWhenRequired(Wallet storage wallet) internal
        {
```

/hebao_v3/contracts/base/libwallet/InheritanceLib.sol

```
35      function setInheritor(
36          Wallet storage wallet,
37          address inheritor,
38          uint32 waitingPeriod
39      ) internal {
40          if (inheritor == address(0)) {
41              require(waitingPeriod == 0, "INVALID_WAITING_PERIOD");
42          } else {
43              require(
44                  waitingPeriod >= TOUCH_GRACE_PERIOD,
45                  "INVALID_WAITING_PERIOD"
46              );
47          }
48
49          require(inheritor != address(this), "INVALID_ARGS");
50          wallet.inheritor = inheritor;
51          wallet.inheritWaitingPeriod = waitingPeriod;
52          wallet.lastActive = uint64(block.timestamp);
53      }
```

Recommendation

It is recommended to emit the `InheritorChanged` event when the `setInheritor` function is called.

Alleviation

Resolved in commit 49167c6.

I-17: Set the Constant to Private

Informational: Optimization Suggestion

File Location:
/hebao_v3/contracts/base/ConnectorRegistry.sol:10
/hebao_v3/contracts/base/LoopringPaymaster.sol:34
/hebao_v3/contracts/base/WalletDeploymentLib.sol:15
/hebao_v3/contracts/base/WalletFactory.sol:28
/hebao_v3/contracts/base/libwallet/ERC20Lib.sol:34,38,42,46
/hebao_v3/contracts/base/libwallet/GuardianLib.sol:21,22,26,30,34
/hebao_v3/contracts/base/libwallet/InheritanceLib.sol:20
/hebao_v3/contracts/base/libwallet/LockLib.sol:22
/hebao_v3/contracts/base/libwallet/QuotaLib.sol:21,22,26
/hebao_v3/contracts/base/libwallet/RecoverLib.sol:24
/hebao_v3/contracts/base/libwallet/UpgradeLib.sol:20
/hebao_v3/contracts/base/libwallet/WhitelistLib.sol:16,20
/hebao_v3/contracts/connectors/base_connector.sol:24,25
/hebao_v3/contracts/connectors/memory.sol:78
/hebao_v3/contracts/price/CachedPriceOracle.sol:15
/hebao_v3/contracts/price/KyberNetworkPriceOracle.sol:20

Description

For constants, if the visibility is set to `public`, the compiler will automatically generate a getter function for it, which will consume more gas during deployment. The value of constant variable can be directly read from verified source code.

/hebao_v3/contracts/base/ConnectorRegistry.sol

```
 9  contract ConnectorRegistry is AccessControl, Ownable {
10      bytes32 public constant MANAGER = keccak256("MANAGER");
11
12      mapping(address => bool) public connectors;
```

/hebao_v3/contracts/base/LoopringPaymaster.sol

```
32      uint256 private constant COST_OF_POST = 60000;
33      uint8 private constant PRICE_DECIMAL = 8;
34      bytes32 public constant SIGNER = keccak256("SIGNER");
35
36      mapping(address => bool) public registeredToken;
```

/hebao_v3/contracts/base/WalletDeploymentLib.sol

```
13      address public immutable walletImplementation;
14
15      string public constant WALLET_CREATION = "WALLET_CREATION";
16
17      constructor(address _walletImplementation) {
```

/hebao_v3/contracts/base/WalletFactory.sol

```
28      bytes32 public constant CREATE_WALLET_TYPEHASH =
29          keccak256(
30              "createWallet(address owner,address[] guardians,uint256
                quota,address inheritor,address feeRecipient,address
                feeToken,uint256 maxFeeAmount,uint256 salt)"
```

/hebao_v3/contracts/base/libwallet/ERC20Lib.sol

```
34      bytes32 public constant TRANSFER_TOKEN_TYPEHASH =
35          keccak256(
36              "transferToken(address wallet,uint256 validUntil,address
                token,address to,uint256 amount,bytes logdata)"
37          );
38      bytes32 public constant APPROVE_TOKEN_TYPEHASH =
39          keccak256(
40              "approveToken(address wallet,uint256 validUntil,address
                token,address to,uint256 amount)"
41          );
42      bytes32 public constant CALL_CONTRACT_TYPEHASH =
43          keccak256(
44              "callContract(address wallet,uint256 validUntil,address to,
                uint256 value,bytes data)"
45          );
46      bytes32 public constant APPROVE_THEN_CALL_CONTRACT_TYPEHASH =
47          keccak256(
48              "approveThenCallContract(address wallet,uint256 validUntil,
                address token,address to,uint256 amount,uint256 value,bytes
                data)"
49          );
```

/hebao_v3/contracts/base/libwallet/GuardianLib.sol

```
21      uint public constant MAX_GUARDIANS = 10;
22      uint public constant GUARDIAN_PENDING_PERIOD = 3 days;
23      SigRequirement public constant SIG_REQUIREMENT =
24          SigRequirement.MAJORITY_OWNER_REQUIRED;
25
26      bytes32 public constant ADD_GUARDIAN_TYPEHASH =
27          keccak256(
28              "addGuardian(address wallet,uint256 validUntil,address
                guardian)"
29          );
30      bytes32 public constant REMOVE_GUARDIAN_TYPEHASH =
31          keccak256(
32              "removeGuardian(address wallet,uint256 validUntil,address
                guardian)"
33          );
34      bytes32 public constant RESET_GUARDIANS_TYPEHASH =
35          keccak256(
36              "resetGuardians(address wallet,uint256 validUntil,address[]
                guardians)"
37          );
```

/hebao_v3/contracts/base/libwallet/InheritanceLib.sol

```
19      // The minimal number of guardians for recovery and locking.
20      uint public constant TOUCH_GRACE_PERIOD = 30 days;
21
22      event Inherited(address inheritor, address newOwner);
```

/hebao_v3/contracts/base/libwallet/LockLib.sol

```
22    bytes32 public constant UNLOCK_TYPEHASH =
23          keccak256("unlock(address wallet,uint256 validUntil)");
24
```

/hebao_v3/contracts/base/libwallet/QuotaLib.sol

```
21      uint128 public constant MAX_QUOTA = type(uint128).max;
22      uint public constant QUOTA_PENDING_PERIOD = 1 days;
23      SigRequirement public constant SIG_REQUIREMENT =
24          SigRequirement.MAJORITY_OWNER_REQUIRED;
25
26      bytes32 public constant CHANGE_DAILY_QUOTE_TYPEHASH =
27          keccak256(
28              "changeDailyQuota(address wallet,uint256 validUntil,uint256
                newQuota)"
29          );
```

/hebao_v3/contracts/base/libwallet/RecoverLib.sol

```
24    bytes32 public constant RECOVER_TYPEHASH =
25          keccak256(
26              "recover(address wallet,uint256 validUntil,address newOwner,
                address[] newGuardians)"
```

/hebao_v3/contracts/base/libwallet/UpgradeLib.sol

```
20      bytes32 public constant CHANGE_MASTER_COPY_TYPEHASH =
21          keccak256(
22              "changeMasterCopy(address wallet,uint256 validUntil,address
                masterCopy)"
```

/hebao_v3/contracts/base/libwallet/WhitelistLib.sol

```
16      uint public constant WHITELIST_PENDING_PERIOD = 1 days;
17      SigRequirement public constant SIG_REQUIREMENT =
18          SigRequirement.MAJORITY_OWNER_REQUIRED;
19
20      bytes32 public constant ADD_TO_WHITELIST_TYPEHASH =
21          keccak256(
22              "addToWhitelist(address wallet,uint256 validUntil,address
                addr)"
23          );
```

/hebao_v3/contracts/connectors/base_connector.sol

```
22
23  contract DSMath {
24      uint public constant WAD = 10 ** 18;
25      uint public constant RAY = 10 ** 27;
26
```

/hebao_v3/contracts/connectors/memory.sol

```
76  contract OwnedMemory is Memory {
77      address public master;
78      address public constant BROADCAST_ADDR = address(0);
```

/hebao_v3/contracts/price/CachedPriceOracle.sol

```
15     uint public constant EXPIRY_PERIOD = 7 days;
```

/hebao_v3/contracts/price/KyberNetworkPriceOracle.sol

```
18  contract KyberNetworkPriceOracle is PriceOracle {
19      KyberNetworkProxy public immutable kyber;
20      address public constant ETH_ADDR =
21          0xEeeeeEeeeEeEeeEeEeEeeEEEeeeeEeeeeeeeEEeE;
```

Recommendation

It is recommended to set the visibility of constants to `private` instead of `public`.

Alleviation

Acknowledged and partially applied in commit 49167c6.

I-18: Interface Defined Not Inherited

Informational: Optimization Suggestion

File Location: /hebao_v3/contracts/base/ConnectorRegistry.sol:9

Description

Interface `IConnectorRegistry` is defined but not properly inherited by contract `ConnectorRegistry`.

/hebao_v3/contracts/base/ConnectorRegistry.sol

```
 7  import "@openzeppelin/contracts/access/AccessControl.sol";
 8
 9  contract ConnectorRegistry is AccessControl, Ownable {
10      bytes32 public constant MANAGER = keccak256("MANAGER");
11
```

Recommendation

It is recommended that the contract inherits the relevant interface when it is defined.

Alleviation

Resolved in commit 49167c6. `ConnectorRegistry` now inherits `IConnectorRegistry`.

4. Disclaimer

No description, statement, recommendation or conclusion in this report shall be construed as endorsement, affirmation or confirmation of the project. The security assessment is limited to the scope of work as stipulated in the Statement of Work.

This report is prepared in response to source code, and based on the attacks and vulnerabilities in the source code that already existed or occurred before the date of this report, excluding any new attacks or vulnerabilities that exist or occur after the date of this report. The security assessment are solely based on the documents and materials provided by the customer, and the customer represents and warrants documents and materials are true, accurate and complete.

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5. Appendix

5.1 Visibility

Contract	FuncName	Visibility	Mutability	Modifiers
BaseConnector	_CTOR_	public		
BaseConnector	getUint	internal		
BaseConnector	setUint	internal		
BaseConnector	changeEthAddress	internal		
BaseConnector	convertEthToWeth	internal		
BaseConnector	convertWethToEth	internal		
BaseConnector	convert18ToDec	internal		
BaseConnector	convertTo18	internal		
BaseConnector	getTokenBal	internal		
LidoConnector	_CTOR_	public		
LidoConnector	deposit	public		
LidoConnector	wrapAndStaking	public		
LidoConnector	unwrap	public		
WETHConnector	_CTOR_	public		
WETHConnector	deposit	public		
WETHConnector	withdraw	public		
ConnectorRegistry	_CTOR_	public		
ConnectorRegistry	addConnectors	external		onlyManager
ConnectorRegistry	removeConnectors	external		onlyManager

Contract	FuncName	Visibility	Mutability	Modifiers
ConnectorRegistry	isConnectors	external		
WalletDeploymentLib	_CTOR_	public		
WalletDeploymentLib	getWalletCode	public		
WalletDeploymentLib	computeWalletSalt	public		
WalletDeploymentLib	_deploy	internal		
WalletDeploymentLib	_computeWalletAddress	internal		
WalletFactory	isOperator	public		
WalletFactory	operators	public		
WalletFactory	numOperators	public		
WalletFactory	addOperator	public		onlyOwner
WalletFactory	removeOperator	public		onlyOwner
WalletFactory	addOperatorInternal	internal		
WalletFactory	_CTOR_	public		
WalletFactory	createWallet	external		onlyOperator
WalletFactory	createWalletByOperator	external		onlyOperator
WalletFactory	computeWalletAddress	public		
WalletFactory	_initializeWallet	internal		
WalletFactory	_validateConfig	private		

Contract	FuncName	Visibility	Mutability	Modifiers
DelayedImplementationManager	_CTOR_	public		
DelayedImplementationManager	delayedUpgradeTo	public		onlyOwner
DelayedImplementationManager	executeUpgrade	public		
ForwardProxy	_CTOR_	public		
ForwardProxy	_implementation	internal		
KyberNetworkPriceOracle	_CTOR_	public		
KyberNetworkPriceOracle	tokenValue	public		
OwnedMemory	_CTOR_	public		
OwnedMemory	getBroadcastAddr	public		
OwnedMemory	setBroadcastAddr	public		isMaster
CachedPriceOracle	_CTOR_	public		
CachedPriceOracle	tokenValue	public		
CachedPriceOracle	updateTokenPrice	external		onlyManager
CachedPriceOracle	setTokenPrice	external		onlyManager
CachedPriceOracle	setOracle	external		onlyManager
CachedPriceOracle	_cacheTokenPrice	internal		
LoopringPaymaster	_CTOR_	public		
LoopringPaymaster	receive	external		
LoopringPaymaster	getHash	public		

Contract	FuncName	Visibility	Mutability	Modifiers
LoopringPaymaster	_validatePaymasterUserOp	internal		
LoopringPaymaster	parsePaymasterAndData	public		
LoopringPaymaster	_postOp	internal		
LoopringPaymaster	addToken	external		onlyOwner
LoopringPaymaster	removeToken	external		onlyOwner
LoopringPaymaster	addDepositFor	external		
LoopringPaymaster	depositInfo	public		
LoopringPaymaster	unlockTokenDeposit	public		
LoopringPaymaster	lockTokenDeposit	public		
LoopringPaymaster	withdrawTokensTo	public		
BalancerFlashLoan	_CTOR_	public		
BalancerFlashLoan	receiveFlashLoan	external		
BalancerFlashLoan	flashLoan	external		
FlashLoanConnector	_CTOR_	public		
FlashLoanConnector	flashBorrowAndCast	external		
FlashLoanConnector	flashPayback	external		
AaveV3Connector	_CTOR_	public		
AaveV3Connector	getIsColl	internal		
AaveV3Connector	getPaybackBalance	internal		

Contract	FuncName	Visibility	Mutability	Modifiers
AaveV3Connector	deposit	external		
AaveV3Connector	withdraw	external		
AaveV3Connector	borrow	external		
AaveV3Connector	payback	external		
UniswapConnector	_CTOR_	public		
UniswapConnector	deposit	external		
UniswapConnector	withdraw	external		
UniswapConnector	buy	external		
UniswapConnector	sell	external		
UniswapConnector	getMinAmount	internal		
UniswapConnector	_addLiquidity	internal		
UniswapConnector	_removeLiquidity	internal		
UniswapConnector	getExpectedBuyAmt	internal		
UniswapConnector	getExpectedSellAmt	internal		
UniswapConnector	checkPair	internal		
UniswapConnector	getPaths	internal		
AggregationalPriceOracle	_CTOR_	public		
AggregationalPriceOracle	tokenValue	public		
CompoundConnector	_CTOR_	public		
CompoundConnector	deposit	public		

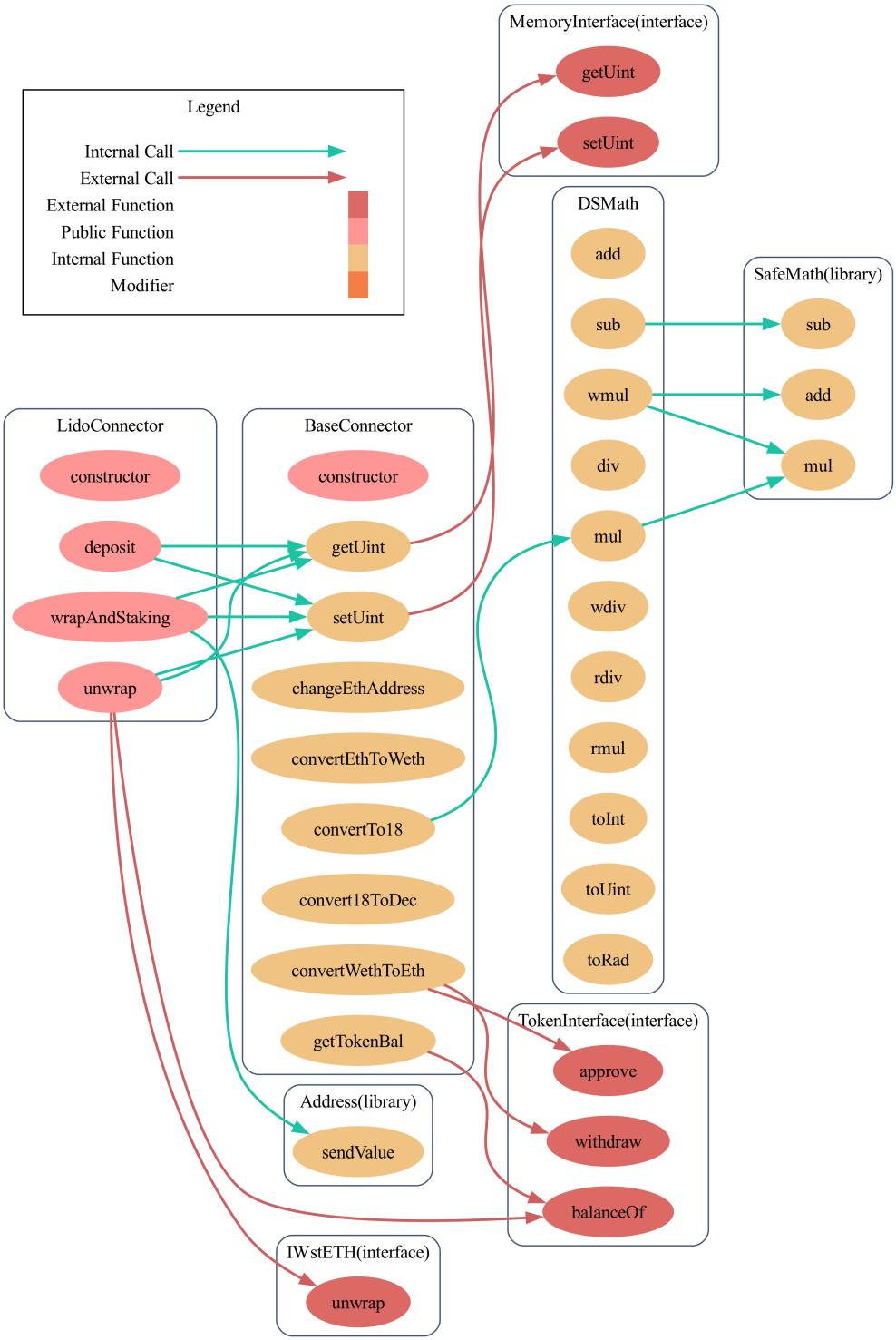
Contract	FuncName	Visibility	Mutability	Modifiers
CompoundConnector	withdraw	public		
CompoundConnector	borrow	public		
CompoundConnector	payback	public		
CompoundConnector	depositCToken	public		
CompoundConnector	withdrawCToken	public		
CompoundConnector	liquidate	public		
CompoundConnector	enterMarket	internal		
UniswapV2PriceOracle	_CTOR_	public		
UniswapV2PriceOracle	tokenValue	public		
SmartWalletV3	_CTOR_	public		
SmartWalletV3	selfBatchCall	external		onlyFromEntryPointOrWalletOrOwnerWhenUnlocked
SmartWalletV3	getDeposit	public		
SmartWalletV3	addDeposit	public		
SmartWalletV3	withdrawDepositTo	public		onlyFromEntryPointOrWalletOrOwnerWhenUnlocked
SmartWalletV3	_validateSignature	internal		
LoopringCreate2Deployer	deploy	public		
OfficialGuardian	initOwner	external		

Contract	FuncName	Visibility	Mutability	Modifiers
OfficialGuardian	isValidSignature	public		
OfficialGuardian	transact	external		onlyManager

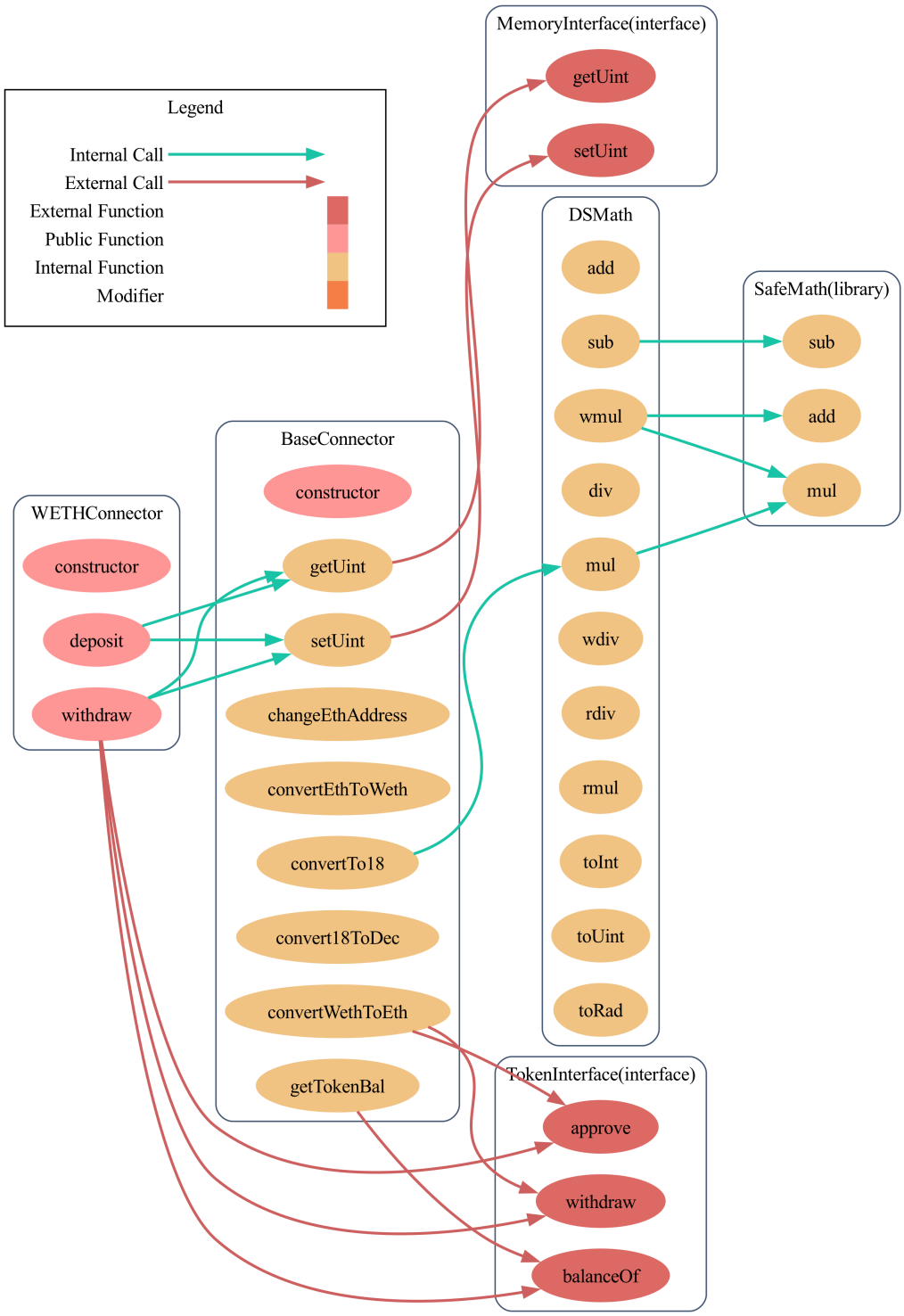
5. Appendix

5.2 Call Graph

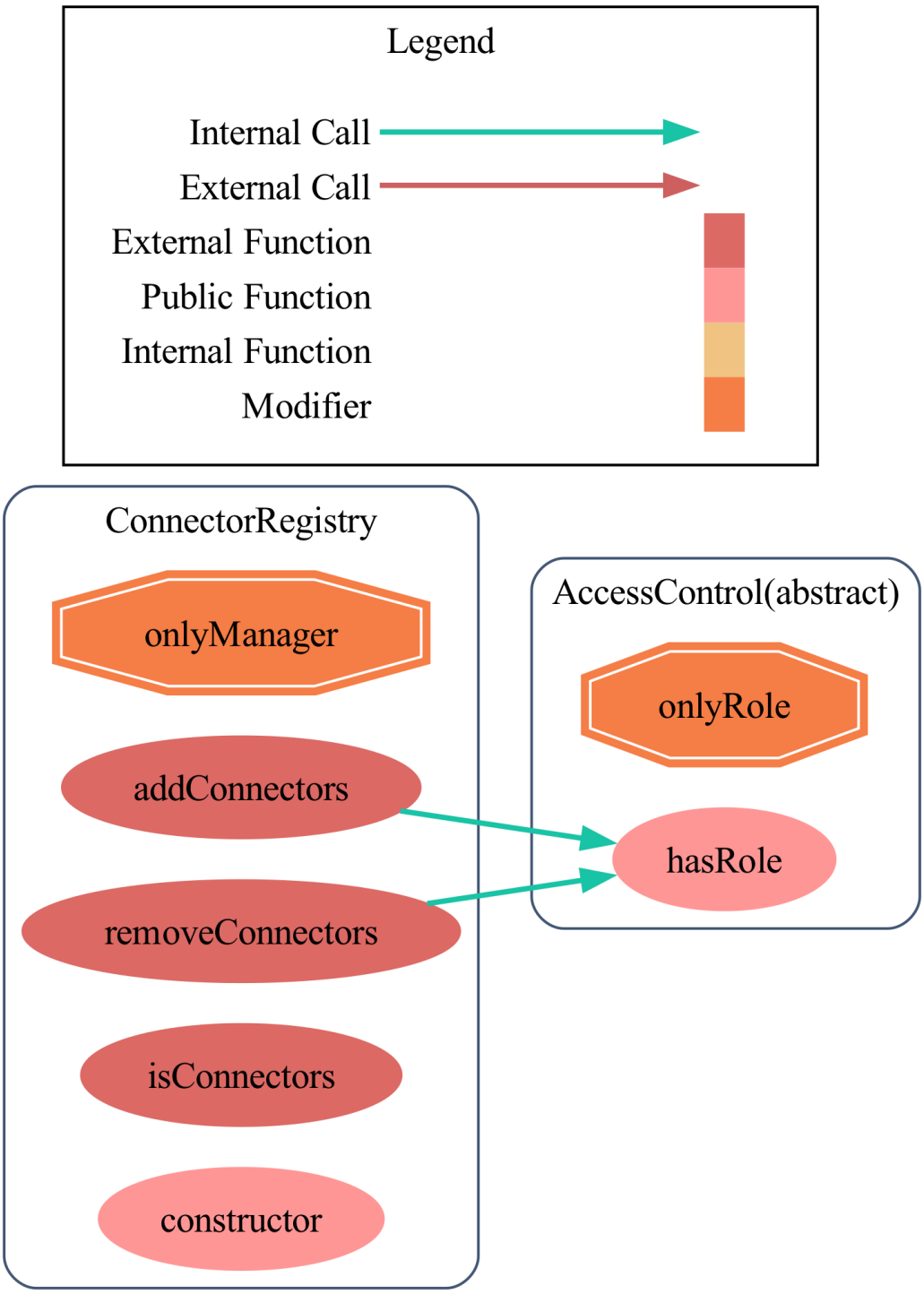
LidoConnector



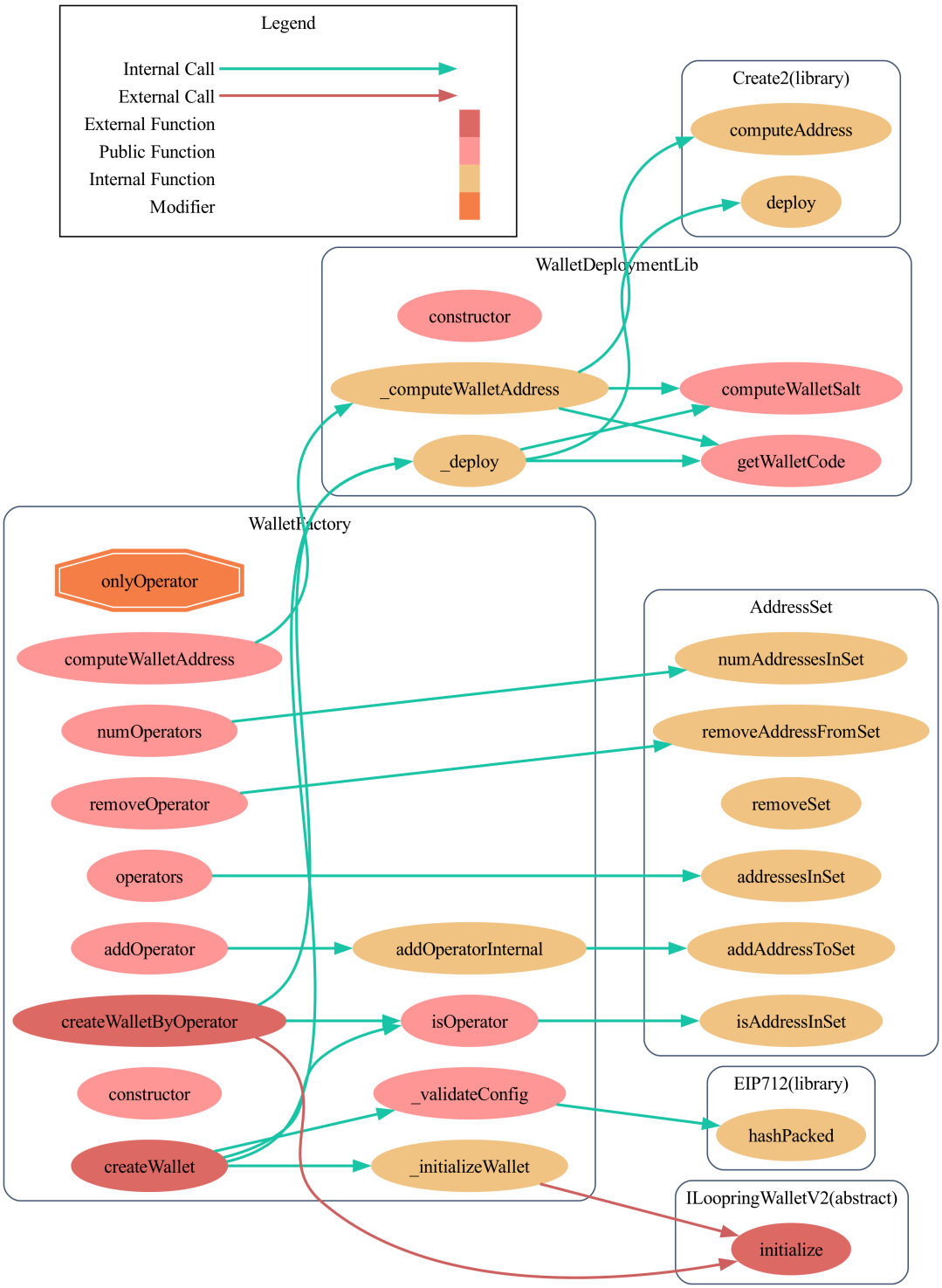
WETHConnector



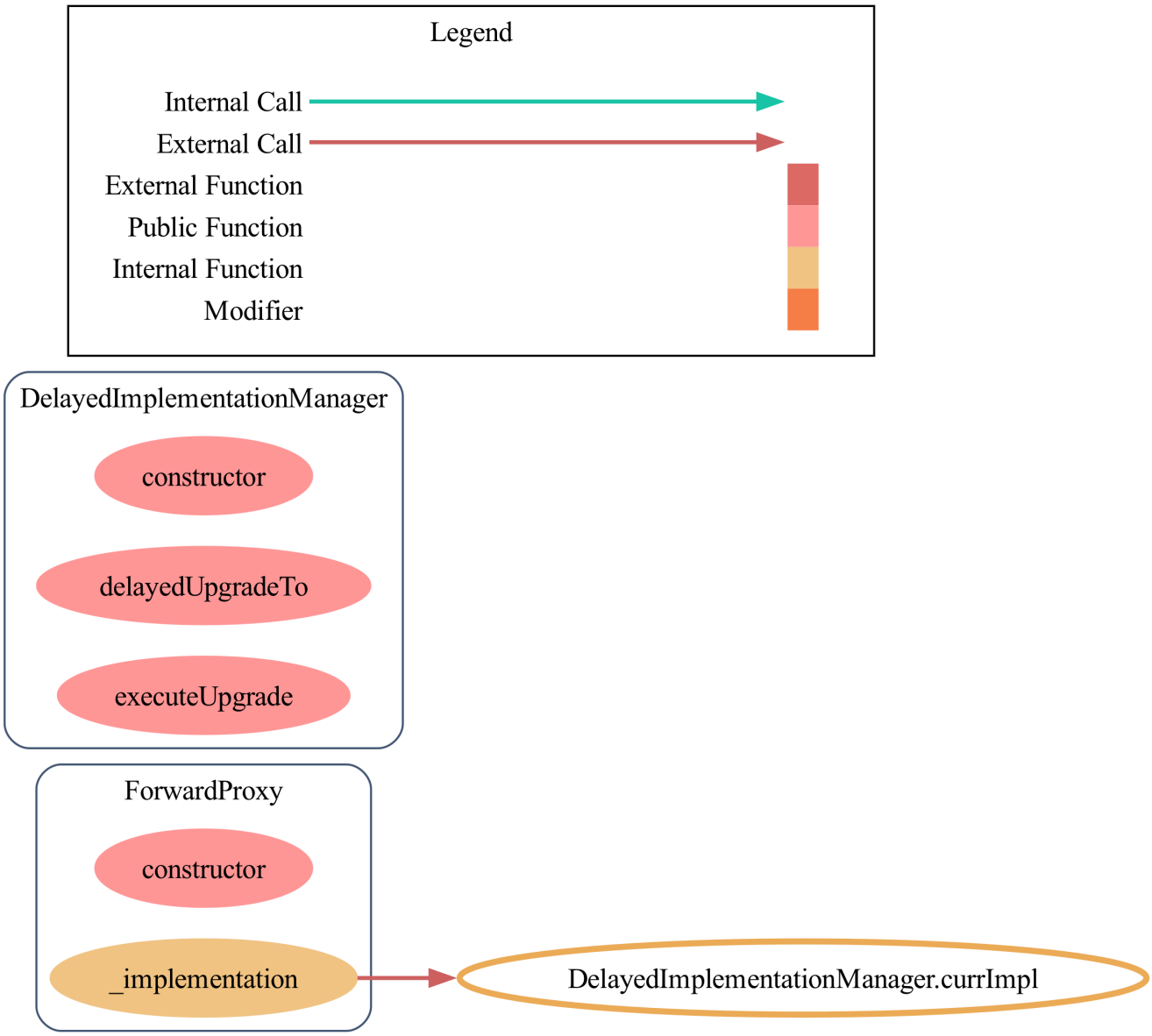
ConnectorRegistry



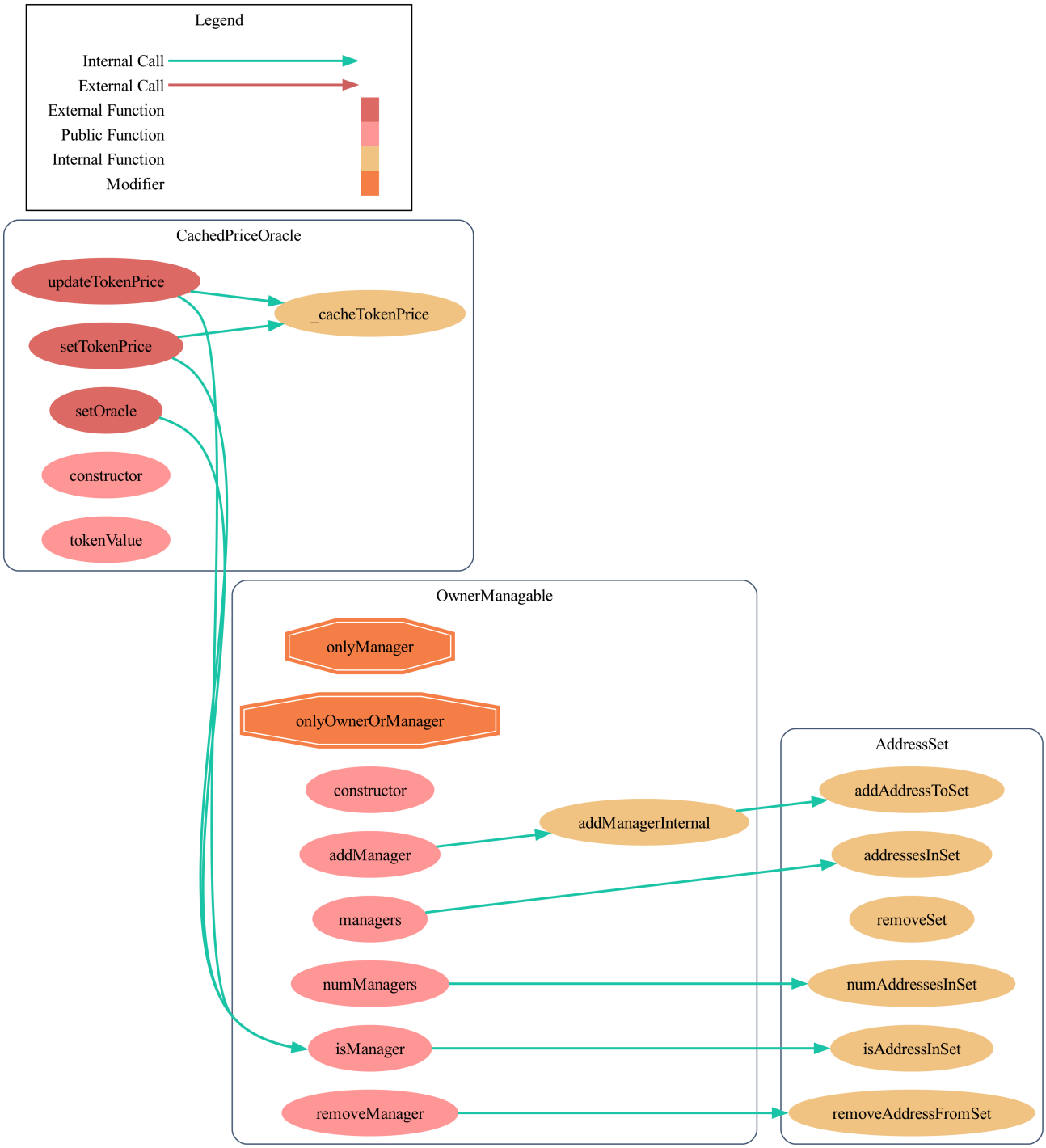
WalletFactory



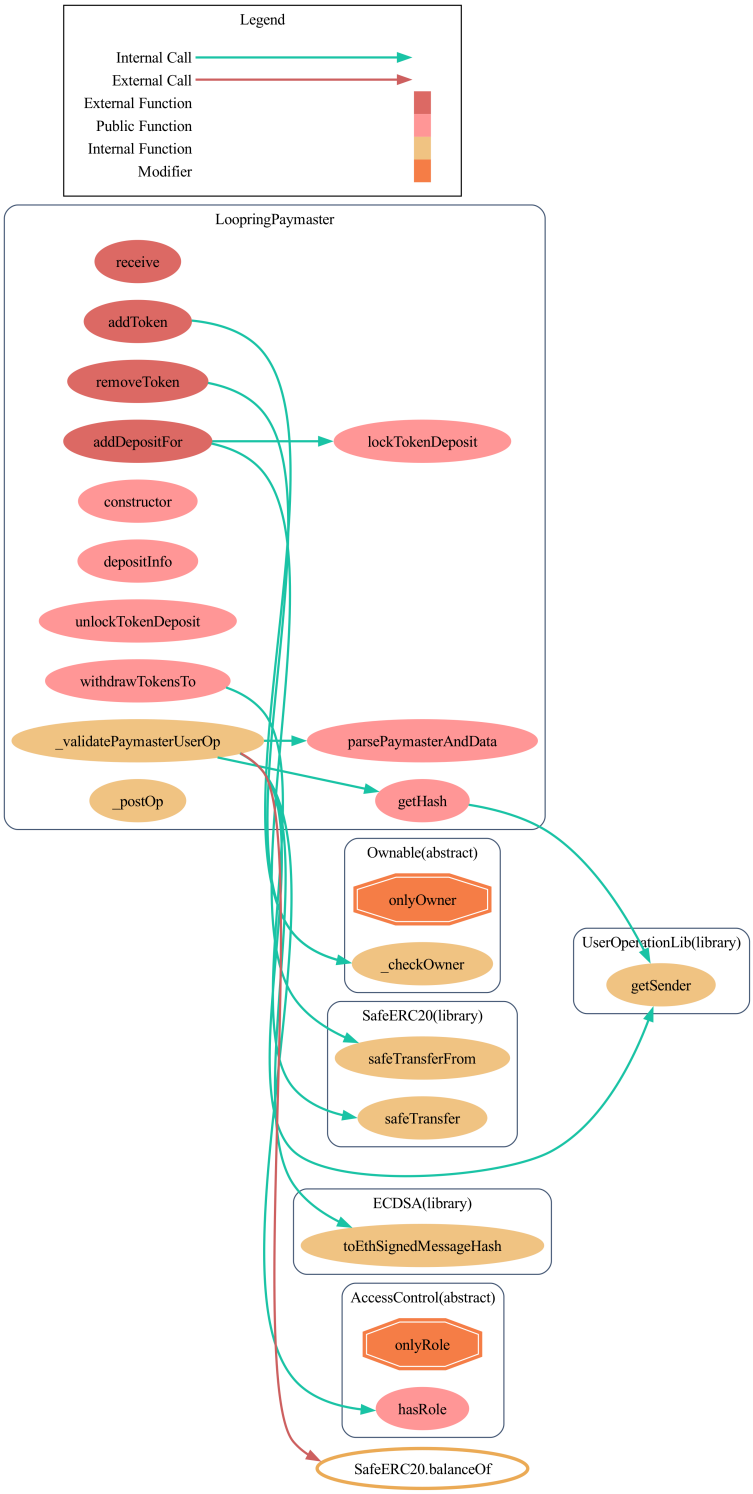
ForwardProxy



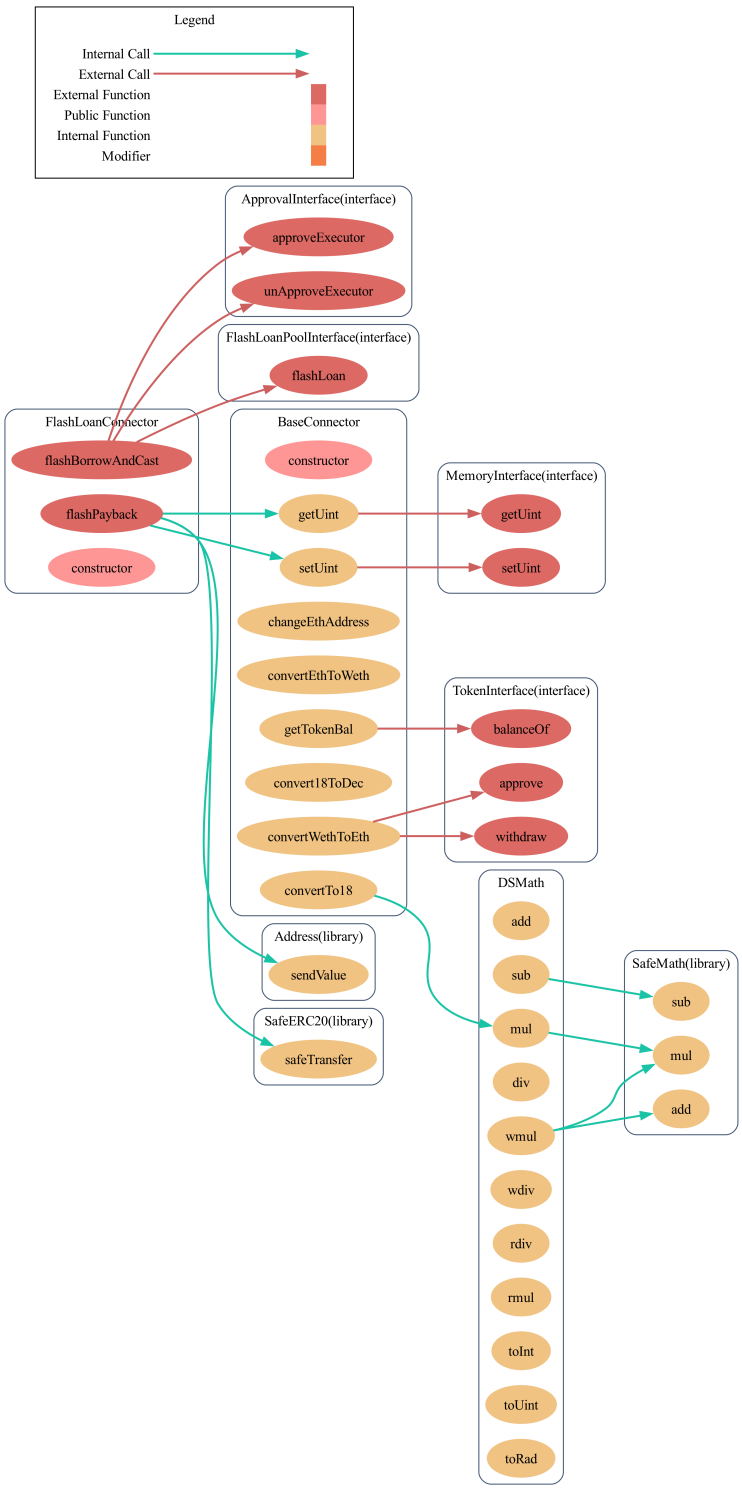
CachedPriceOracle



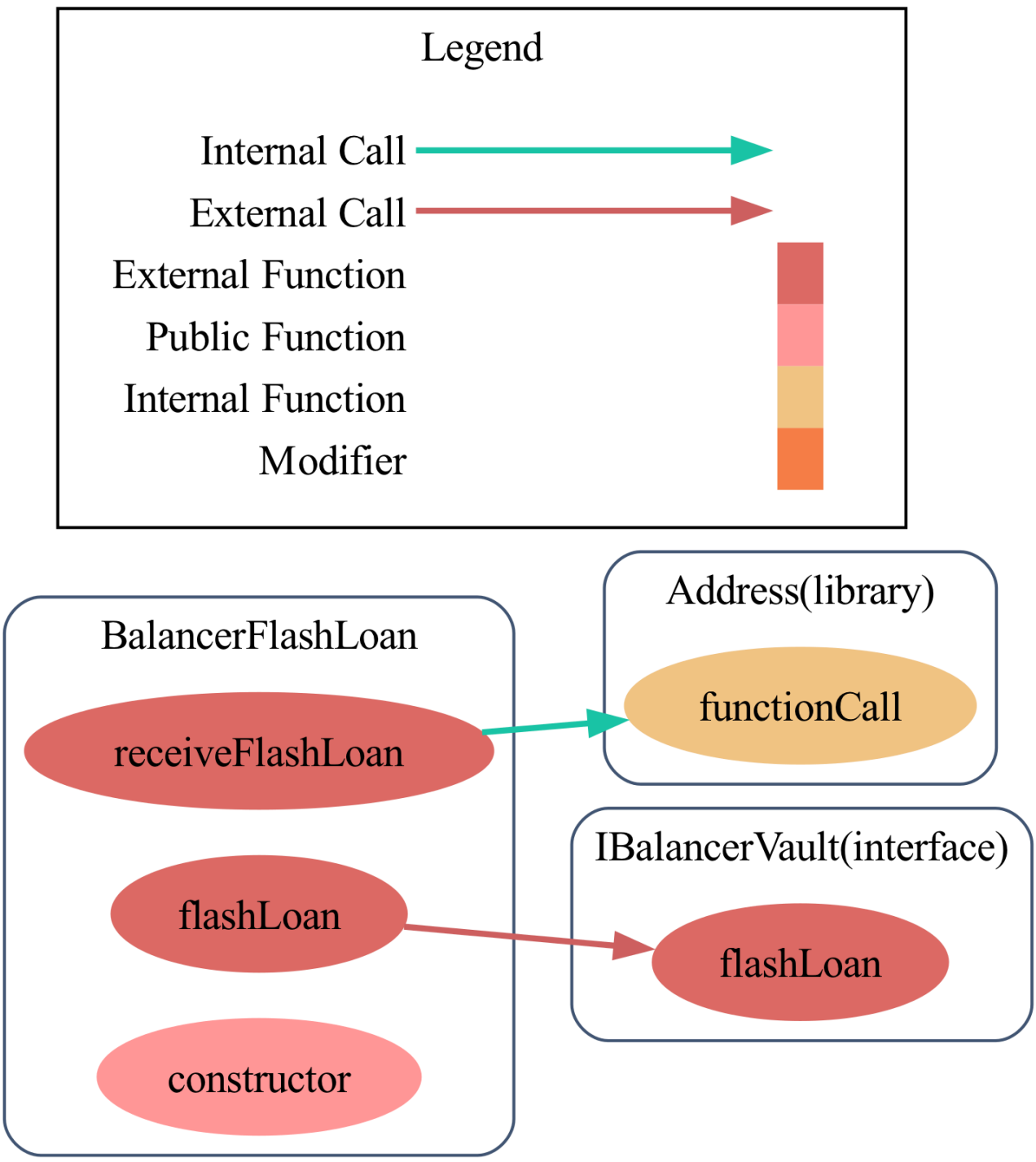
LoopringPaymaster



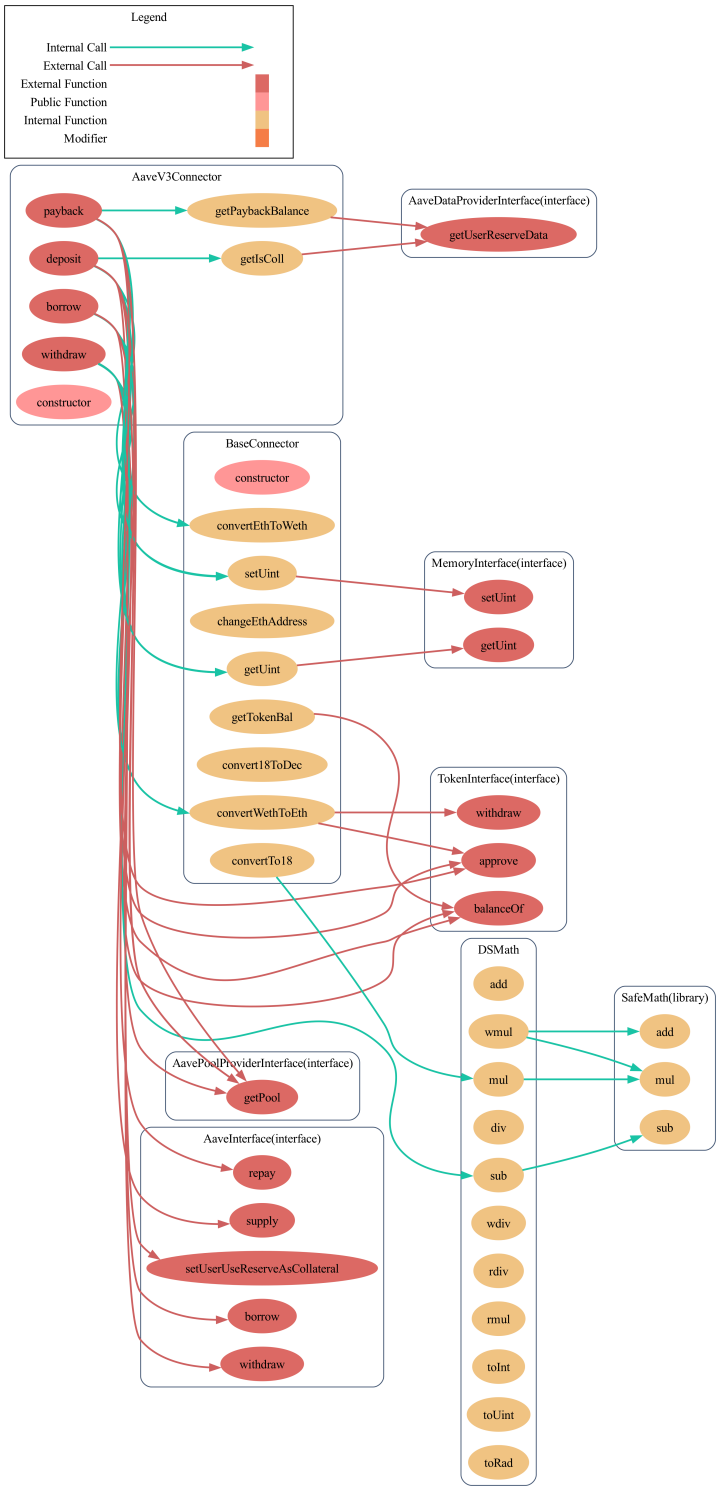
FlashLoanConnector



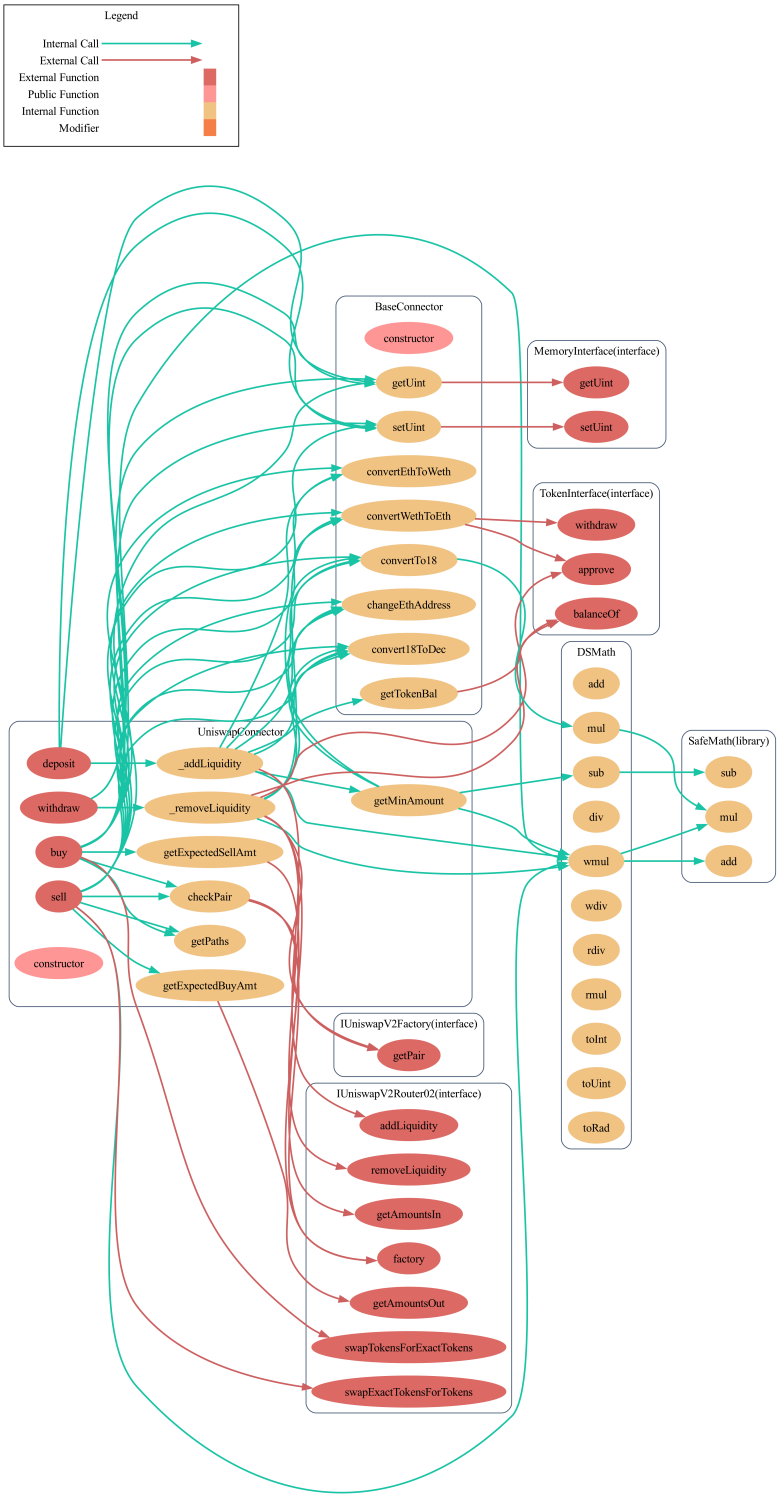
BalancerFlashLoan



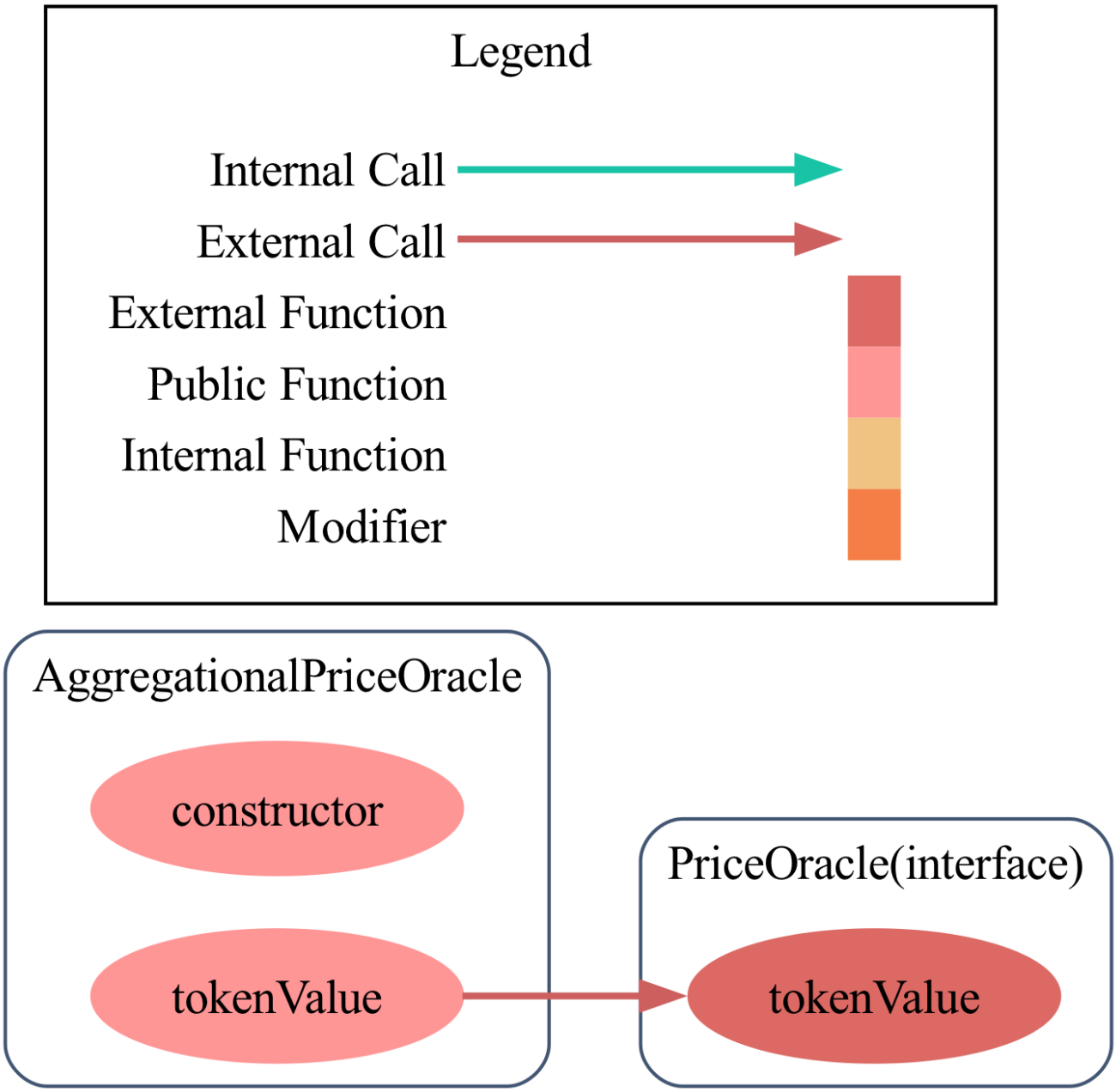
AaveV3Connector



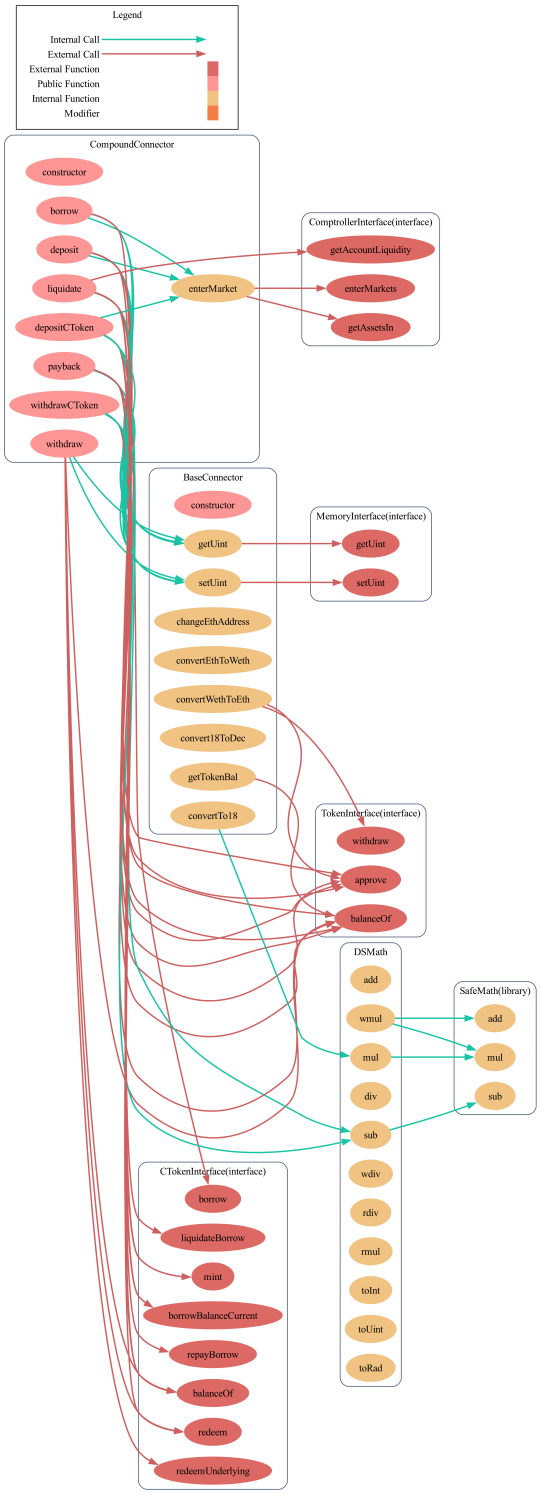
UniswapConnector



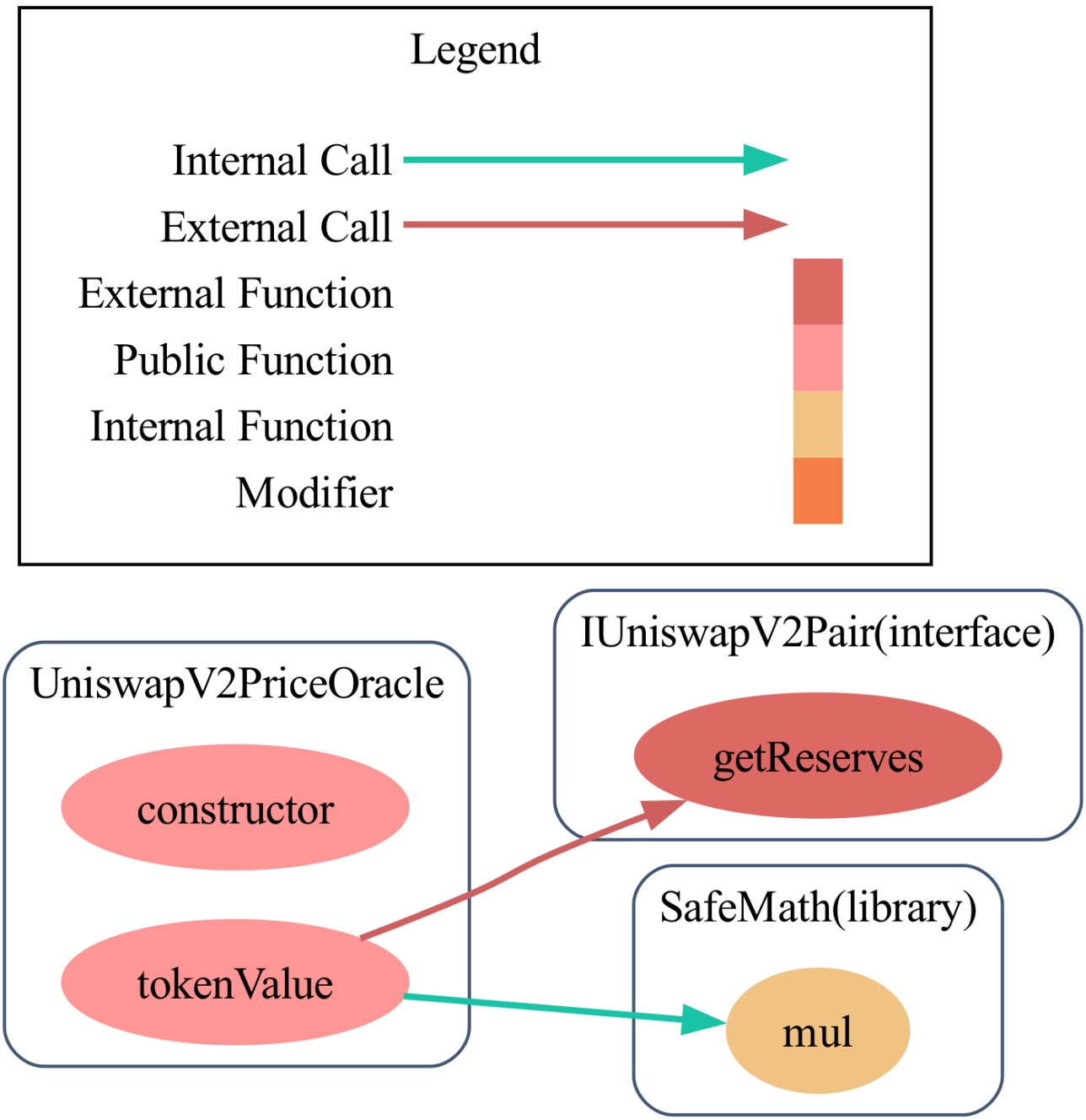
AggregationalPriceOracle



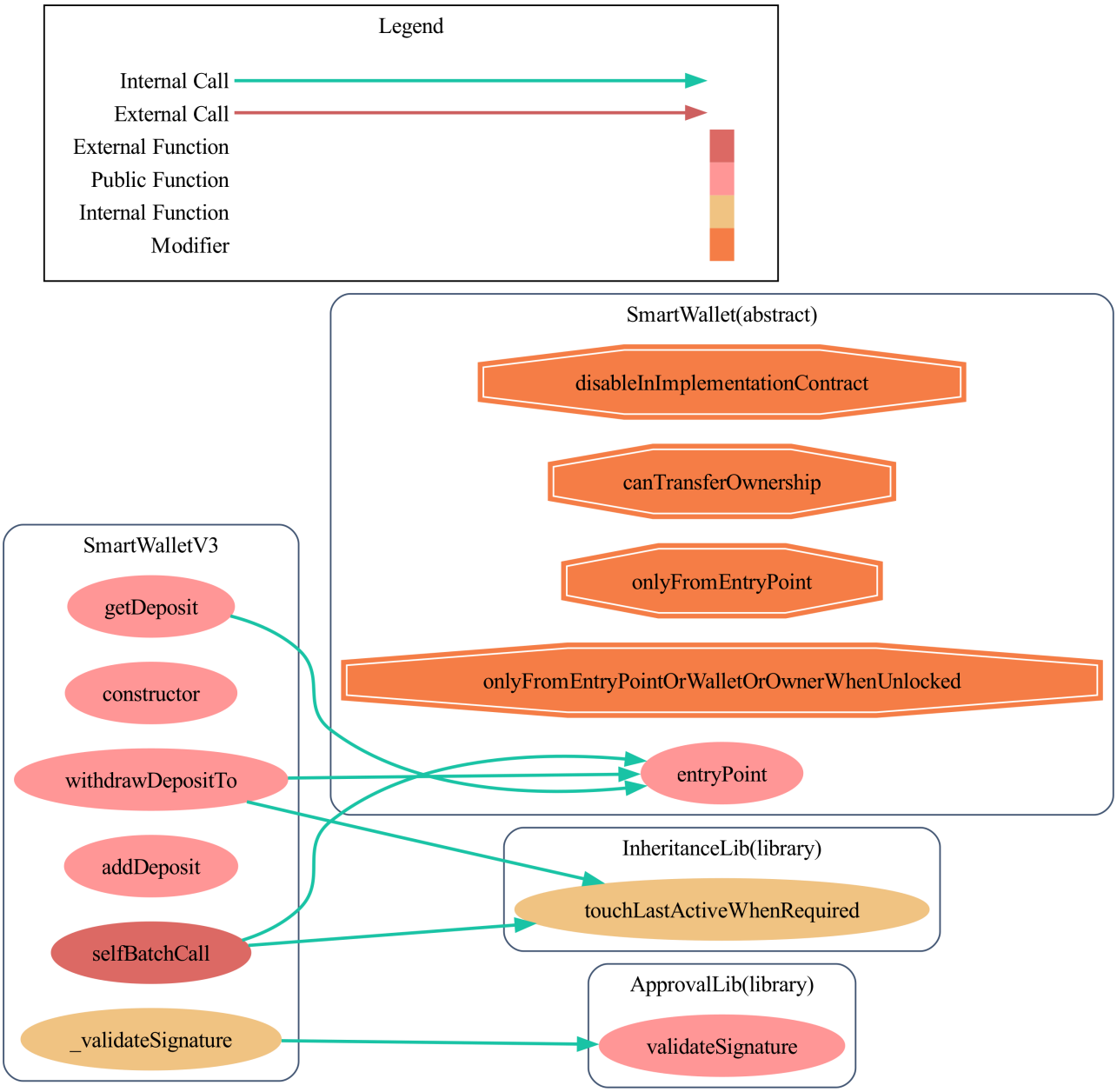
CompoundConnector



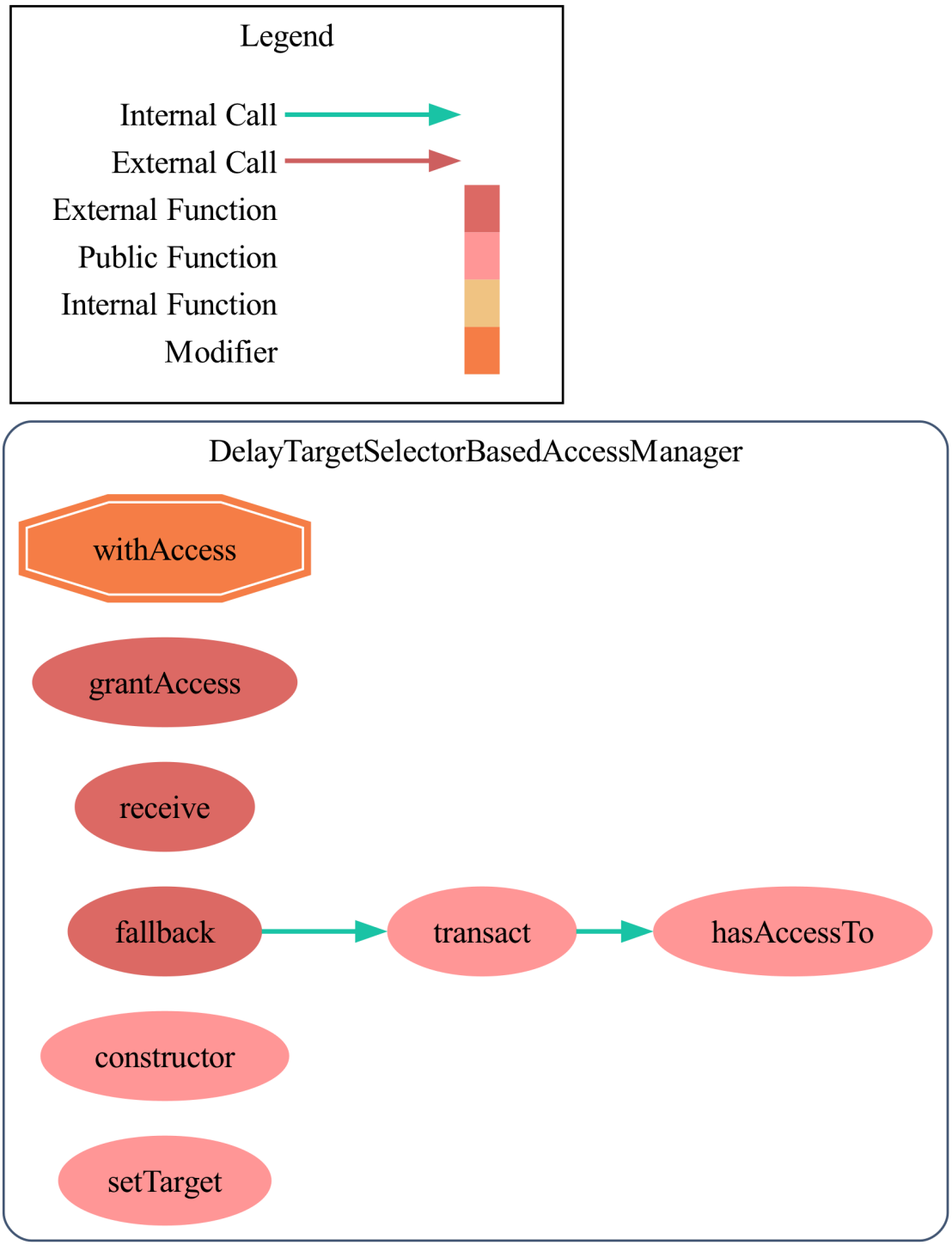
UniswapV2PriceOracle



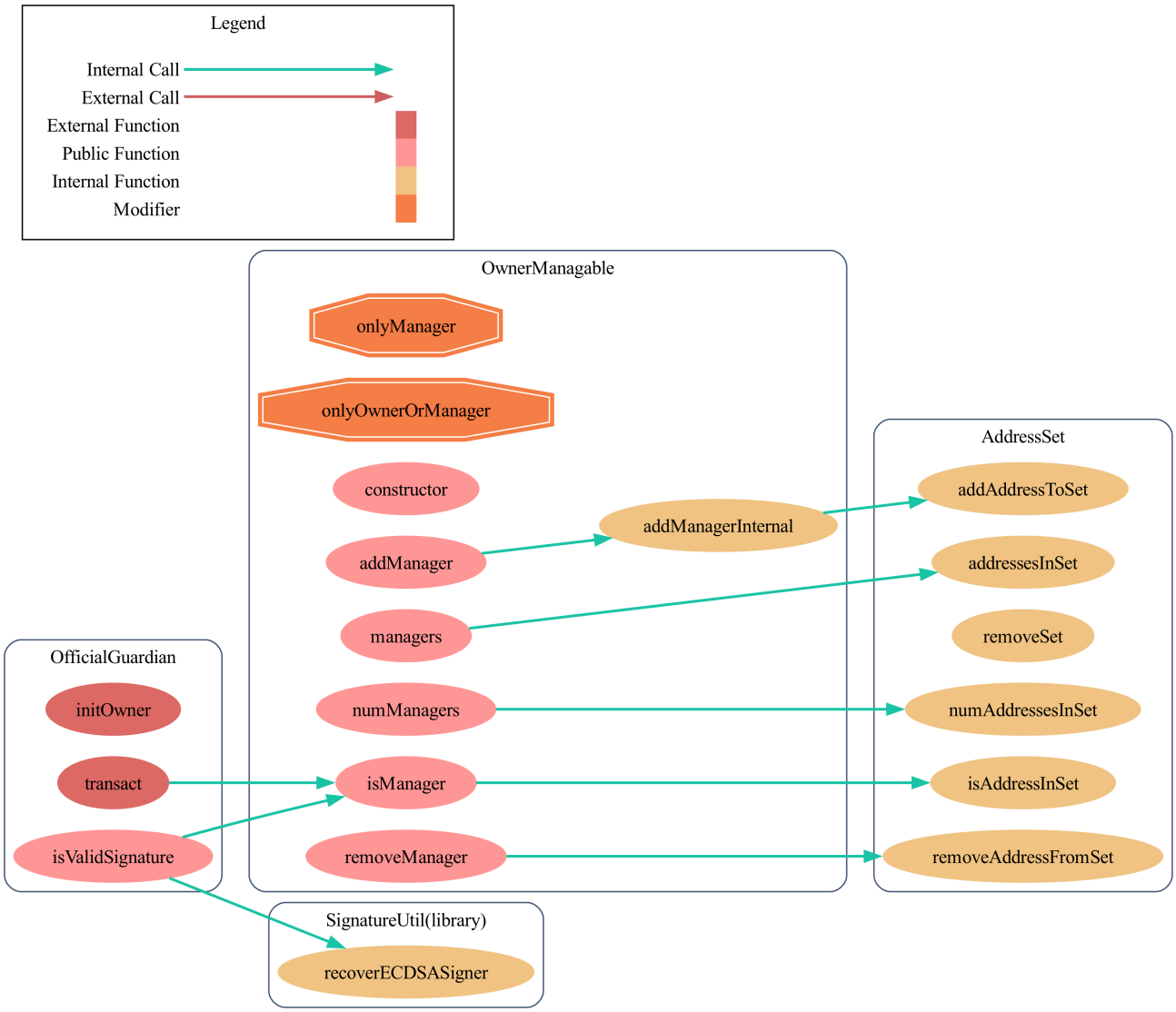
SmartWalletV3



LoopringCreate2Deployer



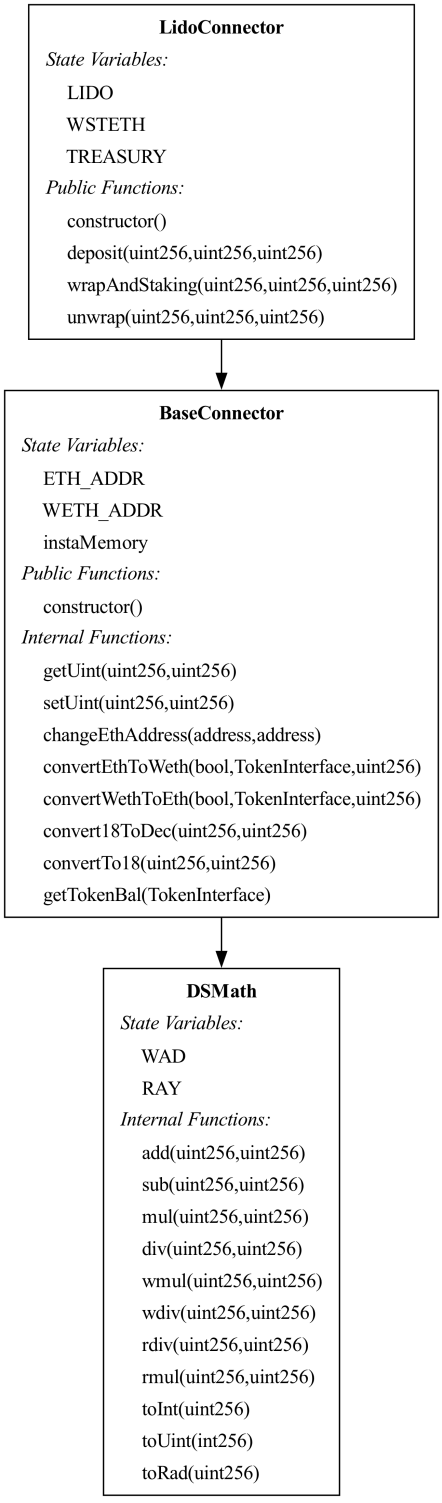
OfficialGuardian



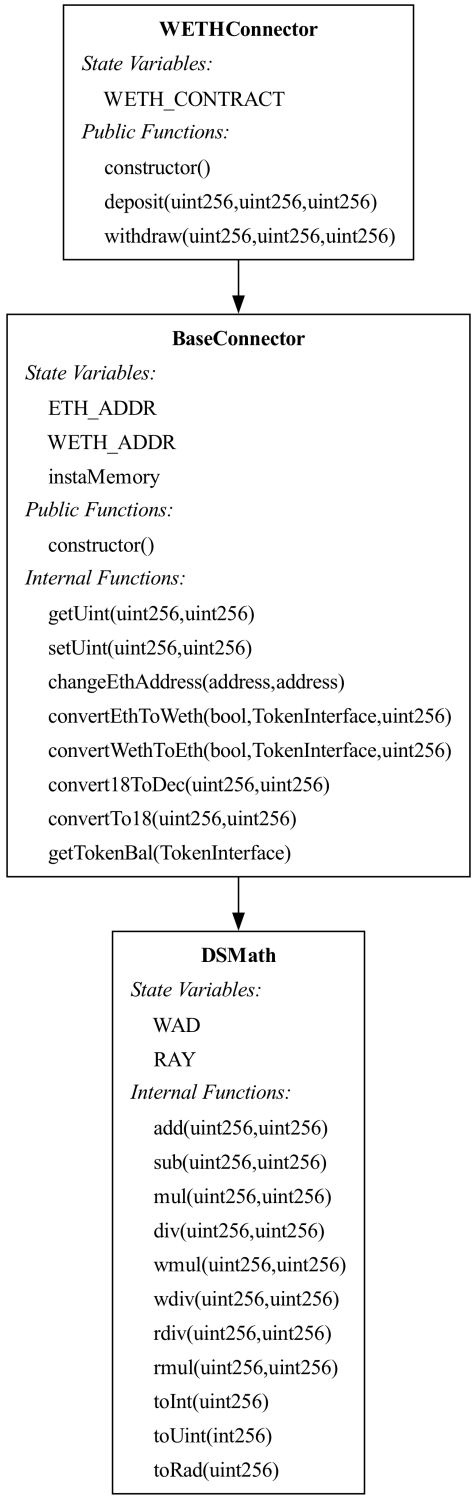
5. Appendix

5.3 Inheritance Graph

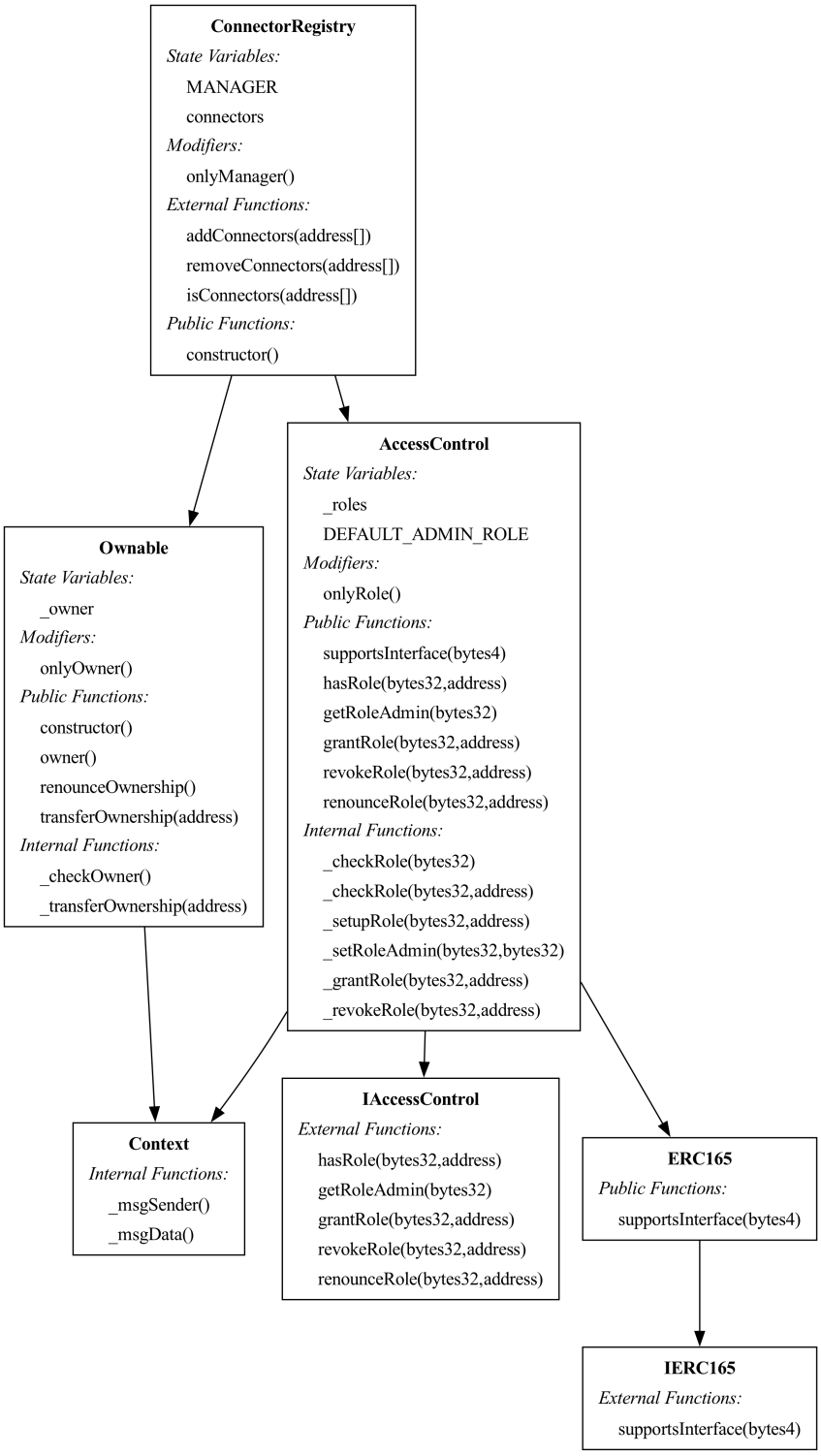
LidoConnector



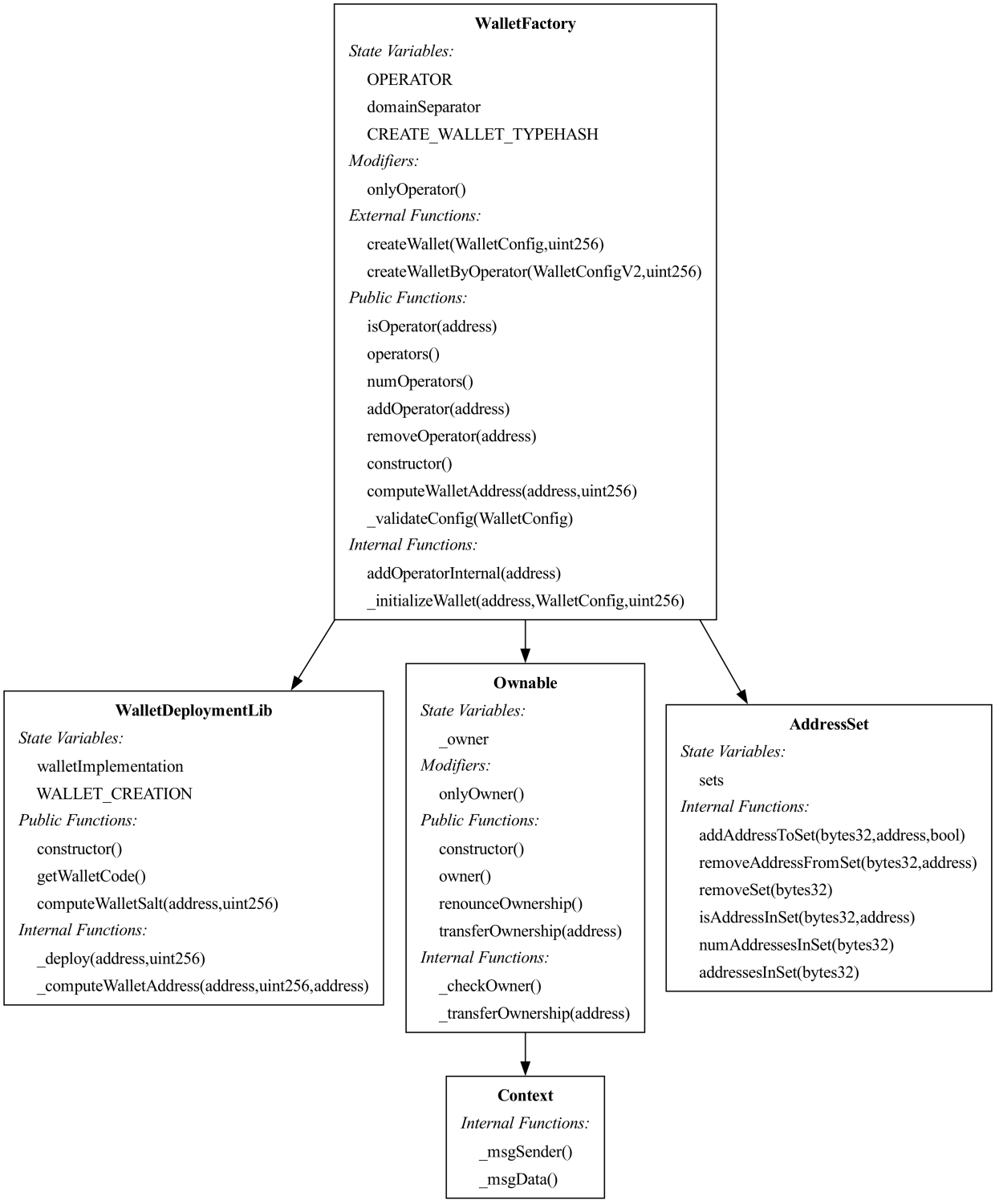
WETHConnector



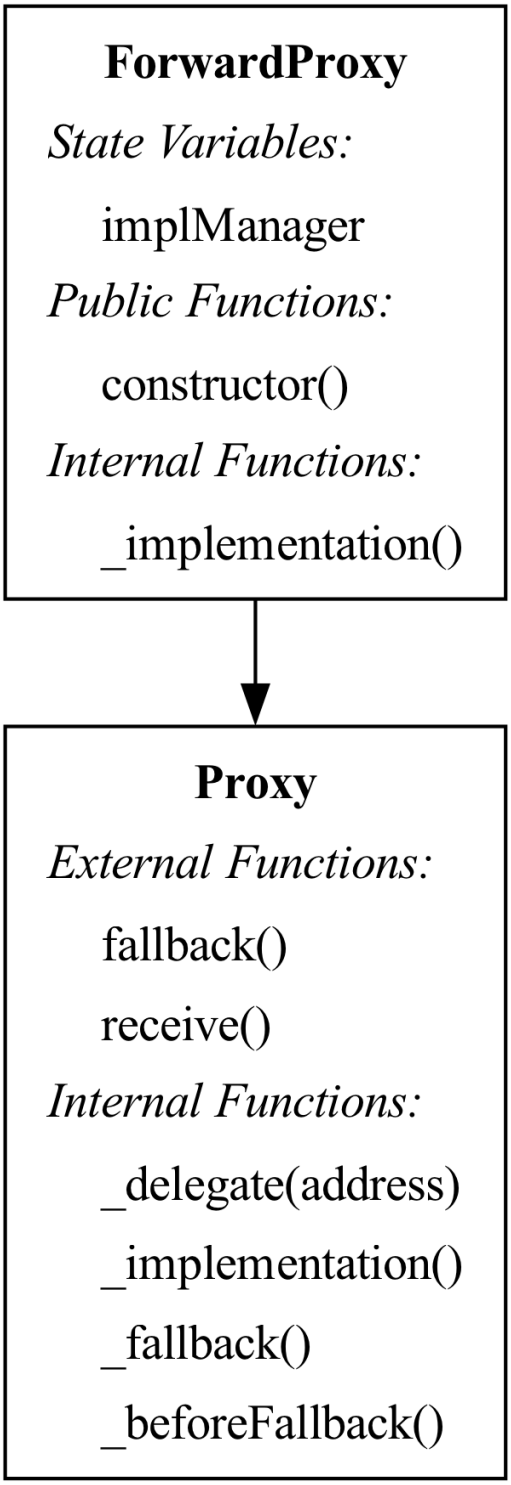
ConnectorRegistry



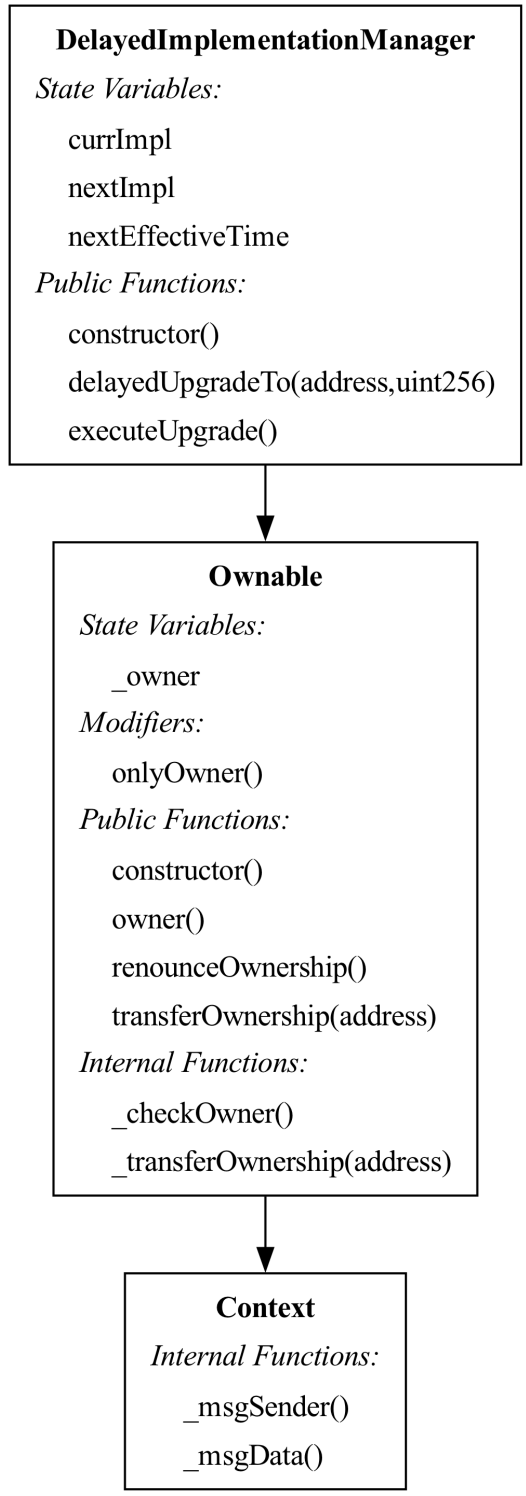
WalletFactory



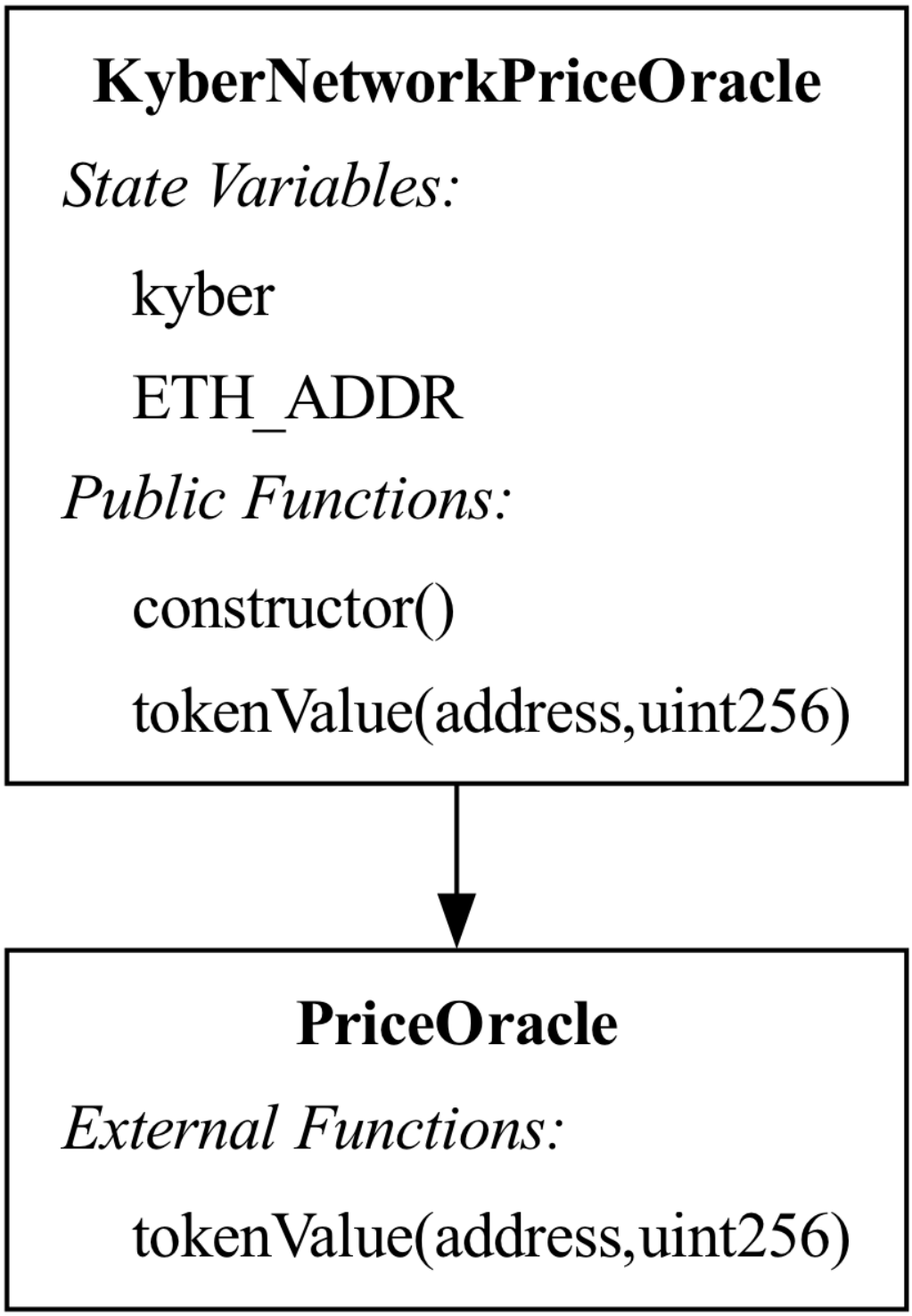
ForwardProxy



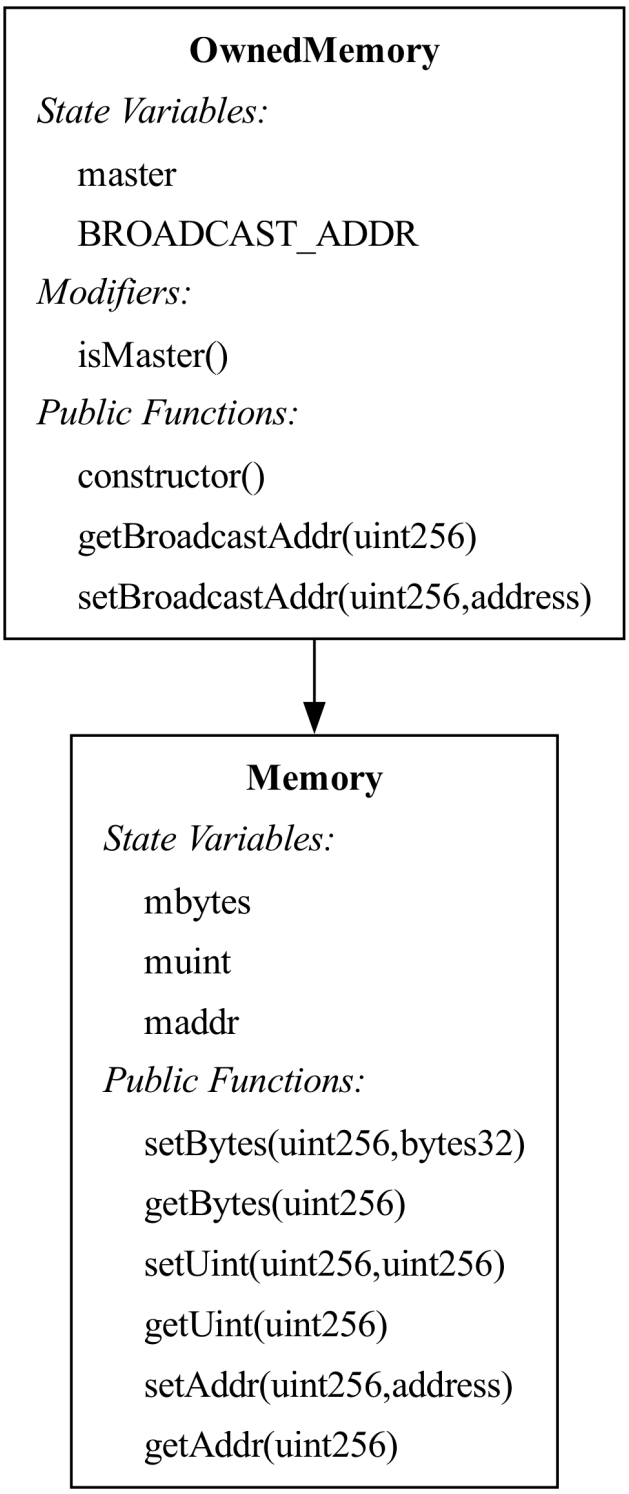
DelayedImplementationManager



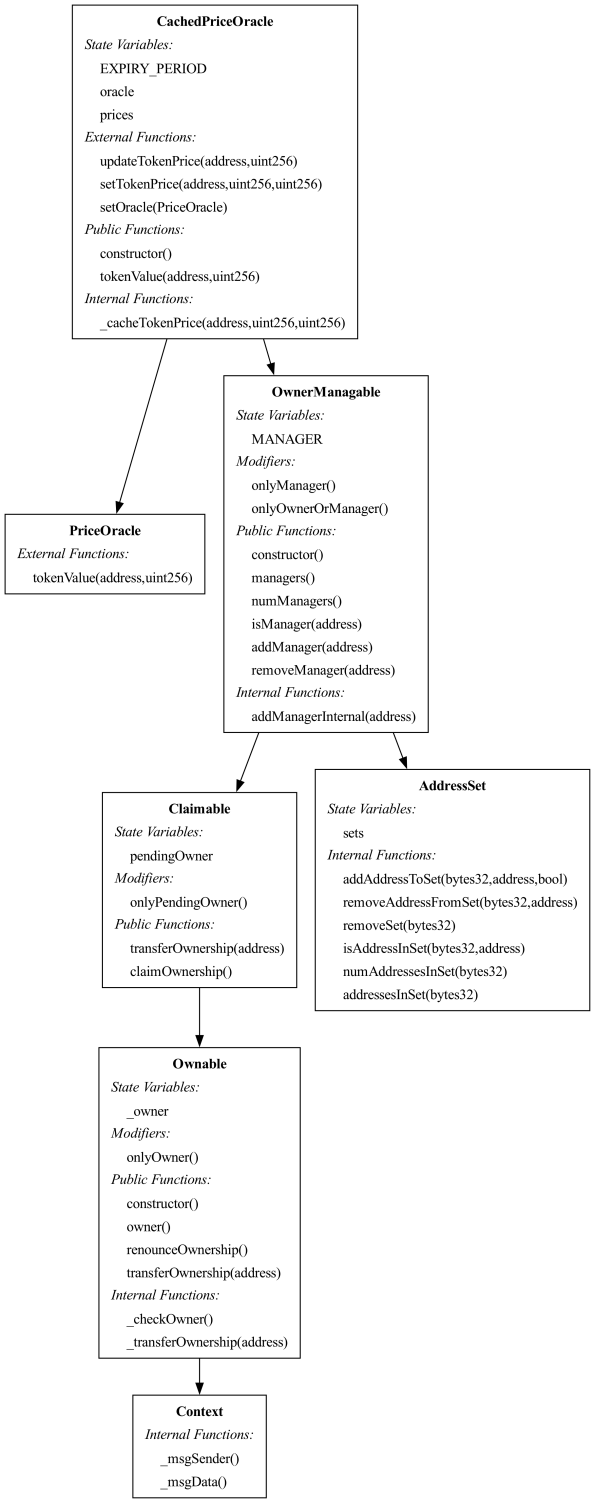
KyberNetworkPriceOracle



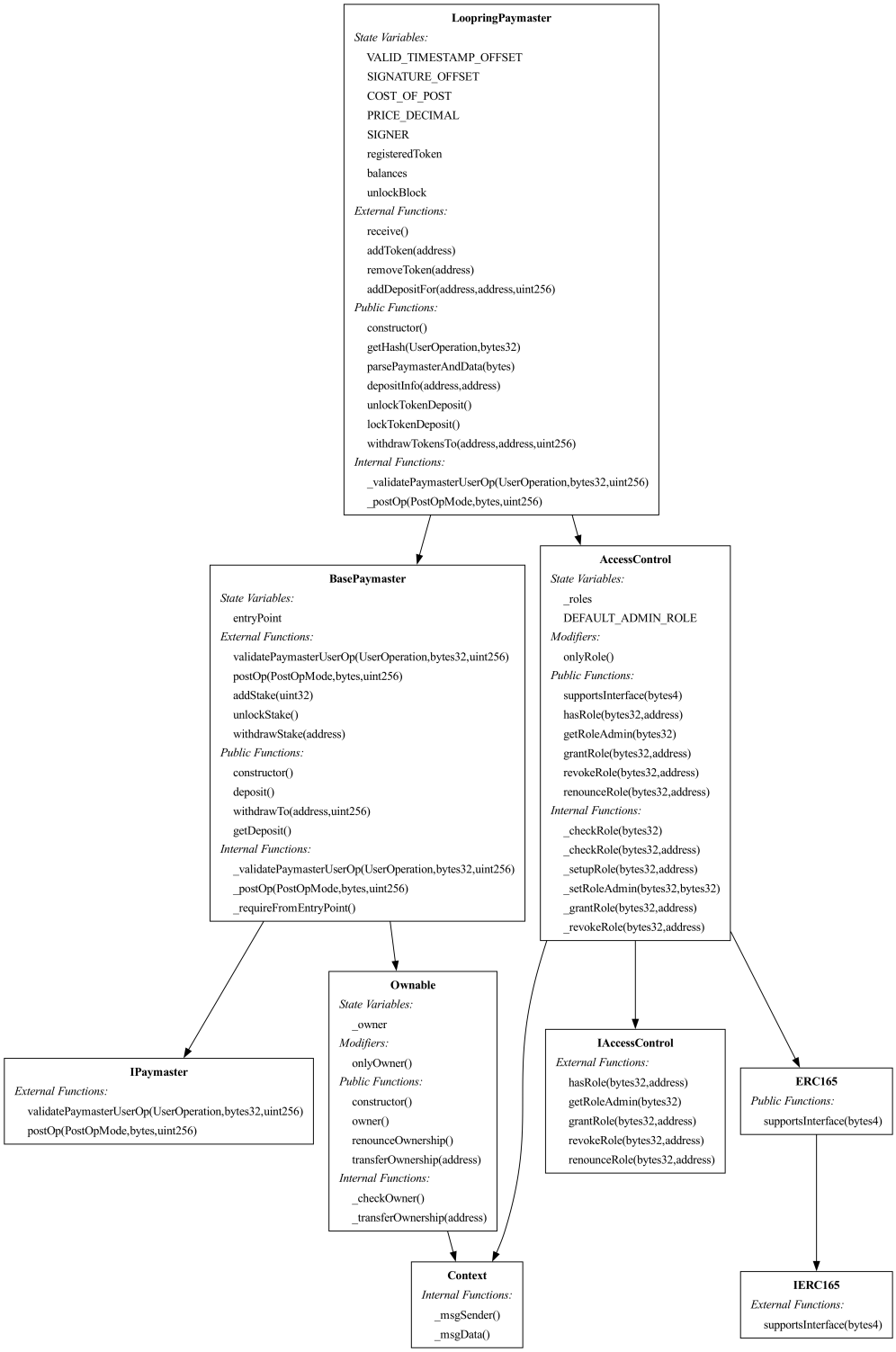
OwnedMemory



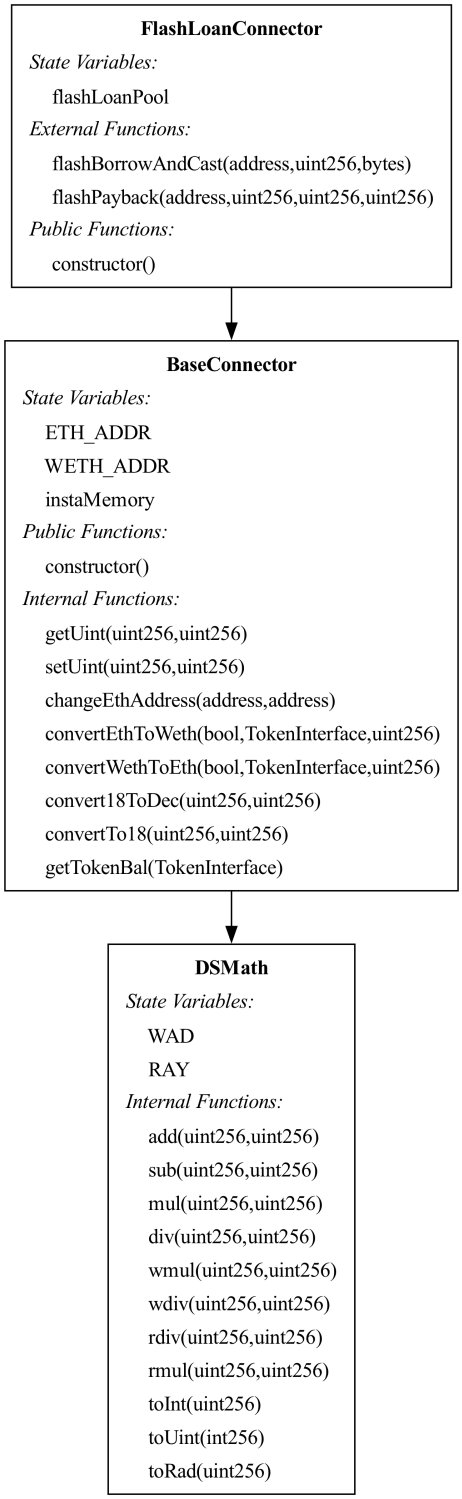
CachedPriceOracle



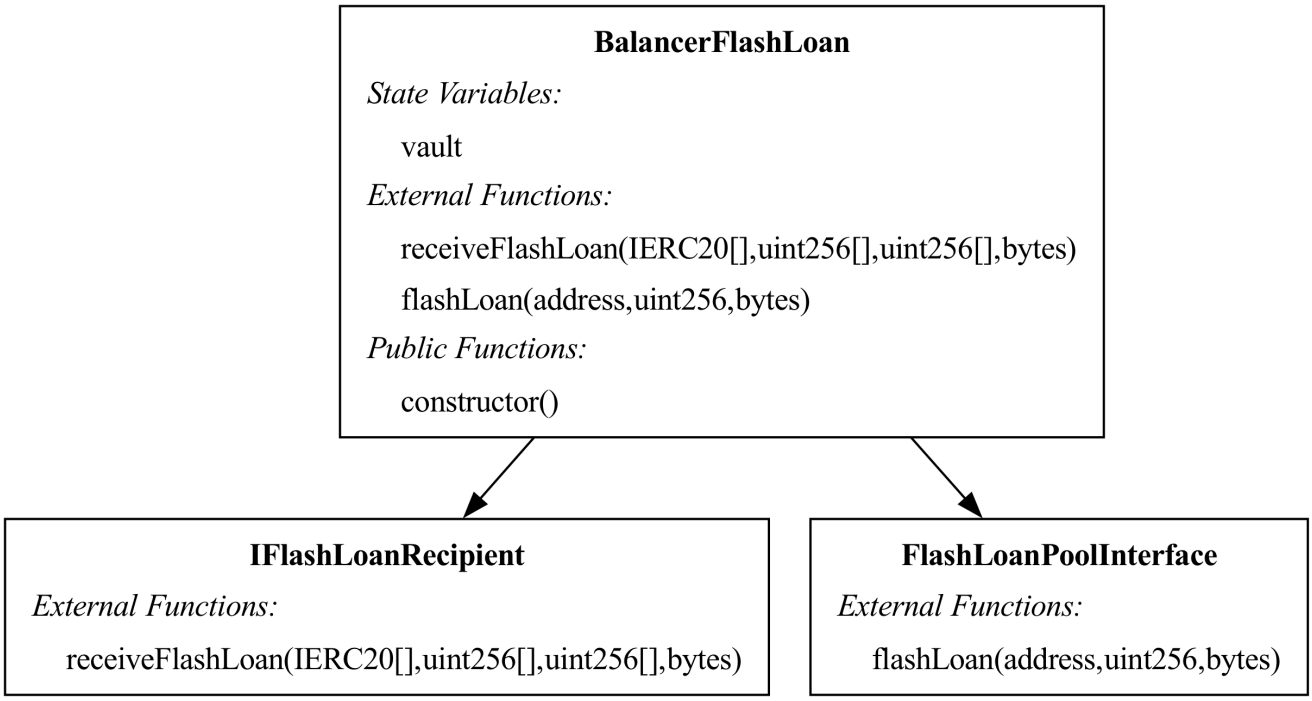
LoopringPaymaster



FlashLoanConnector

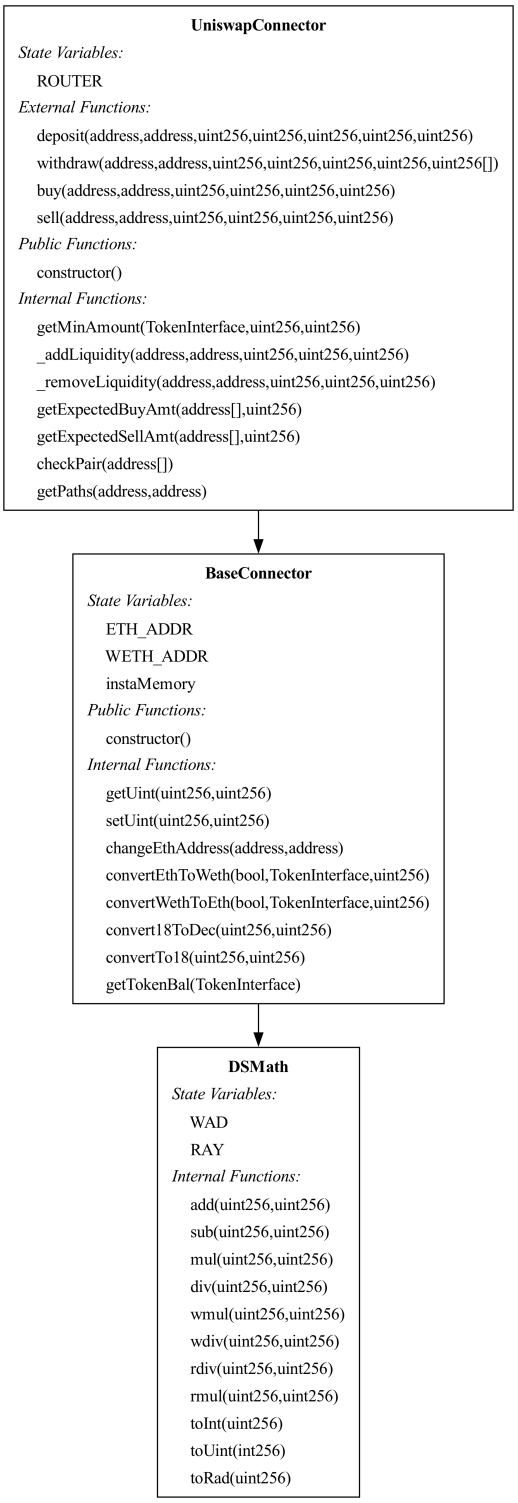


BalancerFlashLoan

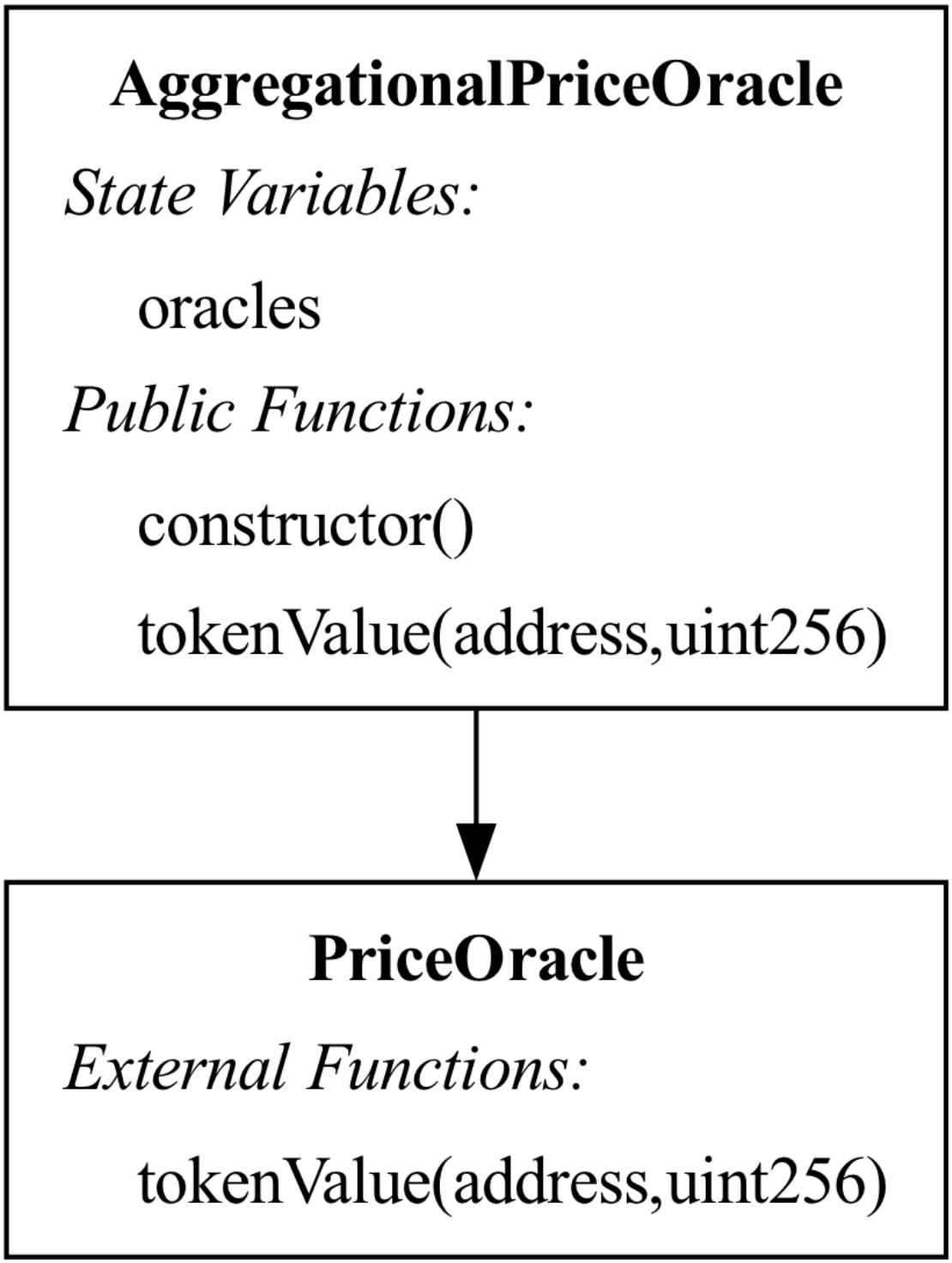


AaveV3Connector

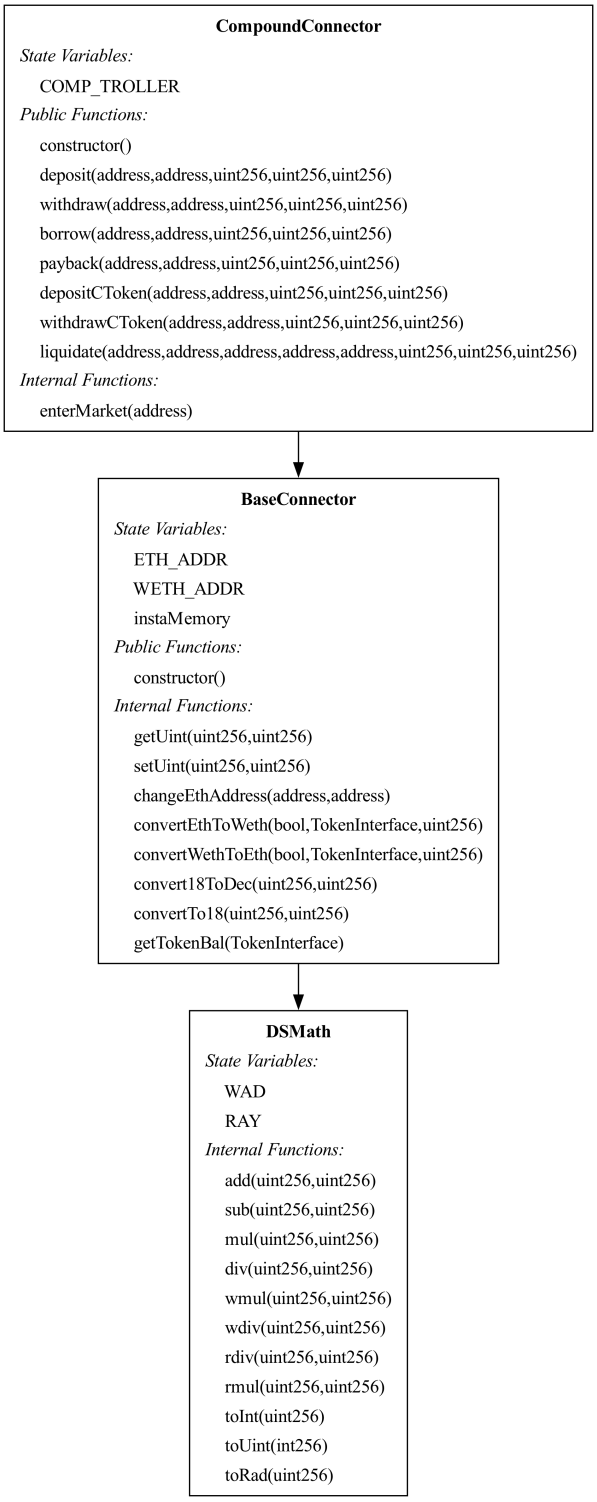
UniswapConnector

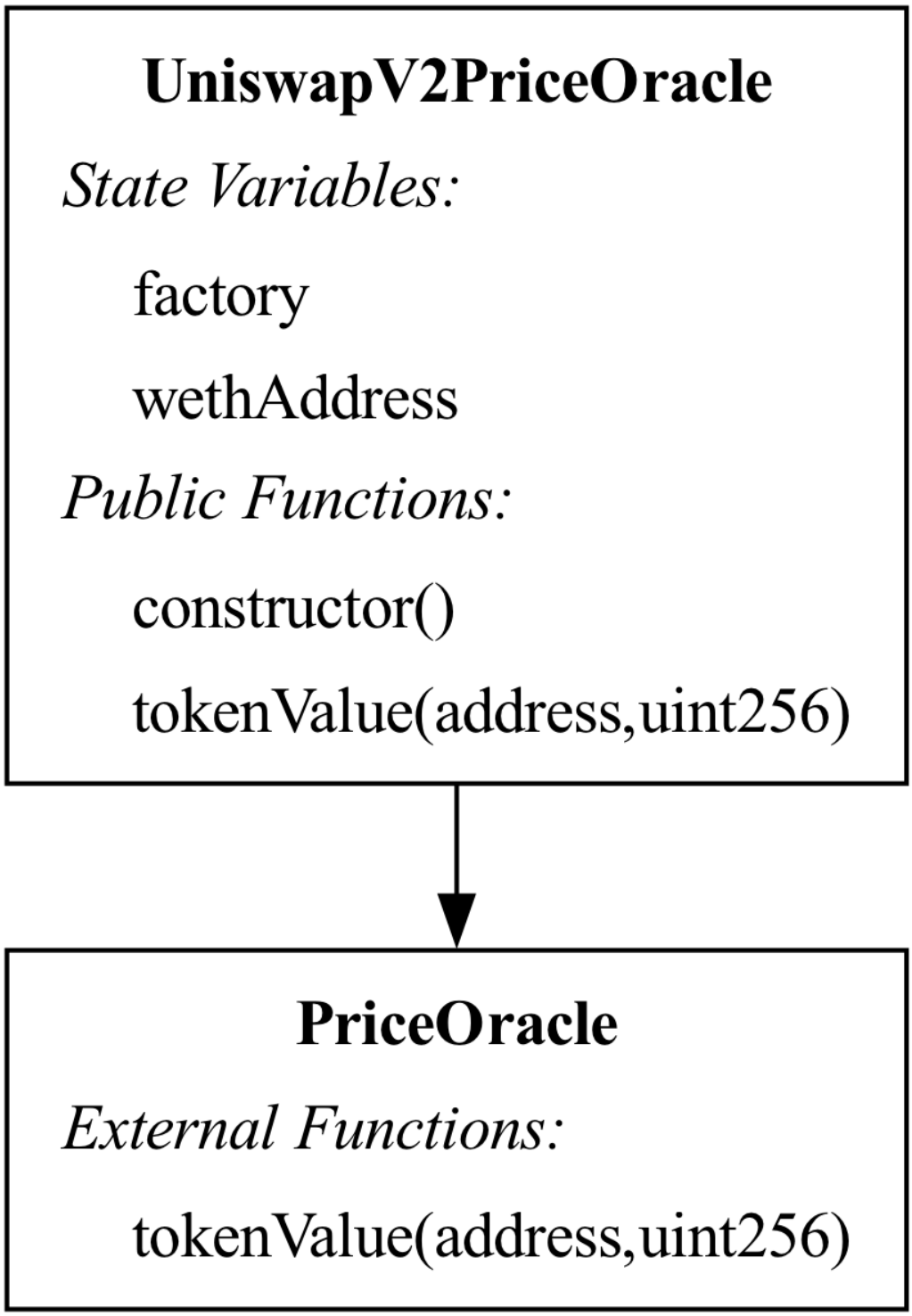


AggregationalPriceOracle

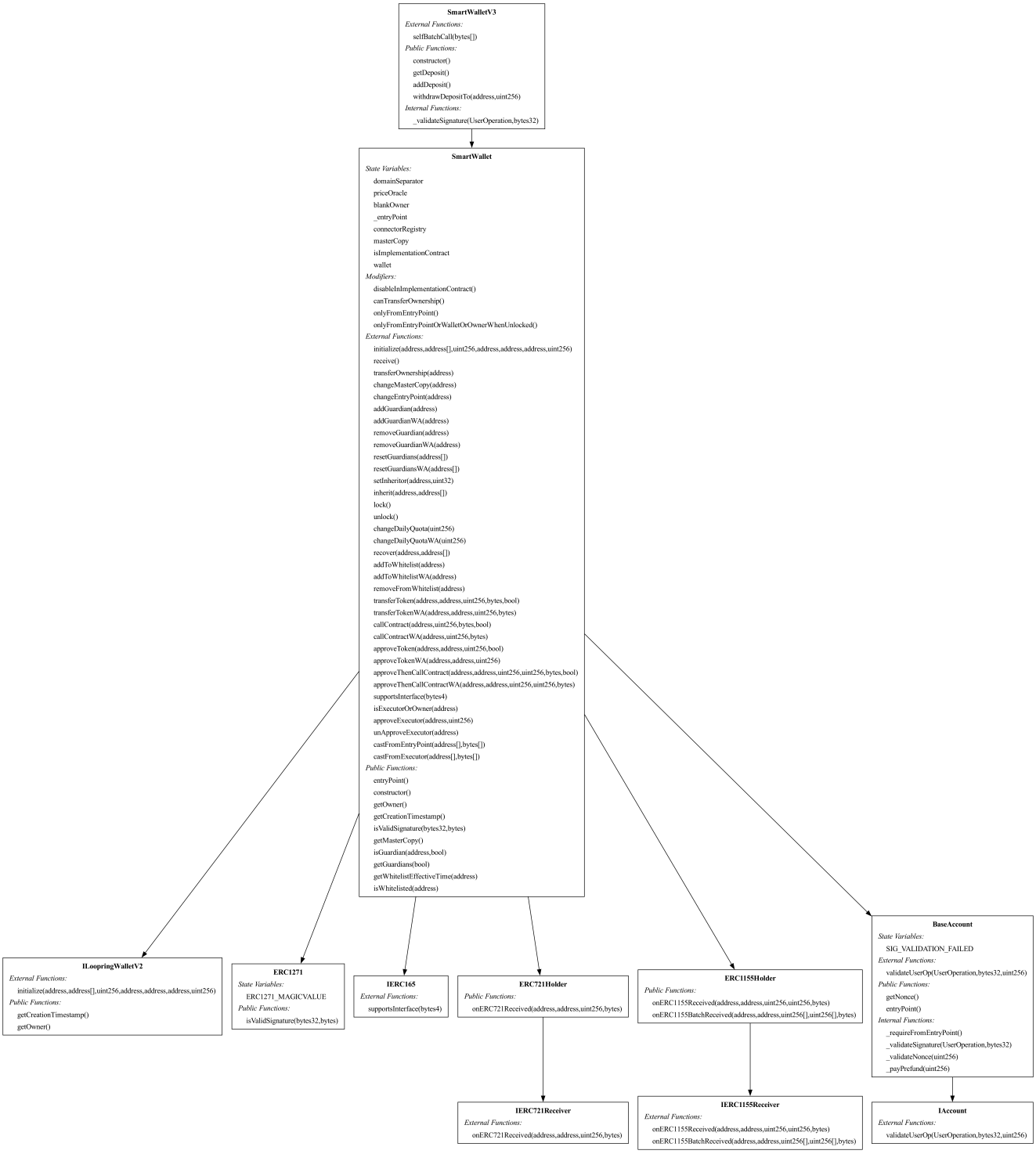


CompoundConnector

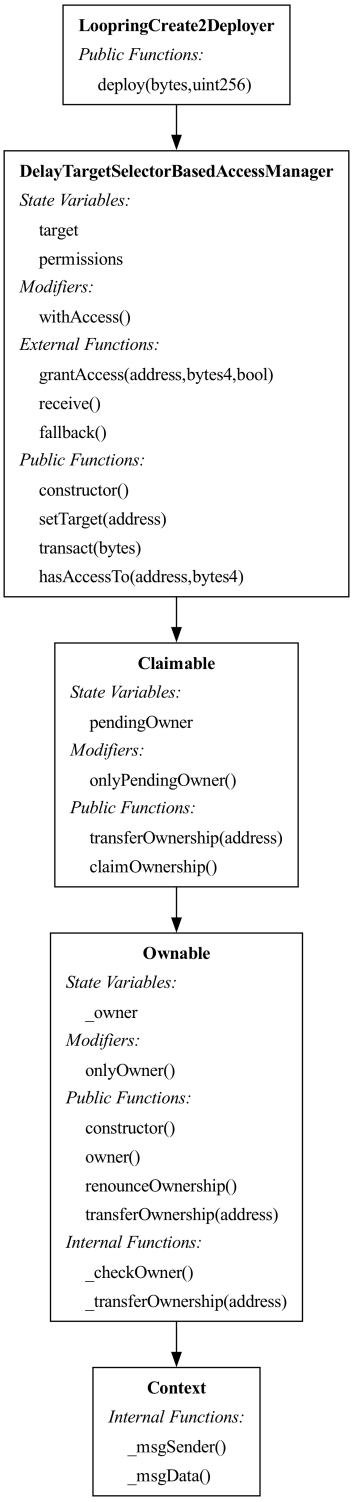



UniswapV2PriceOracle
State Variables:
factory
wethAddress
Public Functions:
constructor()
tokenValue(address,uint256)
PriceOracle
External Functions:
tokenValue(address,uint256)

SmartWalletV3



LoopringCreate2Deployer



OfficialGuardian