// HALBORN

Orion - Liquidity Aggregator

Smart Contract Security Assessment

Prepared by: **Halborn**

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Visit: **Halborn.com**

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EXECUTIVE OVERVIEW

1.1 INTRODUCTION

Orion engaged Halborn to conduct a security assessment on their smart contracts beginning on August 18th, 2023 and ending on October 13th, 2023. The security assessment was scoped to the smart contracts provided to the Halborn team.

1.2 ASSESSMENT SUMMARY

The team at Halborn was provided about two months for the engagement and assigned a full-time security engineer to verify the security of the smart contract. The security engineer is a blockchain and smart-contract security expert with advanced penetration testing, smart-contract hacking, and deep knowledge of multiple blockchain protocols.

The purpose of this assessment is to:

- Ensure that smart contract functions operate as intended.
- Identify potential security issues with the smart contracts.

In summary, Halborn identified some security risks that were addressed and accepted by the Orion team.

1.3 TEST APPROACH & METHODOLOGY

Halborn performed a combination of manual and automated security testing to balance efficiency, timeliness, practicality, and accuracy in regard to the scope of this assessment. While manual testing is recommended to uncover flaws in logic, process, and implementation; automated testing techniques help enhance coverage of the code and can quickly identify items that do not follow the security best practices. The following phases and associated tools were used during the assessment:

- Research into architecture and purpose.
- Smart contract manual code review and walkthrough.
- Graphing out functionality and contract logic/connectivity/functions. (solgraph)
- Manual assessment of use and safety for the critical Solidity variables and functions in scope to identify any arithmetic related vulnerability classes.
- Manual testing by custom scripts.
- Static Analysis of security for scoped contract, and imported functions. (Slither)
- Testnet deployment. (Brownie, Anvil, Foundry)

2. RISK METHODOLOGY

Every vulnerability and issue observed by Halborn is ranked based on **two sets** of **Metrics** and a **Severity Coefficient**. This system is inspired by the industry standard Common Vulnerability Scoring System.

The two **Metric sets** are: **Exploitability** and **Impact**. **Exploitability** captures the ease and technical means by which vulnerabilities can be exploited and **Impact** describes the consequences of a successful exploit.

The **Severity Coefficients** is designed to further refine the accuracy of the ranking with two factors: **Reversibility** and **Scope**. These capture the impact of the vulnerability on the environment as well as the number of users and smart contracts affected.

The final score is a value between 0-10 rounded up to 1 decimal place and 10 corresponding to the highest security risk. This provides an objective and accurate rating of the severity of security vulnerabilities in smart contracts.

The system is designed to assist in identifying and prioritizing vulnerabilities based on their level of risk to address the most critical issues in a timely manner.

2.1 EXPLOITABILITY

Attack Origin (AO):

Captures whether the attack requires compromising a specific account.

Attack Cost (AC):

Captures the cost of exploiting the vulnerability incurred by the attacker relative to sending a single transaction on the relevant blockchain. Includes but is not limited to financial and computational cost.

Attack Complexity (AX):

Describes the conditions beyond the attacker’s control that must exist in order to exploit the vulnerability. Includes but is not limited to macro situation, available third-party liquidity and regulatory challenges.

Metrics:

Exploitability Metric (m_E)	Metric Value	Numerical Value
Attack Origin (AO)	Arbitrary (AO:A) Specific (AO:S)	1 0.2
Attack Cost (AC)	Low (AC:L) Medium (AC:M) High (AC:H)	1 0.67 0.33
Attack Complexity (AX)	Low (AX:L) Medium (AX:M) High (AX:H)	1 0.67 0.33

Exploitability E is calculated using the following formula:

$$E = \prod m_e$$

2.2 IMPACT

Confidentiality (C):

Measures the impact to the confidentiality of the information resources managed by the contract due to a successfully exploited vulnerability. Confidentiality refers to limiting access to authorized users only.

Integrity (I):

Measures the impact to integrity of a successfully exploited vulnerability. Integrity refers to the trustworthiness and veracity of data stored and/or processed on-chain. Integrity impact directly affecting Deposit or Yield records is excluded.

Availability (A):

Measures the impact to the availability of the impacted component resulting from a successfully exploited vulnerability. This metric refers to smart contract features and functionality, not state. Availability impact directly affecting Deposit or Yield is excluded.

Deposit (D):

Measures the impact to the deposits made to the contract by either users or owners.

Yield (Y):

Measures the impact to the yield generated by the contract for either users or owners.

Metrics:

Impact Metric (m_I)	Metric Value	Numerical Value
Confidentiality (C)	None (I:N)	0
	Low (I:L)	0.25
	Medium (I:M)	0.5
	High (I:H)	0.75
	Critical (I:C)	1
Integrity (I)	None (I:N)	0
	Low (I:L)	0.25
	Medium (I:M)	0.5
	High (I:H)	0.75
	Critical (I:C)	1
Availability (A)	None (A:N)	0
	Low (A:L)	0.25
	Medium (A:M)	0.5
	High (A:H)	0.75
	Critical	1
Deposit (D)	None (D:N)	0
	Low (D:L)	0.25
	Medium (D:M)	0.5
	High (D:H)	0.75
	Critical (D:C)	1
Yield (Y)	None (Y:N)	0
	Low (Y:L)	0.25
	Medium: (Y:M)	0.5
	High: (Y:H)	0.75
	Critical (Y:H)	1

Impact I is calculated using the following formula:

$$I = max(m_I) + \frac{\sum m_I - max(m_I)}{4}$$

2.3 SEVERITY COEFFICIENT

Reversibility (R):

Describes the share of the exploited vulnerability effects that can be reversed. For upgradeable contracts, assume the contract private key is available.

Scope (S):

Captures whether a vulnerability in one vulnerable contract impacts resources in other contracts.

Coefficient (C)	Coefficient Value	Numerical Value
Reversibility (r)	None (R:N)	1
	Partial (R:P)	0.5
	Full (R:F)	0.25
Scope (s)	Changed (S:C)	1.25
	Unchanged (S:U)	1

Severity Coefficient C is obtained by the following product:

$$C = rs$$

The Vulnerability Severity Score S is obtained by:

$$S = min(10, EIC * 10)$$

The score is rounded up to 1 decimal places.

Severity	Score Value Range
Critical	9 - 10
High	7 - 8.9
Medium	4.5 - 6.9
Low	2 - 4.4
Informational	0 - 1.9

2.4 SCOPE

IN-SCOPE CODE & COMMITS:

- Repository: orion-exchange-private
  - Commit ID: 45c67b084b957ca9203e397402885aeee1fb09f7
  - Smart contracts **in scope**:
    - All smart contracts under /contracts folder **except** the ones located under /contracts/dexes.

OUT-OF-SCOPE:

- Third-party libraries and dependencies.
- Economic attacks.

REMEDIATION COMMITS:

- Repository: orion-exchange-private
  - Commit IDs:
    - af075b821a966f058bfc5ab1aa8ee70c67953d6d
    - b206e0f56153cd0625dcaebb264066fdbe4993a1

3. ASSESSMENT SUMMARY & FINDINGS OVERVIEW

CRITICAL	HIGH	MEDIUM	LOW	INFORMATIONAL
1	2	1	4	3

SECURITY ANALYSIS	RISK LEVEL	REMEDIATION DATE
(HAL-01) INCORRECT PRICES ARE FETCHED DURING LIQUIDATION	Critical (9.4)	SOLVED - 11/06/2023
(HAL-02) USERS WITH NO ORN STAKED CAN NOT BE LIQUIDATED	High (8.8)	SOLVED - 11/03/2023
(HAL-03) SELF-SIGNED ORDERS CAN BE REUSED IN OTHER CHAINS	High (8.8)	SOLVED - 11/03/2023
(HAL-04) SWAPS COULD SET INACCURATE FILLORDERS	Medium (5.6)	RISK ACCEPTED
(HAL-05) MISSING STALENESS CHECKS IN THE CHAINLINK.LATESTROUNDDATA() CALLS	Low (2.5)	RISK ACCEPTED
(HAL-06) LACK OF DISABLEINITIALIZERS CALL TO PREVENT UNINITIALIZED CONTRACTS	Low (2.5)	RISK ACCEPTED
(HAL-07) HARDCODED DOMAIN SEPARATOR	Low (2.5)	RISK ACCEPTED
(HAL-08) HARDCODED CHAINID	Low (2.5)	RISK ACCEPTED
(HAL-09) SECRET VALUES CAN BE RETRIEVED FROM MEMPOOL	Informational (0.0)	ACKNOWLEDGED
(HAL-10) LACK OF A DOUBLE-STEP TRANSFEROWNERSHIP PATTERN	Informational (0.0)	ACKNOWLEDGED
(HAL-11) USE CUSTOM ERRORS INSTEAD OF REVERT STRINGS TO SAVE GAS	Informational (0.0)	ACKNOWLEDGED

FINDINGS & TECH DETAILS

4.1 (HAL-01) INCORRECT PRICES ARE FETCHED DURING LIQUIDATION - CRITICAL(9.4)

Description:

In the commit af075b821a966f058bfc5ab1aa8ee70c67953d6d, during the remediation plan, some lines of code were added to allow a liquidator to specify the collateral asset that will be used to cover the debt instead of only ORN as it was implemented before these changes. However, when collateralAsset is not the address of ORN token, the code tries to fetch the collateral's price but instead of it, the getAssetPrice function uses as argument the redeemedAsset address. Therefore, both tokens will always have the same price in the following operations.

Code Location:

In the MarginalFunctionality.partiallyLiquidate() function:

Listing 1: MarginalFunctionality.sol (Lines 279,283)

```
279     (uint64 price, uint64 ts1) = getAssetPrice(redeemedAsset,
  ↳ constants._oracleAddress);
280     require(ts1 + constants.priceOverdue > block.timestamp, "E9");
  ↳  //Price is outdated
281
282     if (collateralAsset != constants._orionTokenAddress) { //
283         (uint64 collateralPrice, uint64 ts2) = getAssetPrice(
  ↳ redeemedAsset, constants._oracleAddress);
284         require(ts2 + constants.priceOverdue > block.timestamp, "
  ↳ E9"); //Price is outdated
285         price = (price * 1e8) / collateralPrice;
286     }
```

BVSS:

AO:A/AC:L/AX:L/C:N/I:H/A:N/D:H/Y:N/R:N/S:U (9.4)

Recommendation:

It is recommended to use the collateralAsset argument instead of redeemedAsset to fetch prices of the collateral token.

Remediation Plan:

SOLVED: The Orion team solved the issue by fetching prices from the collateral token instead of the one to redeem in the following commit ID:

- b206e0f56153cd0625dcaebb264066fdbe4993a1.

4.2 (HAL-02) USERS WITH NO ORN STAKED CAN NOT BE LIQUIDATED - HIGH (8.8)

Description:

In the Exchange contract, the function partiallyLiquidate() can be called by any user to cover some of overdue broker liabilities and get ORN in exchange:

Listing 2: Exchange.sol (Line 391)

```
/**
 * @dev method to cover some of overdue broker liabilities and get
    ORN in exchange
         same as liquidation or margin call
 * @param broker - broker which will be liquidated
 * @param redeemedAsset - asset, liability of which will be
   covered
 * @param amount - amount of covered asset
 */
function partiallyLiquidate(address broker, address redeemedAsset,
    uint112 amount) public {
    MarginalFunctionality.UsedConstants memory constants =
   getConstants(broker);
    MarginalFunctionality.partiallyLiquidate(
        collateralAssets,
        liabilities,
        assetBalances,
        assetRisks,
        constants,
        redeemedAsset,
        amount
    );
}
```

This function internally called MarginalFunctionality.partiallyLiquidate():

Listing 3: MarginalFunctionality.sol (Lines 281-289)

```
/**
 * @dev partially liquidate, that is cover some asset liability to
↳ get
        ORN from misbehavior broker
 */
function partiallyLiquidate(
    address[] storage collateralAssets,
    mapping(address => Liability[]) storage liabilities,
    mapping(address => mapping(address => int192)) storage
↳ assetBalances,
    mapping(address => uint8) storage assetRisks,
    UsedConstants memory constants,
    address redeemedAsset,
    uint112 amount
) public {
    //Note: constants.user - is broker who will be liquidated
    Position memory initialPosition = calcPosition(
        collateralAssets,
        liabilities,
        assetBalances,
        assetRisks,
        constants
    );
    require(
        initialPosition.state == PositionState.NEGATIVE ||
↳ initialPosition.state == PositionState.OVERDUE,
        "E7"
    );
    address liquidator = msg.sender;
    require(assetBalances[liquidator][redeemedAsset] >= int192(
↳ uint192(amount)), "E8");
    require(assetBalances[constants.user][redeemedAsset] < 0, "E15
↳ ");
    assetBalances[liquidator][redeemedAsset] -= int192(uint192(
↳ amount));
    assetBalances[constants.user][redeemedAsset] += int192(uint192
↳ (amount));

    if (assetBalances[constants.user][redeemedAsset] >= 0)
        removeLiability(constants.user, redeemedAsset, liabilities
↳ );

    (uint64 price, uint64 timestamp) = getAssetPrice(redeemedAsset
, constants._oracleAddress);
    require((timestamp + constants.priceOverdue) > block.timestamp, "E9"); //Price is outdated

    reimburseLiquidator(
        amount,
        price,
        liquidator,
        assetBalances,
        constants.liquidationPremium,
        constants.user,
        constants._orionTokenAddress
    );

    Position memory finalPosition = calcPosition(
        collateralAssets,
        liabilities,
        assetBalances,
        assetRisks,
        constants
    );
    require(
        uint(finalPosition.state) < 3 && //POSITIVE,NEGATIVE or OVERDUE
            (finalPosition.weightedPosition > initialPosition.weightedPosition),
        "E10"
    ); //Incorrect state position after liquidation
    if (finalPosition.state == PositionState.POSITIVE)
        require(finalPosition.weightedPosition < 10e8, "Can not liquidate to very positive state");
}
```

The liquidator is rewarded with ORN. This functionality is implemented in the reimburseLiquidator() function:

Listing 4: MarginalFunctionality.sol (Lines 325-327)

```
307 /**
308  * @dev reimburse liquidator with ORN: first from stake, than from broker balance
309  */
310 function reimburseLiquidator(
311     uint112 amount,
312     uint64 price,
313     address liquidator,
314     mapping(address => mapping(address => int192)) storage assetBalances,
315     uint8 liquidationPremium,
316     address user,
317     address orionTokenAddress
318 ) internal {
319     int192 _orionAmount = int192((int256(uint256(amount)) * int256(uint256(price))) / 1e8);
320     _orionAmount += uint8Percent(_orionAmount, liquidationPremium); //Liquidation premium
321     // There is only 100m Orion tokens, fits i64
322     require(_orionAmount == int64(_orionAmount), "E11");
323     int192 onBalanceOrion = assetBalances[user][orionTokenAddress];
324
325     require(onBalanceOrion >= _orionAmount, "E10");
326     assetBalances[user][orionTokenAddress] -= _orionAmount;
327     assetBalances[liquidator][orionTokenAddress] += _orionAmount;
328 }
```

Although, if the user being liquidated does not have any ORN in his balances, his position can never be liquidated.

BVSS:

AO:A/AC:L/AX:L/C:N/I:H/A:N/D:M/Y:N/R:N/S:U (8.8)

Recommendation:

It is recommended to update the partiallyLiquidate() implementation, so users cannot avoid liquidation in this scenario.

Remediation Plan:

SOLVED: The Orion team solved the issue by letting users choose which collateral asset to use for his liquidation reward in the following commit IDs:

- af075b821a966f058bfc5ab1aa8ee70c67953d6d.
- b206e0f56153cd0625dcaebb264066fdbe4993a1.

4.3 (HAL-03) SELF-SIGNED ORDERS CAN BE REUSED IN OTHER CHAINS - HIGH (8.8)

Description:

The buy/sell orders are implemented with the following struct:

Listing 5: LibValidator.sol (Line 35)

```
struct Order {
    address senderAddress;
    address matcherAddress;
    address baseAsset;
    address quoteAsset;
    address matcherFeeAsset;
    uint64 amount;
    uint64 price;
    uint64 matcherFee;
    uint64 nonce;
    uint64 expiration;
    uint8 buySide; // buy or sell
    bool isPersonalSign;
    bytes signature;
}
```

These buy/sell orders can be self-signed if isPersonalSign is set to true. As such, the sender will have to provide a signature which is built as:

Listing 6: LibValidator.sol

```
function getEthSignedOrderHash(Order memory _order) public pure
↳ returns (bytes32) {
    return
        keccak256(
            abi.encodePacked(
                "order",
                _order.senderAddress,
                _order.matcherAddress,
                _order.baseAsset,
                        _order.quoteAsset,
                        _order.matcherFeeAsset,
                        _order.amount,
                        _order.price,
                        _order.matcherFee,
                        _order.nonce,
                        _order.expiration,
                        _order.buySide
                    )
            ).toEthSignedMessageHash();
}
```

chain.id and as the Orion protocol is supposed to be deployed in multiple chains, this signature could be used to perform a cross-chain signature replay attack. For example:

1. Alice creates a personal signed order to buy 1000 DAI on the Ethereum mainnet.
2. This signature is replayed by a malicious user to send an order on behalf of Alice in the Arbitrum blockchain.

BVSS:

AO:A/AC:L/AX:L/C:N/I:H/A:N/D:M/Y:N/R:N/S:U (8.8)

Recommendation:

It is recommended to include a domain separator with a chain.id to the getEthSignedOrderHash() function in order to prevent signature replay attacks.

Remediation Plan:

SOLVED: The Orion team solved the issue by removing self-signed orders in the following commit ID:

- af075b821a966f058bfc5ab1aa8ee70c67953d6d.

4.4 (HAL-04) SWAPS COULD SET INACCURATE FILLORDERS - MEDIUM (5.6)

Description:

Every time an order is modified or filled, the filledAmounts mapping must be modified according to the amount of assets that will be covered regarding an order. The updateFilledAmount function is responsible for updating this mapping to track the current amount of assets already filled in an existing order.

However, there is a case where this mapping is not being updated accordingly. Since a swap can return an undetermined amount of tokens, the fillThroughPools function updates the filledAmounts mapping right before the swap is performed, taking as reference for the amount of tokens to fill to the desc.minReturnAmount variable used as slippage. Therefore, the protocol won't be able to track the correct amount of tokens filled in case more tokens are returned after the swap's execution.

Code location:

Listing 7: contracts/ExchangeWithGenericSwap.sol (Lines 50,55)

```
49 LibValidator.checkOrderSingleMatch(order, desc, filledAmount,
   ↳ block.timestamp);
50 updateFilledAmount(order, filledAmount);
51 // stack to deep
52 {
53     address senderAddress = order.senderAddress;
54     uint256 matcherFee = order.matcherFee;
55     (returnAmount, spentAmount, gasLeft) = _swap(senderAddress,
   ↳ executor, desc, permit, data, matcherFee);
56 }
57 LibExchange._updateBalance(order.matcherAddress, order.
   ↳ matcherFeeAsset, int(uint(order.matcherFee)), assetBalances,
   ↳ liabilities);
```

Listing 8: contracts/libs/LibValidator.sol (Line 180)

```
        uint256 amountQuote = uint256(filledAmount) * order.price /
    ↳ 10**8;
if (order.buySide == 1) {
    require(order.quoteAsset == address(desc.srcToken) && order.
    ↳ baseAsset == address(desc.dstToken), "E3As");
            (amount_spend, amount_receive) = (amountQuote,
    ↳ filledAmount);
} else {
    require(order.baseAsset == address(desc.srcToken) && order.
    ↳ quoteAsset == address(desc.dstToken), "E3As");
            (amount_spend, amount_receive) = (filledAmount,
    ↳ amountQuote);
}

        require(order.senderAddress == desc.dstReceiver, "
    ↳ IncorrectReceiver");
        require(amount_spend == desc.amount, "IncorrectAmount");
        require(order.matcherFeeAsset == address(desc.dstToken), "
    ↳ IncorrectFeeToken");
        require(amount_receive >= desc.minReturnAmount, "
    ↳ IncorrectAmount");
```

BVSS:

AO:A/AC:L/AX:L/C:N/I:N/A:L/D:M/Y:N/R:N/S:U (5.6)

Recommendation:

It is recommended to update the filledAmounts mapping with the amount obtained from swapping assets. For example, the following LOC could be added right after the swap:

Listing 9

```
updateFilledAmount(order, returnAmount - filledAmount);
```

Remediation Plan:

RISK ACCEPTED: The Orion team accepted the risk of this issue and stated that:

> This situation occurs when a trader creates a buy order that is filled through decentralized exchanges (dexes). Some dexes may not be able to execute exact receive trades, leading to the transformation of the trader's buyOrder into a sellOrder. While this approach may result in a final filledAmount greater than the initial order.amount, we prioritize ensuring that the trade's price is always better or at least equal to what the user initially signed in their order. We understand that there may be a slight discrepancy in the stored filledAmount value due to this process, but we maintain the commitment to ensuring that the settlement price is not worse than what the user expected.

4.5 (HAL-05) MISSING STALENESS CHECKS IN THE CHAINLINK.LATESTROUNDDATA() CALLS - LOW (2.5)

Description:

In the PriceOracle contract, the latestRoundData() function of Chainlink price feeds is called to retrieve the price of different assets.

Although, this call is performed without any kind of staleness checks. If there is a problem with Chainlink starting a new round and finding consensus on the new value for the oracle (e.g. Chainlink nodes abandoning the oracle, chain congestion, vulnerability/attacks on the Chainlink system) consumers of these contracts may continue using obsolete data.

Code location:

PriceOracle.sol
- Line 176:
```
(, int _basePrice, , uint timestamp, )= AggregatorV3Interface(
baseAggregator).latestRoundData();
```
- Line 198:
```
(, int _aPrice, , uint aTimestamp, )= AggregatorV3Interface(
currentAggregator).latestRoundData();
```

BVSS:

AO:A/AC:L/AX:L/C:N/I:L/A:N/D:N/Y:N/R:N/S:U (2.5)

Recommendation:

It is recommended to use Chainlink's latestRoundData() function with checks on the return data with proper revert messages if the price is stale or the round is incomplete, for example:

Listing 10: latestRoundData example call (Line 2)

```
1 uint256 private constant GRACE_PERIOD_TIME = 7200; // 2 hours
2 (uint80 roundId, int256 price, uint256 startedAt, uint256
↳ updatedAt, uint80 answeredInRound) = AggregatorV3Interface(
↳ baseAggregator).latestRoundData();;
3 require(answeredInRound >= roundID, "Stale price");
4 require(price > 0, "invalid price");
5 require(block.timestamp <= updatedAt + GRACE_PERIOD_TIME, "Stale
↳ price");
```

If in the case that we are dealing with Price Feeds in Arbitrum, the sequencer state should be validated, ensuring that is up before accepting any price as valid.

Remediation Plan:

RISK ACCEPTED: The Orion team accepted the risk of this issue.

4.6 (HAL-06) LACK OF DISABLEINITIALIZERS CALL TO PREVENT UNINITIALIZED CONTRACTS - LOW (2.5)

Description:

The Exchange contract uses the Initializable module from OpenZeppelin. In order to prevent leaving the contract uninitialized OpenZeppelin's documentation recommends adding the _disableInitializers function in the constructor to automatically lock the contract when it is deployed:

Listing 11: DisableInitializers function

```
/**
 * @dev Locks the contract, preventing any future reinitialization
↳ . This cannot be part of an initializer call.
 * Calling this in the constructor of a contract will prevent that
↳  contract from being initialized or reinitialized
 * to any version. It is recommended to use this to lock
↳ implementation contracts that are designed to be called
 * through proxies.
 */
function _disableInitializers() internal virtual {
    require(!_initializing, "Initializable: contract is
↳ initializing");
    if (_initialized < type(uint8).max) {
        _initialized = type(uint8).max;
        emit Initialized(type(uint8).max);
    }
}
```

BVSS:

AO:A/AC:L/AX:L/C:N/I:L/A:N/D:N/Y:N/R:N/S:U (2.5)

Recommendation:

Consider calling the _disableInitializers function in the Exchange contract's constructor:

Listing 12: Constructor preventing uninitialized contracts

```
/// @custom:oz-upgrades-unsafe-allow constructor
constructor() {
    _disableInitializers();
}
```

Remediation Plan:

RISK ACCEPTED: The Orion team accepted the risk of this issue.

4.7 (HAL-07) HARDCODED DOMAIN SEPARATOR - LOW (2.5)

Description:

The variable DOMAIN_SEPARATOR in the LibValidator library is defined as a constant and will not change after the contract deployment. However, if a hard fork happens, the DOMAIN_SEPARATOR would become invalid on one of the forked chains as the block.chainid would have changed.

Listing 13: LibValidator.sol

```
bytes32 public constant DOMAIN_SEPARATOR =
    keccak256(
        abi.encode(
            EIP712_DOMAIN_TYPEHASH,
            keccak256(bytes(DOMAIN_NAME)),
            keccak256(bytes(DOMAIN_VERSION)),
            CHAIN_ID,
            DOMAIN_SALT
        )
    );
```

BVSS:

AO:A/AC:L/AX:L/C:N/I:L/A:N/D:N/Y:N/R:N/S:U (2.5)

Recommendation:

Consider using the implementation from OpenZeppelin, which recalculates the domain separator if the current block.chainid is not the cached chain ID.

Remediation Plan:

RISK ACCEPTED: The Orion team accepted the risk of this issue.

4.8 (HAL-08) HARDCODED CHAINID - LOW (2.5)

Description:

The variable CHAIN_ID in the LibValidator library is defined as a constant and hardcoded to 1.

Listing 14: LibValidator.sol

```
uint256 public constant CHAIN_ID = 1;
```

BVSS:

AO:A/AC:L/AX:L/C:N/I:L/A:N/D:N/Y:N/R:N/S:U (2.5)

Recommendation:

It is recommended to use chain.id to set the CHAIN_ID state variable. This can be done in the constructor during the contract deployment.

Remediation Plan:

RISK ACCEPTED: The Orion team accepted the risk of this issue.

4.9 (HAL-09) SECRET VALUES CAN BE RETRIEVED FROM MEMPOOL - INFORMATIONAL (0.0)

Description:

The ExchangeWithAtomic smart contract allows users to perform operations over different orders, locking them as atomic. These atomic orders require a hash associated to a secret that only the user who locks the order knows. This secret should be provided when the user wants to perform any of the available atomic operations.

However, since the secret is revealed when a function is executed over the locked order, during a period of time the secret remains readable for every user who is watching the mempool which receives the associated transaction. Therefore, these atomic operations do not give any kind of defense against front-run attacks, for example.

Code location:

Listing 15: contracts/libs/LibAtomic.sol (Lines 82,90,91)

```
80 function doRedeemAtomic(
81     LibAtomic.RedeemOrder calldata order,
82     bytes calldata secret,
83     mapping(bytes32 => bool) storage secrets,
84     mapping(address => mapping(address => int192)) storage
   ↳ assetBalances,
85     mapping(address => MarginalFunctionality.Liability[]) storage
   ↳ liabilities
86 ) public {
87     require(!secrets[order.secretHash], "E17R");
88     require(getEthSignedAtomicOrderHash(order).recover(order.
   ↳ signature) == order.sender, "E2");
89     require(order.expiration / 1000 >= block.timestamp, "E4A");
90     require(order.secretHash == keccak256(secret), "E17");
91     secrets[order.secretHash] = true;
```

Listing 16: contracts/libs/LibAtomic.sol (Lines 100,108,109)

```
 98 function doClaimAtomic(
 99     address receiver,
100     bytes calldata secret,
101     bytes calldata matcherSignature,
102     address allowedMatcher,
103     mapping(bytes32 => LockInfo) storage atomicSwaps,
104     mapping(address => mapping(address => int192)) storage
  ↳ assetBalances,
105     mapping(address => MarginalFunctionality.Liability[]) storage
  ↳ liabilities
106 ) public returns (LockInfo storage swap) {
107     bytes32 secretHash = keccak256(secret);
108     bytes32 coHash = getEthSignedClaimOrderHash(ClaimOrder(
  ↳ receiver, secretHash));
109     require(coHash.recover(matcherSignature) == allowedMatcher, "
  ↳ E2");
110
```

BVSS:

AO:A/AC:L/AX:L/C:N/I:N/A:N/D:N/Y:N/R:F/S:C (0.0)

Recommendation:

It is not recommended to use this kind of mechanism to prevent of front-run attacks since, as it was explained, secret values can be retrieved from mempools.

Remediation Plan:

ACKNOWLEDGED: The Orion team acknowledged the risk of this issue.

4.10 (HAL-10) LACK OF A DOUBLE-STEP TRANSFEROWNERSHIP PATTERN - INFORMATIONAL (0.0)

Description:

The current ownership transfer process for all the contracts inheriting from Ownable or OwnableUpgradeable involves the current owner calling the transferOwnership() function:

Listing 17: Ownable.sol

```
function transferOwnership(address newOwner) public virtual
↳ onlyOwner {
    require(newOwner != address(0), "Ownable: new owner is the
↳ zero address");
    _setOwner(newOwner);
}
```

If the nominated EOA account is not a valid account, it is entirely possible that the owner may accidentally transfer ownership to an uncontrolled account, losing the access to all functions with the onlyOwner modifier.

Code Location:

Contracts using the Ownable/OwnableUpgradeable library

- PriceOracle

BVSS:

AO:A/AC:L/AX:L/C:N/I:N/A:N/D:N/Y:N/R:F/S:C (0.0)

Recommendation:

It is recommended to implement a two-step process where the owner nominates an account and the nominated account needs to call an acceptOwnership() function for the transfer of the ownership to fully succeed. This ensures the nominated EOA account is a valid and active account. This can be easily achieved by using OpenZeppelin's Ownable2Step contract instead of Ownable:

Listing 18: Ownable2Step.sol (Lines 52-56)

```
// SPDX-License-Identifier: MIT
// OpenZeppelin Contracts (last updated v4.8.0) (access/
↳ Ownable2Step.sol)

pragma solidity ^0.8.0;

import "./Ownable.sol";

/**
 * @dev Contract module which provides access control mechanism,
↳ where
 * there is an account (an owner) that can be granted exclusive
↳ access to
 * specific functions.
 *
 * By default, the owner account will be the one that deploys the
↳ contract. This
 * can later be changed with {transferOwnership} and {
↳ acceptOwnership}.
 *
 * This module is used through inheritance. It will make available
↳  all functions
 * from parent (Ownable).
 */
abstract contract Ownable2Step is Ownable {
    address private _pendingOwner;

    event OwnershipTransferStarted(address indexed previousOwner,
↳ address indexed newOwner);

    /**
     * @dev Returns the address of the pending owner.
     */
    function pendingOwner() public view virtual returns (address)
↳ {
        return _pendingOwner;
    }

    /**
     * @dev Starts the ownership transfer of the contract to a new
↳  account. Replaces the pending transfer if there is one.
     * Can only be called by the current owner.
     */
    function transferOwnership(address newOwner) public virtual
↳ override onlyOwner {
        _pendingOwner = newOwner;
        emit OwnershipTransferStarted(owner(), newOwner);
    }

    /**
     * @dev Transfers ownership of the contract to a new account
↳ (`newOwner`) and deletes any pending owner.
     * Internal function without access restriction.
     */
    function _transferOwnership(address newOwner) internal virtual
↳  override {
        delete _pendingOwner;
        super._transferOwnership(newOwner);
    }

    /**
     * @dev The new owner accepts the ownership transfer.
     */
    function acceptOwnership() external {
        address sender = _msgSender();
        require(pendingOwner() == sender, "Ownable2Step: caller is
↳  not the new owner");
        _transferOwnership(sender);
    }
}
```

Remediation Plan:

ACKNOWLEDGED: The Orion team acknowledged the risk of this issue.

4.11 (HAL-11) USE CUSTOM ERRORS INSTEAD OF REVERT STRINGS TO SAVE GAS - INFORMATIONAL (0.0)

Description:

Failed operations in several contracts are reverted with an accompanying message selected from a set of hard-coded strings.

In the EVM, emitting a hard-coded string in an error message costs **~50** more gas than emitting a custom error. Additionally, hard-coded strings increase the gas required to deploy the contract.

BVSS:

AO:A/AC:L/AX:L/C:N/I:N/A:N/D:N/Y:N/R:N/S:U (0.0)

Recommendation:

Custom errors are available from Solidity version 0.8.4 up. Consider replacing all revert strings with custom errors. Usage of custom errors should look like this:

Listing 19

```
error CustomError();

// ...

if (condition)
    revert CustomError();
```

Remediation Plan:

ACKNOWLEDGED: The Orion team acknowledged the risk of this issue.

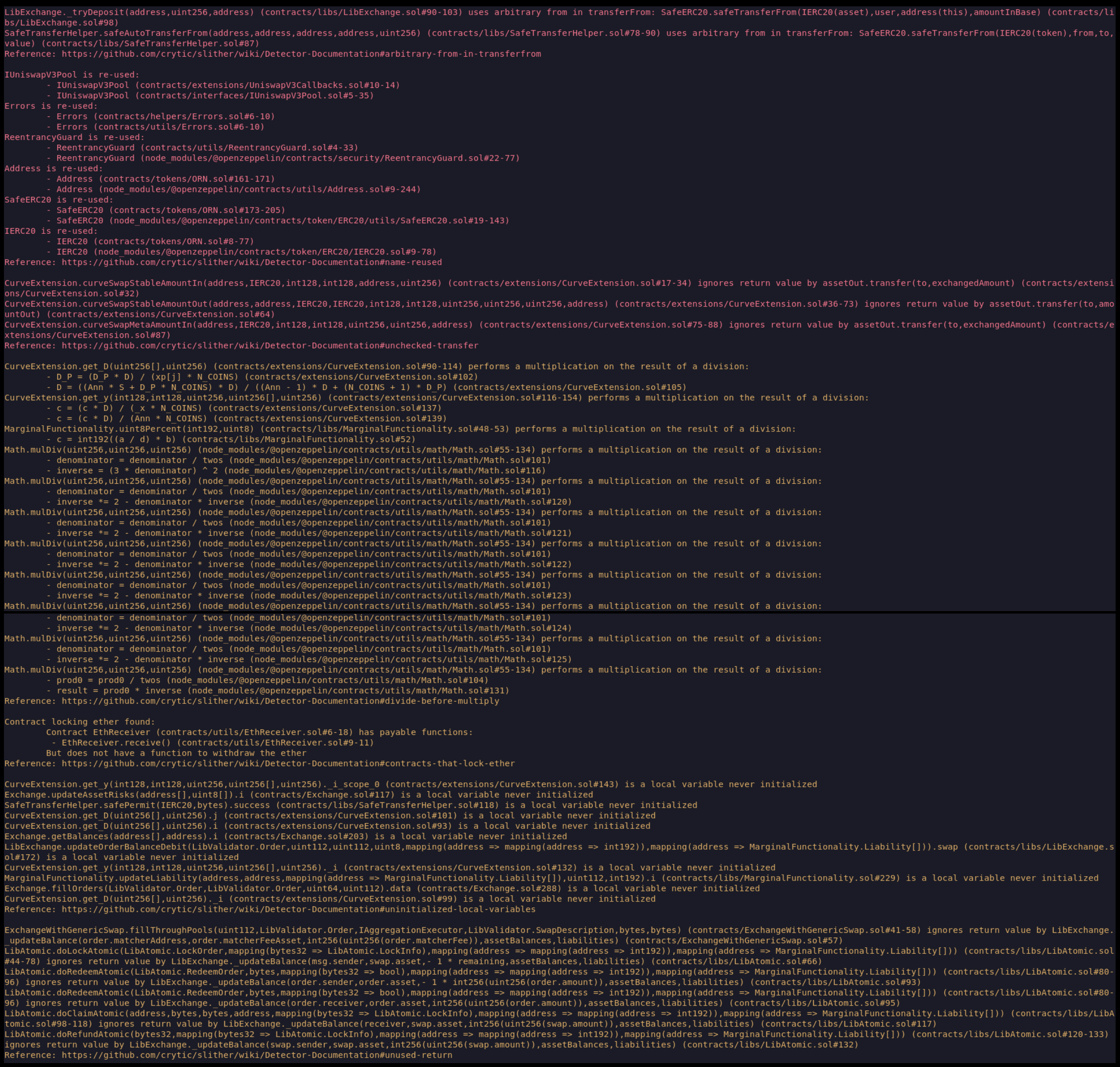
AUTOMATED TESTING

5.1 STATIC ANALYSIS REPORT

Description:

Halborn used automated testing techniques to enhance the coverage of certain areas of the smart contracts in scope. Among the tools used was Slither, a Solidity static analysis framework. After Halborn verified the smart contracts in the repository and was able to compile them correctly into their ABIs and binary format, Slither was run against the contracts. This tool can statically verify mathematical relationships between Solidity variables to detect invalid or inconsistent usage of the contracts' APIs across the entire code-base.

Results:



```
LibExchange._tryDeposit(address,uint256,address) (contracts/libs/LibExchange.sol#90-103) uses arbitrary from in transferFrom: SafeERC20.safeTransferFrom(IERC20(asset),user,address(this),amountInBase) (contracts/li
bs/LibExchange.sol#98)
SafeTransferHelper.safeAutoTransferFrom(address,address,address,address,uint256) (contracts/libs/SafeTransferHelper.sol#78-90) uses arbitrary from in transferFrom: SafeERC20.safeTransferFrom(IERC20(token),from,to,
value) (contracts/libs/SafeTransferHelper.sol#87)
Reference: https://github.com/crytic/slither/wiki/Detector-Documentation#arbitrary-from-in-transferfrom

IUniswapV3Pool is re-used:
        - IUniswapV3Pool (contracts/extensions/UniswapV3Callbacks.sol#10-14)
        - IUniswapV3Pool (contracts/interfaces/IUniswapV3Pool.sol#5-35)
Errors is re-used:
        - Errors (contracts/helpers/Errors.sol#6-10)
        - Errors (contracts/utils/Errors.sol#6-10)
ReentrancyGuard is re-used:
        - ReentrancyGuard (contracts/utils/ReentrancyGuard.sol#4-33)
        - ReentrancyGuard (node_modules/@openzeppelin/contracts/security/ReentrancyGuard.sol#22-77)
Address is re-used:
        - Address (contracts/tokens/ORN.sol#161-171)
        - Address (node_modules/@openzeppelin/contracts/utils/Address.sol#9-244)
SafeERC20 is re-used:
        - SafeERC20 (contracts/tokens/ORN.sol#173-205)
        - SafeERC20 (node_modules/@openzeppelin/contracts/token/ERC20/utils/SafeERC20.sol#19-143)
IERC20 is re-used:
        - IERC20 (contracts/tokens/ORN.sol#8-77)
        - IERC20 (node_modules/@openzeppelin/contracts/token/ERC20/IERC20.sol#9-78)
Reference: https://github.com/crytic/slither/wiki/Detector-Documentation#name-reused

CurveExtension.curveSwapStableAmountIn(address,IERC20,int128,int128,address,uint256) (contracts/extensions/CurveExtension.sol#17-34) ignores return value by assetOut.transfer(to,exchangedAmount) (contracts/extensi
ons/CurveExtension.sol#32)
CurveExtension.curveSwapStableAmountOut(address,address,IERC20,IERC20,int128,int128,uint256,uint256,uint256,address) (contracts/extensions/CurveExtension.sol#36-73) ignores return value by assetOut.transfer(to,amo
untOut) (contracts/extensions/CurveExtension.sol#64)
CurveExtension.curveSwapMetaAmountIn(address,IERC20,int128,int128,uint256,uint256,address) (contracts/extensions/CurveExtension.sol#75-88) ignores return value by assetOut.transfer(to,exchangedAmount) (contracts/e
xtensions/CurveExtension.sol#87)
Reference: https://github.com/crytic/slither/wiki/Detector-Documentation#unchecked-transfer

CurveExtension.get_D(uint256[],uint256) (contracts/extensions/CurveExtension.sol#90-114) performs a multiplication on the result of a division:
        - D_P = (D_P * D) / (xp[j] * N_COINS) (contracts/extensions/CurveExtension.sol#102)
        - D = ((Ann * S + D_P * N_COINS) * D) / ((Ann - 1) * D + (N_COINS + 1) * D_P) (contracts/extensions/CurveExtension.sol#105)
CurveExtension.get_y(int128,int128,uint256,uint256[],uint256) (contracts/extensions/CurveExtension.sol#116-154) performs a multiplication on the result of a division:
        - c = (c * D) / (_x * N_COINS) (contracts/extensions/CurveExtension.sol#137)
        - c = (c * D) / (Ann * N_COINS) (contracts/extensions/CurveExtension.sol#139)
MarginalFunctionality.uint8Percent(int192,uint8) (contracts/libs/MarginalFunctionality.sol#48-53) performs a multiplication on the result of a division:
        - c = int192((a / d) * b) (contracts/libs/MarginalFunctionality.sol#52)
Math.mulDiv(uint256,uint256,uint256) (node_modules/@openzeppelin/contracts/utils/math/Math.sol#55-134) performs a multiplication on the result of a division:
        - denominator = denominator / twos (node_modules/@openzeppelin/contracts/utils/math/Math.sol#101)
        - inverse = (3 * denominator) ^ 2 (node_modules/@openzeppelin/contracts/utils/math/Math.sol#116)
Math.mulDiv(uint256,uint256,uint256) (node_modules/@openzeppelin/contracts/utils/math/Math.sol#55-134) performs a multiplication on the result of a division:
        - denominator = denominator / twos (node_modules/@openzeppelin/contracts/utils/math/Math.sol#101)
        - inverse *= 2 - denominator * inverse (node_modules/@openzeppelin/contracts/utils/math/Math.sol#120)
Math.mulDiv(uint256,uint256,uint256) (node_modules/@openzeppelin/contracts/utils/math/Math.sol#55-134) performs a multiplication on the result of a division:
        - denominator = denominator / twos (node_modules/@openzeppelin/contracts/utils/math/Math.sol#101)
        - inverse *= 2 - denominator * inverse (node_modules/@openzeppelin/contracts/utils/math/Math.sol#121)
Math.mulDiv(uint256,uint256,uint256) (node_modules/@openzeppelin/contracts/utils/math/Math.sol#55-134) performs a multiplication on the result of a division:
        - denominator = denominator / twos (node_modules/@openzeppelin/contracts/utils/math/Math.sol#101)
        - inverse *= 2 - denominator * inverse (node_modules/@openzeppelin/contracts/utils/math/Math.sol#122)
Math.mulDiv(uint256,uint256,uint256) (node_modules/@openzeppelin/contracts/utils/math/Math.sol#55-134) performs a multiplication on the result of a division:
        - denominator = denominator / twos (node_modules/@openzeppelin/contracts/utils/math/Math.sol#101)
        - inverse *= 2 - denominator * inverse (node_modules/@openzeppelin/contracts/utils/math/Math.sol#123)
Math.mulDiv(uint256,uint256,uint256) (node_modules/@openzeppelin/contracts/utils/math/Math.sol#55-134) performs a multiplication on the result of a division:
        - denominator = denominator / twos (node_modules/@openzeppelin/contracts/utils/math/Math.sol#101)
        - inverse *= 2 - denominator * inverse (node_modules/@openzeppelin/contracts/utils/math/Math.sol#124)
Math.mulDiv(uint256,uint256,uint256) (node_modules/@openzeppelin/contracts/utils/math/Math.sol#55-134) performs a multiplication on the result of a division:
        - denominator = denominator / twos (node_modules/@openzeppelin/contracts/utils/math/Math.sol#101)
        - inverse *= 2 - denominator * inverse (node_modules/@openzeppelin/contracts/utils/math/Math.sol#125)
Math.mulDiv(uint256,uint256,uint256) (node_modules/@openzeppelin/contracts/utils/math/Math.sol#55-134) performs a multiplication on the result of a division:
        - prod0 = prod0 / twos (node_modules/@openzeppelin/contracts/utils/math/Math.sol#104)
        - result = prod0 * inverse (node_modules/@openzeppelin/contracts/utils/math/Math.sol#131)
Reference: https://github.com/crytic/slither/wiki/Detector-Documentation#divide-before-multiply

Contract locking ether found:
        Contract EthReceiver (contracts/utils/EthReceiver.sol#6-18) has payable functions:
         - EthReceiver.receive() (contracts/utils/EthReceiver.sol#9-11)
        But does not have a function to withdraw the ether
Reference: https://github.com/crytic/slither/wiki/Detector-Documentation#contracts-that-lock-ether

CurveExtension.get_y(int128,int128,uint256,uint256[],uint256)._i_scope_0 (contracts/extensions/CurveExtension.sol#143) is a local variable never initialized
Exchange.updateAssetRisks(address[],uint8[]).i (contracts/Exchange.sol#117) is a local variable never initialized
SafeTransferHelper.safePermit(IERC20,bytes).success (contracts/libs/SafeTransferHelper.sol#118) is a local variable never initialized
CurveExtension.get_D(uint256[],uint256).j (contracts/extensions/CurveExtension.sol#101) is a local variable never initialized
CurveExtension.get_D(uint256[],uint256).i (contracts/extensions/CurveExtension.sol#93) is a local variable never initialized
Exchange.getBalances(address[],address).i (contracts/Exchange.sol#203) is a local variable never initialized
LibExchange.updateOrderBalanceDebit(LibValidator.Order,uint112,uint112,uint8,mapping(address => mapping(address => int192)),mapping(address => MarginalFunctionality.Liability[])).swap (contracts/libs/LibExchange.s
ol#172) is a local variable never initialized
CurveExtension.get_y(int128,int128,uint256,uint256[],uint256)._i (contracts/extensions/CurveExtension.sol#132) is a local variable never initialized
MarginalFunctionality.updateLiability(address,address,mapping(address => MarginalFunctionality.Liability[]),uint112,int192).i (contracts/libs/MarginalFunctionality.sol#229) is a local variable never initialized
Exchange.fillOrders(LibValidator.Order,LibValidator.Order,uint64,uint112).data (contracts/Exchange.sol#288) is a local variable never initialized
CurveExtension.get_D(uint256[],uint256)._i (contracts/extensions/CurveExtension.sol#99) is a local variable never initialized
Reference: https://github.com/crytic/slither/wiki/Detector-Documentation#uninitialized-local-variables

ExchangeWithGenericSwap.fillThroughPools(uint112,LibValidator.Order,IAggregationExecutor,LibValidator.SwapDescription,bytes,bytes) (contracts/ExchangeWithGenericSwap.sol#41-58) ignores return value by LibExchange.
_updateBalance(order.matcherAddress,order.matcherFeeAsset,int256(uint256(order.matcherFee)),assetBalances,liabilities) (contracts/ExchangeWithGenericSwap.sol#57)
LibAtomic.doLockAtomic(LibAtomic.LockOrder,mapping(bytes32 => LibAtomic.LockInfo),mapping(address => mapping(address => int192)),mapping(address => MarginalFunctionality.Liability[])) (contracts/libs/LibAtomic.sol
#44-78) ignores return value by LibExchange._updateBalance(msg.sender,swap.asset,- 1 * remaining,assetBalances,liabilities) (contracts/libs/LibAtomic.sol#66)
LibAtomic.doRedeemAtomic(LibAtomic.RedeemOrder,bytes,mapping(bytes32 => bool),mapping(address => mapping(address => int192)),mapping(address => MarginalFunctionality.Liability[])) (contracts/libs/LibAtomic.sol#80-
96) ignores return value by LibExchange._updateBalance(order.sender,order.asset,- 1 * int256(uint256(order.amount)),assetBalances,liabilities) (contracts/libs/LibAtomic.sol#93)
LibAtomic.doRedeemAtomic(LibAtomic.RedeemOrder,bytes,mapping(bytes32 => bool),mapping(address => mapping(address => int192)),mapping(address => MarginalFunctionality.Liability[])) (contracts/libs/LibAtomic.sol#80-
96) ignores return value by LibExchange._updateBalance(order.receiver,order.asset,int256(uint256(order.amount)),assetBalances,liabilities) (contracts/libs/LibAtomic.sol#95)
LibAtomic.doClaimAtomic(address,bytes,bytes,address,mapping(bytes32 => LibAtomic.LockInfo),mapping(address => mapping(address => int192)),mapping(address => MarginalFunctionality.Liability[])) (contracts/libs/LibA
tomic.sol#98-118) ignores return value by LibExchange._updateBalance(receiver,swap.asset,int256(uint256(swap.amount)),assetBalances,liabilities) (contracts/libs/LibAtomic.sol#117)
LibAtomic.doRefundAtomic(bytes32,mapping(bytes32 => LibAtomic.LockInfo),mapping(address => mapping(address => int192)),mapping(address => MarginalFunctionality.Liability[])) (contracts/libs/LibAtomic.sol#120-133)
ignores return value by LibExchange._updateBalance(swap.sender,swap.asset,int256(uint256(swap.amount)),assetBalances,liabilities) (contracts/libs/LibAtomic.sol#132)
Reference: https://github.com/crytic/slither/wiki/Detector-Documentation#unused-return
```

- Arbitrary from in transferFrom issue does not pose any risk since the contract controls this value.
- Flagged ignored/unused return value does not pose any risk.
- No major issues found by Slither.

THANK YOU FOR CHOOSING

HALBORN