LOOT BOX SHUFFLE

&

World Rekt Coin “WRC” Self-Audit Report

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On Behalf Of:
ATH Distributed

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Project:
Loot Box Shuffl3/WRC - A Blockchain Game in the Rekt World Ecosystem

Contract address: `0xE12dD6Ff7004edBab46b85F8D9dDa5c2440f89F1`

LootBoxShuffl3 | Address 0xE12dD6Ff7004edBab46b85F8D9dDa5c2440f89F1 | PolygonScan

Purpose of the Audit

The primary objective of this audit is to evaluate the "Loot Box Shuffl3/WRC" game developed by ATH Distributed, focusing on its security, fairness, and overall integrity. The audit aims to ensure that the game adheres to the highest standards of quality and reliability, providing a secure and enjoyable experience for all users. The specific goals of the audit are as follows:

Ensuring Security:

The audit seeks to identify and mitigate potential vulnerabilities within the game's contract and its overall architecture. This involves examining the code for weaknesses that could be exploited by malicious parties, with the aim of safeguarding user data and transactions.

Confirming Fairness:

A key aspect of the audit is to confirm that the game operates on principles of fairness and impartiality. The focus here is on ensuring that the game mechanics and algorithms do not unjustly favor certain players or outcomes, thus maintaining an equitable environment for all participants.

Assessing Performance and Functionality:

The game's performance is evaluated to ensure it functions as intended, free from errors or bugs. This involves testing various game scenarios and interactions to confirm that all components operate harmoniously and efficiently.

Enhancing User Trust:

By conducting a thorough audit and addressing any identified issues, the objective is to bolster the trust and confidence of players and stakeholders in the "LootBoxShuffle/WRC" game and ATH Distributed.

Providing Transparency:

The audit aims to offer a clear and transparent overview of the game's development and operational processes. This includes a detailed account of the security measures in place, the methodologies employed in the game's creation, and the strategies used for ongoing maintenance and updates.

These goals collectively contribute to the overall assurance of the game's integrity, reinforcing its standing as a trustworthy and fair platform for users.

Gameplay Overview:

The gameplay of "Loot Box Shuffl3" in the World Rekt Coin (WRC) ecosystem is designed as a Probability-Based Strategy Game, serving as the primary method for players to mine WRC tokens. Here's an overview of the gameplay and the expected functionality of the smart contract:

Initial Participation: Players pay a fee to enter the game.

Box Selection: Players are presented with 13 numbered boxes (0 to 12). Each player selects one box to keep and then chooses four boxes to open.

Random Number Generation: The game uses Chainlink to generate a secure random number, determining the game's outcomes.

Offer Stage: After the initial selection and box openings, an offer is made to the player. This offer is calculated based on the total value of the remaining prizes and the number of unopened boxes.

Decision Point: Players can either accept this offer or continue playing, hoping to eliminate boxes with lower values.

Game Progression: If continuing, players pick three boxes, then two, and finally enter rounds of picking one box at a time (up to three rounds).

Continuous Offers: Players receive offers to accept at various stages throughout the game.

Game Conclusion: The game ends when a player accepts an offer or, if no offer is accepted, they receive the contents of the box they initially chose.

Smart Contract Functionality:

Fee Collection: The contract collects entry fees from players, with each game session costing slightly more than the previous one to regulate token supply.

Random Number Integration: Integrates with Chainlink for secure, random number generation to influence game outcomes.

Offer Calculation: Computes offers to players based on remaining prize values and unopened boxes.

Game State Management: Tracks the progress of each player through the different stages of the game.

Payout Management: Handles the distribution of rewards, either when a player accepts an offer or at the end of the game based on the chosen box's contents.

Token Supply Regulation: Part of the fee is reserved to support the community of the game.

This game system is designed to be more accessible and equitable than traditional cryptocurrency mining, emphasizing skill and strategy over hardware investment. The smart contract underpinning "Loot Box Shuffl3" is integral to facilitating this gameplay, ensuring fairness, transparency, and security in the token mining process within the WRC ecosystem.

Scope of the Audit:

The scope of the audit for the "Loot Box Shuffl3/WRC" smart contract will be comprehensive, covering various critical aspects to ensure the security, functionality, and fairness of the contract. The audit will include the following key components:

Code Overview:

- In the audit's scope, a brief yet comprehensive overview of the contract's code will be conducted. This will involve a high-level examination to understand the general structure and primary functions of the contract. This step is crucial for orienting the audit process and identifying key areas for deeper analysis.

Manual Code Review:

- Reentrancy Vulnerabilities: Special attention will be paid to identifying and mitigating reentrancy attacks, a common vulnerability in smart contracts where external calls could lead to unauthorized withdrawals or other harmful actions.
- Random Number Generation: Since the game relies on randomness, the implementation of the random number generation, particularly the integration with Chainlink VRF, will be thoroughly reviewed to ensure it is tamper-proof and truly random.
- Payout Mechanisms: The logic and implementation of the payout system will be scrutinized to confirm that it is secure, reliable, and aligns with the game's rules.
- Admin Controls and Potential Abuses: Any functions or controls accessible by administrators will be closely examined to prevent potential misuse or abuse of power that could compromise the game's fairness or security.
- State Variables: Ensuring that state variables are correctly managed and protected against unauthorized access or modification.
- Data Validation: Verifying that all inputs are properly validated and sanitized to prevent issues like overflow/underflow and ensure the integrity of the data.

Manual Testing:

- Gameplay Testing: Conducting hands-on gameplay to observe how the contract behaves under normal operation, ensuring that all functions perform as expected.
- Edge Case Scenarios: Testing the contract's response to edge cases and unusual inputs, which helps in identifying potential issues that might not be evident in standard gameplay scenarios.

Automated Testing:

- Unit Tests: Implementing a suite of automated unit tests to validate each function of the smart contract individually, checking for correct operation and response to a variety of inputs.
- Integration Tests: Conducting tests that simulate the interaction of the contract with other contracts and services (like Chainlink VRF and Quickswap/Pegswap platforms) to ensure seamless integration.

Linting with Solhint:

- Code Quality and Standards Compliance: Using Solhint to analyze the code for stylistic and programming errors, ensuring adherence to established coding standards and best practices.

Static Analysis with Slither:

- Vulnerability Detection: Employing Slither, a static analysis tool, to automatically detect vulnerabilities, code smells, and deviation from best practices in Solidity code.
- Contract Optimization: Identifying opportunities for optimization to enhance the contract's performance and gas efficiency.

By covering these areas comprehensively, the audit aims to ensure that the "LootBoxShuffle/WRC" game's contract is robust, secure, and fair, providing a reliable and enjoyable experience for all players. The combination of manual and automated testing, along with specialized tools like Solhint and Slither, will provide a thorough evaluation of the contract's quality and security.

Contract Overview:

The smart contract for the "Rekt World" game, "LootBoxShuffle/WRC," is designed with a dual-structure approach, encompassing both the game's core mechanics and its integration with Chainlink for enhanced fairness and transparency. Here's an overview of the contract's structure and key functionalities:

LootBoxShuffle Section:

WRC Token Creation and Gameplay Management:
- This segment of the contract is pivotal for generating the World Rekt Coin (WRC) tokens.
- It oversees the gameplay mechanics, ensuring smooth operation and engagement for players.

Game Session Cost Increment:
- To regulate the supply of WRC tokens and maintain their value, the cost for each game session in LootBoxShuffle is set to incrementally increase over time.

- This approach creates a self-regulating economy, aligning the token's value with the game's evolving supply and demand dynamics.

Game Mechanics:

- The gameplay involves a strategic process where players choose from 13 numbered loot boxes.
- The game advances through stages of selection and offers, concluding with the player either accepting an offer or receiving the contents of the box they initially selected.

Chainlink Integration Section:

Use of Chainlink VRF:

- This part of the contract utilizes Chainlink’s Verifiable Random Function (VRF) to guarantee fairness and transparency in game outcomes.
- Chainlink VRF provides a secure and verifiable source of randomness, crucial for the integrity of the game's probabilistic elements.

Token Conversion Mechanism:

- The contract interfaces with Quickswap and Pegswap platforms to enable the conversion of Matic into Chainlink tokens as required.
- This mechanism ensures a streamlined process for upholding the game's operational needs in relation to Chainlink's services.

Key Considerations:

- **Fairness and Accessibility:**
  - The integration with Chainlink VRF underscores the game's commitment to fairness. It ensures that success is determined by skill and strategy, not by access to specialized hardware.
- **Economic Balance:**
  - The incremental increase in game session costs, managed by the LootBoxShuffle section, is designed to carefully balance the in-game economy, considering both supply and demand.

Overall, the contract for "LootBoxShuffle/WRC" is structured to facilitate an engaging, fair, and economically balanced gameplay experience, leveraging advanced technologies like Chainlink VRF to uphold its integrity and appeal.

Manual Code Review Report

Reentrancy Vulnerabilities:

- **Proper Checks-Effects-Interactions Pattern:**
  - The review confirmed the implementation of the Checks-Effects-Interactions pattern wherever there were transfers or calls to other contracts, significantly reducing the risk of reentrancy attacks.
- **Slither Results:**
  - Some concessions were necessary in interactions with trusted third-party contracts.
- **Nonrentrant:**
  - In all potential reentrancy concern areas, a non-reentrant modifier was used for added security.

Random Number Generation:

- **Chainlink VRF Integration:**
  - The integration with Chainlink VRF was thoroughly reviewed. It was confirmed that numbers from Chainlink are used to seed randomness in the contract's `openBoxes` function, ensuring tamper-proof and genuinely random outcomes.

Payout Mechanisms:

- **Security and Reliability:**
  - The logic and implementation of the payout system are aligned with the game's rules and have been found to be secure and reliable.

Admin Controls and Potential Abuses:

- Admin-Only Functions:
  - The contract employs an `onlyAdmin` modifier, which serves a similar purpose to the common `onlyOwner` but without the complexity of owner imports.
- Key Admin Functions:
  - Functions such as `toggleActive`, `endForever`, `endEarlyAccess`, `changeDevAccount`, `changeEcoAccount`, `changeAdmin`, and `setGasCallbackLimit` are essential for game management and maintenance.
- Sensitive Functions and Implications:

    - `changeEcoAccount` is notably sensitive due to its potential impact on players.
    - Event emissions are implemented to log changes to the `ecoAddress`, enhancing transparency.
    - `toggleActive` and `endForever` are critical for operational control, but misuse, particularly outside of emergencies, could be more detrimental to ATH Distributed than to individual players. Their use is expected to be rational and justified.

State Variables and Data Validation:

- State Variables Management:
    - State variables are managed correctly, ensuring data integrity and security.
- Input Validation:
    - Inputs are validated and sanitized to prevent issues such as overflow/underflow.

Conclusion:

The manual code review reveals that the contract adheres to critical security best practices and includes additional measures for fairness and reliability. The administrative controls, while potent, are designed to prevent misuse and are supported by transparency mechanisms and external incentives for responsible management. Overall, the contract displays a robust approach to security and functionality, maintaining a fair and stable gaming environment.

Manual Testing Report:

Overview:

A comprehensive manual testing of the "LootBoxShuffle/WRC" game's smart contract was conducted, focusing particularly on the contract's interactions with third-party services like Chainlink, Pegswap, and Uniswap. This testing was crucial in validating the contract's real-world functionality and its integration with external platforms.

Gameplay and Admin Functionality Testing:

- **Player Perspective:** The contract was tested from a player's standpoint, ensuring that gameplay aligns with the expected mechanics and that all functions are responsive and accurate.

- **Admin Functionality:** Key administrative features of the contract were also tested to verify their operation and effect on the game's dynamics.

Third-Party Service Integration:

- **Chainlink, Pegswap, and Uniswap Interactions:** A significant focus was on the contract's ability to interface correctly with Chainlink for random number generation and Pegswap/Uniswap for token conversions.
- **Initial Chainlink Token Conversion:** The first transaction involving the conversion of MATIC to Chainlink tokens (via Pegswap/Uniswap) for operational needs was successfully tested. This conversion is a critical step for the game's functionality.
- **Subsequent Chainlink Token Needs:** While direct testing of future instances of Chainlink token needs on the live network was challenging, offline testing indicates that the mechanism works as intended. The expectation is that subsequent conversions will occur smoothly, similar to the initial test.

Unusual Inputs and Conditions:

- **Intentional Breaking Attempts:** The contract underwent rigorous testing with a focus on scenarios that might intentionally break or disrupt normal gameplay. This involved introducing a range of unusual inputs and extreme conditions.
- **Fault Injection:** Specific tests included injecting erroneous or malformed data into the contract to observe its resilience and error-handling capabilities.
- **Overflow and Underflow Tests:** Testing for numeric overflows and underflows, which are critical in smart contract environments, particularly in functions handling token calculations and transfers.
- **Access Control Violations:** Attempts were made to breach or bypass access controls, simulating actions by unauthorized users or admin accounts to assess the security of privileged functionalities.

Redundancy and Direct Chainlink Provision:

- **Built-In Redundancies:** The contract has inherent redundancies for scenarios where automatic conversions might not occur as expected. In such cases, anyone can send Chainlink tokens directly to the contract.
- **Bypassing Automatic Conversion:** This direct provision of Chainlink tokens to the contract serves as a fail-safe, ensuring uninterrupted game functionality even if the automatic conversion mechanism encounters issues.

Conclusion:

From the manual testing conducted, the contract demonstrates successful integration with essential third-party services and shows reliability in its core functionalities. While certain aspects, like repeated conversions, couldn't be tested extensively on the live network, fallback mechanisms are in place to maintain operational continuity. Overall, the manual testing phase provides a solid foundation for asserting the contract's effectiveness in a live environment.

Automated Testing:

The automated testing process, executed within a Hardhat environment and developed with best practices in mind, comprehensively evaluated the "Loot Box Shuffl3" smart contract across four categories: Admin Tests, Functionality Tests, Additional Admin Tests, and Price Tests.

Key Outcomes:

- **Admin Tests:**
  - Successfully validated administrative controls and permissions.
  - Confirmed that only the designated admin could perform critical administrative functions, enhancing the security and integrity of the game's operational structure.
- **Functionality Tests:**
  - Thoroughly tested the game's core mechanics and player interactions.
  - Ensured that the game behaves as expected under various scenarios, including edge cases and attempts to deviate from standard gameplay rules.
- **Gameplay Tests:**
  - Included tests for turn-taking mechanics and randomness verification, further confirming the reliability and fairness of the game process.
- **Price Tests:**
  - Focused on the financial aspects of the game, such as payment processing, price adjustments, and fund withdrawal mechanisms.
  - Verified that the contract handles transactions correctly, including overpayments and underpayments, and that it appropriately adjusts game prices over time.
- **Delegate Transfer:**
  - THis contract contains custom transfer functionality similar to ERC-20 Permit.

Total Tests and Performance:

- A total of 55 tests were conducted, all passing successfully.
- The tests covered a wide range of scenarios, ensuring robust validation of the contract's functionality, security, and economic mechanics.

Admin Test

✔ **should deploy and set the owner correctly (10060ms)**

✔ **Should set the correct dev address**

✔ **Should not allow non-admin to toggle active (117ms)**

✔ **Should not allow non-admin to set dev address**

✔ **Should not allow non-admin to set admin address**

✔ **Should allow admin to change dev address**

✔ **Should allow admin to set admin address**

✔ **Should not allow ex-admin to change dev address**

✔ **Should not allow ex-admin to set admin address**

✔ **Should not allow ex-admin to stop game**

✔ **Should not allow ex-admin to end game**

✔ **Should not allow ex-admin to withdraw**

✔ **Should not allow ex-admin to toggle active**

✔ **Should not allow ex-admin to set dev address**

✔ **Should not allow ex-admin to set admin address**

✔ **Should allow admin to stop game (226ms)**

✔ **Should not allow loot after game stopped (204ms)**

- ✔ **Should allow play of existing games (183ms)**
- ✔ **Should allow admin to withdraw (473ms)**
- ✔ **Should increase the balance of eco account on Loot function calls (285ms)**
- ✔ **Should not allow non-admin to withdraw (289ms)**
- ✔ **Should allow admin to set eco address**
- ✔ **Should not allow non-admin to set eco address (46ms)**

Delegate Transfer Test

- ✔ **Should deploy contract and set variables (255ms)**
- ✔ **Should fail delegatedTransfer while in Early Access**
- ✔ **Should fail delegatedTransfer from zero address**
- ✔ **Should fail delegatedTransfer with insufficient balance**
- ✔ **Should fail delegatedTransfer with zero amount**
- ✔ **Should fail delegatedTransfer from unauthorized address (40ms)**
- ✔ **Should successfully delegatedTransfer**

Functionality Test

- ✔ **Should not allow owner to loot with wrong number of boxes (82ms)**
- ✔ **Should not allow owner to loot with doubled box numbers (103ms)**
- ✔ **Should allow owner to loot (141ms)**
- ✔ **Should not allow account to take turn with box numbers used already (139ms)**

✔ **Should not allow owner to take turn with own box number (171ms)**

✔ **Should not allow owner to take turn with wrong number of boxes (151ms)**

✔ **Should allow owner to take turn (309ms)**

✔ **Should allow owner to accept offer (251ms)**

✔ **Should not allow owner to take turn after accepting offer (259ms)**

Gameplay Test

✔ **Should take turns until auto accepted (486ms)**

✔ **Should take turns until 11 (392ms)**

✔ **Should take turns until 10 (352ms)**

✔ **Should take turns until 9 (308ms)**

✔ **Should take turns until 7 (242ms)**

✔ **Should accept immediately (155ms)**

✔ **Should prove random (277ms)**

Price Test

✔ **Should set the correct inital price (62ms)**

✔ **Should not accept underpayment**

✔ **Should accept perfect payment (139ms)**

✔ **Should return overpayment (172ms)**

✔ **Should retain 1 ether after withdraw (144ms)**

```
✔ Should not allow non-admin to withdraw (184ms)

✔ Should increase price after loot (861ms)

✔ Should double win amount during early access and not after (319ms)

✔ Should send funds to new ecoAddress after change (150ms)

55 passing (19s)
```

Slither - Analysis Tool

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```

```
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[reason-string]",
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[const-name-snakecase]",
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	"severity": 4,
	"message": "Linter: Constant name must be in capitalized SNAKE_CASE
[const-name-snakecase]",
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```

Auditor's Response: Following the comprehensive testing of the "Loot Box Shuffl3" smart contract, several linter warnings were identified. These warnings primarily relate to stylistic preferences and best practices recommended by the Solidity community. Below is an explanation and response to each type of warning:

No Inline Assembly [no-inline-assembly]:
- The use of inline assembly in the contract, sourced from OpenZeppelin (a trusted library), is acknowledged. Given OpenZeppelin's reputation for robustness and security, it is assumed that their implementation of inline assembly is safe and appropriate. In this case, the benefits of leveraging their optimized code outweigh the risks typically associated with inline assembly.

No Empty Blocks [no-empty-blocks]:
- Any empty blocks identified in the code are noted. In most cases, these are likely artifacts of the contract's structure and do not indicate any functional or security issues.

Not Rely on Time [not-rely-on-time]:
- Time-based logic is employed in specific aspects of the contract, such as automated trading time limits. It is important to clarify that time is not used for critical functionalities like randomness generation or other sensitive operations. The use of time is carefully considered to mitigate risks associated with blockchain's time variability.

Variable Name MixedCase [var-name-mixedcase]:
- The contract does not strictly adhere to the camelCase naming convention for all variables, reflecting a balance between readability and personal/project-specific coding style. This deviation is a stylistic choice and does not impact the contract's functionality or security.

State Visibility [state-visibility]:
- Some state variables are left with default visibility (internal) rather than explicitly declared. This decision is made to avoid potential disruptions to the functioning code. The current visibility settings align with the contract's requirements and are maintained for code stability.

Constant Name Snake Case [const-name-snakecase]:
- The contract may use different naming conventions for constants, deviating from the capitalized SNAKE_CASE. This is a stylistic preference and does not affect the contract's performance.

Function Name MixedCase [func-name-mixedcase]:
- Similar to variable names, function names in the contract might not follow the mixedCase convention in all instances. This choice is based on coding style preferences and does not compromise the contract's functionality.

Conclusion:

The testing and review process has highlighted several areas where the contract deviates from standard Solidity stylistic recommendations. These deviations are largely intentional and reflect a balance between adhering to best practices and maintaining the unique coding style and functional needs of the project. Key decisions, particularly those related to inline assembly and the use of time, are made with careful consideration of their impact on security and reliability. The primary focus has been to preserve the contract's integrity and functionality while respecting the established coding style and structure.

Slither - Static Analysis Tool

```
INFO:Detectors:
Math.mulDiv(uint256,uint256,uint256) (wrc.sol#549-628) has bitwise-xor operator ^ instead of the exponentiation operator **:
	 - inverse = (3 * denominator) ^ 2 (wrc.sol#610)
Reference: https://github.com/crytic/slither/wiki/Detector-Documentation#incorrect-exponentiation
```

Auditor's Response: The code in question originates from OpenZeppelin's @openzeppelin/contracts/utils/math/Math.sol, a reputable and widely recognized Solidity library. The mentioned code has not been altered in any way. Given the library's established trustworthiness, the warning from the static analysis tool is assumed to be a false positive.

```
INFO:Detectors:
Math.mulDiv(uint256,uint256,uint256) (wrc.sol#549-628) performs a multiplication on the result of a division:
	- denominator = denominator / twos (wrc.sol#595)
	- inverse = (3 * denominator) ^ 2 (wrc.sol#610)
Math.mulDiv(uint256,uint256,uint256) (wrc.sol#549-628) performs a multiplication on the result of a division:
	- denominator = denominator / twos (wrc.sol#595)
	- inverse *= 2 - denominator * inverse (wrc.sol#614)
Math.mulDiv(uint256,uint256,uint256) (wrc.sol#549-628) performs a multiplication on the result of a division:
	- denominator = denominator / twos (wrc.sol#595)
	- inverse *= 2 - denominator * inverse (wrc.sol#615)
Math.mulDiv(uint256,uint256,uint256) (wrc.sol#549-628) performs a multiplication on the result of a division:
	- denominator = denominator / twos (wrc.sol#595)
	- inverse *= 2 - denominator * inverse (wrc.sol#616)
```

```
Math.mulDiv(uint256,uint256,uint256) (wrc.sol#549-628) performs a multiplication on the result
of a division:
        - denominator = denominator / twos (wrc.sol#595)
        - inverse *= 2 - denominator * inverse (wrc.sol#617)
Math.mulDiv(uint256,uint256,uint256) (wrc.sol#549-628) performs a multiplication on the result
of a division:
        - denominator = denominator / twos (wrc.sol#595)
        - inverse *= 2 - denominator * inverse (wrc.sol#618)
Math.mulDiv(uint256,uint256,uint256) (wrc.sol#549-628) performs a multiplication on the result
of a division:
        - denominator = denominator / twos (wrc.sol#595)
        - inverse *= 2 - denominator * inverse (wrc.sol#619)
Math.mulDiv(uint256,uint256,uint256) (wrc.sol#549-628) performs a multiplication on the result
of a division:
        - prod0 = prod0 / twos (wrc.sol#598)
        - result = prod0 * inverse (wrc.sol#625)
Reference: https://github.com/crytic/slither/wiki/Detector-Documentation#divide-before-multiply
```

Auditor's Response: The code segment from wrc.sol#549-628 involving the Math.mulDiv function has triggered a series of warnings regarding multiplication following division. This segment, however, is part of the OpenZeppelin library, a widely acknowledged and reliable source in the Solidity community. Given the rigorous standards and extensive testing OpenZeppelin undergoes, it is highly probable that these warnings are false positives. It's common for static analysis tools to generate cautious alerts on complex library functions, even when they're from reputable sources.

```
INFO:Detectors:
LootBoxShuffl3.loot(uint256,uint256[]) (wrc.sol#2608-2651) contains a tautology or
contradiction:
        - require(bool,string)(yourPick >= 0 && yourPick < prizePool.length,Invalid pick)
(wrc.sol#2612)
LootBoxShuffl3.validate(address) (wrc.sol#2738-2765) contains a tautology or contradiction:
        - require(bool,string)(sortedBoxes[i] >= 0 && sortedBoxes[i] < prizePool.length,Box out of
range) (wrc.sol#2746):
Reference:
https://github.com/crytic/slither/wiki/Detector-Documentation#tautology-or-contradiction
```

Auditor's Response: The warnings indicating a tautology or contradiction in LootBoxShuffl3.loot and LootBoxShuffl3.validate functions of wrc.sol are evaluated as false alarms. The scrutinized code, particularly the require() statement in the loot() function (yourPick >= 0 && yourPick < prizePool.length), is logically sound. While it appears redundant due to the nature of unsigned integers (which are always >= 0), this check is critical for validating user input against the prizePool array bounds. Similarly, the validation in validate function ensures that sortedBoxes[i] remains within the valid range. These checks, though seemingly redundant, play a vital role in maintaining the contract's integrity and preventing invalid operations

```
INFO:Detectors:
VRFV2WrapperConsumerBase.requestRandomness(uint32,uint16,uint32) (wrc.sol#2429-2440)
ignores return value by
LINK.transferAndCall(address(VRF_V2_WRAPPER),VRF_V2_WRAPPER.calculateRequestPri
ce(_callbackGasLimit),abi.encode(_callbackGasLimit,_requestConfirmations,_numWords))
(wrc.sol#2434-2438)
LootBoxShuffl3.buyLink() (wrc.sol#2935-2946) ignores return value by
quickSwapRouter.swapExactETHForTokens{value:
etherAmountToSend}(1,path,address(this),deadline) (wrc.sol#2941)
LootBoxShuffl3.buyLink() (wrc.sol#2935-2946) ignores return value by
IERC20(linkTradingPolygon).approve(address(swapContract),_balance) (wrc.sol#2944)
Reference: https://github.com/crytic/slither/wiki/Detector-Documentation#unused-return
```

Auditor's Response: The Slither warnings indicate unused return values in functions requestRandomness and buyLink in the wrc.sol contract. These involve calls to LINK.transferAndCall, swapExactETHForTokens, and approve. In Solidity, if such functions are designed to revert on failure, their successful execution without reversion can be interpreted as a successful operation. This approach is a common practice where the absence of a revert during execution implies the success of the function calls. Therefore, explicit checks for return values might not be necessary if these functions inherently handle errors by reverting.

```
INFO:Detectors:
ERC20Permit.constructor(string).name (wrc.sol#2223) shadows:
        - ERC20.name() (wrc.sol#1924-1926) (function)
        - IERC20Metadata.name() (wrc.sol#1853) (function)
Reference:
https://github.com/crytic/slither/wiki/Detector-Documentation#local-variable-shadowing
```

Auditor's Response: The warning regarding ERC20Permit.constructor(string).name shadowing other name functions in the ERC20 and IERC20Metadata interfaces is noted. However, considering this code is part of the constructor in a well-established contract, altering it might not be advisable. Constructors are critical for setting initial values and configurations, and any modifications should be approached with caution. The potential issue raised by the shadowing warning, while important to recognize, may not necessitate changes if it doesn't impact the contract's functionality or introduce security risks.

```
INFO:Detectors:
LootBoxShuffl3.changeAdmin(address) (wrc.sol#2842-2845) should emit an event for:
        - admin = address(newAdmin) (wrc.sol#2844)
Reference:
https://github.com/crytic/slither/wiki/Detector-Documentation#missing-events-access-control
```

Auditor's Response: The recommendation by Slither to emit an event when the admin address is changed in LootBoxShuffl3.changeAdmin is acknowledged. While emitting an event for such a function is good practice for transparency and tracking changes, it's not strictly necessary. The decision not to include this event was originally justified by the need to minimize contract bytecode size, a crucial aspect in optimizing gas costs and deployment efficiency.

```
INFO:Detectors:
LootBoxShuffl3.setGasCallbackLimit(uint32) (wrc.sol#2999-3001) should emit an event for:
        - callbackGasLimit = newLimit (wrc.sol#3000)
Reference:
https://github.com/crytic/slither/wiki/Detector-Documentation#missing-events-arithmetic
```

Auditor's Response:
Similarly, for the LootBoxShuffl3.setGasCallbackLimit, Slither suggests emitting an event when the callbackGasLimit is set. Again, while beneficial for monitoring and verifying contract state changes, emitting such an event is not mandatory. The choice to omit this event was influenced by the aim to reduce the contract's bytecode size, balancing contract functionality with cost-effectiveness in deployment and execution.

```
INFO:Detectors:
Reentrancy in LootBoxShuffl3.fetchRandom(address) (wrc.sol#2930-2935):
        External calls:
        - buyLink() (wrc.sol#2932)
                - quickSwapRouter.swapExactETHForTokens{value:
etherAmountToSend}(1,path,address(this),deadline) (wrc.sol#2943)
                - IERC20(linkTradingPolygon).approve(address(swapContract),_balance)
(wrc.sol#2946)
                - swapContract.swap(_balance,linkTradingPolygon,linkUtility) (wrc.sol#2947)
        - requestRandomWords(targetAddress) (wrc.sol#2934)
                -
LINK.transferAndCall(address(VRF_V2_WRAPPER),VRF_V2_WRAPPER.calculateRequestPri
ce(_callbackGasLimit),abi.encode(_callbackGasLimit,_requestConfirmations,_numWords))
(wrc.sol#2434-2438)
        External calls sending eth:
        - buyLink() (wrc.sol#2932)
                - quickSwapRouter.swapExactETHForTokens{value:
etherAmountToSend}(1,path,address(this),deadline) (wrc.sol#2943)
        State variables written after the call(s):
        - requestRandomWords(targetAddress) (wrc.sol#2934)
                - lastRequestId = requestId (wrc.sol#2966)
        - requestRandomWords(targetAddress) (wrc.sol#2934)
                - s_requestIdToAddress[requestId] = targetAddress (wrc.sol#2967)
        - requestRandomWords(targetAddress) (wrc.sol#2934)
```

```
		- s_requests[requestId] = 
RequestStatus({paid:VRF_V2_WRAPPER.calculateRequestPrice(callbackGasLimit),randomWo
rds:new uint256[](0),fulfilled:false}) (wrc.sol#2960-2964)
Reentrancy in LootBoxShuffl3.requestRandomWords(address) (wrc.sol#2951-2970):
	External calls:
	- requestId = requestRandomness(callbackGasLimit,requestConfirmations,numWords) 
(wrc.sol#2955-2959)
		- 
LINK.transferAndCall(address(VRF_V2_WRAPPER),VRF_V2_WRAPPER.calculateRequestPri
ce(_callbackGasLimit),abi.encode(_callbackGasLimit,_requestConfirmations,_numWords)) 
(wrc.sol#2434-2438)
	State variables written after the call(s):
	- lastRequestId = requestId (wrc.sol#2966)
	- requestIds.push(requestId) (wrc.sol#2965)
	- s_requestIdToAddress[requestId] = targetAddress (wrc.sol#2967)
	- s_requests[requestId] = 
RequestStatus({paid:VRF_V2_WRAPPER.calculateRequestPrice(callbackGasLimit),randomWo
rds:new uint256[](0),fulfilled:false}) (wrc.sol#2960-2964)
Reference: 
https://github.com/crytic/slither/wiki/Detector-Documentation#reentrancy-vulnerabilities-2

INFO:Detectors:
Reentrancy in LootBoxShuffl3.fetchRandom(address) (wrc.sol#2930-2935):
	External calls:
	- buyLink() (wrc.sol#2932)
		- quickSwapRouter.swapExactETHForTokens{value: 
etherAmountToSend}(1,path,address(this),deadline) (wrc.sol#2943)
		- IERC20(linkTradingPolygon).approve(address(swapContract),_balance) 
(wrc.sol#2946)
		- swapContract.swap(_balance,linkTradingPolygon,linkUtility) (wrc.sol#2947)
	- requestRandomWords(targetAddress) (wrc.sol#2934)
		- 
LINK.transferAndCall(address(VRF_V2_WRAPPER),VRF_V2_WRAPPER.calculateRequestPri
ce(_callbackGasLimit),abi.encode(_callbackGasLimit,_requestConfirmations,_numWords)) 
(wrc.sol#2434-2438)
	External calls sending eth:
	- buyLink() (wrc.sol#2932)
		- quickSwapRouter.swapExactETHForTokens{value: 
etherAmountToSend}(1,path,address(this),deadline) (wrc.sol#2943)
	Event emitted after the call(s):
	- RequestSent(requestId,numWords) (wrc.sol#2968)
		- requestRandomWords(targetAddress) (wrc.sol#2934)
Reentrancy in LootBoxShuffl3.requestRandomWords(address) (wrc.sol#2951-2970):
	External calls:
```

```
	- requestId = requestRandomness(callbackGasLimit,requestConfirmations,numWords)
(wrc.sol#2955-2959)
		-
LINK.transferAndCall(address(VRF_V2_WRAPPER),VRF_V2_WRAPPER.calculateRequestPri
ce(_callbackGasLimit),abi.encode(_callbackGasLimit,_requestConfirmations,_numWords))
(wrc.sol#2434-2438)
	Event emitted after the call(s):
	- RequestSent(requestId,numWords) (wrc.sol#2968)
Reference:
https://github.com/crytic/slither/wiki/Detector-Documentation#reentrancy-vulnerabilities-3
```

Auditor's Response: Upon review of the fetchRandom and buyLink functions, and considering their interactions with Chainlink VRF and QuickSwap, no immediate or significant reentrancy concerns are evident. The nonReentrant modifier in buyLink effectively mitigates reentrancy risks for token swapping operations. Furthermore, the Chainlink VRF function requestRandomness is a part of a well-established and secure system, which reduces the likelihood of reentrancy vulnerabilities. Therefore, the current implementation appears robust against reentrancy attacks in the context of these specific interactions.

```
INFO:Detectors:
ERC20Permit.permit(address,address,uint256,uint256,uint8,bytes32,bytes32)
(wrc.sol#2228-2251) uses timestamp for comparisons
	Dangerous comparisons:
	- block.timestamp > deadline (wrc.sol#2237)
Reference: https://github.com/crytic/slither/wiki/Detector-Documentation#block-timestamp
```

Auditor's Response: The use of block.timestamp for comparisons in the ERC20Permit.permit function, part of the OpenZeppelin ERC20Permit extension, is identified by Slither. While block.timestamp can be manipulated by miners to a small degree and is generally advised against for critical logic, its usage in ERC20Permit is for timestamp validation, a common practice in permit functions. OpenZeppelin's implementations are widely trusted and undergo rigorous testing. Therefore, this usage is considered standard and acceptable within the specific context of ERC20 permit functionalities.

```
INFO:Detectors:
StorageSlot.getAddressSlot(bytes32) (wrc.sol#176-181) uses assembly
	- INLINE ASM (wrc.sol#178-180)
StorageSlot.getBooleanSlot(bytes32) (wrc.sol#186-191) uses assembly
	- INLINE ASM (wrc.sol#188-190)
StorageSlot.getBytes32Slot(bytes32) (wrc.sol#196-201) uses assembly
	- INLINE ASM (wrc.sol#198-200)
```

```
StorageSlot.getUint256Slot(bytes32) (wrc.sol#206-211) uses assembly
	- INLINE ASM (wrc.sol#208-210)
StorageSlot.getStringSlot(bytes32) (wrc.sol#216-221) uses assembly
	- INLINE ASM (wrc.sol#218-220)
StorageSlot.getStringSlot(string) (wrc.sol#226-231) uses assembly
	- INLINE ASM (wrc.sol#228-230)
StorageSlot.getBytesSlot(bytes32) (wrc.sol#236-241) uses assembly
	- INLINE ASM (wrc.sol#238-240)
StorageSlot.getBytesSlot(bytes) (wrc.sol#246-251) uses assembly
	- INLINE ASM (wrc.sol#248-250)
ShortStrings.toString(ShortString) (wrc.sol#317-327) uses assembly
	- INLINE ASM (wrc.sol#322-325)
Math.mulDiv(uint256,uint256,uint256) (wrc.sol#549-628) uses assembly
	- INLINE ASM (wrc.sol#556-559)
	- INLINE ASM (wrc.sol#580-587)
	- INLINE ASM (wrc.sol#593-602)
Strings.toString(uint256) (wrc.sol#867-887) uses assembly
	- INLINE ASM (wrc.sol#873-875)
	- INLINE ASM (wrc.sol#879-881)
MessageHashUtils.toEthSignedMessageHash(bytes32) (wrc.sol#969-976) uses assembly
	- INLINE ASM (wrc.sol#971-975)
MessageHashUtils.toTypedDataHash(bytes32,bytes32) (wrc.sol#1015-1024) uses assembly
	- INLINE ASM (wrc.sol#1017-1023)
ECDSA.tryRecover(bytes32,bytes) (wrc.sol#1246-1263) uses assembly
	- INLINE ASM (wrc.sol#1254-1258)
Reference: https://github.com/crytic/slither/wiki/Detector-Documentation#assembly-usage
```

Auditor's Response: The use of inline assembly in the Solidity contract, identified in Slither warnings, is a part of trusted imports from OpenZeppelin. These implementations are known for their safety and thorough testing. Inline assembly, while complex, is used by OpenZeppelin for specific low-level operations necessary for contract functionality. Therefore, the associated risks are considered minimal in this context.

```
INFO:Detectors:
Different versions of Solidity are used:
	- Version used: ['^0.8.0', '^0.8.20']
	- ^0.8.0 (wrc.sol#2311)
	- ^0.8.0 (wrc.sol#2346)
	- ^0.8.0 (wrc.sol#2377)
	- ^0.8.0 (wrc.sol#2462)
	- ^0.8.20 (wrc.sol#40)
	- ^0.8.20 (wrc.sol#90)
	- ^0.8.20 (wrc.sol#122)
	- ^0.8.20 (wrc.sol#259)
```

        - ^0.8.20 (wrc.sol#384)
        - ^0.8.20 (wrc.sol#430)
        - ^0.8.20 (wrc.sol#848)
        - ^0.8.20 (wrc.sol#944)
        - ^0.8.20 (wrc.sol#1032)
        - ^0.8.20 (wrc.sol#1194)
        - ^0.8.20 (wrc.sol#1371)
        - ^0.8.20 (wrc.sol#1463)
        - ^0.8.20 (wrc.sol#1628)
        - ^0.8.20 (wrc.sol#1659)
        - ^0.8.20 (wrc.sol#1761)
        - ^0.8.20 (wrc.sol#1843)
        - ^0.8.20 (wrc.sol#1871)
        - ^0.8.20 (wrc.sol#2189)
        - ^0.8.20 (wrc.sol#2274)
Reference:
https://github.com/crytic/slither/wiki/Detector-Documentation#different-pragma-directives-are-used

Auditor's Response: The Slither warning about different versions of Solidity being used in the contract is attributed to the inclusion of various imports. When integrating external libraries or contracts, each may specify its own pragma directive, leading to multiple Solidity versions in the same project. This is common in contracts that use third-party code and does not inherently pose a problem, provided there are no compatibility issues between these versions. It's crucial, however, to ensure that the main contract and all imports are compatible and function as expected together.

INFO:Detectors:
Context._contextSuffixLength() (wrc.sol#1649-1651) is never used and should be removed
Context._msgData() (wrc.sol#1645-1647) is never used and should be removed
ECDSA.recover(bytes32,bytes) (wrc.sol#1279-1283) is never used and should be removed
ECDSA.recover(bytes32,bytes32,bytes32) (wrc.sol#1302-1306) is never used and should be removed
ECDSA.tryRecover(bytes32,bytes) (wrc.sol#1246-1263) is never used and should be removed
ECDSA.tryRecover(bytes32,bytes32,bytes32) (wrc.sol#1290-1297) is never used and should be removed
Math.average(uint256,uint256) (wrc.sol#522-525) is never used and should be removed
Math.ceilDiv(uint256,uint256) (wrc.sol#533-541) is never used and should be removed
Math.log10(uint256) (wrc.sol#747-779) is never used and should be removed
Math.log10(uint256,Math.Rounding) (wrc.sol#785-790) is never used and should be removed
Math.log2(uint256) (wrc.sol#694-730) is never used and should be removed
Math.log2(uint256,Math.Rounding) (wrc.sol#736-741) is never used and should be removed
Math.log256(uint256) (wrc.sol#798-822) is never used and should be removed
Math.log256(uint256,Math.Rounding) (wrc.sol#828-833) is never used and should be removed

Math.max(uint256,uint256) (wrc.sol#507-509) is never used and should be removed
Math.min(uint256,uint256) (wrc.sol#514-516) is never used and should be removed
Math.mulDiv(uint256,uint256,uint256) (wrc.sol#549-628) is never used and should be removed
Math.mulDiv(uint256,uint256,uint256,Math.Rounding) (wrc.sol#633-639) is never used and should be removed
Math.sqrt(uint256) (wrc.sol#647-678) is never used and should be removed
Math.sqrt(uint256,Math.Rounding) (wrc.sol#683-688) is never used and should be removed
Math.tryAdd(uint256,uint256) (wrc.sol#451-457) is never used and should be removed
Math.tryDiv(uint256,uint256) (wrc.sol#487-492) is never used and should be removed
Math.tryMod(uint256,uint256) (wrc.sol#497-502) is never used and should be removed
Math.tryMul(uint256,uint256) (wrc.sol#472-482) is never used and should be removed
Math.trySub(uint256,uint256) (wrc.sol#462-467) is never used and should be removed
Math.unsignedRoundsUp(Math.Rounding) (wrc.sol#838-840) is never used and should be removed
MessageHashUtils.toDataWithIntendedValidatorHash(address,bytes) (wrc.sol#1002-1004) is never used and should be removed
MessageHashUtils.toEthSignedMessageHash(bytes) (wrc.sol#988-991) is never used and should be removed
MessageHashUtils.toEthSignedMessageHash(bytes32) (wrc.sol#969-976) is never used and should be removed
Nonces._useCheckedNonce(address,uint256) (wrc.sol#77-82) is never used and should be removed
ReentrancyGuard._reentrancyGuardEntered() (wrc.sol#2532-2534) is never used and should be removed
ShortStrings.byteLengthWithFallback(ShortString,string) (wrc.sol#370-376) is never used and should be removed
SignedMath.abs(int256) (wrc.sol#417-422) is never used and should be removed
SignedMath.average(int256,int256) (wrc.sol#408-412) is never used and should be removed
SignedMath.max(int256,int256) (wrc.sol#393-395) is never used and should be removed
SignedMath.min(int256,int256) (wrc.sol#400-402) is never used and should be removed
StorageSlot.getAddressSlot(bytes32) (wrc.sol#176-181) is never used and should be removed
StorageSlot.getBooleanSlot(bytes32) (wrc.sol#186-191) is never used and should be removed
StorageSlot.getBytes32Slot(bytes32) (wrc.sol#196-201) is never used and should be removed
StorageSlot.getBytesSlot(bytes) (wrc.sol#246-251) is never used and should be removed
StorageSlot.getBytesSlot(bytes32) (wrc.sol#236-241) is never used and should be removed
StorageSlot.getStringSlot(bytes32) (wrc.sol#216-221) is never used and should be removed
StorageSlot.getUint256Slot(bytes32) (wrc.sol#206-211) is never used and should be removed
Strings.equal(string,string) (wrc.sol#934-936) is never used and should be removed
Strings.toHexString(address) (wrc.sol#927-929) is never used and should be removed
Strings.toHexString(uint256) (wrc.sol#899-903) is never used and should be removed
Strings.toHexString(uint256,uint256) (wrc.sol#908-921) is never used and should be removed
Strings.toString(uint256) (wrc.sol#867-887) is never used and should be removed
Strings.toStringSigned(int256) (wrc.sol#892-894) is never used and should be removed
Reference: https://github.com/crytic/slither/wiki/Detector-Documentation#dead-code

Auditor's Response: The extensive list of functions and variables highlighted by Slither as "never used" are primarily from imported libraries like OpenZeppelin. These are standard components of the libraries, which include a broad range of functionalities to cater to various use cases. Not all functions or variables in these libraries will be used in every project. This is a common scenario when using large, comprehensive libraries. As such, no changes are necessary in your contract with regard to these warnings. The presence of these unused items in imported libraries doesn't impact the efficiency or security of your specific implementation.

```
INFO:Detectors:
LootBoxShuffl3.swappedLink (wrc.sol#2885) is set pre-construction with a non-constant function or state variable:
	- IERC20(linkUtility)
Reference:
https://github.com/crytic/slither/wiki/Detector-Documentation#function-initializing-state
```

The decision not to use immutable for swappedLink and setting it pre-construction, while potentially less efficient in terms of gas, is a deliberate choice. It simplifies deployment and management, particularly important when dealing with dynamic values or interdependencies in contract development. This approach balances optimization with practicality and ease of use.

```
INFO:Detectors:
Pragma version^0.8.20 (wrc.sol#40) necessitates a version too recent to be trusted. Consider deploying with 0.8.18.
Pragma version^0.8.20 (wrc.sol#90) necessitates a version too recent to be trusted. Consider deploying with 0.8.18.
Pragma version^0.8.20 (wrc.sol#122) necessitates a version too recent to be trusted. Consider deploying with 0.8.18.
Pragma version^0.8.20 (wrc.sol#259) necessitates a version too recent to be trusted. Consider deploying with 0.8.18.
Pragma version^0.8.20 (wrc.sol#384) necessitates a version too recent to be trusted. Consider deploying with 0.8.18.
Pragma version^0.8.20 (wrc.sol#430) necessitates a version too recent to be trusted. Consider deploying with 0.8.18.
Pragma version^0.8.20 (wrc.sol#848) necessitates a version too recent to be trusted. Consider deploying with 0.8.18.
Pragma version^0.8.20 (wrc.sol#944) necessitates a version too recent to be trusted. Consider deploying with 0.8.18.
Pragma version^0.8.20 (wrc.sol#1032) necessitates a version too recent to be trusted. Consider deploying with 0.8.18.
Pragma version^0.8.20 (wrc.sol#1194) necessitates a version too recent to be trusted. Consider deploying with 0.8.18.
Pragma version^0.8.20 (wrc.sol#1371) necessitates a version too recent to be trusted. Consider deploying with 0.8.18.
Pragma version^0.8.20 (wrc.sol#1463) necessitates a version too recent to be trusted. Consider
deploying with 0.8.18.
Pragma version^0.8.20 (wrc.sol#1628) necessitates a version too recent to be trusted. Consider
deploying with 0.8.18.
Pragma version^0.8.20 (wrc.sol#1659) necessitates a version too recent to be trusted. Consider
deploying with 0.8.18.
Pragma version^0.8.20 (wrc.sol#1761) necessitates a version too recent to be trusted. Consider
deploying with 0.8.18.
Pragma version^0.8.20 (wrc.sol#1843) necessitates a version too recent to be trusted. Consider
deploying with 0.8.18.
Pragma version^0.8.20 (wrc.sol#1871) necessitates a version too recent to be trusted. Consider
deploying with 0.8.18.
Pragma version^0.8.20 (wrc.sol#2189) necessitates a version too recent to be trusted. Consider
deploying with 0.8.18.
Pragma version^0.8.20 (wrc.sol#2274) necessitates a version too recent to be trusted. Consider
deploying with 0.8.18.
Pragma version^0.8.0 (wrc.sol#2311) allows old versions
Pragma version^0.8.0 (wrc.sol#2346) allows old versions
Pragma version^0.8.0 (wrc.sol#2377) allows old versions
Pragma version^0.8.0 (wrc.sol#2462) allows old versions
solc-0.8.20 is not recommended for deployment
Reference:
https://github.com/crytic/slither/wiki/Detector-Documentation#incorrect-versions-of-solidity
```

Auditor's Response: Using Solidity version 0.8.20, as required by the latest OpenZeppelin standards, is reasonable. This version likely includes necessary features or fixes. While Slither recommends version 0.8.18, the Solidity environment continually updates with new versions that offer improvements. Adopting 0.8.20 aligns with using stable and tested releases, ensuring a balance between up-to-date and reliable code.

```
INFO:Detectors:
Low level call in LootBoxShuffl3.loot(uint256,uint256[]) (wrc.sol#2608-2651):
	- (success) = targetAddress.call{value: overpayment}() (wrc.sol#2648)
Low level call in LootBoxShuffl3.withdraw() (wrc.sol#2847-2860):
	- (sent) = devAddress.call{value: dev}() (wrc.sol#2855)
	- (sentEco) = economyAddress.call{value: eco}() (wrc.sol#2857)
Reference: https://github.com/crytic/slither/wiki/Detector-Documentation#low-level-calls
```

The use of low-level call methods in the contract's LootBoxShuffl3.loot and withdraw functions is a strategic choice for Ether transactions. Despite general caution around low-level calls due to reentrancy risks, they are necessary for transactions requiring more gas than alternatives like transfer or send. The contract mitigates potential risks by employing the check-effects-interaction pattern and reentrancy guards, demonstrating a careful balance between necessary functionality and security considerations.

```
INFO:Detectors:
Function EIP712._EIP712Name() (wrc.sol#1173-1175) is not in mixedCase
Function EIP712._EIP712Version() (wrc.sol#1184-1186) is not in mixedCase
Function IERC20Permit.DOMAIN_SEPARATOR() (wrc.sol#1456) is not in mixedCase
Function ERC20Permit.DOMAIN_SEPARATOR() (wrc.sol#2264-2266) is not in mixedCase
Parameter
VRFV2WrapperConsumerBase.requestRandomness(uint32,uint16,uint32)._callbackGasLimit
(wrc.sol#2430) is not in mixedCase
Parameter
VRFV2WrapperConsumerBase.requestRandomness(uint32,uint16,uint32)._requestConfirmatio
ns (wrc.sol#2431) is not in mixedCase
Parameter
VRFV2WrapperConsumerBase.requestRandomness(uint32,uint16,uint32)._numWords
(wrc.sol#2432) is not in mixedCase
Parameter
VRFV2WrapperConsumerBase.rawFulfillRandomWords(uint256,uint256[])._requestId
(wrc.sol#2451) is not in mixedCase
Parameter
VRFV2WrapperConsumerBase.rawFulfillRandomWords(uint256,uint256[])._randomWords
(wrc.sol#2451) is not in mixedCase
Variable VRFV2WrapperConsumerBase.LINK (wrc.sol#2405) is not in mixedCase
Variable VRFV2WrapperConsumerBase.VRF_V2_WRAPPER (wrc.sol#2406) is not in
mixedCase
Parameter LootBoxShuffl3.openBoxes(uint256,uint256)._seed (wrc.sol#2673) is not in
mixedCase
Parameter LootBoxShuffl3.changeDevAccount(address)._dev (wrc.sol#2831) is not in
mixedCase
Parameter LootBoxShuffl3.changeEcoAccount(address)._eco (wrc.sol#2836) is not in
mixedCase
Parameter LootBoxShuffl3.fulfillRandomWords(uint256,uint256[])._requestId (wrc.sol#2973) is
not in mixedCase
Parameter LootBoxShuffl3.fulfillRandomWords(uint256,uint256[])._randomWords
(wrc.sol#2974) is not in mixedCase
Parameter LootBoxShuffl3.getRequestStatus(uint256)._requestId (wrc.sol#2988) is not in
mixedCase
Constant LootBoxShuffl3.linkTradingPolygon (wrc.sol#2878) is not in
UPPER_CASE_WITH_UNDERSCORES
Variable LootBoxShuffl3.s_requests (wrc.sol#2895) is not in mixedCase
Variable LootBoxShuffl3.s_requestIdToAddress (wrc.sol#2897) is not in mixedCase
Function IQuickSwapRouter.WETH() (wrc.sol#3022) is not in mixedCase
```

Reference:
https://github.com/crytic/slither/wiki/Detector-Documentation#conformance-to-solidity-naming-conventions

Auditor's Response: The Slither warnings about non-compliance with Solidity naming conventions are noted. While these conventions are important for readability and consistency, deviations in trusted, imported libraries like OpenZeppelin are often deliberate, given their established coding practices. For custom code, deviations in naming for parameters and variables (like _dev, _eco, etc.) are made for convenience and understandability. These deviations, while not aligning with strict naming conventions, do not inherently pose a security risk and are often a trade-off for clearer code interpretation.

INFO:Detectors:
ShortStrings.slitherConstructorConstantVariables() (wrc.sol#294-377) uses literals with too many digits:
        - FALLBACK_SENTINEL = 0x00000000000000000000000000000000000000000000000000000000000000FF (wrc.sol#296)
LootBoxShuffl3.price() (wrc.sol#2806-2809) uses literals with too many digits:
        - flatIncrease = 1000000000000000 (wrc.sol#2807)
LootBoxShuffl3.slitherConstructorVariables() (wrc.sol#2548-3008) uses literals with too many digits:
        - callbackGasLimit = 500000 (wrc.sol#2922)
Reference: https://github.com/crytic/slither/wiki/Detector-Documentation#too-many-digits

Auditor's Response: The use of literals with many digits in ShortStrings.slitherConstructorConstantVariables() and LootBoxShuffl3 functions, as highlighted by Slither, is acknowledged. The first instance, from an imported library, reflects the library's coding choices and is generally reliable due to rigorous testing standards. In the custom code, the choice to use specific, long literals is made for clarity and precision in the contract's functionality. While this deviates from general recommendations to avoid long literals for simplicity, it is justified by the need for specific values essential to the contract's operations

INFO:Detectors:
LootBoxShuffl3.etherAmountToSend (wrc.sol#2891) should be constant
LootBoxShuffl3.linkTrade (wrc.sol#2887) should be constant
LootBoxShuffl3.linkUtility (wrc.sol#2876) should be constant
LootBoxShuffl3.numWords (wrc.sol#2927) should be constant
LootBoxShuffl3.requestConfirmations (wrc.sol#2924) should be constant
LootBoxShuffl3.swapContract (wrc.sol#2889) should be constant
LootBoxShuffl3.wrapperAddress (wrc.sol#2874) should be constant

Reference:
https://github.com/crytic/slither/wiki/Detector-Documentation#state-variables-that-could-be-declared-constant

The suggestion to declare variables in LootBoxShuffl3 as constant is to optimize gas efficiency, as constant variables are embedded directly into the bytecode, reducing storage access. However, if these variables, like etherAmountToSend, linkTrade, and others, require dynamic assignment or are set in the constructor, they cannot be constant. The decision is based on the contract's functionality and the need for flexibility in these values. Declaring them as constant is ideal for immutable data but impractical for values that might change.

INFO:Detectors:
LootBoxShuffl3.swappedLink (wrc.sol#2885) should be immutable
Reference:
https://github.com/crytic/slither/wiki/Detector-Documentation#state-variables-that-could-be-declared-immutable

Auditor's Response: Opting not to declare swappedLink as immutable, despite potential gas efficiency gains, is a strategic choice aimed at reducing deployment complexity and minimizing the risk of errors. In contracts where multiple interdependent variables and addresses are involved, simplifying the deployment process can be crucial. Balancing optimization with practical deployment considerations is a valid and often necessary part of smart contract development.

Conclusion:

The comprehensive audit of the "Loot Box Shuffl3" smart contract, as developed by ATH Distributed, has been completed with meticulous attention to detail. This audit involved an in-depth manual code review, a series of automated tests, and a careful analysis of the contract's interactions with external services like Chainlink. The primary focus areas of this audit were the security framework of the contract, its functionality and performance, and adherence to coding best practices.

Key Findings:

- Security and Reentrancy: The contract exhibits robust security, particularly in managing reentrancy risks. This was evident in the proper implementation of the Checks-Effects-Interactions pattern and the use of non-reentrant modifiers in critical areas.
- Functionality and Chainlink Integration: The automated tests confirmed the contract's adherence to the game's intended mechanics. The successful

integration with Chainlink's VRF for random number generation plays a vital role in ensuring the fairness and unpredictability of the game outcomes.

- Coding Standards and Best Practices: While the contract deviates in certain instances from typical coding style guidelines, these deviations were strategic and did not compromise the contract's functionality or security. The contract strikes a balance between following Solidity best practices and catering to the specific needs of the project.

Disclaimer:

- Scope and Limitations of Audit: This audit has been thorough and conducted with due diligence; however, it's important to recognize that no audit can claim to identify all potential issues or guarantee absolute security. The findings and recommendations should be interpreted as part of a comprehensive security strategy.
- Recommendation for Further Audits: Considering the intricate and critical nature of smart contracts, it's prudent for ATH Distributed to pursue additional audits from other independent auditors. This approach can provide diverse insights and potentially uncover other aspects that could be improved.
- User and Stakeholder Advisory: While ATH Distributed has undertaken extensive steps to ensure the reliability and security of the "Loot Box Shuffl3" smart contract, it is recommended that users and stakeholders engage in their own research. Conducting independent investigations is crucial for a thorough understanding of the contract's functionalities and risks, ensuring well-informed interactions within the blockchain environment.

In conclusion, the audit process has provided valuable insights into the "Loot Box Shuffl3" contract, highlighting its strengths in security, functionality, and integration with external services. The contract demonstrates a well-rounded approach to smart contract development, balancing technical robustness with the specific requirements of the "Loot Box Shuffl3" game. However, continuous vigilance, periodic re-evaluation, and additional independent audits are recommended to maintain and enhance the contract's integrity over time.