Vonder Finance Token and Farm

Smart Contract Audit Report

Date Issued: *24 Aug 2021*

Version: *Final v1.0*

ValiX Consulting

Public

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Executive Summary

Overview

Valix conducted a smart contract audit to evaluate potential security issues of the **Token and Farm features**. This audit report was published on `August 24, 2021`. The audit scope is limited to the **Token and Farm features.** Our security best practices strongly recommend that the **Vonder Finance team** conduct a full security audit for both on-chain and off-chain components of its infrastructure and their interaction. A comprehensive examination has been performed during the audit process utilizing Valix's Formal Verification, Static Analysis, and Manual Review techniques.

Scope of Work

The security audit conducted does not replace the full security audit of the overall Vonder Finance protocol. The scope is limited to the **Token and Farm features** and their related smart contracts.

The security audit covered the components at this specific state:

Item	Description
Components	▪ *Vonder MasterChef smart contract* ▪ *VonderToken smart contract* ▪ *Imported associated smart contracts*
GitHub Repository	▪ *https://github.com/vonderfinance/vonder-masterchef*
Commit	▪ *edacb5cb3ed72546e706043bfe3078a63cb07fbe*
Reassessment Commit	▪ *36dec4e96394925af233ea08c0490e4f18edf3ac*
Audited Files	▪ *MasterChef.sol* ▪ *VonderToken.sol*
Excluded Files/Contracts	-

Remark: Our security best practices strongly recommend that the Vonder Finance team conduct a full security audit for both on-chain and off-chain components of its infrastructure and the interaction between them.

Auditors

Phuwanai Thummavet
Sumedt Jitpukdebodin
Keerati Torach
Boonpoj Thongakaraniroj

Disclaimer

Our smart contract audit was conducted over a limited period and was performed on the smart contract at a single point in time. As such, the scope was limited to current known risks during the work period. The review does not indicate that the smart contract and blockchain software has no vulnerability exposure.

We reviewed the security of the smart contracts with our best effort, and we do not guarantee a hundred percent coverage of the underlying risk existing in the ecosystem. The audit was scoped only in the provided code repository. The on-chain code is not in the scope of auditing.

This audit report does not provide any warranty or guarantee, nor should it be considered an “approval” or “endorsement” of any particular project. This audit report should also not be used as investment advice nor provide any legal compliance.

Audit Result Summary

From the audit results and the remediation and response from the developer, Valix trusts that the **Token and Farm features** have sufficient security protections to be safe for use.

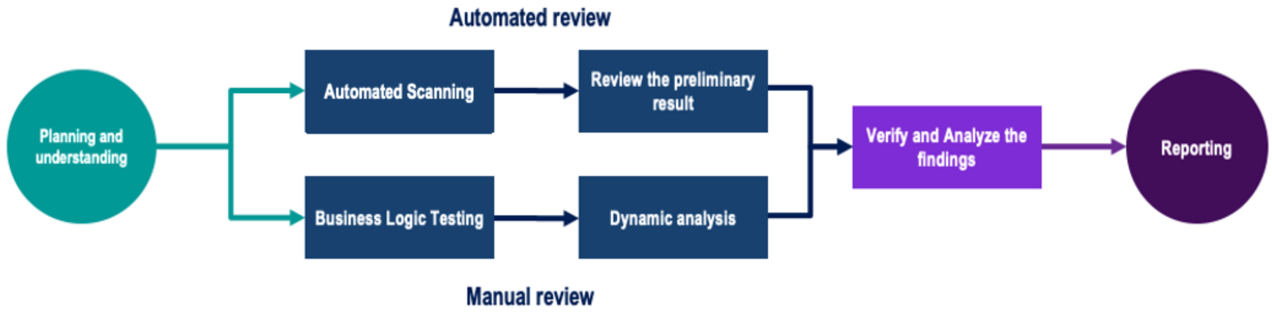
Initially, Valix was able to identify **14 issues** that were categorized from the "Critical" to "Informational" risk level in the given timeframe of the assessment. On the reassessment, all high and medium risk issues were fixed. For the acknowledged issues, the Vonder team acknowledged each issue but decided to remain the original code. Below is the breakdown of the vulnerabilities found and their associated risk rating for each assessment conducted.

Target	Assessment Result					Reassessment Result				
	C	H	M	L	I	C	H	M	L	I
Token and Farm	-	4	2	5	3	-	0	0	5	3

Note: *Risk Rating* **C** *Critical,* **H** *High,* **M** *Medium,* **L** *Low,* **I** *Informational*

Methodology

The smart contract security audit methodology is based on Smart Contract Weakness Classification and Test Cases (SWC Registry), CWE, well-known best practices, and smart contract hacking case studies. Manual and automated review approaches can be mixed and matched, including business logic analysis in terms of the malicious doer's perspective. Using automated scanning tools to navigate or find offending software patterns in the codebase along with a purely manual or semi-automated approach, where the analyst primarily relies on one's knowledge, is performed to eliminate the false-positive results.



Planning and Understanding

- Determine the scope of testing and understanding the application’s purposes and workflows.
- Identify key risk areas, including technical and business risks.
- Determine which sections to review within the resource constraints and review method – automated, manual or mixed.

Automated Review

- Adjust automated source code review tools to inspect the code for known unsafe coding patterns.
- Verify the tool's output to eliminate false-positive results, and adjust and re-run the code review tool if necessary.

Manual Review

- Analyzing the business logic flaws requires thinking in unconventional methods.
- Identify unsafe coding behavior via static code analysis.

Reporting

- Analyze the root cause of the flaws.
- Recommend improvements for secure source code.

Audit Items

We perform the audit according to the following categories and test names.

Category	ID	Test Name
Security Issue	SEC01	*Authorization Through tx.origin*
	SEC02	*Business Logic Flaw*
	SEC03	*Delegatecall to Untrusted Callee*
	SEC04	*DoS With Block Gas Limit*
	SEC05	*DoS with Failed Call*
	SEC06	*Function Default Visibility*
	SEC07	*Hash Collisions With Multiple Variable Length Arguments*
	SEC08	*Incorrect Constructor Name*
	SEC09	*Improper Access Control or Authorization*
	SEC10	*Improper Emergency Response Mechanism*
	SEC11	*Insufficient Validation of Address Length*
	SEC12	*Integer Overflow and Underflow*
	SEC13	*Outdated Compiler Version*
	SEC14	*Outdated Library Version*
	SEC15	*Private Data On-Chain*
	SEC16	*Reentrancy*
	SEC17	*Transaction Order Dependence*
	SEC18	*Unchecked Call Return Value*
	SEC19	*Unexpected Token Balance*
	SEC20	*Unprotected Assignment of Ownership*
	SEC21	*Unprotected SELFDESTRUCT Instruction*
	SEC22	*Unprotected Token Withdrawal*
	SEC23	*Unsafe Type Inference*
	SEC24	*Use of Deprecated Solidity Functions*
	SEC25	*Use of Untrusted Code or Libraries*
	SEC26	*Weak Sources of Randomness from Chain Attributes*
	SEC27	*Write to Arbitrary Storage Location*

Category	ID	Test Name
Functional Issue	**FNC01**	*Arithmetic Precision*
	FNC02	*Permanently Locked Fund*
	FNC03	*Redundant Fallback Function*
	FNC04	*Timestamp Dependence*
Operational Issue	**OPT01**	*Code With No Effects*
	OPT02	*Message Call with Hardcoded Gas Amount*
	OPT03	*The Implementation Contract Flow or Value and the Document is Mismatched*
	OPT04	*The Usage of Excessive Byte Array*
	OPT05	*Unenforced Timelock on An Upgradeable Proxy Contract*
Developmental Issue	**DEV01**	*Assert Violation*
	DEV02	*Other Compilation Warnings*
	DEV03	*Presence of Unused Variables*
	DEV04	*Shadowing State Variables*
	DEV05	*State Variable Default Visibility*
	DEV06	*Typographical Error*
	DEV07	*Uninitialized Storage Pointer*
	DEV08	*Violation of Solidity Coding Convention*
	DEV09	*Violation of Token (ERC20) Standard API*

Risk Rating

To prioritize the vulnerabilities, we have adopted the scheme of five distinct levels of risk: **Critical**, **High**, **Medium**, **Low**, and **Informational**, based on OWASP Risk Rating Methodology. The risk level definitions are presented in the table.

Risk Level	Definition
Critical	The code implementation does not match the specification, and it could disrupt the platform.
High	The code implementation does not match the specification, or it could result in the loss of funds for contract owners or users.
Medium	The code implementation does not match the specification under certain conditions, or it could affect the security standard by losing access control.
Low	The code implementation does not follow best practices or use suboptimal design patterns, which may lead to security vulnerabilities further down the line.
Informational	Findings in this category are informational and may be further improved by following best practices and guidelines.

The **risk value** of each issue was calculated from the product of the **impact** and **likelihood values**, as illustrated in a two-dimensional matrix below.

- **Likelihood** represents how likely a particular vulnerability is exposed and exploited in the wild.
- **Impact** measures the technical loss and business damage of a successful attack.
- **Risk** demonstrates the overall criticality of the risk.

Impact \ Likelihood	High	Medium	Low
High	Critical	High	Medium
Medium	High	Medium	Low
Low	Medium	Low	Informational

The shading of the matrix visualizes the different risk levels. Based on the acceptance criteria, the risk levels "Critical" and "High" are unacceptable. Any issue obtaining the above levels must be resolved to lower the risk to an acceptable level.

Findings

Review Findings Summary

The table below shows the summary of our assessments.

No.	Issue	Risk	Status	Functionality is in use
1	Voting Amplification	High	Fixed	Not in use
2	Voting Displacement	High	Fixed	Not in use
3	Contract Parameters Can Be Altered By The Platform Developer Without Timelock	High	Partially Fixed	In use
4	Redelegation Failure	High	Fixed	Not in use
5	No Maximum Supply Minting Check	Medium	Fixed	In use
6	No LP Token Adding After Deposit	Medium	Fixed	In use
7	Emission Rate Update May Fail	Low	Acknowledged	In use
8	*DevAddress* Reassignment May Fail	Low	Acknowledged	In use
9	*FeeAddress* Reassignment May Fail	Low	Acknowledged	In use
10	The Compiler May Be Susceptible To The Publicly Disclosed Bugs	Low	Acknowledged	In use
11	The Compiler Is Not Locked To A Specific Version	Low	Acknowledged	In use
12	Same LP Token May Be Added More Than Once	Informational	Acknowledged	In use
13	The Function Name With internal Visibility Is Not Complied With The Naming Convention	Informational	Acknowledged	In use
14	Public Functions That Could Be Declared As *external*	Informational	Acknowledged	In use

The statuses of the issues are defined as follows:

Fixed: The issue has been completely resolved and has no further complications.

Partially Fixed: The issue has been partially resolved.

Acknowledged: The issue's risk has been reported and acknowledged.

Detailed Result

This section provides our issues found in detail.

<table>
<tr><td>No. 1</td><td colspan="3">Voting Amplification</td></tr>
<tr><td rowspan="2">Risk</td><td rowspan="2">High</td><td>Likelihood</td><td>High</td></tr>
<tr><td>Impact</td><td>Medium</td></tr>
<tr><td>Functionality is in use</td><td>Not in use</td><td>Status</td><td>Fixed</td></tr>
<tr><td>Associated Files</td><td colspan="3">VonderToken.sol</td></tr>
<tr><td>Locations</td><td colspan="3">_moveDelegates(address, address, uint256) L:874 - 892</td></tr>
<tr><td colspan="4">Description</td></tr>
<tr><td colspan="4">VON token was designed to be a governance token. Therefore, VON token holders can vote on the desired representative or proposal by delegating their tokens to. The <code>_moveDelegates</code> function would be executed during the delegation/voting process to transfer votes (represented by VON tokens) from each delegator to a representative.

However, the <code>_moveDelegates</code> function does not lock up the delegated VON tokens inside the contract. This delegation mechanism potentially causes a double-spending issue leading to a Sybil attack which amplifies the voting power improperly.

Consider the following voting amplification attack scenario:

1. Attacker #1 has 100 tokens and delegates his vote to Bob (the representative). Bob gains 100 votes now.
2. Attacker #1 transfers his 100 tokens to Attacker #2.
3. Attacker #2 delegates the obtained 100 tokens to Bob. Now, Bob captures 200 votes.
4. Attackers can easily amplify Bob’s votes by performing Steps 2 and 3 repeatedly.</td></tr>
<tr><td colspan="4">Recommendations</td></tr>
<tr><td colspan="4">We recommend two possible solutions. The first solution is improving the <code>VonderToken</code> contract to lock away the delegated VON tokens inside until the voting or delegating period is complete. The <code>VonderToken</code> contract also has to record the number of votes of each delegator correctly so that the contract can check and move each delegator's votes precisely when re-delegating.

Another solution is implementing another <code>voting</code> contract and using VON tokens as the contract's voting tokens. The <code>voting</code> contract also needs to lock up and record the delegated VON tokens correctly nonetheless.</td></tr>
</table>

Platform Developer Response
The affected voting functionality was removed from the VonderToken contract.

Detailed Issue

This issue enables attackers to massively amplify their votes on any desired representative or proposals with a minimal attack cost.

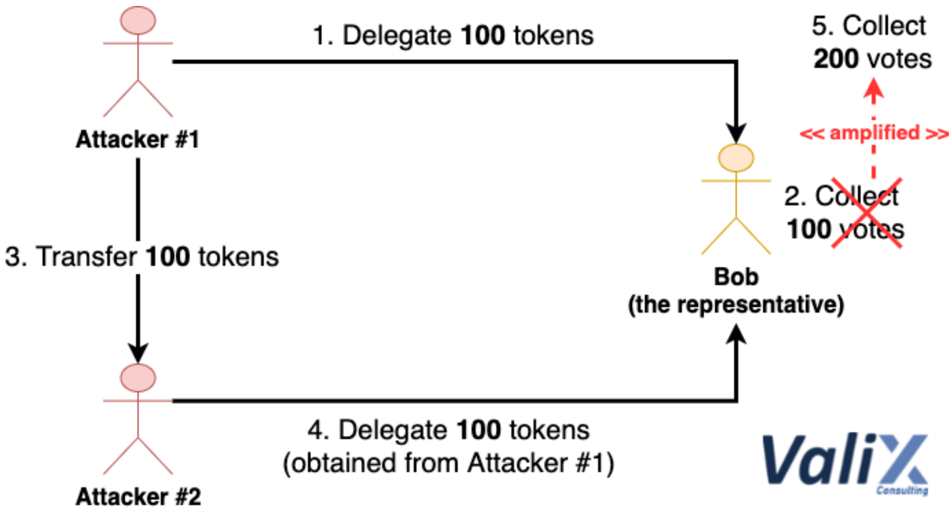
VonderToken.sol

```
874 function _moveDelegates(address srcRep, address dstRep, uint256 amount) internal {
875     if (srcRep != dstRep && amount > 0) {
876         if (srcRep != address(0)) {
877             // decrease old representative
878             uint32 srcRepNum = numCheckpoints[srcRep];
879             uint256 srcRepOld = srcRepNum > 0 ? checkpoints[srcRep][srcRepNum - 1].votes : 0;
880             uint256 srcRepNew = srcRepOld.sub(amount);
881             _writeCheckpoint(srcRep, srcRepNum, srcRepOld, srcRepNew);
882         }
883
884         if (dstRep != address(0)) {
885             // increase new representative
886             uint32 dstRepNum = numCheckpoints[dstRep];
887             uint256 dstRepOld = dstRepNum > 0 ? checkpoints[dstRep][dstRepNum - 1].votes : 0;
888             uint256 dstRepNew = dstRepOld.add(amount);
889             _writeCheckpoint(dstRep, dstRepNum, dstRepOld, dstRepNew);
890         }
891     }
892 }
```

The code snippet above shows the *_moveDelegates* function that is the root cause of the issue. This function is executed during the voting delegation process to move the delegator's votes to the representative. In other words, the amount of the votes (represented by the VON tokens) from a delegator will be increased to the representative (line no's. 886–889).

Although the *_moveDelegates* function can move the delegator's votes to the targeting representative correctly, the function does not lock up the delegated VON tokens inside the contract.

This design flaw opens the room for a double-spending attack in which attackers can create Sybil accounts leading to the voting amplification.



Voting amplification attack

Consider the voting amplification attack scenario in the figure above.

1. **Attacker #1** initially has *100 tokens* and delegates his vote to **Bob**
2. **Bob** now collects *100 votes*
3. **Attacker #1** transfers his *100 tokens* to **Attacker #2**
4. **Attacker #2** delegates the obtained *100 tokens* to **Bob**
5. **Bob**'s collected votes have been amplified to *200*

The attackers can easily amplify Bob's votes by performing Steps 3 and 4 repeatedly.

Reassessment

The affected voting functionality was removed from the VonderToken contract.

No. 2	Voting Displacement		
Risk	High	Likelihood	High
		Impact	Medium
Functionality is in use	Not in use	Status	Fixed
Affected Files	*VonderToken.sol*		
Locations	*_delegate(address, address) L:862 - 872* *_moveDelegates(address, address, uint256) L:874 - 892*		

Description

A voter/delegator (VON token holder) can re-delegate his votes to another representative by calling the external *delegate* or *delegateBySig* function. The external function will subsequently call the internal *_delegate* function which will obtain a delegator balance.

The *_moveDelegates* function is then invoked to move the delegator's votes (the previously obtained delegator balance) from the current to the new representative. Unfortunately, this redelegation mechanism allows attackers to perform the votes withdrawal over their previous delegation, potentially leading to an attack that displaces other voters' votes.

Consider the following voting displacement scenario:

1. **Bob** (the representative) received *450 votes* from **other voters**.
2. **Attacker #1** has *1 token* and delegates his vote to **Bob**. **Bob** now has *451 votes*.
3. **Attacker #2** transfers *450 tokens* to **Attacker #1**. **Attacker #1** now has *451 tokens* in his wallet.
4. **Attacker #1** re-delegates his vote from **Bob** to **Attacker #2**. Since the current token balance of **Attacker #1** is *451*, the *_moveDelegate* function moves *451 votes* from **Bob** to **Attacker #2**. Total votes from **other voters** were displaced unexpectedly.

Recommendations

We recommend two possible solutions. The first solution is improving the *VonderToken* contract to lock away the delegated VON tokens inside until the voting or delegating period is complete. The *VonderToken* contract also has to record the number of votes of each delegator correctly so that the contract can check and move each delegator's votes precisely when re-delegating.

Another solution is implementing another *voting* contract and using VON tokens as the contract's voting tokens. The *voting* contract also needs to lock up and record the delegated VON tokens correctly nonetheless.

Platform Developer Response

The affected voting functionality was removed from the VonderToken contract.

Detailed Issue

This issue allows attackers to take out other voters' votes.

VonderToken.sol

```
862 function _delegate(address delegator, address delegatee)
863     internal
864 {
865     address currentDelegate = _delegates[delegator];
866     uint256 delegatorBalance = balanceOf(delegator); // balance of underlying VONs (not scaled);
867     _delegates[delegator] = delegatee;
868 
869     emit DelegateChanged(delegator, currentDelegate, delegatee);
870 
871     _moveDelegates(currentDelegate, delegatee, delegatorBalance);
872 }
873 
874 function _moveDelegates(address srcRep, address dstRep, uint256 amount) internal {
875     if (srcRep != dstRep && amount > 0) {
876         if (srcRep != address(0)) {
877             // decrease old representative
878             uint32 srcRepNum = numCheckpoints[srcRep];
879             uint256 srcRepOld = srcRepNum > 0 ? checkpoints[srcRep][srcRepNum - 1].votes : 0;
880             uint256 srcRepNew = srcRepOld.sub(amount);
881             _writeCheckpoint(srcRep, srcRepNum, srcRepOld, srcRepNew);
882         }
883 
884         if (dstRep != address(0)) {
885             // increase new representative
886             uint32 dstRepNum = numCheckpoints[dstRep];
887             uint256 dstRepOld = dstRepNum > 0 ? checkpoints[dstRep][dstRepNum - 1].votes : 0;
888             uint256 dstRepNew = dstRepOld.add(amount);
889             _writeCheckpoint(dstRep, dstRepNum, dstRepOld, dstRepNew);
890         }
891     }
892 }
```

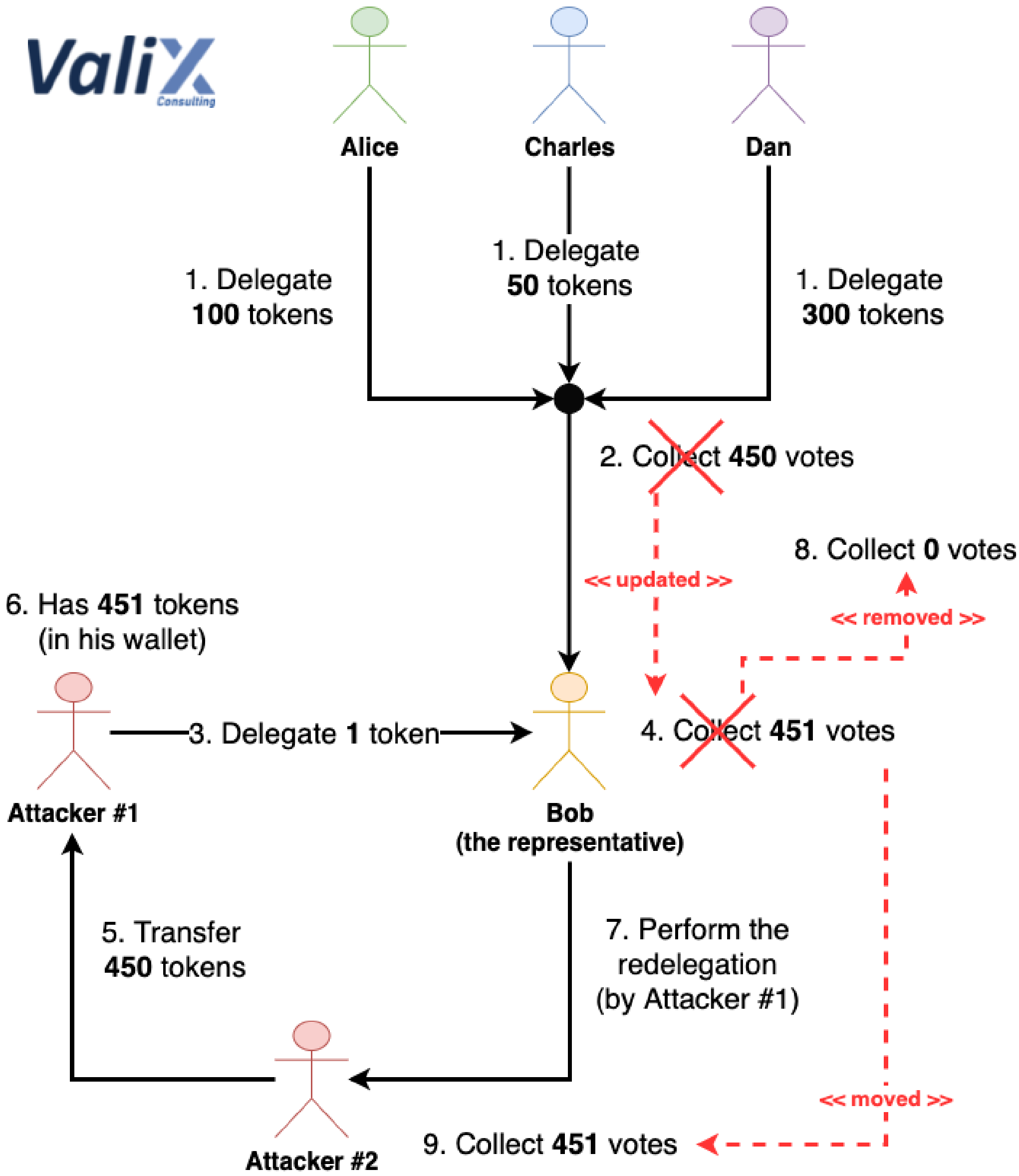
The code snippet above shows the *_delegate* and *_moveDelegates* functions that are the root cause of the issue. During the redelegation process, the *_delegate* function would be executed. This function gets the delegator's current representative (line no. 865). Then, the function reads the delegator's current VON balance (line no. 866). Next, the function changes the representative to the new one (line no. 867).

The delegator's VON balance (from line no. 866) is then passed into the *_moveDelegates* function (line no. 871) and becomes the function parameter, amount.

In the `_moveDelegates` function, the old representative's votes are decreased by the variable amount (line no. 880). The exact amount is also increased to the new representative's votes (line no. 888). In other words, the votes will be moved from the old to the new representative.

Since the amount of the moved votes is determined by the delegator's current VON balance, not the previously delegated VONs, the attackers can manipulate the incorrect number of the votes movement.

To conclude, the delegator's VON balance (line no. 866) is the root cause of the issue.



Voting displacement attack

Consider the voting displacement scenario illustrated in the figure above.

1. **Alice**, **Charles**, and **Dan** delegate *100*, *50*, and *300 tokens* respectively to **Bob**
2. **Bob** collects *450 votes*
3. **Attacker #1** initially has *1 token* and delegates his vote to **Bob**
4. **Bob** collects *451 votes* for now
5. **Attacker #2** transfers his *450 tokens* to **Attacker #1**
6. **Attacker #1** now has *451 tokens* in his wallet
7. **Attacker #1** re-delegates his vote to **Attacker #2**
8. **Bob**'s collected votes are improperly removed by *451* (i.e., the current token balance of **Attacker #1**) and finally become *0*
9. **Attacker #2** eventually receives the *manipulated 451 votes*

The ***450 votes*** (delegated by **Alice**, **Charles**, and **Dan**) to **Bob** are improperly removed at Step 8 due to the design flaw explained earlier. Hence, **the attackers can use this voting displacement attack to dismiss the votes of other voters easily**.

Reassessment

The affected voting functionality was removed from the VonderToken contract.

No. 3	Contract Parameters Can Be Altered By The Platform Developer Without Timelock		
Risk	High	Likelihood	Medium
		Impact	High
Functionality is in use	In use	Status	Partially Fixed
Affected Files	*MasterChef.sol*		
Locations	-		

Description

The MasterChef contract is owned by an Externally Owned Account (EOA) without having an intermediate contract to prevent an administrative user from executing an arbitrary function immediately. The state variables such as `vonPerBLock` (emission rate) could be updated and effective immediately without user notification.

Recommendations

Implement the Timelock contract and transfer the ownership of the MasterChef contract to the Timelock contract.

The linkage of the associated contracts should be as follows:

Deployer or **multi-signature contract** --> **Timelock** --> **MasterChef**

Specifically, the MasterChef is owned by the Timelock, whereas the TImelock is owned by a deployer (admin).

It is acceptable to use an externally owned account as an administrator of the Timelock.
For best practices, a multi-signature contract should be an administrator of the Timelock.

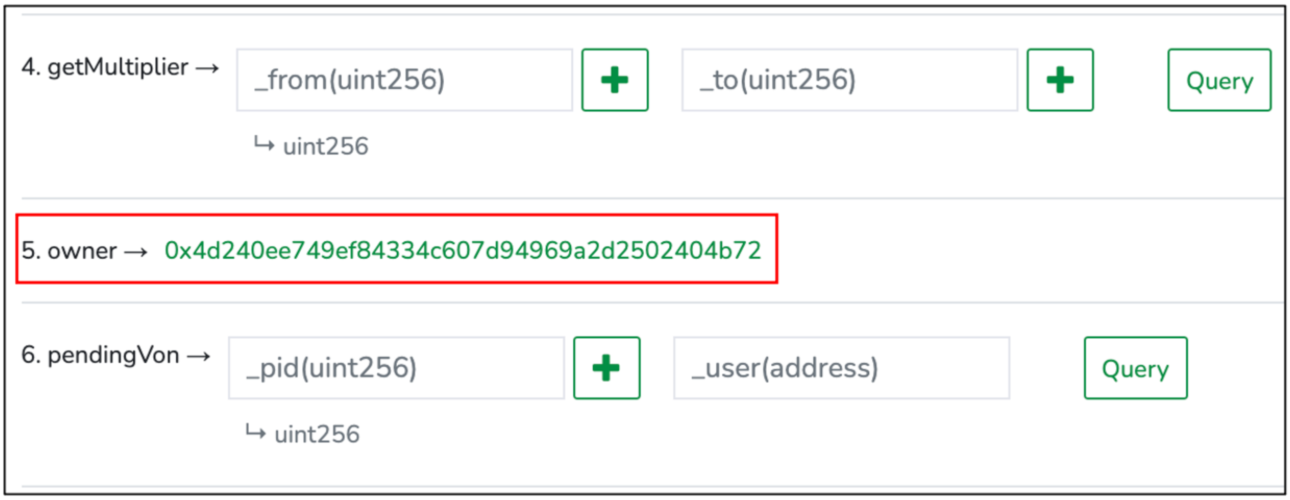
Reference: https://docs.gnosis.io/safe/docs/contracts_architecture/

Platform Developer Response

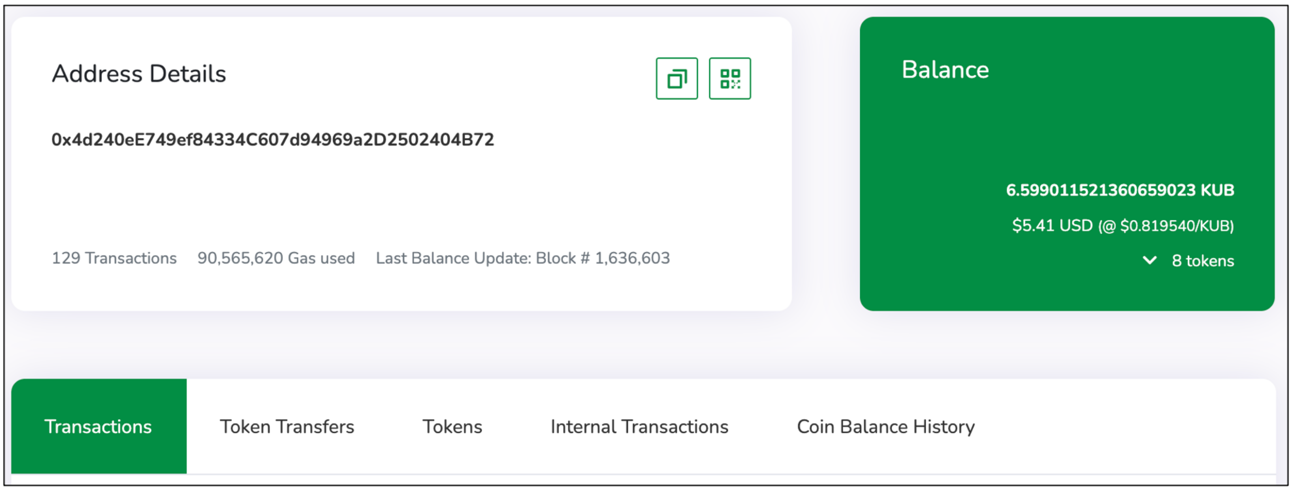
The developer implemented the Timelock contract for resolving this issue.

Detailed Issue

According to the MasterChef contract on the BKCScan (https://bkcscan.com/address/0x60326f6Ad05adeE2ffD42B0c05c68Ead535B104E), its owner address was 0x4d240ee749ef84334c607d94969a2d2502404b72.



Apparently, the owner of the MasterChef contract was an Externally Owned Account (EOA) wallet: https://bkcscan.com/address/0x4d240eE749ef84334C607d94969a2D2502404B72.



Since the EOA account (admin) can immediately change and affect the platform's parameters, users cannot have time to inspect any parameter changes.

For example, the state variable *vonPerBlock* could be changed and take effect immediately.

MasterChef.sol

```
function updateEmissionRate(uint256 _vonPerBlock) public onlyOwner {
    massUpdatePools();
    vonPerBlock = _vonPerBlock;
}
```

Reassessment

The developer implemented the Timelock contract for resolving this issue.

Timelock.sol

```
// SPDX-License-Identifier: MIT

pragma solidity 0.6.12;

import './libs/SafeMath.sol';

contract Timelock {
    using SafeMath for uint;

    event NewAdmin(address indexed newAdmin);
    event NewPendingAdmin(address indexed newPendingAdmin);
    event NewDelay(uint indexed newDelay);
    event CancelTransaction(bytes32 indexed txHash, address indexed target, uint value, string signature,  bytes data, uint eta);
    event ExecuteTransaction(bytes32 indexed txHash, address indexed target, uint value, string signature,  bytes data, uint eta);
    event QueueTransaction(bytes32 indexed txHash, address indexed target, uint value, string signature, bytes data, uint eta);

    uint public constant GRACE_PERIOD = 14 days;
    uint public constant MINIMUM_DELAY = 6 hours;
    uint public constant MAXIMUM_DELAY = 30 days;
...
```

However, we found that the *setPendingAdmin* function of the Timelock contract allows the developer to set the state variable *pendingAdmin* without time delay (line no's. 63 - 66) for the first call of the *admin* address changes. In other words, the developer can change the *admin* address for the first time immediately.

Timelock.sol

```
58 function setPendingAdmin(address pendingAdmin_) public {
59     // allows one time setting of admin for deployment purposes
60     if (admin_initialized) {
61         require(msg.sender == address(this), "Timelock::setPendingAdmin: Call must come from Timelock.");
62     } else {
63         require(msg.sender == admin, "Timelock::setPendingAdmin: First call must come from admin.");
64         admin_initialized = true;
65     }
66     pendingAdmin = pendingAdmin_;
67 
68     emit NewPendingAdmin(pendingAdmin);
69 }
```

We notified this concern to the Vonder team. The team acknowledged our concern but decided to make no further improvements.

No. 4	Redelegation Failure		
Risk	High	Likelihood	High
		Impact	Medium
Functionality is in use	Not in use	Status	Fixed
Affected Files	*VonderToken.sol*		
Locations	*_delegate(address, address) L:862 - 872* *_moveDelegates(address, address, uint256) L:874 - 892*		

Description

A voter/delegator (VON token holder) can re-delegate his votes to another representative by calling the external `delegate` or `delegateBySig` function. The external function will subsequently call the internal `_delegate` function which will obtain a delegator balance.

The `_moveDelegates` function is then invoked to move the delegator's votes (the previously obtained delegator balance) from the current to the new representative.

There are some situations where the voter/delegator cannot re-delegate their votes. **Consider the following redelegation scenario:**

1. **Alice** has *100 tokens* and delegates her vote to **Bob**.
2. **Alice** receives additional *10 tokens* from her yield farming.
3. If **Alice** attempts to re-delegate her *110 tokens* to **Dan**, the transaction will fail since the `_moveDelegates` function will try to un-delegate *110* (not *100*) votes from **Bob**, causing the `sub` function of the `SafeMath` library to revert.

Recommendations

We recommend two possible solutions. The first solution is improving the `VonderToken` contract to lock away the delegated VON tokens inside until the voting or delegating period is complete. The `VonderToken` contract also has to record the number of votes of each delegator correctly so that the contract can check and move each delegator's votes precisely when re-delegating.

Another solution is implementing another `voting` contract and using VON tokens as the contract's voting tokens. The `voting` contract also needs to lock up and record the delegated VON tokens correctly nonetheless.

Platform Developer Response

The affected voting functionality was removed from the VonderToken contract.

Detailed Issue

This issue causes a transaction revert during the redelegation process, which can affect every regular voter.

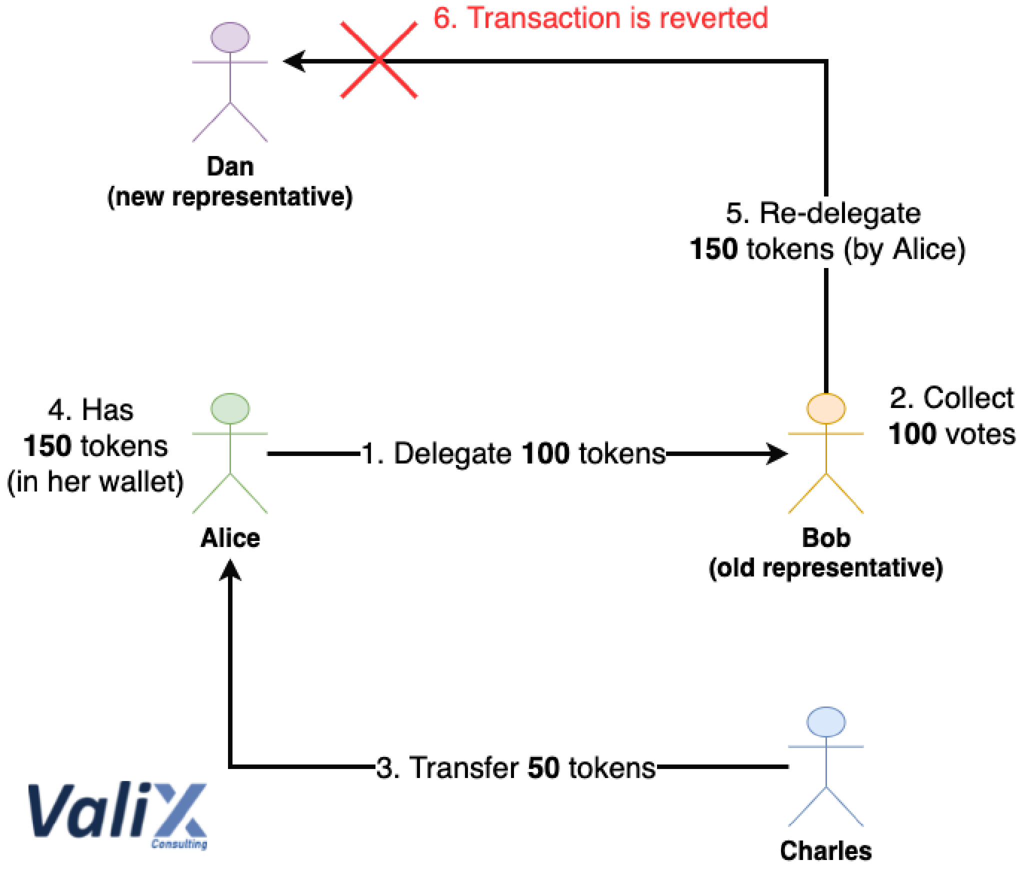
VonderToken.sol

```
862 function _delegate(address delegator, address delegatee)
863     internal
864 {
865     address currentDelegate = _delegates[delegator];
866      uint256 delegatorBalance = balanceOf(delegator); // balance of underlying VONs (not scaled);
867     _delegates[delegator] = delegatee;
868
869     emit DelegateChanged(delegator, currentDelegate, delegatee);
870
871     _moveDelegates(currentDelegate, delegatee, delegatorBalance);
872 }
873
874 function _moveDelegates(address srcRep, address dstRep, uint256 amount) internal {
875     if (srcRep != dstRep && amount > 0) {
876         if (srcRep != address(0)) {
877             // decrease old representative
878             uint32 srcRepNum = numCheckpoints[srcRep];
879              uint256 srcRepOld = srcRepNum > 0 ? checkpoints[srcRep][srcRepNum - 1].votes : 0;
880             uint256 srcRepNew = srcRepOld.sub(amount);
881             _writeCheckpoint(srcRep, srcRepNum, srcRepOld, srcRepNew);
882         }
883
884         if (dstRep != address(0)) {
885             // increase new representative
886             uint32 dstRepNum = numCheckpoints[dstRep];
887              uint256 dstRepOld = dstRepNum > 0 ? checkpoints[dstRep][dstRepNum - 1].votes : 0;
888             uint256 dstRepNew = dstRepOld.add(amount);
889             _writeCheckpoint(dstRep, dstRepNum, dstRepOld, dstRepNew);
890         }
891     }
892 }
```

The code snippet above points out the root cause of the issue; the *_delegate* and *_moveDelegates* functions. The *_moveDelegates* function will move a certain amount of votes from the old (line no's. 878–881) to the new representative (line no's. 886–889). The votes movement amount is determined by the delegator's current VON balance (line no. 866) in the *_delegate* function.

During the re-delegation process, the transaction would be reverted in line no. 880 if the delegator has more VON balance than the votes previously recorded.

More specifically, the `_moveDelegates` function would attempt to deduct the surpassing number from the exact number recorded, causing an ***integer underflow*** error. Thus, the `sub` function of the `SafeMath` library would revert the transaction.



Redelegation failure

The redelegation failure scenario can be depicted using the figure above.

1. **Alice** initially has *100 tokens* and delegates her vote to **Bob**
2. **Bob** obtains *100 votes* now
3. **Charles** transfers his *50 tokens* to **Alice**
4. **Alice** now has *150 tokens* in her wallet
5. **Alice** tries to re-delegate her votes to another representative, **Dan**
6. The ***redelegation transaction*** is reverted due to the ***integer underflow*** error

Three possible actions can cause **Alice**’s transaction to revert.

1. **Alice** receives additional tokens from the **token transfer** (from others)
2. **Alice** receives additional tokens from the **token buying**
3. **Alice** receives additional tokens from the **yield farming**

This issue can affect both the ***voting redelegation*** and ***voting withdrawal*** transactions invoked by a regular voter.

Reassessment

The affected voting functionality was removed from the VonderToken contract.

No. 5	No Maximum Supply Minting Check		
Risk	Medium	Likelihood	Medium
		Impact	Medium
Functionality is in use	In use	Status	Fixed
Affected Files	*VonderToken.sol*		
Locations	*mint(address, uint256) L: 690-693* *_mint(address, uint256) L: 537-543*		

Description

According to Vonder's official documentation, the VON maximum supply is 101,051,200. The MasterChef contract is responsible for minting the new VON tokens to distribute as a reward to the users staking the liquidity pools.

However, the Vonder developer did not expressly declare the VON maximum supply in the VonderToken contract. Over time, the MasterChef contract can mint excessive tokens.

Reference: https://docs.vonder.finance/tokenomics-1/tokenomics/vonder-emission-schedule

Recommendations

Implement the statement to check whether the *totalSupply* is more than the maximum supply or not. The statement should be checked before minting the new VON token. For example, consider the pseudo-code below:

```
uint private _maxSupply = 101051200e18;

function mint(address _to, uint256 _amount) public onlyOwner {
    require(totalSupply().add(_amount) <= _maxSupply, "VON exceeds maxSupply");
    _mint(_to, _amount);
    _moveDelegates(address(0), _delegates[_to], _amount);
}
```

Platform Developer Response

The developer implemented the maximum supply check to resolve this issue.

Detailed Issue

On the *updatePool* function, new VON tokens will be minted to the *devaddr and the MasterChef* contract itself by calling the *mint* function of the VonderToken contract.

MasterChef.sol

```
function updatePool(uint256 _pid) public {
    PoolInfo storage pool = poolInfo[_pid];
    if (block.number <= pool.lastRewardBlock) {
        return;
    }
    uint256 lpSupply = pool.lpToken.balanceOf(address(this));
    if (lpSupply == 0 || pool.allocPoint == 0) {
        pool.lastRewardBlock = block.number;
        return;
    }
    uint256 multiplier = getMultiplier(pool.lastRewardBlock, block.number);
    uint256 vonReward =
multiplier.mul(vonPerBlock).mul(pool.allocPoint).div(totalAllocPoint);
    von.mint(devaddr, vonReward.div(10));
    von.mint(address(this), vonReward);
    pool.accVonPerShare =
pool.accVonPerShare.add(vonReward.mul(1e12).div(lpSupply));
    pool.lastRewardBlock = block.number;
}
```

The *mint* function of the VonderToken contract calls the internal *_mint* function.

VonderToken.sol

```
function mint(uint256 amount) public onlyOwner returns (bool) {
    _mint(_msgSender(), amount);
    return true;
}
```

According to Vonder's official documentation, the VON maximum supply is 101,051,200. In the *_mint* function, however, there is no maximum supply checking. Therefore, the MasterChef contract can mint excessive tokens over time.

VonderToken.sol

```
function _mint(address account, uint256 amount) internal {
    require(account != address(0), 'BEP20: mint to the zero address');

    _totalSupply = _totalSupply.add(amount);
    _balances[account] = _balances[account].add(amount);
    emit Transfer(address(0), account, amount);
}
```

Reassessment

The maximum supply is checked in the *mint* function of the VonderToken contract.

VonderToken.sol

```
contract VonderToken is BEP20('Extended VONDER Token', 'xVON') {
    uint256 private _cap = 101051200e18; //101,051,200

    function cap() public view returns (uint256) {
        return _cap;
    }

    // @notice Creates `_amount` token to `_to`. Must only be called by the owner (MasterChef).
    function mint(address _to, uint256 _amount) public onlyOwner {
        require(totalSupply().add(_amount) <= cap(), "cap exceeded");
        _mint(_to, _amount);
        // _moveDelegates(address(0), _delegates[_to], _amount);
    }
}
```

No. 6	No LP Token Adding After Deposit		
Risk	Medium	Likelihood	Low
		Impact	High
Functionality is in use	In use	Status	Fixed
Affected Files	*MasterChef.sol*		
Locations	*deposit(uint256, uint256) L:389-411*		

Description

On the *deposit* function, if the state variable *pool.depositFeeBP* was set to *10000*, the computed *depositFee* variable will equal the user's deposit *_amount* (line no. 402). The total deposit amount will be transferred to the fee address as a deposit fee (line no. 403). Thus, no LP token will be left adding to the user account (line no. 404).

Recommendations

Limit a maximum cap for the *depositFeeBP* variable to less than *10000*. For example, if the maximum cap is 5000. Therefore, the maximum deposit fee is 50%.

Platform Developer Response

The developer set the maximum cap of the *depositFeeBP* variable to 5000. That is, the maximum deposit fee is 50%.

Detailed Issue

On the *deposit* function, if the state variable *pool.depositFeeBP* was set to *10000*, the computed *depositFee* variable will equal the user's deposit *_amount* (line no. 402). The total deposit amount will be transferred to the fee address as a deposit fee (line no. 403). Thus, no LP token will be left adding to the user account (line no. 404).

MasterChef.sol

```
389 function deposit(uint256 _pid, uint256 _amount) public {
390     PoolInfo storage pool = poolInfo[_pid];
391     UserInfo storage user = userInfo[_pid][msg.sender];
392     updatePool(_pid);
393     if (user.amount > 0) {
394         uint256 pending =
user.amount.mul(pool.accVonPerShare).div(1e12).sub(user.rewardDebt);
395         if(pending > 0) {
396             safeVonTransfer(msg.sender, pending);
397         }
398     }
399     if(_amount > 0) {
400         pool.lpToken.safeTransferFrom(address(msg.sender), address(this),
_amount);
401         if(pool.depositFeeBP > 0){
402             uint256 depositFee = _amount.mul(pool.depositFeeBP).div(10000);
403             pool.lpToken.safeTransfer(feeAddress, depositFee);
404             user.amount = user.amount.add(_amount).sub(depositFee);
405         }else{
406             user.amount = user.amount.add(_amount);
407         }
408     }
409     user.rewardDebt = user.amount.mul(pool.accVonPerShare).div(1e12);
410     emit Deposit(msg.sender, _pid, _amount);
411 }
```

Reassessment

The issue was fixed by limiting the maximum cap of the *depositFeeBP* variable to *5000* in the *add* and *set* functions of the MasterChef contract. The maximum deposit fee, therefore, became 50%.

MasterChef.sol

```
function add(uint256 _allocPoint, IBEP20 _lpToken, uint16 _depositFeeBP, bool _withUpdate) public onlyOwner {
    require(_depositFeeBP <= 5000, "add: invalid deposit fee basis points");
    if (_withUpdate) {
        massUpdatePools();
    }
    uint256 lastRewardBlock = block.number > startBlock ? block.number : startBlock;
    totalAllocPoint = totalAllocPoint.add(_allocPoint);
    poolInfo.push(PoolInfo({
        lpToken: _lpToken,
        allocPoint: _allocPoint,
        lastRewardBlock: lastRewardBlock,
        accVonPerShare: 0,
        depositFeeBP: _depositFeeBP
    }));
}

// Update the given pool's VON allocation point and deposit fee. Can only be called by the owner.
function set(uint256 _pid, uint256 _allocPoint, uint16 _depositFeeBP, bool _withUpdate) public onlyOwner {
    require(_depositFeeBP <= 5000, "set: invalid deposit fee basis points");
    if (_withUpdate) {
        massUpdatePools();
    }
    totalAllocPoint = totalAllocPoint.sub(poolInfo[_pid].allocPoint).add(_allocPoint);
    poolInfo[_pid].allocPoint = _allocPoint;
    poolInfo[_pid].depositFeeBP = _depositFeeBP;
}
```

No. 7	Emission Rate Update May Fail		
Risk	Low	Likelihood	Low
		Impact	Medium
Functionality is in use	In use	Status	Acknowledged
Affected Files	*MasterChef.sol*		
Locations	*updateEmissionRate(uint256) L:464-467*		

Description

The *updateEmissionRate* function calls the *massUpdatePools* function before updating the emission rate variable *vonPerBlock*. Since the *massUpdatePools* function will iterate over all the pools to update pools' reward variables, this function consumes as much gas as the number of pools in the Vonder system.

If the Vonder system has more pools, the *massUpdatePools* function may consume more gas than the gas limit per block, causing a transaction failure with an out-of-gas error. Consequently, the *updateEmissionRate* function will not be able to update the *vonPerBlock* variable anymore.

Recommendations

The first solution is adding the boolean parameter *_withUpdate* to the *updateEmissionRate* function to enable a platform owner to update the *vonPerBlock* variable without the mass pools update.

Another solution is separating the tasks between the mass pools update and the *vonPerBlock* variable update into different functions.

Platform Developer Response

The Vonder team acknowledged this issue but decided to remain the original code.

Detailed Issue

The *updateEmissionRate* function calls the *massUpdatePools* function (line no. 465) before updating the emission rate variable *vonPerBlock* (line no. 466). Since the *massUpdatePools* function will iterate over all the pools to update pools' reward variables, this function consumes as much gas as the number of pools in the Vonder system.

If the Vonder system has more pools, the *massUpdatePools* function may consume more gas than the gas limit per block, causing a transaction failure with an out-of-gas error. Consequently, the *updateEmissionRate* function will not be able to update the *vonPerBlock* variable anymore.

Masterchef.sol

```
464 function updateEmissionRate(uint256 _vonPerBlock) public onlyOwner {
465     massUpdatePools();
466     vonPerBlock = _vonPerBlock;
467 }
```

Reassessment

The Vonder team acknowledged this issue but decided to remain the original code.

No. 8	`DevAddress` Reassignment May Fail		
Risk	Low	Likelihood	Low
		Impact	Medium
Functionality is in use	In use	Status	Acknowledged
Affected Files	*MasterChef.sol*		
Locations	*dev(address) L:453 - 456*		

Description

The address variable *_devaddr* on the *dev* function may be incorrectly specified by the platform developer by mistake; for example, a zero address or an address that the developer does not own was inputted.

The incorrectly inputted address makes the *dev* function unavailable since it strictly checks that the user who can change the new address must be the current *devaddr* only. But if the platform developer cannot access the mistakenly inputted address, he cannot change the *devaddr* anymore because of the *require* statement in line no. 454.

Recommendations

To prevent human error, we recommend allowing another address (e.g., the contract's owner address) to be able to execute the *dev* function as a backup account.

We recommend allowing another address (e.g., the contract's owner address) to execute the *dev* function as a backup account to protect against human error.

Platform Developer Response

The Vonder team acknowledged this issue but decided to remain the original code.

Detailed Issue

The address variable *_devaddr* on the *dev* function may be incorrectly specified by the platform developer by mistake; for example, a zero address or an address that the developer does not own was inputted.

The incorrectly inputted address makes the *dev* function unavailable since it strictly checks that the user who can change the new address must be the current *devaddr* only. But if the platform developer cannot access the mistakenly inputted address, he cannot change the *devaddr* anymore because of the *require* statement in line no. 454.

Masterchef.sol

```
453 function dev(address _devaddr) public {
454     require(msg.sender == devaddr, "dev: wut?");
455     devaddr = _devaddr;
456 }
```

Reassessment

The Vonder team acknowledged this issue but decided to remain the original code.

No. 9	`FeeAddress` Reassignment May Fail		
Risk	Low	Likelihood	Low
		Impact	Medium
Functionality is in use	In use	Status	Acknowledged
Affected Files	*MasterChef.sol*		
Locations	*setFeeAddress(address) L:458 - 461*		

Description

The address variable `_feeAddress` on the `setFeeAddress` function may be incorrectly specified by the platform developer by mistake; for example, a zero address or an address that the developer does not own was inputted.

The incorrectly inputted address makes the `setFeeAddress` function unavailable since it strictly checks that the user who can change the new address must be the current `feeAddress` only. But if the platform developer cannot access the mistakenly inputted address, he cannot change the `feeAddress` anymore because of the `require` statement in line no. 459.

Recommendations

We recommend allowing another address (e.g., the contract's owner address) to execute the `setFeeAddress` function as a backup account to protect against human error.

Platform Developer Response

The Vonder team acknowledged this issue but decided to remain the original code.

Detailed Issue

The address variable *_feeAddress* on the *setFeeAddress* function may be incorrectly specified by the platform developer by mistake; for example, a zero address or an address that the developer does not own was inputted.

The incorrectly inputted address makes the *setFeeAddress* function unavailable since it strictly checks that the user who can change the new address must be the current *feeAddress* only. But if the platform developer cannot access the mistakenly inputted address, he cannot change the *feeAddress* anymore because of the *require* statement in line no. 459.

Masterchef.sol

```
458 function setFeeAddress(address _feeAddress) public{
459     require(msg.sender == feeAddress, "setFeeAddress: FORBIDDEN");
460     feeAddress = _feeAddress;
461 }
```

Reassessment

The Vonder team acknowledged this issue but decided to remain the original code.

No. 10	The Compiler May Be Susceptible To The Publicly Disclosed Bugs		
Risk	Low	Likelihood	Low
		Impact	Medium
Functionality is in use	In use	Status	Acknowledged
Affected Files	*MasterChef.sol* *VonderToken.sol*		
Locations	*MasterChef.sol L:3* *VonderToken.sol L:2*		
Description			
The contract uses an outdated Solidity compiler version which may be susceptible to publicly disclosed vulnerabilities. The compiler version currently used by Vonder Finance is 0.6.6 which contains the list of known bugs as the following link: https://docs.soliditylang.org/en/v0.6.6/bugs.html The known bugs may not directly lead to the vulnerability, but it may increase an opportunity to trigger some attacks further.			
Recommendations			
We recommend using the latest patch version, v0.6.12.			
Platform Developer Response			
The Vonder team acknowledged this issue but decided to remain the original code.			

Detailed Issue

The usage example of the Solidity compiler is not the latest patch version (v0.6.12).

Masterchef.sol

```
// SPDX-License-Identifier: MIT

pragma solidity ^0.6.6;

import "./VonderToken.sol";

library Address {
```

Reassessment

The Vonder team acknowledged this issue but decided to remain the original code.

No. 11	The Compiler Is Not Locked To A Specific Version		
Risk	Low	Likelihood	Low
		Impact	Medium
Functionality is in use	In use	Status	Acknowledged
Affected Files	*MasterChef.sol* *VonderToken.sol*		
Locations	*MasterChef.sol L:3* *VonderToken.sol L:2*		

Description

Contract should be deployed with the compiler version that is used in a development and testing process.

The compiler version that is not strictly locked via the *pragma* statement leads the contract to be incompatible against unforeseen circumstances.

Recommendations

Lock the pragma version like the example code snippet below.

```
pragma solidity 0.8.6;
// or
pragma solidity =0.8.6;

contract SemVerFloatingPragmaFixed {
}
```

Reference: https://swcregistry.io/docs/SWC-103

Platform Developer Response

The Vonder team acknowledged this issue but decided to remain the original code.

Detailed Issue

The example of the Solidity compiler that is not locked to a specific version (i.e., using >= or ^ directive).

Masterchef.sol

```
// SPDX-License-Identifier: MIT

pragma solidity ^0.6.6;

import "./VonderToken.sol";

library Address {
```

Reassessment

The Vonder team acknowledged this issue but decided to remain the original code.

No. 12	Same LP Token May Be Added More Than Once		
Risk	Informational	Likelihood	Low
		Impact	Low
Functionality is in use	In use	Status	Acknowledged
Affected Files	*MasterChef.sol*		
Locations	*add(uint256, IBEP20, uint16, bool) L:315-329*		

Description

The *add* function allows a platform developer to add the same LP token to the yield farming system without verifying that the token has previously been added. If the same LP token is added more than once, this will affect the reward distribution parameters, such as `totalAllocPoint`, as well as affecting the user experience.

Recommendations

Verify the duplication of the LP token before adding it to the yield farming system.

Platform Developer Response

The Vonder team acknowledged this issue but decided to remain the original code.

Detailed Issue

Masterchef.sol

```
function add(uint256 _allocPoint, IBEP20 _lpToken, uint16 _depositFeeBP, bool _withUpdate) public onlyOwner {
    require(_depositFeeBP <= 10000, "add: invalid deposit fee basis points");
    if (_withUpdate) {
        massUpdatePools();
    }
    uint256 lastRewardBlock = block.number > startBlock ? block.number : startBlock;
    totalAllocPoint = totalAllocPoint.add(_allocPoint);
    poolInfo.push(PoolInfo({
        lpToken: _lpToken,
        allocPoint: _allocPoint,
        lastRewardBlock: lastRewardBlock,
        accVonPerShare: 0,
        depositFeeBP: _depositFeeBP
    }));
}
```

The *add* function allows a platform developer to add the same LP token to the yield farming system without verifying that the token has previously been added. If the same LP token is added more than once, this will affect the reward distribution parameters, such as `totalAllocPoint`, as well as affecting the user experience.

Reassessment

The Vonder team acknowledged this issue but decided to remain the original code.

No. 13	The Function Name With *internal* Visibility Is Not Complied With The Naming Convention		
Risk	Informational	Likelihood	Low
		Impact	Low
Functionality is in use	In use	Status	Acknowledged
Affected Files	*MasterChef.sol*		
Locations	*safeVonTransfer(address, uint256) L:443 - 450*		
Description			
The coding style in the contract is inconsistent due to an incompliant Solidity style guide leading to a code transfer disadvantage, or loss of backward compatibility.			
Recommendations			
The internal or private variables should be used "_" at the beginning.			
Platform Developer Response			
The Vonder team acknowledged this issue but decided to remain the original code.			

Detailed Issue

The internal function does not comply with the Solidity Style guide.

Masterchef.sol

```
443 function safeVonTransfer(address _to, uint256 _amount) internal {
444     uint256 vonBal = von.balanceOf(address(this));
445     if (_amount > vonBal) {
446         von.transferWithLock(_to, vonBal);
447     } else {
448         von.transferWithLock(_to, _amount);
449     }
450 }
```

Reassessment

The Vonder team acknowledged this issue but decided to remain the original code.

No. 14	Public Functions That Could Be Declared As `external`		
Risk	Informational	Likelihood	Low
		Impact	Low
Functionality is in use	In use	Status	Acknowledged
Affected Files	*Masterchef.sol* *VonderToken.sol*		

Locations

Masterchef.sol
add(uint256, IBEP20, uint16, bool) L:315
set(uint256, uint256, uint16, bool) L:332
deposit(uint256, uint256) L:389
withdraw(uint256, uint256) L:414
emergencyWithdraw(uint256) L:432
dev(address) L:453
setFeeAddress(address) L:458
updateEmissionRate(uint256) L:464
setVonRewardLock(uint256) L:470
setVonTotalBlockRelease(uint256) L:474

VonderToken.sol
renounceOwnership() L:216
transferOwnership(address) L:225
symbol() L:377
decimals() L:384

VonderToken.sol (Cont'd)
totalSupply() L:391
transfer(address, uint256) L:410
allowance(address, address) L:418
approve(address, uint256) L:427
transferFrom (address, address, uint256) L:446
increaseAllowance(address, uint256) L:468
decreaseAllowance(address, uint256) L:487
mint(uint256) L:500
setRewardLock(uint256) L:605
setTotalBlockRelease(uint256) L:611
transferWithLock(address, uint256) L:616
claimRewardLock() L:645
getTotalRewardLock(address) L:674
getLastClaimBlock(address) L:678
getEndClaimBlock(address) L:682
mint(address, uint256) L: 690

Description

The `public` functions that have never been called inside the contracts should be declared `external` to save gas.

Recommendations

Use the `external` attribute for functions that have never been called inside the contracts.

Platform Developer Response

The Vonder team acknowledged this issue but decided to remain the original code.

Detailed Issue

An example of the *public* function that has never been called inside any contract but not declared *external*.

Masterchef.sol

```
function add(uint256 _allocPoint, IBEP20 _lpToken, uint16 _depositFeeBP, bool
_withUpdate) public onlyOwner {
    require(_depositFeeBP <= 10000, "add: invalid deposit fee basis points");
    if (_withUpdate) {
        massUpdatePools();
    }
    uint256 lastRewardBlock = block.number > startBlock ? block.number :
startBlock;
    totalAllocPoint = totalAllocPoint.add(_allocPoint);
    poolInfo.push(PoolInfo({
        lpToken: _lpToken,
        allocPoint: _allocPoint,
        lastRewardBlock: lastRewardBlock,
        accVonPerShare: 0,
        depositFeeBP: _depositFeeBP
    }));
}
```

Reassessment

The Vonder team acknowledged this issue but decided to remain the original code.

Appendix

About Us

Founded in 2020, Valix Consulting is a blockchain and smart contract security firm offering a wide range of cybersecurity consulting services such as blockchain and smart contract security consultant, smart contract security review, and smart contract security audit.

Our team members are passionate cybersecurity professionals and researchers in areas of private and public blockchain technology, smart contract, and decentralized application (DApp).

We provide a service for assessing and certifying the security of smart contracts. Our service also includes recommendations on smart contracts' security and gas optimization to bring the most benefit to users and platform creators.

Contact Information

info@valix.io

https://www.facebook.com/ValixConsulting

https://twitter.com/ConsultingValix

https://medium.com/valixconsulting

References

Title	Link
OWASP Risk Rating Methodology	https://owasp.org/www-community/OWASP_Risk_Rating_Methodology
Smart Contract Weakness Classification and Test Cases	https://swcregistry.io/