



CERTIK

# dForce Network

## Lending Smart Contracts

Security Assessment

February 12th, 2021





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- A document describing in detail an in depth analysis of a particular piece(s) of source code provided to CertiK by a Client.
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## Project Summary

<b>Project Name</b>	dForce Network - Lending Smart Contracts
<b>Description</b>	Smart contracts of the dForceLending repository. The code implements a lending protocol with the functionality of providing flash loans. All of the assets lent and borrowed accrue interests based on the set the parameters.
<b>Platform</b>	Ethereum; Solidity, Yul
<b>Codebase</b>	<a href="#">GitHub Repository</a>
<b>Commits</b>	1. <a href="#">4dd190395651e8e5b10bd8be733fb0ba4262613c</a> 2. <a href="#">397ec65b5676bd2f64d72e532e961595ab931e3d</a>

## Audit Summary

<b>Delivery Date</b>	Feb. 12, 2021
<b>Method of Audit</b>	Static Analysis, Manual Review
<b>Consultants Engaged</b>	3
<b>Timeline</b>	Jan. 2, 2021 - Jan. 31, 2021

## Vulnerability Summary

<b>Total Issues</b>	61 (24 Resolved, 37 Acknowledged)
<b>● Total Medium</b>	4 (3 Resolved, 1 Acknowledged)
<b>● Total Minor</b>	8 (5 Resolved, 3 Acknowledged)
<b>● Total Informational</b>	49 (16 Resolved, 33 Acknowledged)



## Executive Summary

All of the functions in the `Controller` contract have proper access restriction and parameter sanitization where necessary. The equity was found to be calculated correctly for each of the accounts. Most of the findings are optimizational, while [CON-13](#) addresses the issue of a market exit while a user still has an active borrow balance in that market.

The `PriceOracle` contract has proper access restriction and parameter sanitization where necessary and applies proper utilization of the `Anchor` and `Reader` architecture. Most of the findings are optimizational, while [POE-12](#) addresses specific uses of `assert` instead of `require`, which should not be used in a production environment, as they will consume all remaining gas in the event of a failure. Protection against flash loan vulnerabilities and price manipulation was found to be implemented via the swing and anchors constraints, but there is still a centralization issue with the `PriceOracle` contract. For most occasions, it would be advisable to utilize a decentralized price oracle system, such as Chainlink.

While the `Base` contract was found to have proper access restriction and parameter sanitization, [BAS-01](#) outlines the possibility for replay attacks, which should be addressed prior to deployment.

The `RewardDistributor` contract contains the potential for re-entrancy attacks in the `claimReward` function, as outlined in [RDR-01](#). The contract also fails to emit an event when updating the global distribution speed in the `_setGlobalDistributionSpeed` function, as outlined in [RDR-02](#). The `_updateReward` function does not check if the supplied `_address` is non-zero, as outlined in [RDR-03](#). All of the other findings are optimizational.

The `TokenERC20` contract has the potential for re-entrancy attacks, as outlined in [TER-01](#), which can be resolved with a simple inclusion of the `nonReentrant` modifier.

The `iToken` contract has proper access restriction for all the functions, where [ITO-01](#) addresses an invalid calculation within the `supplyRatePerBlock` function, where the calculation unnecessarily performs a multiplication with `BASE`.

The `iETH` contract was checked for native ETH transferring and receiving in order to ensure that they are properly implemented for flash loans. In particular, [ETH-02](#) points out the usage of `transfer` for sending ETH, while [ETH-05](#) points out the usage of `receive` for receiving ETH. Proper access restriction was found to be implemented along with correct parameter sanitization, which is missing in the actual function implementations but they are handled in their internal counterparts.

It should be noted that the `nonReentrant` modifier should be refactored on the external `liquidateBorrow` function in the `iETH` and `iToken` contracts in order to allow calling it from within the `flashloan` function. Removing the `nonReentrant` modifier from the `liquidateBorrow` function altogether is not an option, as it would open the potential for re-entrancy attacks. The `nonReentrant` modifier should be replaced with a separate `bool` state variable which acts as a mutex to prevent re-entrancy attacks within the `liquidateBorrow` function, requiring the `bool` mutex to be `false` at the beginning of `liquidateBorrow`, setting the `bool` mutex to `true` after the requirement, calling the `_liquidateBorrowInternal` function, then setting the `bool` mutex back to `false` after the call to the `_liquidateBorrowInternal` function. The reason the `nonReentrant` modifier is insufficient is because it shares a single `bool` across all functions marked `nonReentrant` within the contract, which makes it impossible to call a separate function marked `nonReentrant` when a `nonReentrant` function is already executing. This is what prevents the `liquidateBorrow` function from being called from within the `flashloan` function.

A review was performed for the flashloan exploit's [fix](#) related to decreasing of `exchangeRate` enabling the liquidation of insolvent positions. The fix of adding flashloan amount to `totalBorrows` is deemed safe and does not introduce any issues in flashloan, minting, borrowing, repay and liquidation functionalities, and is regarded important to be incorporated for production deployment.



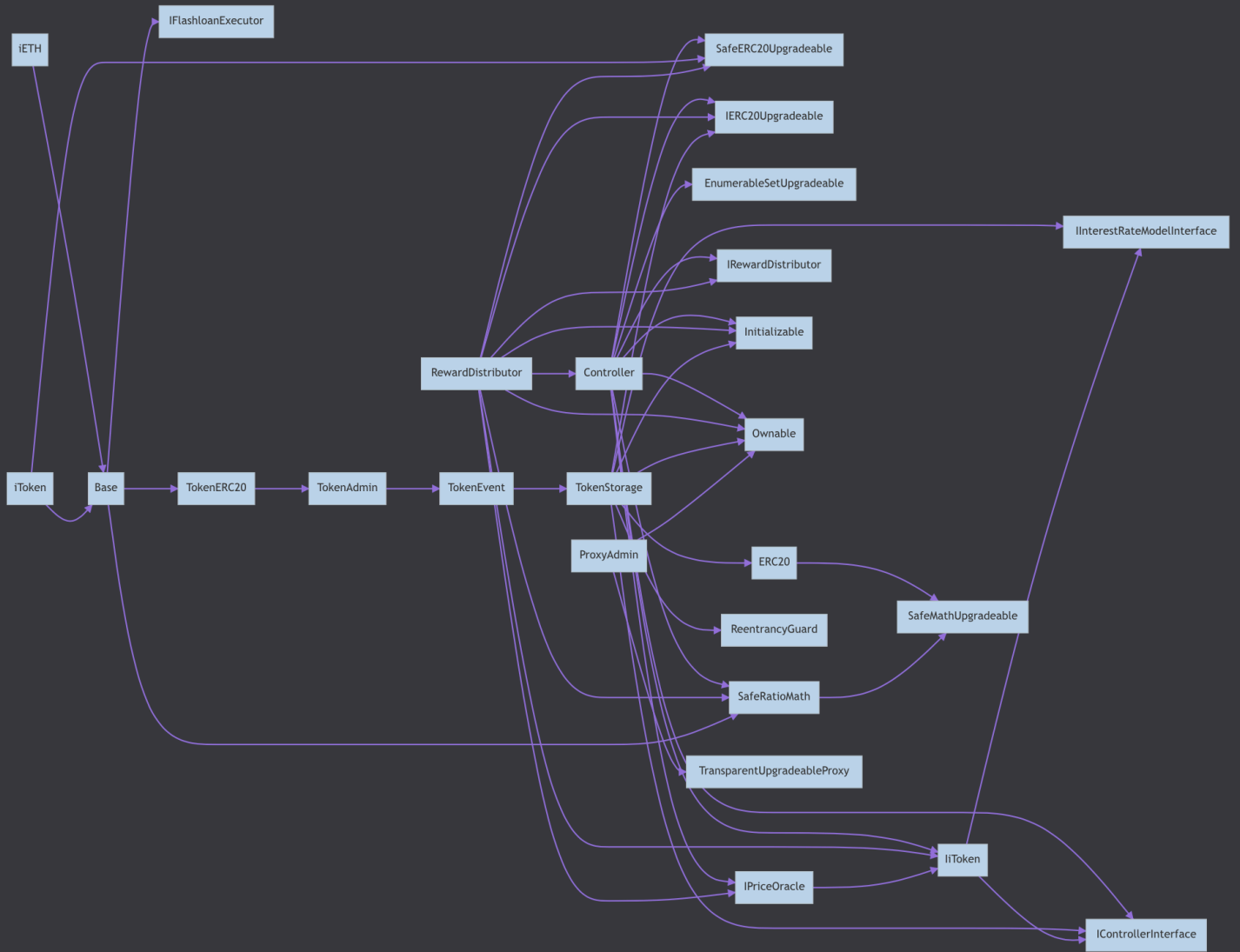
# Files In Scope

ID	Contract	Location
BAS	Base.sol	<a href="#">contracts/TokenBase/Base.sol</a>
CON	Controller.sol	<a href="#">contracts/Controller.sol</a>
ERC	ERC20.sol	<a href="#">contracts/library/ERC20.sol</a>
ITN	liToken.sol	<a href="#">contracts/interface/liToken.sol</a>
IPO	IPriceOracle.sol	<a href="#">contracts/interface/IPriceOracle.sol</a>
INI	Initializable.sol	<a href="#">contracts/library/Initializable.sol</a>
IRM	InterestRateModel.sol	<a href="#">contracts/InterestRateModel/InterestRateModel.sol</a>
IFE	IFlashloanExecutor.sol	<a href="#">contracts/interface/IFlashloanExecutor.sol</a>
IRD	IRewardDistributor.sol	<a href="#">contracts/interface/IRewardDistributor.sol</a>
ICI	IControllerInterface.sol	<a href="#">contracts/interface/IControllerInterface.sol</a>
IIR	IInterestRateModelInterface.sol	<a href="#">contracts/interface/IInterestRateModelInterface.sol</a>
OWN	Ownable.sol	<a href="#">contracts/library/Ownable.sol</a>
PAN	ProxyAdmin.sol	<a href="#">contracts/library/ProxyAdmin.sol</a>
POE	PriceOracle.sol	<a href="#">contracts/PriceOracle.sol</a>
RGD	ReentrancyGuard.sol	<a href="#">contracts/library/ReentrancyGuard.sol</a>
RDR	RewardDistributor.sol	<a href="#">contracts/RewardDistributor.sol</a>
SRM	SafeRatioMath.sol	<a href="#">contracts/library/SafeRatioMath.sol</a>
TAN	TokenAdmin.sol	<a href="#">contracts/TokenBase/TokenAdmin.sol</a>
TER	TokenERC20.sol	<a href="#">contracts/TokenBase/TokenERC20.sol</a>
TET	TokenEvent.sol	<a href="#">contracts/TokenBase/TokenEvent.sol</a>
TSE	TokenStorage.sol	<a href="#">contracts/TokenBase/TokenStorage.sol</a>

ETH	iETH.sol	<a href="#"><u>contracts/iETH.sol</u></a>
ITO	iToken.sol	<a href="#"><u>contracts/iToken.sol</u></a>



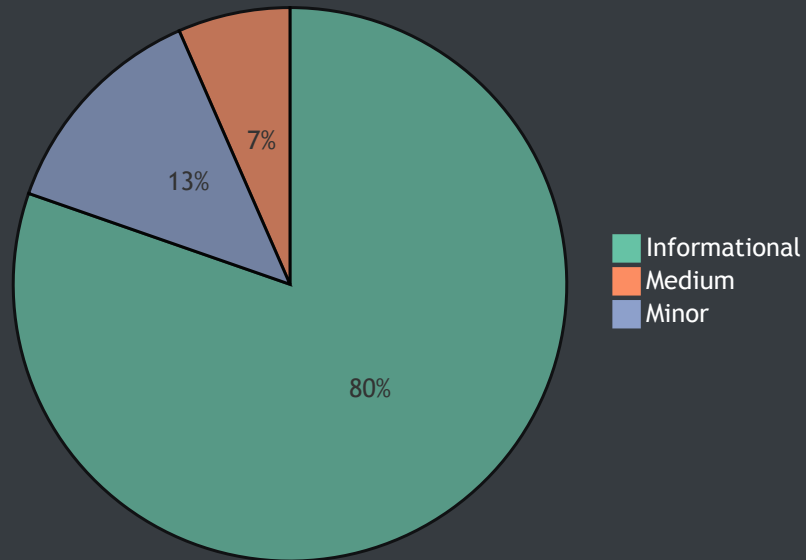
# File Dependency Graph







# Findings



ID	Title	Type	Severity	Resolved
<u>CON-01</u>	Mappings data can be packed in a struct	Gas Optimization	● Informational	✓
<u>CON-02</u>	Mappings data can be packed in a struct	Gas Optimization	● Informational	✓
<u>CON-03</u>	Comparison with literal true	Gas Optimization	● Informational	✓
<u>CON-04</u>	Inefficient use of require statements	Gas Optimization	● Informational	✓

<u>CON-05</u>	Inefficient use of require statements	Gas Optimization	● Informational	✓
<u>CON-06</u>	Redundant casting to type address	Gas Optimization	● Informational	✓
<u>CON-07</u>	Ineffectual code	Inconsistency	● Informational	✓
<u>CON-08</u>	Explicitly returning local variable	Gas Optimization	● Informational	✓
<u>CON-09</u>	Functions visibility can be changed to external	Gas Optimization	● Informational	✓
<u>CON-10</u>	Documentation discrepancy	Inconsistency	● Informational	✓
<u>CON-11</u>	Incorrect naming convention for external functions	Language Specific	● Informational	🔄
<u>CON-12</u>	Lack of verification for the passed argument	Logical Issue	● Minor	✓
<u>CON-13</u>	Borrow status of the user is not checked when exiting from a market	Logical Issue	● Informational	🔄
<u>CON-15</u>	Redundant casting to uint8	Gas Optimization	● Informational	✓
<u>CON-16</u>	Contract name does not comply with the convention	Language Specific	● Informational	🔄
<u>POE-01</u>	Code Optimization	Gas Optimization	● Informational	🔄
<u>POE-02</u>	Conditional Optimization	Gas Optimization	● Informational	🔄
<u>POE-03</u>	Visibility Specifiers Missing	Language Specific	● Informational	🔄

<u>POE-04</u>	State Layout Optimization	Gas Optimization	● Informational	🕒
<u>POE-05</u>	Order of Layout	Coding Style	● Informational	🕒
<u>POE-06</u>	Variable Visibility	Gas Optimization	● Informational	🕒
<u>POE-07</u>	event Optimization	Language Specific	● Informational	🕒
<u>POE-08</u>	Ambiguous Error Message	Inconsistency	● Informational	🕒
<u>POE-09</u>	Function Optimization	Gas Optimization	● Informational	🕒
<u>POE-10</u>	Code Optimization	Gas Optimization	● Informational	🕒
<u>POE-11</u>	Ambiguous NetSpec Comments	Coding Style	● Informational	✓
<u>POE-12</u>	Introduction of require Statements	Volatile Code	● Minor	🕒
<u>POE-13</u>	Function Visibility Optimization	Gas Optimization	● Informational	🕒
<u>POE-14</u>	Naming Conventions	Coding Style	● Informational	🕒
<u>POE-15</u>	Inexistent Input Sanitization	Volatile Code	● Informational	🕒
<u>ETH-01</u>	Ambiguous Statement	Volatile Code	● Informational	🕒
<u>ETH-02</u>	Usage of transfer() for sending Ether	Volatile Code	● Minor	🕒
<u>ETH-03</u>	Possibility of incorrect calculation	Volatile Code	● Medium	✓
<u>ETH-04</u>	Non Standard Contract Naming	Coding Style	● Informational	🕒
<u>ETH-05</u>	Inexistent Input Sanitization	Volatile Code	● Minor	✓
<u>ETH-06</u>	Contract Size	Compiler Error	● Informational	✓
<u>ITO-01</u>	Possibility of incorrect	Volatile Code	● Medium	✓

	calculation			
<u>ITO-02</u>	Redundant casting to uint8	Gas Optimization	● Informational	✓
<u>ITO-03</u>	Contract name does not comply with the convention	Language Specific	● Informational	🔄
<u>BAS-01</u>	Possibility of replay attack in permit	Volatile Code	● Minor	🔄
<u>RDR-01</u>	Potential for re-entrancy attacks in claimReward	Volatile Code	● Medium	✓
<u>RDR-02</u>	Missing event for updating global distribution speed	Implementation	● Minor	✓
<u>RDR-03</u>	Lack of address check in _updateReward	Volatile Code	● Minor	✓
<u>RDR-04</u>	Unnecessary underscore prefixing _setRewardToken	Naming Conventions	● Informational	🔄
<u>RDR-05</u>	Unnecessary underscore prefixing _addRecipient	Naming Conventions	● Informational	🔄
<u>RDR-06</u>	Unnecessary underscore prefixing _pause	Naming Conventions	● Informational	🔄
<u>RDR-07</u>	Unnecessary underscore prefixing _unpause	Naming Conventions	● Informational	🔄
<u>RDR-08</u>	Unnecessary underscore prefixing _setGlobalDistributionSpeed	Naming Conventions	● Informational	🔄
<u>RDR-09</u>	Inefficient early return in	Gas Optimization	● Informational	✓

	updateDistributionSpeed			
<u>RDR-10</u>	Unnecessary underscore prefixing _setDistributionFactors	Naming Conventions	● Informational	🕒
<u>RDR-11</u>	Inefficient early return in updateDistributionState	Gas Optimization	● Informational	🕒
<u>RDR-12</u>	Inefficient early return in updateReward	Gas Optimization	● Informational	🕒
<u>RDR-13</u>	claimAllReward should be declared external	Implementation	● Informational	✓
<u>IRM-01</u>	getBorrowRate should be declared external	Implementation	● Informational	🕒
<u>TAN-01</u>	Unnecessary underscore prefixing _setController	Naming Conventions	● Informational	🕒
<u>TAN-02</u>	Unnecessary underscore prefixing _setInterestRateModel	Naming Conventions	● Informational	🕒
<u>TAN-03</u>	Unnecessary underscore prefixing _setNewReserveRatio	Naming Conventions	● Informational	🕒
<u>TAN-04</u>	Unnecessary underscore prefixing _setNewFlashloanFeeRatio	Naming Conventions	● Informational	🕒
<u>TAN-05</u>	Unnecessary underscore	Naming Conventions	● Informational	🕒

	prefixing _setNewProtocolFeeRatio			
<u>TAN-06</u>	Unnecessary underscore prefixing _withdrawReserves	Naming Conventions	● Informational	🕒
<u>TER-01</u>	Potential for re-entrancy attacks in _transferTokens	Volatile Code	● Minor	✓



## CON-01: mappings data can be packed in a struct

Type	Severity	Location
Gas Optimization	● Informational	<u>Controller.sol L62, L66</u>

### Description:

The mappings on the aforementioned lines have key of type `address` representing a user's address. These mappings can be combined into a single mapping having `address` as key type and the value type will be a struct having properties from both aforementioned mappings. This will reduce the lookup gas cost when reading data from these mappings.

### Recommendation:

We advise to replace the aforementioned mappings with a single mapping by utilizing a struct for the value types.

```
struct UserData {
    EnumerableSetUpgradeable.AddressSet collaterals;
    EnumerableSetUpgradeable.AddressSet borrowed;
}
```

```
mapping(address => User) internal usersData;
```

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).



## CON-02: Mappings data can be packed in a struct

Type	Severity	Location
Gas Optimization	● Informational	<u><a href="#">Controller.sol L59</a></u> , <u><a href="#">L107</a></u> , <u><a href="#">L110</a></u> , <u><a href="#">L113</a></u>

### Description:

The mappings on the aforementioned lines have key of type `address` representing a market's address. These mappings can be combined into a single mapping having `address` as key type and the value type will be a struct having properties from all aforementioned mappings. This will reduce the lookup gas cost when reading data from these mappings.

### Recommendation:

We advise to replace the aforementioned mappings with a single mapping by utilizing a struct for the value types.

```
struct MarketData {
    Market market;
    bool mintPaused;
    bool borrowPaused;
    bool redeemPaused;
}
```

```
mapping(address => MarketData) public marketsData;
```

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).





## CON-03: Comparison with literal `true`

Type	Severity	Location
Gas Optimization	● Informational	<a href="#">Controller.sol L136</a>

### Description:

The aforementioned line performs comparison with a literal `true`. This comparison can be replaced with the expression itself to increase the legibility of the code.

### Recommendation:

We advise to utilize the expression itself in place of comparison with literal `true`.

```
require(  
    msg.sender == owner || _paused,  
    "Only owner can unpause"  
);
```

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).



## CON-04: Inefficient use of `require` statements

Type	Severity	Location
Gas Optimization	● Informational	<u><a href="#">Controller.sol L130-L138</a></u>

### Description:

The `require` statements on the aforementioned lines can be replaced with a single `require` statement to increase the legibility of the codebase and optimizing deploying gas cost from reduced bytecode footprint of the contract.

### Recommendation:

We advise to use a single `require` statements with the combined conditional logic from both of the aforementioned `require` statements.

```
require(  
    msg.sender == owner || (msg.sender == pauseGuardian && _paused),  
    "only owner can pause/unpause and only guardian can pause"  
);
```

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).



## CON-05: Inefficient use of `require` statements

Type	Severity	Location
Gas Optimization	<span style="color: green;">●</span> Informational	<a href="#">Controller.sol L300</a> , <a href="#">L336</a> , <a href="#">L374</a> , <a href="#">L395</a> , <a href="#">L432</a> , <a href="#">L454</a> , <a href="#">L476</a> , <a href="#">L588</a> , <a href="#">L700</a> , <a href="#">L770</a> , <a href="#">L802</a> , <a href="#">L1037</a>

### Description:

The `require` statements on the aforementioned lines can be substituted with a function call which would perform the said assertion. This will reduce the bytecode footprint of the contract resulting in reduced gas cost upon the deployment.

### Recommendation:

We advise to introduce a private function and that be used in place of the `require` statements to reduce gas cost associated with individual use same `require` statement.

```
function _isTokenAdded(address iToken) private {  
    require(iTokens.contains(_iToken), "Token has not been listed");  
}
```

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).



## CON-06: Redundant casting to type `address`

Type	Severity	Location
Gas Optimization	● Informational	<u><a href="#">Controller.sol L1067, L1072, L1079, L1410</a></u>

### Description:

The aforementioned lines perform redundant casting of `iToken` to type `address` which already is of type `address`.

### Recommendation:

We advise to remove the redundant casting to `address` to save gas cost associated with it.

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).



## CON-07: Ineffectual code

Type	Severity	Location
Inconsistency	● Informational	<u>Controller.sol L601</u>

### Description:

The aforementioned line utilizes local variable `_minter` as an expression to silence the compiler warning of unused variable. As the variable is being used on L610, the line specifying the expression can be removed.

### Recommendation:

We advise to remove the use of expression on the aforementioned line.

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).



## CON-08: Explicitly returning local variable

Type	Severity	Location
Gas Optimization	<span style="color: green;">●</span> Informational	<a href="#">Controller.sol L1249</a> , <a href="#">L1292</a> , <a href="#">L1315</a> , <a href="#">L1373</a> , <a href="#">L1429</a> , <a href="#">L1494</a>

### Description:

The function on the aforementioned line explicitly returns a local variable which increases the overall cost of gas.

### Recommendation:

Since named return variables can be declared in the signature of a function, consider refactoring to remove the local variable declaration and explicit return statement in order to reduce the overall cost of gas.

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).



## CON-09: Functions visibility can be changed to `external`

Type	Severity	Location
Gas Optimization	● Informational	<u><a href="#">Controller.sol L1315, L1373</a></u>

### Description:

The functions on the aforementioned lines are never called within the contract and can have their visibilities changed to `external` and the data location of their array parameters can be changed to `calldata` which will save the gas cost associated with copying parameters to memory .

### Recommendation:

We advise to change the functions' visibilities to `external` and the data location of their reference parameters to `calldata` .

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).



## CON-10: Documentation discrepancy

Type	Severity	Location
Inconsistency	● Informational	<u><a href="#">Controller.sol L51</a></u>

### Description:

There is documentation discrepancy in the comment on aforementioned line which describes the property `supplyCapacity` following it as being checked in `beforeBorrow` function hook yet it is only checked in `beforeMint` .

### Recommendation:

We advise to change the comment on the aforementioned line to `The supply capacity of the asset, will be checked in beforeMint()` .

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).





## CON-11: Incorrect naming convention for external functions

Type	Severity	Location
Language Specific	<span style="color: green;">●</span> Informational	<a href="#">Controller.sol L174</a> , <a href="#">L231</a> , <a href="#">L246</a> , <a href="#">L267</a> , <a href="#">L295</a> , <a href="#">L331</a> , <a href="#">L368</a> , <a href="#">L389</a> , <a href="#">L409</a> , <a href="#">L426</a> , <a href="#">L448</a> , <a href="#">L470</a> , <a href="#">L481</a> , <a href="#">L491</a> , <a href="#">L509</a> , <a href="#">L527</a> , <a href="#">L552</a>

### Description:

The names of external functions on the aforementioned lines are prefixed with underscore (`_`), which is a convention typically reserved for private and internal declarations.

### Recommendation:

We advise to remove the `_` from the start of the function names to comply with the naming convention for external functions.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "Public functions starts with `_` are owner functions for easy interaction on Remix or Etherscan."



## CON-12: Lack of verification for the passed argument

Type	Severity	Location
Logical Issue	● Minor	<a href="#">Controller.sol L409</a>

### Description:

The function `_setPauseGuardian` receives `_newPauseGuardian` of type `address` as its parameter, which is not validated against zero value.

### Recommendation:

We advise to check the zero value of the argument `_newPauseGuardian` passed to the function.

```
require(  
    _newPauseGuardian != address(0),  
    "_newPauseGuardian cannot be zero"  
);
```

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).



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## CON-13: Borrow status of the user is not checked when exiting from a

Type	Severity	Location
Logical Issue	● Informational	<a href="#">Controller.sol L1394</a>

### Description:

When exiting market the user should have no borrow balance in that market. Calling `redeemAllowed` does not necessarily ensure it as a user could have higher collateral in another market and shortfall remains `0`. Although, this position can still be liquidated.

### Recommendation:

A check can be added to ensure that user does not have borrow balance in the exiting market.

```
require(  
    LiToken(iToken).borrowBalanceStored(_account) == 0,  
    "borrow balance must be 0 for exiting market"  
);
```

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "Such operation is allowed. Now user has entering a market is treated as use the asset as collateral, and exiting a market only means the asset is no longer a collateral. The state is the same as user has not use the token as collateral but has borrowed some."



## CON-15: Redundant casting to uint8

Type	Severity	Location
Gas Optimization	● Informational	<u><a href="#">Controller.sol L34</a></u>

### Description:

The aforementioned line performs redundant casting to `uint8` as the value returns by the function `decimals` is already a `uint8`.

### Recommendation:

We advise to remove the redundant casting to `uint8` to save gas cost associated with the casting operation.

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).



## CON-16: Contract name does not comply with the convention

Type	Severity	Location
Language Specific	● Informational	<u>Controller.sol L13</u>

### Description:

The contract name `iToken` starts with the small letter, which is against the convention of the contract names as the convention is to start the contract name with capital letter.

### Recommendation:

We advise to changed the name of contract to comply with the convention of contract names.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "No plan to change the token contract name."



## POE-01: Code Optimization

Type	Severity	Location
Gas Optimization	● Informational	<u>PriceOracle.sol L187, L200</u>

### Description:

The `else` block is redundant, as it only contains the `return` statement that is meant to be executed in every scenario other than the one checked in the `if` block.

### Recommendation:

We advise to remove the `else` block and directly use the `return` statement.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "No plan to change the oracle implementation."



## POE-02: Conditional Optimization

Type	Severity	Location
Gas Optimization	● Informational	<a href="#">PriceOracle.sol L233</a>

### Description:

The linked conditional should only check against the edge case, i.e. inequality with zero.

### Recommendation:

We advise to change to a "not equal" operation instead.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "No plan to change the oracle implementation."



## POE-03: Visibility Specifiers Missing

Type	Severity	Location
Language Specific	● Informational	<a href="#">PriceOracle.sol L259</a> , <a href="#">L262</a> , <a href="#">L268</a> , <a href="#">L269</a>

### Description:

The linked variable declarations do not have a visibility specifier explicitly set.

### Recommendation:

Inconsistencies in the default visibility the Solidity compilers impose can cause issues in the functionality of the codebase. We advise that visibility specifiers for the linked variables are explicitly set.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "No plan to change the oracle implementation."





## POE-04: State Layout Optimization

Type	Severity	Location
Gas Optimization	● Informational	<u><a href="#">PriceOracle.sol L495-L522</a></u>

### Description:

The state should be as tightly packed as possible to 256-bit sized variables.

### Recommendation:

We advise to change to a more optimal state layout.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "No plan to change the oracle implementation."



## POE-05: Order of Layout

Type	Severity	Location
Coding Style	● Informational	<a href="#">PriceOracle.sol General</a>

### Description:

The order of layout does not follow the Solidity conventions.

### Recommendation:

We advise to closely follow the [Solidity style guide](#).

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "No plan to change the oracle implementation."



## POE-06: Variable Visibility

Type	Severity	Location
Gas Optimization	● Informational	<u>PriceOracle.sol L498, L505</u>

### Description:

The linked variables are only used for `internal` operations, hence can have a stricter visibility specifier to save gas.

### Recommendation:

We advise to change the visibility of the linked variables to `internal`.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "No plan to change the oracle implementation."



## POE-07: event Optimization

Type	Severity	Location
Language Specific	<span style="color: green;">●</span> Informational	<a href="#">PriceOracle.sol L602</a> , <a href="#">L669</a> , <a href="#">L714</a> , <a href="#">L721</a> , <a href="#">L731</a> , <a href="#">L746</a> , <a href="#">L751</a> , <a href="#">L761</a> , <a href="#">L776</a> , <a href="#">L784</a> , <a href="#">L789</a>

### Description:

The linked events could add the `address` parameters to the `topics` data structure.

### Recommendation:

We advise to add the `indexed` attribute to the `address` parameters of the linked events.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "No plan to change the oracle implementation."



## POE-08: Ambiguous Error Message

Type	Severity	Location
Inconsistency	● Informational	<a href="#">PriceOracle.sol L946</a>

### Description:

The error message of the linked `require` statement does not point to the problem at hand.

### Recommendation:

We advise to update the linked error message.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "No plan to change the oracle implementation."



## POE-09: Function Optimization

Type	Severity	Location
Gas Optimization	● Informational	<u><a href="#">PriceOracle.sol L918-L973</a></u>

### Description:

The `setExchangeRate()` function can be optimized in two parts, hence saving gas.

### Recommendation:

We advise to store the `ExchangeRateModel(exchangeRateModel)` into a local variable instead of casting the `address` to `ExchangeRateModel`. Also, introduce a `storage` variable and update that instead of redundantly looking-up the `exchangeRates` mapping for the specific `asset`.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "No plan to change the oracle implementation."



## POE-10: Code Optimization

Type	Severity	Location
Gas Optimization	● Informational	<a href="#">PriceOracle.sol L1149</a>

### Description:

The `for` loop conditional redundantly does a look-up to the `length` member of the `_assets` array on every iteration.

### Recommendation:

We advise to introduce a local variable with the value of `_assets.length` instead.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "No plan to change the oracle implementation."



## POE-11: Ambiguous NatSpec Comments

Type	Severity	Location
Coding Style	● Informational	<a href="#">PriceOracle.sol L1248-L1252</a>

### Description:

The linked NatSpec comments are describing some `return` values twice and are missing the boolean `return` value description.

### Recommendation:

We advise to update the linked NatSpec comments.

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).





## POE-12: Introduction of `require` Statements

Type	Severity	Location
Volatile Code	● Minor	<u><a href="#">PriceOracle.sol L401</a></u> , <u><a href="#">L888</a></u> , <u><a href="#">L1344</a></u> , <u><a href="#">L1522</a></u> , <u><a href="#">L1526</a></u> , <u><a href="#">L1579</a></u>

### Description:

A failed `assert` statement will consume all the gas available to the call.

### Recommendation:

We advise to change the linked `assert` statements with `require` ones.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "No plan to change the oracle implementation."



## POE-13: Function Visibility Optimization

Type	Severity	Location
Gas Optimization	<span style="color: green;">●</span> Informational	<a href="#">PriceOracle.sol L683</a> , <a href="#">L797</a> , <a href="#">L822</a> , <a href="#">L854</a> , <a href="#">L887</a> , <a href="#">L918</a> , <a href="#">L982</a> , <a href="#">L1035</a> , <a href="#">L1240</a> , <a href="#">L1254</a> , <a href="#">L1305</a> , <a href="#">L1600</a>

### Description:

The linked functions are declared as `public`, yet they are never called by the contract.

### Recommendation:

We advise that the functions' visibility specifiers are set to `external`, optimizing the gas cost of the function.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "No plan to change the oracle implementation."



## POE-14: Naming Conventions

Type	Severity	Location
Coding Style	<span style="color: green;">●</span> Informational	<a href="#">PriceOracle.sol L259</a> , <a href="#">L262</a> , <a href="#">L268</a> , <a href="#">L269</a> , <a href="#">L498</a> , <a href="#">L500</a> , <a href="#">L565</a> , <a href="#">L683</a> , <a href="#">L797</a> , <a href="#">L822</a> , <a href="#">L854</a> , <a href="#">L887</a> , <a href="#">L1078</a> , <a href="#">L1112</a> , <a href="#">L1141</a>

### Description:

The linked `public / external` variables and functions do not follow the Solidity standards in regards to their naming.

### Recommendation:

We advise to closely follow the [Solidity style guide](#).

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "No plan to change the oracle implementation."



## POE-15: Inexistent Input Sanitization

Type	Severity	Location
Volatile Code	● Informational	<u><a href="#">PriceOracle.sol L822-L847</a></u>

### Description:

The `_setPendingAnchorAdmin()` function does not check whether the input value is equal to the existing one.

### Recommendation:

We advise to add a `require` statement checking against the existing value of `pendingAnchorAdmin`.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "No plan to change the oracle implementation."



## ETH-01: Ambiguous Statement

Type	Severity	Location
Volatile Code	● Informational	<a href="#">iETH.sol L37</a>

### Description:

The linked statement does not properly use the `_spender` parameter. Also, the `_doTransferIn()` function does not follow the functionality explained in the NatSpec comments.

### Recommendation:

We advise to revise the `_doTransferIn()` function.

### Alleviation:

The recommendation was not taken into account.



## ETH-02: Usage of `transfer()` for sending Ether

Type	Severity	Location
Volatile Code	● Minor	<a href="#">iETH.sol L49</a> , <a href="#">L124</a> , <a href="#">L139</a>

### Description:

After [EIP-1884](#) was included in the Istanbul hard fork, it is not recommended to use `.transfer()` or `.send()` for transferring ether as these functions have a hard-coded value for gas costs making them obsolete as they are forwarding a fixed amount of gas, specifically 2300. This can cause issues in case the linked statements are meant to be able to transfer funds to other contracts instead of EOAs.

### Recommendation:

We advise that the linked `.transfer()` and `.send()` calls are substituted with the utilization of [the `sendValue\(\)` function](#) from the `Address.sol` implementation of OpenZeppelin either by directly importing the library or copying the linked code.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "No plan to change, aiming to restrict the gas."



## ETH-03: Possibility of incorrect calculation

Type	Severity	Location
Volatile Code	● Medium	<a href="#">iETH.sol L298</a>

### Description:

The aforementioned line `totalBorrows.mul(BASE).rdiv(_underlying)` multiplies `totalBorrows` with `BASE` so the decimals are not lost in division. It is not needed as `rdiv`, in its implementation, also multiplies the expression with `BASE`.

### Recommendation:

We advise to remove the multiplication with `BASE` on the aforementioned line.

### Alleviation:

The dForce team stated "The calculation itself is correct, changed for easy reading."



## ETH-04: Non Standard Contract Naming

Type	Severity	Location
Coding Style	● Informational	<a href="#">iETH.sol L11</a>

### Description:

The contract naming does not follow the Solidity naming conventions.

### Recommendation:

We advise to closely follow the [Solidity style guide](#).

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "No plan to change the token contract name."





## ETH-05: Inexistent Input Sanitization

Type	Severity	Location
Volatile Code	● Minor	<a href="#">iETH.sol L186</a>

### Description:

The `receive()` function allows the contract to receive ETH, to repay a successful flash loan.

### Recommendation:

We advise to add a `require` statement ensuring that only a contract is able to send ETH to the contract.

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).



## ETH-06: Contract Size

Type	Severity	Location
Compiler Error	● Informational	<a href="#">iETH.sol General</a>

### Description:

Contract size exceeds byte limit, may cause an issue in mainnet deployment.

### Recommendation:

No recommendation.

### Alleviation:

The dForce team stated "With 200 runs of optimization, code size is okay."



## ITO-01: Possibility of incorrect calculation

Type	Severity	Location
Volatile Code	● Medium	<a href="#">iToken.sol L307</a>

### Description:

The aforementioned line `totalBorrows.mul(BASE).rdiv(_underlying)` multiplies `totalBorrows` with `BASE` so the decimals are not lost in division. It is not needed as `rdiv`, in its implementation, also multiplies the expression with `BASE`.

### Recommendation:

We advise to remove the multiplication with `BASE` on the aforementioned line.

```
borrowRatePerBlock().tmul(  
    BASE.sub(reserveRatio),  
    totalBorrows.rdiv(_underlying)  
);
```

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).



## ITO-02: Redundant casting to uint8

Type	Severity	Location
Gas Optimization	● Informational	<a href="#">iToken.sol L34</a>

### Description:

The aforementioned line performs redundant casting to `uint8` as the value returns by the function `decimals` is already a `uint8`.

### Recommendation:

We advise to remove the redundant casting to `uint8` to save gas cost associated with the casting operation.

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).



## ITO-03: Contract name does not comply with the convention

Type	Severity	Location
Language Specific	● Informational	<u>iToken.sol L13</u>

### Description:

The contract name `iToken` starts with the small letter, which is against the convention of the contract names as the convention is to start the contract name with capital letter.

### Recommendation:

We advise to changed the name of contract to comply with the convention of contract names.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "No plan to change the token contract name."



## BAS-01: Possibility of replay attack in `permit`

Type	Severity	Location
Volatile Code	● Minor	<a href="#">Base.sol L577</a> , <a href="#">L45</a>

### Description:

The `permit` function on L577 performs the operation of deriving signer address from the signature values of `v`, `r` and `s`. The state variable `DOMAIN_SEPARATOR` that is used to calculate hash has a value of `chainid` that is derived only once in initialize function, which does not change after contract deployment. The issue arises in the event of fork when the cross-chain replay attacks can be executed.

The attack scenario can be thought of as if a fork of Ethereum happens and two different networks have id of for example 1 and 9. The chainid coded in `DOMAIN_SEPARATOR` will be the same on contracts residing in both of the forks. If the chainid 1 is stored in the contract then the `permit` transaction signed for chainid 1 will be executable on both of the forks.

### Recommendation:

We advise to construct the `DOMAIN_SEPARATOR` hash inside the `permit` function so the current `chainid` could be fetched and only the transactions signed for current network could succeed.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "More explanation needed."



## RDR-01: Potential for re-entrancy attacks in `claimReward`

Type	Severity	Location
Volatile Code	● Medium	<a href="#">contracts/RewardDistributor.sol L419-L420</a>

### Description:

The public `claimReward` function in the `RewardDistributor` contract has the potential for re-entrancy attacks due to the lack of access restriction and transferring from the arbitrary `rewardToken` address state variable to arbitrary `_holders` addresses. In the case that the caller supplies a valid account address in the `_holders` address array parameter with a non-zero `reward` value, a malicious `rewardToken` contract or `_account` address could re-enter the `claimReward` function and drain the funds, because each account's reward amount is not updated in the public `reward` address-to-amount mapping state variable until L420, following the transfer on L419.

### Recommendation:

This can be resolved by following the [Check-Effects-Interactions](#) pattern, setting the `reward` value for the current `_account` to zero before the transfer by effectively swapping L419 and L420.

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).



## RDR-02: Missing event for updating global distribution speed

Type	Severity	Location
Implementation	● Minor	<a href="#">contracts/RewardDistributor.sol L172</a>

### Description:

The public `_setGlobalDistributionSpeed` function in the `RewardDistributor` contract allows the owner to modify the `globalDistributionSpeed` state variable without emitting an event, which makes it difficult to track off-chain.

### Recommendation:

Consider introducing a `SetGlobalDistributionSpeed` event in order to safely track changing of the `globalDistributionSpeed` state variable on chain.

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).





## RDR-03: Lack of address check in `_updateReward`

Type	Severity	Location
Volatile Code	● Minor	<a href="#">contracts/RewardDistributor.sol L360</a>

### Description:

The internal `_updateReward` function in the `RewardDistributor` contract does not check if the supplied `_account` address parameter is non-zero.

### Recommendation:

Consider introducing a requirement in order to verify that the supplied `_account` address parameter is non-zero before using it in the function.

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).



## RDR-04: Unnecessary underscore prefixing `_setRewardToken`

Type	Severity	Location
Naming Conventions	● Informational	<a href="#">contracts/RewardDistributor.sol L90</a>

### Description:

The external `_setRewardToken` function in the `RewardDistributor` contract is prefixed with an underscore ( `_` ), which is a convention typically reserved for private and internal declarations.

### Recommendation:

Since the function is external, consider renaming the function to `setRewardToken` .

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "Public functions starts with `_` are owner functions for easy interaction on Remix or Etherscan."



## RDR-05: Unnecessary underscore prefixing `_addRecipient`

Type	Severity	Location
Naming Conventions	● Informational	<a href="#">contracts/RewardDistributor.sol L110</a>

### Description:

The external `_addRecipient` function in the `RewardDistributor` contract is prefixed with an underscore ( `_` ), which is a convention typically reserved for private and internal declarations.

### Recommendation:

Since the function is external, consider renaming the function to `addRecipient` .

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "Public functions starts with `_` are owner functions for easy interaction on Remix or Etherscan."



## RDR-06: Unnecessary underscore prefixing `_pause`

Type	Severity	Location
Naming Conventions	● Informational	<a href="#">contracts/RewardDistributor.sol L132</a>

### Description:

The external `_pause` function in the `RewardDistributor` contract is prefixed with an underscore ( `_` ), which is a convention typically reserved for private and internal declarations.

### Recommendation:

Since the function is external, consider renaming the function to `pause` .

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "Public functions starts with `_` are owner functions for easy interaction on Remix or Etherscan."



## RDR-07: Unnecessary underscore prefixing `_unpause`

Type	Severity	Location
Naming Conventions	● Informational	<a href="#">contracts/RewardDistributor.sol L144</a>

### Description:

The external `_unpause` function in the `RewardDistributor` contract is prefixed with an underscore ( `_` ), which is a convention typically reserved for private and internal declarations.

### Recommendation:

Since the function is external, consider renaming the function to `unpause` .

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "Public functions starts with `_` are owner functions for easy interaction on Remix or Etherscan."



## RDR-08: Unnecessary underscore prefixing `_setGlobalDistributionSpeed`

Type	Severity	Location
Naming Conventions	● Informational	<a href="#">contracts/RewardDistributor.sol L165</a>

### Description:

The public `_setGlobalDistributionSpeed` function in the `RewardDistributor` contract is prefixed with an underscore ( `_` ), which is a convention typically reserved for private and internal declarations.

### Recommendation:

Since the function is public, consider renaming the function to `setGlobalDistributionSpeed`.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "Public functions starts with `_` are owner functions for easy interaction on Remix or Etherscan."



## RDR-09: Inefficient early return in `updateDistributionSpeed`

Type	Severity	Location
Gas Optimization	● Informational	<a href="#">contracts/RewardDistributor.sol L185-L187</a>

### Description:

The public `updateDistributionSpeed` function in the `RewardDistributor` contract checks if the `paused` state variable is set before returning, which is inefficient.

### Recommendation:

This should most likely revert instead so that the gas is refunded.

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).



## RDR-10: Unnecessary underscore prefixing `_setDistributionFactors`

Type	Severity	Location
Naming Conventions	● Informational	<a href="#">contracts/RewardDistributor.sol L271</a>

### Description:

The external `_setDistributionFactors` function in the `RewardDistributor` contract is prefixed with an underscore ( `_` ), which is a convention typically reserved for private and internal declarations.

### Recommendation:

Since the function is external, consider renaming the function to `setDistributionFactors` .

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "Public functions starts with `_` are owner functions for easy interaction on Remix or Etherscan."





## RDR-11: Inefficient early return in `updateDistributionState`

Type	Severity	Location
Gas Optimization	● Informational	<a href="#">contracts/RewardDistributor.sol L300-L302</a>

### Description:

The external `updateDistributionState` function in the `RewardDistributor` contract checks if the `paused` state variable is set before returning, which is inefficient.

### Recommendation:

This should most likely revert instead so that the gas is refunded.

### Alleviation:

The recommendation was not taken into account.



## RDR-12: Inefficient early return in `updateReward`

Type	Severity	Location
Gas Optimization	● Informational	<a href="#">contracts/RewardDistributor.sol L351-L353</a>

### Description:

The external `updateReward` function in the `RewardDistributor` contract checks if the `paused` state variable is set before returning, which is inefficient.

### Recommendation:

This should most likely revert instead so that the gas is refunded.

### Alleviation:

The recommendation was not taken into account.



## RDR-13: `claimAllReward` should be declared external

Type	Severity	Location
Implementation	● Informational	<a href="#">contracts/RewardDistributor.sol L429</a>

### Description:

The public `claimAllReward` function in the `RewardDistributor` contract should be re-declared as external.

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).



## IRM-01: `getBorrowRate` should be declared external

Type	Severity	Location
Implementation	● Informational	<u><a href="#">contracts/InterestRateModel/InterestRateModel.sol L97-L101</a></u>

### Description:

The public `getBorrowRate` view function in the `InterestRateModel` contract should be re-declared as external.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "The Interest Rate Model will be completely rewrote."



## TAN-01: Unnecessary underscore prefixing `_setController`

Type	Severity	Location
Naming Conventions	● Informational	<u><a href="#">contracts/TokenBase/TokenAdmin.sol L28</a></u>

### Description:

The external `_setController` function in the `TokenAdmin` contract is prefixed with an underscore ( `_` ), which is a convention typically reserved for private and internal declarations.

### Recommendation:

Since the function is external, consider renaming the function to `setController` .

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "Public functions starts with `_` are owner functions for easy interaction on Remix or Etherscan."



## TAN-02: Unnecessary underscore prefixing `_setInterestRateModel`

Type	Severity	Location
Naming Conventions	● Informational	<u><a href="#">contracts/TokenBase/TokenAdmin.sol L50</a></u>

### Description:

The external `_setInterestRateModel` function in the `TokenAdmin` contract is prefixed with an underscore ( `_` ), which is a convention typically reserved for private and internal declarations.

### Recommendation:

Since the function is external, consider renaming the function to `setInterestRateModel` .

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "Public functions starts with `_` are owner functions for easy interaction on Remix or Etherscan."



## TAN-03: Unnecessary underscore prefixing `_setNewReserveRatio`

Type	Severity	Location
Naming Conventions	● Informational	<a href="#">contracts/TokenBase/TokenAdmin.sol L71</a>

### Description:

The external `_setNewReserveRatio` function in the `TokenAdmin` contract is prefixed with an underscore ( `_` ), which is a convention typically reserved for private and internal declarations.

### Recommendation:

Since the function is external, consider renaming the function to `setNewReserveRatio` .

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "Public functions starts with `_` are owner functions for easy interaction on Remix or Etherscan."



## TAN-04: Unnecessary underscore prefixing `_setNewFlashloanFeeRatio`

Type	Severity	Location
Naming Conventions	● Informational	<u><a href="#">contracts/TokenBase/TokenAdmin.sol L94</a></u>

### Description:

The external `_setNewFlashloanFeeRatio` function in the `TokenAdmin` contract is prefixed with an underscore ( `_` ), which is a convention typically reserved for private and internal declarations.

### Recommendation:

Since the function is external, consider renaming the function to `setNewFlashloanFeeRatio`.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "Public functions starts with `_` are owner functions for easy interaction on Remix or Etherscan."





## TAN-05: Unnecessary underscore prefixing `_setNewProtocolFeeRatio`

Type	Severity	Location
Naming Conventions	● Informational	<a href="#">contracts/TokenBase/TokenAdmin.sol L117</a>

### Description:

The external `_setNewProtocolFeeRatio` function in the `TokenAdmin` contract is prefixed with an underscore ( `_` ), which is a convention typically reserved for private and internal declarations.

### Recommendation:

Since the function is external, consider renaming the function to `setNewProtocolFeeRatio`.

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "Public functions starts with `_` are owner functions for easy interaction on Remix or Etherscan."



## TAN-06: Unnecessary underscore prefixing `_withdrawReserves`

Type	Severity	Location
Naming Conventions	● Informational	<a href="#">contracts/TokenBase/TokenAdmin.sol L142</a>

### Description:

The external `_withdrawReserves` function in the `TokenAdmin` contract is prefixed with an underscore ( `_` ), which is a convention typically reserved for private and internal declarations.

### Recommendation:

Since the function is external, consider renaming the function to `withdrawReserves` .

### Alleviation:

The recommendation was not taken into account, with the dForce team stating "Public functions starts with `_` are owner functions for easy interaction on Remix or Etherscan."



## TER-01: Potential for re-entrancy attacks in `_transferTokens`

Type	Severity	Location
Volatile Code	● Minor	<a href="#">contracts/TokenBase/TokenERC20.sol L34</a>

### Description:

The internal `_transferTokens` function in the `TokenERC20` contract has the potential for re-entrancy attacks due to being accessible from the public `transfer` and `transferFrom` functions and making a call to the internal `ERC20._transfer` function.

### Recommendation:

Consider utilizing the `nonReentrant` modifier on the internal `_transferTokens` function in order to protect against re-entrancy attacks.

### Alleviation:

The recommendation was applied in commit [397ec65b5676bd2f64d72e532e961595ab931e3d](#).



# Appendix

## Finding Categories

### Gas Optimization

Gas Optimization findings refer to exhibits that do not affect the functionality of the code but generate different, more optimal EVM opcodes resulting in a reduction on the total gas cost of a transaction.

### Arithmetic

Arithmetic exhibits entail findings that relate to mishandling of math formulas, such as overflows, incorrect operations etc.

### Logical Issue

Logical Issue findings are exhibits that detail a fault in the logic of the linked code, such as an incorrect notion on how `block.timestamp` works.

### Control Flow

Control Flow findings concern the access control imposed on functions, such as owner-only functions being invoke-able by anyone under certain circumstances.

### Volatile Code

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

### Data Flow

Data Flow findings describe faults in the way data is handled at rest and in memory, such as the result of a `struct` assignment operation affecting an in-memory `struct` rather than an in-storage one.

## Language Specific

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

## Coding Style

Coding Style findings usually do not affect the generated byte-code and comment on how to make the codebase more legible and as a result easily maintainable.

## Inconsistency

Inconsistency findings refer to functions that should seemingly behave similarly yet contain different code, such as a `constructor` assignment imposing different `require` statements on the input variables than a setter function.

## Magic Numbers

Magic Number findings refer to numeric literals that are expressed in the codebase in their raw format and should otherwise be specified as `constant` contract variables aiding in their legibility and maintainability.

## Compiler Error

Compiler Error findings refer to an error in the structure of the code that renders it impossible to compile using the specified version of the project.

## Dead Code

Code that otherwise does not affect the functionality of the codebase and can be safely omitted.