

Draft
Security Assessment for

37-2021-10-tempus (10K-FLP) (1Positive-WOI)

July 23, 2023



Executive Summary

Overview OFF	27-2021-10 tompus (10K-ELD)
Project Name	37-2021-10-tempus (10K-FLP) (1Positive-WOI)
Codebase URL	https://github.com/code-423n4/2021- 10-tempus
Scan Engine	Al Analyzer
Scan Time	2023/07/23 17:07:53
Commit Id	df5b441

Total		N
Critical Issues	PIAL AUDIT REPORT	
High risk Issues	8 87	
Medium risk Issues	0	
Low risk Issues	0	
Informational Issues	0	Λ//

Critical Issues	The issue can cause large economic losses, large-scale data disorder, loss of control of authority management, failure of key functions, or indirectly affect the correct operation of other smart contracts interacting with it.
High Risk Issues	The issue puts a large number of users' sensitive information at risk or is reasonably likely to lead to catastrophic impacts on clients' reputations or serious financial implications for clients and users.
Medium Risk Issues	The issue puts a subset of users' sensitive information at risk, would be detrimental to the client's reputation if exploited, or is reasonably likely to lead to moderate financial impact.
Low Risk Issues	The risk is relatively small and could not be exploited on a recurring basis, or is a risk that the client has indicated is low-impact in view of the client's business circumstances.
	The issue does not pose an

immediate risk but is relevant to security best practices or Defence

in Depth.



Informational Issue

3



Summary of Findings

MetaScan security assessment was performed on July 23, 2023 17:07:53 on project 37-2021-10-tempus (10K-FLP) (1Positive-WOI) with the repository https://github.com/code-423n4/2021-10-tempus on branch default branch. The assessment was carried out by scanning the project's codebase using the scan engine Al Analyzer. There are in total 8 vulnerabilities / security risks discovered during the scanning session, among which 0 critical vulnerabilities, 8 high risk vulnerabilities, 0 medium risk vulnerabilities, 0 low risk vulnerabilities, 0 informational issues.

ID	Description	Severity
MSA-001	MWE-200: Insecure LP Token Value Calculation	High risk
MSA-002	MWE-209: Wrong Order for Interest or ExchangeRate	High risk
MSA-003	MWE-200: Insecure LP Token Value Calculation	High risk
MSA-004	MWE-200: Insecure LP Token Value Calculation	High risk
MSA-005	MWE-200: Insecure LP Token Value Calculation	High risk
MSA-006	MWE-200: Insecure LP Token Value Calculation	High risk
MSA-007	MWE-200: Insecure LP Token Value Calculation	High risk
MSA-008	MWE-200: Insecure LP Token Value Calculation	High risk







Findings



Critical (0)

No Critical vulnerabilities found here

FICIAL AUDIT REPORT 4 High risk (8)







Liquidity token value/price can be manipulated to cause flashloan attacks.

File(s) Affected

contracts/TempusController.sol #337-367

```
function _provideLiquidity(
   address sender,
   IVault vault,
   bytes32 poolId,
   IERC20[] memory ammTokens,
   uint256[] memory ammBalances,
   uint256 sharesAmount,
   address recipient
) private returns (uint256[] memory) {
   uint256[] memory ammLiquidityProvisionAmounts = ammBalances.getLiquidityProvisionSharesAmounts
   if (sender != address(this)) {
       ammTokens[0].safeTransferFrom(sender, address(this), ammLiquidityProvisionAmounts[0]);
       ammTokens[1].safeTransferFrom(sender, address(this), ammLiquidityProvisionAmounts[1]);
   ammTokens[0].safeIncreaseAllowance(address(vault), ammLiquidityProvisionAmounts[0]);
   ammTokens[1].safeIncreaseAllowance(address(vault), ammLiquidityProvisionAmounts[1]);
   IVault.JoinPoolRequest memory request = IVault.JoinPoolRequest({
       assets: ammTokens,
       maxAmountsIn: ammLiquidityProvisionAmounts,
       userData: abi.encode(uint8(ITempusAMM.JoinKind.EXACT_TOKENS_IN_FOR_BPT_OUT), ammLiquidityP1
                                                     CIAL AUDIT REPORT
    fromInternalBalance: false
   });
    // Provide TPS/TYS liquidity to TempusAMM
   vault.joinPool(poolId, address(this), recipient, request);
   return ammLiquidityProvisionAmounts;
```

NON-OFFICIAL AUDIT REPOR

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contracts/TempusController.sol #304-335

```
function _depositAndProvideLiquidity(
           ITempusAMM tempusAMM,
           uint256 tokenAmount,
          bool isBackingToken
308 , (
309 (
IVault vault,
               bytes32 poolId,
              IERC20[] memory ammTokens,
               uint256[] memory ammBalances
           ) = _getAMMDetailsAndEnsureInitialized(tempusAMM);
           uint256 mintedShares = _deposit(tempusAMM.tempusPool(), tokenAmount, isBackingToken);
            uint256[] memory sharesUsed = _provideLiquidity(
               address(this),
               vault,
321 ammTokens,
                ammBalances,
              mintedShares,
              msg.sender
          );
            // Send remaining Shares to user
           if (sharesUsed[0] < mintedShares) {</pre>
                ammTokens[0].safeTransfer(msq.sender, mintedShares - sharesUsed[0]);
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            if (sharesUsed[1] < mintedShares) {</pre>
                ammTokens[1].safeTransfer(msg.sender, mintedShares - sharesUsed[1]);
```

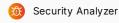
Recommendation





2. MWE-209: Wrong Order for Interest or ExchangeRate





Update of interest or exchange rate should be executed before calculating new balance, share, stake, loan or fee.

File(s) Affected

contracts/TempusPool.sol #257-282

```
function burnShares(
     address from,
     uint256 principalAmount,
     uint256 yieldAmount
     internal
     returns (
         uint256 redeemedYieldTokens,
         uint256 fee,
         uint256 interestRate
require (IERC20 (address (principalShare)).balanceOf (from) >= principalAmount, "Insufficient principal
     require (IERC20 (address (yieldShare)).balanceOf (from) >= yieldAmount, "Insufficient yields.");
     // Redeeming prior to maturity is only allowed in equal amounts.
     require(matured || (principalAmount == yieldAmount), "Inequal redemption not allowed before mat
     // Burn the appropriate shares
     PrincipalShare(address(principalShare)).burnFrom(from, principalAmount);
     YieldShare(address(yieldShare)).burnFrom(from, yieldAmount);
     uint256 currentRate = updateInterestRate();
     (redeemedYieldTokens, , fee, interestRate) = getRedemptionAmounts(principalAmount, yieldAmount,
     totalFees += fee;
```

Recommendation

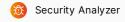
Check the business logic and move the statements about updating exchange rate or interest forward.



NON-OFF







Liquidity token value/price can be manipulated to cause flashloan attacks.

File(s) Affected

contracts/TempusPool.sol #284-332

```
function getRedemptionAmounts(
          uint256 principalAmount,
             uint256 yieldAmount,
             uint256 currentRate
             private
             view
             returns (
                 uint256 redeemableYieldTokens,
                 uint256 redeemableBackingTokens,
                 uint256 redeemFeeAmount.
                 uint256 interestRate
                                                  NON-OFFICIAL AUDIT REPORT
             interestRate = effectiveRate(currentRate);
             if (interestRate < initialInterestRate) {</pre>
                 redeemableBackingTokens = (principalAmount * interestRate) / initialInterestRate;
             } else {
                 uint256 rateDiff = interestRate - initialInterestRate;
                 // this is expressed in percent with exchangeRate precision
                 uint256 yieldPercent = rateDiff.divfV(initialInterestRate, exchangeRateONE);
                 uint256 redeemAmountFromYieldShares = yieldAmount.mulfV(yieldPercent, exchangeRateONE);
                 // TODO: Scale based on number of decimals for tokens
                 redeemableBackingTokens = principalAmount + redeemAmountFromYieldShares;
                  // after maturity, all additional yield is being collected as fee
                 if (matured && currentRate > interestRate) {
                     uint256 additionalYieldRate = currentRate - interestRate;
                     uint256 feeBackingAmount = yieldAmount.mulfV(
                         additionalYieldRate.mulfV(initialInterestRate, exchangeRateONE),
                         exchangeRateONE
                     );
                     redeemFeeAmount = numYieldTokensPerAsset(feeBackingAmount, currentRate);
             redeemableYieldTokens = numYieldTokensPerAsset(redeemableBackingTokens, currentRate);
             uint256 redeemFeePercent = matured ? feesConfig.matureRedeemPercent : feesConfig.earlyRedeemPe
             if (redeemFeePercent != 0) {
                 uint256 regularRedeemFee = redeemableYieldTokens.mulfV(redeemFeePercent, yieldBearingONE);
                 redeemableYieldTokens -= regularRedeemFee;
                 redeemFeeAmount += regularRedeemFee;
                 redeemableBackingTokens = numAssetsPerYieldToken(redeemableYieldTokens, currentRate);
             }
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```



contracts/TempusPool.sol #257-282

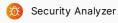
```
function burnShares(
    address from,
    uint256 principalAmount,
    uint256 yieldAmount
    internal
    returns (
                                        NON-OFFICIAL AUDIT REPORT
        uint256 redeemedYieldTokens,
        uint256 fee,
uint256 interestRate
    )
    require(IERC20(address(principalShare)).balanceOf(from) >= principalAmount, "Insufficient princ
    require(IERC20(address(yieldShare)).balanceOf(from) >= yieldAmount, "Insufficient yields.");
     // Redeeming prior to maturity is only allowed in equal amounts.
     require(matured || (principalAmount == yieldAmount), "Inequal redemption not allowed before mat
     // Burn the appropriate shares
     PrincipalShare(address(principalShare)).burnFrom(from, principalAmount);
     YieldShare(address(yieldShare)).burnFrom(from, yieldAmount);
     uint256 currentRate = updateInterestRate();
     (redeemedYieldTokens, , fee, interestRate) = getRedemptionAmounts(principalAmount, yieldAmount,
    totalFees += fee;
```

Recommendation









Liquidity token value/price can be manipulated to cause flashloan attacks.

File(s) Affected

contracts/TempusPool.sol #370-380

```
function estimatedYield(uint256 yieldCurrent) private view returns (uint256) {
   if (matured) {
      return yieldCurrent;
   }
}

uint256 currentTime = block.timestamp;
   uint256 timeToMaturity = (maturityTime > currentTime) ? (maturityTime - currentTime) : 0;

uint256 poolDuration = maturityTime - startTime;
   uint256 timeLeft = timeToMaturity.divfV(poolDuration, exchangeRateONE);

return yieldCurrent + timeLeft.mulfV(initialEstimatedYield, exchangeRateONE);
}
```

contracts/TempusPool.sol #396-403

```
function pricePerPrincipalShare(uint256 currYield, uint256 estYield) private view returns (uint256)

// in case we have estimate for negative yield

if (estYield < exchangeRateONE) {

return interestRateToSharePrice(currYield);

uint256 principalPrice = currYield.divfV(estYield, exchangeRateONE);

return interestRateToSharePrice(principalPrice);

return interestRateToSharePrice(principalPrice);

}</pre>
```

Recommendation

Do not use AMM pool or custom liquidity calculation to caculate LP token value/price.

5. MWE-200: Insecure LP Token Value Calculation





Liquidity token value/price can be manipulated to cause flashloan attacks.

File(s) Affected

contracts/TempusPool.sol #384-392

```
function pricePerYieldShare(uint256 currYield, uint256 estYield) private view returns (uint256) {
    uint one = exchangeRateONE;

// in case we have estimate for negative yield

if (estYield < one) {
    return uint256(0);

}

uint256 yieldPrice = (estYield - one).mulfV(currYield, one).divfV(estYield, one);

return interestRateToSharePrice(yieldPrice);

}</pre>
```

Recommendation







Liquidity token value/price can be manipulated to cause flashloan attacks.

File(s) Affected

contracts/mocks/compound/CTokenMock.sol #48-68

```
function mintFresh(address minter, uint mintAmount) internal returns (uint errorCode, uint actualMin
        uint err = comptroller.mintAllowed(address(this), minter, mintAmount);
        require(err == 0, "mint is not allowed");
uint exchangeRate = exchangeRateStored(); // exchangeRate has variable decimal precision
                                                              L AUDIT REPORT
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         * We call `doTransferIn` for the minter and the mintAmount.
         * Note: The cToken must handle variations between ERC-20 and ETH underlying.
            `doTransferIn` reverts if anything goes wrong, since we can't be sure if
         * side-effects occurred. The function returns the amount actually transferred,
         * in case of a fee. On success, the cToken holds an additional `actualMintAmount
         * of cash.
         */
        actualMintAmount = doTransferIn(minter, mintAmount); // 18 decimal precision
     // exchange rate precision: 18 - 8 + Underlying Token Decimals
        uint mintTokens = (actualMintAmount * 1e18) / exchangeRate; // (18 + 18) - 28 = 8 decimal precis
        _mint(minter, mintTokens);
        errorCode = 0;
```

Recommendation













Liquidity token value/price can be manipulated to cause flashloan attacks.

File(s) Affected

contracts/amm/TempusAMM.sol #155-171

```
function getExpectedReturnGivenIn(uint256 amount, bool yieldShareIn) public view returns (uint256)
   (, uint256[] memory balances, ) = getVault().getPoolTokens(getPoolId());
   (uint256 currentAmp, ) = _getAmplificationParameter();
   (IPoolShare tokenIn, IPoolShare tokenOut) = yieldShareIn
       ? (tempusPool.yieldShare(), tempusPool.principalShare())
       : (tempusPool.principalShare(), tempusPool.yieldShare());
    (uint256 indexIn, uint256 indexOut) = address(tokenIn) == address(_token0) ? (0, 1) : (1, 0);
   amount = _subtractSwapFeeAmount(amount);
   balances.mul(_getTokenRatesStored(), _TEMPUS_SHARE_PRECISION);
   uint256 rateAdjustedSwapAmount = (amount * tokenIn.getPricePerFullShareStored()) / _TEMPUS_SHAF
   uint256 amountOut = StableMath._calcOutGivenIn(currentAmp, balances, indexIn, indexOut, rateAd
   amountOut = (amountOut * _TEMPUS_SHARE_PRECISION) / tokenOut.getPricePerFullShareStored();
   return amountOut;
                                        NON-OFFICIAL AUDIT REPORT
```

Recommendation







Liquidity token value/price can be manipulated to cause flashloan attacks.

File(s) Affected

contracts/amm/TempusAMM.sol #686-691

```
function _getTokenRatesStored() private view returns (uint256[] memory) {
   uint256[] memory rates = new uint256[](_TOTAL_TOKENS);
   rates[0] = _token0.getPricePerFullShareStored();
   rates[1] = _token1.getPricePerFullShareStored();
   return rates;
```

contracts/amm/TempusAMM.sol #258-277

```
function getExpectedLPTokensForTokensIn(uint256[] memory amountsIn) external view returns (uint256)
    (, uint256[] memory balances, ) = getVault().getPoolTokens(getPoolId());
   uint256[] memory tokenRates = _getTokenRatesStored();
   balances.mul(tokenRates, _TEMPUS_SHARE_PRECISION);
   amountsIn.mul(tokenRates, _TEMPUS_SHARE_PRECISION);
    (uint256 currentAmp, ) = _getAmplificationParameter();
 return
       (balances[0] == 0)
           ? StableMath._calculateInvariant(currentAmp, amountsIn, true)
            : StableMath._calcBptOutGivenExactTokensIn(
               currentAmp,
               balances,
               amountsIn,
               totalSupply(),
               getSwapFeePercentage()
           );
```

Recommendation

Do not use AMM pool or custom liquidity calculation to caculate LP token value/price.



Medium risk (0)

No Medium risk vulnerabilities found here



\Lambda Low risk (0)

No Low risk vulnerabilities found here



Informational (0)



No Informational vulnerabilities found here



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