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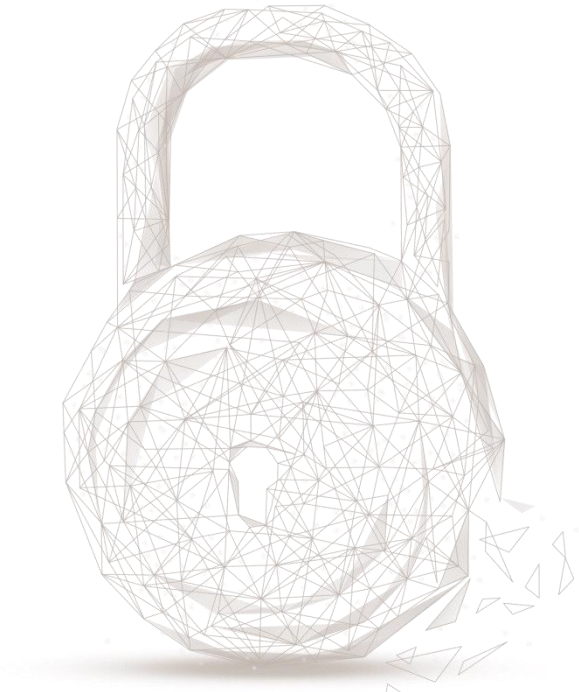
智能合约安全审计报告



审计编号：202104261544

审计合约名称：

AppleToken（Apple）

审计合约地址：

0x28F1Ec92Dd1BF76e2Bc2eE9290fb841A4547a325

合约审计开始日期：2021.04.20

合约审计完成日期：2021.04.26

审计结果：通过（优）

审计团队：成都链安科技有限公司

审计类型及结果：

序号	审计类型	审计子项	审计结果
1	代码规范审计	HRC-20 Token 标准规范审计	通过
		编译器版本安全审计	通过
		可见性规范审计	通过
		gas 消耗审计	通过
		SafeMath 功能审计	通过
		fallback 函数使用审计	通过
		tx.origin 使用审计	通过
		弃用项审计	通过
		冗余代码审计	通过
		变量覆盖审计	通过
2	函数调用审计	函数调用权限审计	通过
		call/delegatecall 安全审计	通过
		返回值安全审计	通过
		自毁函数安全审计	通过
3	业务安全审计	owner 权限审计	通过
		业务逻辑审计	通过
		业务实现审计	通过
4	整型溢出审计	-	通过
5	可重入攻击审计	-	通过
6	异常可达状态审计	-	通过
7	交易顺序依赖审计	-	通过
8	块参数依赖审计	-	通过
9	伪随机数生成审计	-	通过
10	拒绝服务攻击审计	-	通过
11	代币锁仓审计	-	通过
12	假充值审计	-	通过

13	event 安全审计	-	通过

备注：审计意见及建议请见代码注释。

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审计结果说明：

本公司采用形式化验证、静态分析、动态分析、典型案例测试和人工审核的方式对智能合约Apple的代码规范性、安全性以及业务逻辑三个方面进行多维度全面的安全审计。**经审计，Apple合约通过所有检测项，合约审计结果为通过(优)，合约可正常使用。**以下为本合约基本信息。

1、代币基本信息

Token name	apple token
Token symbol	apt
decimals	18
totalSupply	初始2亿（可铸币，最大上限20亿）
Token type	HRC-20

表1 代币基本信息

2、代币锁仓信息

如下图所示，合约所有者可调用 lock 函数进行锁仓。锁仓时，需指定锁仓地址、锁仓金额及锁仓种类，不同种类锁仓对应的日释放量不同，且可被合约所有者调控。锁仓释放最小时间单位为“一天”，不满一天不计算，因此全部锁仓释放时间可能会比预期时间长，但不影响总释放量。

```
389     function lock(address _account, uint256 _amount, uint256 _type) public onlyOwner {
390         require(_account != address(0), "Cannot transfer to the zero address");
391         require(lockedUser[_account].lockedAmount == 0, "exist locked token");
392         require(_account != swapGovContract, "equal to swapGovContract");
393         lockedUser[_account].initLock = _amount;
394         lockedUser[_account].lockedAmount = _amount;
395         lockedUser[_account].lastUnlockTs = block.timestamp >= lockreleasetime ? block.timestamp : lockreleasetime;
396         lockedUser[_account].releaseType = _type;
397         _balances[_msgSender()] = _balances[_msgSender()].sub(_amount);
398         _balances[_account] = _balances[_account].add(_amount);
399         emit Lock(_account, block.timestamp, _amount, _type);
400         emit Transfer(_msgSender(), _account, _amount);
401     }
```

图 1 lock 函数源码截图

如下图所示，代币锁仓余额需要用户手动调用 unlock 函数进行解锁，不会自动解锁。

```
403     function unlock() public {
404         uint256 amount = getAvailablelockAmount(_msgSender(), lockedUser[_msgSender()].releaseType);
405         require(amount > 0, "amount equal 0");
406         lockedUser[_msgSender()].lockedAmount = lockedUser[_msgSender()].lockedAmount.sub(amount);
407         lockedUser[_msgSender()].lastUnlockTs = block.timestamp;
408         emit UnLock(_msgSender(), block.timestamp, amount);
409     }
```

图 2 unlock 函数源码截图

- 修复建议：调用 unlock 解锁时，更改 lastUnlockTs 变量为当前已解锁的天数的时间戳，即可避免误差。
- 修复结果：忽略

3、其它函数功能描述

➢ 铸币功能

合约实现了铸币功能，合约所有者可以添加Minter权限，拥有Minter权限的地址可以调用mint函数进行铸币，铸币上限为20亿。

➢ 黑名单功能

合约实现了黑名单功能，合约所有者将有权添加地址黑名单。被添加为黑名单的地址将无法参与转账。

合约源代码审计注释：

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

pragma solidity 0.6.12;

/**
```

```
 * @title SafeMath
 * @dev Unsigned math operations with safety checks that revert on error.
 */
// 成都链安 // SafeMath 库，用于安全数学运算以避免整型溢出
library SafeMath {
    /**
     * @dev Multiplie two unsigned integers, revert on overflow.
     */
    function mul(uint256 a, uint256 b) internal pure returns (uint256) {
        // Gas optimization: this is cheaper than requiring 'a' not being zero, but the
        // benefit is lost if 'b' is also tested.
        // See: https://github.com/OpenZeppelin/openzeppelin-solidity/pull/522
        if (a == 0) {
            return 0;
        }

        uint256 c = a * b;
        require(c / a == b);

        return c;
    }

    /**
     * @dev Integer division of two unsigned integers truncating the quotient, revert on division by zero.
     */
    function div(uint256 a, uint256 b) internal pure returns (uint256) {
        // Solidity only automatically asserts when dividing by 0
        require(b > 0);
        uint256 c = a / b;
        // assert(a == b * c + a % b); // There is no case in which this doesn't hold

        return c;
    }

    /**
     * @dev Subtract two unsigned integers, revert on underflow (i.e. if subtrahend is greater than
minuend).
     */
    function sub(uint256 a, uint256 b) internal pure returns (uint256) {
        require(b <= a);
        uint256 c = a - b;

        return c;
    }

    /**
```

```
    * @dev Add two unsigned integers, revert on overflow.
    */
    function add(uint256 a, uint256 b) internal pure returns (uint256) {
        uint256 c = a + b;
        require(c >= a);

        return c;
    }
}


/**
 * @title Roles
 * @dev Library for managing addresses assigned to a Role.
 */
library Roles {
    struct Role {
        mapping (address => bool) bearer;
    }

    /**
     * @dev Give an account access to this role.
     */
    function add(Role storage role, address account) internal {
        require(!has(role, account), "Roles: account already has role");
        role.bearer[account] = true;
    }

    /**
     * @dev Remove an account's access to this role.
     */
    function remove(Role storage role, address account) internal {
        require(has(role, account), "Roles: account does not have role");
        role.bearer[account] = false;
    }

    /**
     * @dev Check if an account has this role.
     * @return bool
     */
    function has(Role storage role, address account) internal view returns (bool) {
        require(account != address(0), "Roles: account is the zero address");
        return role.bearer[account];
    }
}
```

```
/*
 * @dev Provides information about the current execution context, including the
 * sender of the transaction and its data. While these are generally available
 * via msg.sender and msg.data, they should not be accessed in such a direct
 * manner, since when dealing with GSN meta-transactions the account sending and
 * paying for execution may not be the actual sender (as far as an application
 * is concerned).
 *
 * This contract is only required for intermediate, library-like contracts.
 */
contract Context {

    function _msgSender() internal view returns (address payable) {
        return msg.sender;
    }
}

/**
 * @title ERC20 interface
 * @dev See https://eips.ethereum.org/EIPS/eip-20
 */
// 成都链安 // 定义 ERC20 标准接口
interface IERC20 {
    function transfer(address to, uint256 value) external returns (bool);

    function approve(address spender, uint256 value) external returns (bool);

    function transferFrom(address from, address to, uint256 value) external returns (bool);

    function totalSupply() external view returns (uint256);

    function balanceOf(address who) external view returns (uint256);

    function allowance(address owner, address spender) external view returns (uint256);

    event Transfer(address indexed from, address indexed to, uint256 value);

    event Approval(address indexed owner, address indexed spender, uint256 value);
}


/**
 * @title Standard ERC20 token
 * @dev Implementation of the basic standard token.
```

```
 */
contract StandardToken is IERC20, Context {
    using SafeMath for uint256; // 成都链安 // 引入 SafeMath 安全数学运算库，避免数学运算整型溢出

    mapping (address => uint256) internal _balances; // 成都链安 // 声明 mapping 变量_balances，存储指定地址的代币余额
    mapping (address => mapping (address => uint256)) internal _allowed; // 成都链安 // 声明 mapping 变量_allowed，存储对应地址间的授权值

    uint256 internal _totalSupply; // 成都链安 // 声明 uint256 变量_totalSupply，存储代币的总量

    /**
     * @dev Total number of tokens in existence.
     */
    function totalSupply() public override view returns (uint256) {
        return _totalSupply;
    }

    /**
     * @dev Get the balance of the specified address.
     * @param owner The address to query the balance of.
     * @return A uint256 representing the amount owned by the passed address.
     */
    function balanceOf(address owner) public override view  returns (uint256) {
        return _balances[owner];
    }

    /**
     * @dev Function to check the amount of tokens that an owner allowed to a spender.
     * @param owner The address which owns the funds.
     * @param spender The address which will spend the funds.
     * @return A uint256 specifying the amount of tokens still available for the spender.
     */
    function allowance(address owner, address spender) public override view returns (uint256) {
        return _allowed[owner][spender];
    }

    /**
     * @dev Transfer tokens to a specified address.
     * @param to The address to transfer to.
     * @param value The amount to be transferred.
     */
    function transfer(address to, uint256 value) public virtual override returns (bool) {
        _transfer(_msgSender(), to, value); // 成都链安 // 调用内部函数_transfer 进行转账
        return true;
```

```
    }

    /**
     * @dev Approve the passed address to spend the specified amount of tokens on behalf of msg.sender.
     * Beware that changing an allowance with this method brings the risk that someone may use both the old
     * and the new allowance by unfortunate transaction ordering. One possible solution to mitigate this
     * race condition is to first reduce the spender's allowance to 0 and set the desired value afterwards:
     * https://github.com/ethereum/EIPs/issues/20#issuecomment-263524729
     * @param spender The address which will spend the funds.
     * @param value The amount of tokens to be spent.
     */
    // 成都链安 // 用户调用该函数修改授权值时，可能导致多重授权，建议使用 increaseAllowance 和 decreaseAllowance 修改授权值
    function approve(address spender, uint256 value) public override returns (bool) {
        _approve(_msgSender(), spender, value); // 成都链安 // 调用内部函数_approve 进行授权
        return true;
    }

    /**
     * @dev Transfer tokens from one address to another.
     * Note that while this function emits an Approval event, this is not required as per the specification,
     * and other compliant implementations may not emit the event.
     * @param from The address which you want to send tokens from.
     * @param to The address which you want to transfer to.
     * @param value The amount of tokens to be transferred.
     */
    function transferFrom(address from, address to, uint256 value) public virtual override returns (bool) {
        _transfer(from, to, value); // 成都链安 // 调用内部函数_transfer 进行转账
        _approve(from, _msgSender(), _allowed[from][_msgSender()].sub(value)); // 成都链安 // 调用内部函数_approve 更新授权
        return true;
    }

    /**
     * @dev Increase the amount of tokens that an owner allowed to a spender.
     * approve should be called when _allowed[msg.sender][spender] == 0. To increment
     * allowed value is better to use this function to avoid 2 calls (and wait until
     * the first transaction is mined)
     * From MonolithDAO Token.sol
     * Emits an Approval event.
     * @param spender The address which will spend the funds.
     * @param addedValue The amount of tokens to increase the allowance by.
     */
    function increaseAllowance(address spender, uint256 addedValue) public returns (bool) {
        _approve(_msgSender(), spender, _allowed[_msgSender()][spender].add(addedValue)); // 成都链安
```

```
// 调用内部函数_approve 进行授权
        return true;
    }

    /**
     * @dev Decrease the amount of tokens that an owner allowed to a spender.
     * approve should be called when _allowed[msg.sender][spender] == 0. To decrement
     * allowed value is better to use this function to avoid 2 calls (and wait until
     * the first transaction is mined)
     * From MonolithDAO Token.sol
     * Emits an Approval event.
     * @param spender The address which will spend the funds.
     * @param subtractedValue The amount of tokens to decrease the allowance by.
     */
    function decreaseAllowance(address spender, uint256 subtractedValue) public returns (bool) {
        _approve(_msgSender(), spender, _allowed[_msgSender()][spender].sub(subtractedValue)); // 成都链安 // 调用内部函数_approve 进行授权
        return true;
    }

    /**
     * @dev Transfer tokens for a specified address.
     * @param from The address to transfer from.
     * @param to The address to transfer to.
     * @param value The amount to be transferred.
     */
    function _transfer(address from, address to, uint256 value) internal {
        require(to != address(0), "Cannot transfer to the zero address"); // 成都链安 // 非零地址检查
        _balances[from] = _balances[from].sub(value); // 成都链安 // 减少 from 地址的代币余额
        _balances[to] = _balances[to].add(value); // 成都链安 // 增加 to 地址的代币余额
        emit Transfer(from, to, value); // 成都链安 // 触发 Transfer 事件
    }

    /**
     * @dev Approve an address to spend another addresses' tokens.
     * @param owner The address that owns the tokens.
     * @param spender The address that will spend the tokens.
     * @param value The number of tokens that can be spent.
     */
    function _approve(address owner, address spender, uint256 value) internal {
        require(spender != address(0), "Cannot approve to the zero address"); // 成都链安 // 非零地址检查
        require(owner != address(0), "Setter cannot be the zero address"); // 成都链安 // 非零地址检查
        _allowed[owner][spender] = value; // 成都链安 // 修改 owner 地址对 spender 地址的授权值
        emit Approval(owner, spender, value); // 成都链安 // 触发 Approval 事件
    }
```

```
    /** @dev Creates `amount` tokens and assigns them to `account`, increasing
     * the total supply.
     *
     * Emits a `Transfer` event with `from` set to the zero address.
     *
     * Requirements
     *
     * - `to` cannot be the zero address.
     */
    function _mint(address account, uint256 amount) internal {
        require(account != address(0), "ERC20: mint to the zero address");

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

    /**
     * @dev Destroys `amount` tokens from `account`, reducing the
     * total supply.
     *
     * Emits a {Transfer} event with `to` set to the zero address.
     *
     * Requirements
     *
     * - `account` cannot be the zero address.
     * - `account` must have at least `amount` tokens.
     */
    function _burn(address account, uint256 amount) internal virtual {
        require(account != address(0), "ERC20: burn from the zero address"); // 成都链安 // 非零地址检查
        _balances[account] = _balances[account].sub(amount); // 成都链安 // 减少 account 地址的代币余额
        _totalSupply = _totalSupply.sub(amount); // 成都链安 // 更新_totalSupply 的值
        emit Transfer(account, address(0), amount); // 成都链安 // 触发 Transfer 事件
    }

    /**
     * @dev Destroys `amount` tokens from `account`.`amount` is then deducted
     * from the caller's allowance.
     *
     * See {_burn} and {_approve}.
     */
    function _burnFrom(address account, uint256 amount) internal virtual {
        _burn(account, amount); // 成都链安 // 调用内部函数_burn 进行代币销毁
        _approve(account, _msgSender(), _allowed[account][_msgSender()].sub(amount)); // 成都链安 // 调用内部函数_approve 更新授权
```

```
    }

}


contract MinterRole {
    using Roles for Roles.Role;

    event MinterAdded(address indexed account);
    event MinterRemoved(address indexed account);

    Roles.Role private _minters;

    constructor () internal {
        _addMinter(msg.sender);
    }

    modifier onlyMinter() {
        require(isMinter(msg.sender), "MinterRole: caller does not have the Minter role");
        _;
    }

    function isMinter(address account) public view returns (bool) {
        return _minters.has(account);
    }

    function addMinter(address account) public onlyMinter {
        _addMinter(account);
    }

    function renounceMinter() public {
        _removeMinter(msg.sender);
    }

    function _addMinter(address account) internal {
        _minters.add(account);
        emit MinterAdded(account);
    }

    function _removeMinter(address account) internal {
        _minters.remove(account);
        emit MinterRemoved(account);
    }
}
```

```
/**
 * @dev Contract module which provides a basic access control mechanism, where
 * there is an account (an owner) that can be granted exclusive access to
 * specific functions.
 *
 * This module is used through inheritance. It will make available the modifier
 * `onlyOwner`, which can be applied to your functions to restrict their use to
 * the owner.
 */
contract Ownable is Context {
    address internal _owner; // 成都链安 // 声明变量_owner，用于存储合约所有者

    event OwnershipTransferred(address indexed previousOwner, address indexed newOwner); // 成都链安 // 声明 OwnershipTransferred 事件

    /**
     * @dev Returns the address of the current owner.
     */
    function owner() public view returns (address) {
        return _owner;
    }

    /**
     * @dev Throws if called by any account other than the owner.
     */
    // 成都链安 // 修饰器，仅_owner 地址可以调用
    modifier onlyOwner() {
        require(isOwner(), "Ownable: caller is not the owner");
        _;
    }

    /**
     * @dev Returns true if the caller is the current owner.
     */
    function isOwner() public view returns (bool) {
        return _msgSender() == _owner;
    }

    /**
     * @dev Transfers ownership of the contract to a new account (`newOwner`).
     * Can only be called by the current owner.
     */
    function transferOwnership(address newOwner) public onlyOwner {
        _transferOwnership(newOwner); // 成都链安 // 调用内部函数_transferOwnership 进行所有者权限转移
    }
```

```
    /**
     * @dev Transfers ownership of the contract to a new account (`newOwner`).
     */
    function _transferOwnership(address newOwner) internal {
        require(newOwner != address(0), "Ownable: new owner is the zero address"); // 成都链安 // 非零地址检查
        emit OwnershipTransferred(_owner, newOwner); // 成都链安 // 触发 OwnershipTransferred 事件
        _owner = newOwner; // 成都链安 // 修改_owner 为 newOwner
    }
}


/**
 * @dev Extension of `ERC20` that adds a set of accounts with the `MinterRole`,
 * which have permission to mint (create) new tokens as they see fit.
 *
 * At construction, the deployer of the contract is the only minter.
 */
contract ERC20Mintable is StandardToken, MinterRole {
    uint256 public constant cap = 2000000000 * (10**18); //20 亿 // 成都链安 // 声明变量 cap，用于存储铸币上限
    /**
     * @dev See `ERC20._mint`.
     *
     * Requirements:
     *
     * - the caller must have the `MinterRole`.
     */
    function mint(address account, uint256 amount) public onlyMinter returns (bool) {
        require(totalSupply().add(amount)<= cap, "more than token limit"); // 成都链安 // 铸币上限检查
        _mint(account, amount); // 成都链安 // 调用内部函数进行铸币
        return true;
    }
}


contract AppleToken is ERC20Mintable, Ownable{

//----------------Token Info----------------//
    string public constant name = "apple token"; // 成都链安 // 声明常量 name，存储代币名称
    string public constant symbol = "apt"; // 成都链安 // 声明常量 symbol，存储代币简称
    uint8 public constant decimals = 18; // 成都链安 // 声明常量 decimals，存储代币精度
    uint256 public constant INITIAL_SUPPLY = 200000000 * 10 ** 18; // 成都链安 // 声明常量 INITIAL_SUPPLY，存储代币初始铸币量
```

```
    address public swapGovContract; // 成都链安 // 声明变量 swapGovContract，用以存储治理合约地址
    // bool setGovFlag = false;

//---------------Lock Info---------------//
    uint256 public techReleaseByDay = 6040 * 10 ** 18; // 成都链安 // 声明变量 techReleaseByDay，存储“技术方”每天的解锁代币数
    uint256 public capitalReleaseByDay =64 * 10 ** 18; // 成都链安 // 声明变量 capitalReleaseByDay，存储“资本方”每天的解锁代币数
    uint256 public nodeReleaseByDay = 44 * 10 ** 18; // 成都链安 // 声明变量 nodeReleaseByDay，存储“超级节点”每天的解锁代币数
    uint256 public lockreleasetime = 1620576000; //05.10 // 成都链安 // 声明变量 lockreleasetime，存储开始释放时间
    // uint256 public lockedAmount;

    // 成都链安 // 声明结构体 LockInfo，用以存储锁仓的相关信息
    struct LockInfo {
        uint256 initLock; // 成都链安 // 声明变量 initLock，存储初始锁仓值
        uint256 lockedAmount; // 成都链安 // 声明变量 lockedAmount，存储剩余锁仓值
        uint256 lastUnlockTs; // 成都链安 // 声明变量 lastUnlockTs，存储上次解锁时间
        uint256 releaseType; // 成都链安 // 声明变量 releaseType，存储锁仓类别
    }

    mapping(address => LockInfo) public lockedUser; // 成都链安 // 声明变量 lockedUser，存储对应地址所有锁仓信息

    event Lock(address account, uint256 startTime, uint256 amount, uint256 releaseType); // 成都链安 // 声明 Lock 事件
    event UnLock(address account, uint256 unlockTime, uint256 amount); // 成都链安 // 声明 UnLock 事件
//---------------Blacklist module---------------//
    mapping(address => bool) private _isBlackListed; // 成都链安 // 声明变量_isBlackListed，用以存储黑名单地址
    event AddedBlackLists(address[]); // 成都链安 // 声明 AddedBlackLists 事件
    event RemovedBlackLists(address[]); // 成都链安 // 声明 RemovedBlackLists 事件

    constructor() public {
        _totalSupply = INITIAL_SUPPLY; // 成都链安 // 更新_totalSupply
        _balances[msg.sender] = _totalSupply; // 成都链安 // 将所有代币发送至调用者地址
        emit Transfer(address(0), msg.sender, INITIAL_SUPPLY); // 成都链安 // 触发 Transfer 事件
        _owner = msg.sender; // 成都链安 // 设置合约所有者为调用者地址
        emit OwnershipTransferred(address(0), msg.sender); // 成都链安 // 触发 OwnershipTransferred 事件
```

```
    }

    function isBlackListed(address user) public view returns (bool) {
        return _isBlackListed[user];
    }

    // 成都链安 // 批量添加黑名单，仅合约所有者可以调用
    function addBlackLists(address[] calldata _evilUser) public onlyOwner {
        for (uint i = 0; i < _evilUser.length; i++) {
            _isBlackListed[_evilUser[i]] = true;
        }
        emit AddedBlackLists(_evilUser);
    }

    // 成都链安 // 批量移除黑名单，仅合约所有者可以调用
    function removeBlackLists(address[] calldata _clearedUser) public onlyOwner {
        for (uint i = 0; i < _clearedUser.length; i++) {
            delete _isBlackListed[_clearedUser[i]];
        }
        emit RemovedBlackLists(_clearedUser);
    }



    // function lockToGov() public onlyOwner {
    //     _transfer(_owner, swapGovContract, MINEREWARD); // transfer/freeze to swapGovContract
    //     lockedAmount = lockedAmount.add(MINEREWARD);
    // }
    function lock(address _account, uint256 _amount, uint256 _type) public onlyOwner {
        require(_type > 0 && _type < 4); // 成都链安 // _type 参数检查
        require(_account != address(0), "Cannot transfer to the zero address"); // 成都链安 // 非零地址检查
        require(lockedUser[_account].lockedAmount == 0, "exist locked token"); // 成都链安 // 检查指定账户是否已经存在锁仓，若存在则不可对其新增锁仓
        require(_account != swapGovContract, "equal to swapGovContract"); // 成都链安 // 检查锁仓地址不能是治理合约地址
        lockedUser[_account].initLock = _amount; // 成都链安 // 设置锁仓信息 initLock
        lockedUser[_account].lockedAmount = _amount; // 成都链安 // 设置锁仓信息 lockedAmount
        lockedUser[_account].lastUnlockTs = block.timestamp >= lockreleasetime ? block.timestamp : lockreleasetime; // 成都链安 // 设置锁仓信息 lastUnlockTs
        lockedUser[_account].releaseType = _type; // 成都链安 // 设置锁仓信息 releaseType
        _balances[_msgSender()] = _balances[_msgSender()].sub(_amount); // 成都链安 // 减少调用者的代币余额
        _balances[_account] = _balances[_account].add(_amount); // 成都链安 // 增加锁仓地址的代币余额
        emit Lock(_account, block.timestamp, _amount, _type); // 成都链安 // 触发 Lock 事件
        emit Transfer(_msgSender(), _account, _amount); // 成都链安 // 触发 Transfer 事件
    }
```

```
    function unlock() public {
        uint256 amount = getAvailablelockAmount(_msgSender(),
lockedUser[_msgSender()].releaseType); // 成都链安 // 调用 getAvailablelockAmount 计算当前可释放的代币数量
        require(amount > 0, "amount equal 0"); // 成都链安 // amount 非零检查
        lockedUser[_msgSender()].lockedAmount =
lockedUser[_msgSender()].lockedAmount.sub(amount); // 成都链安 // 更新锁仓信息 lockedAmount
        lockedUser[_msgSender()].lastUnlockTs = block.timestamp; // 成都链安 // 更新锁仓信息 lastUnlockTs
        emit UnLock(_msgSender(), block.timestamp, amount); // 成都链安 // 触发 UnLock 事件
    }

    function getAvailablelockAmount(address account, uint256 releaseType) public view returns (uint256)
{
        if(lockedUser[account].lockedAmount == 0) { // 成都链安 // lockedAmount 非零检查
            return 0;
        }

        if(block.timestamp <= lockedUser[account].lastUnlockTs) { // 成都链安 // 检查当前时间大于上次解锁时间
            return 0;
        }

        uint256 _days = block.timestamp.sub(lockedUser[account].lastUnlockTs).div(86400); // 成都链安 // 计算当前据上次解锁的时间间隔，以“天”为单位
        if(_days > 0 && releaseType == 1) {
            uint256 _releaseAmount = _days.mul(techReleaseByDay); // 成都链安 // 根据类别计算出解锁量
            return lockedUser[account].lockedAmount > _releaseAmount ? _releaseAmount :
lockedUser[account].lockedAmount; // 成都链安 // 返回最终可解锁的值
        }

        if(_days > 0 && releaseType == 2) { // 成都链安 // 根据类别计算出解锁量
            uint256 _releaseAmount = _days.mul(capitalReleaseByDay);
            return lockedUser[account].lockedAmount > _releaseAmount ? _releaseAmount :
lockedUser[account].lockedAmount; // 成都链安 // 返回最终可解锁的值
        }

        if(_days > 0 && releaseType == 3) { // 成都链安 // 根据类别计算出解锁量
            uint256 _releaseAmount = _days.mul(nodeReleaseByDay);
            return lockedUser[account].lockedAmount > _releaseAmount ? _releaseAmount :
lockedUser[account].lockedAmount; // 成都链安 // 返回最终可解锁的值
        }
        return 0;
    }
```

```
    function transfer(address _to, uint256 _value) public override returns (bool) {
        require(!isBlackListed(_msgSender())); // 成都链安 // 调用者黑名单检查
        require(!isBlackListed(_to)); // 成都链安 // _to 地址黑名单检查
        require(_balances[_msgSender()].sub(lockedUser[_msgSender()].lockedAmount) >= _value); // 成都链安 // 调用者可用余额检查
        return super.transfer(_to, _value); // 成都链安 // 调用父合约中的 transfer 函数进行转账
    }

    function transferFrom(address _from, address _to, uint256 _value) public override returns (bool) {
        require(!isBlackListed(_msgSender())); // 成都链安 // 调用者黑名单检查
        require(!isBlackListed(_from)); // 成都链安 // _from 地址黑名单检查
        require(!isBlackListed(_to)); // 成都链安 // _to 地址黑名单检查
        require(_balances[_from].sub(lockedUser[_from].lockedAmount) >= _value); // 成都链安 // _from 地址可用余额检查
        return super.transferFrom(_from, _to, _value); // 成都链安 // 调用父合约中的 transferFrom 函数进行转账
    }

    /**
     * @dev Transfer tokens to multiple addresses.
     */
    function batchTransfer(address[] memory addressList, uint256[] memory amountList) public onlyOwner returns (bool) {
        uint256 length = addressList.length; // 成都链安 // 读取参数 addressList 的长度
        require(addressList.length == amountList.length, "Inconsistent array length"); // 成都链安 // 检查 addressList 长度与 amountList 相等
        require(length > 0 && length <= 150, "Invalid number of transfer objects"); // 成都链安 // 检查 addressList 的长度非零且不超过 150
        uint256 amount; // 成都链安 // 声明临时变量 amount，用以存储转账总量
        for (uint256 i = 0; i < length; i++) {
            require(amountList[i] > 0, "The transfer amount cannot be 0"); // 成都链安 // amountList 非零检查
            require(addressList[i] != address(0), "Cannot transfer to the zero address"); // 成都链安 // addressList 非零地址检查
            require(!isBlackListed(addressList[i])); // 成都链安 // addressList 黑名单检查
            amount = amount.add(amountList[i]); // 成都链安 // 更新临时变量 amount
            _balances[addressList[i]] = _balances[addressList[i]].add(amountList[i]); // 成都链安 // 增加 addressList[i]地址的代币余额
            emit Transfer(_msgSender(), addressList[i], amountList[i]); // 成都链安 // 触发 Transfer 事件
        }
        require(_balances[_msgSender()].sub(lockedUser[_msgSender()].lockedAmount) >= amount, "Not enough tokens to transfer"); // 成都链安 // 检查调用者可用代币余额足够
        _balances[_msgSender()] = _balances[_msgSender()].sub(amount); // 成都链安 // 检查调用者可用代币余额足够
        return true;
```

```
    }

    function burn(uint256 amount) public virtual {
        _checkBeforeBurn(_msgSender(), amount); // 成都链安 // 检查调用者可用余额足够
        _burn(_msgSender(), amount); // 成都链安 // 调用内部函数_burn 对调用者的代币进行销毁
    }

    function burnFrom(address account, uint256 amount) public virtual {
        _checkBeforeBurn(account, amount); // 成都链安 // 检查调用者可用余额足够
        _burnFrom(account, amount); // 成都链安 // 调用内部函数_burnFrom 对 account 地址的代币进行销毁
    }

    function _checkBeforeBurn(address account, uint256 amount) internal {
        uint256 amt = lockedUser[account].lockedAmount;
        if (amt > 0) {
            require(balanceOf(account).sub(amt) >= amount, "token balance no enought burn");
            }

    }



    function setGovAddr(address _swapGovContract) public onlyOwner {
        // require(!setGovFlag); // only once
        swapGovContract = _swapGovContract; // 成都链安 // 修改变量 swapGovContract 为 _swapGovContract
        // setGovFlag = true;
    }
    function setReleaseByDay(uint256 _techReleaseByDay, uint256 _capitalReleaseByDay, uint256 _nodeReleaseByDay) public onlyOwner {
        require(_techReleaseByDay > 0, " must be great 0"); // 成都链安 // _techReleaseByDay 非零检查
        require(_capitalReleaseByDay > 0, " must be great 0"); // 成都链安 // _capitalReleaseByDay 非零检查
        require(_nodeReleaseByDay > 0, " must be great 0"); // 成都链安 // _nodeReleaseByDay 非零检查
        techReleaseByDay = _techReleaseByDay; // 成都链安 // 修改 techReleaseByDay 的值为 _techReleaseByDay
        capitalReleaseByDay = _capitalReleaseByDay; // 成都链安 // 修改 capitalReleaseByDay 的值为 _capitalReleaseByDay
        nodeReleaseByDay = _nodeReleaseByDay; // 成都链安 // 修改 nodeReleaseByDay 的值为 _nodeReleaseByDay
    }
}
// 成都链安 // 建议主合约继承 Pausable 模块，当出现重大异常时 owner 可以暂停所有交易
```

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BEOSIN

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