



Blockchain Autopsies: Analyzing Ethereum Smart Contract Deaths

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Jay Little



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@computerality

Favorite IDA Pro keyboard shortcuts : Y and D

Working with Smart Contracts >1 year

Cyber security research company - High-end security research with a real-world attacker mentality to reduce risk and fortify code.

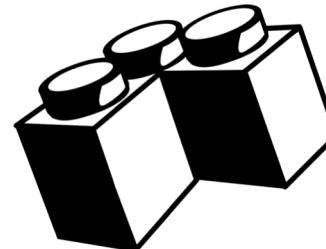
Security Research

- As a leading cybersecurity research provider to DARPA, the Army and the Navy – we create and release open source research tools



Security Engineering

- We offer custom engineering for every stage of software creation, from initial planning to enhancing the security of completed works



Security Assessments

- We offer security auditing for code and systems requiring extreme robustness and niche system expertise



Agenda

- Introduction to Ethereum, EVM, and Solidity
- Vulnerabilities and Reversing Tools
- Ethereum Node Software
- Blockchain Contract Trace Analysis
- Analyze Contract Deaths

Prompt

```
eth.getCode(0xD6D2cD79fD754C6B909585E46541D32ec491962)
```

```
> 0x
```

- Where did the code go?
- Who created this contract?
- What was the last transaction to this contract?
- Why are articles only about open-source contracts?
- When did all of this happen?

Ethereum, EVM, and Solidity

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Ethereum

- A blockchain based distributed ledger
- A “world computer” with “smart” contracts
- The 2nd largest cryptocurrency by valuation
- Mainnet started July 30 2015

\$463.02 USD (-1.11%)

0.05705910 BTC (0.21%)

Market Cap	Volume (24h)	Circulating Supply
\$46,765,782,741 USD 5,763,088 BTC	\$1,633,000,000 USD 201,239 BTC	101,002,084 ETH

<https://coinmarketcap.com/currencies/ethereum/>

Ethereum Implementation

- Ethereum is formally described by the Yellow Paper
 - <https://github.com/ethereum/yellowpaper>
 - <https://github.com/chronaeon/beigepaper>

ETHEREUM: A SECURE DECENTRALISED GENERALISED TRANSACTION LEDGER

BYZANTIUM VERSION c0444c1 - 2018-03-06

DR. GAVIN WOOD
FOUNDER, ETHEREUM & PARITY
GAVIN@PARITY.IO

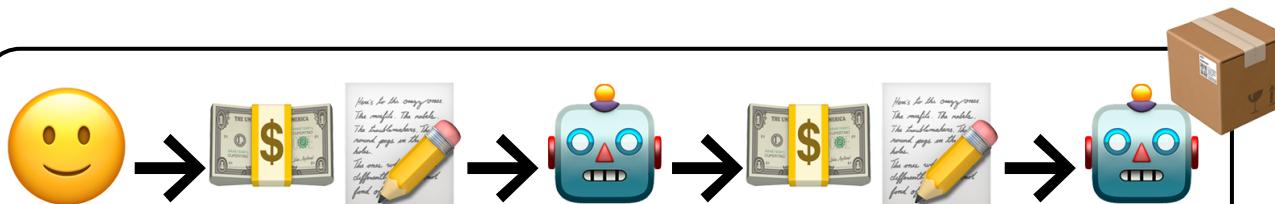
ABSTRACT. The blockchain paradigm when coupled with cryptographically-secured transactions has demonstrated its utility through a number of projects, with Bitcoin being one of the most notable ones. Each such project can be seen as a simple application on a decentralised, but singleton, compute resource. We can call this paradigm a transactional singleton machine with shared-state.

Ethereum implements this paradigm in a generalised manner. Furthermore it provides a plurality of such resources, each with a distinct state and operating code but able to interact through a message-passing framework with others. We discuss its design, implementation issues, the opportunities it provides and the future hurdles we envisage.

Accounts and Transactions and Blocks



- Account: 😊
- Contract: 🤖
- 1 Ether (ETH) = 10^{18} Wei
- 21000 Wei per TX
- Contracts can call other contracts



EVM: Ethereum Virtual Machine

- Big Endian stack machine
- ~185 opcodes
- Native data width is 256 bits
- Many instructions are similar
 - PUSH1 – PUSH32
 - DUP1 – DUP16
 - SWAP1 – SWAP16
- Instructions have various gas cost
- ethervm.io or <https://github.com/ailofbits/evm-opcodes>

[Switch Back To Bytecodes View](#) [Find Similar Contracts](#)

```
PUSH1 0x60
PUSH1 0x40
MSTORE
CALLDATASIZE
ISZERO
PUSH2 0x0061
JUMPI
PUSH1 0xe0
PUSH1 0x02
EXP
```

ABI and Address Spaces

- EVM is a Harvard architecture
- There are ~5 address spaces
- Storage and memory are 256-bit address space
- All execution enters at PC=0x0
- Jump destinations labeled with JUMPDEST
- Functions dispatched based on first 4 bytes in TX input

Code	EVM, implements contract logic
Stack	Limited to 32 elements
Call Data	Invocation arguments
Memory	Non-persistent storage, per tx
Storage	Persistent storage

Solidity

- JavaScript-inspired high-level language for smart contracts
- Compiles to EVM

```
1 contract NiceGuyTax {
2
3     // Make a database of investors.
4     struct Investor {
5         address addr;
6     }
7     Investor[] public investors;
8
9     // Make a database of Nice Guys.
10    struct NiceGuy {
11        address addr;
12    }
13    NiceGuy[] public niceGuys;
14
15    //Counters. this counts things. A new round begins when investorIndex reaches 10.
16    uint public payoutIndex = 0;
17    uint public currentNiceGuyIndex = 0;
```

Sample Contract

```
contract CookieShop {
    address owner;
    mapping (address=>uint) public jar;

    constructor() public {
        owner = msg.sender;
    }

    function bake() public payable {
        if(msg.value > 0.1 ether) {
            jar[msg.sender] += 13;
        }
    }

    function eat(uint count) public {
        jar[msg.sender] -= count;
    }

    function close() public {
        require(msg.sender == owner);
        selfdestruct(msg.sender);
    }
}
```

Sample Contract Creation

```
contract CookieShop {
    address owner;
    mapping (address=>uint) public jar;

    constructor() public {
        owner = msg.sender;
    }

    function bake() public payable {
        if(msg.value > 0.1 ether) {
            jar[msg.sender] += 13;
        }
    }

    function eat(uint count) public {
        jar[msg.sender] -= count;
    }

    function close() public {
        require(msg.sender == owner);
        selfdestruct(msg.sender);
    }
}
```



0x0



owner:



jar[]

Sample Contract Death

```
contract CookieShop {
    address owner;
    mapping (address=>uint) public jar;

    constructor() public {
        owner = msg.sender;
    }

    function bake() public payable {
        if(msg.value > 0.1 ether) {
            jar[msg.sender] += 13;
        }
    }

    function eat(uint count) public {
        jar[msg.sender] -= count;
    }

    function close() public {
        require(msg.sender == owner);
        selfdestruct(msg.sender);
    }
}
```

close() = 0x43d726d6

👨‍🍳 → **close()** → 🤖

🤖 → 💰 → 👨‍🍳

🤖 = 0x

owner: []

jar[]

Sample Contract Usage

```
contract CookieShop {
    address owner;
    mapping (address=>uint) public jar;

    constructor() public {
        owner = msg.sender;
    }

    function bake() public payable {
        if(msg.value > 0.1 ether) {
            jar[msg.sender] += 13;
        }
    }

    function eat(uint count) public {
        jar[msg.sender] -= count;
    }

    function close() public {
        require(msg.sender == owner);
        selfdestruct(msg.sender);
    }
}
```

bake() = 0xb0de262e

🧑‍🚀 → bake() → 🤖

🧑‍🚀 → bake() → 🤖

🏋️ → bake() → 🤖

🤖 owner: 🎩

jar[🏋️] = 🍪🍪

jar[🧑‍🚀] = 🍪🍪🍪🍪

Sample Contract Usage (2)

```
contract CookieShop {
    address owner;
    mapping (address=>uint) public jar;

    constructor() public {
        owner = msg.sender;
    }

    function bake() public payable {
        if(msg.value > 0.1 ether) {
            jar[msg.sender] += 13;
        }
    }

    function eat(uint count) public {
        jar[msg.sender] -= count;
    }

    function close() public {
        require(msg.sender == owner);
        selfdestruct(msg.sender);
    }
}
```

`CookieShop.eat(5) =`
0x85e0ebaf0000000000000000
0000000000000000000000000000
0000000000000000000000000000
05

🏃 → eat(5) → 🤖

🤖 owner: 🍪

jar[🏃] = 🍪

jar[👩] = 🍪🍪🍪🍪

Sample Contract Usage (3)

```
contract CookieShop {
    address owner;
    mapping (address=>uint) public jar;

    constructor() public {
        owner = msg.sender;
    }

    function bake() public payable {
        if(msg.value > 0.1 ether) {
            jar[msg.sender] += 13;
        }
    }

    function eat(uint count) public {
        jar[msg.sender] -= count;
    }

    function close() public {
        require(msg.sender == owner);
        selfdestruct(msg.sender);
    }
}
```



→ eat(1) →

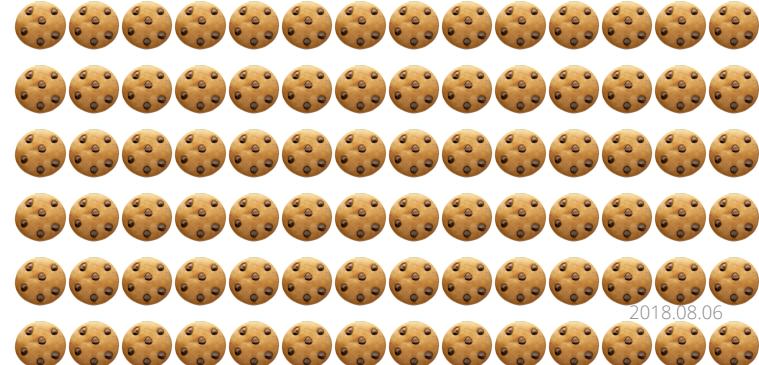


owner:

jar[robot] =

jar[chef] =

jar[man] =



2018.08.06

Features / Vulnerabilities

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Solidity Behaviors and Issues

- Int overflow/underflow
 - Incomplete initialization
 - Uninitialized variables
 - Callbacks / re-entrancy
 - Variable name shadowing
 - Type inference (var)
 - Unintentional visibility
 - Array.length
 - Delegatecall
- Division by zero
 - Race conditions
 - Replay attacks
 - Bad RNG
 - Time sensitivity
 - Blockchain as random

Uninitialized Variables

```
contract OpenAddressLottery{      0x741F1923974464eFd0Aa70e77800BA5d9ed18902
    struct SeedComponents { https://www.reddit.com/r/ethdev/comments/7wp363
        uint component1;
        uint component2;
    }

    address owner; //address of the owner
    uint private secretSeed; //seed used to calculate number of an address

    function forceReseed() {
        require(msg.sender==owner);
        SeedComponents s;
        s.component1 = uint(msg.sender);
        s.component2 = uint256(block.blockhash(block.number - 1));
    }

}
```

Not So Smart Contracts

<https://github.com/trailofbits/not-so-smart-contracts>

(Not So) Smart Contracts

This repository contains examples of common Ethereum smart contract vulnerabilities, including code from real smart contracts.

Vulnerabilities

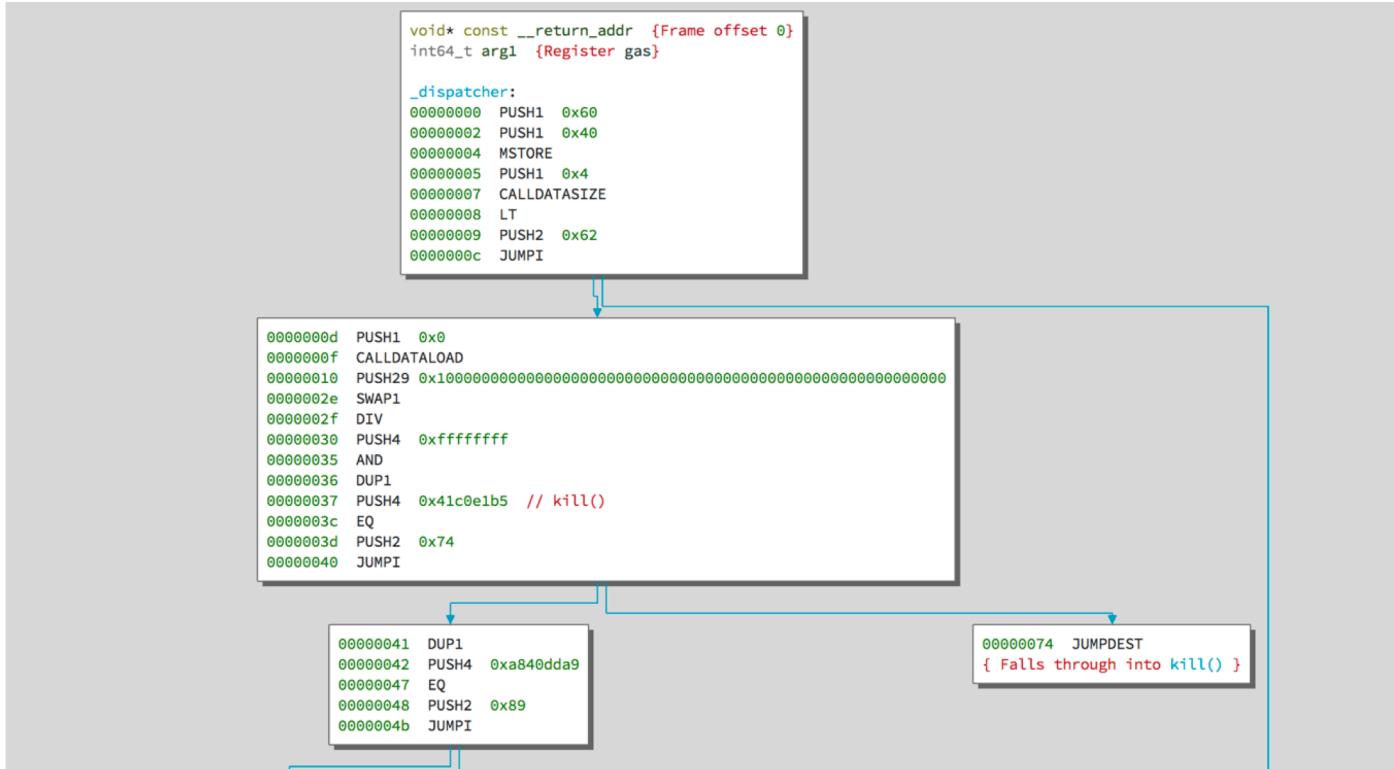
- Integer Overflow
- Missing Constructor
- Reentrancy
- Unchecked External Call
- Unprotected Function
- Incorrect Interface

Analysis Tools

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Ethersplay

Binary Ninja Plugin <https://github.com/trailofbits/ethersplay>



IDA-EVM

IDA Pro Module <https://github.com/trailofbits/ida-evm>

The screenshot shows the IDA Pro interface with the following components:

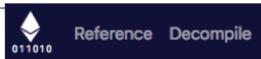
- Function name:** start
- EVM bytecode disassembly:** A large window displaying EVM bytecode assembly. It includes:
 - Header: 0000 EVM bytecode disassembly, ; Segment type: Pure code
 - Code:

```
0000 60 60 PUSH1 0x60
0002 60 40 PUSH1 0x40
0004 52 MSTORE
0005 60 04 PUSH1 0x4
0007 36 CALLDATASIZE
0008 10 LT
0009 61 00 62 PUSH2 0x62
000C 57 JUMPI
```
 - Right pane: A list of EVM instructions with their opcodes:

```
0003 91 ADD
0004 91 SWAP2
0005 C5 POP
0006 50 DUP
0007 60 40 PUSH1
0009 51 MLOAD
000A 80 DUP1
000B 91 SWAP2
000C 03 SUB
000D 90 SWAP1
000E F3 RETURN
```
- Graph overview:** A complex control flow graph showing the execution flow between various EVM instructions and memory locations.
- Callstack:** A stack window showing the current callstack state.
- Registers:** A window showing the current values of EVM registers.
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- Registers:** A window showing the current values of EVM registers.
- Registers:** A window showing the current values of EVM registers.

Bottom status bar: 100.00% (1652,351) (78,1112) 0000079D 0000000000000092: start+92 (Synchronized with Hex View-1)

2018.08.06



Decompilation (experimental)

```

memory[temp0:temp0 + 0x20] = -0x00 & -0x00 & varl;
var templ = memory[0x40:0x60];
return memory[templ:templ + (0x20 + temp0) - templ];
} else if (0x5b6b431d == var0) {
    if (msg.value) { revert(memory[0x00:0x00]); }

    varl = 0x00c0;
    var2 = msg.data[0x04:0x24];
    // Method call to func_0138
    stop();
} else {
    if (0x9f1b3bad != var0) { revert(memory[0x00:0x00]); }

    varl = 0x00ca;
    // Method call to func_01D6
    stop();
}
}

function func_00CC() {
    var var0 = 0x00;

    if (0xffff & arg0 != 0xffff & storage[0x01] / 0x01) {
        arg1 = 0x01 * 0x00;
        // Could not resolve jump destination (is this a return?)
    } else {
        memory[0x00:0x20] = 0xffffffffffffffffffffffffffff & 0xffffffffffffffffffff & 0xffffffffffffffffffff & 0xffffffffffff;
        var temp0 = 0x20 + 0x00;
        memory[temp0:temp0 + 0x20] = 0x02;
        var0 = storage[keccak256(memory[0x00:0x00 + 0x20 + temp0])];
        arg1 = var0;
        // Could not resolve jump destination (is this a return?)
    }
}

function func_0138() {
    if (0xffffffffffffffffffff & msg.sender != 0xffffffffffffffffffff & msg.sender) {

        var temp0 = arg0;
        var templ = memory[0x40:0x60];
        memory[templ:templ + 0x00] = address(0xffffffffffffffffffff & msg.sender).call.gas(!temp0 * 0x08fc).value(temp0);

        if (!address(0xffffffffffffffffffff & msg.sender).call.gas(!temp0 * 0x08fc).value(temp0))

        // Could not resolve jump destination (is this a return?)
    }
}

```

F0	CREATE	<table border="1"><tr><td>value</td><td>offset</td><td>length</td></tr></table>	value	offset	length	<table border="1"><tr><td>addr</td></tr></table>	addr			
value	offset	length								
addr										
F1	CALL	<table border="1"><tr><td>addr</td><td>value</td><td>argsOffset</td><td>argsLength</td><td>retOffset</td><td>retLength</td></tr></table>	addr	value	argsOffset	argsLength	retOffset	retLength	<table border="1"><tr><td>success</td></tr></table>	success
addr	value	argsOffset	argsLength	retOffset	retLength					
success										
F2	CALLCODE	<table border="1"><tr><td>addr</td><td>value</td><td>argsOffset</td><td>argsLength</td><td>retOffset</td><td>retLength</td></tr></table>	addr	value	argsOffset	argsLength	retOffset	retLength	<table border="1"><tr><td>success</td></tr></table>	success
addr	value	argsOffset	argsLength	retOffset	retLength					
success										
F3	RETURN	<table border="1"><tr><td>offset</td><td>length</td></tr></table>	offset	length	=					
offset	length									
F4	DELEGATECALL	<table border="1"><tr><td>addr</td><td>argsOffset</td><td>argsLength</td><td>retOffset</td><td>retLength</td></tr></table>	addr	argsOffset	argsLength	retOffset	retLength	<table border="1"><tr><td>success</td></tr></table>	success	
addr	argsOffset	argsLength	retOffset	retLength						
success										

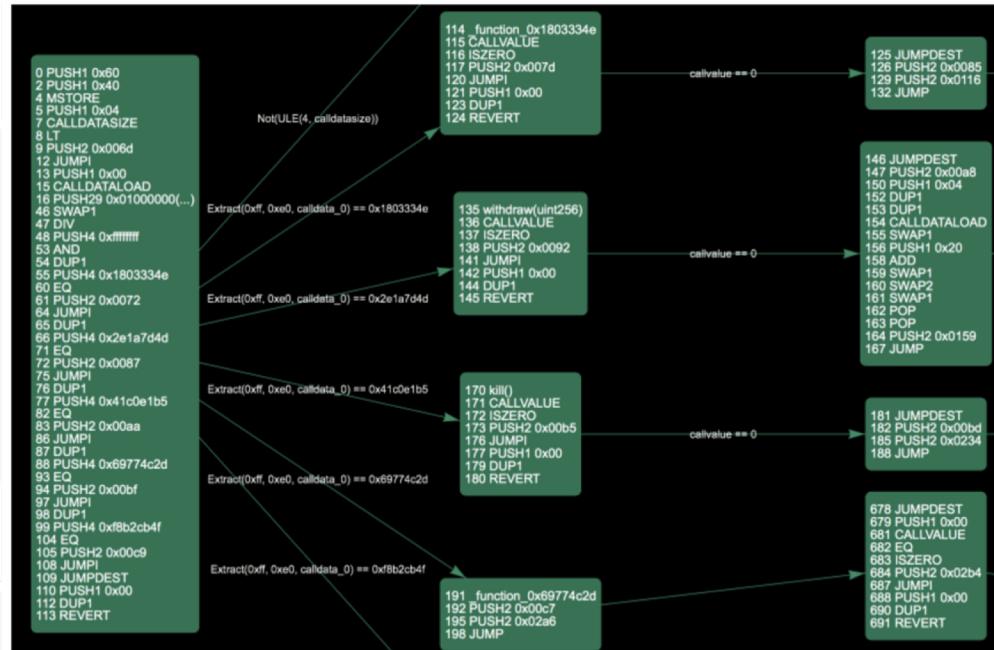
Mythril

<https://github.com/consensys/mythril>

```
$ myth -x solidity_examples/ether_send.sol
==== Ether send ====
Type: Warning
Contract: Crowdfunding
Function name: withdrawfunds()
PC address: 816
In the function 'withdrawfunds()' a non-zero amount of Ether is sent to msg.sender.
```

```
There is a check on storage index 7. This storage slot can be written to by calling
-----
In file: solidity_examples/ether_send.sol:18
msg.sender.transfer(this.balance)
```

```
$ myth --search "func#changeMultisig(address)@"
$ myth --search "code#PUSH1 0x50,POP@"
$ myth --search "func#changeMultisig(address)@ and code#PUSH1 0x50@"
```

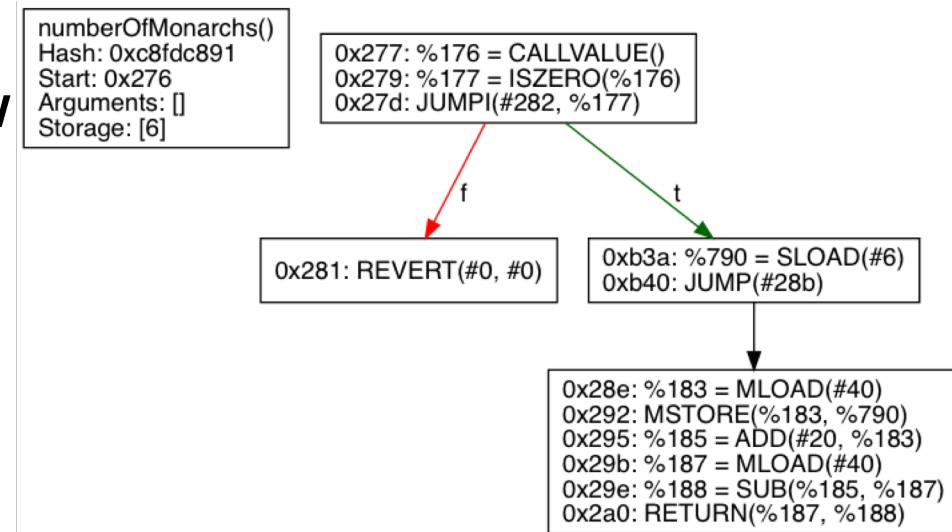


Rattle

<https://github.com/trailofbits/rattle>

Released this morning!

- Recovers EVM Control Flow
- Lifts EVM to IR to SSA IR
- Optimizes and simplifies
- Recovers variables
- Generates function CFGs



Manticore

<https://github.com/trailofbits/manticore>



```
$ manticore simple.sol
[25981] m.main:INFO: Beginning analysis
[25981] m.ethereum:INFO: Starting symbolic transaction: 1
[25981] m.ethereum:INFO: Generated testcase No. 0 - REVERT
[25981] m.ethereum:INFO: Generated testcase No. 1 - REVERT
[25981] m.ethereum:INFO: Finished symbolic transaction: 1 | Code Coverage: 100% |
Terminated States: 3 | Alive States: 1
[32058] m.ethereum:INFO: Generated testcase No. 2 - STOP
```

```
from manticore.ethereum import ManticoreEVM
from manticore.core.smtp import solver

m = ManticoreEVM() # initiate the blockchain
source_code = "" pragma solidity ^0.4.20; ... ""

# Generate the accounts. Creator has 10 ethers; attacker 0
creator_account = m.create_account(balance=10*10**18)
attacker_account = m.create_account(balance=0)
contract_account = m.solidity_create_contract(source_code,
                                               owner=creator_account)

print "Creator account: 0x%x (%d)%(creator_account, creator_account)
print "Attacker account: 0x%x (%d)%(attacker_account, attacker_account)

# Deposit 1 ether, from the creator
contract_account.deposit(caller=creator_account, value=10**18)
```

Ethereum Software

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Storage Requirements

Check stackexchange first.

Client / Mode	Block Number	Disk Space
geth light	5_600_000	363M
geth fast full	5_600_000	142G
geth full full	?_??_?? [1]	239G + [1]
geth full archive	4_980_000 [2]	671G

- [1] My disk was full, I didn't expect this to run out of space and wasn't able to repeat this sync mode
- [2] I didn't manage to fully sync the archive node within 6 weeks, unfortunately.

Client / Mode	Block Number	Disk Space
parity light	5_600_000	89M
parity warp fast	5_600_000	82G
parity full fast	5_600_000	78G
parity full archive	5_600_000	1.1T

- Parity 1.10.0
- Ubuntu 16.4 LTS, VPS instance with SSD backed storage

Process Name	Bytes Written	Bytes Read
parity	19.17 TB	12.79 TB

From @5chdn at
<https://wiki.parity.io/faq> and
<https://ethereum.stackexchange.com/questions/143/what-are-the-ethereum-disk-space-needs>

Geth and Parity

Geth - official implementation, runs 75% public nodes

Written in Go/LevelDB

Parity - alternate implementation, runs 15% public nodes

Written in Rust/RocksDB

Client Type	Size	Time	Details
Full	100GB-1.5TB	~ Weeks to Forever	Large SSD, can fetch any TX
Fast	50-200GB	~ Hours to Days	SSD, Recent TX only
Light	50MB+	~ Minutes to Hours	HDD, Intended for “end user”

Geth Running Options

```
./geth --datadir /mnt/fastssd/.geth  
--rpc --rpcapi=debug,eth,net,rpc,web3  
--syncmode=full  
--gcmode=archive  
--cache 4096  
--trie-cache-gens 1024
```

Parity Running Options

```
parity -d /mnt/fastssd/.parity
--jsonrpc-apis web3,eth,net,parity,rpc,traces
--mode=active
--pruning=archive
--tracing=on --fat-db=on
--min-peers=50 --max-peers=100
--cache-size=4096
--db-compaction=ssd
--tx-queue-size=8192000
--scale-verifiers --num-verifiers=8
--jsonrpc-server-threads 4 --jsonrpc-threads 8
```

Client Operation Suggestions

- Have patience
- Troubleshoot with `rm -rf` and resync
- Use Linux
- Use the fastest SSDs you can afford
- Ethereum clients and web browsing don't mix



Many Days Later...

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Contract Analysis

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Answering Questions

```
eth.getCode(0xD6D2cD79fD754C6B909585E46541D32ec491962)  
> 0x
```

- Who created this contract?
- What was the last transaction to this contract?
- Where did the code go?
- When did all of this happen?

Tracing

Parity:

```
trace_replayTransaction(tx_hash, ['trace'])
```

Geth:

```
debug_traceTransaction(tx_hash)
```

Transactions

```
{'blockNumber': '5269390',
'from': '0xcd6d2cd79fd754c6b909585e46541d32ec491962',
'hash':
'0x9ebcb287709403cb4c11d6c82203cf0428b1dda72b417a65d2ba120fc70947',
'isError': '0',
'timeStamp': '1521260221',
'to': '0x3f9ed84ef180fae940ebf4bce4c4d70e2f751482',
'type': 'suicide',
'value': '298227981000000000'}
```

Who? What? When?

Block: 5245655

From: 0x00bb585e7be7b095be9aba3c5777121c5ba7924a

To: 0

[Contract 0xcd6d2cd79fd754c6b909585e46541d32ec491962

Created]

0x00bb585e7be7b095be9aba3c5777121c5ba7924a Adds 0.2 Ether

0x3f9ed84ef180fae940ebf4bce4c4d70e2f751482: 0xa840dda9

0x3f9ed84ef180fae940ebf4bce4c4d70e2f751482: kill()

0xcd6d2cd79fd754c6b909585e46541d32ec491962 => selfdestruct

0x3f9ed84ef180fae940ebf4bce4c4d70e2f751482

Scanning the Blockchain

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Blockchain Data

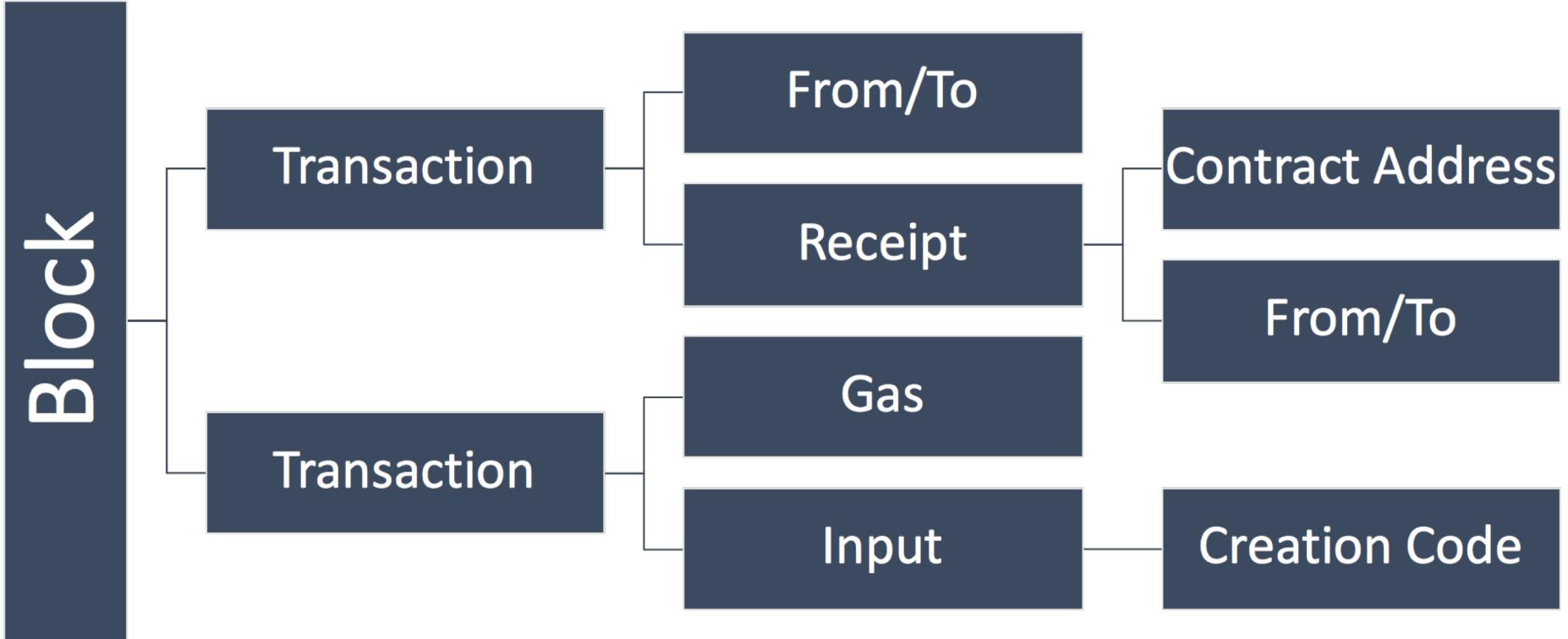
Distributed Ledger != Distributed Database

Only a key/value store with list of blocks/transactions

No queryable structure

Ethereum is focused on recent transaction and current state, not history

The Block in Blockchain



web3.js and web3.py

web3.js is official client library

- Many API changes between v0.20 and v1.0

web3.py is Python implementation of web3.js

- Version 4.0 switched to Python3.5+

Both communicate to Ethereum nodes via:

- IPC - use when local
- WebSockets - use when streaming events
- RPC - use in any other situation

Finding Contracts

```
for b in range(0, 6000000):
    block = w.eth.getBlock(b, full_transactions=True)
    for tx in block.transactions:
        if tx['to'] == None:
            r = w.eth.getTransactionReceipt(tx['hash'])
            address = r['contractAddress']
            if address:
                code = w.eth.getCode(address)
                if code == '0x' and r['status'] == 1:
                    saveContract(block, address, tx['input'])
```

Geth Experience

➊ Geth crashing with syncmode fast - consistently - new install

#16244 opened 4 days ago by 0xbitcoin

➊ Unable to sync with geth 1.8.1

#16202 opened 9 days ago by Fargusson

➋ leveldb/table corrupted, then dropping peers and failing to sync.

#16148 by okayplanet was closed 15 days ago

➊ How long does it take for geth to sync on windows? It keeps on importing new block scripts, receipts and headers.

#15887 opened on Jan 15 by ongweijie

➊ Does Ethereum Wallet (geth) need to write 800 GB of data to sync finally? #414

#15010 opened on Aug 20, 2017 by plasticbomb1986

➊ chaindata is 450Gb

#15872 opened on Jan 12 by 97zgxgw

➋ Last 200 blocks never sync with geth 1.7.3 using fast sync

#16122 by prachantorebhaker was closed 17 days ago

```
Imported new state entries      count=2233 elapsed=9.461ms    processed=187452035 pending=8725    retry=0    duplicate=367530 unexpected=1054813
Imported new state entries      count=1519 elapsed=44.120ms   processed=187453554 pending=8918    retry=0    duplicate=367530 unexpected=1054813
Imported new state entries      count=2016 elapsed=8.563ms   processed=187455570 pending=8108    retry=0    duplicate=367530 unexpected=1054813
Imported new state entries      count=1519 elapsed=6.350ms   processed=187457089 pending=8487    retry=0    duplicate=367530 unexpected=1054813
Imported new state entries      count=751  elapsed=3.067ms    processed=187457840 pending=8207    retry=0    duplicate=367530 unexpected=1054813
Imported new state entries      count=326  elapsed=803.259μs  processed=187458166 pending=9447    retry=0    duplicate=367530 unexpected=1054813
Imported new state entries      count=1247 elapsed=7.034ms   processed=187459413 pending=10652   retry=0    duplicate=367530 unexpected=1054813
```

2018.08.06

Parity Experience

```
Syncing #5945549 8a65..47c9      0 blk/s  11 tx/s  0 Mgas/s
bytes queue 9 MiB sync  RPC: 0 conn, 0 req/s, 340 µs
Imported #5945550 8caf..ac37 (155 txs, 8.00 Mgas, 785.31 ms, 2.02 MiB)
=====
Imported #5945551 585d..789b (35 txs, 2.56 Mgas, 124.59 ms, 6.02 MiB)
#419735 3/25 peers 74 MiB chain 154 MiB db 0 bytes queue 0 MiB sync
Imported #5945552 9722..0dca (150 txs, 7.99 Mgas, 988.78 ms, 3.02 MiB)
Imported #5945553 ce48..4b90 (7 txs, 5.28 Mgas, 68.28 ms, 6.68 MiB)
Imported #5945554 a0c8..6a33 (199 txs, 7.89 Mgas, 489.44 ms, 3.02 MiB)
#427359 4/25 peers 76 MiB chain 154 MiB db 0 bytes queue 0 MiB sync
Imported #5945555 8b14..4caf (111 txs, 7.99 Mgas, 210.40 ms, 2.02 MiB)
Imported #5945556 cb55..8e09 (168 txs, 7.98 Mgas, 688.74 ms, 2.02 MiB)
Syncing #5945556 cb55..8e09      0 blk/s  0 tx/s  0 Mgas/s
```

```
> eth.getBlock(427360)
> null
```

```
2018-07-21 01:53:39 Syncing #1589194 0x19d5..cf87    73.32 blk/s
```

```
=====
stack backtrace:
```

```
0: 0x7fceccb8964c - <no info>
1: 0x7fceccb88c12 - <no info>
2: 0x7fceccb8816a - <no info>
3: 0x7fceca710a85 - <no info>
4: 0x7fceccbbe4d55 - <no info>
5: 0x7fceccb0a16 - <no info>
6: 0x7fceccb00dd - <no info>
7: 0x7fcecb2bcc5 - <no info>
8: 0x7fcecb1b9284 - <no info>
9: 0x7fcecaefba1b - <no info>
10: 0x7fcecaf182f3 - <no info>
11: 0x7fcecaefc7fc - <no info>
12: 0x7fcecaf021d6 - <no info>
13: 0x7fcecbc10199 - <no info>
14: 0x7fcecaf16228 - <no info>
15: 0x7fcecbc015ba - <no info>
16: 0x7fceccb5365 - <no info>
17: 0x7fce94376b9 - <no info>
18: 0x7fce8f4741c - <no info>
19: 0x0 - <no info>
```

```
Thread 'IO Worker #1' panicked at 'assertion failed: rc == -1', l
```

```
2018.08.06
```

etherscan.io

Latest 25 txns from a total Of 109 transactions

TxHash	Block	Age	From	To
0x2fee0607ba1d19...	5216606	4 mins ago	0x7f720aa17df840f...	IN
0xade37816be1e00...	5216605	4 mins ago	0xc95bad7a549d3b...	IN
0xb7b0ec86f9a49d...	5216605	4 mins ago	0xc95bad7a549d3b...	IN
0x361ce0cc85e399...	5216605	4 mins ago	0x097d2f2ff03e0b...	IN
0x1442ad578fec713...	5216602	5 mins ago	0xb5b3e475501b6...	IN
0xe0e23337e7d6d54...	5216602	5 mins ago	0xf898f063d22a994...	IN
0xb718b4fdbac8cb...	5216601	5 mins ago	0x327fb6286026b...	IN

Contract Overview

ETH Balance:	0.16107 Ether
ETH USD Value:	\$119.64 (@ \$742.76/ETH)
No Of Transactions:	109 txns

Contract Source Code Verified

Contract Name:	KpopItem	Optimization Enabled:
Compiler Version:	v0.4.20+commit.3155dd80	Runs (Optimiser): 200

Contract Source Code </>

```
1 // KpopItem is a ERC-721 item (https://github.com/ethereum/eips/issues/721)
2 // Each KpopItem has its connected KpopToken itemrity card
3 // Kpop.io is the official website
4
5 pragma solidity ^0.4.18;
6
7
8 /**
9  * @title SafeMath
10 * @dev Math operations with safety checks that throw on error
11 */
12 library SafeMath {
13
14 /**
15 * @dev Multiplies two numbers, throws on overflow.
16 */
17 function mul(uint256 a, uint256 b) internal pure returns (uint256) {
18     if (a == 0) {
19         return 0;
20     }
21     uint256 c = a * b;
22     require(c / a == b);
23     return c;
24 }
```

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Hybrid Approach

Local Ethereum software + Etherscan API

<https://etherscan.io/apis>

- txlist
- txlistinternal

Empty Code Results

From block 0 to 6,000,000 (July 20 2018):

- 1,799,570 total contracts
- 1,745,317 alive, 54,253 empty contracts
- 28,174 unique creation code for empty contracts
- 32,308 empty contracts with 0 balance

First Contract Creation

Block 46402 (2015-08-07)

From: [0xa1e4380a3b1f749673e270229993ee55f35663b4](https://etherscan.io/address/0xa1e4380a3b1f749673e270229993ee55f35663b4)

To: [Contract [0x9a049f5d18c239efaa258af9f3e7002949a977a0](https://etherscan.io/address/0x9a049f5d18c239efaa258af9f3e7002949a977a0) Created] ⚠️
└... Warning! Error encountered during contract execution [Out of gas] ☹

Value: 0 Ether (\$0.00)

Gas Limit: 24000

Gas Used By Txn: 24000

Gas Price: 0.00001 Ether (10,000 Gwei)

Actual Tx Cost/Fee: 0.24 Ether (\$108.78)

Nonce & {Position}: 3 | {0}

Input Data:

```
0x606060405260008054600160a060020a0319163317905560068060236000396000f3006060604052
```

00000000: PUSH1 0x60 00000015: SWAP1
00000002: PUSH1 0x40 00000016: SSTORE
00000004: MSTORE 00000017: PUSH1 0x6
00000005: PUSH1 0x0 00000019: DUP1
00000007: DUP1 0000001a: PUSH1 0x23
00000008: SLOAD 0000001c: PUSH1 0x0
00000009: PUSH1 0x1 0000001e: CODECOPY
0000000b: PUSH1 0xa0 0000001f: PUSH1 0x0
0000000d: PUSH1 0x2 00000021: RETURN
0000000f: EXP 00000022: STOP
00000010: SUB 00000023: PUSH1 0x60
00000011: NOT 00000025: PUSH1 0x40
00000012: AND 00000027: MSTORE
00000013: CALLER 00000028: STOP
00000014: OR

First Contract “Creation” (With Enough Gas)

TxHash: 0x31ded263506ea36e6ea777efc2c39a999e6fba4f4d338c7313af6aac6d9bf3e3

Block Height: 47205 (6013548 block confirmations)

TimeStamp: 1088 days 18 hrs ago (Aug-07-2015 08:26:34 AM +UTC)

From: 0fbe0afcd7658ba86be41922059dd879c192d4c73

To: [Contract 0xc669eaad75042be84daaf9b461b0e868b9ac1871 Created] 

Value: 14.985 Ether (\$6,790.60)

Gas Limit: 21000

Gas Used By Txn: 21000

Gas Price: 0.0000005 Ether (500 Gwei)

Actual Tx Cost/Fee: 0.0105 Ether (\$4.76)

Nonce & {Position}: 0 | {0}

Input Data:

0x

First Contract Creation (With Code)

Block 48643 (2015-08-07)

Account 0x6516298e1c94769432ef6d5f450579094e8c21fa

Block	Age	From	To	Value	[TxFee]
5868974	32 days 15 hrs ago	0x3406577823d26c...	IN 0x6516298e1c9476...	69 wei	0.000035753454
5864543	33 days 9 hrs ago	0x0668dea6b5ec94...	IN 0x6516298e1c9476...	420 wei	0.000105345
5864460	33 days 9 hrs ago	0x20c945800de433...	IN 0x6516298e1c9476...	0 Ether	0.00004508
48643	1088 days 12 hrs ago	0x3d0768da09ce77...	IN Contract Creation	0 Ether	0.005201664565

Top Duplicates

Count: 10,072

Code:

0x5b620186a05a1315
601357600160205260
00565b600080601f60
0039601f565b6000f3



Top Duplicates (2)

Count: 9,512

Code:

0x

Total: 6203 ETH (~\$2,600,000)

Top Duplicates (3)

Count: 1,963

Code:

```
0x000000000000000000000000000000000000000000000000000000000000000  
000000000000000000000000...00000000000000000000000000000000
```

6000 NULs (ST0P)

*EIP-170 sets max size to 0x6000

Noise / Spam

0x7F62E6C7Ec6700187aB99f71997912A9CDF184D1

PUSH20 0xff5932556071d5ac315d240b92b97a3b4f7daf3d
SELFDESTRUCT

0, 1 or 2 Wei transferred
1988 contracts after filtering

Massive selfdestruct

<https://etherscan.io/tx/0x0bb3c5ec638d167a00d3e790cbf7692b39e70d343ad4900ef241c21e10d016a0>

0xd3e32594cedbc102d739142aa70d21f4caeae5618

Q Contract 0x0978b496a1635e4a0b4ff867569cf43ee030e967 ▲

Warning! Error encountered during contract execution [Out of gas] ☹

SELF-DESTRUCT Contract 0x7fe6f3ab78407e54e19f9...

SELF-DESTRUCT Contract 0xfd202f5050c98025a017...

SELF-DESTRUCT Contract 0xb7e2330fb74da72b66e0...

SELF-DESTRUCT Contract 0xd0273f27aa56fcf7c178f...

SELF-DESTRUCT Contract 0xaebcc9e99b11cca9dc94...

SELF-DESTRUCT Contract 0xf30137e9ebd2ad27b7b68...

SELF-DESTRUCT Contract 0x4e01c8ee7766480e391...

SELF-DESTRUCT Contract 0x12cff668a28961051e7...

SELF-DESTRUCT Contract 0x44eb7d265e9d29e54...

SELF-DESTRUCT Contract 0x90f51a9a171a9b3ebc98...

SELF-DESTRUCT Contract 0x2b123e2d4f0ebf94e95b...

SELF-DESTRUCT Contract 0x1d7019b512f0e903da284...

SELF-DESTRUCT Contract 0x69329f24e05ec98c61d...

SELF-DESTRUCT Contract 0x0b1c3cf74aaa0f33863c...

SELF-DESTRUCT Contract 0x7619bbe628563bf043...

SELF-DESTRUCT Contract 0x537ac00a527e87270554...

SELF-DESTRUCT Contract 0xd39ae24478b35bd9b7...

SELF-DESTRUCT Contract 0x368b2fecaa96542b30cc...

SELF-DESTRUCT Contract 0xc35481071fb2072e6abc...

SELF-DESTRUCT Contract 0xba1c2eb4d48a273394f1...

SELF-DESTRUCT Contract 0x429fb13d3262de2d9057...

SELF-DESTRUCT Contract 0xfb8ba984b657ab3cea3e...

SELF-DESTRUCT Contract 0xcf97bd19c4b8c1595c68...

SELF-DESTRUCT Contract 0x3fb9d17b561d67b6b9...

SELF-DESTRUCT Contract 0x1c51c595bcf676484ddd...

SELF-DESTRUCT Contract 0xce5b4ddc2ee28524dc8b...

SELF-DESTRUCT Contract 0xca9a097735557d7350b3...

SELF-DESTRUCT Contract 0x0fc67bfa4ce0bf7ea2935d...

SELF-DESTRUCT Contract 0x8bf2f079af6cb3d0fce2...

SELF-DESTRUCT Contract 0x2839c0f47409064b368...

SELF-DESTRUCT Contract 0x42b43c236211bdc6c58...

SELF-DESTRUCT Contract 0x1b2454101b9450393d5...

SELF-DESTRUCT Contract 0x8895e37a29993befab94...

SELF-DESTRUCT Contract 0xd3f83dc22b9883fa0e83...

SELF-DESTRUCT Contract 0x7233c01a6a020fefa263c...

SELF-DESTRUCT Contract 0xb3738f9201122a734b...

SELF-DESTRUCT Contract 0x9950f5b302e69922d1...

SELF-DESTRUCT Contract 0xddb33cda8a3b9ff8edf0...

SELF-DESTRUCT Contract 0x2481c01e05bc999a3...

SELF-DESTRUCT Contract 0x2e158e3256225a0f298e...

SELF-DESTRUCT Contract 0xda5846bea1bded1ad51...

SELF-DESTRUCT Contract 0xb7dbb5fa147d9a4acf...

SELF-DESTRUCT Contract 0x9d88e0612b482b8b...

SELF-DESTRUCT Contract 0x01032a8a363ebc0fce...

SELF-DESTRUCT Contract 0x299e0de8fbab5c35e...

SELF-DESTRUCT Contract 0x5a26884c5a7128b055d...

SELF-DESTRUCT Contract 0x42721d2498de037ec19...

SELF-DESTRUCT Contract 0x32968b23023551e950f...

SELF-DESTRUCT Contract 0x19132313e5468ac55ce0...

SELF-DESTRUCT Contract 0x6ae10ecd00dc36a86bf...

SELF-DESTRUCT Contract 0x322b6f11499362975h...

SELF-DESTRUCT Contract 0x3ce1a6b2be7aae018fe8...

SELF-DESTRUCT Contract 0xa0cb84d8003d12d8815...

SELF-DESTRUCT Contract 0x0557c4d2a77177c835...

SELF-DESTRUCT Contract 0x4e7c1c91218f7c753a038...

SELF-DESTRUCT Contract 0xcaa146086b3e202864...

SELF-DESTRUCT Contract 0x9a310671bb795127aec...

SELF-DESTRUCT Contract 0x8c48dd581f0080fbc...

SELF-DESTRUCT Contract 0xed020756a3cae168b3...

SELF-DESTRUCT Contract 0x4ad9a80d8c2e6a27ad42...

SELF-DESTRUCT Contract 0x74688a137679d058a04...

SELF-DESTRUCT Contract 0x7d5d2e5c5a76f147d7d...

SELF-DESTRUCT Contract 0x4d9dd3c2a1f1c6897d0...

SELF-DESTRUCT Contract 0x6a25ab326472a0682a...

SELF-DESTRUCT Contract 0xd595356b5cbe12e71c3...

SELF-DESTRUCT Contract 0x8ec7d495dcfd129e5...

SELF-DESTRUCT Contract 0xa08967e5b2d2ce3509bc...

SELF-DESTRUCT Contract 0x4eb6d3ca932f0c21b4...

SELF-DESTRUCT Contract 0x7cbe69d944e90c6a654...

SELF-DESTRUCT Contract 0x5be8394573dc43cb032...

SELF-DESTRUCT Contract 0x88c6e6713bc5a07b943...

SELF-DESTRUCT Contract 0x2ff93d2f03a1e26229b...

SELF-DESTRUCT Contract 0x7151cbe210a214fae22...

SELF-DESTRUCT Contract 0x8f3d61d394982039174...

SELF-DESTRUCT Contract 0x4a47a59e434fd13e42...

SELF-DESTRUCT Contract 0x79a8c6ca304dd432975...

SELF-DESTRUCT Contract 0x6682d4a36c251906...

SELF-DESTRUCT Contract 0x224a6e77c0470c8aa04...

SELF-DESTRUCT Contract 0x7226098ec032deca7d...

SELF-DESTRUCT Contract 0x724368ca2068c2edb806...

SELF-DESTRUCT Contract 0x4fa0ab11c9c03bcc31a0...

SELF-DESTRUCT Contract 0xb42dec2a3a6683ed29...

SELF-DESTRUCT Contract 0x1e938271761742dedf0...

SELF-DESTRUCT Contract 0x48e50cf4f41b0dc028d...

SELF-DESTRUCT Contract 0x45b0f65639551872ab46...

SELF-DESTRUCT Contract 0x2bc03999055803d99f6...

SELF-DESTRUCT Contract 0x1e9845db13ca712c1b...

SELF-DESTRUCT Contract 0x94e70bcf859eb39a2dc7...

SELF-DESTRUCT Contract 0xcf5ba2f2d7350f17d267e...

SELF-DESTRUCT Contract 0xdfc00da94fb29a33a467...

SELF-DESTRUCT Contract 0x4fa155fcbe13bfa3584...

SELF-DESTRUCT Contract 0x55f93872c69f2a24149...

SELF-DESTRUCT Contract 0x6bb5e0c68f50d28662c...

SELF-DESTRUCT Contract 0x3be151b9ec83d732e41...

SELF-DESTRUCT Contract 0x6be5c834d997e205053...

SELF-DESTRUCT Contract 0xbb6face2bf3d2bbaca0ad...

SELF-DESTRUCT Contract 0x152a020db2c7b7896248...

SELF-DESTRUCT Contract 0xbb55d969a126a4b74ab...

SELF-DESTRUCT Contract 0x200537ec0f0d97faacd5...

SELF-DESTRUCT Contract 0x3f949950a0f767dd4cf7...

SELF-DESTRUCT Contract 0xba4ec62b1b26f1e329...

SELF-DESTRUCT Contract 0x7c3477e5f341cabcc33e...

SELF-DESTRUCT Contract 0x1e92562a6bc959a0c9a0...

SELF-DESTRUCT Contract 0x7f6754da75d7a2cad8...

SELF-DESTRUCT Contract 0x7226098ec032deca7d...

SELF-DESTRUCT Contract 0x03f234b831a6a3c402ae...

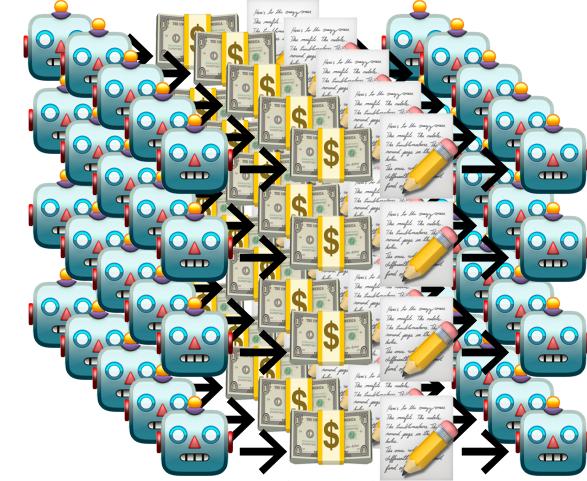
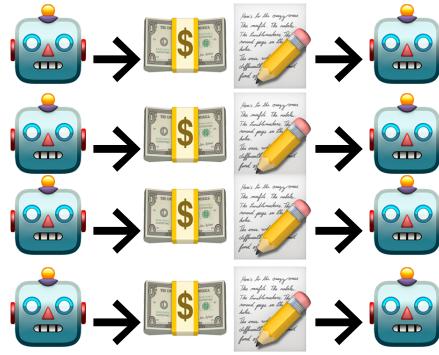
SELF-DESTRUCT Contract 0x269be445456ec5458a8c...

SELF-DESTRUCT Contract 0x0ba6d8004961d688fa...

SELF-DESTRUCT Contract 0x7c9a61104627612ccac02...

SELF-DESTRUCT Contract 0x0ba6d8004961d688fa...

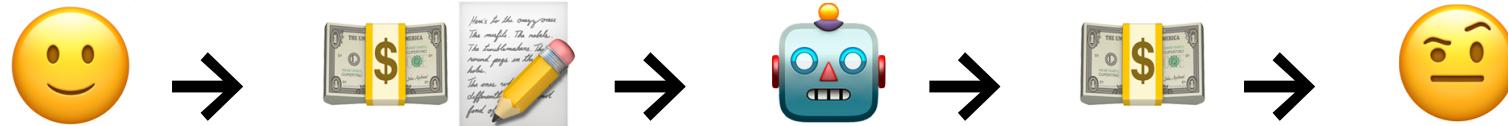
Massive selfdestruct (2)



Analyzing 2,000 Deaths

TRAIL
ofBITS

Criteria



Creator != selfdestruct destination

From trace, we know the destination of selfdestruct

Filter when this is not the original contract creator

630 contracts remaining

10 of these send ETH to address 0x0

50ETH to Oxo

0xf73d247ffDBD5A9964d1a1444c86343650b67ed4

<https://etherscan.io/address/0xf73d247ffdbd5a9964d1a1444c86343650b67ed4>

Function: kill(address _to) MethodID: 0xcbf0b0c0

[0]:

000
0000000000000000

10,000 ETH!

0xf199Af8B17D81c41ABe6220a1D7C9fe04d0d9d2c

Parity multisig wallet initWallet() attack?

<https://blog.zeppelin.solutions/on-the-parity-wallet-multisig-hack-405a8c12e8f7>

0xbec591de75b869...	→	0xb3764761e297d6...	82,189 Ether
0x50126e8fcb9be2...	→	0xb3764761e297d6...	44,055 Ether
0x91efffb9c6cd3a6...	→	0xb3764761e297d6...	26,793 Ether

Creator != selfdestruct transaction originator

159 contracts meet these conditions

25 contracts sent > 0.1 ETH

Only 16 contracts sent ≥ 1 ETH

300ETH selfdestruct

Account: 0x96f65700904cB464F3D153a2744B84FCa27ABF9C

Sent 300ETH to 0xCafe00be401442Bfb5E480C355393FD8C147abBB

Function: changeOwner(address _from, address _to) ***

MethodID: 0xf00d4b5d

[0]: 00000000000000000000000000000000374139a05ac55917badd3f934f1b93f5c8623ded

[1]: 00000000000000000000000000000000cafe00be401442Bfb5e480c355393fd8c147abbb

Dice2Win

0xD1CEeee6B94DE402e14F24De0871580917ede8a7

Sent 65.7 ETH to 0xD1CEeee271fd5a8B0e2BFc12Ea5B5b2E5CeDEC95

Function: approveNextOwner(address _nextOwner)

MethodID: 0xd579fd44

[0]: 000000000000000000000000d1ceeee271fd5a8b0e2bfcc12ea5b5b2e5cedec95

Etherwow

0x4DF6DE08D11f11EBAd5d9E136B768849426fB8a7

Function: ownerChangeOwner(address newOwner)

MethodID: 0x4f44728d

[0]: 000000000000000000000000000000007d138be0eed529ae42a468472b2beb0314af5e28

Function: ownerkill()

```
/** @dev owner selfdestruct contract
***BE CAREFUL! EMERGENCY ONLY
/ CONTRACT UPGRADE*/
function ownerkill() public onlyOwner
{ selfdestruct(owner); }
```

Etherwow

国内最火爆的区块链猜数字小游戏

选择投注类型

数字

76

投币

0.1

赢币

0.12

51

0.2

0.36

31

1

3

16

0.5

3

The most popular blockchain guessing digital game in China

Becoming Mortal

0xf4D3CEd0929eA3F3Fd94F32ba460a66b428932F2

```
function mortal() { owner = msg.sender; }

function kill() {
    if(msg.sender == owner) selfdestruct(owner);
}
```

Conclusion

If you are developing contracts:

- Understand and fix all warnings
- Add an Echidna test
- Write exhaustive positive/negative tests
- **Perform an rigorous assessment**

If you are a security researcher:

- Become a blockchain explorer
- Have patience
- Symbolically execute with Manticore
- **Work with us**

Contact

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