Learn Blockchain Programming

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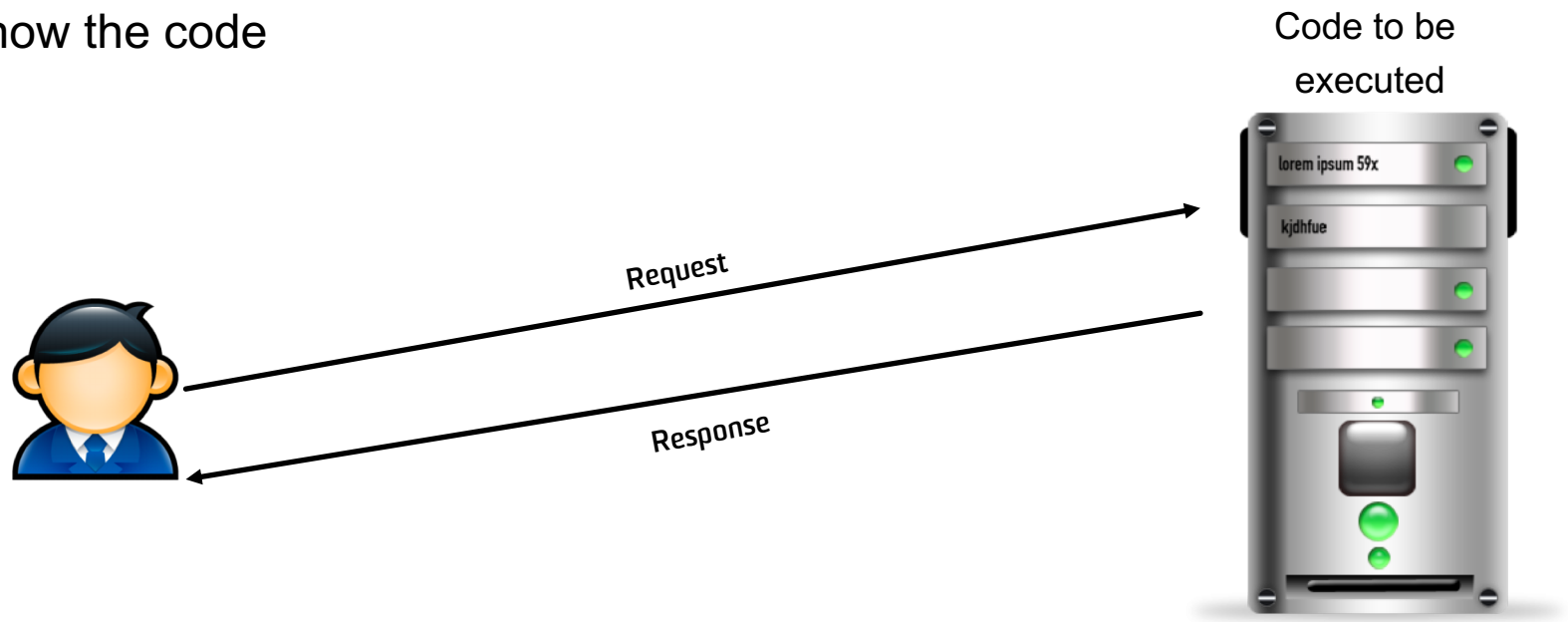
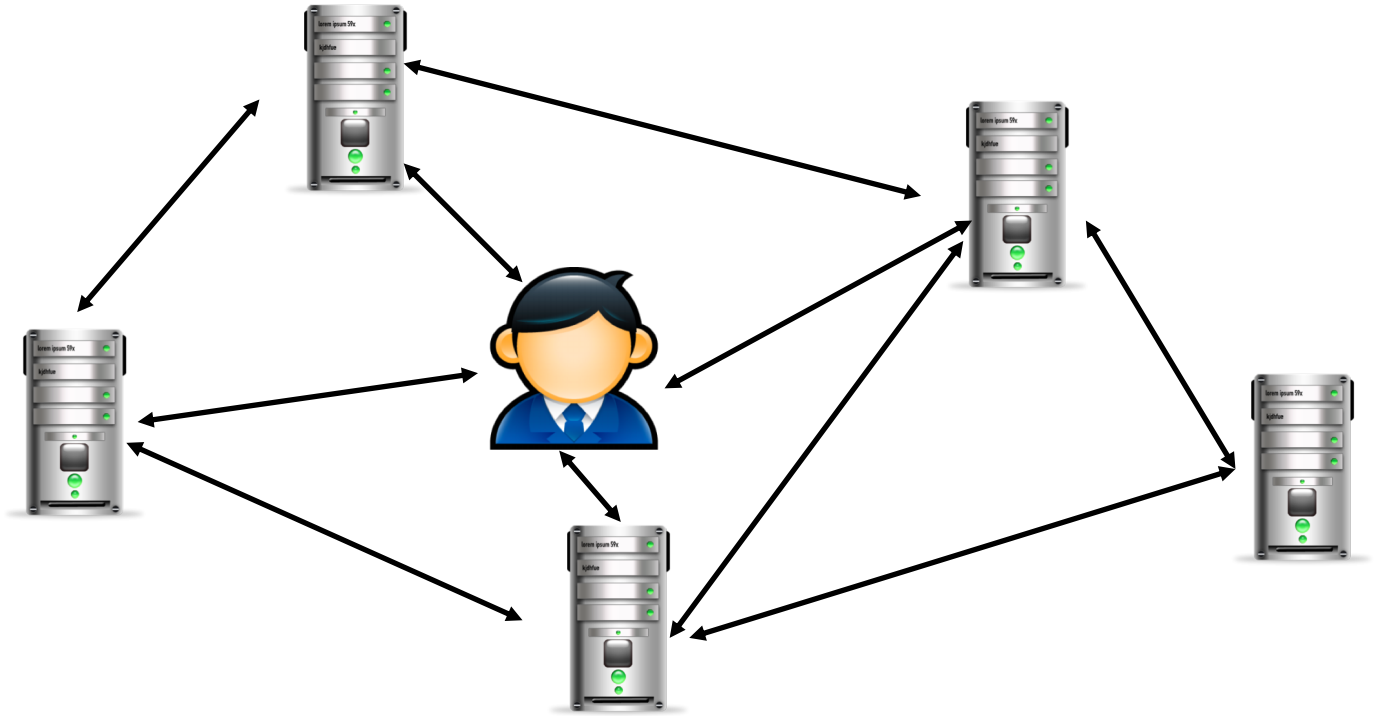
Traditional Programming

- Server runs the code
- User may or may not know the code
- Complicated algorithms
- Database



DApps: Distributed Applications



DApps: Distributed Applications

Open Source: All nodes have to verify the contract to verify transaction and state in blockchain.

Decentralized

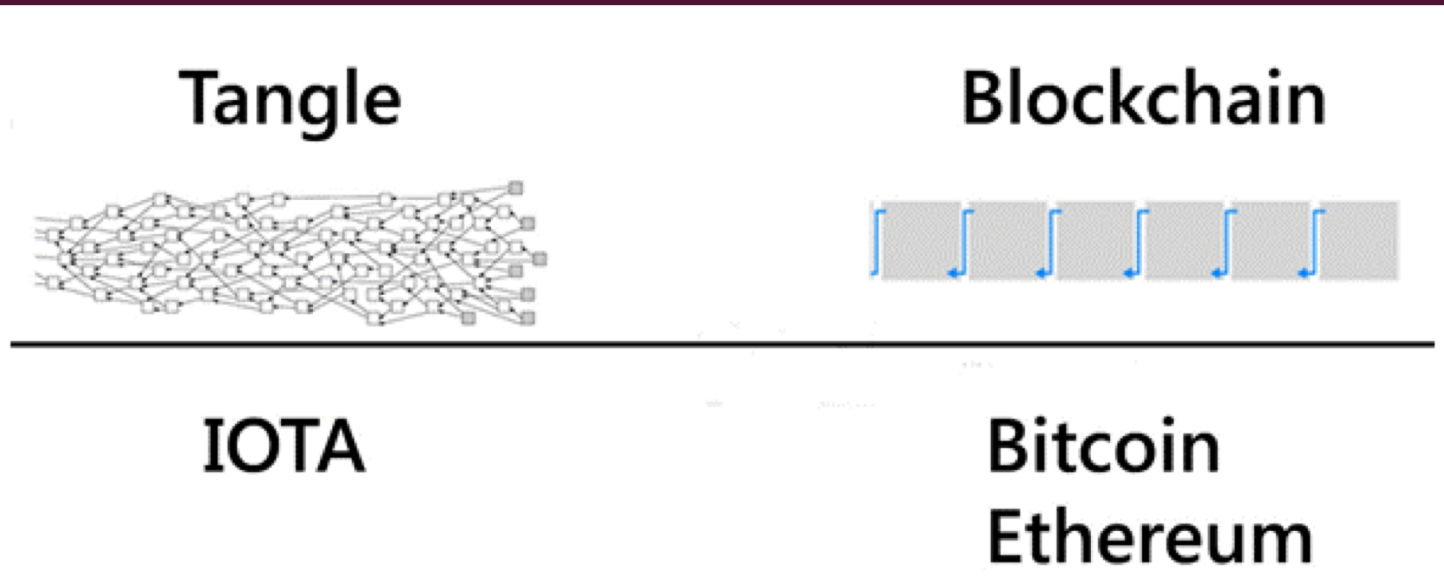
Incentive: Normally use token/assets to fuel the code

Algorithm/Protocol

Immutable

Different Blockchains, Different Platforms

HYPERLEDGER



- To store its transaction, each node has to verify two other transactions
- Self-scaling
- Reduce cost and delay

HYPERLEDGER

- Different blockchains
- Can be used to build blockchain and evaluate performance
- Open source

Solidity

- Influenced by C++, Java, and Python
- Runs on Ethereum Virtual Machine (EVM)
- EVM: The computer that all full nodes agree to run, i.e., runtime environment for smart contract
- All nodes perform the code execution
- Write Solidity code online in: https://remix.ethereum.org

Accounts

- Each account has an address:
  - External accounts: determined by public key
  - Smart contract account: creator address and nonce
- Each account has *balance* in Ether (in “Wei” to be exact, 1 ether is 10**18 wei)

Gas

- Gas Limit
- Gas Price

Transaction fee = Gas limit * Gas price

Gas limit: Amount of liters of gas for a car

Gas price: Cost of liter of gas

Solidity

```
pragma solidity ^0.4.0;

contract SimpleStorage {
    uint storedData;

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

    function get() public view returns (uint) {
        return storedData;
    }
}
```

https://solidity.readthedocs.io/en/develop/introduction-to-smart-contracts.html

You can define *Structs* in solidity

```
struct Person {
        uint age;
        string name;
}
```

You can define *Arrays* in solidity as well

```
// Array with a fixed length of 2 elements:
uint[2] fixedArray;

// another fixed Array, can contain 5 strings:
string[5] stringArray;

// a dynamic Array - has no fixed size, can keep growing:
 uint[] dynamicArray;
```

- **Define Function**

```
function setAge(string _name, uint _age) {

}
```

Function visibility

- Public
  - Your contract can be called by anyone or any other contract
  - Default
  - Security issue

- Private
  - Only functions within the contract can call the function

```
function setAge(string _name, uint _age) private {

}
```

- Internal
  - Similar to private, but accessible to contracts that inherit from this contract

- External
  - Similar to public, but can “only” be called outside the contract

- Return value

```
string greeting = "What's up";
function sayHello() public returns (string) {
return greeting;
}
```

- Function modifiers
  - View: the function only views data, but not modifying any value, i.e., only read action is performed.
  - Pure: the function does not access data in blockchain, i.e., the return value only depends on the input values.

```
function _multiply(uint a, uint b) private pure returns
(uint) {
 return a * b;
}
```

- Mapping (key→value)

```
mapping (address => uint) public accountBalance;

mapping (uint => string) userIdToName;
```

- How to find out the address of the person who called the transaction?

```
msg.sender
```

- Running a function with a condition:

```
function sayHiToVitalik(string _name) public returns (string) {
require(keccak256(_name) == keccak256(”Ali"));
return "Hi!";
}
```

Contract inheritance

```
contract Doge {
function catchphrase() public returns (string) {
return "So Wow CryptoDoge";
}}

contract BabyDoge is Doge {
function anotherCatchphrase() public returns (string) {
return "Such Moon BabyDoge";
} }
```

```
import "./someothercontract.sol";
```

Ownable

- "Ownable" is a contract from OpenZeppelin.
- OpenZeppelin is a library for secure smart contract development.
- Has a modifier named "onlyOwner"

```
contract MyContract is Ownable {

function likeABoss() external onlyOwner {
LaughManiacally("Muahahahaha");
} }
```

https://github.com/OpenZeppelin/openzeppelin-solidity

Payable

- Marks a contract as payable

```
contract OnlineStore {
function buySomething() external payable {

require(msg.value == 0.001 ether);

transferThing(msg.sender);
 } }
```

- Withdraw

```
uint itemFee = 0.001 ether;
msg.sender.transfer(msg.value - itemFee);
```

What to do after writing the smart code?

To interact with a contract you need:

1. The address of the smart contract
2. The function you want to call, and
3. The variables you want to pass to that function.

JSON files

Infura

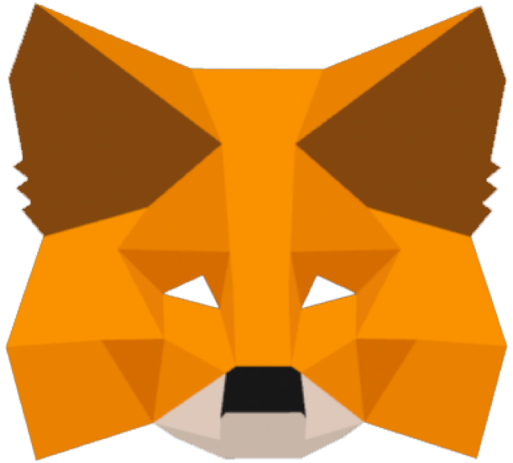
- Maintains a set of Ethereum nodes
- Connects you to the Ethereum
- Use the address in your API.

```
var web3 = new Web3(new Web3.providers.WebsocketProvider
("wss://mainnet.infura.io/ws"));
```

https://infura.io/

Metamask

- Browser extension for chrome and Firefox
- Allows users to manage their Ethereum accounts while connecting to websites.
- As a developer, if you want the users to interact with your DApp using website, you need to make it metamask-compatible.
- Check if the user has installed metamask



Contract Application Binary Interface (ABI)

- Your contract in JSON format
- Clarifies how to call functions

Private Ethereum testnet

- Install Node.js,
  - `brew install node`
- Install compiler
  - `npm install -g solc`
- Install Ethereum
  - `brew tap ethereum/ethereum brew`
  - `install ethereum`

Create a genesis.JSON file

```
{
        "config": {
                "chainId": 15,
                "homesteadBlock": 0,
                "eip155Block": 0,
                "eip158Block": 0
        },
        "difficulty": "1",
        "gasLimit": "2100000",
        "alloc":{
                "yourNewlyCreatedAccountAddressMustGoHere": {
                        "balance": "300000"
                },
                "yourNewlyCreatedAccountAddressMustGoHere": {
                        "balance": "400000"
                },
                "yourNewlyCreatedAccountAddressMustGoHere": {
                        "balance": "500000"
                }
        }
}
```

https://medium.com/cybermiles/running-a-quick-ethereum-private-network-for-experimentation-and-testing-6b1c23605bce

Initialize the first node

```
geth --datadir ~/gethDataDir/ init genesis.json
```

Start the first node

```
geth --datadir ./myDataDir --networkid 1114 console 2>> myEth.log
```

Create account

```
personal.newAccount("<YOUR_PASSPHRASE>")
```

Check account

```
Eth.accounts
```

Checking account balance

```
Eth.getbalance(eth.coinbase/eth.accounts[0])
```

Start mining

```
Miner.start(1)
```

Add another node

```
geth --datadir ./peer2DataDir --networkid 1114 --port 30304
console 2>> myEth2.log
```

Node address

```
admin.nodeInfo.enode
```

Verify peers

```
Admin.peers
```

How to create your own cryptocurrency (ICO)?

Token

- Token is a smart contract that follows some common rules and implements a standard set of functions.

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