



Creative
Emergy

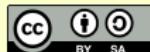
Introduction to Blockchain

a hands-on approach

By Marc Lijour

July 16, 2021

The Art and Science of Eternal Blossom



Who am I?

<https://www.linkedin.com/in/marclijour/>



Access these slides

<https://bit.ly/3rcN8J7>

or find in the folder [Workshop: introduction to blockchain](#) at

<https://github.com/marclijour/presentations>



Table of Contents

1 What is Blockchain?

2 Hands-on Introduction to Crypto

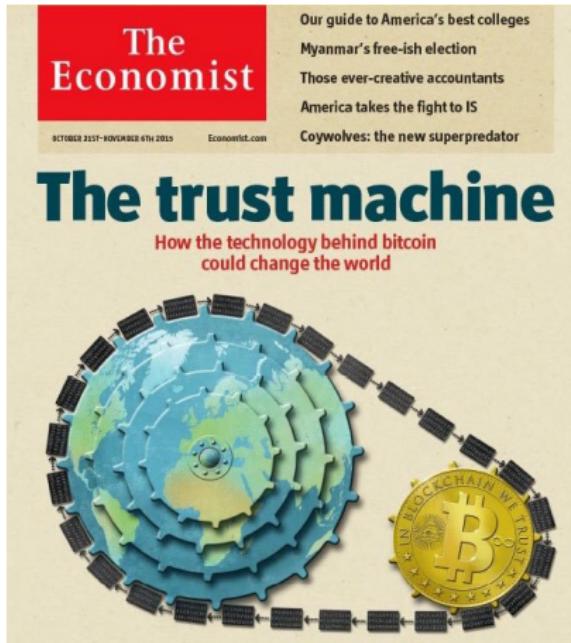
3 Create your own token

- The easy way
- The programmatic way

4 Introduction to Ethereum



The Trust Machine



Source of Trust

World Economic Forum: *What is Blockchain* Youtube Video

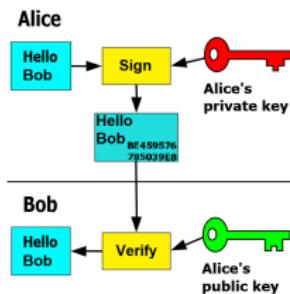


BLOCKCHAIN WILL BECOME A GLOBAL
DECENTRALISED SOURCE OF TRUST



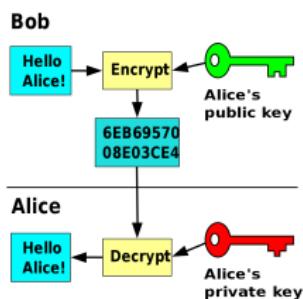
Key Cryptographic Primitives

Signing



Credit: FlippyFlink

Encrypting



Hashing

Input	cryptographic hash function	Digest
Fox	cryptographic hash function	DFCD 3454 BBEA 788A 751A 696C 24D9 7009 CA99 2D1C
The red fox jumps over the blue dog	cryptographic hash function	00B6 46BB FB7D CBE2 823C ACC7 6CD1 90B1 EEE6 3ABC
The red fox jumps over the blue dog	cryptographic hash function	8FD8 7558 7851 4F32 D1C6 76B1 79A9 DCA4 AEF8 4819
The red fox jumps oevr the blue dog	cryptographic hash function	FC03 TFB8 5AF2 C6FF 915F D401 C0A9 7D9A 46A7 FB45
The red fox jumps over the blue dog	cryptographic hash function	BACA D682 D588 4C75 4BF4 1799 7D88 BCFB 92B9 4A6C



Where do we need more trust?

- payments



Where do we need more trust?

- payments
- national identity



Where do we need more trust?

- payments
- national identity
- supply chain (e.g. food: Spanghero horse meat trial, Opioids, expensive cargos)



Where do we need more trust?

- payments
- national identity
- supply chain (e.g. food: Spanghero horse meat trial, Opioids, expensive cargos)
- contracts



Where do we need more trust?

- payments
- national identity
- supply chain (e.g. food: Spanghero horse meat trial, Opioids, expensive cargos)
- contracts
- *real* news & historical events (e.g. bombings)



Where do we need more trust?

- payments
- national identity
- supply chain (e.g. food: Spanghero horse meat trial, Opioids, expensive cargos)
- contracts
- *real* news & historical events (e.g. bombings)
- collaborative data reporting
- ...



Table of Contents

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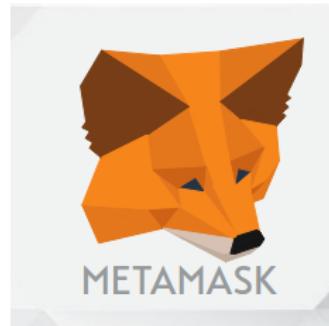
Let's try things out!



Install MetaMask

Follow step by step:

- ① Install the [Chrome/Chromium extension](#)
- ② Watch the [intro on Youtube](#)
- ③ Create an account
- ④ Switch to the Ropsten Testnet
(top-right in MetaMask)
- ⑤ Fill your account with Ether from
<https://faucet.metamask.io>



<https://metamask.io>



Create a new Wallet



New to MetaMask?



No, I already have a Secret Recovery Phrase

Import your existing wallet using a Secret Recovery Phrase

Import wallet



Yes, let's get set up!

This will create a new wallet and Secret Recovery Phrase

Create a Wallet



Discover your secret backup phrase

aka seed phrase, aka the 12 words



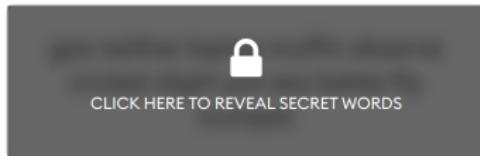
METAMASK

< Back

Secret Backup Phrase

Your secret backup phrase makes it easy to back up and restore your account.

WARNING: Never disclose your backup phrase. Anyone with this phrase can take your Ether forever.



Remind me later

Next

Tips:

Store this phrase in a password manager like 1Password.

Write this phrase on a piece of paper and store in a secure location. If you want even more security, write it down on multiple pieces of paper and store each in 2 - 3 different locations.

Memorize this phrase.

Download this Secret Backup Phrase and keep it stored safely on an external encrypted hard drive or storage medium.



Fully setup Wallet

The screenshot shows the MetaMask wallet interface. At the top left is the Metamask logo (a fox head icon) and the word "METAMASK". To the right is a dropdown menu showing "Ethereum Mainnet" with a downward arrow, and a circular network status icon. Below this, the account information is displayed: "Account 1" and the address "0xDf5c...a96E". A central feature is the ETH balance, shown as "0 ETH" and "\$0.00 USD", accompanied by a small ETH icon. Below the balance are three buttons: "Buy" (with a download icon), "Send" (with an upward arrow icon), and "Swap" (with a circular arrow icon). The interface is divided into two main sections: "Assets" (selected, indicated by a blue underline) and "Activity". Under "Assets", there is a single entry for "0 ETH" worth "\$0.00 USD", represented by an ETH icon. An "Add Token" button is located at the bottom of this section. At the very bottom, a message reads "Need help? Contact [MetaMask Support](#)".



Switch to the Ropsten test network

The screenshot shows the MetaMask extension interface. At the top left is the Metamask logo. To the right is a dropdown menu titled "Ethereum Mainnet" with a "Switch Network" button. The main area displays "Account 1" with address 0xDf5c...a96E. Below it, there's a section for "0 ETH" with a value of "\$0.00 USD" and three buttons: "Buy", "Send", and "Swap". A "Assets" tab is visible below. At the bottom, there's an "Add Token" button and a link to "MetaMask Support". A "Networks" dropdown menu is open on the right, listing the following options:

- Ethereum Mainnet (selected, indicated by a checked checkbox)
- Ropsten Test Network
- Kovan Test Network
- Rinkeby Test Network
- Goerli Test Network
- localhost 8545
- Custom RPC

Request Ether from the faucet (on the Ropsten network)

Do it several times; then donate 1 ether to the faucet

← → ⌛ 🔒 <https://faucet.metamask.io>

MetaMask Ether Faucet

faucet

address: 0x81b7e08f65bdf5648606c89998a9cc8164397647
balance: 4094302.54 ether

[request 1 ether from faucet](#)

user

address: 0x56e552eb5a9ab277d9eb841f92d473bf0cae7ebf
balance: 1.00 ether

donate to faucet:

[1 ether](#) [10 ether](#) [100 ether](#)

transactions



Check the transaction on Metamask

Click on the transaction for a detailed view

The screenshot shows the Metamask wallet interface. At the top, it displays "0.9999 ETH" and "\$88.94 USD". Below this, there's a "History" section with a single entry: "Sent Ether" from address 0x56E5...7EBf to address 0x81b7E0BF65Bd564B606cB9998A9CC8164397647 on December 12, 2018, at 23:23. The status is "CONFIRMED" with "-1 ETH" and "-\$88.95 USD". A "View on Etherscan" button is present. On the left, there's a sidebar with a balance of "0.9999 ETH" and "\$88.94 USD". It also includes a "Don't see your tokens?" link, a "Click on Add Token to add them to your account" note, and an "ADD TOKEN" button.



Check the transaction on Etherscan

 **ROPSTEN**
The Ethereum Block Explorer

ROPSTEN (Revival) TESTNET Search by Address / Txhash / Block / Token / Ens **GO** Language

HOME BLOCKCHAIN TOKEN MISC

Transaction [0xa8a8f32539cb69bd3e506b6527fcc7d44c43cccead09b30b10a9891c99355a3d](#) 

Home / Transactions / [Tx Info](#)

Overview

Transaction Information   Tools & Utilities 

[This is a Ropsten Testnet Transaction Only]

TxHash:	0xa8a8f32539cb69bd3e506b6527fcc7d44c43cccead09b30b10a9891c99355a3d
TxReceipt Status:	Success
Block Height:	4610407 (348 Block Confirmations)
TimeStamp:	1 hr 12 mins ago (Dec-12-2018 04:23:14 AM +UTC)
From:	0x56e552eb5a9ab277d9eb841f92d473bf0cae7ebf
To:	0x81b7e08f65bdf5648606c89998a9cc8164397647
Value:	1 Ether (\$0.00)
Gas Limit:	21000
Gas Used By Transaction:	21000 (100%)
Gas Price:	0.000000005 Ether (5 Gwei)
Actual Tx Cost/Fee:	0.000105 Ether (\$0.000000)
Nonce & (Position):	0 {6}
Input Data:	



A note about gas price

<https://ethgasstation.info>

ETH Gas Station Estimates over last 1,500 blocks - Last update: Block 5164391 Change Currency ▾

Std Cost for Transfer \$0.056 | **Gas Price Std (wei)** 3 | **SafeLow Cost for Transfer** \$0.056 | **Gas Price SafeLow (wei)** 3 | **Median Wait (s)** 29 | **Median Wait (blocks)** 2

Gas-Time-Price Estimator: For transactions sent at block: 5164391

Adjust confirmation time: 3

Avg Time (min)	4.38
95% Time (min)	10.95
Gas Price (wei)*	3
Tx Fee (Flat)	\$0.056

Gas Used*	21000
Avg Time (blocks)	18.02
95% Time (blocks)	45.05
Tx Fee (ETH)	0.00006

Real Time Gas Use: % block limit (last 10)

Last Block: 5164391

Transaction Count by Gas Price

Confirmation Time by Gas Price

Recommended Gas Prices (based on current network conditions)

Speed	Gas Price (wei)
SafeLow (<30m)	3
Standard (<5m)	3
Fast (<2m)	18

Note: Estimates not valid when multiple transactions are batched from the same address or for transactions sent to addresses with many (e.g. > 100) pending nonce confirmations.

Misc Stats (Last 1,500 blocks)

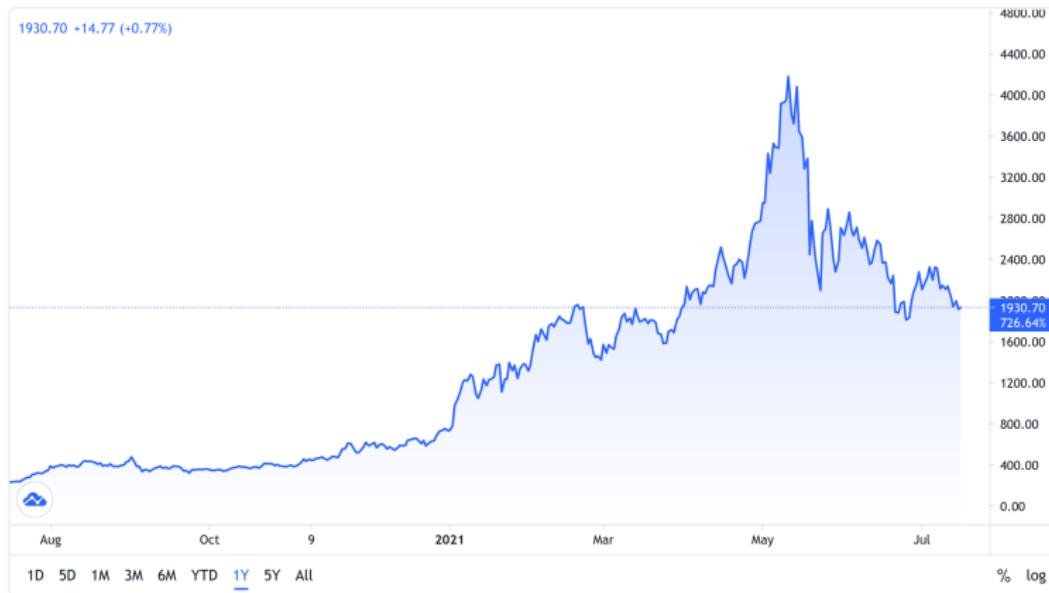


Price of (real) ether: ETH

More information: <https://www.tradingview.com/symbols/ETHUSD/>

ETHUSD Crypto Chart

[Full-featured chart](#)



Wallets

More information: <https://blockgeeks.com/guides/cryptocurrency-wallet-guide/>

Software



Hardware



Paper



Exchanges

- ① Centralized Exchanges (Coinbase, Binance, Kraken, eToro, Huobi, ...)
- ② Decentralized Exchanges (DEXes)



Top DEXes

More information: <https://defipulse.com>

DEFI PULSE	Name	Chain	Category	Locked (USD) ▾	1 Day %
1.	Curve Finance	Ethereum	DEXes	\$7.31B	-3.34%
2.	Uniswap	Ethereum	DEXes	\$5.11B	-3.29%
3.	SushiSwap	Ethereum	DEXes	\$2.67B	-0.42%
4.	Bancor	Ethereum	DEXes	\$1.14B	-1.67%
5.	Balancer	Ethereum	DEXes	\$652.3M	-2.25%
6.	Kyber	Ethereum	DEXes	\$293.2M	-2.74%
7.	Saddle	Ethereum	DEXes	\$117.8M	5.45%
8.	Loopring	Ethereum	DEXes	\$106.1M	-1.06%
9.	Integral	Ethereum	DEXes	\$80.9M	-1.25%
10.	DeFi Swap	Ethereum	DEXes	\$40.5M	-2.44%

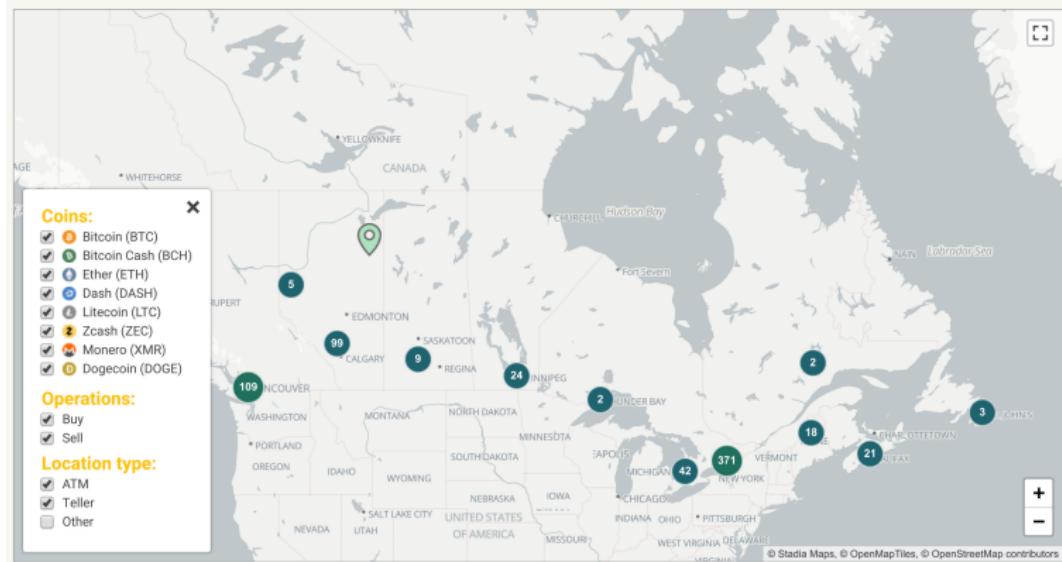


ATMs

More information: <https://coinatmradar.com/country/38/bitcoin-atm-canada/>

Bitcoin ATMs in Canada. 🇨🇦

Total number of Bitcoin ATMs / Tellers in Canada: 707

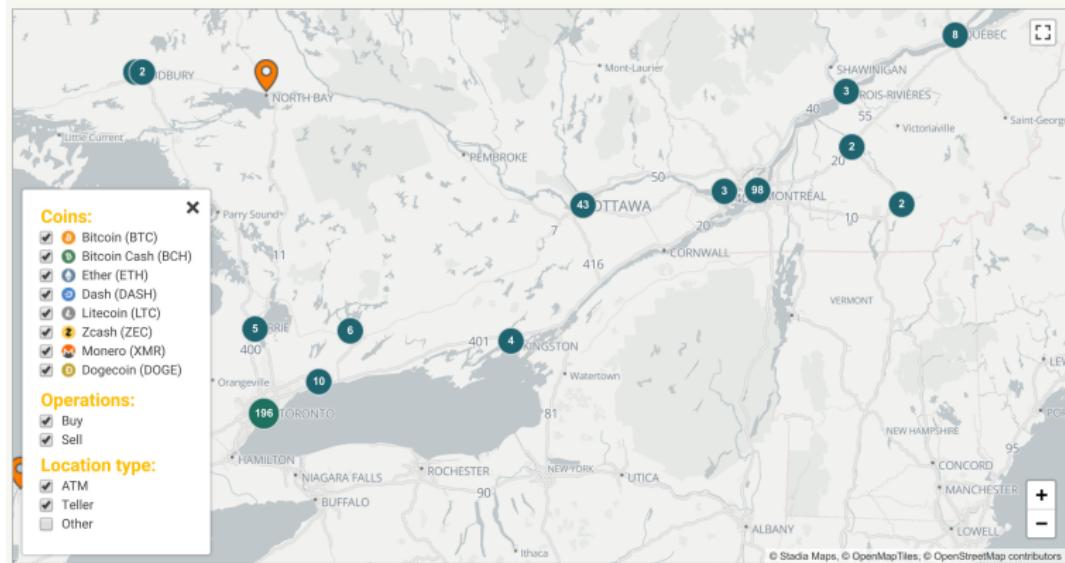


ATMs

More information: <https://coinatmradar.com/country/38/bitcoin-atm-canada/>

Bitcoin ATMs in Canada . 🇨🇦

Total number of Bitcoin ATMs / Tellers in Canada: 707



Other crypto-assets

More information:

<https://www.tradingview.com/markets/cryptocurrencies/prices-all/>

NAME 791 MATCHES	<input type="text"/>	MKT CAP	FD MKT CAP	LAST	AVAIL COINS	TOTAL COINS	TRADED VOL	CHG %
Bitcoin		595.594B	666.796B	31752.18	18.758M	21M	22.839B	-0.30%
Ethereum		225.376B	225.376B	1931.078308	116.71M	116.71M	15.492B	0.66%
Tether		62.013B	64.463B	0.99990000	62.019B	64.47B	46.673B	0.02%
Binance Coin		48.472B	53.874B	315.917097	153.433M	170.533M	2.364B	0.02%
Cardano		39.296B	55.189B	1.22641209	32.041B	45B	1.599B	0.12%
XRP		28.066B	60.728B	0.60728	46.217B	100B	2.141B	2.00%
HEX		27.21B	99.41B	0.15691183000	173.411B	633.543B	147.157M	-8.69%
USD Coin		26.376B	26.376B	1.0000	26.376B	26.376B	2B	-0.01%
Dogecoin		24.065B	24.065B	0.18447521	130.453B	130.453B	1.07B	-0.50%
Polkadot		12.696B	14.203B	13.01468538	975.551M	1.091B	792.263M	-0.50%
Uniswap		10.083B	17.168B	17.16849875	587.306M	1B	366.157M	0.61%
Bitcoin Cash		8.65B	9.667B	460.340	18.791M	21M	1.438B	1.10%
Litecoin		8.428B	10.606B	126.259614	66.752M	84M	1.512B	0.41%
Sola Token		7.826B	14.196B	28.70606914	272.637M	494.519M	335.007M	0.65%



Table of Contents

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Let's create your own token!



Create your own (ERC-20) token

Create Token

Create Token Contract with the following parameters.

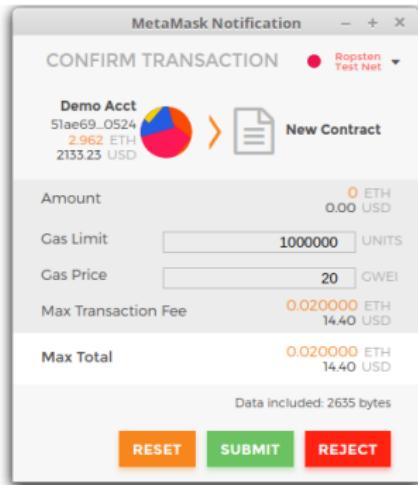
100

Marc's Coin #2

8

MLD

Create Token



- 1 Use the Token Factory Dapp at <https://tokenfactory.surge.sh/#/factory>
- 2 MetaMask will pop up (see picture above)
- 3 Submit the transaction (on the Ropsten Testnet)
- 4 Check your transaction on <https://ropsten.etherscan.io>



Check your Smart Contract

SENT TOKENS

2 December 29 2017 04:49
Contract Published 0 ETH

- ① Select the “Sent” tab
- ② Check the orange Copy icon (Tx Hash)
- ③ Click on “Contract Published”
- ④ That should bring you to Etherscan (see next page)



Watch your Token



- ① Click on the “Add Token” button
- ② Wait for the next window (picture on the right)
- ③ Copy your contract address (from Etherscan)
- ④ Go back to your Token Factory tab, which should show an UI to interact with your contract or go to the URL:
<https://tokenfactory.surge.sh/#/token/0x...> (replace 0x... by your contract address)
- ⑤ Move coins around
- ⑥ In MetaMask, click on your token to check the tx on Etherscan



Too easy?

Let's code it in Solidity
like the pros!



Compile your first ERC-20 Smart Contract

The screenshot shows the Remix IDE interface. On the left, there's a sidebar with compiler settings: Compiler (0.5.11+commit.c082d0b), Language (Solidity), EVM Version (compiler default), and a button to "Compile TokenRecipient.sol". Below these are checkboxes for Compiler Configuration, Auto compile, Enable optimization, and Hide warnings. At the bottom of the sidebar is a "Contract" dropdown set to "TokenERC20 (TokenRecipient)". The main area is titled "TokenRecipient.sol" and contains the following Solidity code:

```
1 pragma solidity >=0.4.22 <0.6.0;
2 
3 interface tokenRecipient {
4     function receiveApproval(address _from, uint256 _value, address _token, bytes calldata _extraData) external;
5 }
6 
7 contract TokenERC20 {
8     // Public variables of the token
9     string public name;
10    string public symbol;
11    uint8 public decimals = 18;
12    // 18 decimals is the strongly suggested default, avoid changing it
13    uint256 public totalSupply;
14 
15    // This creates an array with all balances
16    mapping (address => uint256) public balanceOf;
17    mapping (address => mapping (address => uint256)) public allowance;
18 
19    // This generates a public event on the blockchain that will notify clients
20    event Transfer(address indexed from, address indexed to, uint256 value);
21 
22    // This generates a public event on the blockchain that will notify clients
23    event Approval(address indexed _owner, address indexed _spender, uint256 _value);
24 
25    // This notifies clients about the amount burnt
26    event Burn(address indexed from, uint256 value);
27 
28    /**
29     * Constructor function
30     * Initializes contract with initial supply tokens to the creator of the contract
31     */
32    constructor(
33        uint256 initialSupply,
34        string memory tokenName,
35        string memory tokenSymbol
36    ) public {
37    }
```

- ① Open the Remix IDE at <http://remix.ethereum.org>
- ② Close the ballot file
- ③ Create a new file named `TokenRecipient.sol`
- ④ Copy the code from <https://raw.githubusercontent.com/ethereum/ethereum-org/master/solidity/token-erc20.sol>
- ⑤ Your compiler can be the default one (5.11)
- ⑥ Click the "Compile TokenRecipient.sol" button



Deploy your smart contract

The screenshot shows the Remix IDE interface. On the left, there's a sidebar with icons for Ethereum, file operations, deployment, and a history section with 4 items. The main area has tabs for "Home" and "TokenRecipient.sol". The "Home" tab displays the Solidity code for a TokenERC20 contract. The "TokenRecipient.sol" tab shows an interface definition. Below these tabs is a "Deploy & Run Transactions" section with the following fields:

- Environment: JavaScript VM
- Account: 0xCA3...a733c (99)
- Gas limit: 3000000
- Value: 0 wei
- Contract Name: TokenERC20 - browser/TokenReci
- Deployment parameters: Deploy, 10, "Marc's Token", "ABC"

- ① Go to the "Deploy and run transaction screen (Ethereum-like logo on the left bar)
- ② Fill in the parameters next to the orange "Deploy" button
- ③ Click the "Deploy" button



Deployed Contract

The screenshot shows the Ethereum Remix IDE interface. At the top, there's a header with the title "TokenERC20 - browser/TokenRec" and a dropdown menu. Below the header, there are two main sections: "Deploy" and "At Address". The "Deploy" section contains a text input field with the value "10. "Marc's Token","ABC" and a "Deploy" button. The "At Address" section has a "Load contract from Address" button. Underneath these, a section titled "Transactions recorded:" shows one transaction. The main area is titled "Deployed Contracts" and lists the deployed contract "TokenERC20 at 0x692...77b3A (memory)". Below this, a list of contract functions is shown:

- approve: address_spender,uint256_val
- approveAndCall: address_spender,uint256_val
- burn: uint256_value
- burnFrom: address_from,uint256_value
- transfer: address_to,uint256_value
- transferFrom: address_from,address_to,value
- allowance: address,address
- balanceOf: address

- ① Expand the "Deployed Contracts"
- ② All the contract functions are available from Remix



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Ethereum

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.

— <https://ethereum.org>



A short history of Ethereum

Key Milestones:

- (late 2013) Vitalik Buterin describes Ethereum in a paper



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- (Spring 2016) The DAO
- (July 2, 2016) ETH – ETC split
- (October 16, 2017) Launch of Metropolis (vByzantium) –version 3
- (2017) ETH goes from \$7 to more than \$700 (100x increase)

Check the nice infographic (Invezz, 2017).

Also, see the official *Ethereum White Paper*.



Decentralization

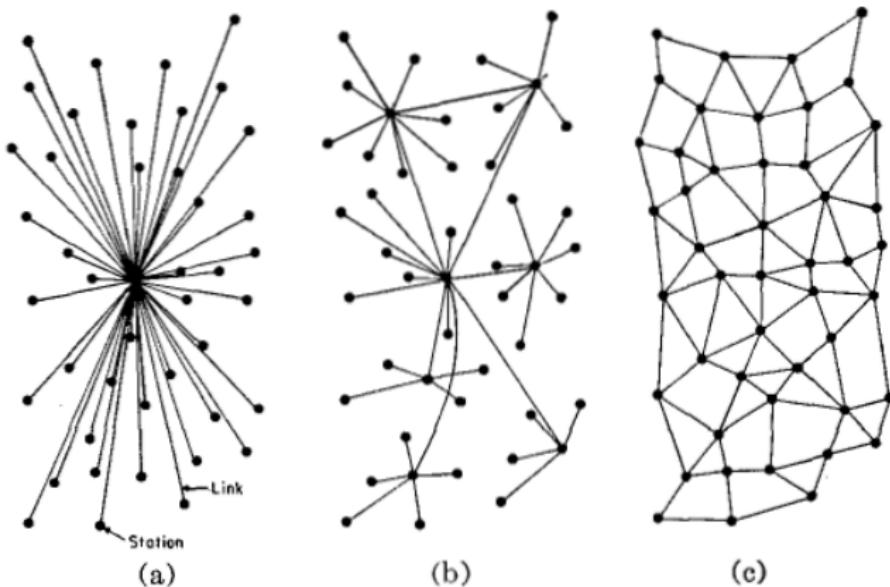


Fig. 1—(a) Centralized. (b) Decentralized. (c) Distributed networks.



Client Types

- Full node



Client Types

- Full node
- Light node



Client Types

- Full node
- Light node
- Something in between (e.g. “fast” for geth)



Disk Space

Full Archive Ethereum node

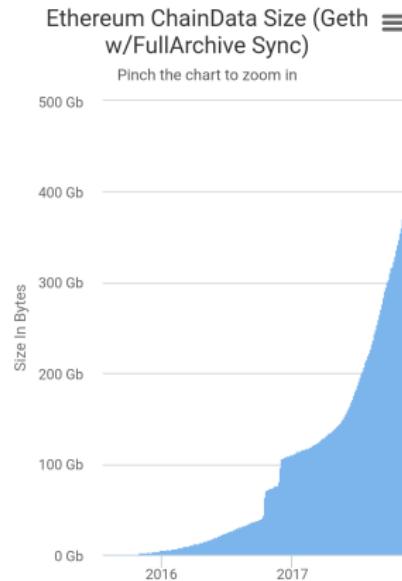
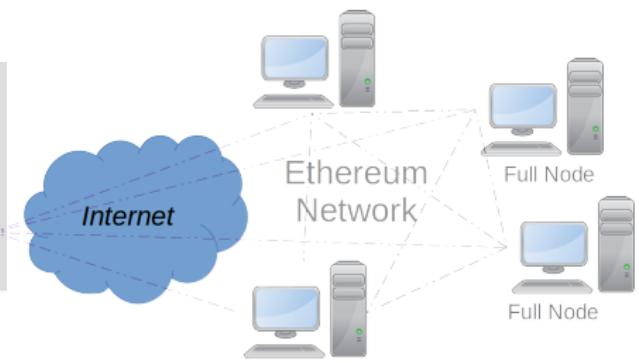
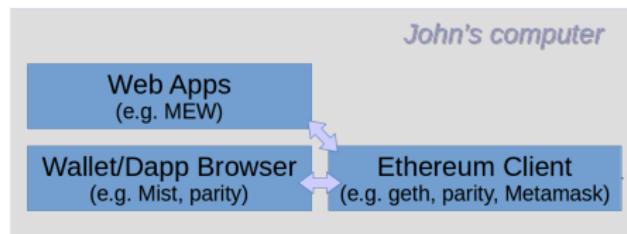


Figure: Miners need a lot of space (Reddit, 2017)



Practical Applications

for personal or business use



Reference books

Blockchain applications

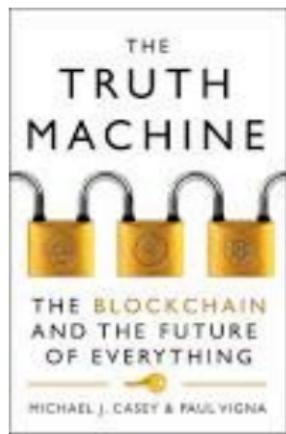


Figure: Book from Vigna and Casey, 2018

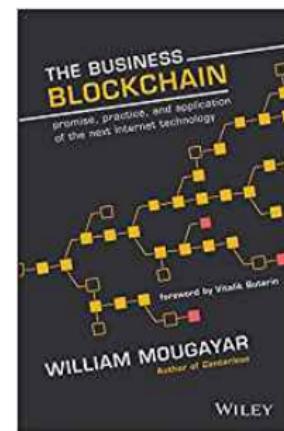


Figure: Book from Mougayar, 2016



Reference books

More recent publications

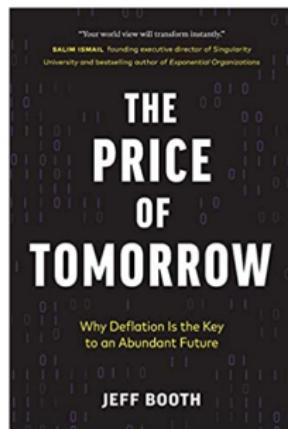


Figure: Book from Booth, 2020

Figure: Book from Russo, 2020

Ultimate references

The must-read white paper from legendary Satoshi Nakamoto: *Bitcoin: A Peer-to-Peer Electronic Cash System* ([2008](#)),

the Ethereum white paper from home-town Toronto Vitalik Buterin: *A Next-Generation Smart Contract and Decentralized Application Platform* ([2013](#)),

and the yellow paper authored by Prof. Gavin Wood: *Ethereum: A secure decentralised generalised transaction ledger* ([2014](#)).



Thank you!

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