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An Open Blockchain Development Platform: DevLeChain Introduction and Application

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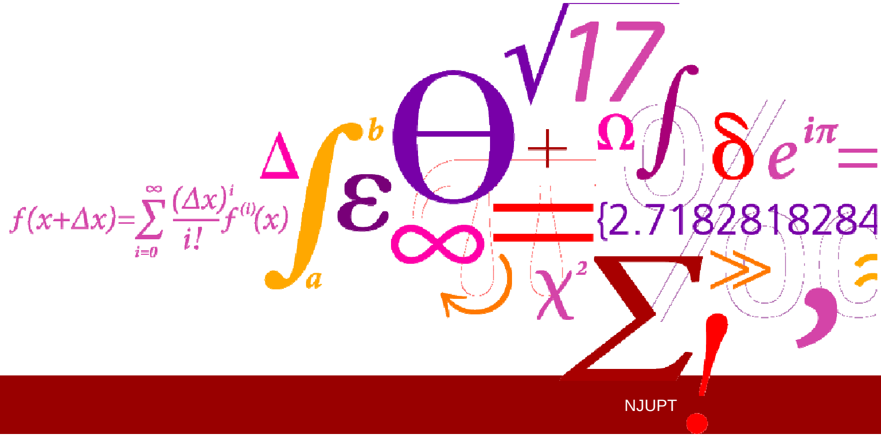

Research Directions

Weizhi Meng
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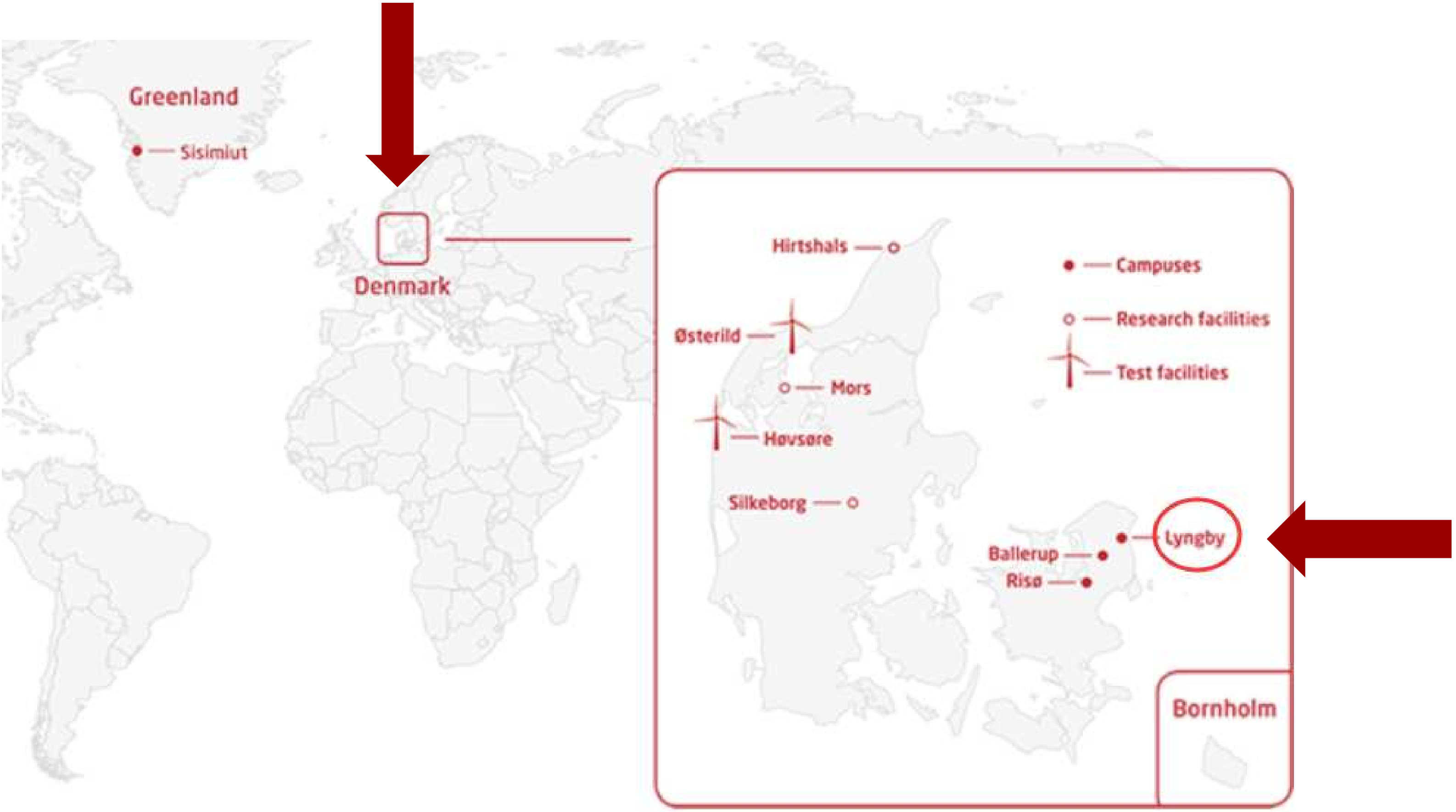
- Intrusion Detection
- Biometric Authentication
- Trust Management
- HCI Security (Smartphone Security
- Blockchain

Technical University of Denmark - Location



Outline

- Background on Blockchain
- DevLeChain
- AirChain
- Discussion

What is

Blockchain ?

It starts with cryptocurrency

A Medium of Exchange

Secure Transaction Records

Control coin creation

Verify and transfer the ownership

Is there more than Bitcoin?

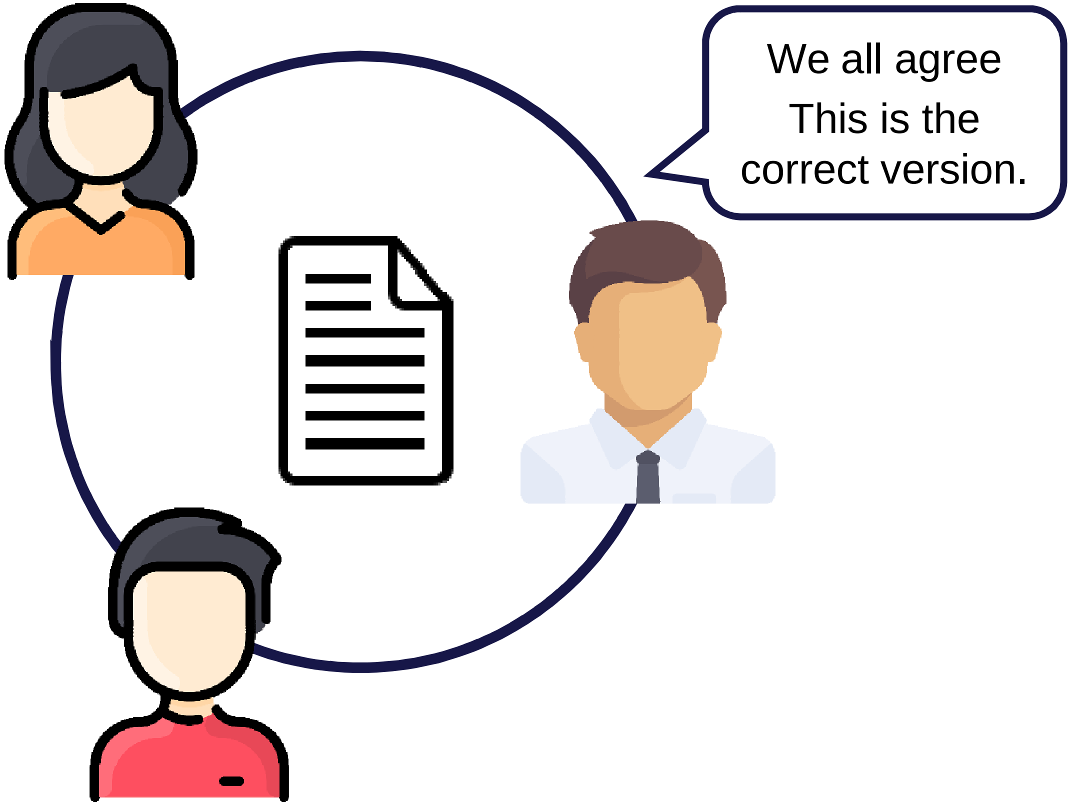
Cryptocurrency	Exchange Rate	Market Cap	Establish
Bitcoin	$ 20.183,42	$ 383.180.333.259	2009
Ethereum	$ 1.352,16	$ 165.840.186.710	2014
Tether	$ 1,0	$ 67.962.220.214	2014
BNB	$ 294,46	$ 47.230.715.732	2017
USD Coin	$ 1,0	$ 47.035.490.955	2018

Do your book-keeping, everyone. However…

I think we are doing our book-keeping correctly !

Some records are missing in your book, I have the correct version.

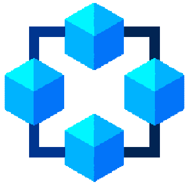
Distributed Ledger



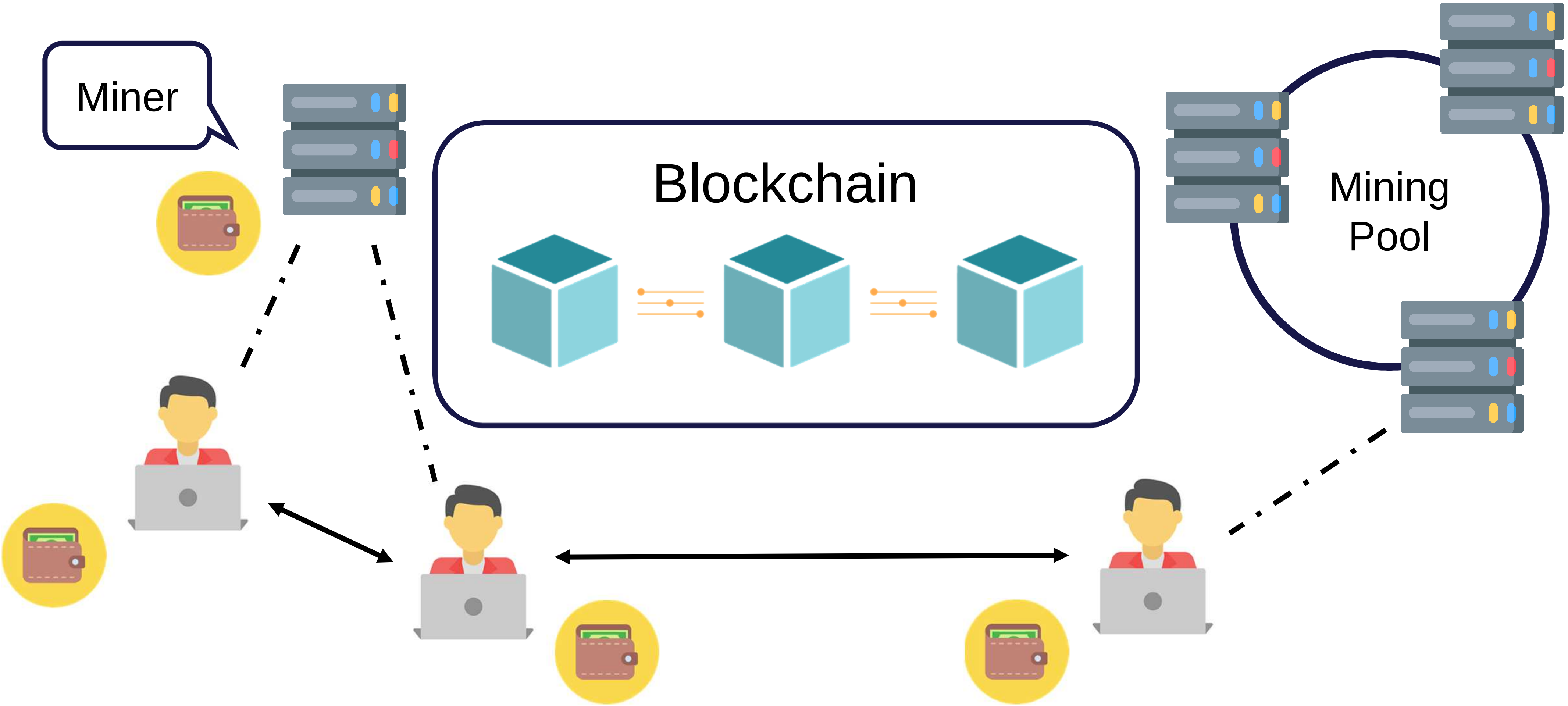
<u>Consensus of</u>

Replicate, Share, Synchronize

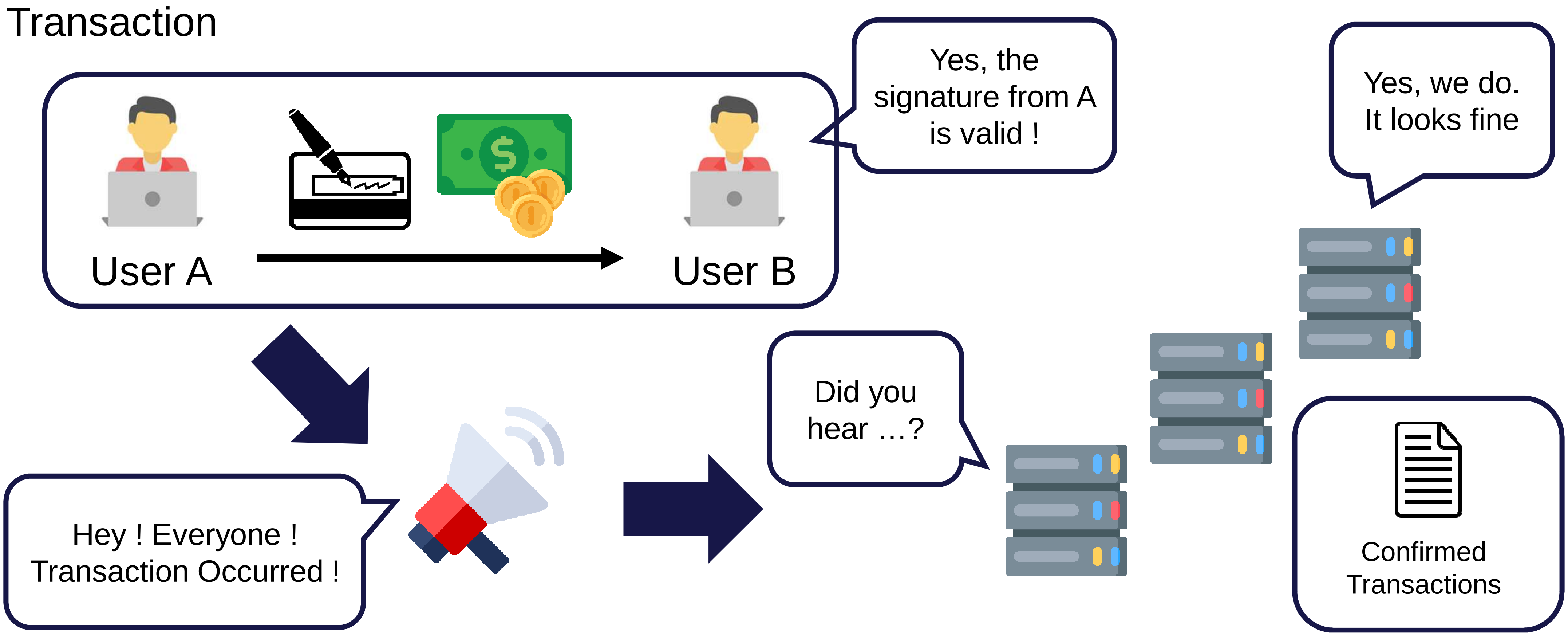
<u>Multiple Sites</u>

 is a Distributed Ledger

The world of Blockchain



How your transaction is handled



Transaction

User A

User B

Yes, the signature from A is valid !

Yes, we do. It looks fine

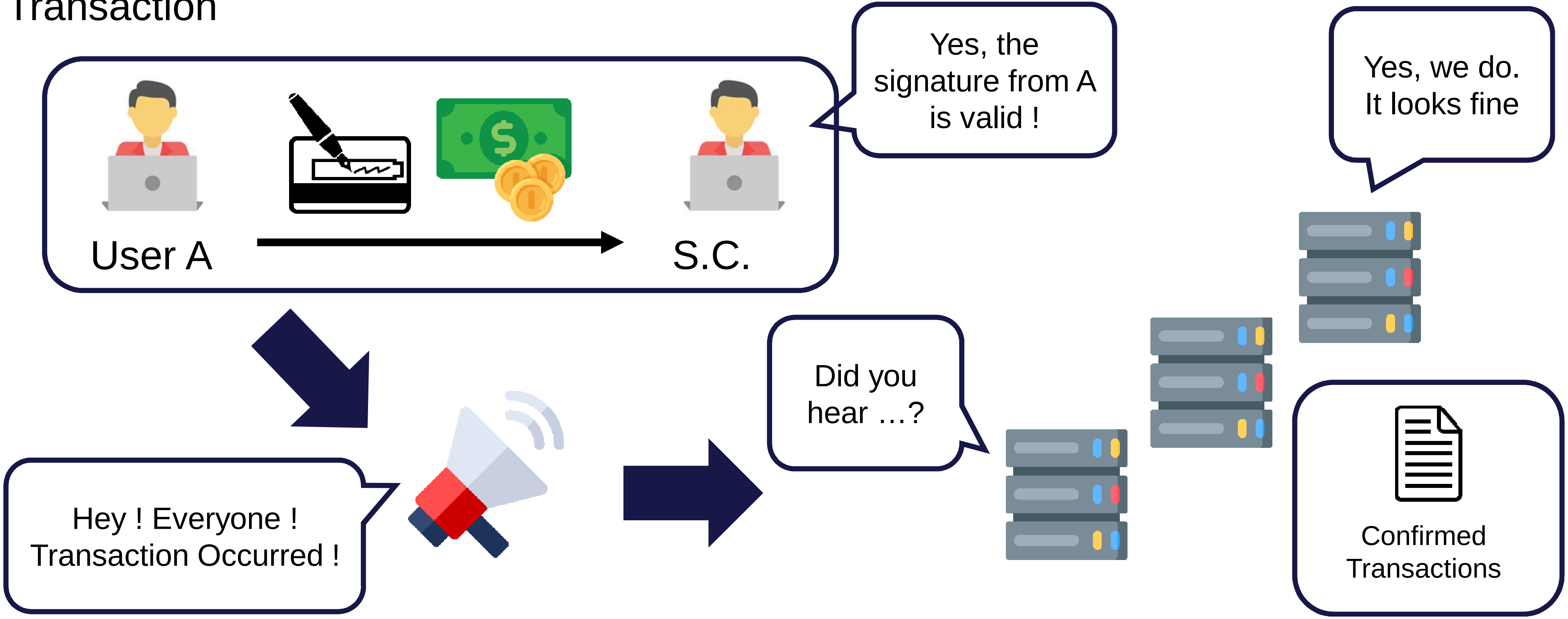
Did you hear …?

Hey ! Everyone ! Transaction Occurred !

Confirmed Transactions

Blockchain – Once Write, Available Everywhere

Transaction



User A

S.C.

Yes, the signature from A is valid !

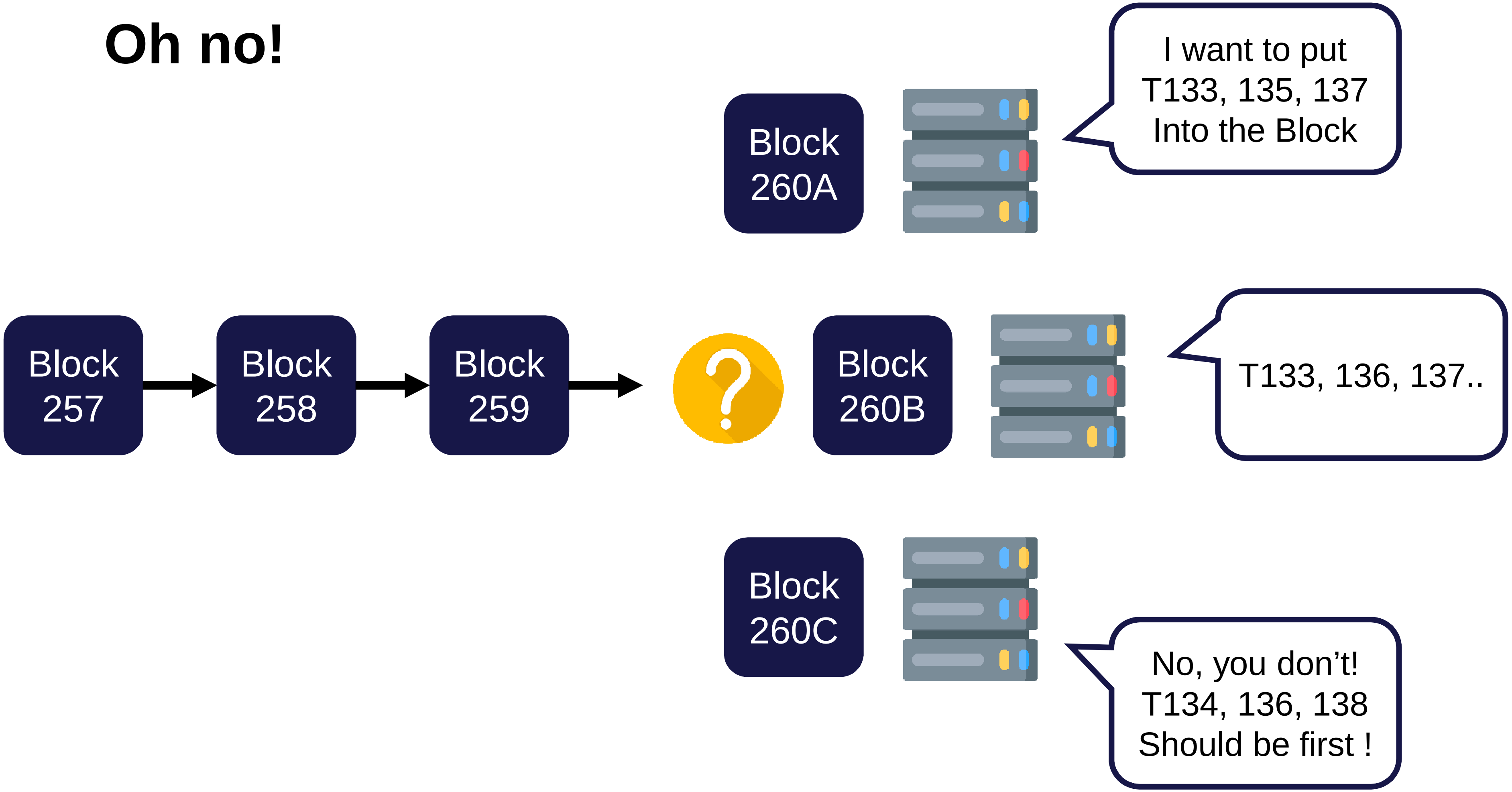
Yes, we do. It looks fine

Did you hear …?

Hey ! Everyone ! Transaction Occurred !

Confirmed Transactions

Oh no!


Block 260A
I want to put T133, 135, 137 Into the Block
Block 257
Block 258
Block 259
Block 260B
T133, 136, 137..
Block 260C
No, you don’t! T134, 136, 138 Should be first !

What should I regard
If I don’t want to mess with economics ?

- There are Blockchain that **do not / doesn’t require to** get along with coins
  - Corda
  - FISCO BCOS
  - Hyperledger Fabric
  - Quorum

- It depends on how you regard “coins”
  - **Allowance to use the system**

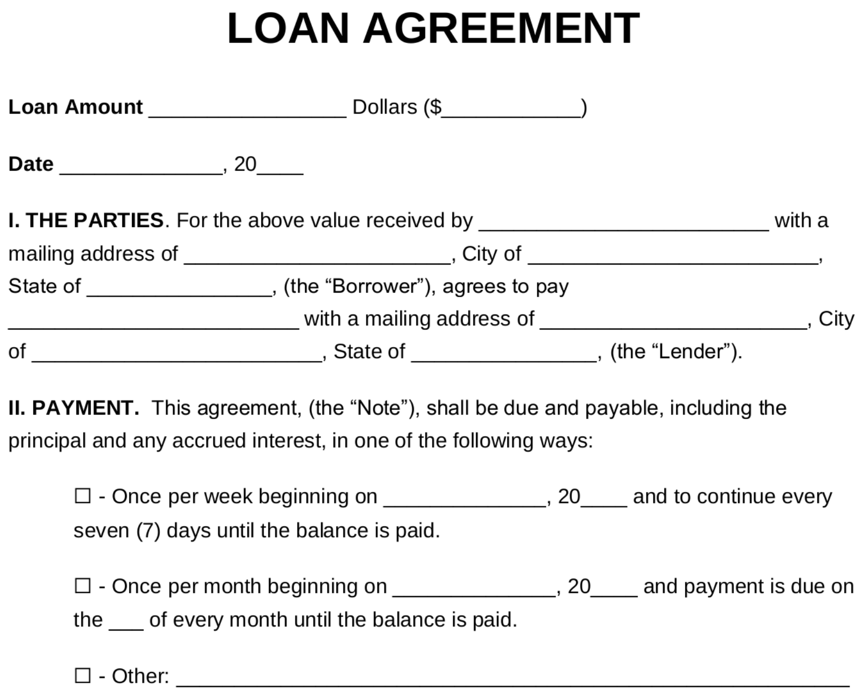
Contract ? Smart Contract ?

- Contract
  - a written or spoken agreement, especially one concerning employment, sales, or tenancy, **that is intended to be enforceable by law**

- Smart Contract
  - A smart contract is a computer program or a transaction protocol which is intended to automatically execute, control or document legally relevant events and actions according to the terms of a contract or an agreement…..

Simply Speaking :
Its just a computer program that stores and runs on Blockchain**.**

Program … ? Contract … ? Relatable ?



LOAN AGREEMENT

Loan Amount ________________ Dollars ($___________)

Date _____________, 20____

I. THE PARTIES. For the above value received by ________________________ with a mailing address of ______________________, City of ________________________, State of _______________, (the "Borrower"), agrees to pay ________________________ with a mailing address of ______________________, City of ________________________, State of _______________, (the "Lender").

II. PAYMENT. This agreement, (the "Note"), shall be due and payable, including the principal and any accrued interest, in one of the following ways:

☐ - Once per week beginning on _____________, 20____ and to continue every seven (7) days until the balance is paid.

☐ - Once per month beginning on _____________, 20____ and payment is due on the ___ of every month until the balance is paid.

☐ - Other: ____

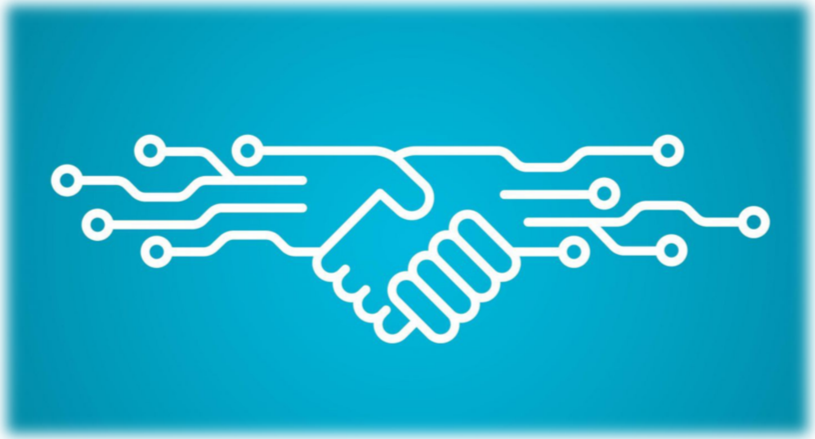
- address lender;
- address borrower;
- Rational interestRate
- uint256 principal
- …

- function makePayment() {…}
- function processPeriod() {…}

Enforceable ?

- Traditional Contract:
  - Once signed / published– Cannot be altered.
  - Once executed – No way back.
  - Enforced By Law

- Smart Contract:
  - Once on-chain / published– Cannot be altered.
  - Once executed – No way back.
  - Enforced By Blockchain



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An Open Blockchain Development Platform for dApps

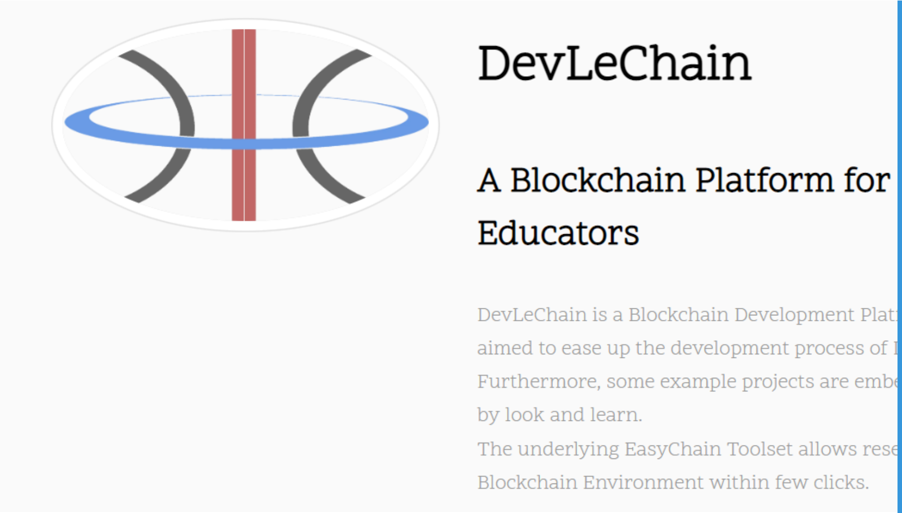
DevLeChain

Wei-Yang Chiu and Weizhi Meng. DevLeChain - An Open Blockchain Development Platform for Decentralized Applications. The 5th IEEE International Conference on Blockchain (IEEE Blockchain 2022), IEEE, 2022.

DevLeChain

A Blockchain Development Platform for Researchers and Educators

https://devlechain.compute.dtu.dk/



DevLeChain

A Blockchain Platform for Educators

DevLeChain is a Blockchain Development Plat
aimed to ease up the development process of I
Furthermore, some example projects are embe
by look and learn.
The underlying EasyChain Toolset allows rese
Blockchain Environment within few clicks.

BlockDemo Platform

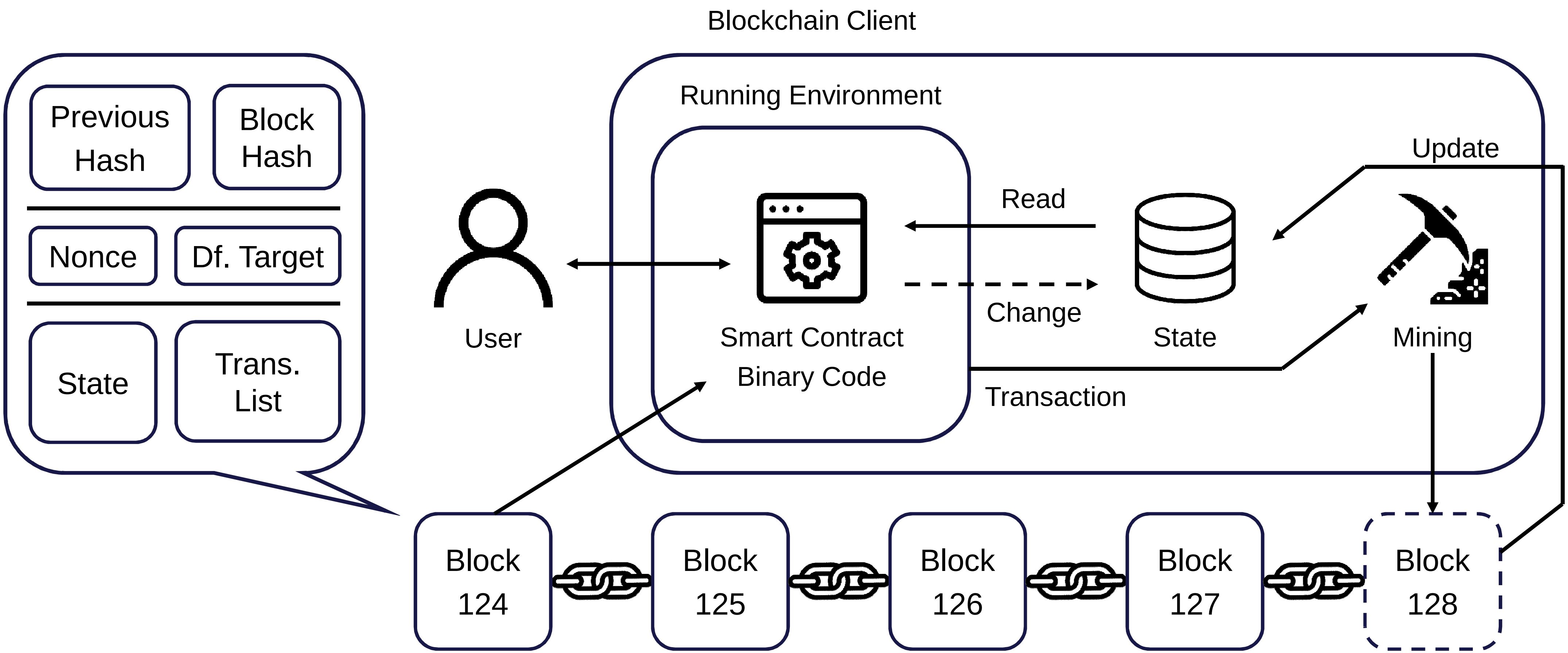
A Trial Platform for Beginners to Mess Around

BlockDemo Platform is the predecessor of DevLeChain. It is a platform that embedded with example projects that beginners can play around.
This is a platform that intended to demonstrate smart-contract enabled applications within a few clicks. It is designed for anyone that is interested in Blockchain, and would like to look into how Blockchian works

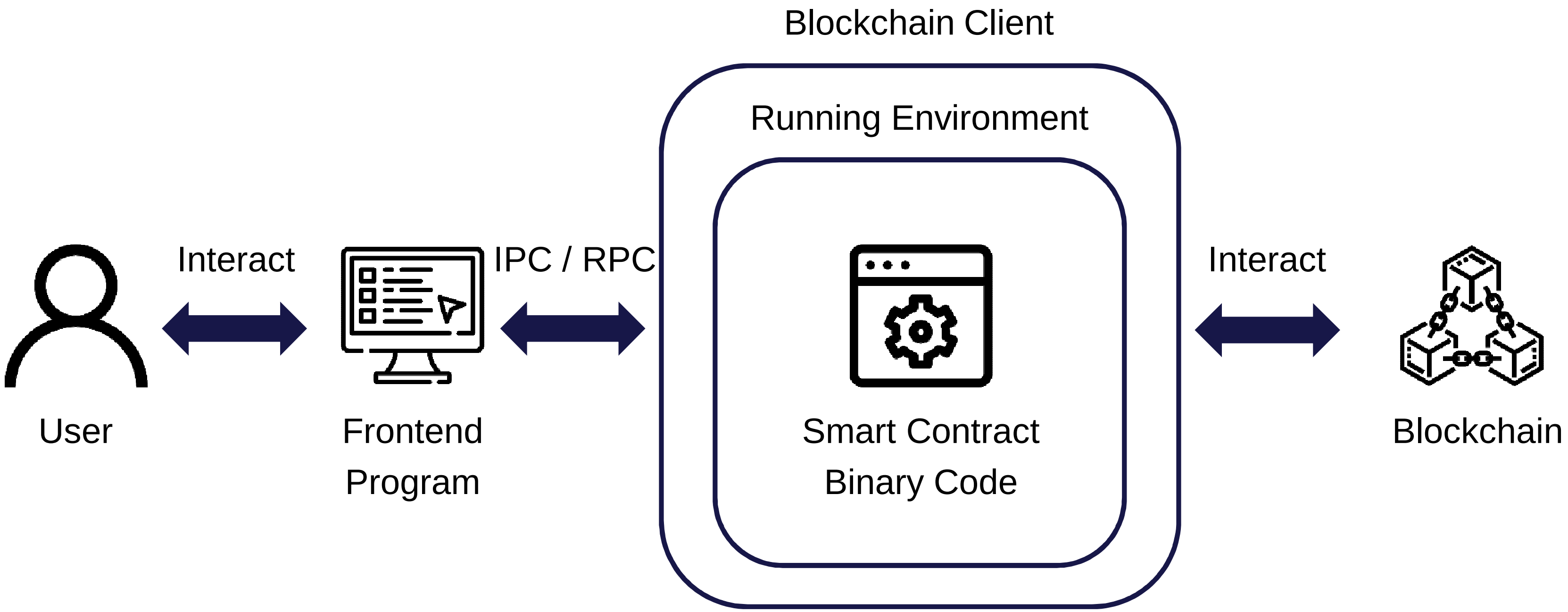
Dansk Version. English Version. 繁體中文版 简体中文版 Simple Start-up Guide

Login: blkdemo/blkdemo
Wallet: blkdemo

How S.C. Works


Blockchain Client
Running Environment
Previous Hash
Block Hash
Nonce
Df. Target
State
Trans. List
User
Smart Contract Binary Code
Read
Change
State
Update
Mining
Transaction
Block 124
Block 125
Block 126
Block 127
Block 128

Technical Phase



Blockchain Client

Running Environment

User

Interact

Frontend Program

IPC / RPC

Smart Contract Binary Code

Interact

Blockchain

Motivation

- In the market, though there are many mature blockchain platforms, it is not the case for the comparatively added smart contract.
- With more functionalities, expectations and security concerns being added into the development of smart contract platforms, breaking changes and practices between releases start to appear.
- This makes developers especially beginners struggle when they tried several solutions but still could not get their applications involved. Even some users may also find themselves entangled with the software configurations and system environments issues.
- All these issues cause confusions and frustrations, leading to a high entry barrier.

Truffle Suite

TRUFFLE

- S.C. Development Environment
  - Automating S.C. Compilation
  - Automating Testing
  - Package Management

A tool for developing smart contracts

Ganache

- A personal private Blockchain
  - Comprehensive GUI
  - Can be interacted with CLI

Ganache is an Ethereum simulator that makes developing Ethereum applications faster, easier, and safer.

Some problems…

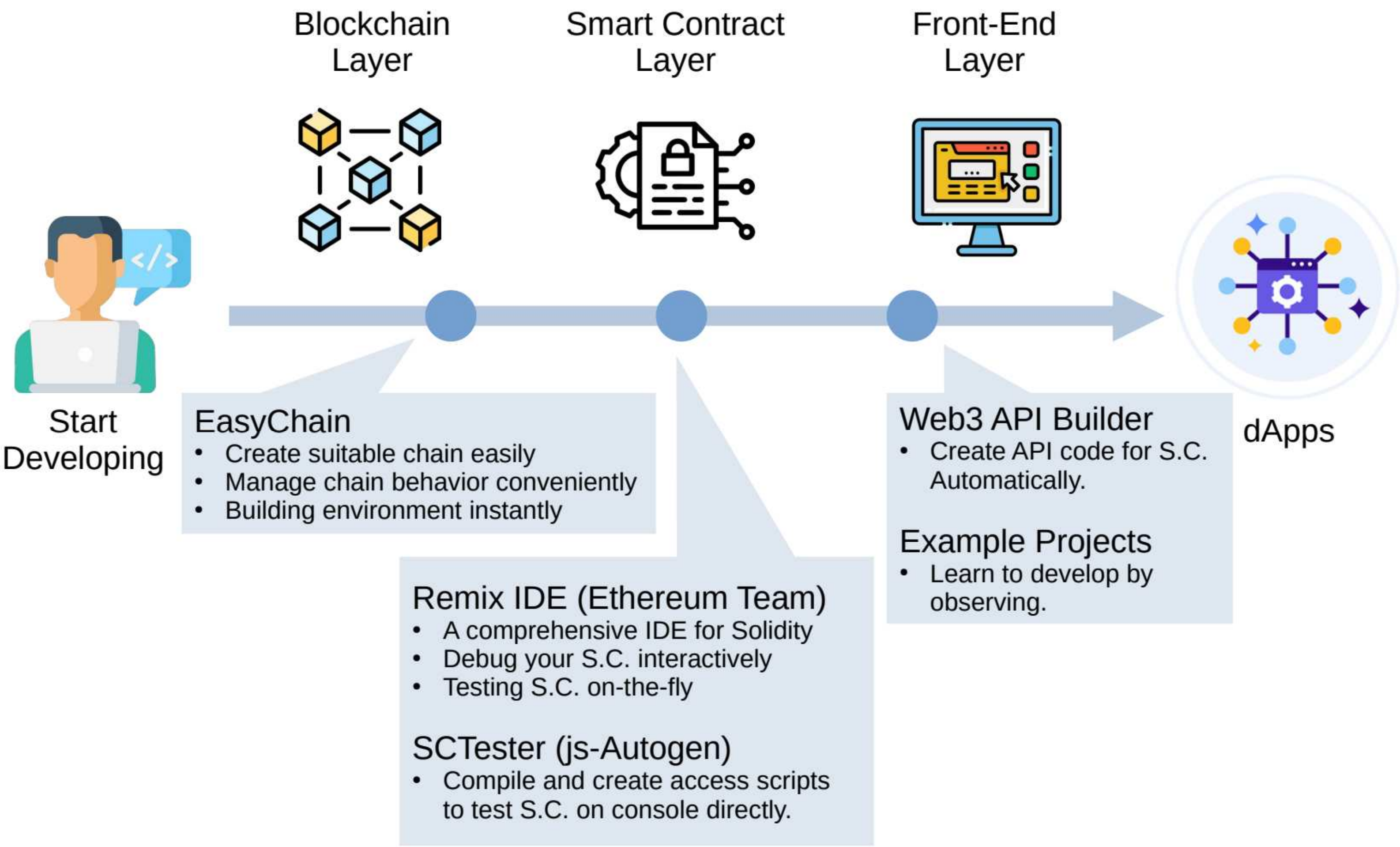
TRUFFLE

- Tightly bounded with Javascript / nodeJS
- Suitable for Experienced Developers:
  - – What's really going on underneath?
  - – What if I would like to clearly know what's going on each step?

Ganache

- For simple testing, that's a great solution
  - – Change underlying consensus algorithm?
  - – Instantly create a private Blockchain network that can operate afterward.
  - – Multiple nodes network?

- To mitigate this issue, we introduce DevLeChain, an open smart contract development platform, offering unified developing workflow, consistent use of toolsets, and simple design philosophy.



Start Developing

Blockchain Layer

Smart Contract Layer

Front-End Layer

dApps

EasyChain
- Create suitable chain easily
- Manage chain behavior conveniently
- Building environment instantly

Remix IDE (Ethereum Team)
- A comprehensive IDE for Solidity
- Debug your S.C. interactively
- Testing S.C. on-the-fly

SCTester (js-Autogen)
- Compile and create access scripts to test S.C. on console directly.

Web3 API Builder
- Create API code for S.C. Automatically.

Example Projects
- Learn to develop by observing.

DevLeChain – Open Blockchain Development Platfom

- **Blockchain Layer.** This layer refers to the underlying blockchain platform's administration and data-storing management, which can range from platform selection to chain management, such as hard-fork, soft-fork, or even the commonly used multi-node environment.

- **Smart Contract Layer.** Depending on the viewpoint of particular development goals and applications, this layer can be a data entity, or a piece of code that works as a backend. While all of these can be considered as a program that resides and shares its execution code and states through blockchain. All nodes that are involved with the contract, based on the implementation of access control, can operate or change the program's state.

- **Frontend Program Layer.** The front-end layer is the front-end program, middleware, or services that accept a user's command and perform the relevant actions toward the smart contracts.

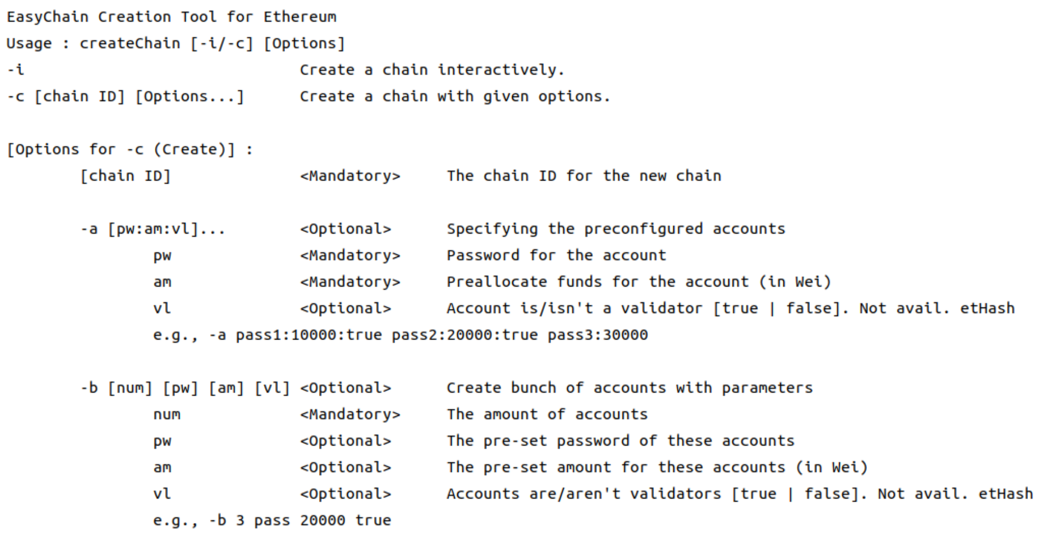
Blockchain Layer - EasyChain

- A tool that help developers to blockchain network they would like to test.
- Support multiple Blockchain clients.
- Support interactive mode.

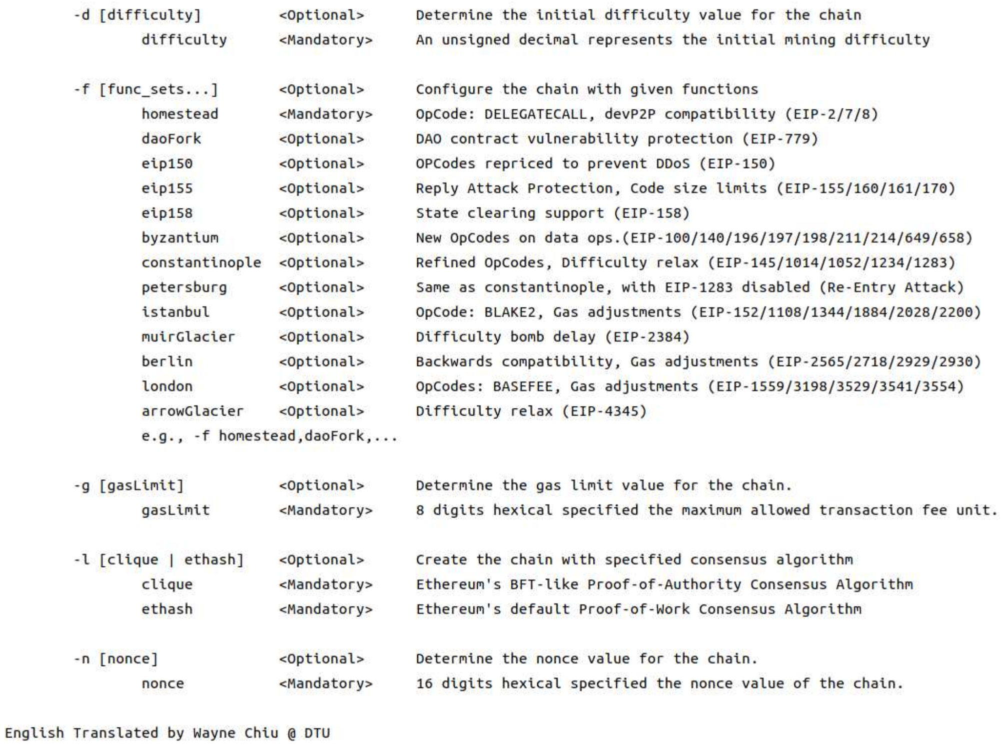
- It has four components
  - createChain
  - initChain
  - bootChain
  - removeChain

createChain (Chain Creation Tool)

- Create chain genesis file with ease.
- For advanced users, it provides simple way of tuning the chain.

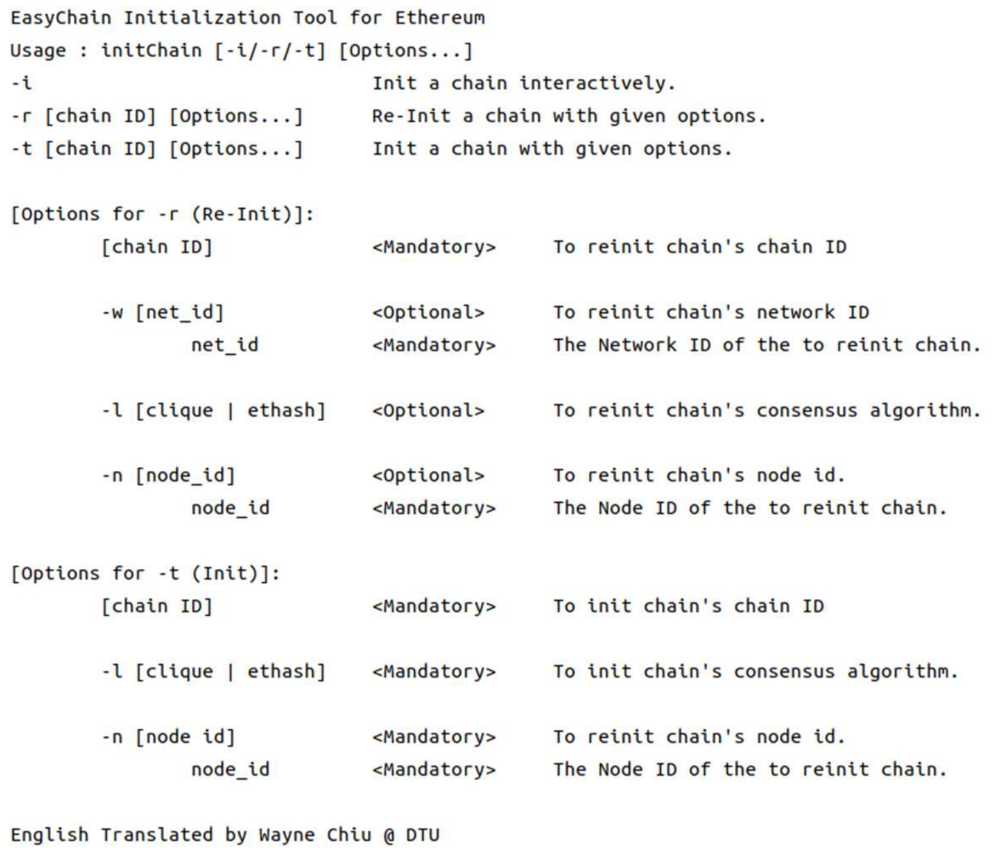


```
EasyChain Creation Tool for Ethereum
Usage : createChain [-i/-c] [Options]
-i                          Create a chain interactively.
-c [chain ID] [Options...]  Create a chain with given options.

[Options for -c (Create)] :
        [chain ID]              <Mandatory>     The chain ID for the new chain

        -a [pw:am:vl]...        <Optional>      Specifying the preconfigured accounts
                pw              <Mandatory>     Password for the account
                am              <Mandatory>     Preallocate funds for the account (in Wei)
                vl              <Optional>      Account is/isn't a validator [true | false]. Not avail. etHash
                e.g., -a pass1:10000:true pass2:20000:true pass3:30000

        -b [num] [pw] [am] [vl] <Optional>      Create bunch of accounts with parameters
                num             <Mandatory>     The amount of accounts
                pw              <Optional>      The pre-set password of these accounts
                am              <Optional>      The pre-set amount for these accounts (in Wei)
                vl              <Optional>      Accounts are/aren't validators [true | false]. Not avail. etHash
                e.g., -b 3 pass 20000 true
```



```
        -d [difficulty]         <Optional>      Determine the initial difficulty value for the chain
                difficulty      <Mandatory>     An unsigned decimal represents the initial mining difficulty

        -f [func_sets...]       <Optional>      Configure the chain with given functions
                homestead       <Mandatory>     OpCode: DELEGATECALL, devP2P compatibility (EIP-2/7/8)
                daoFork         <Optional>      DAO contract vulnerability protection (EIP-779)
                eip150          <Optional>      OPCodes repriced to prevent DDoS (EIP-150)
                eip155          <Optional>      Reply Attack Protection, Code size limits (EIP-155/160/161/170)
                eip158          <Optional>      State clearing support (EIP-158)
                byzantium       <Optional>      New OpCodes on data ops.(EIP-100/140/196/197/198/211/214/649/658)
                constantinople  <Optional>      Refined OpCodes, Difficulty relax (EIP-145/1014/1052/1234/1283)
                petersburg      <Optional>      Same as constantinople, with EIP-1283 disabled (Re-Entry Attack)
                istanbul        <Optional>      OpCode: BLAKE2, Gas adjustments (EIP-152/1108/1344/1884/2028/2200)
                muirGlacier     <Optional>      Difficulty bomb delay (EIP-2384)
                berlin          <Optional>      Backwards compatibility, Gas adjustments (EIP-2565/2718/2929/2930)
                london          <Optional>      OpCodes: BASEFEE, Gas adjustments (EIP-1559/3198/3529/3541/3554)
                arrowGlacier    <Optional>      Difficulty relax (EIP-4345)
                e.g., -f homestead,daoFork,...

        -g [gasLimit]           <Optional>      Determine the gas limit value for the chain.
                gasLimit        <Mandatory>     8 digits hexical specified the maximum allowed transaction fee unit.

        -l [clique | ethash]    <Optional>      Create the chain with specified consensus algorithm
                clique          <Mandatory>     Ethereum's BFT-like Proof-of-Authority Consensus Algorithm
                ethash          <Mandatory>     Ethereum's default Proof-of-Work Consensus Algorithm

        -n [nonce]              <Optional>      Determine the nonce value for the chain.
                nonce           <Mandatory>     16 digits hexical specified the nonce value of the chain.

English Translated by Wayne Chiu @ DTU
```

initChain (Chain Initialization Tool)

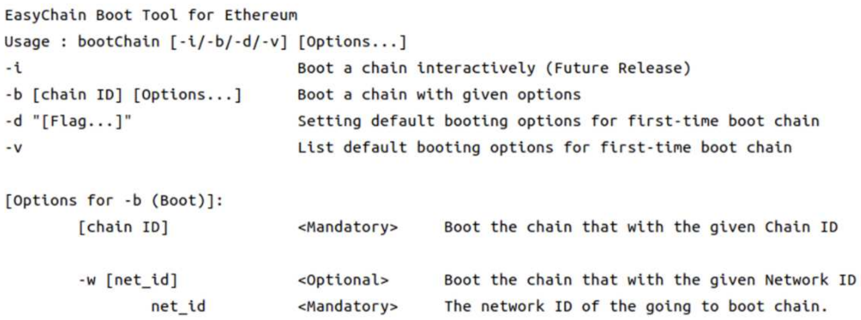


```
EasyChain Initialization Tool for Ethereum
Usage : initChain [-i/-r/-t] [Options...]
-i                              Init a chain interactively.
-r [chain ID] [Options...]      Re-Init a chain with given options.
-t [chain ID] [Options...]      Init a chain with given options.

[Options for -r (Re-Init)]:
        [chain ID]              <Mandatory>     To reinit chain's chain ID

        -w [net_id]             <Optional>      To reinit chain's network ID
                net_id          <Mandatory>     The Network ID of the to reinit chain.

        -l [clique | ethash]    <Optional>      To reinit chain's consensus algorithm.

        -n [node_id]            <Optional>      To reinit chain's node id.
                node_id         <Mandatory>     The Node ID of the to reinit chain.

[Options for -t (Init)]:
        [chain ID]              <Mandatory>     To init chain's chain ID

        -l [clique | ethash]    <Mandatory>     To init chain's consensus algorithm.

        -n [node id]            <Mandatory>     To reinit chain's node id.
                node_id         <Mandatory>     The Node ID of the to reinit chain.

English Translated by Wayne Chiu @ DTU
```

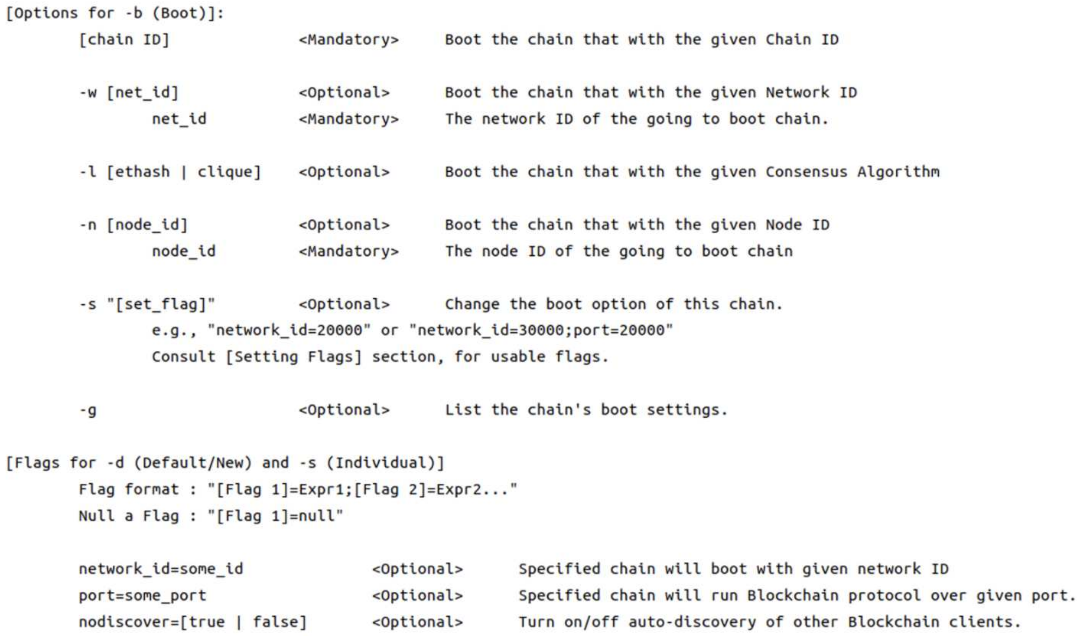
- Initialize the Blockchain storage accordingly to the genesis file.

bootChain (Chain Startup Tool)

- Startup a node with given configuration.



```
EasyChain Boot Tool for Ethereum
Usage : bootChain [-i/-b/-d/-v] [Options...]
-i                              Boot a chain interactively (Future Release)
-b [chain ID] [Options...]      Boot a chain with given options
-d "[Flag...]"                  Setting default booting options for first-time boot chain
-v                              List default booting options for first-time boot chain

[Options for -b (Boot)]:
        [chain ID]              <Mandatory>     Boot the chain that with the given Chain ID

        -w [net_id]             <Optional>      Boot the chain that with the given Network ID
                net_id          <Mandatory>     The network ID of the going to boot chain.
```

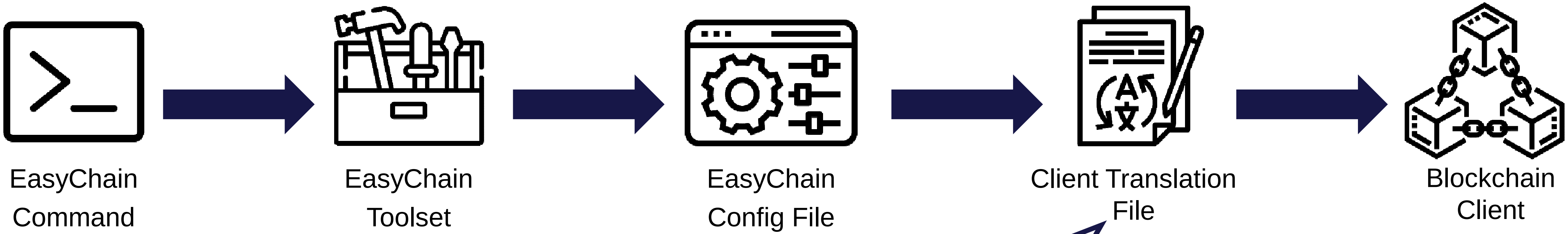


```
[Options for -b (Boot)]:
        [chain ID]              <Mandatory>     Boot the chain that with the given Chain ID

        -w [net_id]             <Optional>      Boot the chain that with the given Network ID
                net_id          <Mandatory>     The network ID of the going to boot chain.

        -l [ethash | clique]    <Optional>      Boot the chain that with the given Consensus Algorithm

        -n [node_id]            <Optional>      Boot the chain that with the given Node ID
                node_id         <Mandatory>     The node ID of the going to boot chain

        -s "[set_flag]"         <Optional>      Change the boot option of this chain.
                e.g., "network_id=20000" or "network_id=30000;port=20000"
                Consult [Setting Flags] section, for usable flags.

        -g                      <Optional>      List the chain's boot settings.

[Flags for -d (Default/New) and -s (Individual)]
        Flag format : "[Flag 1]=Expr1;[Flag 2]=Expr2..."
        Null a Flag : "[Flag 1]=null"

        network_id=some_id              <Optional>      Specified chain will boot with given network ID
        port=some_port                  <Optional>      Specified chain will run Blockchain protocol over given port.
        nodiscover=[true | false]       <Optional>      Turn on/off auto-discovery of other Blockchain clients.
```

Unified Command

- There are many Blockchain clients:
  - – Some of them shared similar design philosophy – Different operation logic
    - E.g., Both Ethereum and FISCO-BCOS has P2P port and RPC port. However, FISCO-BCOS triggered by –p arguments, while Ethereum triggered by geth –port and –ws.port/--http.port
  - – Some of them extended the functionality of others
    - E.g., goQuorum extends the functions of Ethereum

Unified Command – Keep it simple.



EasyChain Command

EasyChain Toolset

EasyChain Config File

Client Translation File

Blockchain Client

```
api_preload=--preload
bh_syncmode=--syncmode
bh_mine=--mine
bh_mine_thread=--miner.threads
bh_mine_base=--miner.etherbase
np_bootnode=--bootnode
np_nat=--nat
np_port=--port
```

Smart Contract Layer - jsAutoGen

- A Smart Contract Test Wrapper
  - Compiling the given smart contract and output the following:
    - The ABI (Application Binary Interface)
    - The BIN (Execution Binary Code)
    - The JS file for developers to test the smart contract under the Blockchain Console.

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Blockchain-based Maintenance Record System for Aircraft

AirChain

Wictor Lang Jensen, Sille Jessing, Wei-Yang Chiu and Weizhi Meng. A Practical Blockchain-based Maintenance Record System for Better Aircraft Security. The 4th International Conference on Science of Cyber Security (SciSec 2022), Springer, 2022.

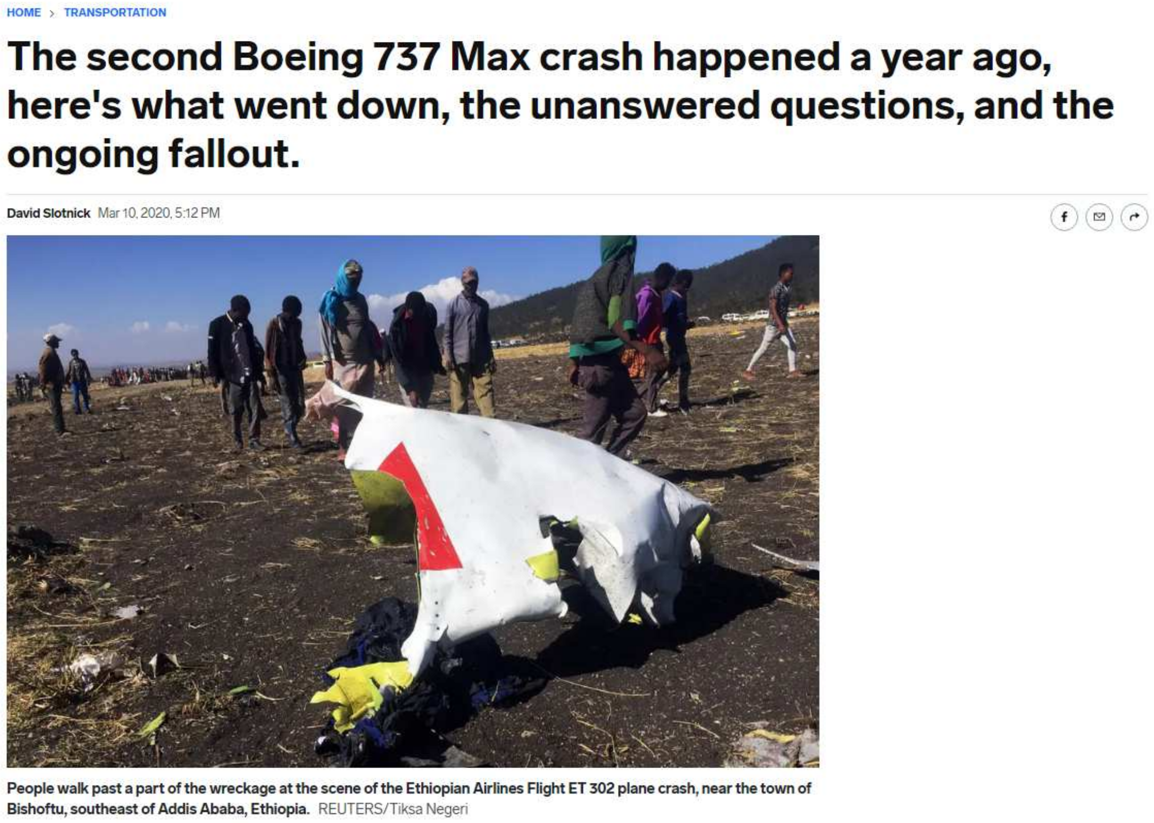
Maintenance Records in Civil Aviation

- The **T**echnical **L**og**B**ook (**TLB**)
  - For repair crew (on-the-ground / on-site) to **log down the mechanical irregularity or pieces that require further maintenance.**
  - If any actions have been taken to fix a particular issue, taken actions needed to be noted down alongside with it.
  - More Complex in its form.

The cost of

Record Inconsistency

Internal Attack

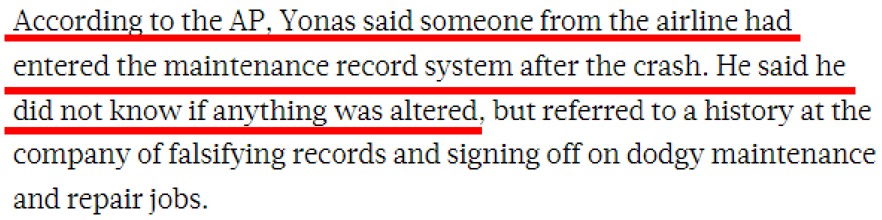


HOME › TRANSPORTATION

The second Boeing 737 Max crash happened a year ago, here's what went down, the unanswered questions, and the ongoing fallout.

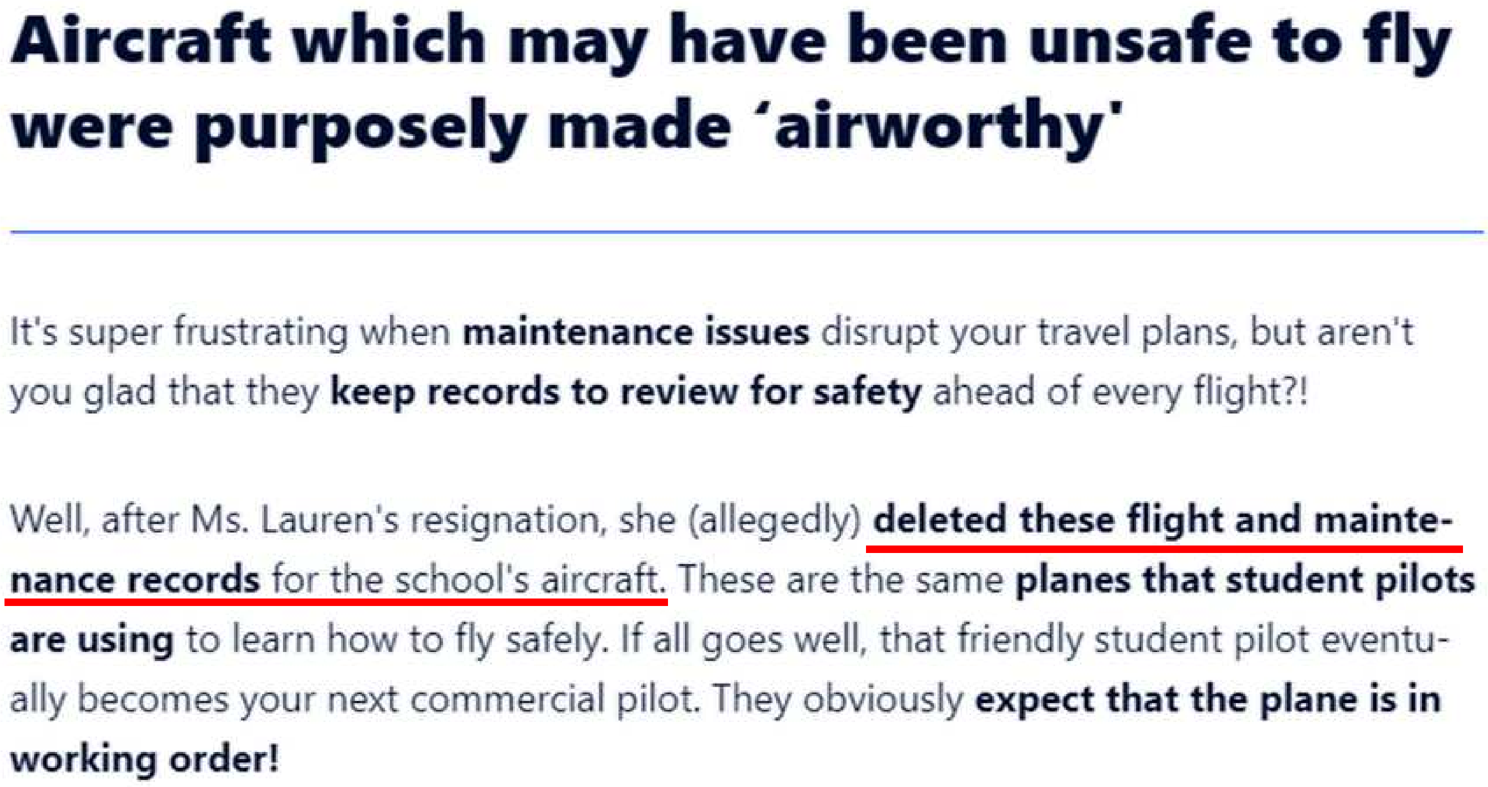
David Slotnick Mar 10, 2020, 5:12 PM

People walk past a part of the wreckage at the scene of the Ethiopian Airlines Flight ET 302 plane crash, near the town of Bishoftu, southeast of Addis Ababa, Ethiopia. REUTERS/Tiksa Negeri



According to the AP, Yonas said someone from the airline had entered the maintenance record system after the crash. He said he did not know if anything was altered, but referred to a history at the company of falsifying records and signing off on dodgy maintenance and repair jobs.

Internal Attack

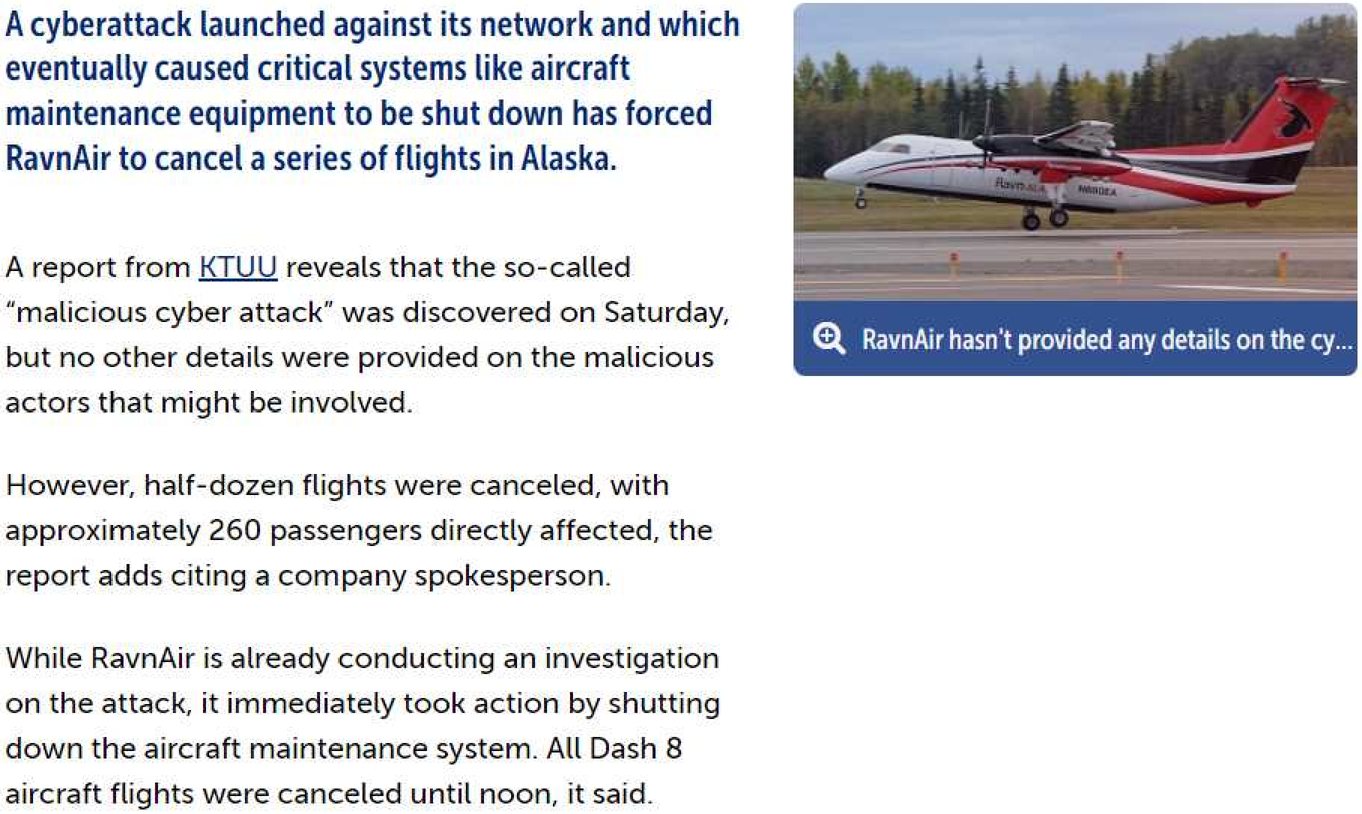


Aircraft which may have been unsafe to fly were purposely made ‘airworthy'

It's super frustrating when **maintenance issues** disrupt your travel plans, but aren't you glad that they **keep records to review for safety** ahead of every flight?!

Well, after Ms. Lauren's resignation, she (allegedly) **deleted these flight and maintenance records** for the school's aircraft. These are the same **planes that student pilots are using** to learn how to fly safely. If all goes well, that friendly student pilot eventually becomes your next commercial pilot. They obviously **expect that the plane is in working order!**

External Attack



A cyberattack launched against its network and which eventually caused critical systems like aircraft maintenance equipment to be shut down has forced RavnAir to cancel a series of flights in Alaska.

A report from KTUU reveals that the so-called "malicious cyber attack" was discovered on Saturday, but no other details were provided on the malicious actors that might be involved.

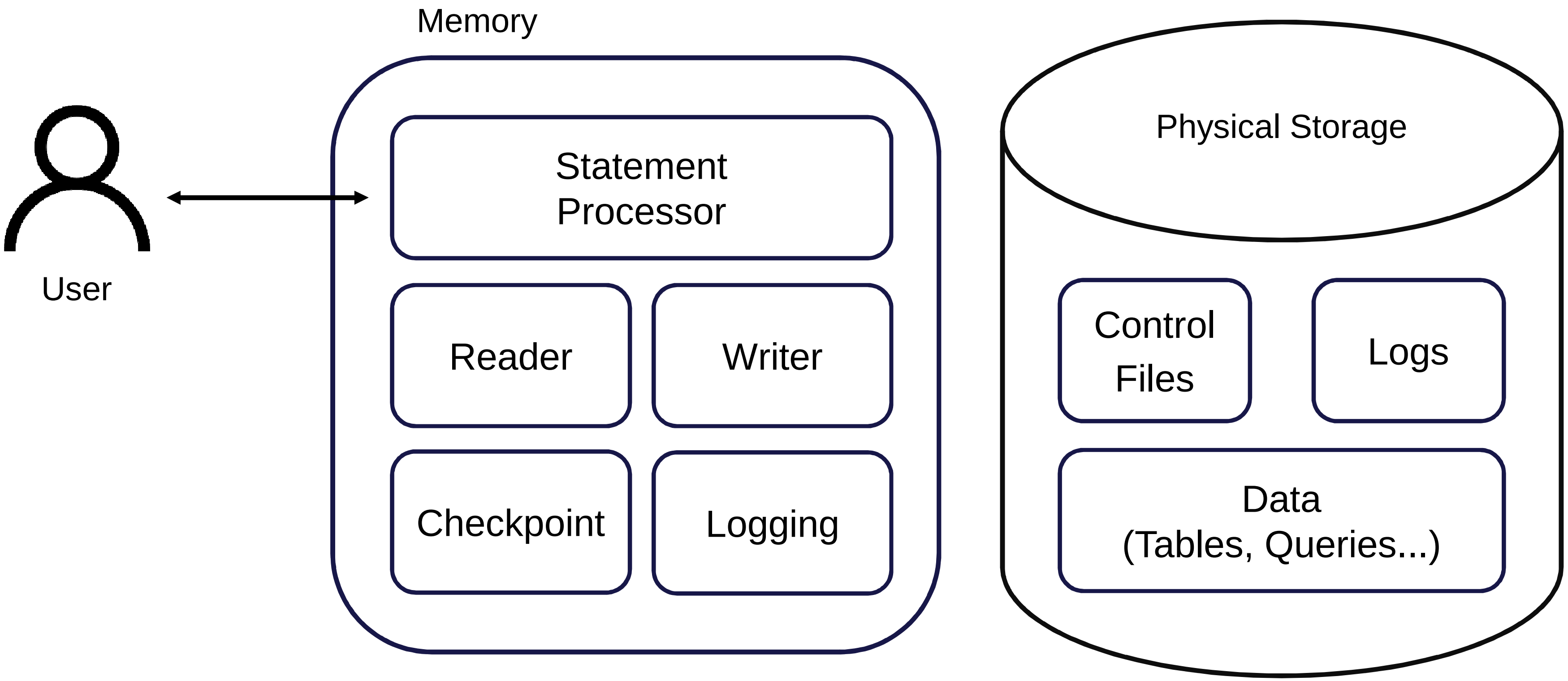
However, half-dozen flights were canceled, with approximately 260 passengers directly affected, the report adds citing a company spokesperson.

While RavnAir is already conducting an investigation on the attack, it immediately took action by shutting down the aircraft maintenance system. All Dash 8 aircraft flights were canceled until noon, it said.

Blockchain

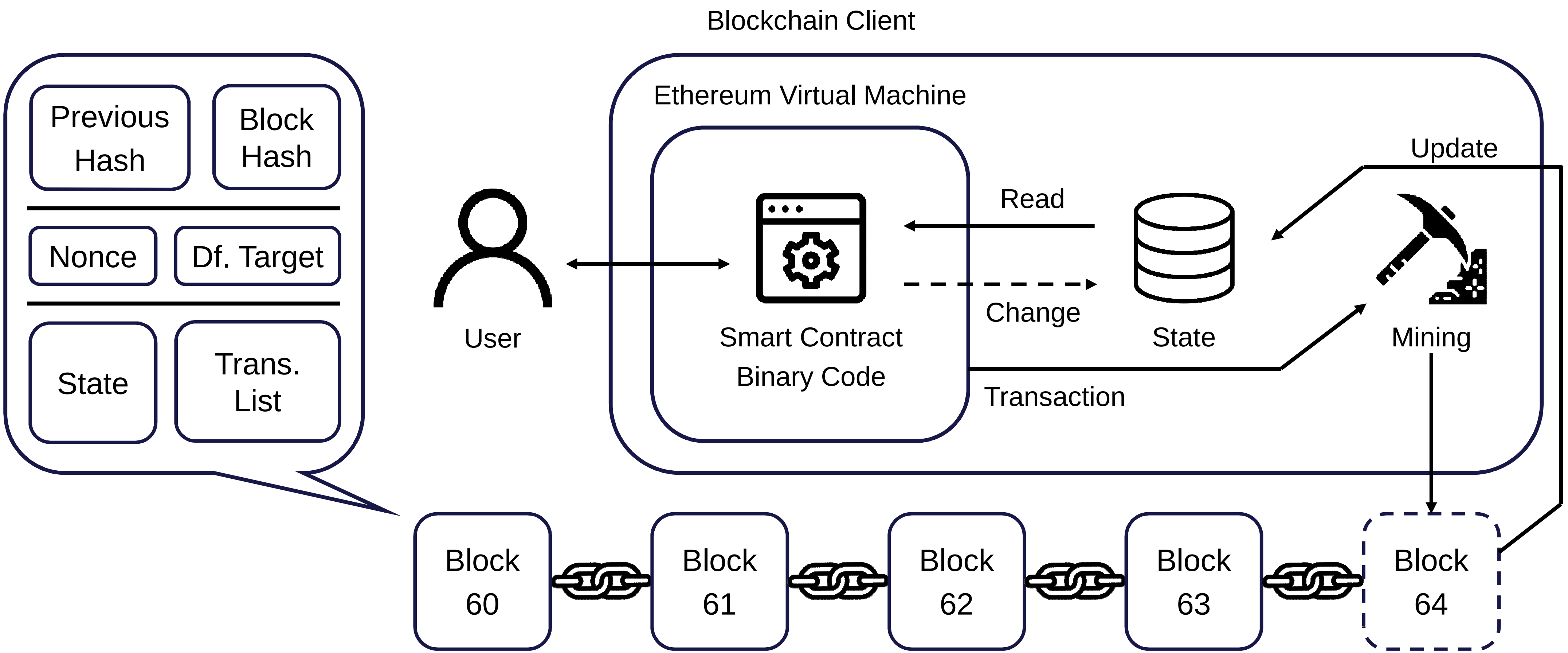
vs. Database

Database



Memory
User
Statement Processor
Reader
Writer
Checkpoint
Logging
Physical Storage
Control Files
Logs
Data (Tables, Queries...)

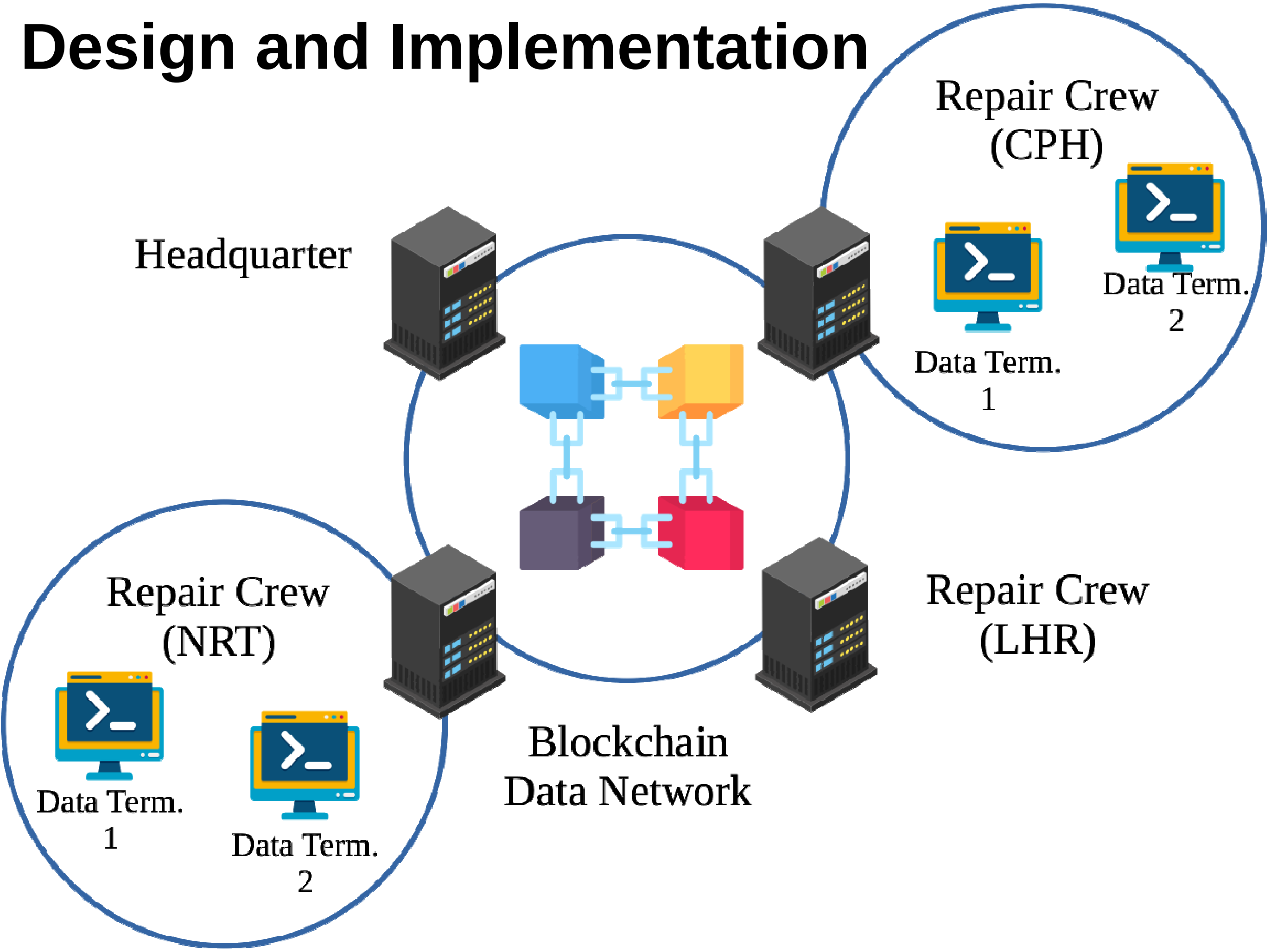
Blockchain


Blockchain Client
Previous Hash
Block Hash
Nonce
Df. Target
State
Trans. List
User
Ethereum Virtual Machine
Smart Contract Binary Code
Read
Change
State
Update
Mining
Transaction
Block 60
Block 61
Block 62
Block 63
Block 64

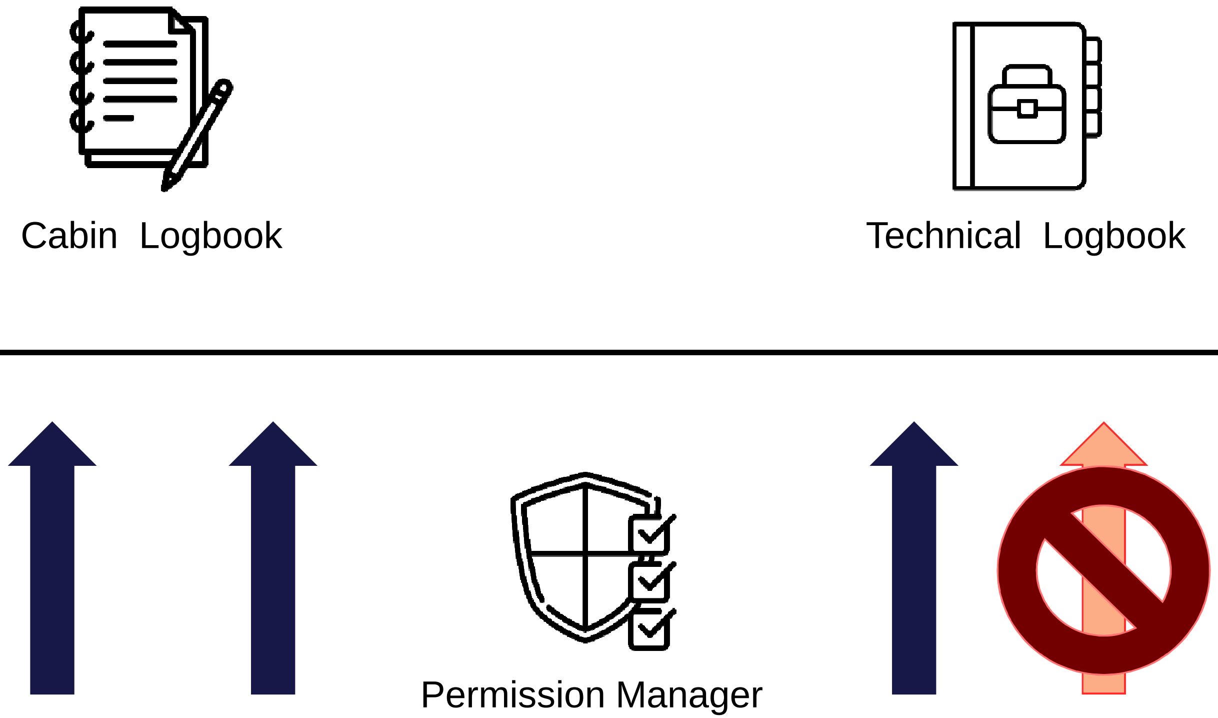
AirChain

Wei-Yang Chiu and Weizhi Meng. DevLeChain - An Open Blockchain Development Platform for Decentralized Applications. The 5th IEEE International Conference on Blockchain (IEEE Blockchain 2022), IEEE, 2022.

The Design and Implementation



The CLB and the TLB

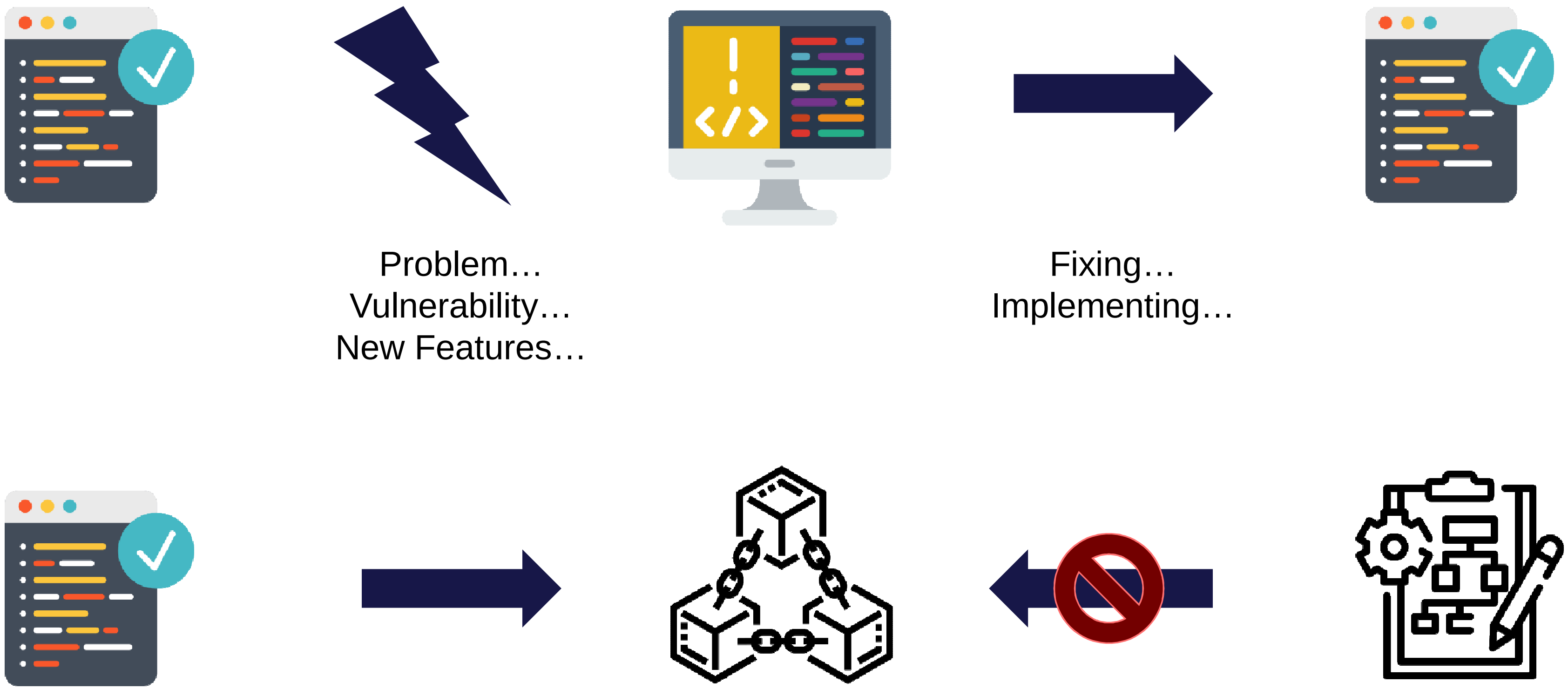


Cabin Logbook

Technical Logbook

Permission Manager

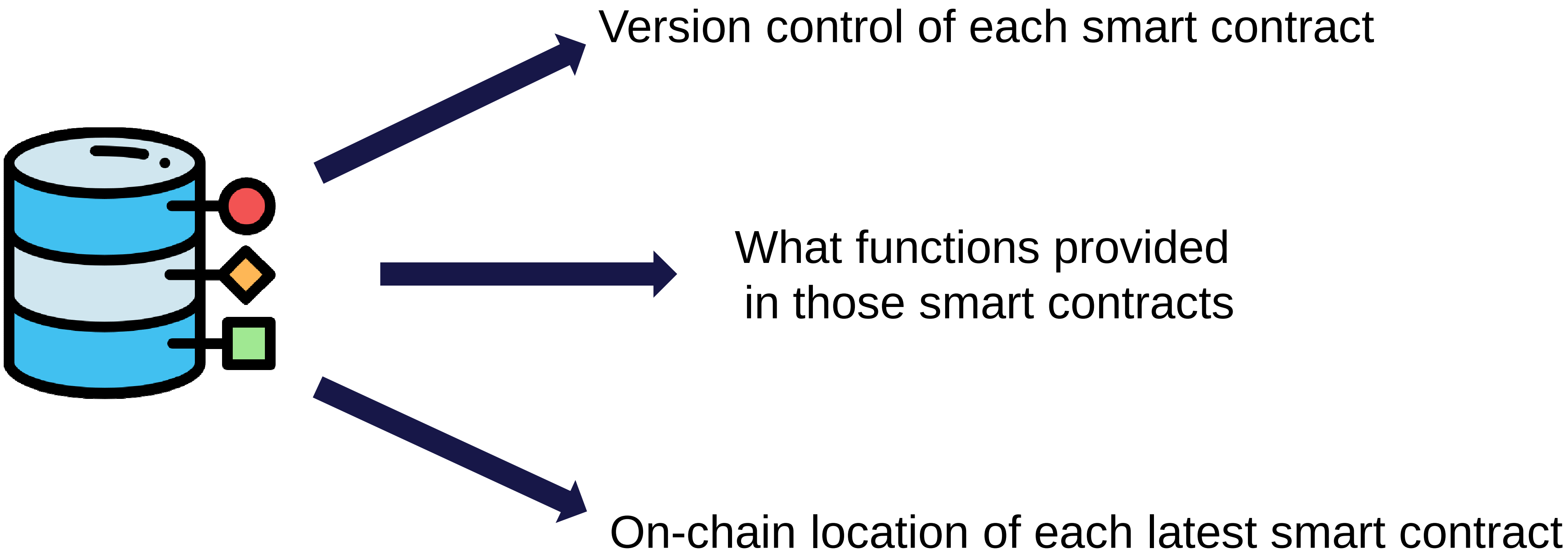
The Problem of Smart Contracts



Problem…
Vulnerability…
New Features…

Fixing…
Implementing…

More than Hub : The Main Contract

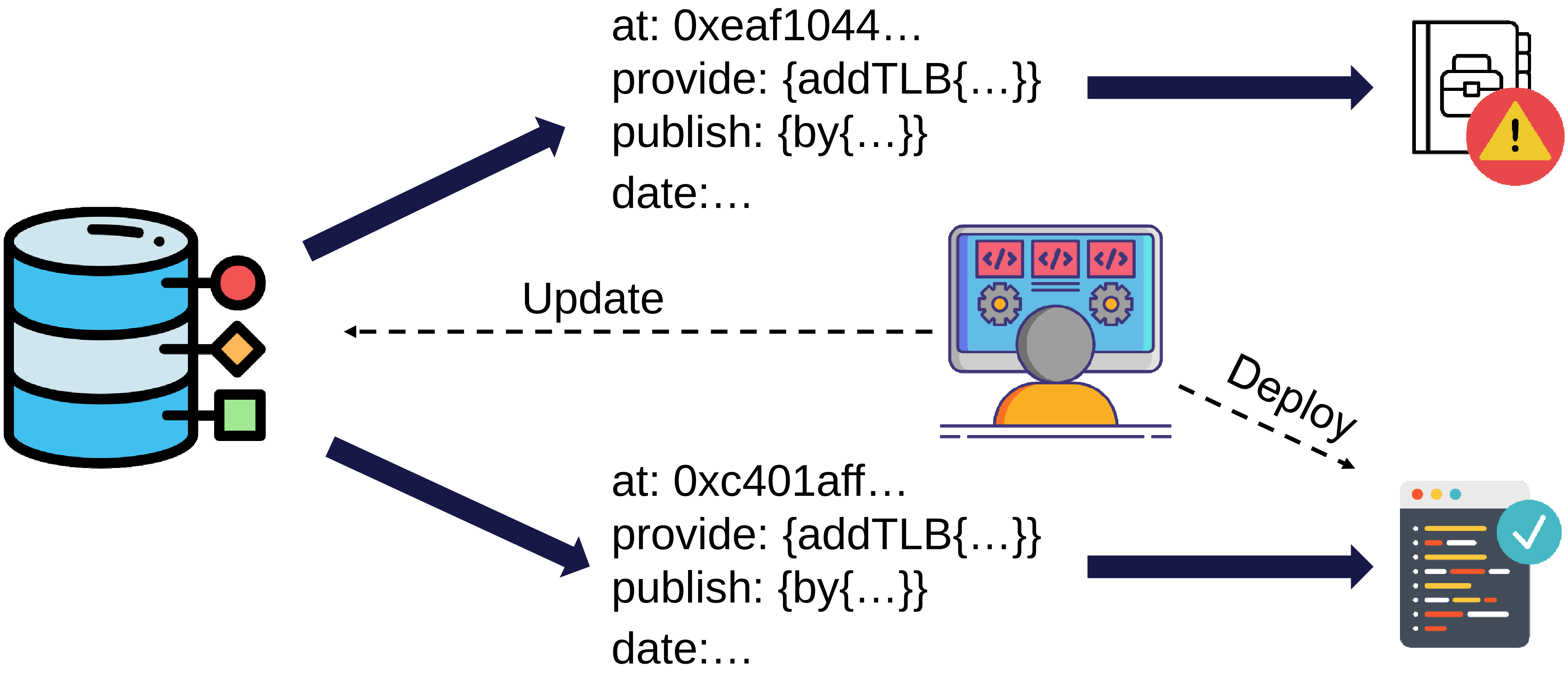


Version control of each smart contract

What functions provided in those smart contracts

On-chain location of each latest smart contract

More than Hub : The Main Contract



at: 0xeaf1044…
provide: {addTLB{…}}
publish: {by{…}}
date:…

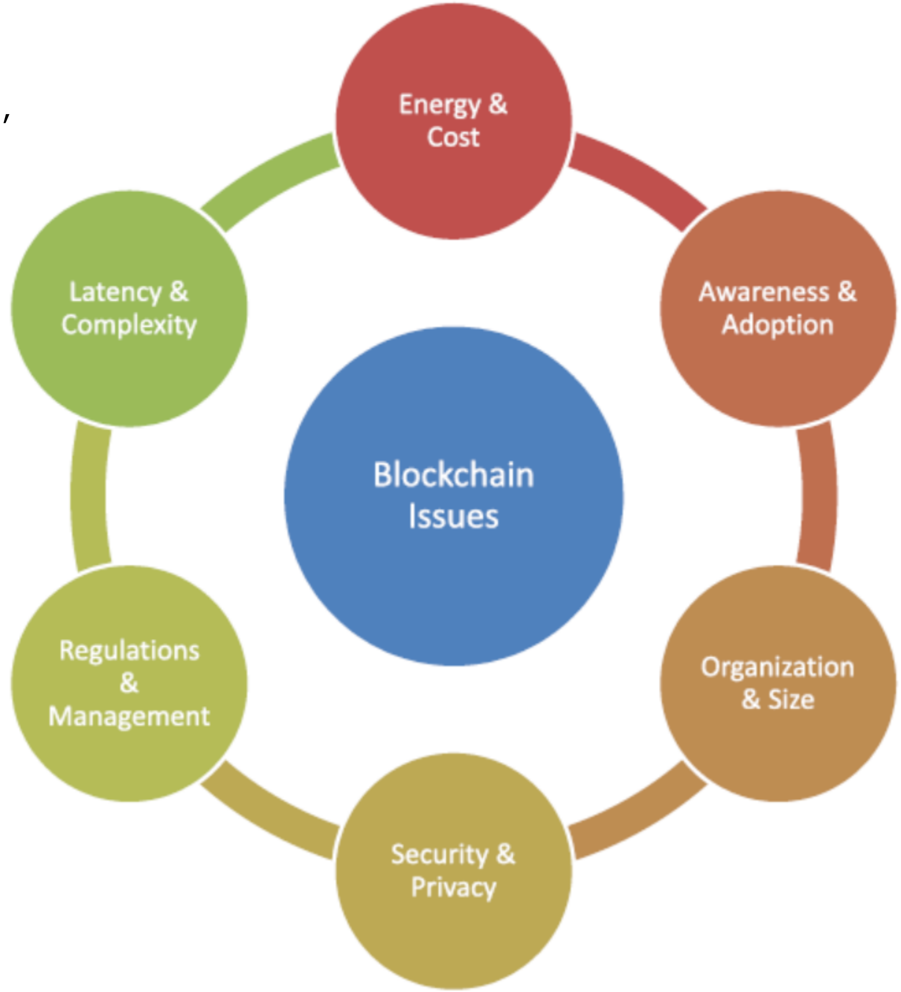
Update

Deploy

at: 0xc401aff…
provide: {addTLB{…}}
publish: {by{…}}
date:…

Blockchain Issues

Weizhi Meng, Elmar Wolfgang Tischhauser, Qingju Wang, Yu Wang, and Jinguang Han. When Intrusion Detection Meets Blockchain Technology: A Review. IEEE Access, vol. 6, no. 1, pp. 10179-10188, IEEE, 2018.



Important

As blockchains were originally designed for cryptocurrencies, we have to avoid the situation that “blockchain is a solution looking for a problem”.

Indeed, we have to still focus on our traditional solutions to some issues and challenges, but keep an eye on such emerging technologies. It means that a balance should always be made in a case-by-case scenario.

Q&A

If you have any question, you can contact via
weme@dtu.dk