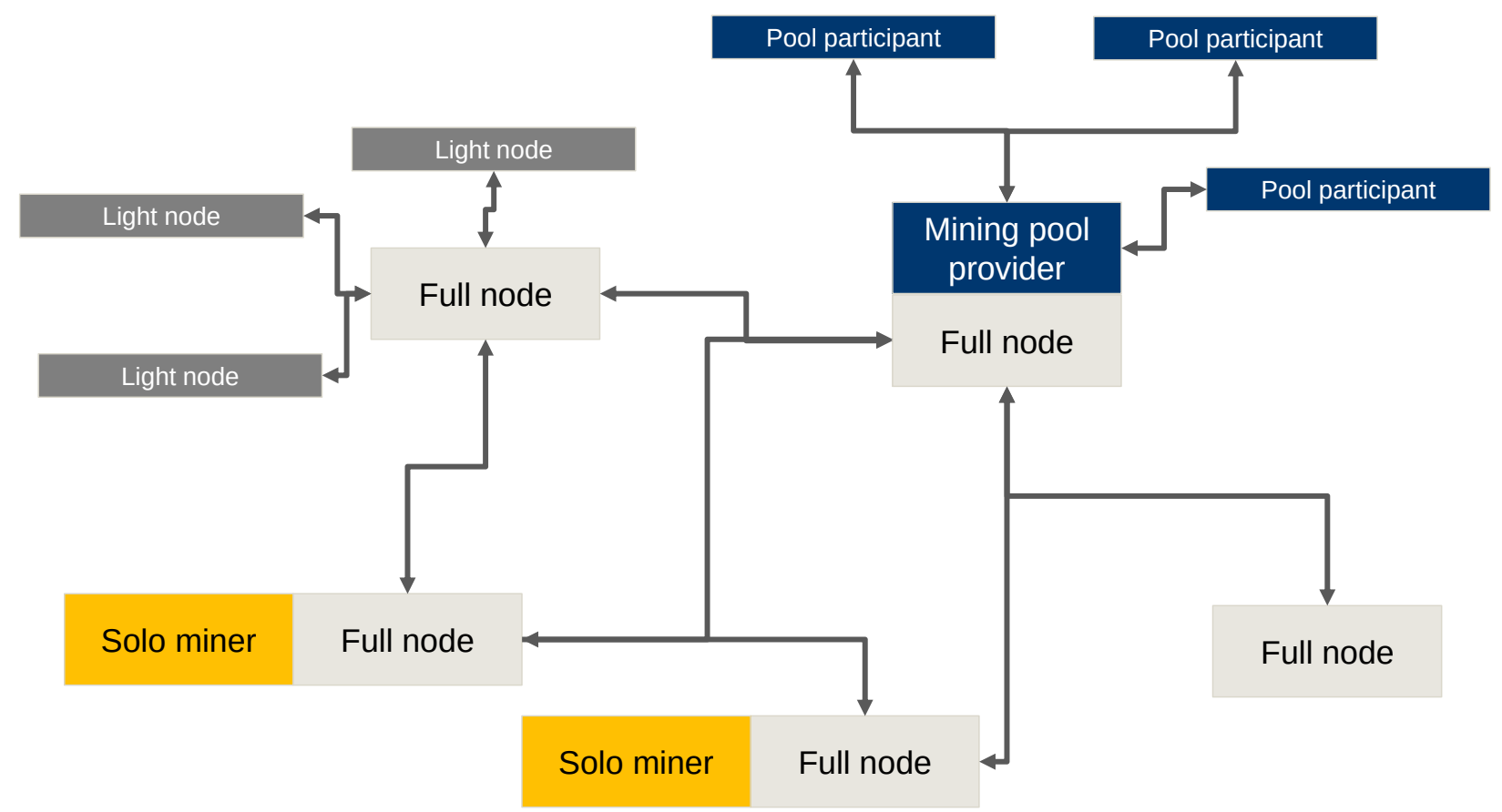
CSE446: Blockchain & Cryptocurrencies

Lecture – 13: Ethereum - 2

Agenda

- Ethereum network
- Ethereum EVM
- Ethereum Transactions
- Gas and Gas price

Ethereum network



Ethereum network node types

- Full nodes are the foundation of the Ethereum network
- Each full node holds a copy of the entire blockchain and syncs it with other nodes
- Transactions must be sent to a full node which distributes it among the network participants
- A light node is a client that is connected to a full node for the sake of not having to sync and download the entire blockchain
- For most private people, light nodes are the most comfortable way of interacting with the Ethereum blockchain
- One of the most common light nodes is https://myetherwallet.com (always triple check the domain)

Ethereum implementation

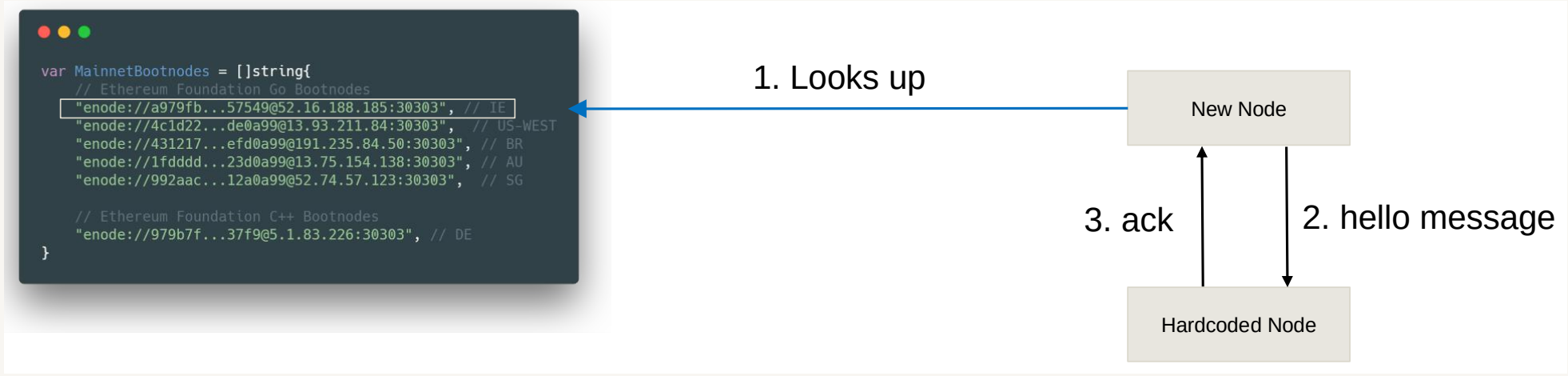
- To connect to the Ethereum network, you will need to download an Ethereum implementation
- Not all Ethereum nodes are using the same code base
- Since the specification for an Ethereum node is open source, basically anyone could create a different implementation
- The two major Ethereum implementations are: Geth and OpenEthereum

Node discovery

- Both Geth and OpenEthereum have a maintained list of default peers hardcoded into their source code
- Otherwise, it would be possible that no nodes are found, and the sync will always fail
- The Geth client comes with 6 hardcoded peers
- Once a node is selected, a hello message is sent to make an initial connection with the node

```
var MainnetBootnodes = []string{
    // Ethereum Foundation Go Bootnodes
    "enode://a979fb...57549@52.16.188.185:30303", // IE
    "enode://4c1d22...de0a99@13.93.211.84:30303",  // US-WEST
    "enode://431217...efd0a99@191.235.84.50:30303", // BR
    "enode://1fdddd...23d0a99@13.75.154.138:30303", // AU
    "enode://992aac...12a0a99@52.74.57.123:30303",  // SG

    // Ethereum Foundation C++ Bootnodes
    "enode://979b7f...37f9@5.1.83.226:30303", // DE
}
```



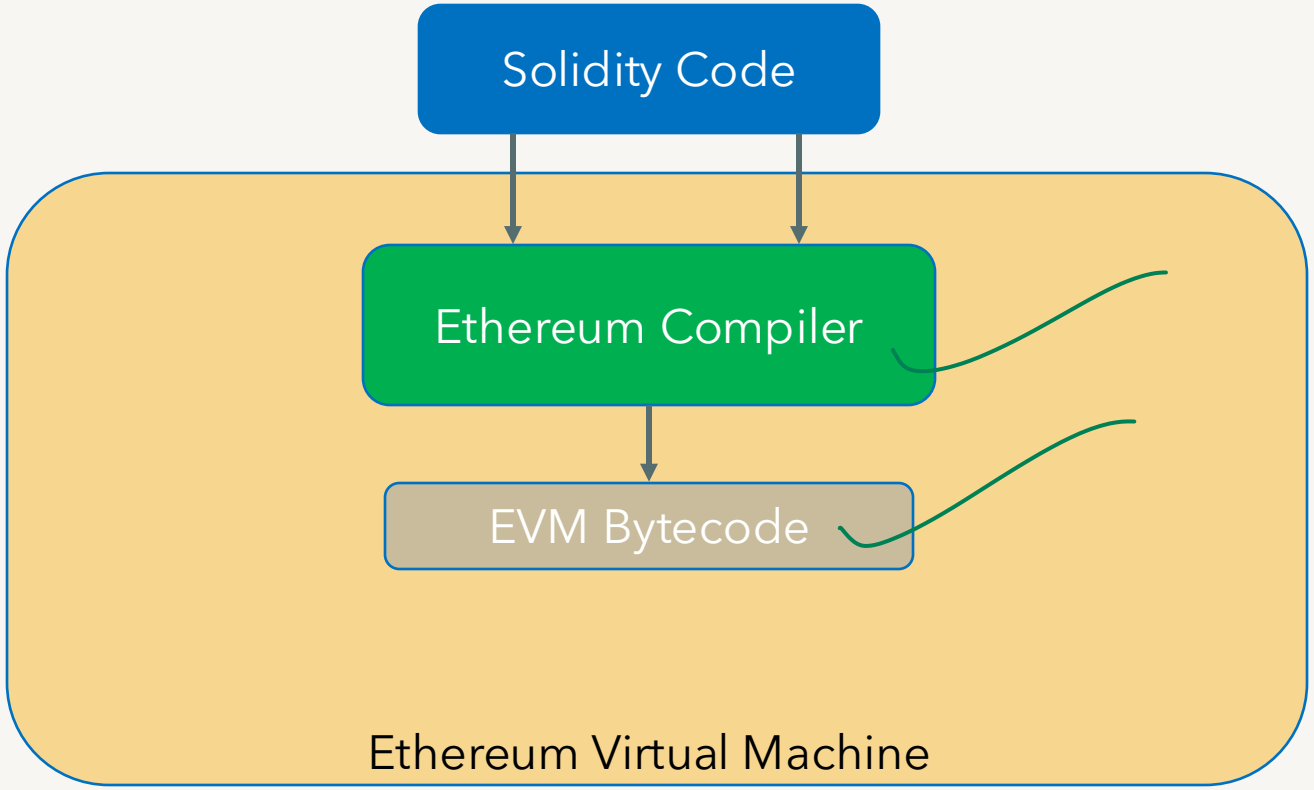
Ethereum Virtual Machine (EVM)

- The Ethereum Virtual Machine (EVM) is a simple but powerful, Turing complete 256bit Virtual Machine that allows anyone to execute arbitrary EVM Byte Code
- Turing completeness means you can write programs (contracts) that can (for the most part) solve any reasonable computational problem or write sophisticated logic
- It allows anyone to execute arbitrary code in a trust-less environment in which the outcome of an execution can be guaranteed and is fully deterministic

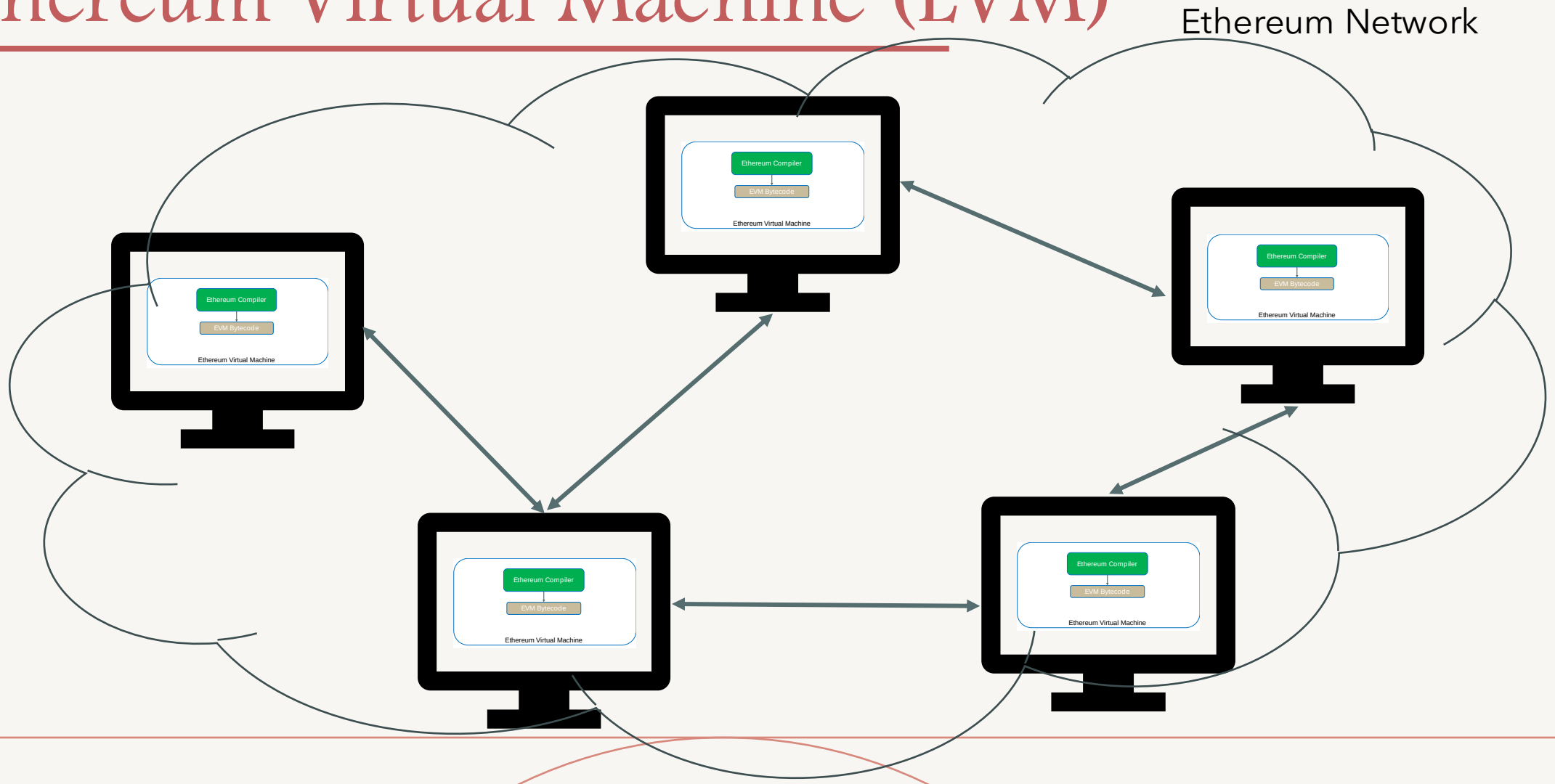
Ethereum Virtual Machine (EVM)

- Smart contract code is usually written in a high level programming language such as Solidity
- This code gets compiled to something called the EVM bytecode which gets deployed to the Ethereum blockchain
- This is very similar to a programming language like Java where the code gets converted to JVM Byte code
- The Ethereum runtime environment only understands and can execute the bytecode

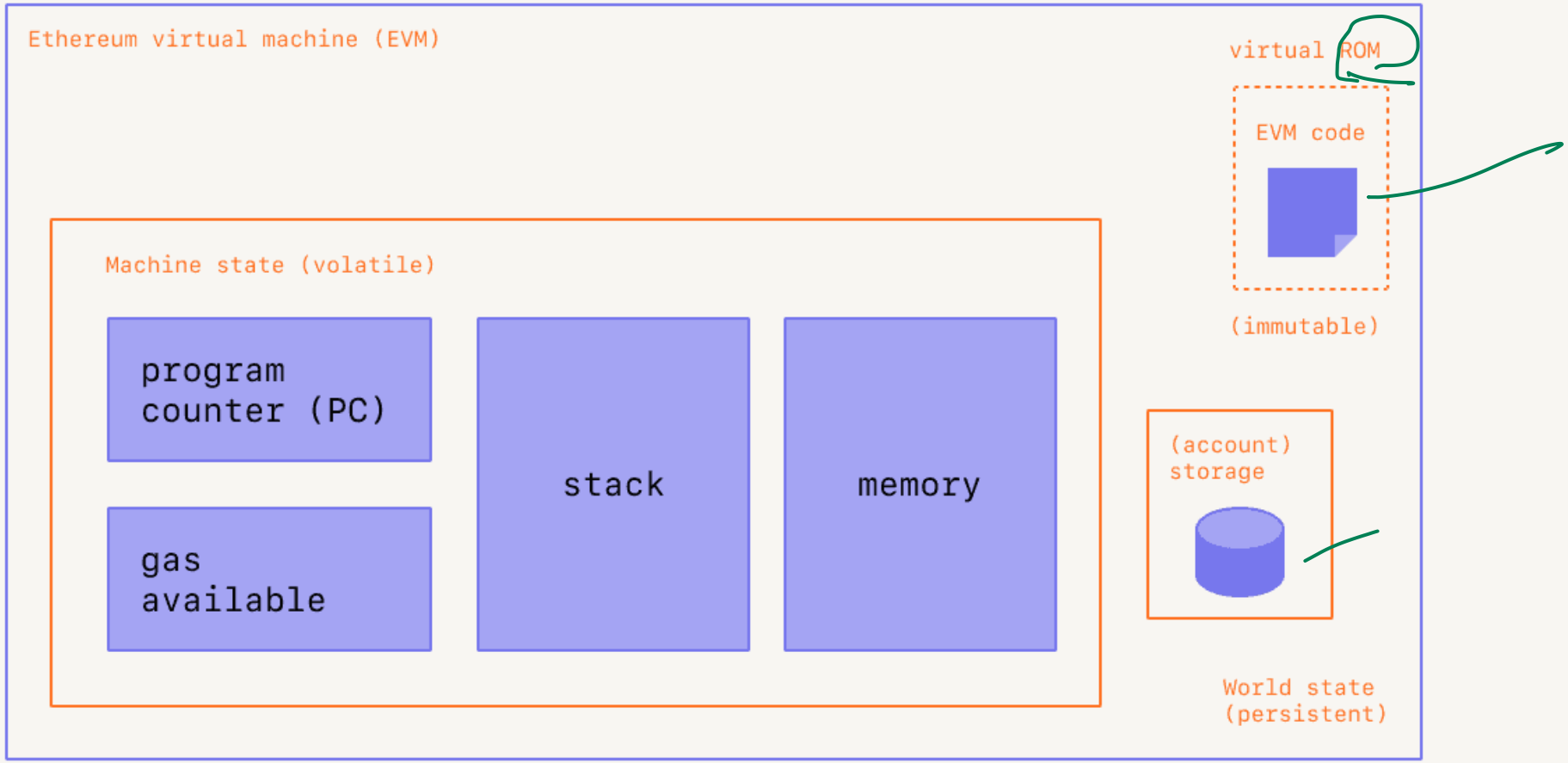
Ethereum Virtual Machine (EVM)



Ethereum Virtual Machine (EVM)

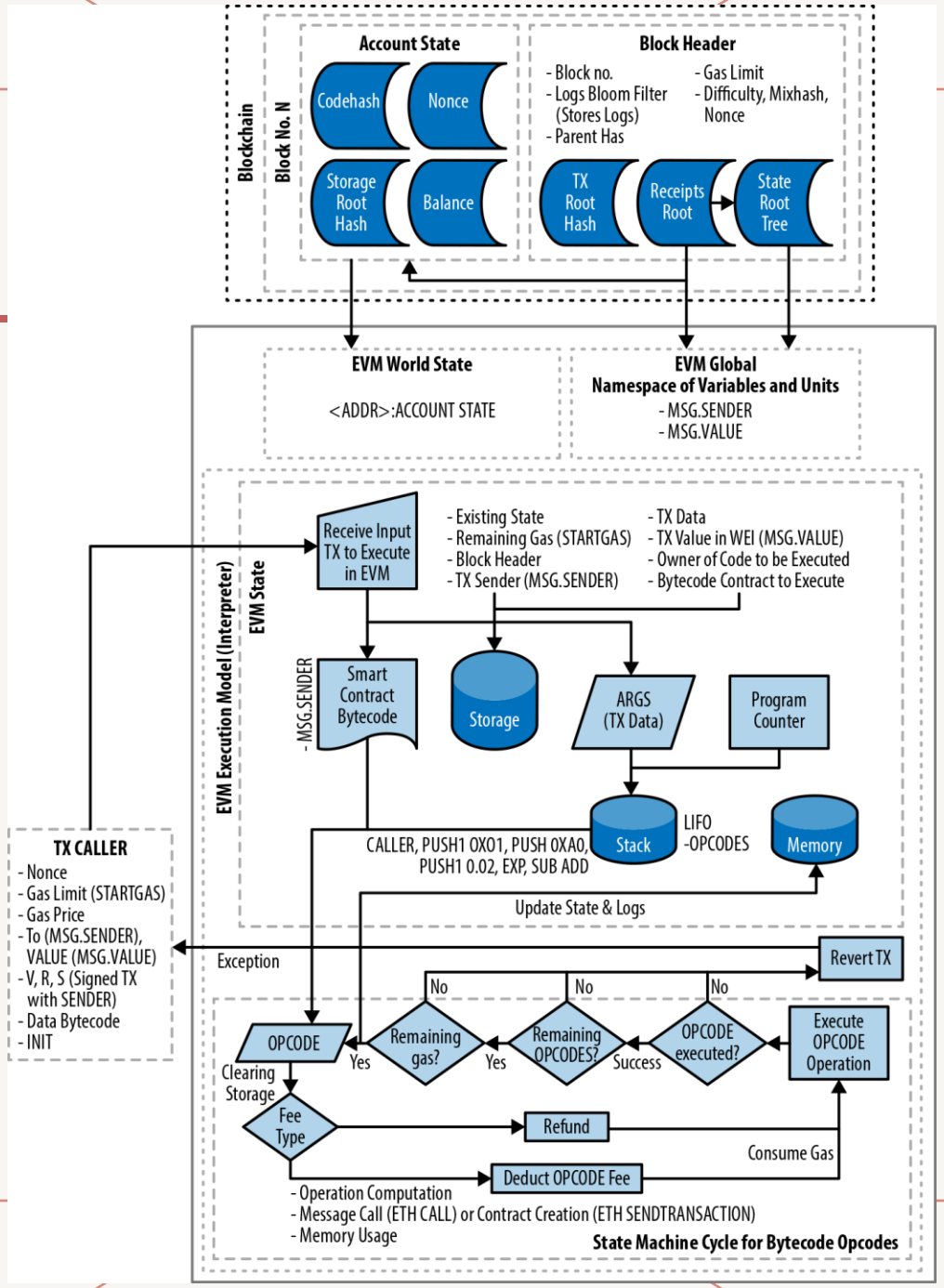


Ethereum Virtual Machine (EVM)



https://ethereum.org/static/e8aca8381c7b3b40c44bf8882d4ab930/302a4/evm.png

EVM



https://cypherpunks-core.github.io/ethereumbook/13evm.html

EVM Bytecode

- EVM bytecode is the instruction sets for the EVM
- The EVM instruction set offers most of the operations you might expect, including
  - Arithmetic and bitwise logic operations
  - Stack, memory, and storage access
  - Control flow operations
  - Logging, calling, and other operators
  - Access to account information (e.g., address and balance) and block information (e.g., block number and current gas price) (Blockchain state information)

https://cypherpunks-core.github.io/ethereumbook/13evm.html

Ethereum blockchain

- Like Bitcoin, there are three major sub-components in the Ethereum blockchain
  - Transactions
  - Blocks
  - Blockchain

Ethereum transactions

- On Ethereum there are mainly two transactions
  - External transactions
  - Internal transactions
- An external transaction
  - is generated by a user, serialised and sent to the Ethereum network, put on the blockchain (just like Bitcoin)
  - Includes payment (regular) transactions and contract creation & contract call (execution) transactions

Ethereum external transactions

- Regular transactions
  - a transaction from one account to another (either to an EOA or to a contract account)
- Contract deployment transactions:
  - to deploy a smart-contract
  - a transaction without a 'to' address, where the data field is used for the contract code
- Execution of a contract:
  - a transaction that interacts with a deployed smart contract
  - In this case, 'to' address is the smart contract address
  - Data field contains the relevant value for the contract (function)

to = ~~address~~ X

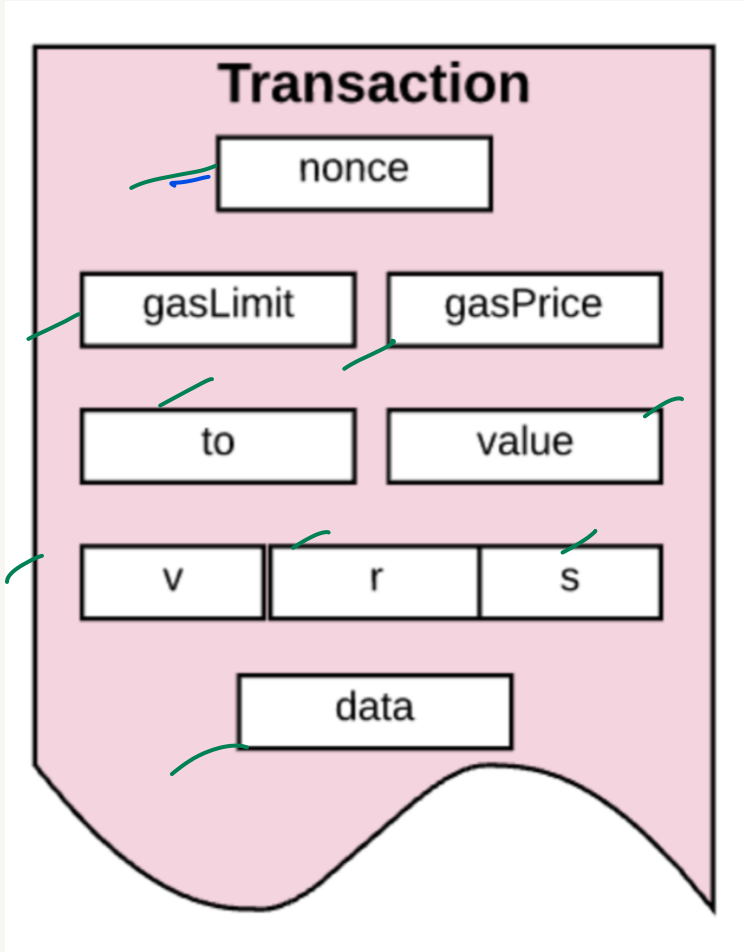
data = code

to = address

data = function

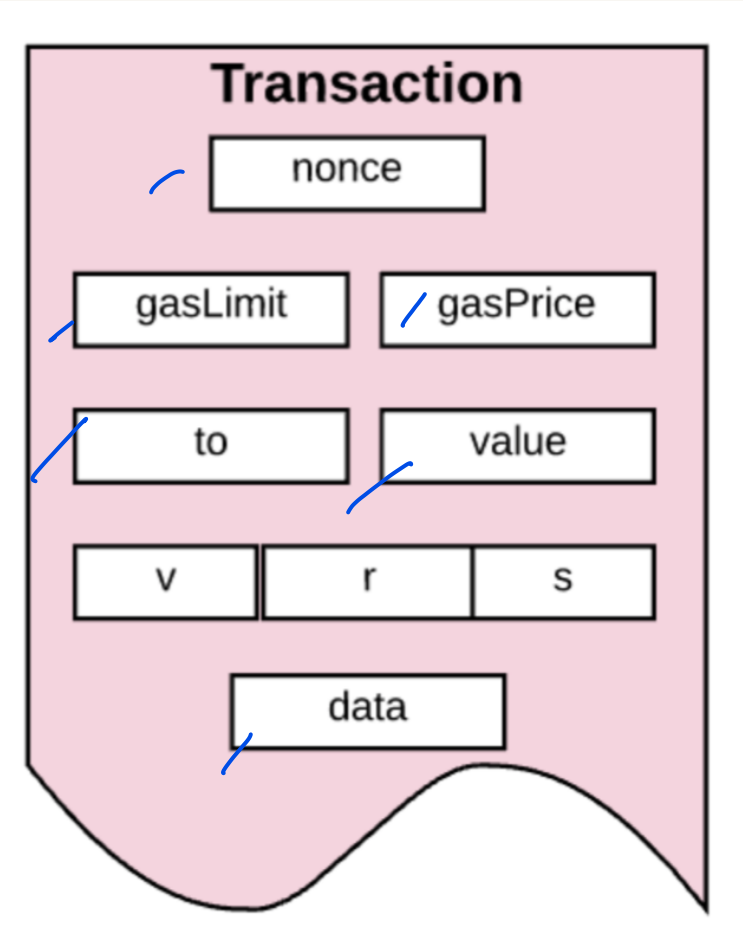
Ethereum external transactions: structure

- nonce: A count of the number of transactions sent by the sender (EOA) number used to prevent message replay
- gasPrice: The price of gas (in wei) the originator (sender) is willing to pay
- gasLimiti: The maximum amount of gas the originator is willing to buy for this transaction



Ethereum transactions

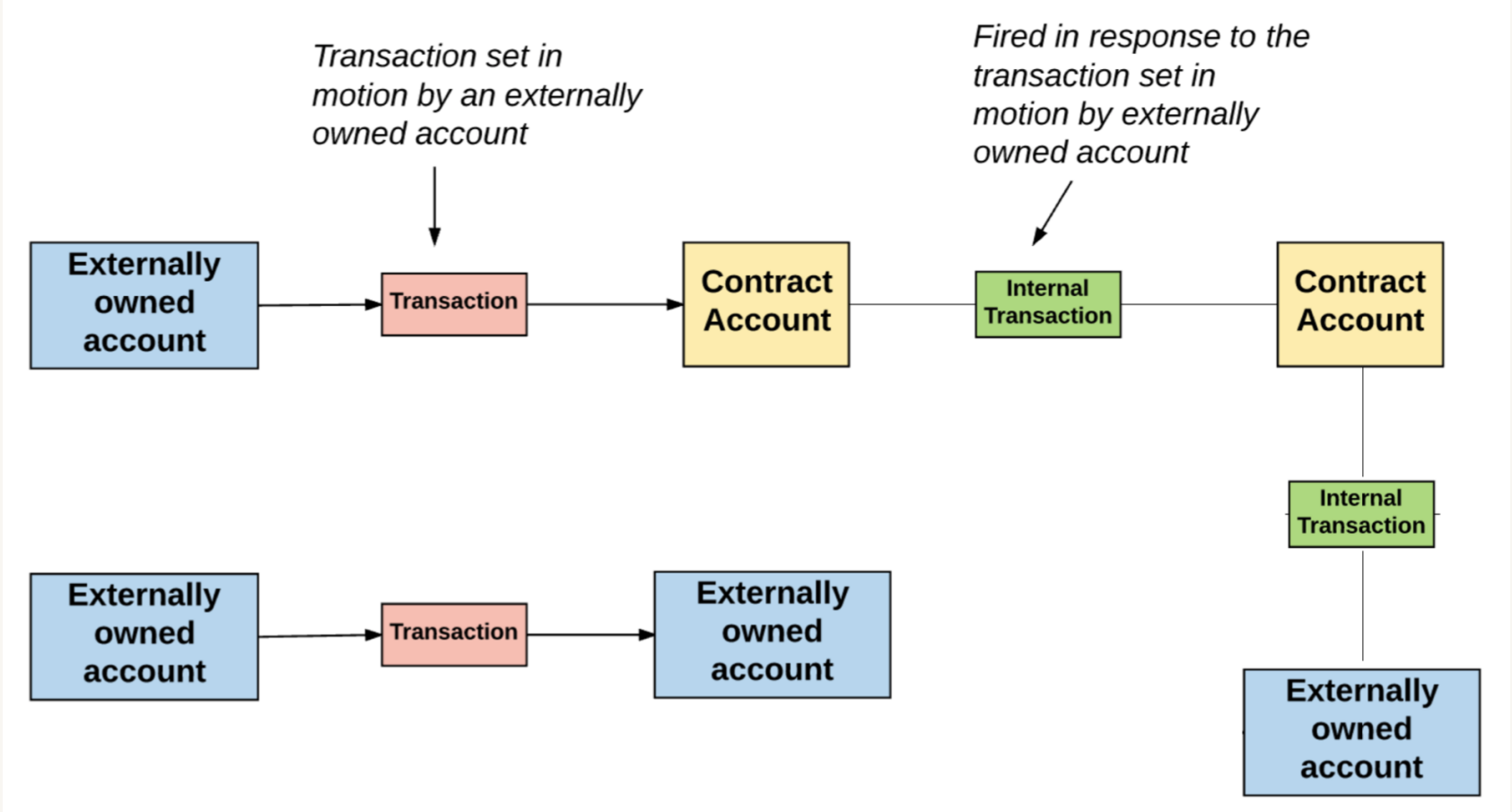
- to: Recipient's/contract address
- value: Amount of Wei transferred from the sender to the receiver
- v,r,s: The three components of an ECDSA digital signature of the originating EOA
- data: optional field to include code to create a contract or data for calling a function of an existing contract



Ethereum transactions types

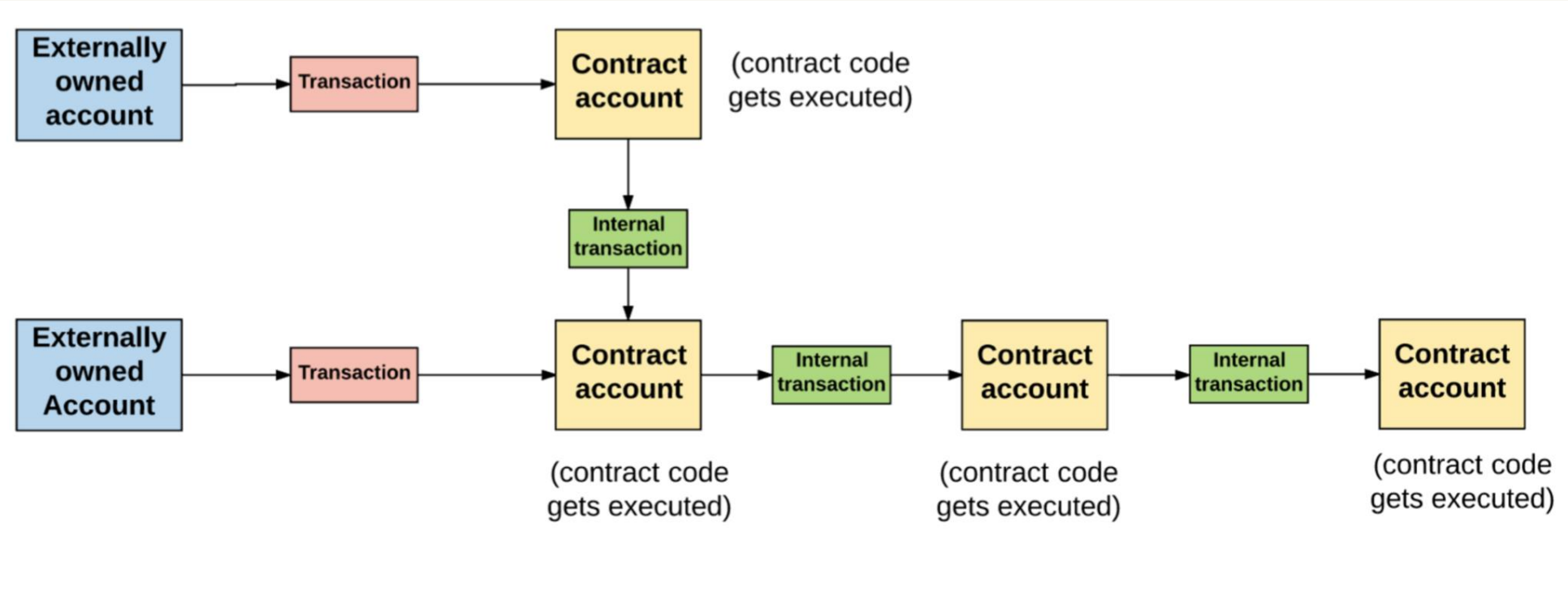
- Internal transactions
  - Contracts A can call a function in Contract B
  - These are not serialised and not put on the blockchain!
  - When these transactions transfer value (Eth) to another account, the account update is stored in the blockchain

Ethereum transactions types



From Lecture Slides of Blockchains & Cryptocurrencies Course at Johns Hopkins University

Ethereum transactions types



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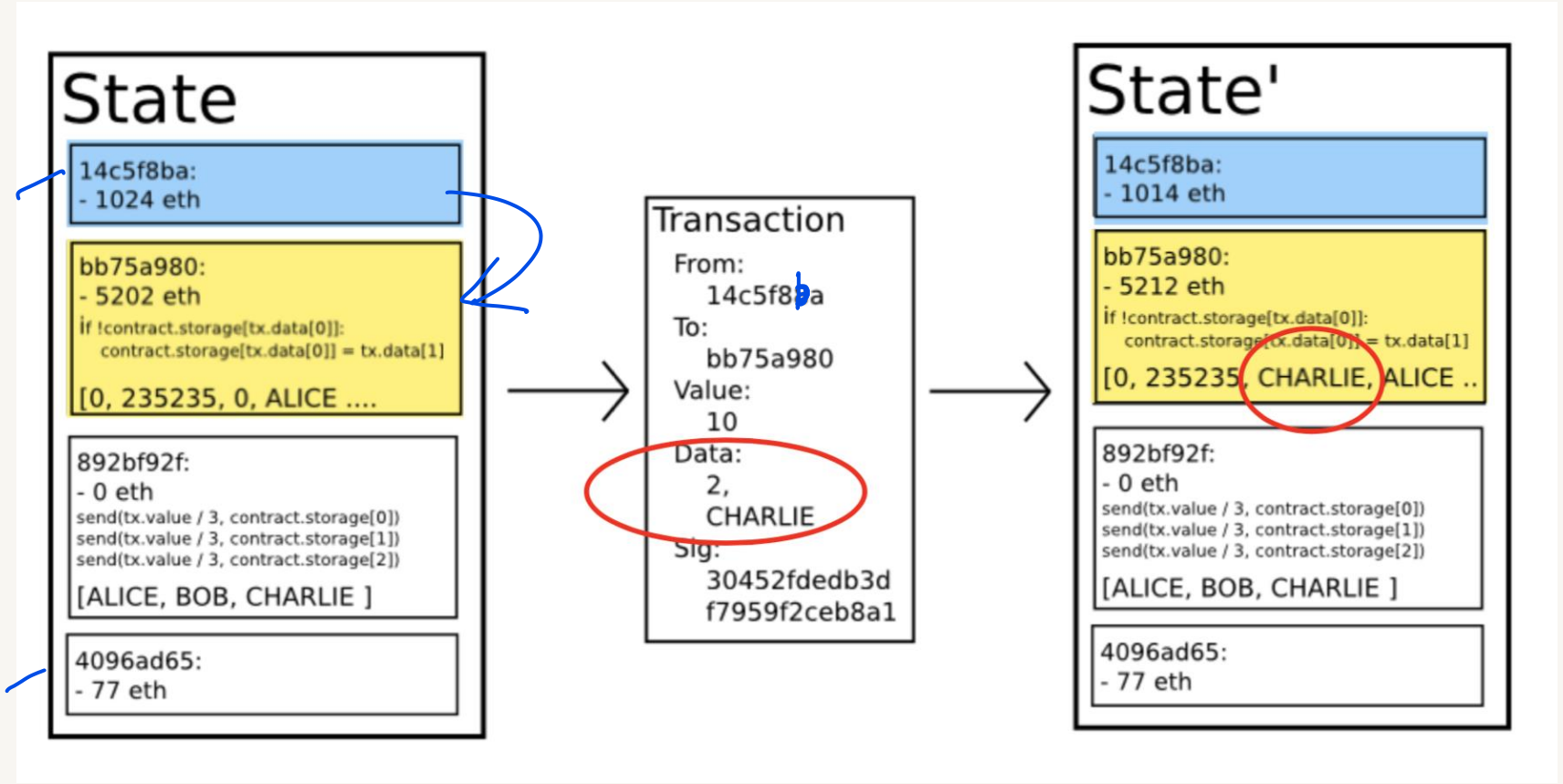
Ethereum transaction execution



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Question?