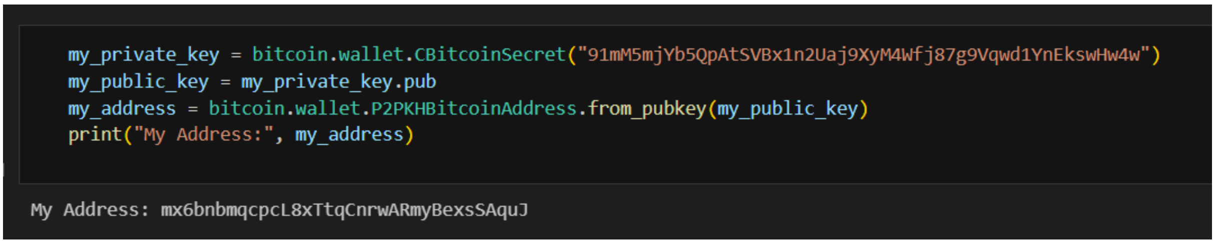
مهدی نوری 810100231

Section 1 : Part 2 : Create transactions

For the first transaction first we got 0.0062 from another account to start the operation.

In this part only 0.00005 coins are being burnt.

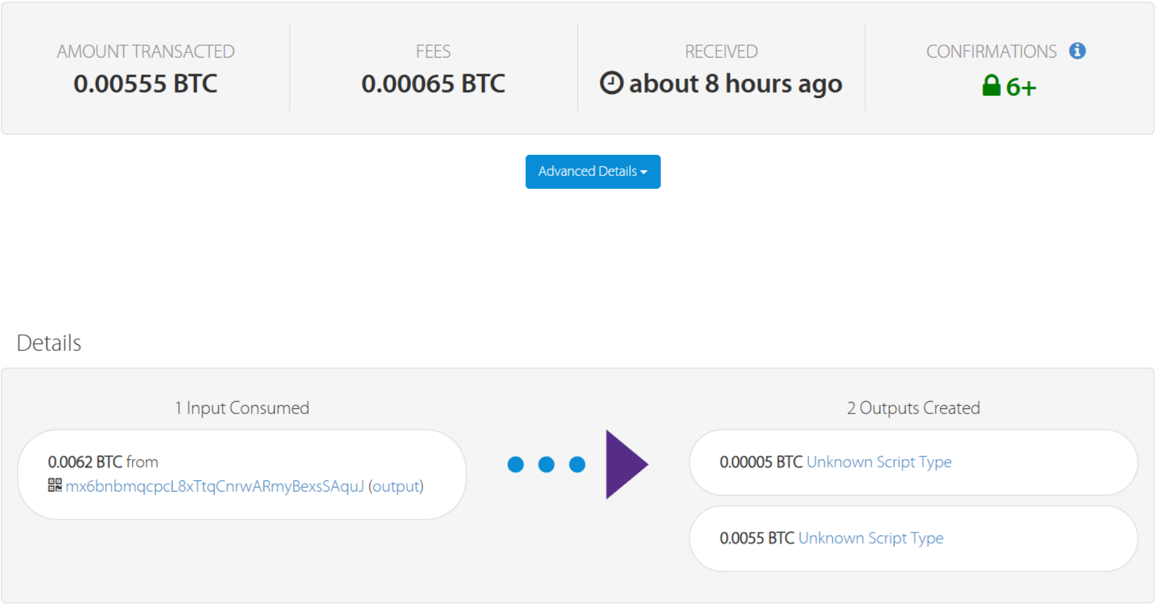
The key we use is our generated key shown below :



```
my_private_key = bitcoin.wallet.CBitcoinSecret("91mM5mjYb5QpAtSVBx1n2Uaj9XyM4Wfj87g9Vqwd1YnEkswHw4w")
my_public_key = my_private_key.pub
my_address = bitcoin.wallet.P2PKHBitcoinAddress.from_pubkey(my_public_key)
print("My Address:", my_address)
```

```
My Address: mx6bnbmqcpcL8xTtqCnrwARmyBexsSAquJ
```

(private key and address)



AMOUNT TRANSACTED	FEES	RECEIVED	CONFIRMATIONS
0.00555 BTC	0.00065 BTC	about 8 hours ago	6+

Details

1 Input Consumed

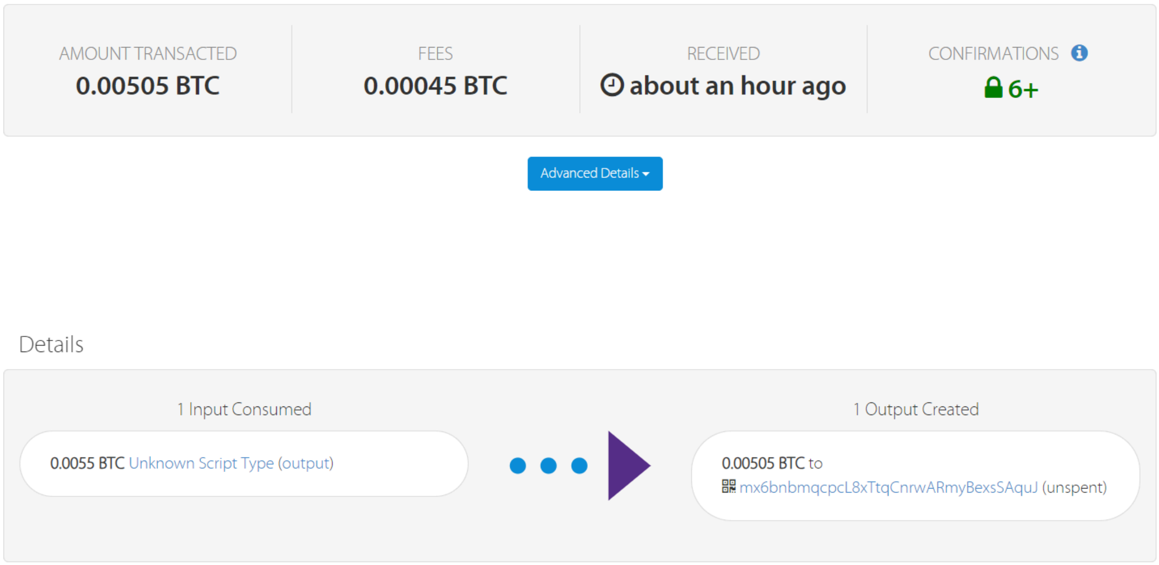
0.0062 BTC from mx6bnbmqcpcL8xTtqCnrwARmyBexsSAquJ (output)

2 Outputs Created

0.00005 BTC Unknown Script Type

0.0055 BTC Unknown Script Type

(send transaction)



AMOUNT TRANSACTED 0.00505 BTC

FEES 0.00045 BTC

RECEIVED about an hour ago

CONFIRMATIONS 6+

Advanced Details ▾

Details

1 Input Consumed

0.0055 BTC Unknown Script Type (output)

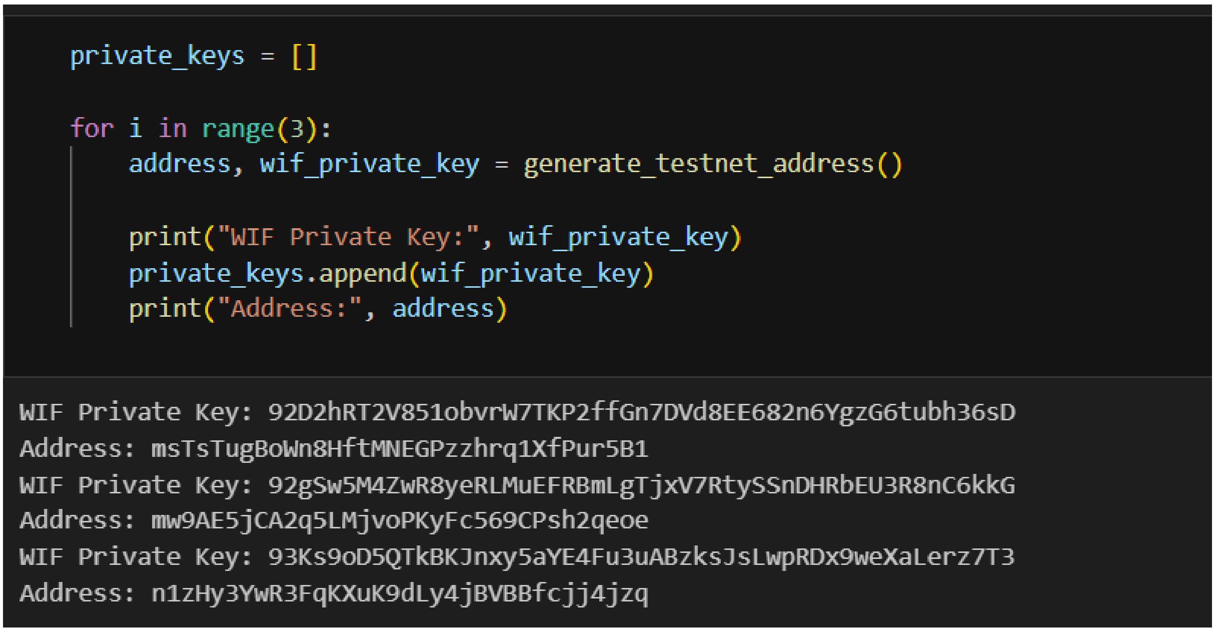
1 Output Created

0.00505 BTC to mx6bnbmqcpcL8xTtqCnrwARmyBexsSAquJ (unspent)

(receive transaction)

For the second transaction first note that we have 0.0046 from the last part to start the operation.

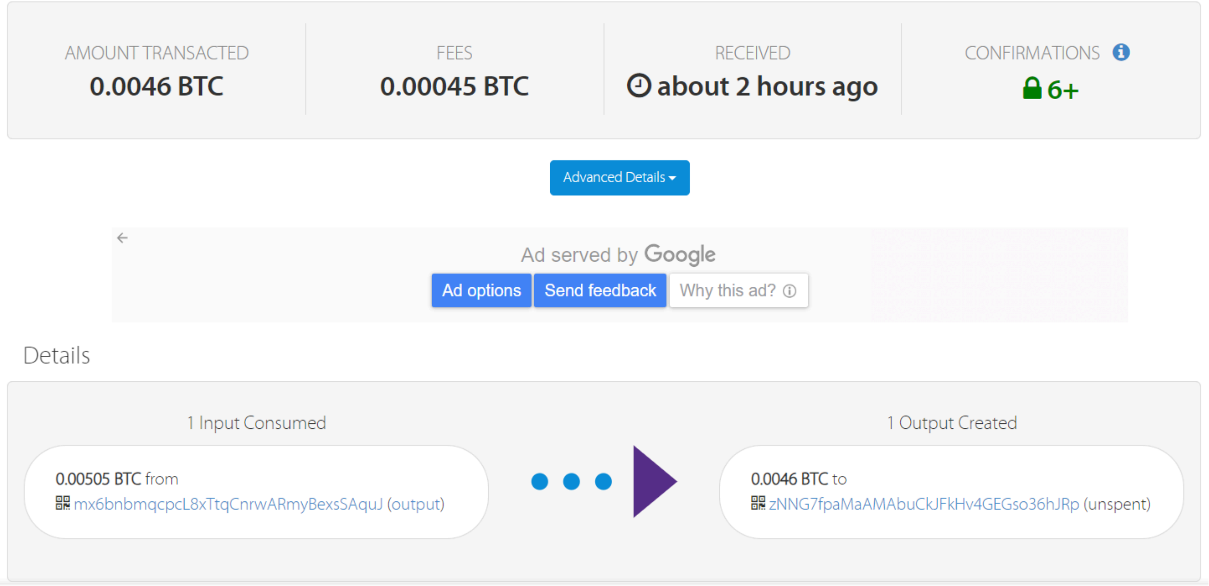
Here are the 3 accounts that we have besides our account :



```
private_keys = []

for i in range(3):
    address, wif_private_key = generate_testnet_address()

    print("WIF Private Key:", wif_private_key)
    private_keys.append(wif_private_key)
    print("Address:", address)
```

```
WIF Private Key: 92D2hRT2V851obvrW7TKP2ffGn7DVd8EE682n6YgzG6tubh36sD
Address: msTsTugBoWn8HftMNEGPzzhrq1XfPur5B1
WIF Private Key: 92gSw5M4ZwR8yeRLMuEFRBmLgTjxV7RtySSnDHRbEU3R8nC6kkG
Address: mw9AE5jCA2q5LMjvoPKyFc569CPsh2qeoe
WIF Private Key: 93Ks9oD5QTkBKJnxy5aYE4Fu3uABzksJsLwpRDx9weXaLerz7T3
Address: n1zHy3YwR3FqKXuK9dLy4jBVBBfcjj4jzq
```

(private key and addresses used)



AMOUNT TRANSACTED	FEES	RECEIVED	CONFIRMATIONS
0.0046 BTC	0.00045 BTC	about 2 hours ago	6+

Details

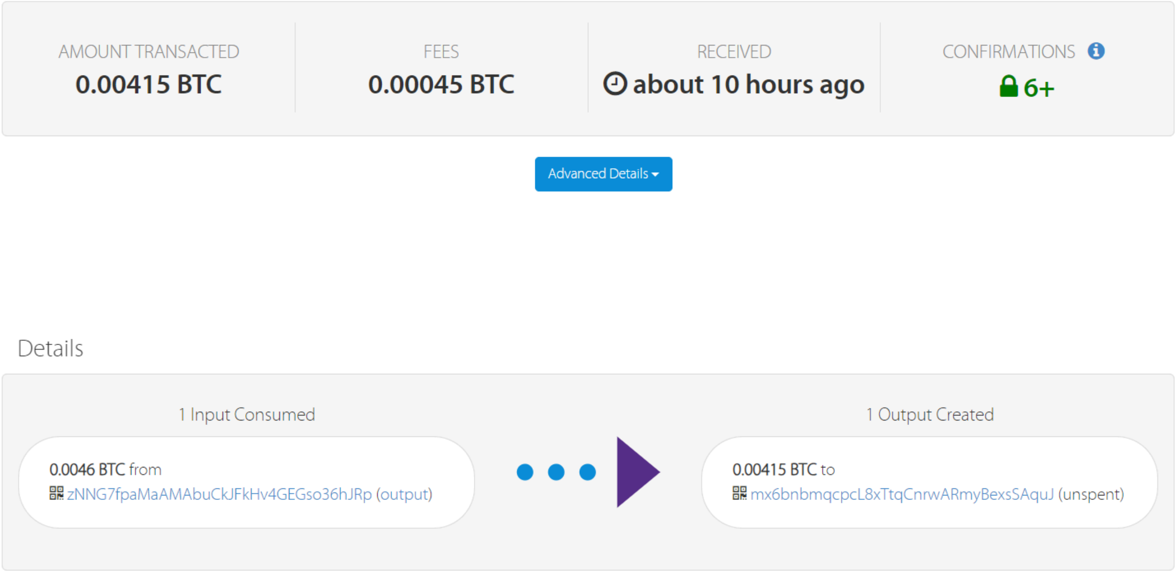
1 Input Consumed

0.00505 BTC from
mx6bnbmqcpcL8xTtqCnrwARmyBexsSAquJ (output)

1 Output Created

0.0046 BTC to
zNNG7fpaMaAMAbuCkJFkHv4GEGso36hJRp (unspent)

(send transaction)



AMOUNT TRANSACTED	FEES	RECEIVED	CONFIRMATIONS
0.00415 BTC	0.00045 BTC	about 10 hours ago	6+

Details

1 Input Consumed

0.0046 BTC from
zNNG7fpaMaAMAbuCkJFkHv4GEGso36hJRp (output)

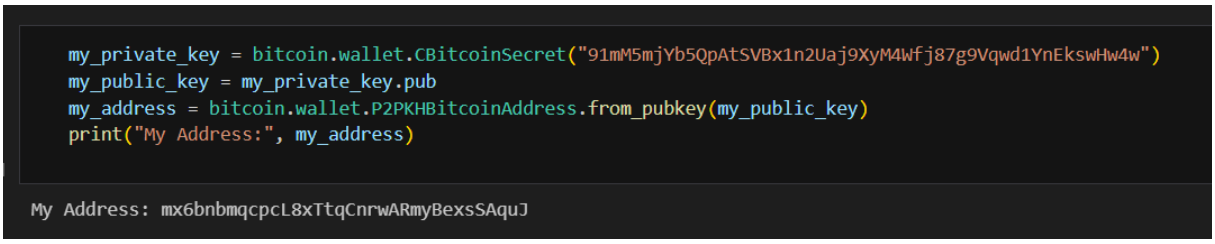
1 Output Created

0.00415 BTC to
mx6bnbmqcpcL8xTtqCnrwARmyBexsSAquJ (unspent)

(receive transaction)

For the third transaction first note that we have 0.00415 from the last part to start the operation.

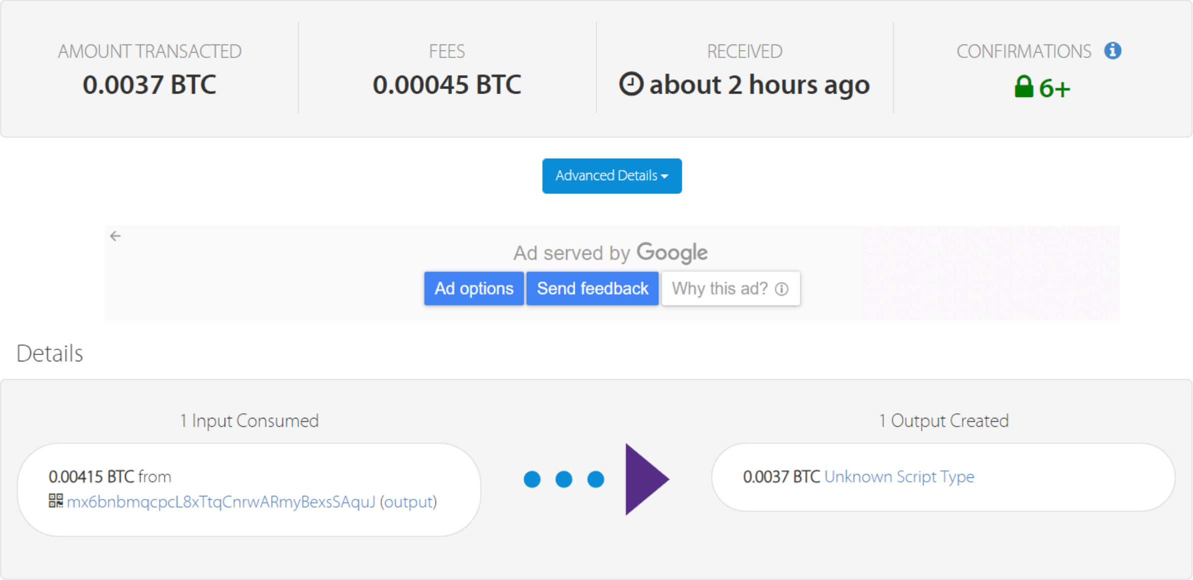
The account we use here is our first account :



```
my_private_key = bitcoin.wallet.CBitcoinSecret("91mM5mjYb5QpAtSVBx1n2Uaj9XyM4Wfj87g9Vqwd1YnEkswHw4w")
my_public_key = my_private_key.pub
my_address = bitcoin.wallet.P2PKHBitcoinAddress.from_pubkey(my_public_key)
print("My Address:", my_address)
```

```
My Address: mx6bnbmqcpcL8xTtqCnrwARmyBexsSAquJ
```

(private key and address)



AMOUNT TRANSACTED
0.0037 BTC

FEES
0.00045 BTC

RECEIVED
about 2 hours ago

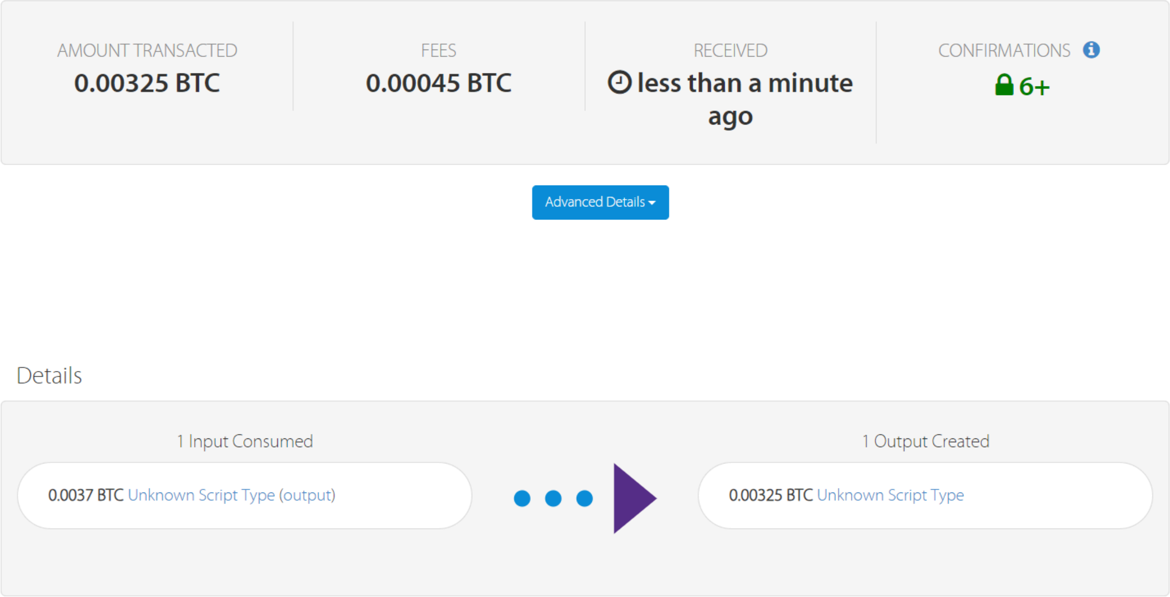
CONFIRMATIONS
6+

Details

1 Input Consumed
0.00415 BTC from
mx6bnbmqcpcL8xTtqCnrwARmyBexsSAquJ (output)

1 Output Created
0.0037 BTC Unknown Script Type

(send transaction)



AMOUNT TRANSACTED
0.00325 BTC

FEES
0.00045 BTC

RECEIVED
less than a minute ago

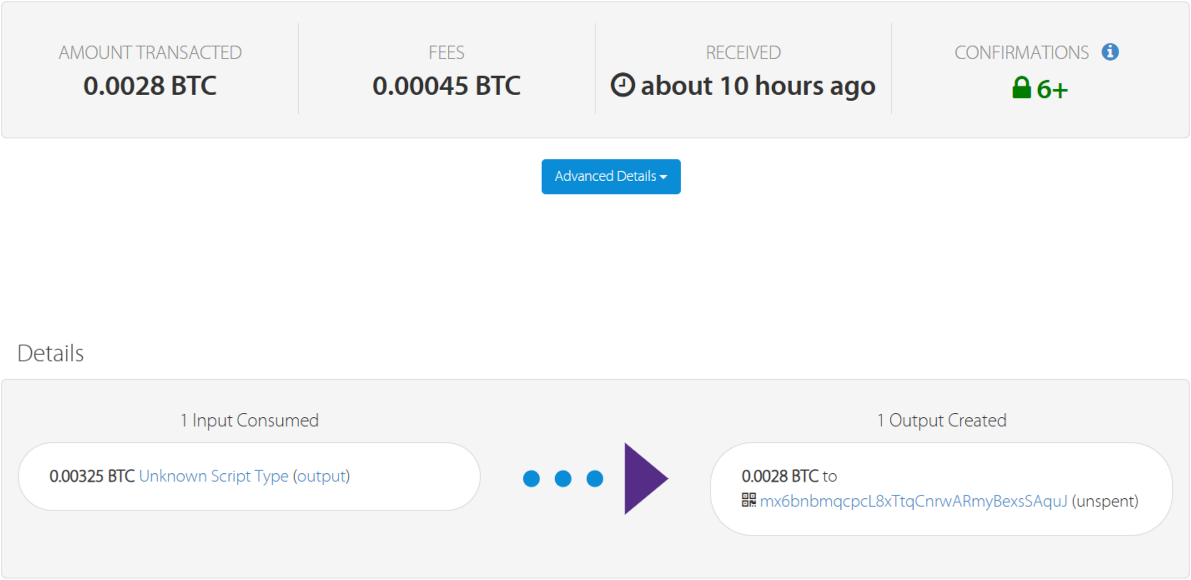
CONFIRMATIONS
6+

Details

1 Input Consumed
0.0037 BTC Unknown Script Type (output)

1 Output Created
0.00325 BTC Unknown Script Type

(middle transaction)



AMOUNT TRANSACTED	FEES	RECEIVED	CONFIRMATIONS
0.0028 BTC	0.00045 BTC	about 10 hours ago	6+

Details

1 Input Consumed

0.00325 BTC Unknown Script Type (output)

1 Output Created

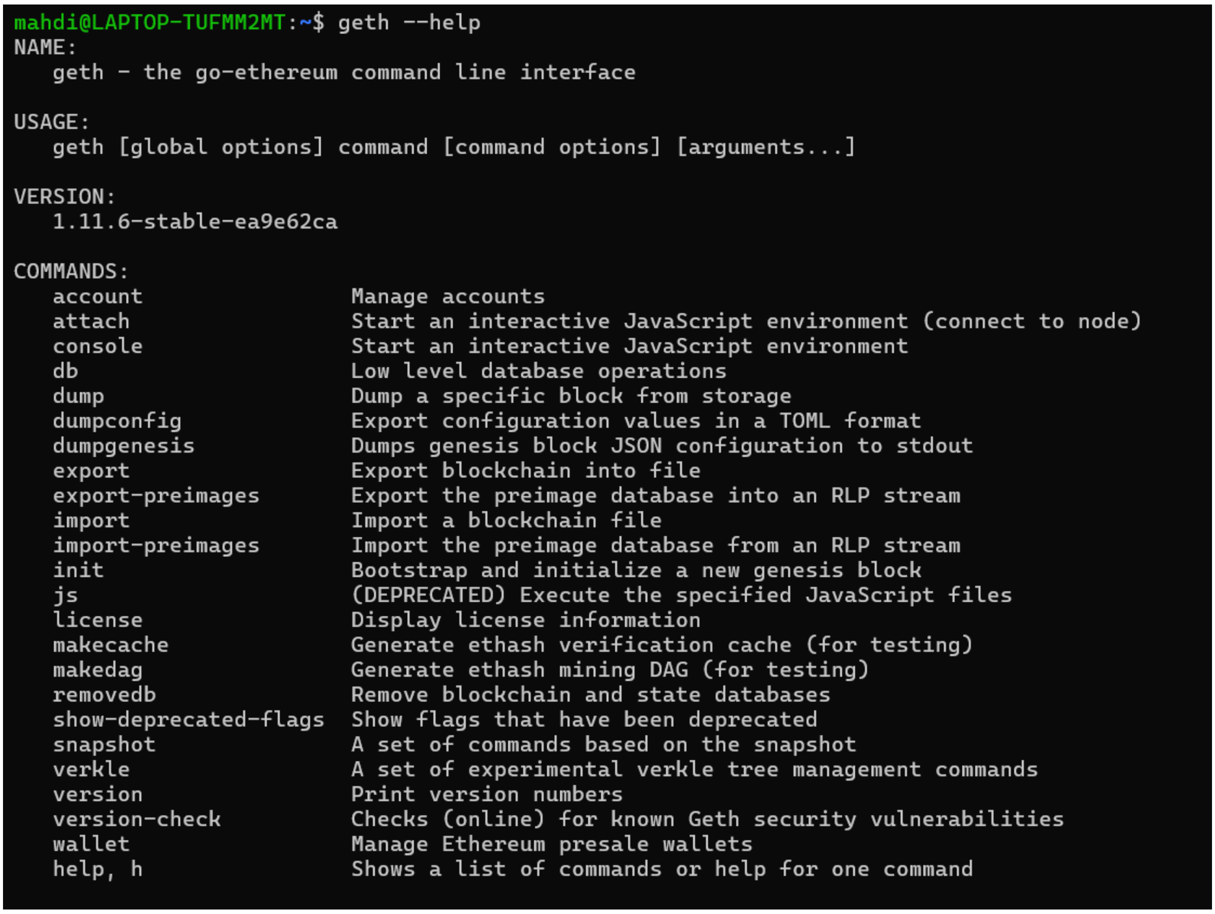
0.0028 BTC to
mx6bnbmqcpcL8xTtqCnrwARmyBexsSAquJ (unspent)

(receive transaction)

Note that here the middle transaction validates the age property and the receive transaction validates password property.

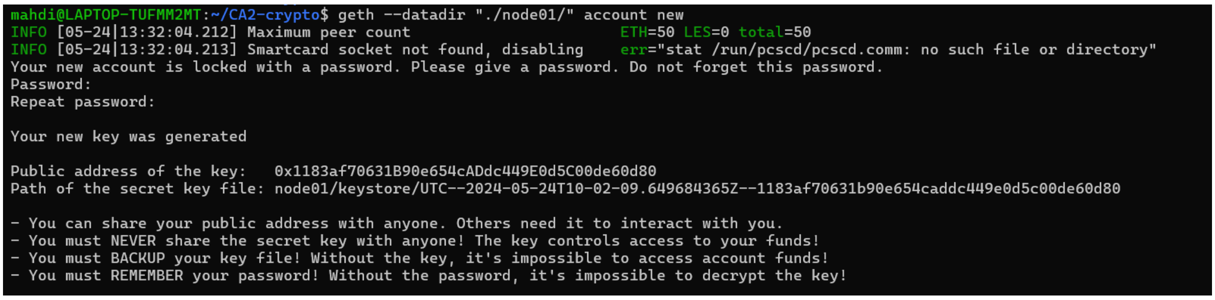
Section 2 : Setup a local ethereum node

After installing geth we run the command bellow:

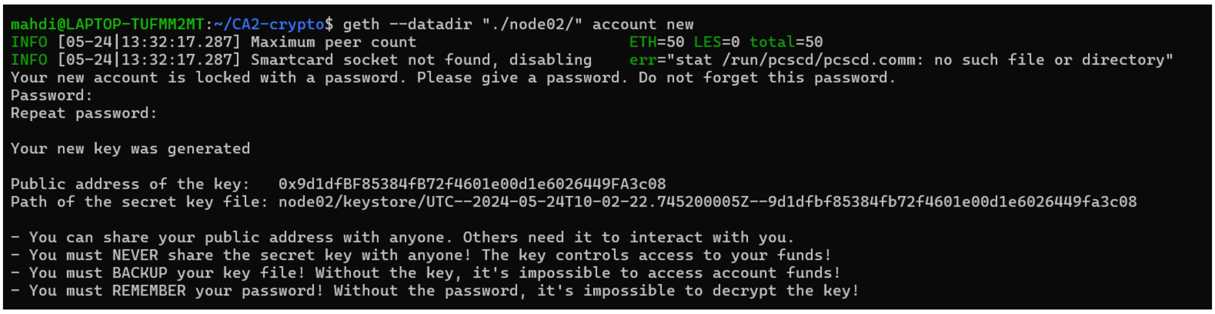


```
mahdi@LAPTOP-TUFMM2MT:~$ geth --help
NAME:
   geth - the go-ethereum command line interface

USAGE:
   geth [global options] command [command options] [arguments...]

VERSION:
   1.11.6-stable-ea9e62ca

COMMANDS:
   account                Manage accounts
   attach                 Start an interactive JavaScript environment (connect to node)
   console                Start an interactive JavaScript environment
   db                     Low level database operations
   dump                   Dump a specific block from storage
   dumpconfig             Export configuration values in a TOML format
   dumpgenesis            Dumps genesis block JSON configuration to stdout
   export                 Export blockchain into file
   export-preimages       Export the preimage database into an RLP stream
   import                 Import a blockchain file
   import-preimages       Import the preimage database from an RLP stream
   init                   Bootstrap and initialize a new genesis block
   js                     (DEPRECATED) Execute the specified JavaScript files
   license                Display license information
   makecache              Generate ethash verification cache (for testing)
   makedag                Generate ethash mining DAG (for testing)
   removedb               Remove blockchain and state databases
   show-deprecated-flags  Show flags that have been deprecated
   snapshot               A set of commands based on the snapshot
   verkle                 A set of experimental verkle tree management commands
   version                Print version numbers
   version-check          Checks (online) for known Geth security vulnerabilities
   wallet                 Manage Ethereum presale wallets
   help, h                Shows a list of commands or help for one command
```

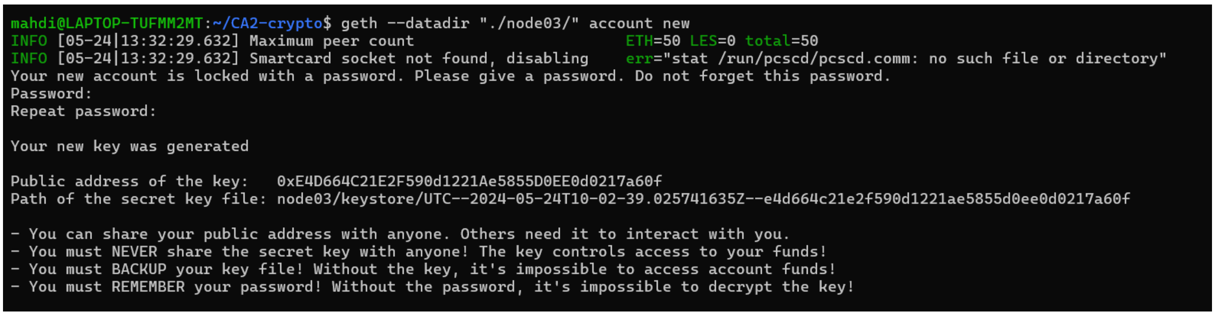
You can see the short description for each command in the picture. After creating directories for each node we create account for each of them.



```
mahdi@LAPTOP-TUFMM2MT:~/CA2-crypto$ geth --datadir "./node01/" account new
INFO [05-24|13:32:04.212] Maximum peer count                       ETH=50 LES=0 total=50
INFO [05-24|13:32:04.213] Smartcard socket not found, disabling    err="stat /run/pcscd/pcscd.comm: no such file or directory"
Your new account is locked with a password. Please give a password. Do not forget this password.
Password:
Repeat password:

Your new key was generated

Public address of the key:   0x1183af70631B90e654cADdc449E0d5C00de60d80
Path of the secret key file: node01/keystore/UTC--2024-05-24T10-02-09.649684365Z--1183af70631b90e654caddc449e0d5c00de60d80

- You can share your public address with anyone. Others need it to interact with you.
- You must NEVER share the secret key with anyone! The key controls access to your funds!
- You must BACKUP your key file! Without the key, it's impossible to access account funds!
- You must REMEMBER your password! Without the password, it's impossible to decrypt the key!
```

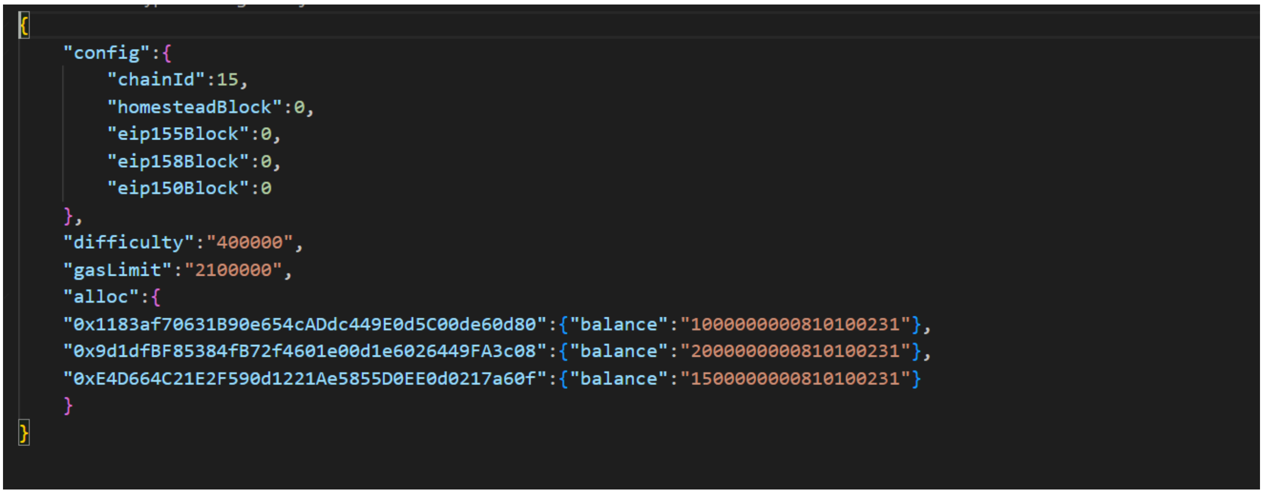


```
mahdi@LAPTOP-TUFMM2MT:~/CA2-crypto$ geth --datadir "./node02/" account new
INFO [05-24|13:32:17.287] Maximum peer count                       ETH=50 LES=0 total=50
INFO [05-24|13:32:17.287] Smartcard socket not found, disabling    err="stat /run/pcscd/pcscd.comm: no such file or directory"
Your new account is locked with a password. Please give a password. Do not forget this password.
Password:
Repeat password:

Your new key was generated

Public address of the key:   0x9d1dfBF85384fB72f4601e00d1e6026449FA3c08
Path of the secret key file: node02/keystore/UTC--2024-05-24T10-02-22.745200005Z--9d1dfbf85384fb72f4601e00d1e6026449fa3c08

- You can share your public address with anyone. Others need it to interact with you.
- You must NEVER share the secret key with anyone! The key controls access to your funds!
- You must BACKUP your key file! Without the key, it's impossible to access account funds!
- You must REMEMBER your password! Without the password, it's impossible to decrypt the key!
```



```
mahdi@LAPTOP-TUFMM2MT:~/CA2-crypto$ geth --datadir "./node03/" account new
INFO [05-24|13:32:29.632] Maximum peer count                       ETH=50 LES=0 total=50
INFO [05-24|13:32:29.632] Smartcard socket not found, disabling    err="stat /run/pcscd/pcscd.comm: no such file or directory"
Your new account is locked with a password. Please give a password. Do not forget this password.
Password:
Repeat password:

Your new key was generated

Public address of the key:   0xE4D664C21E2F590d1221Ae5855D0EE0d0217a60f
Path of the secret key file: node03/keystore/UTC--2024-05-24T10-02-39.025741635Z--e4d664c21e2f590d1221ae5855d0ee0d0217a60f

- You can share your public address with anyone. Others need it to interact with you.
- You must NEVER share the secret key with anyone! The key controls access to your funds!
- You must BACKUP your key file! Without the key, it's impossible to access account funds!
- You must REMEMBER your password! Without the password, it's impossible to decrypt the key!
```

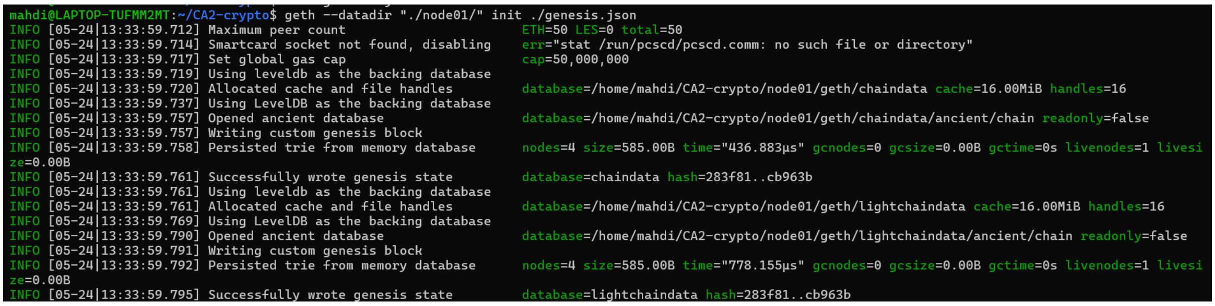
Now that we have the address for each account in each node we configure the genesis block.



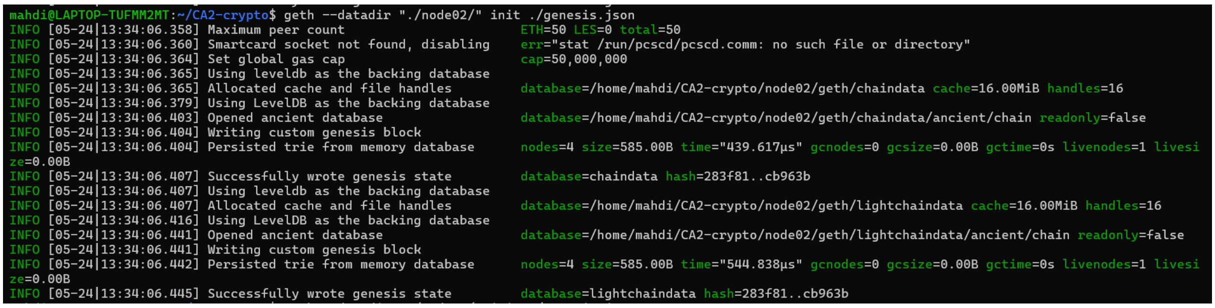
```
{
    "config":{
        "chainId":15,
        "homesteadBlock":0,
        "eip155Block":0,
        "eip158Block":0,
        "eip150Block":0
    },
    "difficulty":"400000",
    "gasLimit":"2100000",
    "alloc":{
    "0x1183af70631B90e654cADdc449E0d5C00de60d80":{"balance":"1000000000810100231"},
    "0x9d1dfBF85384fB72f4601e00d1e6026449FA3c08":{"balance":"2000000000810100231"},
    "0xE4D664C21E2F590d1221Ae5855D0EE0d0217a60f":{"balance":"1500000000810100231"}
    }
}
```

As it is obvious we allocate each address with a specific balance.

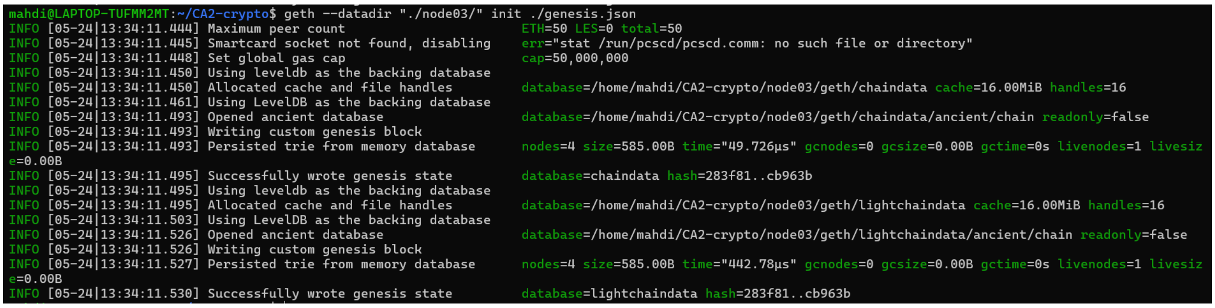
Now we initialize each node with the configured genesis block.



```
mahdi@LAPTOP-TUFMM2MT:~/CA2-crypto$ geth --datadir "./node01/" init ./genesis.json
INFO [05-24|13:33:59.712] Maximum peer count                       ETH=50 LES=0 total=50
INFO [05-24|13:33:59.714] Smartcard socket not found, disabling    err="stat /run/pcscd/pcscd.comm: no such file or directory"
INFO [05-24|13:33:59.717] Set global gas cap                       cap=50,000,000
INFO [05-24|13:33:59.719] Using leveldb as the backing database
INFO [05-24|13:33:59.720] Allocated cache and file handles         database=/home/mahdi/CA2-crypto/node01/geth/chaindata cache=16.00MiB handles=16
INFO [05-24|13:33:59.737] Using LevelDB as the backing database
INFO [05-24|13:33:59.757] Opened ancient database                  database=/home/mahdi/CA2-crypto/node01/geth/chaindata/ancient/chain readonly=false
INFO [05-24|13:33:59.757] Writing custom genesis block
INFO [05-24|13:33:59.758] Persisted trie from memory database      nodes=4 size=585.00B time="436.883µs" gcnodes=0 gcsize=0.00B gctime=0s livenodes=1 livesi
ze=0.00B
INFO [05-24|13:33:59.761] Successfully wrote genesis state         database=chaindata hash=283f81..cb963b
INFO [05-24|13:33:59.761] Using leveldb as the backing database
INFO [05-24|13:33:59.761] Allocated cache and file handles         database=/home/mahdi/CA2-crypto/node01/geth/lightchaindata cache=16.00MiB handles=16
INFO [05-24|13:33:59.769] Using LevelDB as the backing database
INFO [05-24|13:33:59.790] Opened ancient database                  database=/home/mahdi/CA2-crypto/node01/geth/lightchaindata/ancient/chain readonly=false
INFO [05-24|13:33:59.791] Writing custom genesis block
INFO [05-24|13:33:59.792] Persisted trie from memory database      nodes=4 size=585.00B time="778.155µs" gcnodes=0 gcsize=0.00B gctime=0s livenodes=1 livesi
ze=0.00B
INFO [05-24|13:33:59.795] Successfully wrote genesis state         database=lightchaindata hash=283f81..cb963b
```

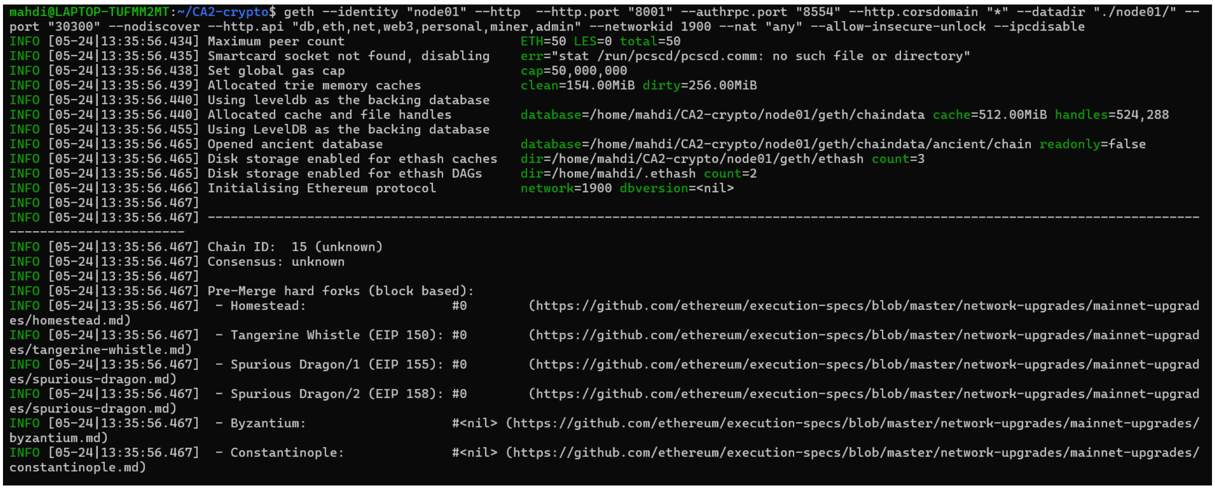


```
mahdi@LAPTOP-TUFMM2MT:~/CA2-crypto$ geth --datadir "./node02/" init ./genesis.json
INFO [05-24|13:34:06.358] Maximum peer count                       ETH=50 LES=0 total=50
INFO [05-24|13:34:06.360] Smartcard socket not found, disabling    err="stat /run/pcscd/pcscd.comm: no such file or directory"
INFO [05-24|13:34:06.364] Set global gas cap                       cap=50,000,000
INFO [05-24|13:34:06.365] Using leveldb as the backing database
INFO [05-24|13:34:06.365] Allocated cache and file handles         database=/home/mahdi/CA2-crypto/node02/geth/chaindata cache=16.00MiB handles=16
INFO [05-24|13:34:06.379] Using LevelDB as the backing database
INFO [05-24|13:34:06.403] Opened ancient database                  database=/home/mahdi/CA2-crypto/node02/geth/chaindata/ancient/chain readonly=false
INFO [05-24|13:34:06.404] Writing custom genesis block
INFO [05-24|13:34:06.404] Persisted trie from memory database      nodes=4 size=585.00B time="439.617µs" gcnodes=0 gcsize=0.00B gctime=0s livenodes=1 livesi
ze=0.00B
INFO [05-24|13:34:06.407] Successfully wrote genesis state         database=chaindata hash=283f81..cb963b
INFO [05-24|13:34:06.407] Using leveldb as the backing database
INFO [05-24|13:34:06.407] Allocated cache and file handles         database=/home/mahdi/CA2-crypto/node02/geth/lightchaindata cache=16.00MiB handles=16
INFO [05-24|13:34:06.416] Using LevelDB as the backing database
INFO [05-24|13:34:06.441] Opened ancient database                  database=/home/mahdi/CA2-crypto/node02/geth/lightchaindata/ancient/chain readonly=false
INFO [05-24|13:34:06.441] Writing custom genesis block
INFO [05-24|13:34:06.442] Persisted trie from memory database      nodes=4 size=585.00B time="544.838µs" gcnodes=0 gcsize=0.00B gctime=0s livenodes=1 livesi
ze=0.00B
INFO [05-24|13:34:06.445] Successfully wrote genesis state         database=lightchaindata hash=283f81..cb963b
```

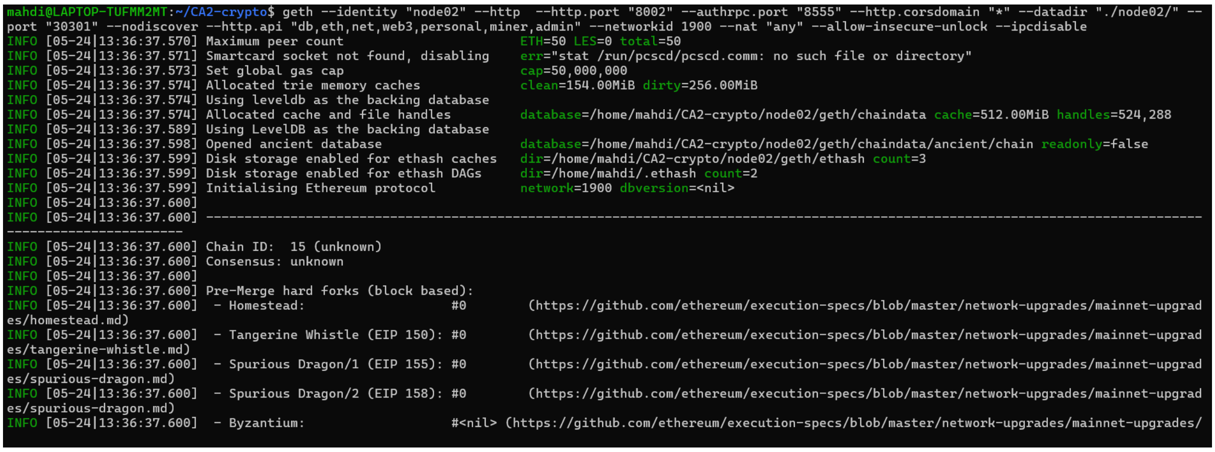


```
mahdi@LAPTOP-TUFMM2MT:~/CA2-crypto$ geth --datadir "./node03/" init ./genesis.json
INFO [05-24|13:34:11.444] Maximum peer count                       ETH=50 LES=0 total=50
INFO [05-24|13:34:11.445] Smartcard socket not found, disabling    err="stat /run/pcscd/pcscd.comm: no such file or directory"
INFO [05-24|13:34:11.448] Set global gas cap                       cap=50,000,000
INFO [05-24|13:34:11.450] Using leveldb as the backing database
INFO [05-24|13:34:11.450] Allocated cache and file handles         database=/home/mahdi/CA2-crypto/node03/geth/chaindata cache=16.00MiB handles=16
INFO [05-24|13:34:11.461] Using LevelDB as the backing database
INFO [05-24|13:34:11.493] Opened ancient database                  database=/home/mahdi/CA2-crypto/node03/geth/chaindata/ancient/chain readonly=false
INFO [05-24|13:34:11.493] Writing custom genesis block
INFO [05-24|13:34:11.493] Persisted trie from memory database      nodes=4 size=585.00B time="49.726µs" gcnodes=0 gcsize=0.00B gctime=0s livenodes=1 livesiz
e=0.00B
INFO [05-24|13:34:11.495] Successfully wrote genesis state         database=chaindata hash=283f81..cb963b
INFO [05-24|13:34:11.495] Using leveldb as the backing database
INFO [05-24|13:34:11.495] Allocated cache and file handles         database=/home/mahdi/CA2-crypto/node03/geth/lightchaindata cache=16.00MiB handles=16
INFO [05-24|13:34:11.503] Using LevelDB as the backing database
INFO [05-24|13:34:11.526] Opened ancient database                  database=/home/mahdi/CA2-crypto/node03/geth/lightchaindata/ancient/chain readonly=false
INFO [05-24|13:34:11.526] Writing custom genesis block
INFO [05-24|13:34:11.527] Persisted trie from memory database      nodes=4 size=585.00B time="442.78µs" gcnodes=0 gcsize=0.00B gctime=0s livenodes=1 livesiz
e=0.00B
INFO [05-24|13:34:11.530] Successfully wrote genesis state         database=lightchaindata hash=283f81..cb963b
```

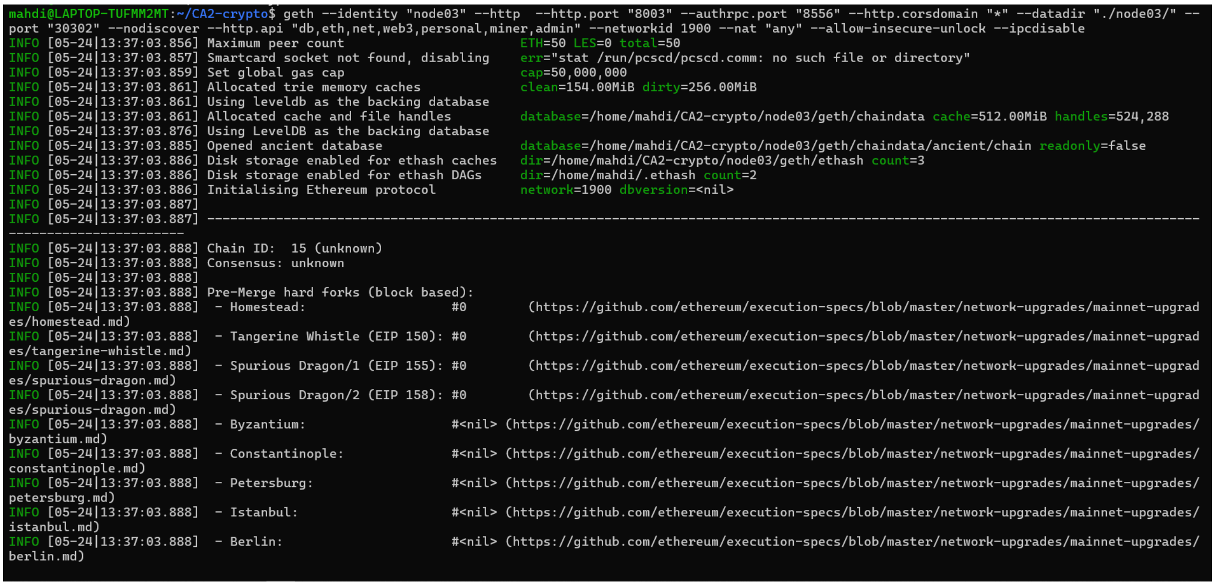
Now after the initialization we start each node’s server.



```
mahdi@LAPTOP-TUFMM2MT:~/CA2-crypto$ geth --identity "node01" --http  --http.port "8001" --authrpc.port "8554" --http.corsdomain "*" --datadir "./node01/" --
port "30300" --nodiscover --http.api "db,eth,net,web3,personal,miner,admin" --networkid 1900 --nat "any" --allow-insecure-unlock --ipcdisable
INFO [05-24|13:35:56.434] Maximum peer count                       ETH=50 LES=0 total=50
INFO [05-24|13:35:56.435] Smartcard socket not found, disabling    err="stat /run/pcscd/pcscd.comm: no such file or directory"
INFO [05-24|13:35:56.438] Set global gas cap                       cap=50,000,000
INFO [05-24|13:35:56.439] Allocated trie memory caches             clean=154.00MiB dirty=256.00MiB
INFO [05-24|13:35:56.440] Using leveldb as the backing database
INFO [05-24|13:35:56.440] Allocated cache and file handles         database=/home/mahdi/CA2-crypto/node01/geth/chaindata cache=512.00MiB handles=524,288
INFO [05-24|13:35:56.455] Using LevelDB as the backing database
INFO [05-24|13:35:56.465] Opened ancient database                  database=/home/mahdi/CA2-crypto/node01/geth/chaindata/ancient/chain readonly=false
INFO [05-24|13:35:56.465] Disk storage enabled for ethash caches   dir=/home/mahdi/CA2-crypto/node01/geth/ethash count=3
INFO [05-24|13:35:56.465] Disk storage enabled for ethash DAGs     dir=/home/mahdi/.ethash count=2
INFO [05-24|13:35:56.466] Initialising Ethereum protocol           network=1900 dbversion=<nil>
INFO [05-24|13:35:56.467]
INFO [05-24|13:35:56.467] -------------------------------------------------------------------------------------------------------------------------------
----------------------
INFO [05-24|13:35:56.467] Chain ID:  15 (unknown)
INFO [05-24|13:35:56.467] Consensus: unknown
INFO [05-24|13:35:56.467]
INFO [05-24|13:35:56.467] Pre-Merge hard forks (block based):
INFO [05-24|13:35:56.467]  - Homestead:                   #0        (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrad
es/homestead.md)
INFO [05-24|13:35:56.467]  - Tangerine Whistle (EIP 150): #0        (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrad
es/tangerine-whistle.md)
INFO [05-24|13:35:56.467]  - Spurious Dragon/1 (EIP 155): #0        (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrad
es/spurious-dragon.md)
INFO [05-24|13:35:56.467]  - Spurious Dragon/2 (EIP 158): #0        (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrad
es/spurious-dragon.md)
INFO [05-24|13:35:56.467]  - Byzantium:                   #<nil> (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrades/
byzantium.md)
INFO [05-24|13:35:56.467]  - Constantinople:              #<nil> (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrades/
constantinople.md)
```



```
mahdi@LAPTOP-TUFMM2MT:~/CA2-crypto$ geth --identity "node02" --http  --http.port "8002" --authrpc.port "8555" --http.corsdomain "*" --datadir "./node02/" --
port "30301" --nodiscover --http.api "db,eth,net,web3,personal,miner,admin" --networkid 1900 --nat "any" --allow-insecure-unlock --ipcdisable
INFO [05-24|13:36:37.570] Maximum peer count                       ETH=50 LES=0 total=50
INFO [05-24|13:36:37.571] Smartcard socket not found, disabling    err="stat /run/pcscd/pcscd.comm: no such file or directory"
INFO [05-24|13:36:37.573] Set global gas cap                       cap=50,000,000
INFO [05-24|13:36:37.574] Allocated trie memory caches             clean=154.00MiB dirty=256.00MiB
INFO [05-24|13:36:37.574] Using leveldb as the backing database
INFO [05-24|13:36:37.574] Allocated cache and file handles         database=/home/mahdi/CA2-crypto/node02/geth/chaindata cache=512.00MiB handles=524,288
INFO [05-24|13:36:37.589] Using LevelDB as the backing database
INFO [05-24|13:36:37.598] Opened ancient database                  database=/home/mahdi/CA2-crypto/node02/geth/chaindata/ancient/chain readonly=false
INFO [05-24|13:36:37.599] Disk storage enabled for ethash caches   dir=/home/mahdi/CA2-crypto/node02/geth/ethash count=3
INFO [05-24|13:36:37.599] Disk storage enabled for ethash DAGs     dir=/home/mahdi/.ethash count=2
INFO [05-24|13:36:37.599] Initialising Ethereum protocol           network=1900 dbversion=<nil>
INFO [05-24|13:36:37.600]
INFO [05-24|13:36:37.600] ----------------------------------------------------------------------------------------------------------------------------
-----------------------
INFO [05-24|13:36:37.600] Chain ID:  15 (unknown)
INFO [05-24|13:36:37.600] Consensus: unknown
INFO [05-24|13:36:37.600]
INFO [05-24|13:36:37.600] Pre-Merge hard forks (block based):
INFO [05-24|13:36:37.600]  - Homestead:                   #0        (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrad
es/homestead.md)
INFO [05-24|13:36:37.600]  - Tangerine Whistle (EIP 150): #0        (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrad
es/tangerine-whistle.md)
INFO [05-24|13:36:37.600]  - Spurious Dragon/1 (EIP 155): #0        (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrad
es/spurious-dragon.md)
INFO [05-24|13:36:37.600]  - Spurious Dragon/2 (EIP 158): #0        (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrad
es/spurious-dragon.md)
INFO [05-24|13:36:37.600]  - Byzantium:                   #<nil> (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrades/
```



```
mahdi@LAPTOP-TUFMM2MT:~/CA2-crypto$ geth --identity "node03" --http  --http.port "8003" --authrpc.port "8556" --http.corsdomain "*" --datadir "./node03/" --
port "30302" --nodiscover --http.api "db,eth,net,web3,personal,miner,admin" --networkid 1900 --nat "any" --allow-insecure-unlock --ipcdisable
INFO [05-24|13:37:03.856] Maximum peer count                       ETH=50 LES=0 total=50
INFO [05-24|13:37:03.857] Smartcard socket not found, disabling    err="stat /run/pcscd/pcscd.comm: no such file or directory"
INFO [05-24|13:37:03.859] Set global gas cap                       cap=50,000,000
INFO [05-24|13:37:03.861] Allocated trie memory caches             clean=154.00MiB dirty=256.00MiB
INFO [05-24|13:37:03.861] Using leveldb as the backing database
INFO [05-24|13:37:03.861] Allocated cache and file handles         database=/home/mahdi/CA2-crypto/node03/geth/chaindata cache=512.00MiB handles=524,288
INFO [05-24|13:37:03.876] Using LevelDB as the backing database
INFO [05-24|13:37:03.885] Opened ancient database                  database=/home/mahdi/CA2-crypto/node03/geth/chaindata/ancient/chain readonly=false
INFO [05-24|13:37:03.886] Disk storage enabled for ethash caches   dir=/home/mahdi/CA2-crypto/node03/geth/ethash count=3
INFO [05-24|13:37:03.886] Disk storage enabled for ethash DAGs     dir=/home/mahdi/.ethash count=2
INFO [05-24|13:37:03.886] Initialising Ethereum protocol           network=1900 dbversion=<nil>
INFO [05-24|13:37:03.887]
INFO [05-24|13:37:03.887] ----------------------------------------------------------------------------------------------------------------------------
-----------------------
INFO [05-24|13:37:03.888] Chain ID:  15 (unknown)
INFO [05-24|13:37:03.888] Consensus: unknown
INFO [05-24|13:37:03.888]
INFO [05-24|13:37:03.888] Pre-Merge hard forks (block based):
INFO [05-24|13:37:03.888]  - Homestead:                   #0        (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrad
es/homestead.md)
INFO [05-24|13:37:03.888]  - Tangerine Whistle (EIP 150): #0        (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrad
es/tangerine-whistle.md)
INFO [05-24|13:37:03.888]  - Spurious Dragon/1 (EIP 155): #0        (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrad
es/spurious-dragon.md)
INFO [05-24|13:37:03.888]  - Spurious Dragon/2 (EIP 158): #0        (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrad
es/spurious-dragon.md)
INFO [05-24|13:37:03.888]  - Byzantium:                   #<nil> (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrades/
byzantium.md)
INFO [05-24|13:37:03.888]  - Constantinople:              #<nil> (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrades/
constantinople.md)
INFO [05-24|13:37:03.888]  - Petersburg:                  #<nil> (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrades/
petersburg.md)
INFO [05-24|13:37:03.888]  - Istanbul:                    #<nil> (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrades/
istanbul.md)
INFO [05-24|13:37:03.888]  - Berlin:                      #<nil> (https://github.com/ethereum/execution-specs/blob/master/network-upgrades/mainnet-upgrades/
berlin.md)
```

Here are the profile about each node :

Node 1 :

Connection port : 8001	Listening port : 30300

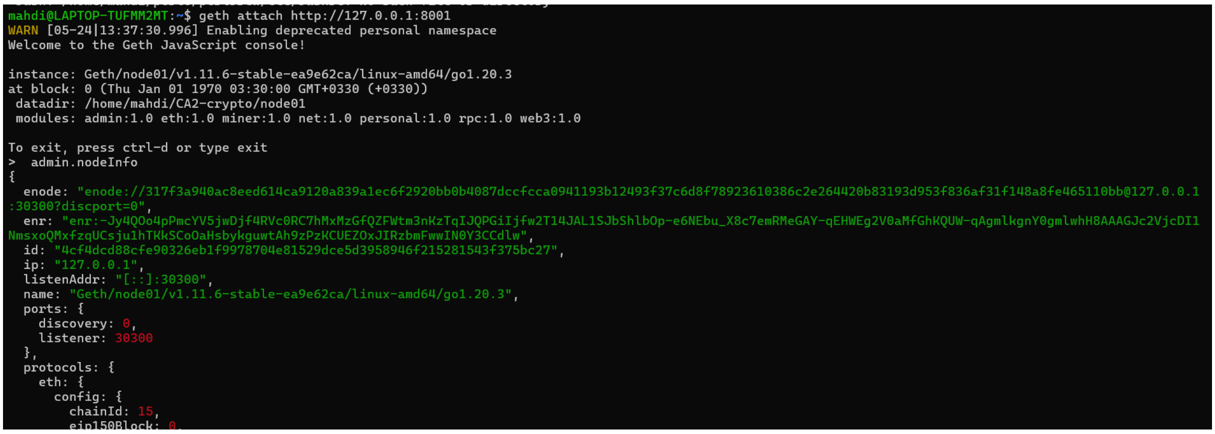
Node 2 :

Connection port : 8002	Listening port : 30301

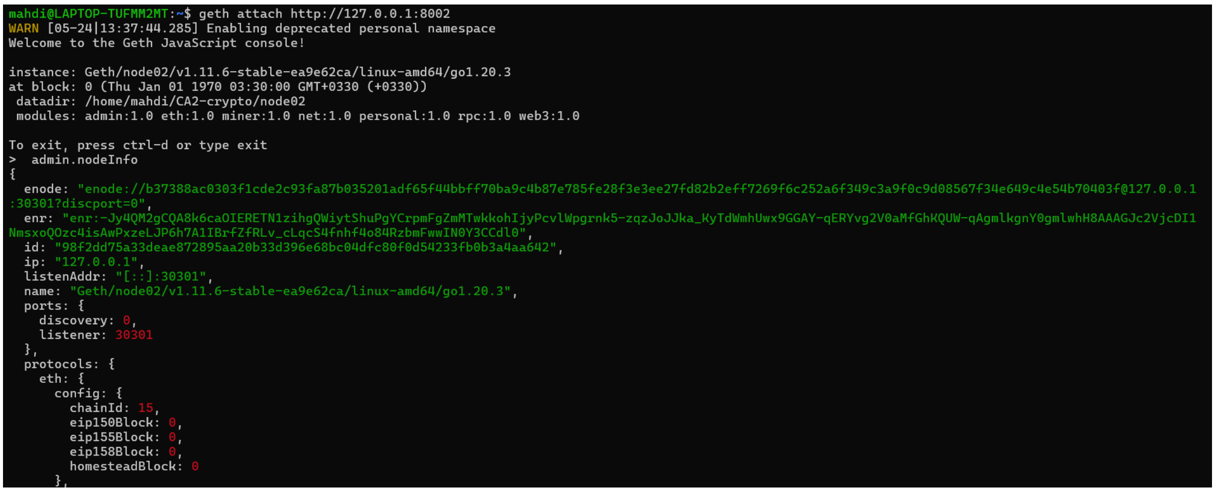
Node 3 :

Connection port : 8003	Listening port : 30302

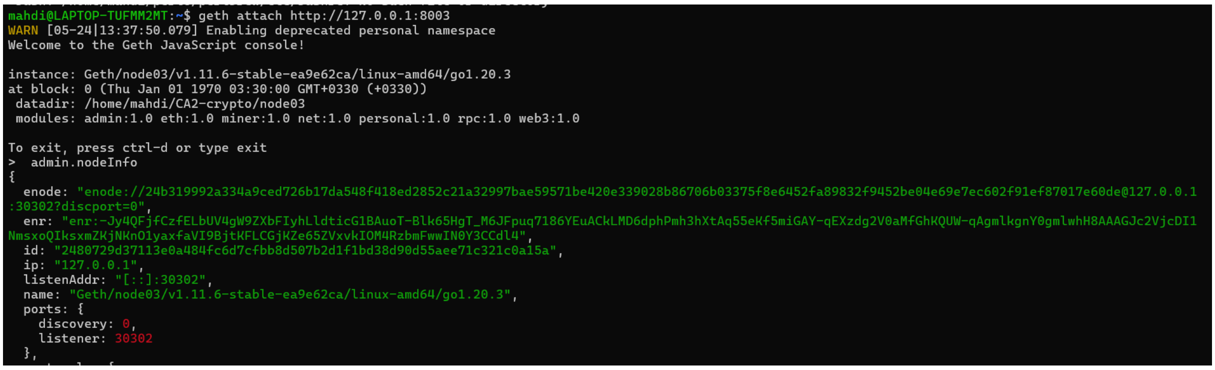
Now using the provided js console we connect to each node and get the node’s info.



```
mahdi@LAPTOP-TUFMM2MT:~$ geth attach http://127.0.0.1:8001
WARN [05-24|13:37:30.996] Enabling deprecated personal namespace
Welcome to the Geth JavaScript console!

instance: Geth/node01/v1.11.6-stable-ea9e62ca/linux-amd64/go1.20.3
at block: 0 (Thu Jan 01 1970 03:30:00 GMT+0330 (+0330))
 datadir: /home/mahdi/CA2-crypto/node01
 modules: admin:1.0 eth:1.0 miner:1.0 net:1.0 personal:1.0 rpc:1.0 web3:1.0

To exit, press ctrl-d or type exit
>  admin.nodeInfo
{
  enode: "enode://317f3a940ac8eed614ca9120a839a1ec6f2920bb0b4087dccfcca0941193b12493f37c6d8f78923610386c2e264420b83193d953f836af31f148a8fe465110bb@127.0.0.1
:30300?discport=0",
  enr: "enr:-Jy4QOo4pPmcYV5jwDjf4RVc0RC7hMxMzGfQZFWtm3nKzTqIJQPGiIjfw2T14JAL1SJbShlbOp-e6NEbu_X8c7emRMeGAY-qEHWEg2V0aMfGhKQUW-qAgmlkgnY0gmlwhH8AAAGJc2VjcDI1
NmsxoQMxfzqUCsju1hTKkSCoOaHsbykguwtAh9zPzKCUEZOxJIRzbmFwwIN0Y3CCdlw",
  id: "4cf4dcd88cfe90326eb1f9978704e81529dce5d3958946f215281543f375bc27",
  ip: "127.0.0.1",
  listenAddr: "[::]:30300",
  name: "Geth/node01/v1.11.6-stable-ea9e62ca/linux-amd64/go1.20.3",
  ports: {
    discovery: 0,
    listener: 30300
  },
  protocols: {
    eth: {
      config: {
        chainId: 15,
        eip150Block: 0,
```



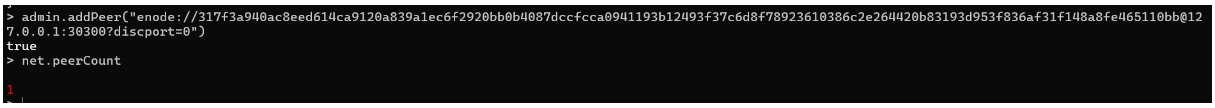
```
mahdi@LAPTOP-TUFMM2MT:~$ geth attach http://127.0.0.1:8002
WARN [05-24|13:37:44.285] Enabling deprecated personal namespace
Welcome to the Geth JavaScript console!

instance: Geth/node02/v1.11.6-stable-ea9e62ca/linux-amd64/go1.20.3
at block: 0 (Thu Jan 01 1970 03:30:00 GMT+0330 (+0330))
 datadir: /home/mahdi/CA2-crypto/node02
 modules: admin:1.0 eth:1.0 miner:1.0 net:1.0 personal:1.0 rpc:1.0 web3:1.0

To exit, press ctrl-d or type exit
>  admin.nodeInfo
{
  enode: "enode://b37388ac0303f1cde2c93fa87b035201adf65f44bbff70ba9c4b87e785fe28f3e3ee27fd82b2eff7269f6c252a6f349c3a9f0c9d08567f34e649c4e54b70403f@127.0.0.1
:30301?discport=0",
  enr: "enr:-Jy4QM2gCQA8k6caOIERETN1zihgQWiytShuPgYCrpmFgZmMTwkkohIjyPcvlWpgrnk5-zqzJoJJka_KyTdWmhUwx9GGAY-qERYvg2V0aMfGhKQUW-qAgmlkgnY0gmlwhH8AAAGJc2VjcDI1
NmsxoQOzc4isAwPxzeLJP6h7A1IBrfZfRLv_cLqcS4fnhf4o84RzbmFwwIN0Y3CCdl0",
  id: "98f2dd75a33deae872895aa20b33d396e68bc04dfc80f0d54233fb0b3a4aa642",
  ip: "127.0.0.1",
  listenAddr: "[::]:30301",
  name: "Geth/node02/v1.11.6-stable-ea9e62ca/linux-amd64/go1.20.3",
  ports: {
    discovery: 0,
    listener: 30301
  },
  protocols: {
    eth: {
      config: {
        chainId: 15,
        eip150Block: 0,
        eip155Block: 0,
        eip158Block: 0,
        homesteadBlock: 0
      },
```



```
mahdi@LAPTOP-TUFMM2MT:~$ geth attach http://127.0.0.1:8003
WARN [05-24|13:37:50.079] Enabling deprecated personal namespace
Welcome to the Geth JavaScript console!

instance: Geth/node03/v1.11.6-stable-ea9e62ca/linux-amd64/go1.20.3
at block: 0 (Thu Jan 01 1970 03:30:00 GMT+0330 (+0330))
 datadir: /home/mahdi/CA2-crypto/node03
 modules: admin:1.0 eth:1.0 miner:1.0 net:1.0 personal:1.0 rpc:1.0 web3:1.0

To exit, press ctrl-d or type exit
>  admin.nodeInfo
{
  enode: "enode://24b319992a334a9ced726b17da548f418ed2852c21a32997bae59571be420e339028b86706b03375f8e6452fa89832f9452be04e69e7ec602f91ef87017e60de@127.0.0.1
:30302?discport=0",
  enr: "enr:-Jy4QFjfCzfELbUV4gW9ZXbFIyhLldticG1BAuoT-Blk65HgT_M6JFpuq7186YEuACkLMD6dphPmh3hXtAq55eKf5miGAY-qEXzdg2V0aMfGhKQUW-qAgmlkgnY0gmlwhH8AAAGJc2VjcDI1
NmsxoQIksxmZKjNKnO1yaxfaVI9BjtKFLCGjKZe65ZVxvkIOM4RzbmFwwIN0Y3CCdl4",
  id: "2480729d37113e0a484fc6d7cfbb8d507b2d1f1bd38d90d55aee71c321c0a15a",
  ip: "127.0.0.1",
  listenAddr: "[::]:30302",
  name: "Geth/node03/v1.11.6-stable-ea9e62ca/linux-amd64/go1.20.3",
  ports: {
    discovery: 0,
    listener: 30302
  },
```

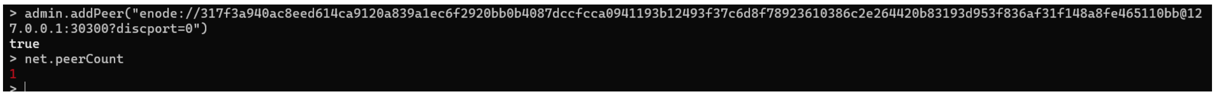
Now we connect nodes to each other. Here we take the node 1 as the central node and using its enode we connect the other two to it. To verify the connection we use peerCount command.

Because of the fact that node 1 is the central node its peerCount should be **2** and the others should be **1**.



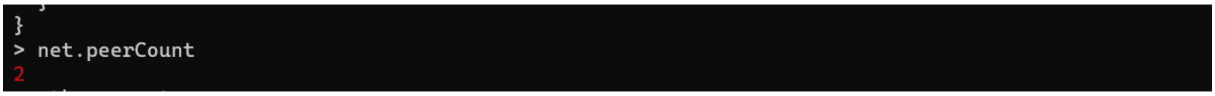
```
> admin.addPeer("enode://317f3a940ac8eed614ca9120a839a1ec6f2920bb0b4087dccfcca0941193b12493f37c6d8f78923610386c2e264420b83193d953f836af31f148a8fe465110bb@12
7.0.0.1:30300?discport=0")
true
> net.peerCount

1
```

(node2)



```
> admin.addPeer("enode://317f3a940ac8eed614ca9120a839a1ec6f2920bb0b4087dccfcca0941193b12493f37c6d8f78923610386c2e264420b83193d953f836af31f148a8fe465110bb@12
7.0.0.1:30300?discport=0")
true
> net.peerCount
1
```

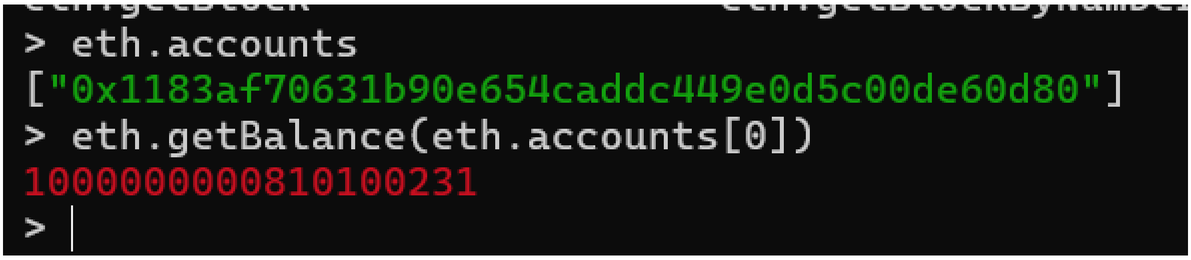
(node3)



```
}
> net.peerCount
2
```

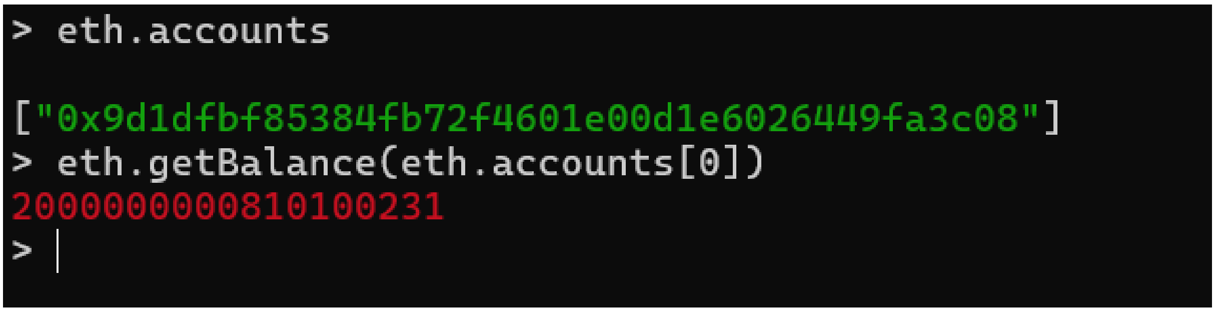
(node1)

Now lets check each node account address and balance.



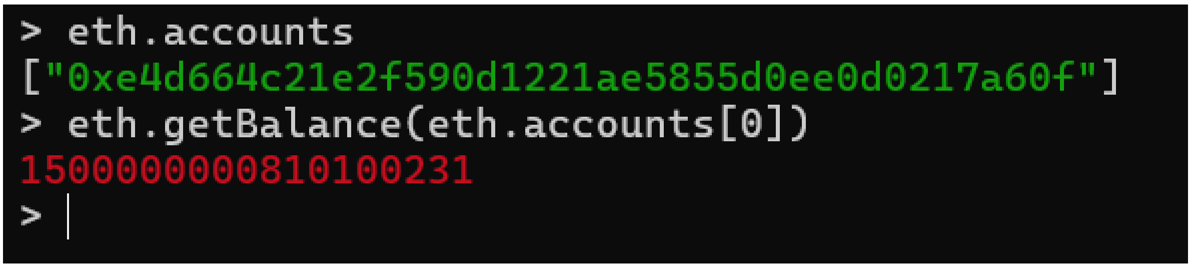
```
> eth.accounts
["0x1183af70631b90e654caddc449e0d5c00de60d80"]
> eth.getBalance(eth.accounts[0])
1000000000810100231
>
```

(node 1)



```
> eth.accounts

["0x9d1dfbf85384fb72f4601e00d1e6026449fa3c08"]
> eth.getBalance(eth.accounts[0])
2000000000810100231
>
```

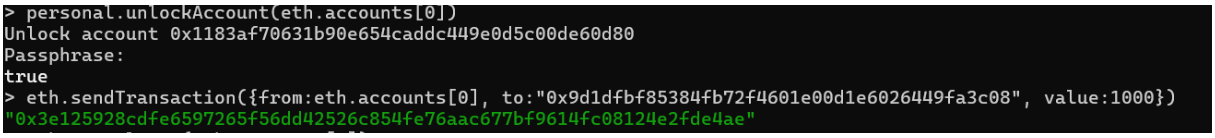
(node 2)



```
> eth.accounts
["0xe4d664c21e2f590d1221ae5855d0ee0d0217a60f"]
> eth.getBalance(eth.accounts[0])
1500000000810100231
>
```

(node 3)

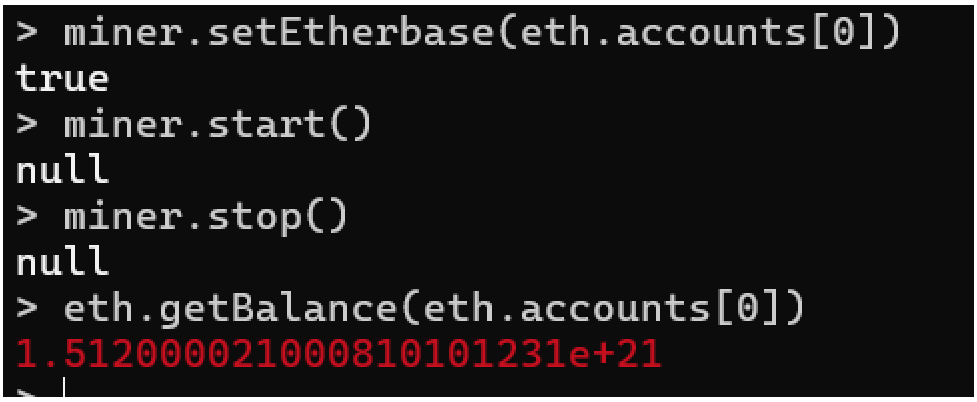
Now we start a transaction. Here the centre node tries to send **1000** coins to node 2.



```
> personal.unlockAccount(eth.accounts[0])
Unlock account 0x1183af70631b90e654caddc449e0d5c00de60d80
Passphrase:
true
> eth.sendTransaction({from:eth.accounts[0], to:"0x9d1dfbf85384fb72f4601e00d1e6026449fa3c08", value:1000})
"0x3e125928cdfe6597265f56dd42526c854fe76aac677bf9614fc08124e2fde4ae"
```

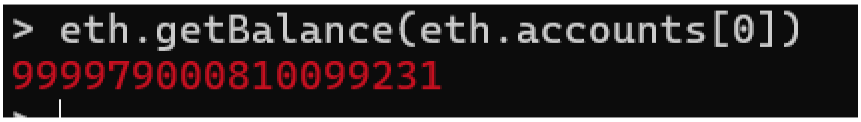
As it is obvious after unlocking the account with the centre node password we send the coins to node 2 where its address is specified in the picture.

Now we have to mine the block so the transaction gets done. We use node 2 to mine blocks.
The configuration is shown.



```
> miner.setEtherbase(eth.accounts[0])
true
> miner.start()
null
> miner.stop()
null
> eth.getBalance(eth.accounts[0])
1.512000021000810101231e+21
```

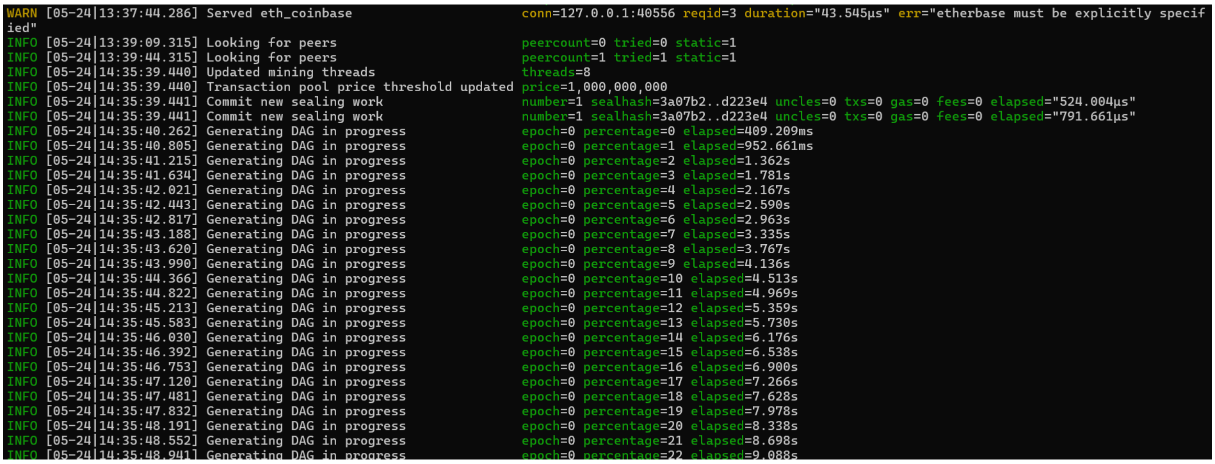
As you can see as the result of mining and the transaction coins the balance has increased.



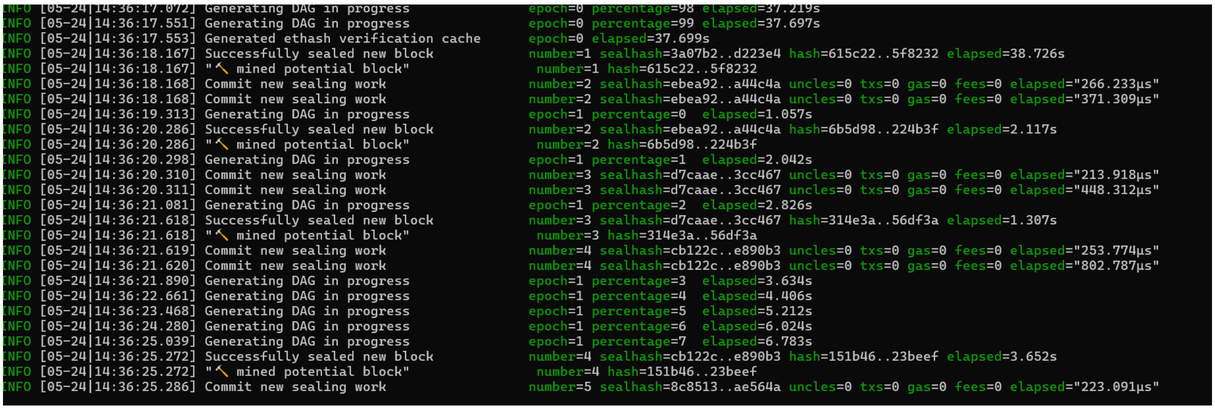
```
> eth.getBalance(eth.accounts[0])
999979000810099231
```

And the other thing to notice as you can see above is that because of the transaction the central node coins have decreased.

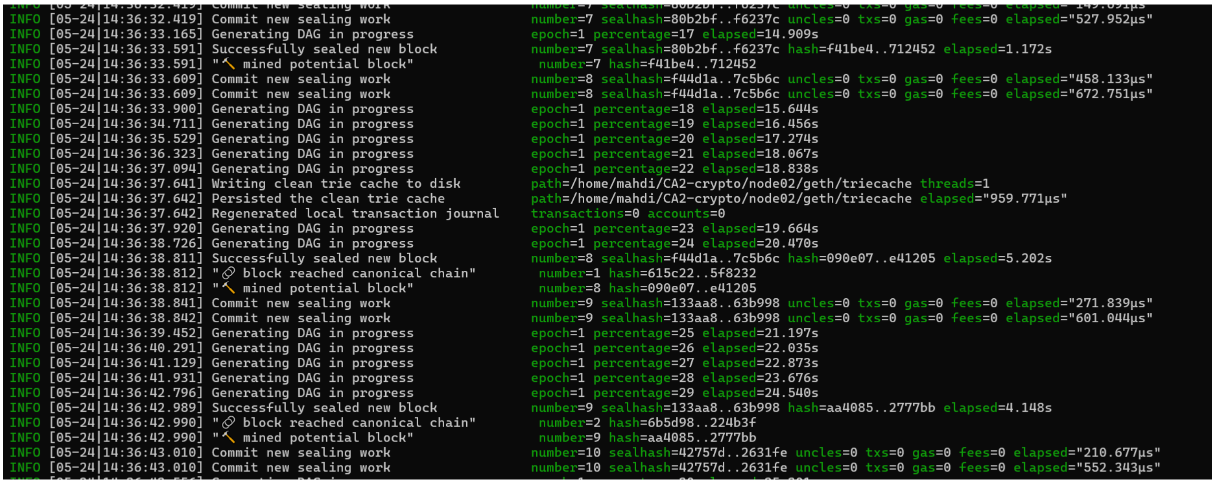
Here we can see the mining logs.



```
WARN [05-24|13:37:44.286] Served eth_coinbase                      conn=127.0.0.1:40556 reqid=3 duration="43.545µs" err="etherbase must be explicitly specif
ied"
INFO [05-24|13:39:09.315] Looking for peers                        peercount=0 tried=0 static=1
INFO [05-24|13:39:44.315] Looking for peers                        peercount=1 tried=1 static=1
INFO [05-24|14:35:39.440] Updated mining threads                   threads=8
INFO [05-24|14:35:39.440] Transaction pool price threshold updated price=1,000,000,000
INFO [05-24|14:35:39.441] Commit new sealing work                  number=1 sealhash=3a07b2..d223e4 uncles=0 txs=0 gas=0 fees=0 elapsed="524.004µs"
INFO [05-24|14:35:39.441] Commit new sealing work                  number=1 sealhash=3a07b2..d223e4 uncles=0 txs=0 gas=0 fees=0 elapsed="791.661µs"
INFO [05-24|14:35:40.262] Generating DAG in progress               epoch=0 percentage=0 elapsed=409.209ms
INFO [05-24|14:35:40.805] Generating DAG in progress               epoch=0 percentage=1 elapsed=952.661ms
INFO [05-24|14:35:41.215] Generating DAG in progress               epoch=0 percentage=2 elapsed=1.362s
INFO [05-24|14:35:41.634] Generating DAG in progress               epoch=0 percentage=3 elapsed=1.781s
INFO [05-24|14:35:42.021] Generating DAG in progress               epoch=0 percentage=4 elapsed=2.167s
INFO [05-24|14:35:42.443] Generating DAG in progress               epoch=0 percentage=5 elapsed=2.590s
INFO [05-24|14:35:42.817] Generating DAG in progress               epoch=0 percentage=6 elapsed=2.963s
INFO [05-24|14:35:43.188] Generating DAG in progress               epoch=0 percentage=7 elapsed=3.335s
INFO [05-24|14:35:43.620] Generating DAG in progress               epoch=0 percentage=8 elapsed=3.767s
INFO [05-24|14:35:43.990] Generating DAG in progress               epoch=0 percentage=9 elapsed=4.136s
INFO [05-24|14:35:44.366] Generating DAG in progress               epoch=0 percentage=10 elapsed=4.513s
INFO [05-24|14:35:44.822] Generating DAG in progress               epoch=0 percentage=11 elapsed=4.969s
INFO [05-24|14:35:45.213] Generating DAG in progress               epoch=0 percentage=12 elapsed=5.359s
INFO [05-24|14:35:45.583] Generating DAG in progress               epoch=0 percentage=13 elapsed=5.730s
INFO [05-24|14:35:46.030] Generating DAG in progress               epoch=0 percentage=14 elapsed=6.176s
INFO [05-24|14:35:46.392] Generating DAG in progress               epoch=0 percentage=15 elapsed=6.538s
INFO [05-24|14:35:46.753] Generating DAG in progress               epoch=0 percentage=16 elapsed=6.900s
INFO [05-24|14:35:47.120] Generating DAG in progress               epoch=0 percentage=17 elapsed=7.266s
INFO [05-24|14:35:47.481] Generating DAG in progress               epoch=0 percentage=18 elapsed=7.628s
INFO [05-24|14:35:47.832] Generating DAG in progress               epoch=0 percentage=19 elapsed=7.978s
INFO [05-24|14:35:48.191] Generating DAG in progress               epoch=0 percentage=20 elapsed=8.338s
INFO [05-24|14:35:48.552] Generating DAG in progress               epoch=0 percentage=21 elapsed=8.698s
INFO [05-24|14:35:48.941] Generating DAG in progress               epoch=0 percentage=22 elapsed=9.088s
```



```
INFO [05-24|14:36:17.072] Generating DAG in progress               epoch=0 percentage=98 elapsed=37.219s
INFO [05-24|14:36:17.551] Generating DAG in progress               epoch=0 percentage=99 elapsed=37.697s
INFO [05-24|14:36:17.553] Generated ethash verification cache      epoch=0 elapsed=37.699s
INFO [05-24|14:36:18.167] Successfully sealed new block            number=1 sealhash=3a07b2..d223e4 hash=615c22..5f8232 elapsed=38.726s
INFO [05-24|14:36:18.167] "🔨 mined potential block"                number=1 hash=615c22..5f8232
INFO [05-24|14:36:18.168] Commit new sealing work                  number=2 sealhash=ebea92..a44c4a uncles=0 txs=0 gas=0 fees=0 elapsed="266.233µs"
INFO [05-24|14:36:18.168] Commit new sealing work                  number=2 sealhash=ebea92..a44c4a uncles=0 txs=0 gas=0 fees=0 elapsed="371.309µs"
INFO [05-24|14:36:19.313] Generating DAG in progress               epoch=1 percentage=0  elapsed=1.057s
INFO [05-24|14:36:20.286] Successfully sealed new block            number=2 sealhash=ebea92..a44c4a hash=6b5d98..224b3f elapsed=2.117s
INFO [05-24|14:36:20.286] "🔨 mined potential block"                number=2 hash=6b5d98..224b3f
INFO [05-24|14:36:20.298] Generating DAG in progress               epoch=1 percentage=1  elapsed=2.042s
INFO [05-24|14:36:20.310] Commit new sealing work                  number=3 sealhash=d7caae..3cc467 uncles=0 txs=0 gas=0 fees=0 elapsed="213.918µs"
INFO [05-24|14:36:20.311] Commit new sealing work                  number=3 sealhash=d7caae..3cc467 uncles=0 txs=0 gas=0 fees=0 elapsed="448.312µs"
INFO [05-24|14:36:21.081] Generating DAG in progress               epoch=1 percentage=2  elapsed=2.826s
INFO [05-24|14:36:21.618] Successfully sealed new block            number=3 sealhash=d7caae..3cc467 hash=314e3a..56df3a elapsed=1.307s
INFO [05-24|14:36:21.618] "🔨 mined potential block"                number=3 hash=314e3a..56df3a
INFO [05-24|14:36:21.619] Commit new sealing work                  number=4 sealhash=cb122c..e890b3 uncles=0 txs=0 gas=0 fees=0 elapsed="253.774µs"
INFO [05-24|14:36:21.620] Commit new sealing work                  number=4 sealhash=cb122c..e890b3 uncles=0 txs=0 gas=0 fees=0 elapsed="802.787µs"
INFO [05-24|14:36:21.890] Generating DAG in progress               epoch=1 percentage=3  elapsed=3.634s
INFO [05-24|14:36:22.661] Generating DAG in progress               epoch=1 percentage=4  elapsed=4.406s
INFO [05-24|14:36:23.468] Generating DAG in progress               epoch=1 percentage=5  elapsed=5.212s
INFO [05-24|14:36:24.280] Generating DAG in progress               epoch=1 percentage=6  elapsed=6.024s
INFO [05-24|14:36:25.039] Generating DAG in progress               epoch=1 percentage=7  elapsed=6.783s
INFO [05-24|14:36:25.272] Successfully sealed new block            number=4 sealhash=cb122c..e890b3 hash=151b46..23beef elapsed=3.652s
INFO [05-24|14:36:25.272] "🔨 mined potential block"                number=4 hash=151b46..23beef
INFO [05-24|14:36:25.286] Commit new sealing work                  number=5 sealhash=8c8513..ae564a uncles=0 txs=0 gas=0 fees=0 elapsed="223.091µs"
```



```
INFO [05-24|14:36:32.419] Commit new sealing work                  number=7 sealhash=80b2bf..f6237c uncles=0 txs=0 gas=0 fees=0 elapsed="149.891µs"
INFO [05-24|14:36:32.419] Commit new sealing work                  number=7 sealhash=80b2bf..f6237c uncles=0 txs=0 gas=0 fees=0 elapsed="527.952µs"
INFO [05-24|14:36:33.165] Generating DAG in progress               epoch=1 percentage=17 elapsed=14.909s
INFO [05-24|14:36:33.591] Successfully sealed new block            number=7 sealhash=80b2bf..f6237c hash=f41be4..712452 elapsed=1.172s
INFO [05-24|14:36:33.591] "🔨 mined potential block"                number=7 hash=f41be4..712452
INFO [05-24|14:36:33.609] Commit new sealing work                  number=8 sealhash=f44d1a..7c5b6c uncles=0 txs=0 gas=0 fees=0 elapsed="458.133µs"
INFO [05-24|14:36:33.609] Commit new sealing work                  number=8 sealhash=f44d1a..7c5b6c uncles=0 txs=0 gas=0 fees=0 elapsed="672.751µs"
INFO [05-24|14:36:33.900] Generating DAG in progress               epoch=1 percentage=18 elapsed=15.644s
INFO [05-24|14:36:34.711] Generating DAG in progress               epoch=1 percentage=19 elapsed=16.456s
INFO [05-24|14:36:35.529] Generating DAG in progress               epoch=1 percentage=20 elapsed=17.274s
INFO [05-24|14:36:36.323] Generating DAG in progress               epoch=1 percentage=21 elapsed=18.067s
INFO [05-24|14:36:37.094] Generating DAG in progress               epoch=1 percentage=22 elapsed=18.838s
INFO [05-24|14:36:37.641] Writing clean trie cache to disk         path=/home/mahdi/CA2-crypto/node02/geth/triecache threads=1
INFO [05-24|14:36:37.642] Persisted the clean trie cache           path=/home/mahdi/CA2-crypto/node02/geth/triecache elapsed="959.771µs"
INFO [05-24|14:36:37.642] Regenerated local transaction journal    transactions=0 accounts=0
INFO [05-24|14:36:37.920] Generating DAG in progress               epoch=1 percentage=23 elapsed=19.664s
INFO [05-24|14:36:38.726] Generating DAG in progress               epoch=1 percentage=24 elapsed=20.470s
INFO [05-24|14:36:38.811] Successfully sealed new block            number=8 sealhash=f44d1a..7c5b6c hash=090e07..e41205 elapsed=5.202s
INFO [05-24|14:36:38.812] "🔗 block reached canonical chain"        number=1 hash=615c22..5f8232
INFO [05-24|14:36:38.812] "🔨 mined potential block"                number=8 hash=090e07..e41205
INFO [05-24|14:36:38.841] Commit new sealing work                  number=9 sealhash=133aa8..63b998 uncles=0 txs=0 gas=0 fees=0 elapsed="271.839µs"
INFO [05-24|14:36:38.842] Commit new sealing work                  number=9 sealhash=133aa8..63b998 uncles=0 txs=0 gas=0 fees=0 elapsed="601.044µs"
INFO [05-24|14:36:39.452] Generating DAG in progress               epoch=1 percentage=25 elapsed=21.197s
INFO [05-24|14:36:40.291] Generating DAG in progress               epoch=1 percentage=26 elapsed=22.035s
INFO [05-24|14:36:41.129] Generating DAG in progress               epoch=1 percentage=27 elapsed=22.873s
INFO [05-24|14:36:41.931] Generating DAG in progress               epoch=1 percentage=28 elapsed=23.676s
INFO [05-24|14:36:42.796] Generating DAG in progress               epoch=1 percentage=29 elapsed=24.540s
INFO [05-24|14:36:42.989] Successfully sealed new block            number=9 sealhash=133aa8..63b998 hash=aa4085..2777bb elapsed=4.148s
INFO [05-24|14:36:42.990] "🔗 block reached canonical chain"        number=2 hash=6b5d98..224b3f
INFO [05-24|14:36:42.990] "🔨 mined potential block"                number=9 hash=aa4085..2777bb
INFO [05-24|14:36:43.010] Commit new sealing work                  number=10 sealhash=42757d..2631fe uncles=0 txs=0 gas=0 fees=0 elapsed="210.677µs"
INFO [05-24|14:36:43.010] Commit new sealing work                  number=10 sealhash=42757d..2631fe uncles=0 txs=0 gas=0 fees=0 elapsed="552.343µs"
```

Question 1:

Node’s functionality :

1. Transaction Validation

Nodes validate transactions by checking that they adhere to the network's protocol rules. This includes verifying digital signatures, ensuring that the sender has sufficient balance, and preventing double-spending.

2. Block Validation
Nodes validate new blocks of transactions. They ensure that each block follows the network's consensus rules, such as proof-of-work or proof-of-stake.
3. Data Propagation
Nodes propagate transactions and blocks to other nodes across the network. When a node receives a new transaction or block, it verifies and then relays it to its peers.
4. Blockchain Maintenance
Nodes maintain a copy of the blockchain, which is the public ledger of all transactions.
5. Network Security
Nodes contribute to the overall security of the network. By validating and relaying transactions and blocks, they help prevent attacks.

Full Nodes : Full nodes are the backbone and basis of the cryptocurrency network. They independently verify every transaction and block against the protocol rules. These nodes by storing the entire history of the blockchain ensure data integrity and availability. They propagate verified transactions and blocks to other nodes. They ensure that all participants follow the protocol rules by rejecting invalid transactions and blocks.

Light Nodes (SPV Nodes): These nodes are less resource-intensive than full nodes. Light nodes download only the block headers and request specific transaction data as needed to verify them. They depend on full nodes to provide transactions and block information which makes them quicker and requiring less storage. These nodes are suitable for light-weight applications.

Question 2 :
For the startup process note that we get **Generating DAG in progress** which will hold the mining process until the process ends and the DAG gets generated .

The next part is the Network and Peer Logs.
Successfully sealed new block and **block reached canonical chain** and **Imported new chain segment** .
These logs mean that a new block has been mined and accepted into the main chain. Details about the block are provided.

Next is the Synchronisation Logs. These logs indicate the progress of synchronising with the blockchain:
Block synchronisation started and **Imported new state entries** and **Imported new block headers** and **Imported new block receipts**.
These logs mean that Geth is synchronising with the blockchain importing state entries, block headers, and block receipts. These logs show the count and performance metrics of these operations.

Now we go through the Mining Activity Logs.
Commit new mining work and **Successfully sealed new block**.

They mean that new mining work is being prepared with details on the block being mined. Once mining is successful a confirmation log is generated.

For the Error and Warning Logs we have **Synchronisation failed** and **Failed to mine block.**

Question 3 :

The scenario involves creating a private chain where you mine blocks locally until your chain has a block height equal to or greater than the current Ethereum mainnet. Then you attempt to publish this private chain to the Ethereum network claiming it as the "real" chain.
Knowing that Ethereum network uses PoW and PoS we have some challenges in this scenario.

Challenges

1. Difficulty and Cumulative Work (PoW):

- **Difficulty Bomb:** Ethereum's PoW included a difficulty bomb, making it exponentially harder to mine new blocks over time. This mechanism was designed to encourage the transition to PoS and would make it impractical to mine a large number of blocks quickly on a private chain.
- **Cumulative Work:** The Ethereum network requires that the chain with the most cumulative work is considered valid. Achieving this would require a big amount of computational power.

2. Validator Consensus and Finality (PoS):

- **Validator Set:** To confirm your transaction you need a significant stake and control over a large portion of the validators to influence the chain.
- **Finality:** Once blocks are finalized in PoS they cannot be reverted without overwhelming consensus. This provides strong security guarantees against such attacks.

3. Network Acceptance:

- **Broadcasting the Chain**: Even if you somehow manage to mine a private chain, broadcasting it to the network and getting nodes to accept it as the canonical chain is highly unlikely. Nodes follow consensus rules, and any attempt to introduce a chain that does not conform to these rules would be rejected.