

Ethereum Private Network Using Docker Compose

Ethereum Private Network(1/13)

- **Build Geth Image :**

- **Step 01.** Make **directories** for each **Geth nodes**.

```
c:\Home\Project\Smart-Contract\Docker>mkdir node1  
c:\Home\Project\Smart-Contract\Docker>mkdir node2  
c:\Home\Project\Smart-Contract\Docker>mkdir node3
```

- **Step 02.** Make Geth image with "**docker build -t geth .**" or "**docker build -t geth . --network=host**" command.

```
c:\Home\Project\Smart-Contract\Docker>docker images  
REPOSITORY    TAG       IMAGE ID       CREATED        SIZE  
geth           latest    df6f7221b8d5   About a minute ago  2.26GB  
hello-world    latest    d1165f221234   4 months ago    13.3kB
```

Note : Geth Image Build in Window 10

▪ Check Result :

```
C:\WINDOWS\system32\cmd.exe

c:\Home\Project\Smart-Contract\Docker>docker build -t geth .
[+] Building 575.8s (25/25) FINISHED
=> [internal] load build definition from Dockerfile                                0.0s
=> => transferring dockerfile: 1.84kB                                           0.0s
=> [internal] load .dockerignore                                                 0.0s
=> => transferring context: 2B                                                  0.0s
=> [internal] load metadata for docker.io/library/ubuntu:latest                 2.3s
=> [auth] library/ubuntu:pull token for registry-1.docker.io                   0.0s
=> [ 1/20] FROM docker.io/library/ubuntu@sha256:aba80b77e27148d99c034a987e7da3a287ed455390352663418c0f2ed40417fe  3.3s
=> => resolve docker.io/library/ubuntu@sha256:aba80b77e27148d99c034a987e7da3a287ed455390352663418c0f2ed40417fe  0.0s
=> => sha256:aba80b77e27148d99c034a987e7da3a287ed455390352663418c0f2ed40417fe 1.20kB / 1.20kB 0.0s
=> => sha256:376209074d481dca0a9cf4282710cd30a9e7ff402dea8261acdaaf57a18971dd 529B / 529B 0.0s
=> => sha256:9873176a8ff5ac192ce4d7df8a403787558b9f3981a4c4d74afb3edceda451c 1.46kB / 1.46kB 0.0s
=> => sha256:c549ccf8d472c3bce9ce02e49c62b8f6cbc736ea2b8ba812a1ae9390c69d0b71 28.55MB / 28.55MB 1.8s
=> => extracting sha256:c549ccf8d472c3bce9ce02e49c62b8f6cbc736ea2b8ba812a1ae9390c69d0b71 1.3s
=> [ 2/20] RUN apt-get update                                                    65.8s
=> [ 3/20] RUN apt-get install -y --no-install-recommends apt-utils build-essential libgmp3-dev git wget debconf ca-certificates openssl net-tools tree inetutils 318.8s
=> [ 4/20] RUN openssl s_client -showcerts -connect github.com:443 </dev/null 2>/dev/null|openssl x509 -outform PEM > /usr/local/share/ca-certificates/github.crt 0.5s
=> [ 5/20] RUN openssl s_client -showcerts -connect proxy.golang.org:443 </dev/null 2>/dev/null|openssl x509 -outform PEM > /usr/local/share/ca-certificates/proxy 0.5s
=> [ 6/20] RUN update-ca-certificates                                           1.0s
=> [ 7/20] RUN mkdir -p /go/src /go/bin                                         0.4s
=> [ 8/20] RUN mkdir -p /usr/local/go                                           0.5s
=> [ 9/20] RUN wget https://dl.google.com/go/go1.16.5.linux-amd64.tar.gz      12.4s
=> [10/20] RUN rm -rf /usr/local/go && tar -C /usr/local -xzf go1.16.5.linux-amd64.tar.gz 4.4s
=> [11/20] RUN rm go1.16.5.linux-amd64.tar.gz                                   0.4s
=> [12/20] RUN go version                                                        0.5s
=> [13/20] WORKDIR /home                                                        0.0s
=> [14/20] RUN git clone https://github.com/ethereum/go-ethereum               22.3s
=> [15/20] WORKDIR /home/go-ethereum                                           0.0s
=> [16/20] RUN make all                                                         132.0s
=> [17/20] RUN cp build/bin/* /usr/local/bin/                                  1.0s
=> [18/20] WORKDIR /home                                                        0.0s
=> [19/20] RUN rm -rf go-ethereum                                               0.5s
=> [20/20] RUN /usr/local/bin/geth version                                     0.5s
=> exporting to image                                                           8.4s
=> => exporting layers                                                           8.4s
=> => writing image sha256:df6f7221b8d51bcc5a64a57b204036a730a3f3ac53c5e10d8552be829a7f9f9d 0.0s
=> => naming to docker.io/library/geth                                         0.0s

Use 'docker scan' to run Snyk tests against images to find vulnerabilities and learn how to fix them

c:\Home\Project\Smart-Contract\Docker>
```

Ethereum Private Network(2/13)

▪ Make Your Accounts :

- **Step 03.** Make **accounts** for each **Geth nodes**. To make an account in Geth node, you need to run "**docker run -it -v <full_directory_path_name>:/home/ethereum geth /bin/bash**" command for **node1**. It will use host directory in Geth container for account creation. Go to "**ethereum**" directory and run "**geth --datadir /home/ethereum account new**" command. **Remember your account and password**. Do the same things for **node2** and **node3**. Make "**account1.txt**" and "**password1.txt**" file with the password for node1. You need to make "**account2.txt, account3.txt and password2.txt, password3.txt**" also for each nodes.

```
c:\Home\Project\Smart-Contract\Docker\node1>docker run -it -v C:\Home\Project\Smart-Contract\Docker\node1:/home/ethereum geth /bin/bash
root@fba6cd1ed252:/home# geth --datadir /home/ethereum account new
INFO [07-08|01:17:02.204] Maximum peer count          ETH=50 LES=0 total=50
INFO [07-08|01:17:02.204] 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: 0xBe1F0126DbDeC69d22b5CF07AA939dE792b8825f
Path of the secret key file: /home/ethereum/keystore/UTC--2021-07-08T01-17-05.582289700Z--be1f0126dbdec69d22b5cf07aa939de792b8825f

- 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!

root@fba6cd1ed252:/home#
```

```
c:\Home\Project\Smart-Contract\Docker>tree
폴더 PATH의 목록입니다.
볼륨 일련 번호는 4E9A-22CD입니다.
C:.
├─node1
│   └─keystore
├─node2
│   └─keystore
└─node3
    └─keystore
```

Ethereum Private Network(3/13)

▪ Make Genesis File :

- **Step 04.** Run "puppeth" program to generate "genesis.json" file. Here we will use "PoA(Clique)" consensus algorithm.

```
Please specify a network name to administer (no spaces, hyphens or capital letters please)
> docker

Sweet, you can set this via --network=docker next time!

INFO [07-08|10:24:39.741] Administering Ethereum network      name=docker
WARN [07-08|10:24:39.819] No previous configurations found      path=..puppeth\docker

What would you like to do? (default = stats)
1. Show network stats
2. Configure new genesis
3. Track new remote server
4. Deploy network components
> 2

What would you like to do? (default = create)
1. Create new genesis from scratch
2. Import already existing genesis
> 1

Which consensus engine to use? (default = clique)
1. Ethash - proof-of-work
2. Clique - proof-of-authority
> 2

How many seconds should blocks take? (default = 15)
> 1

Which accounts are allowed to seal? (mandatory at least one)
> 0x8e1f0126DbDeC69d22b5CF07AA939dE792b8825f
> 0x53350Fe0d0D69f14adbc1b54B46971552B0FEaA8
> 0x7829FD00a73979985057CdbC66551655de5c5980
> 0x

Which accounts should be pre-funded? (advisable at least one)
> 0x8e1f0126DbDeC69d22b5CF07AA939dE792b8825f
> 0x53350Fe0d0D69f14adbc1b54B46971552B0FEaA8
> 0x7829FD00a73979985057CdbC66551655de5c5980
> 0x

Should the precompile-addresses (0x1 .. 0xff) be pre-funded with 1 wei? (advisable yes)
> 
```

```
Should the precompile-addresses (0x1 .. 0xff) be pre-funded with 1 wei? (advisable yes)
> yes

Specify your chain/network ID if you want an explicit one (default = random)
> 786
INFO [07-08|10:26:45.139] Configured new genesis block

What would you like to do? (default = stats)
1. Show network stats
2. Manage existing genesis
3. Track new remote server
4. Deploy network components
> 2

1. Modify existing configurations
2. Export genesis configurations
3. Remove genesis configuration
> 2

Which folder to save the genesis specs into? (default = current)
> Will create docker.json, docker-aleth.json, docker-harmony.json, docker-parity.json

INFO [07-08|10:26:57.612] Saved native genesis chain spec      path=docker.json
ERROR[07-08|10:26:57.614] Failed to create Aleth chain spec     err="unsupported consensus engine"
ERROR[07-08|10:26:57.615] Failed to create Parity chain spec    err="unsupported consensus engine"
INFO [07-08|10:26:57.617] Saved genesis chain spec              client=harmony path=docker-harmony.json

What would you like to do? (default = stats)
1. Show network stats
2. Manage existing genesis
3. Track new remote server
4. Deploy network components
> CRIT [07-08|10:27:11.132] Failed to read user input             err=EOF

c:\Home\Project\Smart-Contract\Docker>
```

- **Change Your Genesis File :**

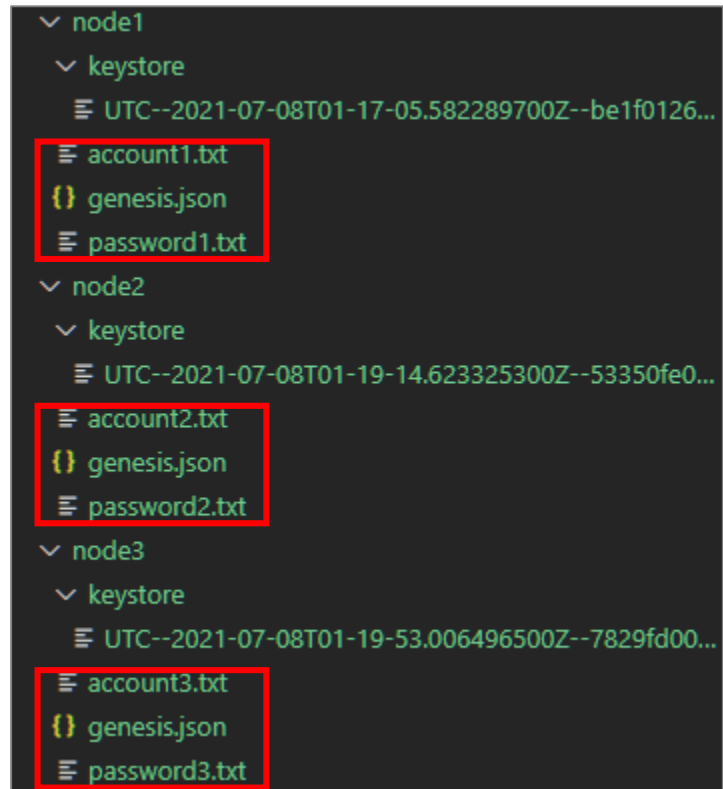
- [illegible]

- 2021-07-08

Ethereum Private Network(5/13)

▪ Initialize Geth :

- **Step 06.** Copy the "**genesis.json**" file into each directories. Copy "**account1.txt** and **password1.txt**" into **node1**. You need to do the same things for **node2** and **node3** also.



Ethereum Private Network(6/13)

▪ Initialize Geth :

- **Step 07.** Run **Geth** for Node1 with "**docker run -it -v C:\Home\Project\Smart-Contract\Wdocker\node3:/home/ethereum geth /bin/bash**" command and "**geth --datadir /home/ethereum init /home/ethereum/genesis.json**" command in the container. You need to **do the same things for the node2 and node3** also.

```
c:\Home\Project\Smart-Contract\Wdocker>docker run -it -v C:\Home\Project\Smart-Contract\Wdocker\node3:/home/ethereum geth /bin/bash
root@75436df666b4:/home# geth --datadir /home/ethereum init /home/ethereum/genesis.json
INFO [07-08|02:10:19.109] Maximum peer count               ETH=50 LES=0 total=50
INFO [07-08|02:10:19.109] Smartcard socket not found, disabling err="stat /run/pcscd/pcscd.comm: no such file or directory"
INFO [07-08|02:10:19.125] Set global gas cap                cap=50,000,000
INFO [07-08|02:10:19.125] Allocated cache and file handles database=/home/ethereum/geth/chaindata cache=16.00MiB h
INFO [07-08|02:10:19.159] Writing custom genesis block      nodes=359 size=50.97KiB time=2.6287ms gcnodes=0 gcsize=
INFO [07-08|02:10:19.166] Persisted trie from memory database database=chaindata hash=3f6056..1b7
INFO [07-08|02:10:19.170] Successfully wrote genesis state   database=/home/ethereum/geth/lightchaindata cache=16.00
INFO [07-08|02:10:19.170] Allocated cache and file handles nodes=359 size=50.97KiB time=2.3699ms gcnodes=0 gcsize=
INFO [07-08|02:10:19.197] Writing custom genesis block      database=lightchaindata hash=3f6056
INFO [07-08|02:10:19.204] Persisted trie from memory database
INFO [07-08|02:10:19.207] Successfully wrote genesis state
root@75436df666b4:/home#
```

```
c:\Home\Project\Smart-Contract\Wdocker>tree
폴더 PATH의 목록입니다.
볼륨 일련 번호는 4E9A-22CD입니다.
C:.
|-- .puppeth
|-- node1
|   |-- geth
|   |   |-- chaindata
|   |   |-- lightchaindata
|   |-- keystore
|-- node2
|   |-- geth
|   |   |-- chaindata
|   |   |-- lightchaindata
|   |-- keystore
|-- node3
|   |-- geth
|   |   |-- chaindata
|   |   |-- lightchaindata
|   |-- keystore
c:\Home\Project\Smart-Contract\Wdocker>
```


Ethereum Private Network(7/13)

▪ Run Geth :

- **Step 08.** Run **Geth** for Node1 with "**docker run -it -v C:\Home\Project\Smart-Contract\W\docker\wnode1:/home/ethereum geth /bin/bash**" command and go to **"/home/ethereum"** directory in the container using **"cd /home/ethereum"** command. Then use the following command for each nodes.

```
geth --identity 'geth01' --nusb --datadir /home/ethereum --nodiscover --syncmode full --port 30303 --miner.gasprice 0 --miner.gastarget 4700000000000 --http --http.addr 0.0.0.0 --http.corsdomain '*' --http.port 8545 --http.api admin,eth,miner,net,txpool,personal,web3 --mine --allow-insecure-unlock --unlock "0xBe1F0126DbDeC69d22b5CF07AA939dE792b8825f" --password password1.txt
```

```
geth --identity 'geth02' --nusb --datadir /home/ethereum --nodiscover --syncmode full --port 30303 --miner.gasprice 0 --miner.gastarget 4700000000000 --http --http.addr 0.0.0.0 --http.corsdomain '*' --http.port 8545 --http.api admin,eth,miner,net,txpool,personal,web3 --mine --allow-insecure-unlock --unlock "0x53350Fe0d0D69f14adbc1b54B46971552B0FEaA8" --password password2.txt
```

```
geth --identity 'geth03' --nusb --datadir /home/ethereum --nodiscover --syncmode full --port 30303 --miner.gasprice 0 --miner.gastarget 4700000000000 --http --http.addr 0.0.0.0 --http.corsdomain '*' --http.port 8545 --http.api admin,eth,miner,net,txpool,personal,web3 --mine --allow-insecure-unlock --unlock "0x7829FD00a73979985057CdbC66551655de5c5980" --password password3.txt
```

- **Step 09.** You need to get the **"enode"** information for each nodes.

```
INFO [07-08|04:12:36.324] Started P2P networking          self="enode://f9a7006c4d1d1514bb5d8d6f1f7b34148e3668@127.0.0.1:30303?discport=0"
INFO [07-08|04:12:36.327] IPC endpoint opened            url=/home/ethereum/geth.ipc
INFO [07-08|04:12:36.328] HTTP server started            endpoint=[::]:8545 prefix= cors=* vhosts=localhost
INFO [07-08|04:12:37.064] Unlocked account              address=0xBe1F0126DbDeC69d22b5CF07AA939dE792b8825f
INFO [07-08|04:12:37.064] Transaction pool price threshold updated price=0
INFO [07-08|04:12:37.064] Transaction pool price threshold updated price=0
INFO [07-08|04:12:37.064] Etherbase automatically configured address=0xBe1F0126DbDeC69d22b5CF07AA939dE792b8825f
```

Ethereum Private Network(8/13)

▪ Make Static Nodes Information :

- **Step 10.** Make "static-nodes.json" file with the "enode" information you got before. Here we **assigned IP address** for each nodes, which will be used in Docker Compose.

```
{  
  "static-nodes.json" > ...  
  1  [  
  2    "enode://f9e9d0b7422cef2f06dd0dc23c7c2e0c42190bbcf8de0cb948388cd23af3fb6633e8a97756a63f3031b2d9bd23f9a7006c4d1d1514bb5d8d6f1f7b34148e36680172.20.0.2:30303",  
  3    "enode://df1cf4331b36b9f388f9c41c5a99c2f388338ccd7cc63e50a1a70f75f858b4a43f914dd6def05e6997e071143fd999943e7086d41f72bb14b3f93f6ee325cae30172.20.0.3:30303",  
  4    "enode://ad90bf8a65692680a961c7c7cc3ee912af9ee56d2221363589a0bd2f685c3b16f3aa8618d70a2e3980806d37e37b930e9e9d7048f7e9c146863896e6bd0f27230172.20.0.4:30303"  
  5  ]  
}
```

- **Step 11.** Copy "static-nodes.json" file into "node1, node2, and node3" directories.

```
c:\Home\Project\Smart-Contract\Docker>dir node1  
c 드라이브의 볼륨에는 이름이 없습니다.  
볼륨 일련 번호: 4E9A-22CD  
  
c:\Home\Project\Smart-Contract\Docker>dir node2  
c 드라이브의 볼륨에는 이름이 없습니다.  
볼륨 일련 번호: 4E9A-22CD  
  
c:\Home\Project\Smart-Contract\Docker>dir node3  
c 드라이브의 볼륨에는 이름이 없습니다.  
볼륨 일련 번호: 4E9A-22CD  
  
c:\Home\Project\Smart-Contract\Docker\node3 디렉터리  
2021-07-08 오후 01:38 <DIR> .  
2021-07-08 오후 01:38 <DIR> ..  
2021-07-08 오전 10:58 42 account3.txt  
2021-07-08 오전 10:52 22,034 genesis.json  
2021-07-08 오후 01:36 <DIR> geth  
2021-07-08 오전 10:19 <DIR> keystore  
2021-07-08 오전 11:01 7 password3.txt  
2021-07-08 오후 01:38 483 static-nodes.json  
4개 파일 22,566 바이트  
4개 디렉터리 396,576,583,680 바이트 남음
```

```
c:\Home\Project\Smart-Contract\Docker>tree  
폴더 PATH의 목록입니다.  
볼륨 일련 번호는 4E9A-22CD입니다.  
C:.  
├── puppeth  
├── node1  
│   ├── geth  
│   │   ├── chaindata  
│   │   │   └── ancient  
│   │   ├── lightchaindata  
│   │   ├── nodes  
│   │   └── triecache  
│   └── keystore  
├── node2  
│   ├── geth  
│   │   ├── chaindata  
│   │   │   └── ancient  
│   │   ├── lightchaindata  
│   │   ├── nodes  
│   │   └── triecache  
│   └── keystore  
└── node3  
    ├── geth  
    │   ├── chaindata  
    │   │   └── ancient  
    │   ├── lightchaindata  
    │   ├── nodes  
    │   └── triecache  
    └── keystore
```

Ethereum Private Network(9/13)

- **Docker Compose Setting :**
 - **Step 12.** Make "docker-compose.yml" file.

```
version: "3"

networks:
  private:
    ipam:
      config:
        - subnet: 172.20.0.0/16

services:
  geth01:
    image: geth
    volumes:
      - ./node1:/home/ethereum
    networks:
      private:
        ipv4_address: 172.20.0.2
    ports:
      - 8545:8545
    container_name: geth01
    command: geth --identity 'geth01' --nousb --datadir /home/ethereum --nodiscover --syncmode full --port 30303 --miner.gasprice 0 --miner.gastarget 470000000000
    --http --http.addr 0.0.0.0 --http.corsdomain '*' --http.port 8545 --http.api admin,eth,miner,net,txpool,personal,web3 --mine --allow-insecure-unlock --unlock
    "0xBE1F0126DbDeC69d22b5CF07AA939dE792b8825f" --password password1.txt
    working_dir: /home/ethereum
```

Ethereum Private Network(10/13)

▪ Docker Compose Setting :

- Step 12. Make "docker-compose.yml" file.(continued)

```
geth02:
  image: geth
  volumes:
    - ./node2:/home/ethereum
  tty: true
  networks:
    private:
      ipv4_address: 172.20.0.3
  ports:
    - 8546:8545
  container_name: geth02
  command: geth --identity 'geth02' --nusb --datadir /home/ethereum --nodiscover --syncmode full --port 30303 --miner.gasprice 0 --miner.gastarget 4700000000000
--http --http.addr 0.0.0.0 --http.corsdomain '*' --http.port 8545 --http.api admin,eth,miner,net,txpool,personal,web3 --mine --allow-insecure-unlock --unlock
"0x53350Fe0d0D69f14adbc1b54B46971552B0FEaA8" --password password2.txt
  working_dir: /home/ethereum

geth03:
  image: geth
  volumes:
    - ./node3:/home/ethereum
  tty: true
  networks:
    private:
      ipv4_address: 172.20.0.4
  ports:
    - 8547:8545
  container_name: geth03
  command: geth --identity 'geth03' --nusb --datadir /home/ethereum --nodiscover --syncmode full --port 30303 --miner.gasprice 0 --miner.gastarget 4700000000000
--http --http.addr 0.0.0.0 --http.corsdomain '*' --http.port 8545 --http.api admin,eth,miner,net,txpool,personal,web3 --mine --allow-insecure-unlock --unlock
"0x7829FD00a73979985057CdbC66551655de5c5980" --password password3.txt
  working_dir: /home/ethereum
```

Ethereum Private Network(11/13)

- Run the Ethereum Private Network with Docker Compose :
 - Step 13. Use "docker-compose up -d" command in the project root directory. Check the **peer count** in the console.

```
C:\WINDOWS\system32\cmd.exe - docker-compose up

geth03 | INFO [07-08|05:45:38.169] HTTP server started           endpoint=[::]:8545 prefix= cors=* vhosts=localhost
geth02 | INFO [07-08|05:45:38.175] IPC endpoint opened           url=/home/ethereum/geth.ipc
geth02 | INFO [07-08|05:45:38.176] HTTP server started           endpoint=[::]:8545 prefix= cors=* vhosts=localhost
geth01 | INFO [07-08|05:45:38.987] Unlocked account              address=0xBe1F0126DbDeC69d22b5CF07AA939dE792b8825f
geth01 | INFO [07-08|05:45:38.987] Transaction pool price threshold updated price=0
geth01 | INFO [07-08|05:45:38.987] Transaction pool price threshold updated price=0
geth01 | INFO [07-08|05:45:38.987] Etherbase automatically configured address=0xBe1F0126DbDeC69d22b5CF07AA939dE792b8825f
geth01 | INFO [07-08|05:45:38.987] Commit new mining work         number=1 sealhash=ab7f97..1f59be uncles=0 txs=0 gas=0 fees=0 elapsed="161.1µs"
geth01 | INFO [07-08|05:45:38.987] Sealing paused, waiting for transactions
geth03 | INFO [07-08|05:45:39.278] Unlocked account              address=0x7829FD00a73979985057CdbC66551655de5c5980
geth03 | INFO [07-08|05:45:39.278] Transaction pool price threshold updated price=0
geth03 | INFO [07-08|05:45:39.278] Transaction pool price threshold updated price=0
geth03 | INFO [07-08|05:45:39.278] Etherbase automatically configured address=0x7829FD00a73979985057CdbC66551655de5c5980
geth03 | INFO [07-08|05:45:39.278] Commit new mining work         number=1 sealhash=808ec0..579e49 uncles=0 txs=0 gas=0 fees=0 elapsed="133.4µs"
geth03 | INFO [07-08|05:45:39.278] Sealing paused, waiting for transactions
geth02 | INFO [07-08|05:45:39.306] Unlocked account              address=0x53350Fe0d0D69f14adbc1b54B46971552B0FEaA8
geth02 | INFO [07-08|05:45:39.306] Transaction pool price threshold updated price=0
geth02 | INFO [07-08|05:45:39.306] Transaction pool price threshold updated price=0
geth02 | INFO [07-08|05:45:39.306] Etherbase automatically configured address=0x53350Fe0d0D69f14adbc1b54B46971552B0FEaA8
geth02 | INFO [07-08|05:45:39.306] Commit new mining work         number=1 sealhash=773e5b..040536 uncles=0 txs=0 gas=0 fees=0 elapsed="152.3µs"
geth02 | INFO [07-08|05:45:39.306] Sealing paused, waiting for transactions
geth01 | INFO [07-08|05:46:12.831] Looking for peers              peercount=2 tried=2 static=3
geth03 | INFO [07-08|05:46:13.162] Looking for peers              peercount=2 tried=2 static=3
geth02 | INFO [07-08|05:46:13.167] Looking for peers              peercount=2 tried=2 static=3
```

Ethereum Private Network(12/13)

- **Get a Smart Contract for migration :**
 - **Step 14.** Use Truffle for testing. Run **"truffle unbox metacoin"** command.

```
c:\Home\Project\Smart-Contract\Truffle>truffle unbox metacoin

Starting unbox...
=====

✓ Preparing to download box
✓ Downloading
✓ Cleaning up temporary files
✓ Setting up box

Unbox successful, sweet!

Commands:

Compile contracts: truffle compile
Migrate contracts: truffle migrate
Test contracts:    truffle test

c:\Home\Project\Smart-Contract\Truffle>
```

- **Step 15.** Check the **"truffle-config.js"** to connect to the private Ethereum network.

```
networks: {
  development: {
    host: "127.0.0.1",
    port: 8545,
    network_id: "*",
  },
},
```

Ethereum Private Network(13/13)

▪ Migrate a Smart Contract :

- Step 16. Run "truffle migrate" command in the truffle project root directory.

```
C:\WINDOWS\system32\cmd.exe - docker-compose up

geth02 | INFO [07-08|06:06:03.756] Sealing paused, waiting for transactions
geth01 | INFO [07-08|06:06:03.805] Submitted transaction      hash=0xb37b395e3040f2f643d9d3015087c86f5e177bf3affb69fca32fc6ad3b9c4179 from=0xbE1F0126DbDeC69d22b5CF07AA939dE792
b8825f nonce=4 recipient=0x02b6c102284bc5623783b66c804C73f9ef8D6A98 value=0
geth01 | INFO [07-08|06:06:03.805] Commit new mining work      number=5 sealhash=6c6298..81ce2e uncles=2 txs=1 gas=27341 fees=0 elapsed="422.8µs"
geth03 | INFO [07-08|06:06:03.806] Commit new mining work      number=5 sealhash=04690a..616799 uncles=2 txs=1 gas=27341 fees=0 elapsed="409.1µs"
geth03 | INFO [07-08|06:06:03.806] Signed recently, must wait for others
geth01 | INFO [07-08|06:06:03.807] Successfully sealed new block number=5 sealhash=6c6298..81ce2e hash=ed282e..ce0afb elapsed=1.380ms
geth01 | INFO [07-08|06:06:03.807] ^mined potential block      number=5 hash=ed282e..ce0afb
geth01 | INFO [07-08|06:06:03.807] Commit new mining work      number=6 sealhash=051cf1..f73183 uncles=2 txs=0 gas=0 fees=0 elapsed="383.8µs"
geth01 | INFO [07-08|06:06:03.807] Sealing paused, waiting for transactions
geth02 | INFO [07-08|06:06:03.807] Commit new mining work      number=5 sealhash=04690a..616799 uncles=2 txs=1 gas=27341 fees=0 elapsed="576.4µs"
geth02 | INFO [07-08|06:06:03.811] Successfully sealed new block number=5 sealhash=04690a..616799 hash=fbe2b6..4cd11e elapsed=4.338ms
geth02 | INFO [07-08|06:06:03.811] ^mined potential block      number=5 hash=fbe2b6..4cd11e
geth02 | INFO [07-08|06:06:03.812] Commit new mining work      number=6 sealhash=3a1945..4f44be uncles=2 txs=0 gas=0 fees=0 elapsed="601µs"
geth02 | INFO [07-08|06:06:03.812] Sealing paused, waiting for transactions
geth03 | INFO [07-08|06:06:03.813] Imported new chain segment   blocks=1 txs=1 mgas=0.027 elapsed=6.045ms mgasps=4.523 number=5 hash=ed282e..ce0afb dirty=15.20KiB
geth03 | INFO [07-08|06:06:03.814] Commit new mining work      number=6 sealhash=051cf1..f73183 uncles=2 txs=0 gas=0 fees=0 elapsed="188.4µs"
geth03 | INFO [07-08|06:06:03.814] Sealing paused, waiting for transactions
geth02 | INFO [07-08|06:06:03.814] Chain reorg detected        number=4 hash=6daaf9..017d30 drop=1 dropfrom=fbe2b6..4cd11e add=1 addfrom=ed282e..ce0afb
geth01 | INFO [07-08|06:06:03.816] Imported new chain segment   blocks=1 txs=1 mgas=0.027 elapsed=3.791ms mgasps=7.210 number=5 hash=fbe2b6..4cd11e dirty=15.20KiB
geth02 | INFO [07-08|06:06:03.817] Imported new chain segment   blocks=1 txs=1 mgas=0.027 elapsed=5.961ms mgasps=4.586 number=5 hash=ed282e..ce0afb dirty=15.20KiB
geth02 | INFO [07-08|06:06:03.818] Commit new mining work      number=6 sealhash=9eb39e..8715c3 uncles=2 txs=0 gas=0 fees=0 elapsed="373.4µs"
geth02 | INFO [07-08|06:06:03.818] Sealing paused, waiting for transactions
geth03 | INFO [07-08|06:06:03.819] Imported new chain segment   blocks=1 txs=1 mgas=0.027 elapsed=5.793ms mgasps=4.720 number=5 hash=fbe2b6..4cd11e dirty=15.20KiB
```

? & !

Thanks!!!