

Introduction to blockchain and Ethereum smart contracts

Create your own Ethereum private network

Written by Peter, Ho Man Fai



Learning outcomes

After you complete this lab, you will be able to:

1. Bootstrap a new Ethereum blockchain using Geth.
2. Understand the usage of the genesis.json and static-nodes.json files.
3. Run an Ethereum node on a computer.
4. Connect an Ethereum node to another node on the same network.

Part 1: Install Ethereum implementation: Geth (Go Ethereum)

1. Visit <https://geth.ethereum.org/downloads/> → Scroll down and look for the “Stable releases” section → Click the Windows tab → Click “Geth 1.7.2 Installer” row on the table.

Go Ethereum

Install

Downloads

Stable releases

These are the current and previous stable releases of go-ethereum, updated automatically when a new version is tagged in our [GitHub repository](#).

Android

iOS

Linux

macOS

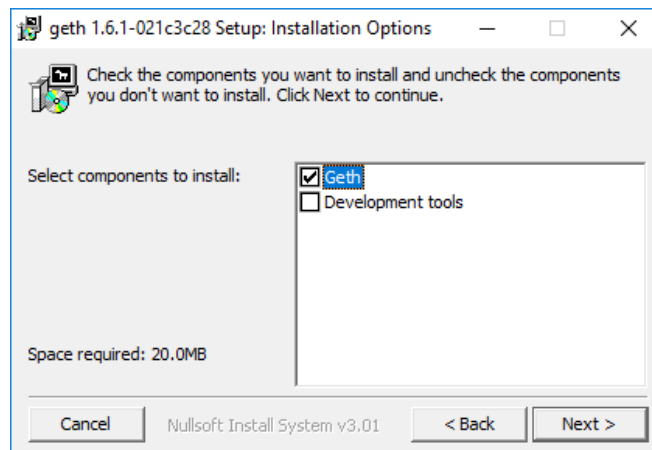
Windows

Release	Commit	Kind	Arch	Size	Published	Signature	Checksum (MD5)
Geth 1.6.1	021c3c28...	Installer	32-bit	21.29 MB	05/04/2017	Signature	d791130df223ea89baea7887b6be1433
Geth 1.6.1	021c3c28...	Archive	32-bit	6.48 MB	05/04/2017	Signature	baf642bfb0c8f309e9e579bbb8fcf420
Geth 1.6.1	021c3c28...	Installer	64-bit	22.59 MB	05/04/2017	Signature	619650ef592498cf48c382e4a9b27b71
Geth 1.6.1	021c3c28...	Archive	64-bit	6.85 MB	05/04/2017	Signature	005b4040060d597026f3054462c4e2af
Geth & Tools 1.6.1	021c3c28...	Archive	32-bit	30.89 MB	05/04/2017	Signature	fb3c8416e93a62e0e6b834b4679377c9
Geth & Tools 1.6.1	021c3c28...	Archive	64-bit	32.64 MB	05/04/2017	Signature	7c1aad40cdbeddb2277e85a163342e8f
Geth 1.6.0	facc47cb...	Installer	32-bit	18.04 MB	04/14/2017	Signature	5394138cd476889770ea21914192e6d8

Important note:

The latest version of Geth keeps updating. The developers of Geth will introduce and deprecate some of the features as time goes by. By the time you are reading this, you should be able to download a version that is beyond 1.7.2. However, **DO NOT use other versions except 1.7.2 for this series of tutorial.** It is because this tutorial is written for version 1.7.2. We do not guarantee the materials here will work other than that version.

2. Download the installer to your desktop → **Click the installer for installation** (no need to check the “Development tools” box when selecting installation options).



3. Open command prompt → run **“geth help”** → If you see a list of help instructions being generated, that means you have successfully installed the Geth implementation.

```
C:\WINDOWS\system32\cmd.exe
Microsoft Windows [Version 10.0.14393]
(c) 2016 Microsoft Corporation. All rights reserved.

C:\Users\Admin>geth help
NAME:
  geth - the go-ethereum command line interface

  Copyright 2013-2017 The go-ethereum Authors

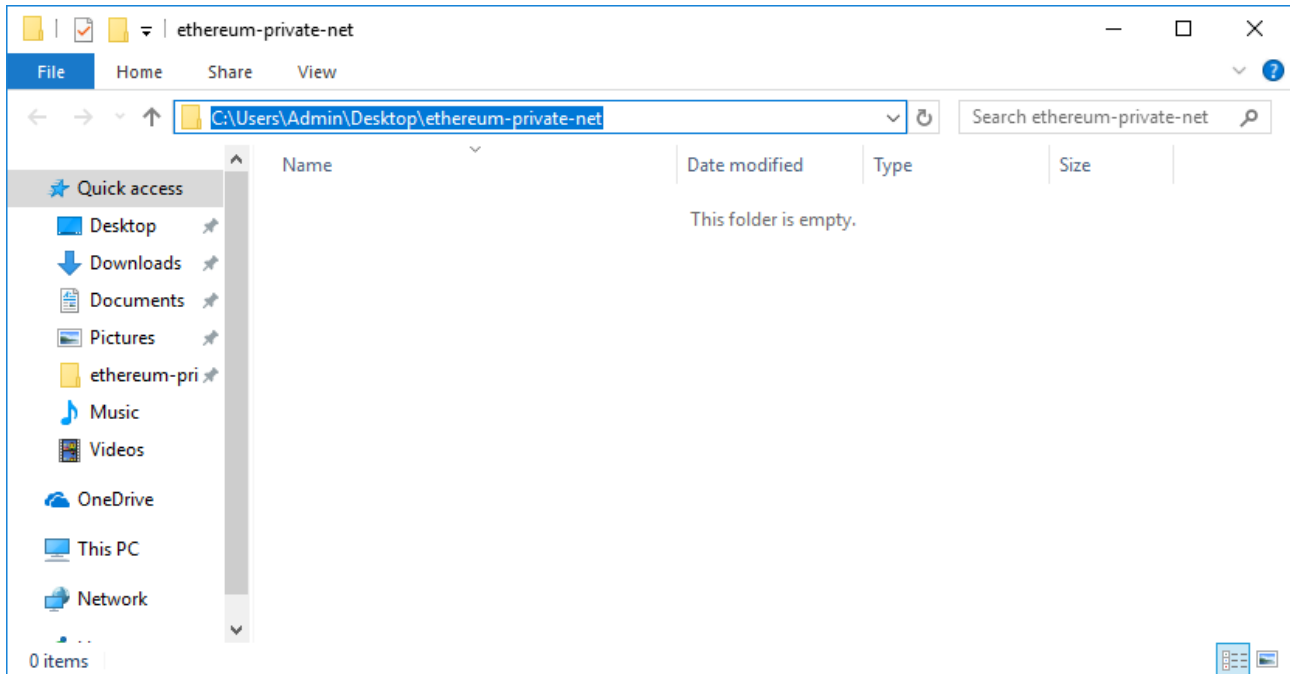
USAGE:
  geth [options] command [command options] [arguments...]

VERSION:
  1.6.1-stable-021c3c28

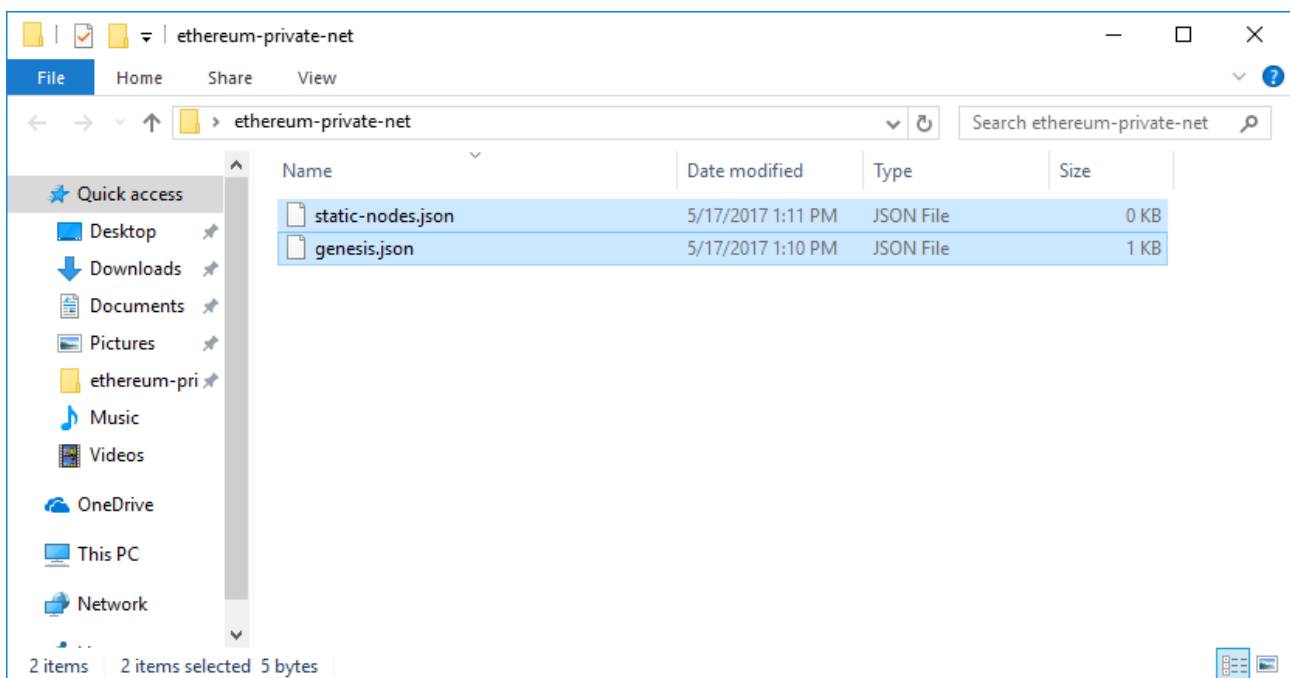
COMMANDS:
  init      Bootstrap and initialize a new genesis block
  import    Import a blockchain file
  export    Export blockchain into file
  removedb  Remove blockchain and state databases
  dump      Dump a specific block from storage
  monitor   Monitor and visualize node metrics
  account   Manage accounts
  wallet    Import Ethereum presale wallets
  console   Start an interactive JavaScript environment
  attach    Start an interactive JavaScript environment (connect to node)
  js        Execute the specified JavaScript files
  makedag   Generate ethash DAG (for testing)
  version   Print version numbers
  bug       opens a window to report a bug on the geth repo
```

Part 2: Initialize a new private Ethereum blockchain data

- Go to your Windows desktop (or other directories if you like) → **Create a new folder called “ethereum-private-net”** (or any name you want). It is recommended not to include any spaces in your path to the folder directory.



- Open your text editor (e.g. Notepad++, but DO NOT use the Windows default notepad.exe) → **Create a JSON file named as “genesis.json” and another JSON file named as “static-nodes.json”** inside the folder you have just created in the previous step.



6. **Edit your genesis.json** → Paste the following JSON content inside → Hit save button.

```
{
  "config": {
    "chainId": 15,
    "homesteadBlock": 0,
    "eip155Block": 0,
    "eip158Block": 0
  },
  "difficulty": "10000",
  "gasLimit": "2100000",
  "alloc": {}
}
```

7. **Edit your static-nodes.json** → Paste the following JSON content inside → Hit save button.

```
[]
```

Explanations:

Blockchain, as the name suggests, is consisted of a chain of blocks. For the blockchain to work, we need to have the first and the initial block being defined (also known as the bootstrapping process), and there is a special name for such a block, called genesis block.

That's where the **genesis.json** file comes in. This file defines all the information and initial settings of your blockchain. Without defining this block, your blockchain will not know where and what to start with.

The explanations of those parameters inside the genesis.json is out of the scope of this tutorial. If you wish to learn more, check out the official documentation on Ethereum website.

Another file is the **static-nodes.json**. Please be reminded that Ethereum is a peer-to-peer blockchain network, and it means a participant (called node) needs to have direct connections between different participants (i.e. node). So the question is, who is/are the first one that a node should look for? That's where the static-nodes.json comes into play.

static-nodes.json is used to define all Ethereum addresses that will be connected to when you start your blockchain node in your computer. Since we haven't setup another computer yet, we leave the JSON an empty array, and we will come back and modify it later.

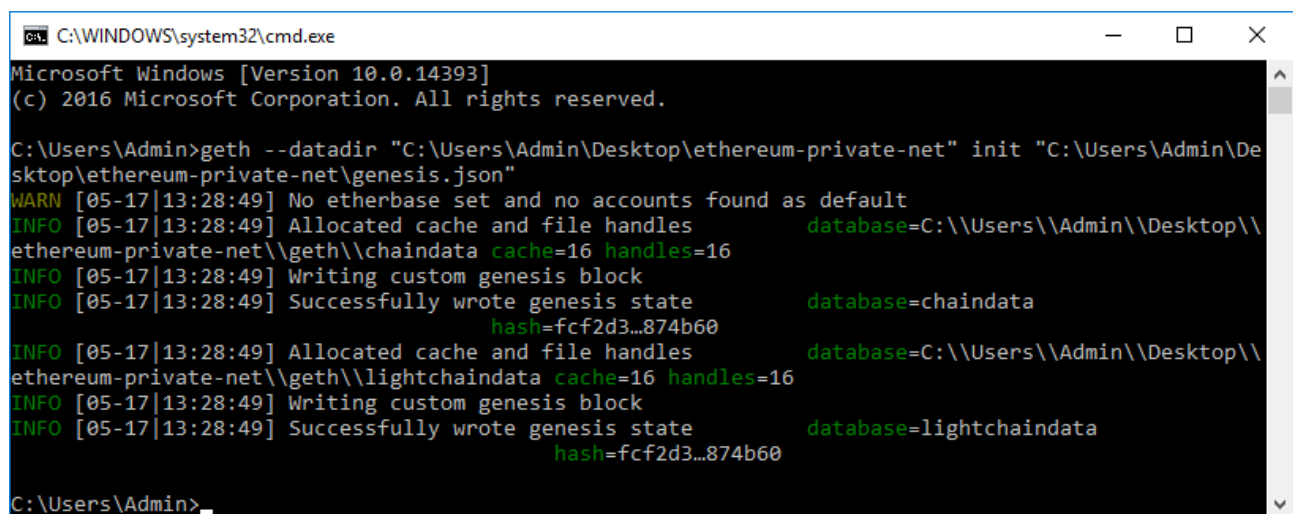
8. Open command prompt → **Run the following command**, you may need to change the highlighted paths below to match the path of your folder created.

```
geth --datadir "C:\Users\Admin\Desktop\ethereum-private-net" init  
"C:\Users\Admin\Desktop\ethereum-private-net\genesis.json"
```

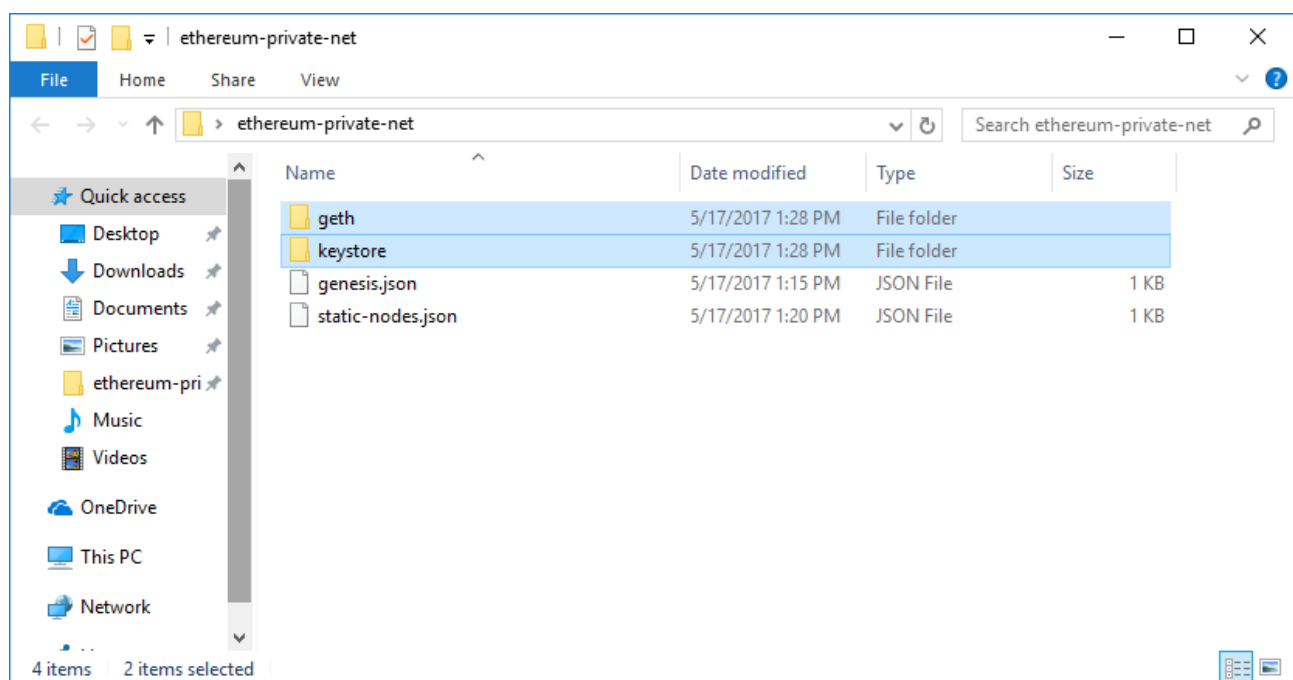
Important note:

Try not to copy commands directly from this document since the quote characters may have changed to some other invalid characters when you paste it into the command prompt. **Type in the command by yourself.**

9. When done, you should see something like below in the command prompt, and you will notice there are two folders being generated inside your ethereum-private-net folder.



```
C:\WINDOWS\system32\cmd.exe  
Microsoft Windows [Version 10.0.14393]  
(c) 2016 Microsoft Corporation. All rights reserved.  
  
C:\Users\Admin>geth --datadir "C:\Users\Admin\Desktop\ethereum-private-net" init "C:\Users\Admin\Desktop\ethereum-private-net\genesis.json"  
WARN [05-17|13:28:49] No etherbase set and no accounts found as default  
INFO [05-17|13:28:49] Allocated cache and file handles      database=C:\Users\Admin\Desktop\ethereum-private-net\geth\chaindata cache=16 handles=16  
INFO [05-17|13:28:49] Writing custom genesis block  
INFO [05-17|13:28:49] Successfully wrote genesis state      database=chaindata  
                                hash=fcf2d3...874b60  
INFO [05-17|13:28:49] Allocated cache and file handles      database=C:\Users\Admin\Desktop\ethereum-private-net\geth\lightchaindata cache=16 handles=16  
INFO [05-17|13:28:49] Writing custom genesis block  
INFO [05-17|13:28:49] Successfully wrote genesis state      database=lightchaindata  
                                hash=fcf2d3...874b60  
C:\Users\Admin>
```



Explanations:

The geth folder stores all the blockchain data. The keystore folder stores all the keys of your Ethereum accounts. We will learn more about Ethereum accounts in the future.

Part 3: Start a Ethereum node

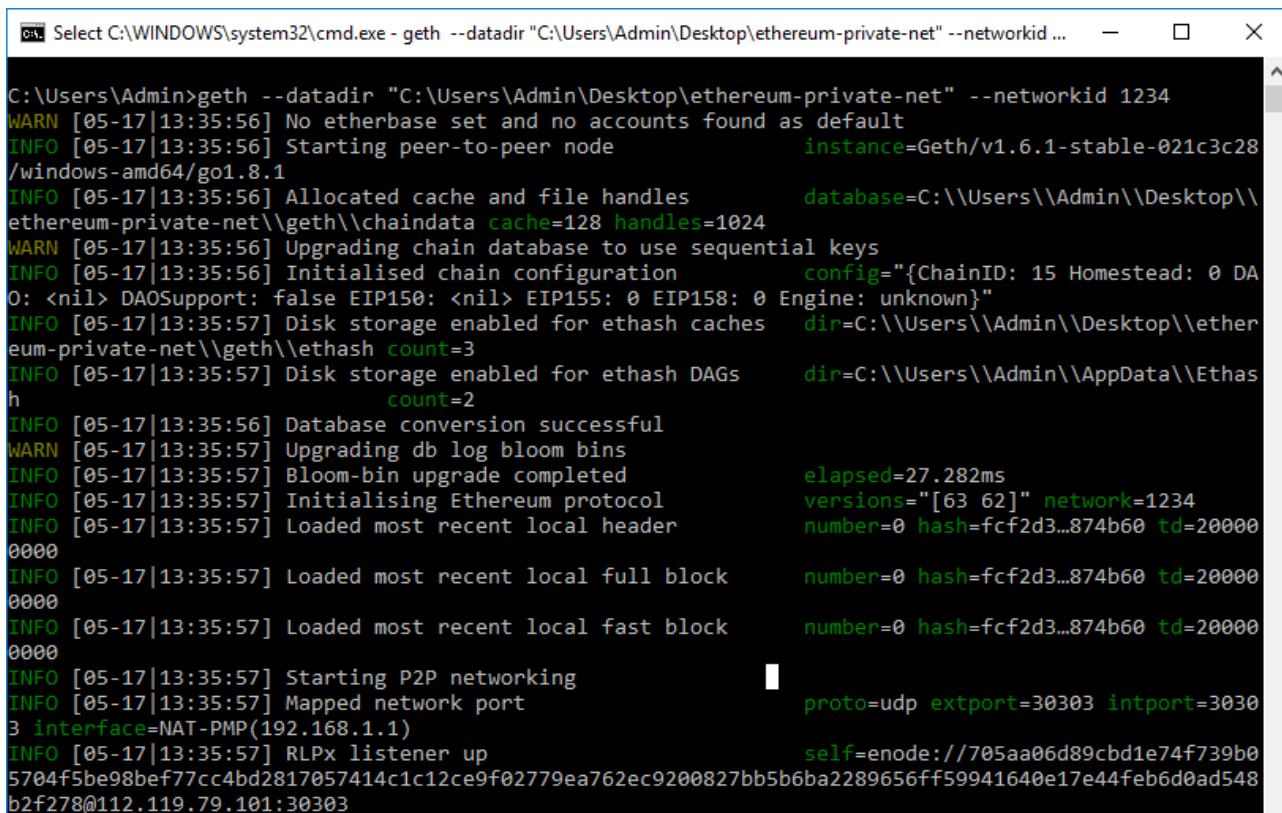
10. In the command prompt, run the following command. You should change the green-color highlighted number into an arbitrary number, you may also need to change the yellow-highlighted paths below to match the path of your folder created.

```
geth --datadir "C:\Users\Admin\Desktop\ethereum-private-net" --  
networkid 1234567890
```

Important note:

This network ID should be unique in your network. For example, if you and your friend are doing your work in a computer lab that shares the same network, both of you should use different network IDs. Otherwise, the blockchain may generate conflicts and unexpected results when both of you running your own blockchain. So, try to use a true random number instead of 1234567890.

11. When done, you should see something like below. This is what we called a Ethereum node daemon.



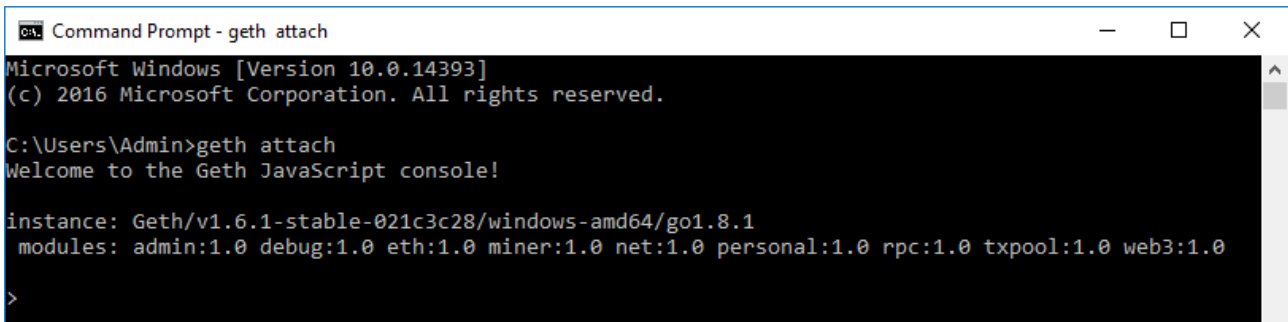
```
C:\Users\Admin>geth --datadir "C:\Users\Admin\Desktop\ethereum-private-net" --networkid 1234  
WARN [05-17|13:35:56] No etherbase set and no accounts found as default  
INFO [05-17|13:35:56] Starting peer-to-peer node instance=Geth/v1.6.1-stable-021c3c28  
/windows-amd64/go1.8.1  
INFO [05-17|13:35:56] Allocated cache and file handles database=C:\\Users\\Admin\\Desktop\\  
ethereum-private-net\\geth\\chaindata cache=128 handles=1024  
WARN [05-17|13:35:56] Upgrading chain database to use sequential keys  
INFO [05-17|13:35:56] Initialised chain configuration config="{ChainID: 15 Homestead: 0 DA  
O: <nil> DAOsupport: false EIP150: <nil> EIP155: 0 EIP158: 0 Engine: unknown}"  
INFO [05-17|13:35:57] Disk storage enabled for ethash caches dir=C:\\Users\\Admin\\Desktop\\ether  
eum-private-net\\geth\\ethash count=3  
INFO [05-17|13:35:57] Disk storage enabled for ethash DAGs dir=C:\\Users\\Admin\\AppData\\Ethas  
h count=2  
INFO [05-17|13:35:56] Database conversion successful  
WARN [05-17|13:35:57] Upgrading db log bloom bins elapsed=27.282ms  
INFO [05-17|13:35:57] Bloom-bin upgrade completed versions="[63 62]" network=1234  
INFO [05-17|13:35:57] Initialising Ethereum protocol number=0 hash=fcf2d3...874b60 td=20000  
INFO [05-17|13:35:57] Loaded most recent local header number=0 hash=fcf2d3...874b60 td=20000  
INFO [05-17|13:35:57] Loaded most recent local full block number=0 hash=fcf2d3...874b60 td=20000  
INFO [05-17|13:35:57] Loaded most recent local fast block number=0 hash=fcf2d3...874b60 td=20000  
INFO [05-17|13:35:57] Starting P2P networking  
INFO [05-17|13:35:57] Mapped network port proto=udp extport=30303 intport=3030  
3 interface=NAT-PMP(192.168.1.1)  
INFO [05-17|13:35:57] RLPx listener up self=enode://705aa06d89cbd1e74f739b0  
5704f5be98bef77cc4bd2817057414c1c12ce9f02779ea762ec9200827bb5b6ba2289656ff59941640e17e44feb6d0ad548  
b2f278@112.119.79.101:30303
```

Important note:

The Ethereum node is running in your first computer now and it needs to keep running. So, **DO NOT** terminate the command prompt or kill the process.

Part 4: Create and connect to a second Ethereum node

12. Switch on your second computer or virtual machine → repeat all the steps in part 1 and part 2 (no need to complete step 3 at this moment) on your second computer.
13. Go back to your first computer → Open a new command prompt → Run “geth attach” → You should have entered the Ethereum interactive console like the image below.



```
Command Prompt - geth attach
Microsoft Windows [Version 10.0.14393]
(c) 2016 Microsoft Corporation. All rights reserved.

C:\Users\Admin>geth attach
Welcome to the Geth JavaScript console!

instance: Geth/v1.6.1-stable-021c3c28/windows-amd64/go1.8.1
modules: admin:1.0 debug:1.0 eth:1.0 miner:1.0 net:1.0 personal:1.0 rpc:1.0 txpool:1.0 web3:1.0
>
```

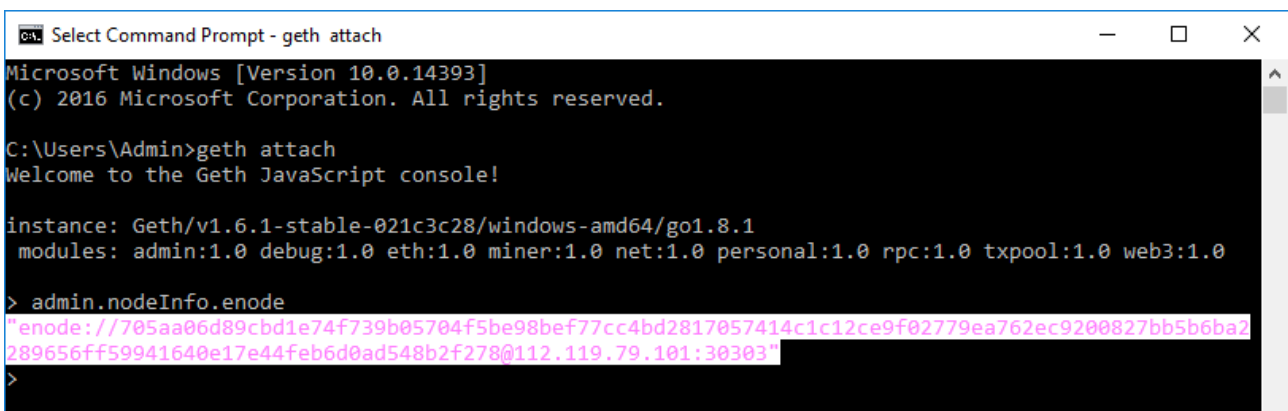
Important note:

Make sure your Ethereum node is running in another command prompt. If you have terminated the Ethereum node, you will not be able to enter the interactive console.

14. Inside the interactive console, run the following code.

```
admin.nodeInfo.enode
```

15. The console will print out an URL-like address of the current Ethereum node → Copy the address printed.



```
Select Command Prompt - geth attach
Microsoft Windows [Version 10.0.14393]
(c) 2016 Microsoft Corporation. All rights reserved.

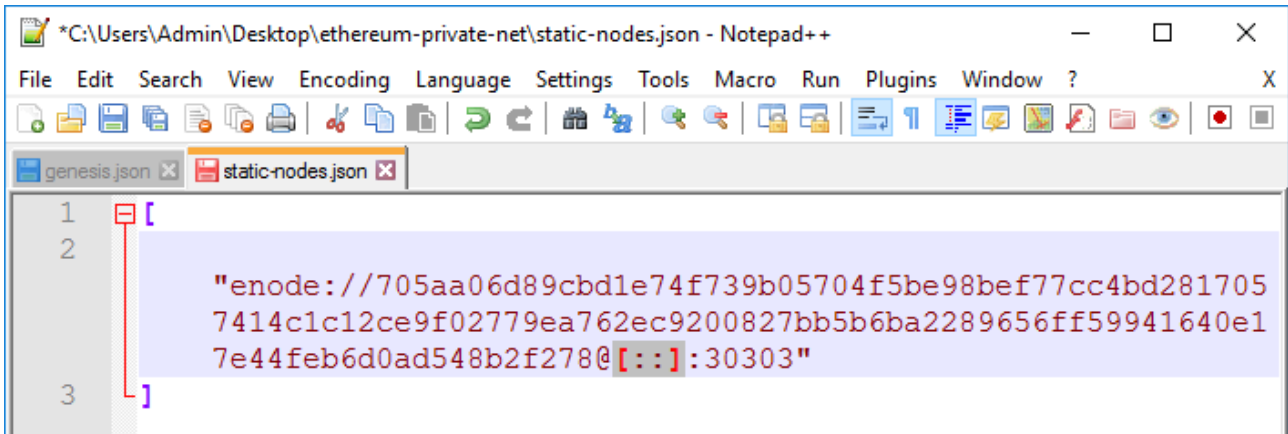
C:\Users\Admin>geth attach
Welcome to the Geth JavaScript console!

instance: Geth/v1.6.1-stable-021c3c28/windows-amd64/go1.8.1
modules: admin:1.0 debug:1.0 eth:1.0 miner:1.0 net:1.0 personal:1.0 rpc:1.0 txpool:1.0 web3:1.0
> admin.nodeInfo.enode
"enode://705aa06d89cbd1e74f739b05704f5be98bef77cc4bd2817057414c1c12ce9f02779ea762ec9200827bb5b6ba2
289656ff59941640e17e44feb6d0ad548b2f2780112.119.79.101:30303"
>
```


Explanations:

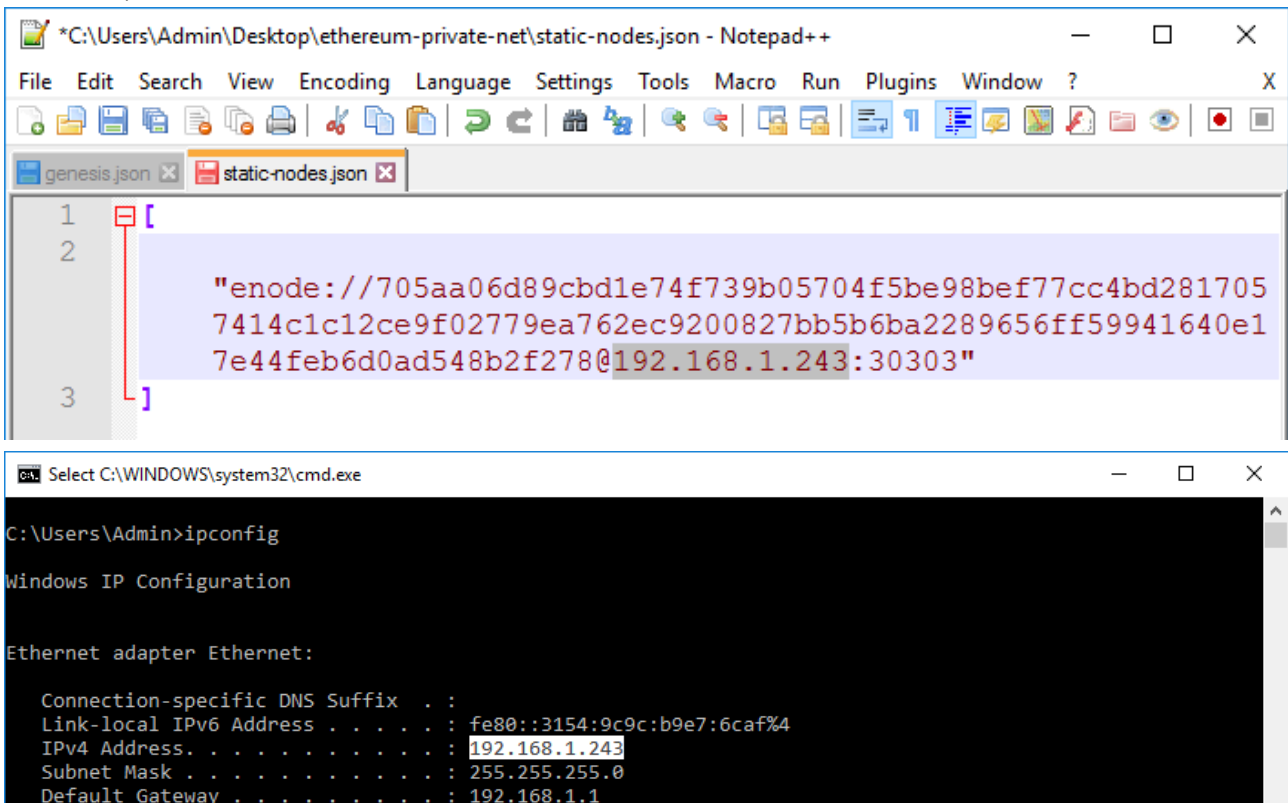
This URL-like address is the address string of your Ethereum node that you are running. This string is unique across the world (theoretically). There is also an IP address and port number that states where your Ethereum node resides on your network.

16. Go back to your second computer / virtual machine → Open the `static-nodes.json` inside your `ethereum-private-net` folder → paste the address string copied from the first computer inside the square bracket (see below).



```
*C:\Users\Admin\Desktop\ethereum-private-net\static-nodes.json - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ? X
genesis.json static-nodes.json
1 [
2   {
3     "enode://705aa06d89cbd1e74f739b05704f5be98bef77cc4bd2817057414c1c12ce9f02779ea762ec9200827bb5b6ba2289656ff59941640e17e44feb6d0ad548b2f278@[::]:30303"
```

17. Notice that there is an @ sign within the string, and you should see an IP address or `[::]` after the @ sign → Replace the IP address or `[::]` with the first computer's internal network IP address, you may find the IP address by running "ipconfig" in the command prompt of the first computer → save the file.



```
*C:\Users\Admin\Desktop\ethereum-private-net\static-nodes.json - Notepad++
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ? X
genesis.json static-nodes.json
1 [
2   {
3     "enode://705aa06d89cbd1e74f739b05704f5be98bef77cc4bd2817057414c1c12ce9f02779ea762ec9200827bb5b6ba2289656ff59941640e17e44feb6d0ad548b2f278@192.168.1.243:30303"
```

```
C:\Users\Admin>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:

   Connection-specific DNS Suffix  . : 
   Link-local IPv6 Address . . . . . : fe80::3154:9c9c:b9e7:6caf%4
   IPv4 Address. . . . . : 192.168.1.243
   Subnet Mask . . . . . : 255.255.255.0
   Default Gateway . . . . . : 192.168.1.1
```

Important note:

There is a port number followed by the IP address (i.e. :30303). **DO NOT** modify it. You must keep it for the Ethereum nodes to connect via the 30303 port.

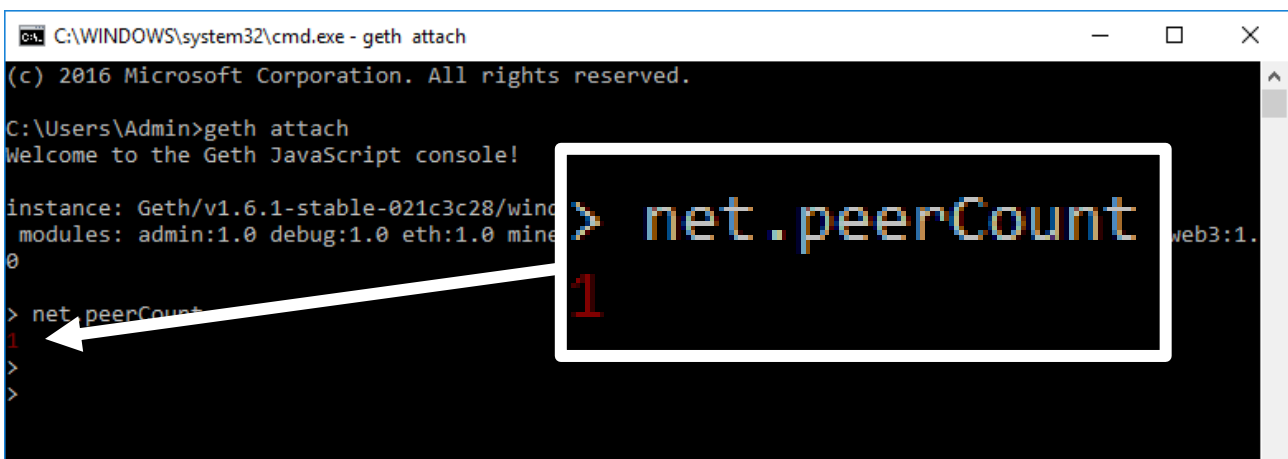
18. Repeat all the steps stated in part 3 in your second computer for starting the Ethereum node.

19. In your second computer, open a new command prompt → Run “geth attach” to start the Ethereum interactive console.

20. In the console opened, run the following code to see how many Ethereum node it has connected to.

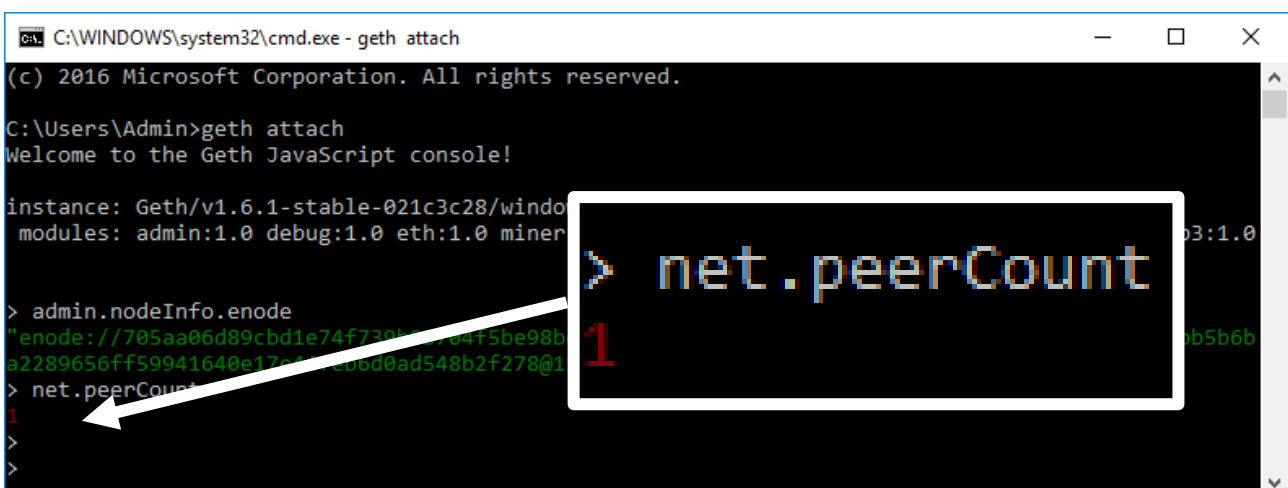
```
net.peerCount
```

21. You should see the output “1” in your console. It means your Ethereum node inside the second computer has connected to an another Ethereum node on the network, which is your first computer.



A screenshot of a Windows command prompt window titled "C:\WINDOWS\system32\cmd.exe - geth attach". The window shows the Geth JavaScript console interface. The user has entered the command `net.peerCount`, and the output is `1`. A white box highlights the command and its output, with an arrow pointing to the output.

22. Go back to your first computer → Run the same command in the interactive console → You should also see the output is also “1”, meaning the connection is bi-directional.



A screenshot of a Windows command prompt window titled "C:\WINDOWS\system32\cmd.exe - geth attach". The window shows the Geth JavaScript console interface. The user has entered the command `net.peerCount`, and the output is `1`. A white box highlights the command and its output, with an arrow pointing to the output.

Now, both of your Ethereum nodes are connected. **However, if you start your second Ethereum node first next time, and then the first one, the connection will not be established. It is because you haven't defined your first computer's Ethereum node address in your second computer.**

23. In your second computer, repeat step 14 – 17: copy the Ethereum address from your second computer → paste that address to the static-nodes.json file in your first computer (remember to replace the IP address or [::] string in the Ethereum address to be the internal IP address of the second computer).