Pakistan Blockchain Institute

PAKISTAN BLOCKCHAIN INSTITUTE

MODULE-2
BLOCKCHAIN AND SMART CONTRACT BASICS

Class-3

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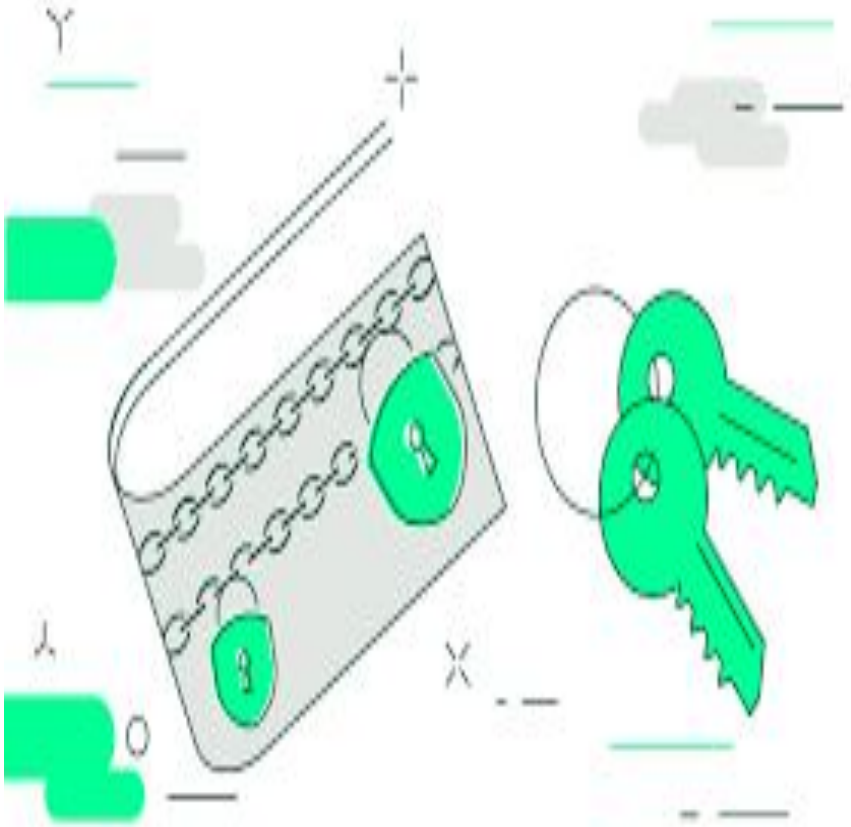
Lead Blockchain Trainer

Edversity.

Wallet & Keys



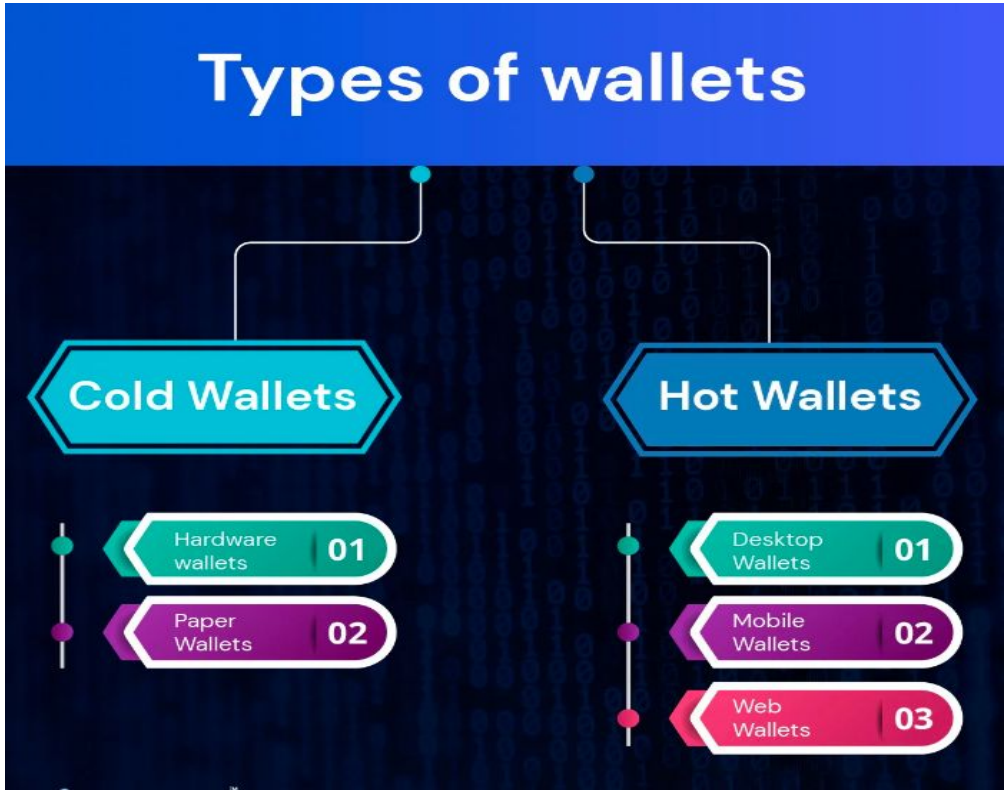
Wallet & Keys

Wallet & Keys

Wallets

- A wallet is software that keeps one or more cryptographic private and public keys.
- Using these keys, you can interact with different blockchains and are allowed to send and receive digital currencies.
- You can also interact with smart contracts using any of the accounts present in your wallet.

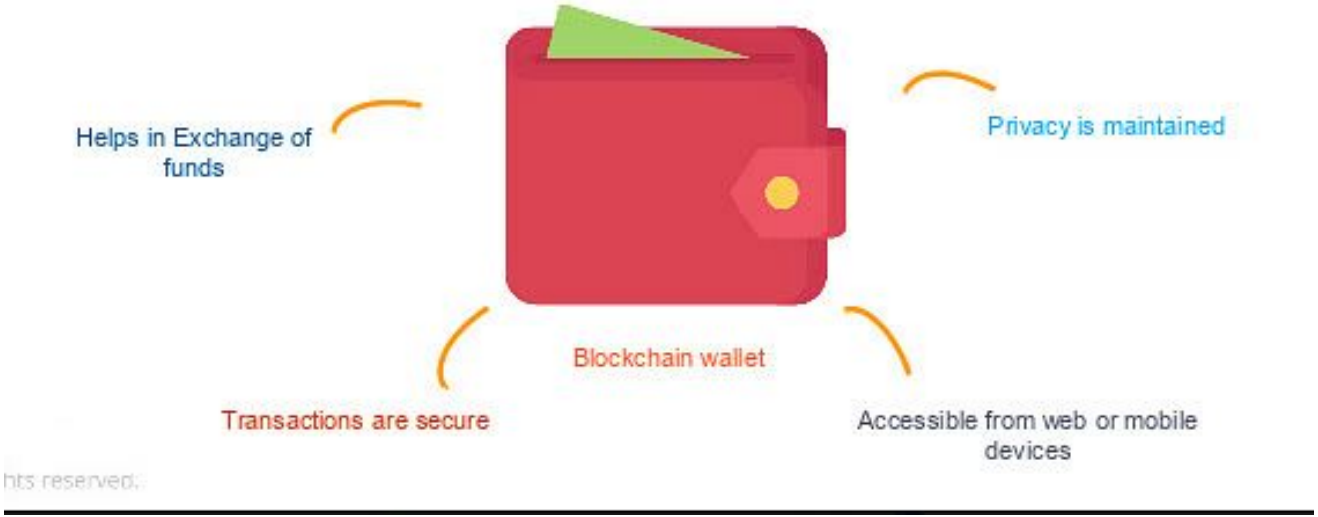
Types of Wallets



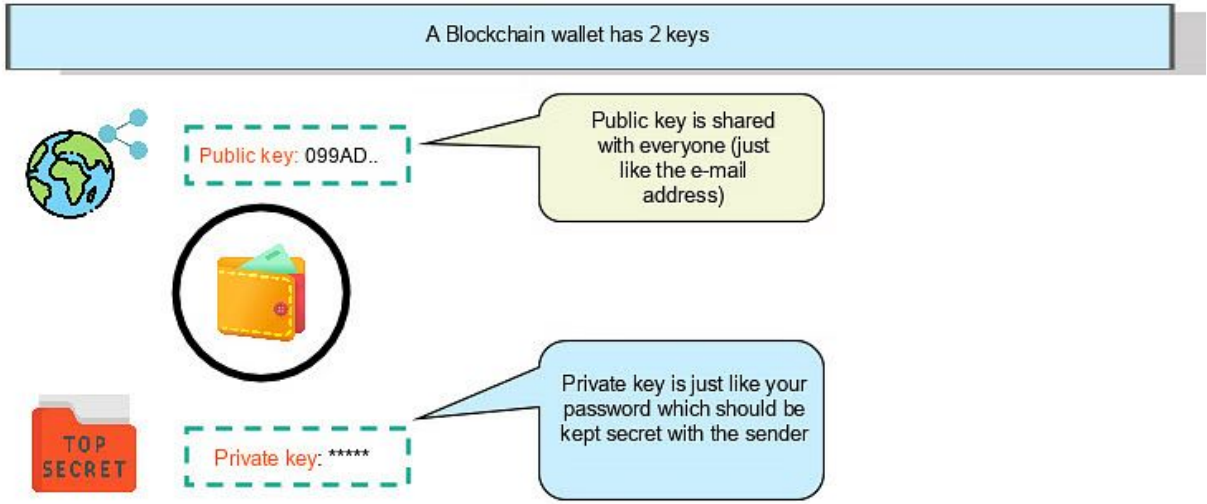
Digital Wallets

- Digital Wallet is simply an E-Wallet
- You are even using it without Bitcoin, like your digital bank applications, Apple Pay & Google Pay (with your credit / debit card)
- But through Digital Wallet you are ready to spend digital cash
- Purpose of the wallets is to save your passwords
- Type of Digital Wallets
  - Desktop
  - Online
  - Mobile
  - Hardware (Flash Drive USB)
  - Paper Wallet

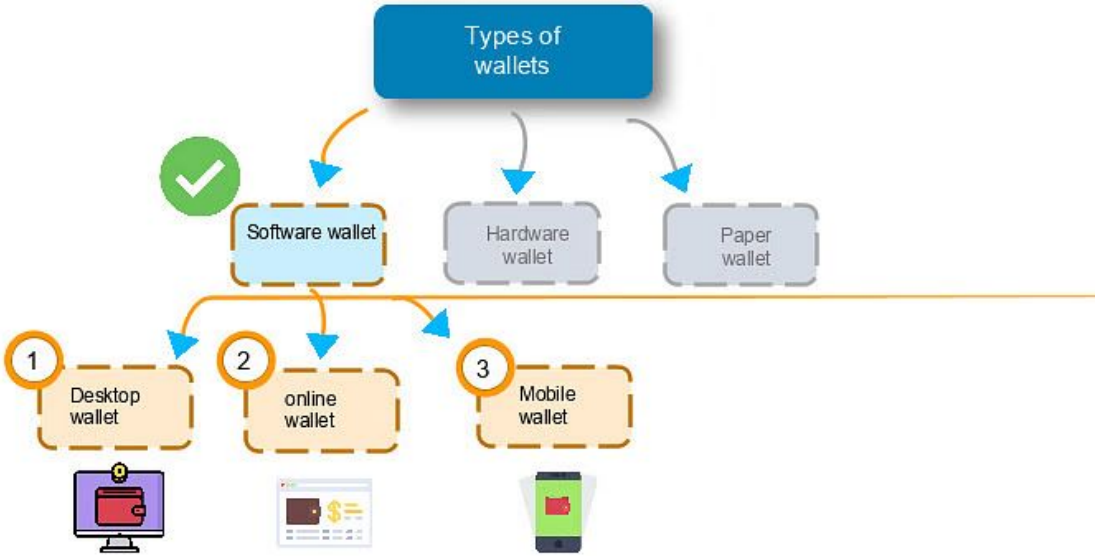
Blockchain Wallet



Blockchain Wallet



Types of Wallets



Hardware Wallets

A hardware wallet is a type of cold storage device which stores the user's private key in a protected hardware device

These wallets are similar to portable devices that can be connected to the computer

It is less prone to malware attacks

Ledger

TREZOR keep key

For example, Ledger Nano S, TREZOR and KeepKey are the top hardware wallets

Note: To make a transaction, the hardware wallet has to be plugged into user's computer system

Hardware Wallets

Paper Wallets

A paper wallet is an offline process of storing cryptocurrencies

This wallet is a printed paper consisting of a private key and a public address (which are accessed using a QR code)

Since these wallets are safe, they are widely used for storing large amounts of cryptocurrencies

For example, Bitcoin paper wallet and MyEtherWallet are one of the widely used paper wallets

Prerequisite

1. Understanding of Blockchain
2. Understanding of Ethereum Blockchain
3. Fundamentals of Programming

Ethereum

Vitalik Buterin

What is Ethereum?

- **Ethereum** is an open-source blockchain-based platform.

Bitcoin →

Ethereum →

Ethereum Currency Units

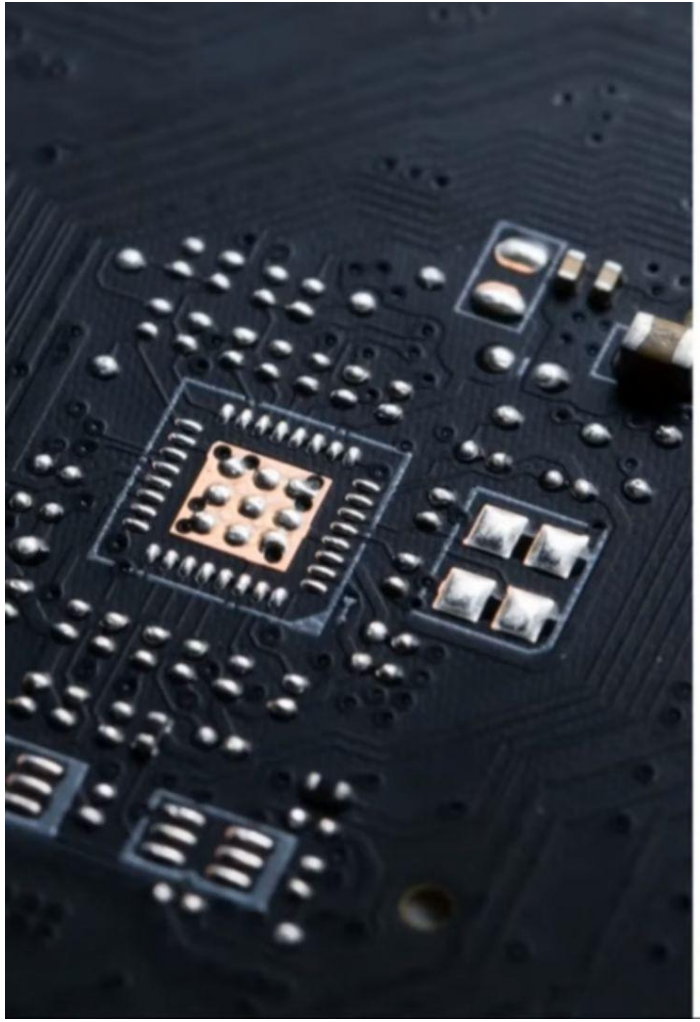
1. Ethereum's currency unit is called *ether*
2. It identified as "ETH" or with the symbols Ξ (from the Greek letter "Xi" or, less often, ♦
3. For example: 1 ether, or 1 ETH, or Ξ1, or ♦1

Ether Smallest Unit = WEI

ethereum

1. Ether is subdivided into smaller units, *wei*.
2. One ether is 1 quintillion wei (10^18 or 1,000,000,000,000,000,000).
3. Ethereum is the system, ether is the currency.
4. When you transact 1 ether, the transaction encodes 1,000,000,000,000,000,000 wei as the value.

Value (in wei)	Exponent	Common name	SI name
1	1	wei	Wei
1,000	10^{3}	Babbage	Kilowei or femtoether
1,000,000	10^{6}	Lovelace	Megawei or picoether
1,000,000,000	10^{9}	Shannon	Gigawei or nanoether
1,000,000,000,000	10^{12}	Szabo	Microether or micro
1,000,000,000,000,000	10^{15}	Finney	Milliether or milli
1,000,000,000,000,000,000	*10^{18}*	*Ether*	*Ether*
1,000,000,000,000,000,000,000	10^{21}	Grand	Kiloether
1,000,000,000,000,000,000,000,000	10^{24}		Megaether



Ethereum Gas Limit

Gas Limit

Let say A wants to send B 2 ETH. So what will be the total fees A that has to pay ?

A sets the gas price per unit = 100 gwei.

Transaction gas limit = 21,000 units.

Total fee will be: Gas units(limit) * Gas price per unit

Total fee will be: `21,000 * 100 = 210,0000 gwei` or 0.0021 ETH

Gas Limit

Let say A wants to send B 2 ETH. So what will be the total fees A that has to pay ?

Case 2: When gas transaction limit < 21000 units.

Transaction gas limit = 20,000 units.

Transaction Fail

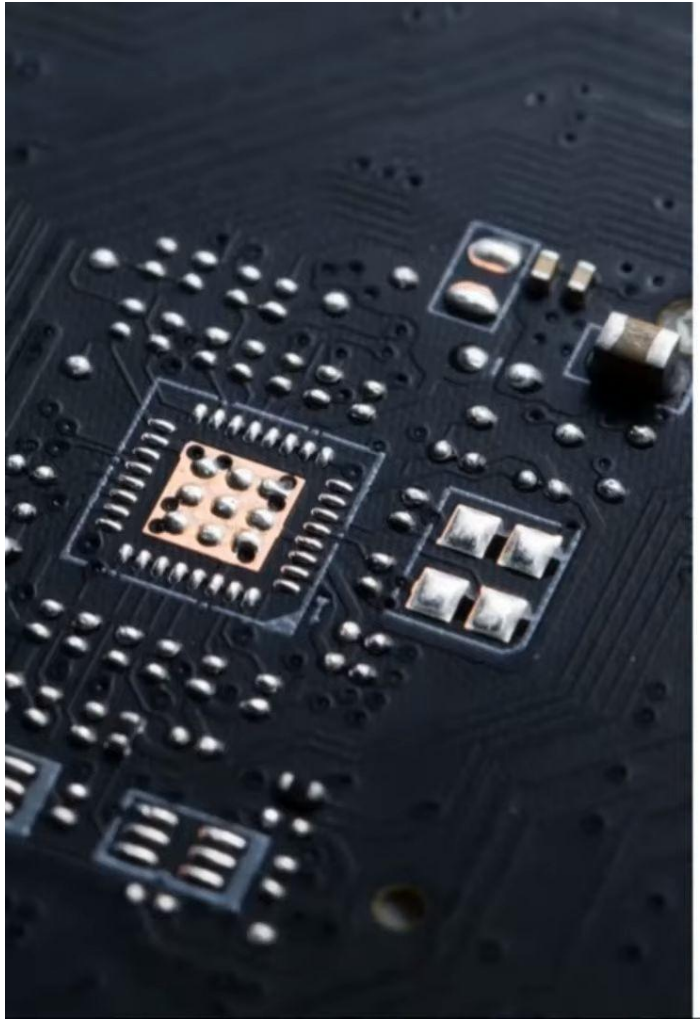
Gas Limit

Q) What is the use of Gas Limit ?

Ethereum Gas

Some important points to note -

- Any transaction that modifies the blockchain costs gas.
- The user that generated the transaction pays for the gas.

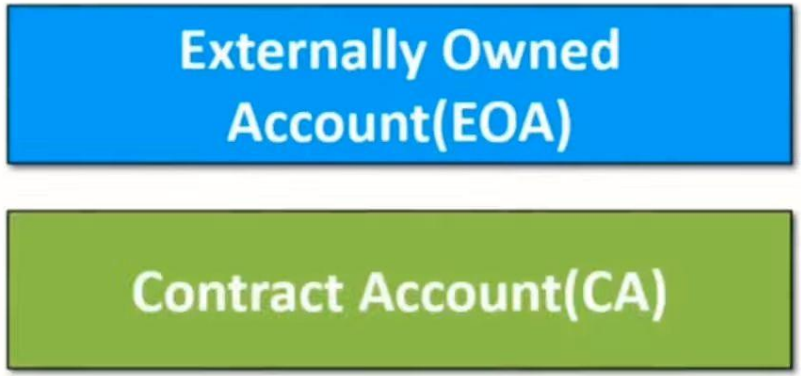


Ethereum Accounts

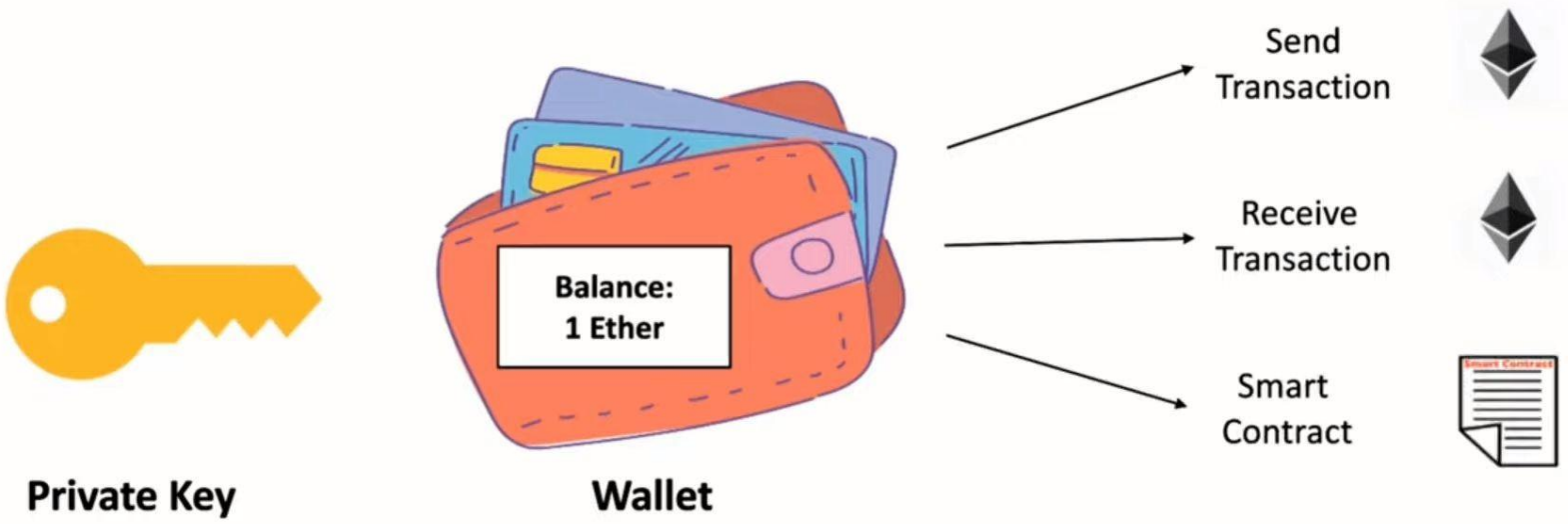
Ethereum Accounts

- An Ethereum account is an entity with an ether (ETH) balance that can send or receive transactions on Ethereum.

Types of Ethereum Accounts



Externally Owned Account(EOA)



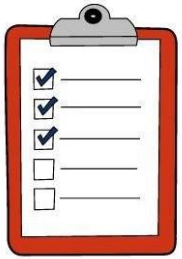
Contract Account (CA)

- Controlled by contract code.

How does the Smart Contract work?

Pre-defined Contract

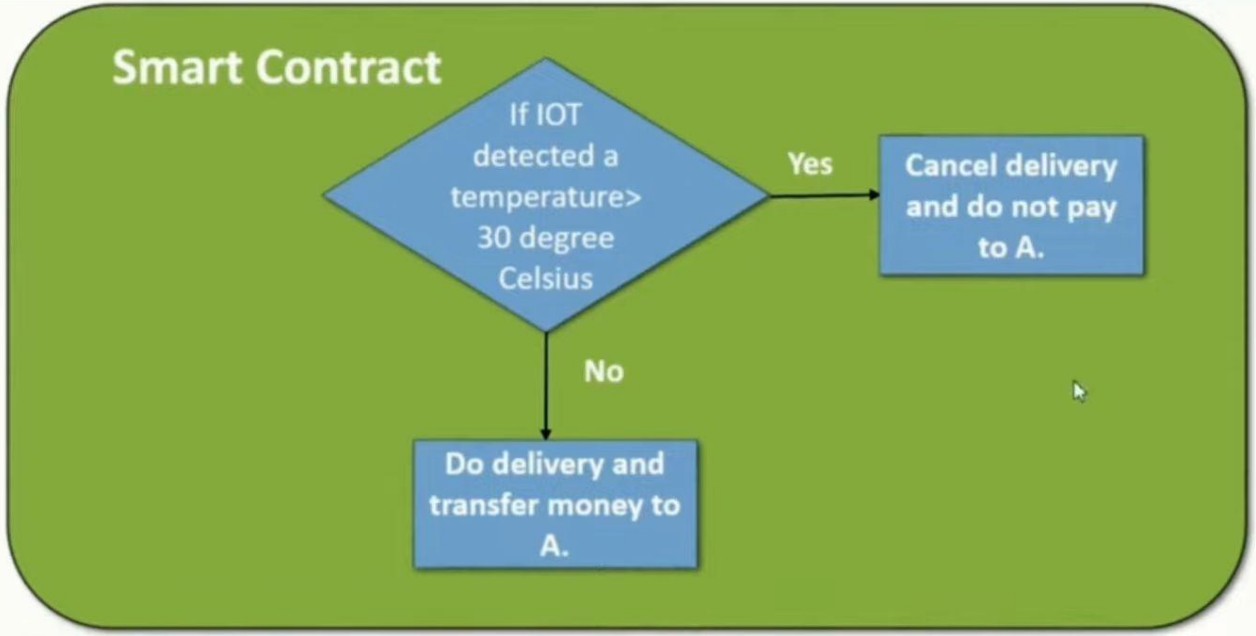
Business Logic



Execution

Settlement

Smart Contract

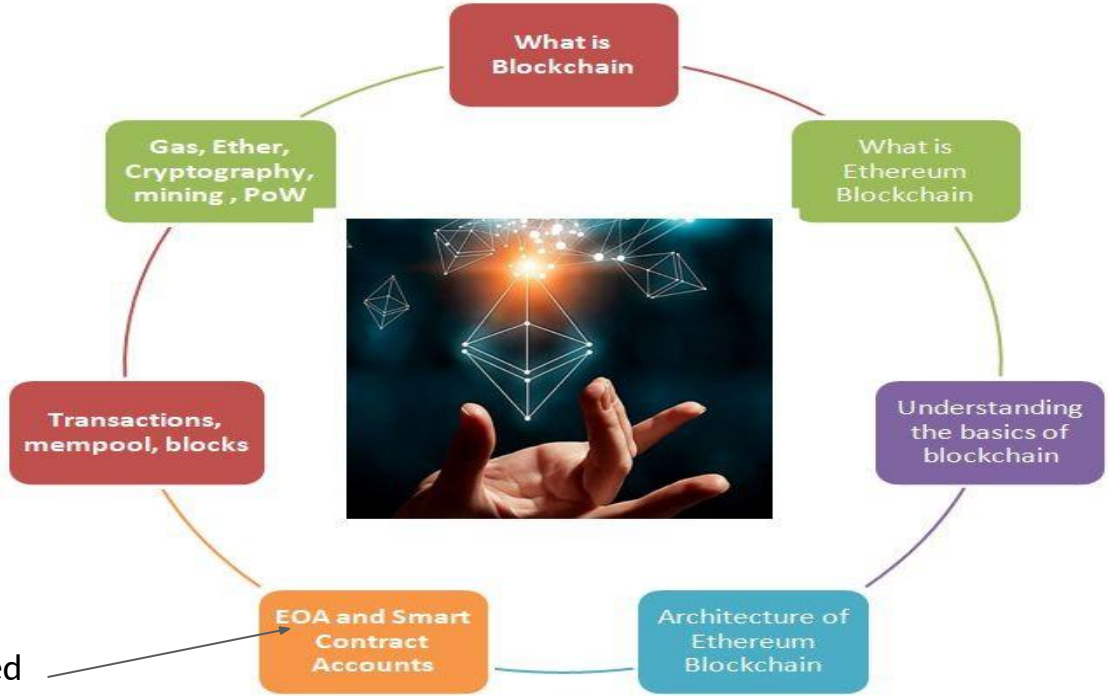


Note-Assuming optimum temperature <30 degree Celsius.

EOA VS CA

EOA	CA
Private Key is needed	No private or public key is needed.
Controlled by Human	Controlled by Contract code
No gas is associated	Gas is associated
Has a unique address	Has a unique address
Holds ETH balance	Holds ETH balance

Eth Developers’ Basic knowledge kit



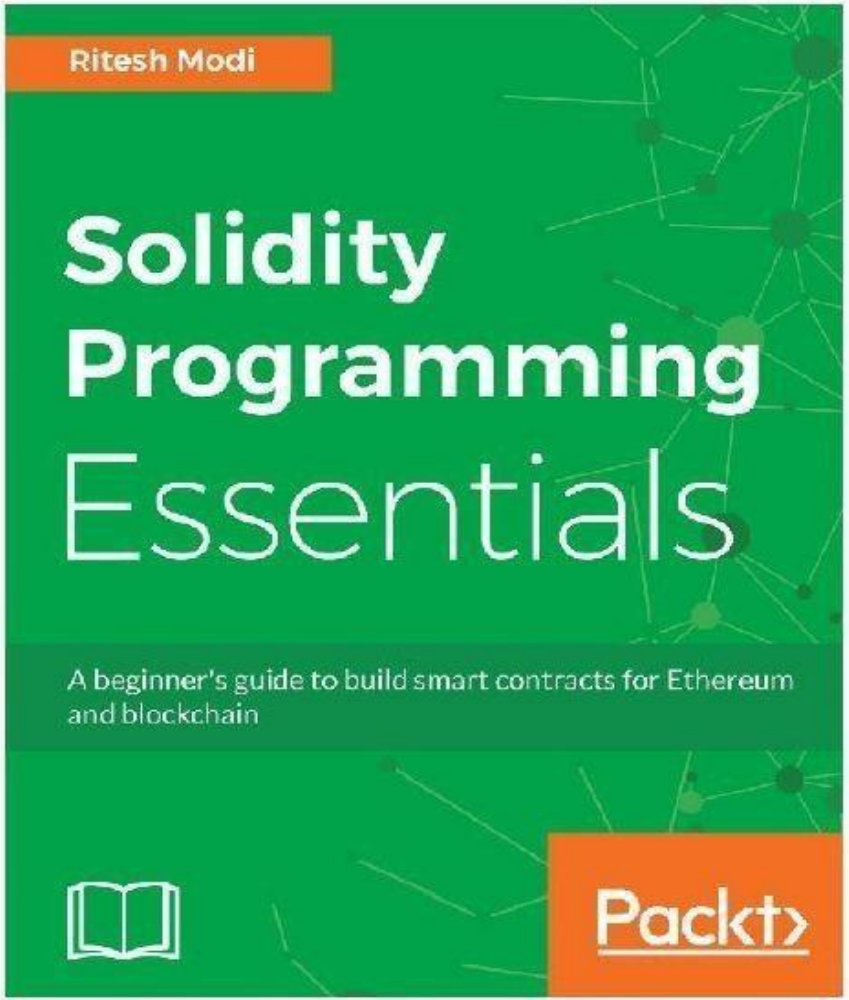
Externally Owned Account

Centralized Setup

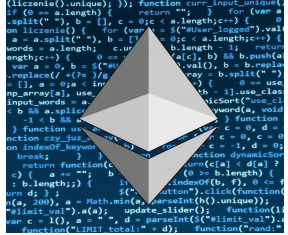
Decentralized Setup


Edversity.
BLOCKCHAIN
BLOCKCHAIN
SOLIDITY
IN BLOCKCHAIN
Pakistan Bockchain Institute

Book we will follow

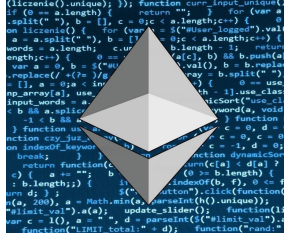


SOLIDITY



- Solidity is an object-oriented, high-level language for implementing smart contracts. Smart contracts are programs which govern the behaviour of accounts within the Ethereum state.
- Solidity is a curly-bracket language designed to target the Ethereum Virtual Machine (EVM). It is influenced by C++, Python and JavaScript.

SOLIDITY



- Solidity is statically typed, supports inheritance, libraries and complex user-defined types among other features.
- With Solidity you can create contracts for uses such as voting, crowdfunding, blind auctions, and multi-signature wallets.
- When deploying contracts, you should use the latest released version of Solidity. Apart from exceptional cases, only the latest version receives security fixes. Furthermore, breaking changes as well as new features are introduced regularly.

Smart Contract Structure

Solidity contracts are similar to object-oriented language classes. Contract can include **state variables, functions, function modifiers, events, struct types, and types of enum declarations**. However, contracts may be inherited from other contracts as well.

- **State variables** are quantities that are stored indefinitely in contract storage.
- **Functions** are the units of code, executable inside a contract.
- **Function modifiers** may be used to modify function semantics in a declarative manner.
- **Events** are channels of comfort for the EVM logging services.
- **Structs** are categories that are custom specified and can group multiple variables.
- **Enums** can be combined with a finite set of 'constant values' to construct custom types.

Variables

Solidity supports 3 variable types.

- **State variables –** Variables whose values are stored permanently in a contract storage.
- **Local variables –** Variables whose values are present before executing function.
- **Global variables –** The generic namespace used to provide knowledge about the blockchain includes special variables.

Solidity is a statically typed language, which means defining the type of state or local variable during declaration. Every variable that was declared also has a default value depending on its type. There is no 'undefined' or 'null' definition.

You can change the accessibility of the variable and control who can access its values.

Reference Types

Reference types include:

- **Arrays** - Arrays are sets of the same type of variables in which each particular variable has a specific location called the index. You can access the attribute by the use of the index position. The array scale can be set or adjustable.
- **Structs** - Solidity helps users to build their own Structure-type. Struct is the category of various forms as a member
  of its own type. Struct is a variable of reference type, which can include both-value types & reference types.
- **Mapping** - Mapping types are the most widely used type of reference; they are used to store data in a key-value
  pair, where the key maybe some form of built-in value or byte and string. Like in any other language, you might think of it as a hashtable or dictionary in which a user might store data in a key-value format and retrieve data by name.

The only difference between value type and reference type is the location of the data. Arrays and Structs have additional locations of data, which determines where data (variable value) should be stored.

Ethereum Networks

1. Ethereum is an Open Source Platform for Creating and Deploying Distributed Applications.
2. Ethereum is backed up by a large number of computers (nodes)
3. All Nodes are interconnected and storing data in a Distributed ledger (each node).
4. Developer can choose an appropriate network based on their requirements and use cases.

Ethereum Networks

5. Different networks help in deploying solutions and smart contracts on networks that do not actually cost any Ether or money.
6. There are networks that are free of cost while there are ones that require its users to pay in terms of Ether or other currencies for its usage.

Main network

1. The main Ethereum network is a global public network that anybody can use.
2. Everybody's free to create an account and deploy their solutions and smart contracts.
3. Main network incurs costs in terms of gas.
4. The main network is known as Homestead.
5. Main network was earlier known as Frontier.

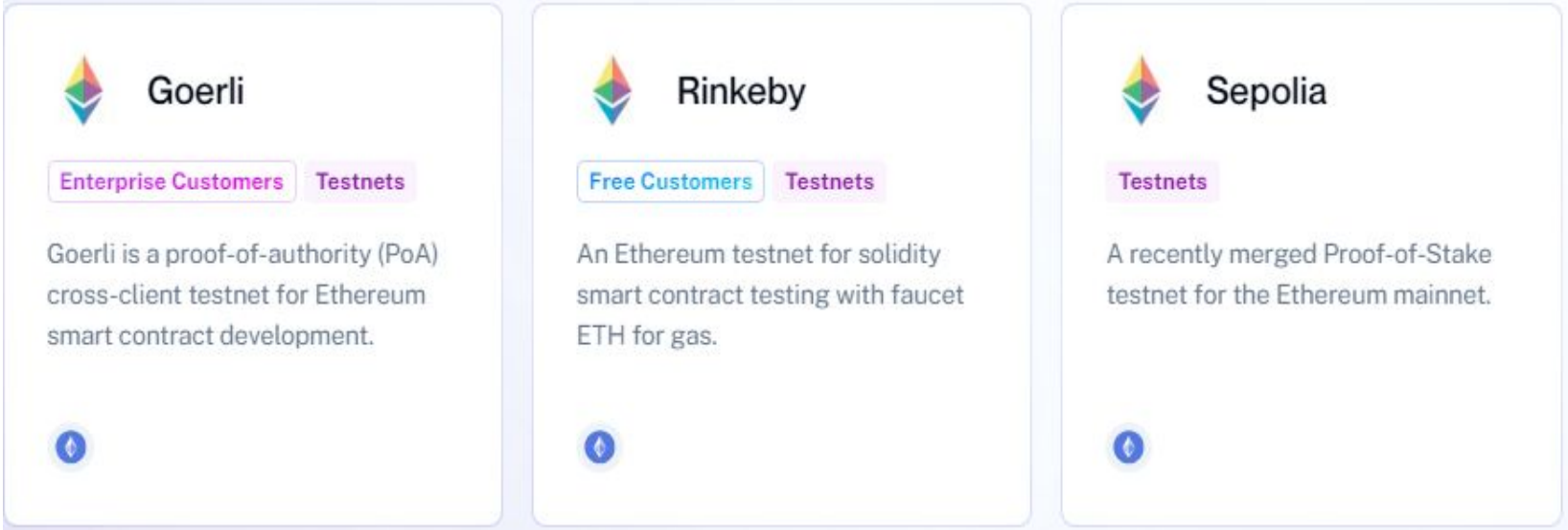
Main network

6. This is a public chain accessible over the internet.
7. Anybody can connect to it and access both data and transactions stored in it.

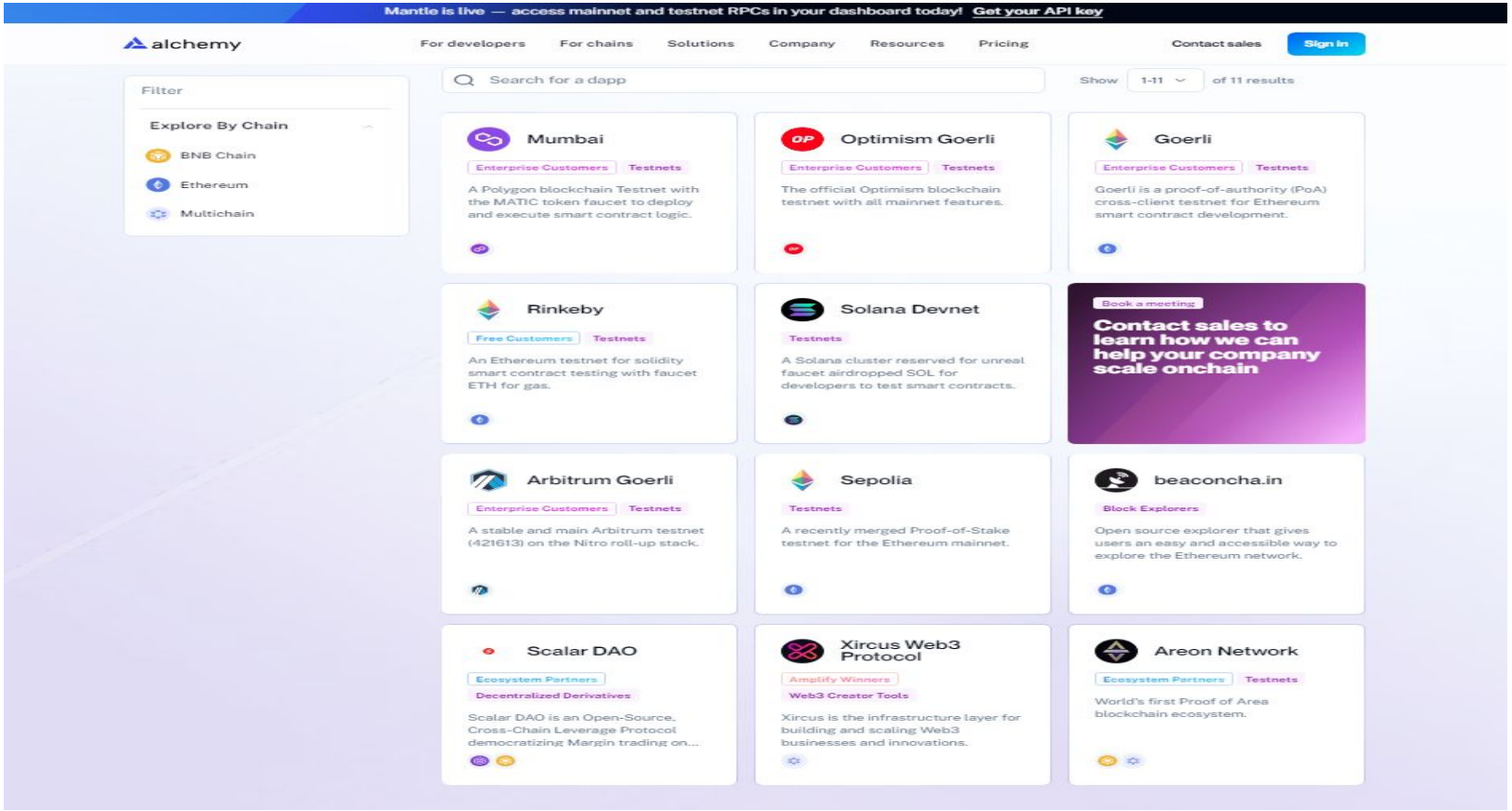
Test network

1. A test network exists to help facilitate and increase adoption of the Ethereum blockchain.
2. Exact replica of the main network.
3. Does not cost anything for deployment and usage of contracts.
4. Test Ethers can be generated using faucets and used on these networks.
5. Multiple test networks available, such as Ropsten, Kovan, and Rinkeby etc

Test network



Test network



Test network

Exploring the Significance of Test Networks in Blockchain Development

Identify and resolve bugs without risking real assets, ensuring a more stable mainnet deployment.

Simulated Environment

Educate users on blockchain operations and functionalities without exposing them to financial vulnerabilities.

Performance Testing

Promotes collaboration, feedback, and community involvement, enhancing network stability and innovation.

Risk Mitigation

Provides a safe setting to simulate real-world interactions, ensuring smoother transitions to the main network.

User Training

Conduct stress tests and evaluate network performance to optimize efficiency and scalability.

Community Engagement

Private network

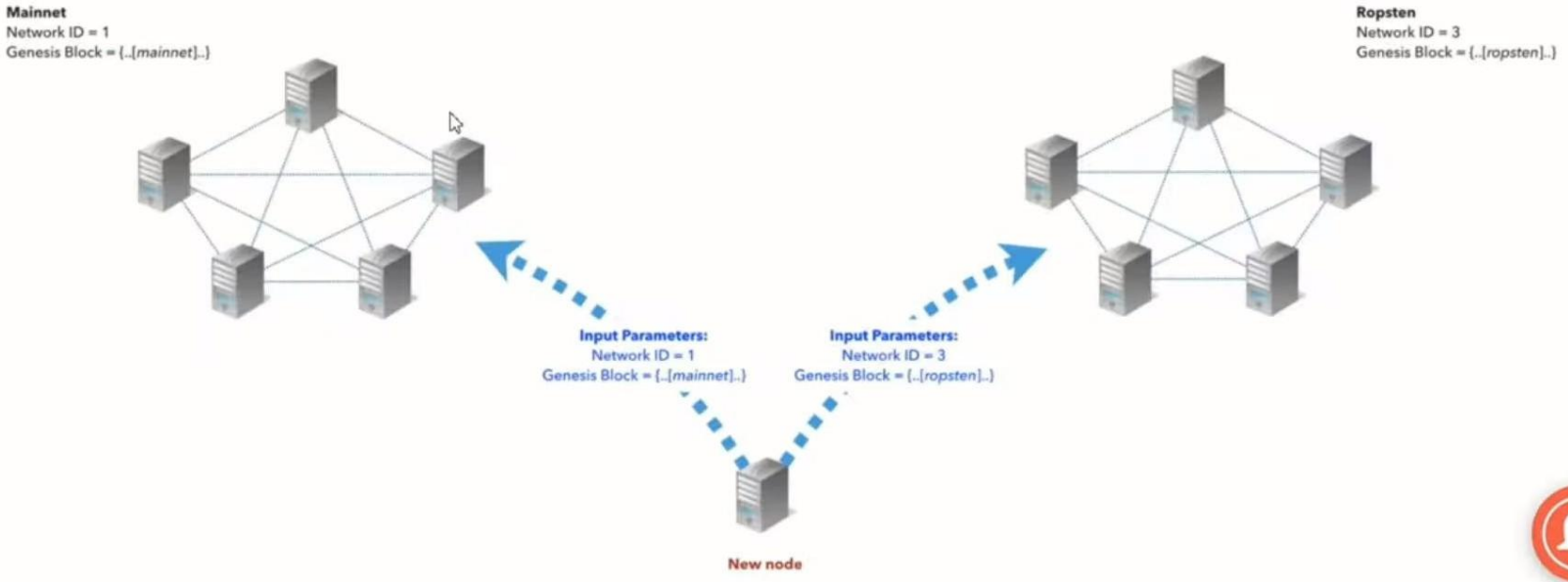
1. Created and hosted on a private infrastructure.
2. Controlled by a single organization and they have full Control over it.
3. There are solutions, contracts, and use cases that an organization might not want to put on a public network even for test purposes.
4. They want to use private chains for development, testing, and production environments.

Consortium network

1. It is also a private network, however, with a difference.
2. The consortium network comprises nodes, each managed by a different organization.
3. In effect, no organization has a control over the data and chain.
4. However, it is shared within the organization and everyone from
   these organizations can view and modify the current state.
5. These might be accessible through the internet or completely private networks using VPN.

Mainnet vs Testnet

A mainnet and a testnet are two separate networks that operate independently from each other. Here's an illustration from the context of Ethereum:



Mainnet vs Testnet

Mainnet	Testnet
Used for actual transactions with value.	Used for testing smart contracts and decentralized applications.
Mainnet's network ID is 1.	Testnets have network IDs of 3, 4, and 42.
Example - Ethereum	Example – Rinkeby Test Network

Case Study: Ethereum Test Networks

Exploring Different Ethereum Test Networks and Their Significance in Blockchain Development

Ropsten: Proof of Work

01

Ropsten operates similarly to the Ethereum mainnet, utilizing proof of work for consensus.

Goerli: Large State Capabilities

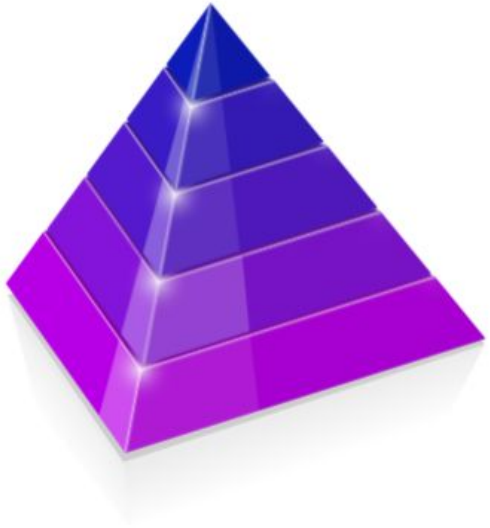
03

Goerli is favored for complex interactions due to its capability to handle large state requirements effectively.

Different Testnets, Unique Purposes

05

Each Ethereum test network serves distinct purposes, catering to various testing needs and scenarios.



Rinkeby: Proof of Authority

02

Rinkeby employs proof of authority consensus mechanism with trusted nodes for faster block confirmations.

Sepolia: Robust Testing Environment

04

Sepolia is designed to replicate challenging network conditions for rigorous testing of Ethereum applications.

BLOCKCHAIN TEST NETWORK B...

Best Practices for Utilizing Test Networks

Enhancing Blockchain Development Through Test Networks

Security Audits

Thorough security audits on testnet deployments are crucial to identify vulnerabilities and ensure robust security measures.

Regular Testing

Frequent testing is essential to identify and resolve issues at an early stage, ensuring smoother mainnet deployment.

Community Involvement

Engaging with the community fosters collaboration, feedback collection, and diverse testing scenarios for comprehensive evaluation.

Simulate Real-World Conditions

Using testnets that closely resemble mainnet conditions helps in predicting performance and scalability accurately.

Tools Required

- MetaMask
- Remix

MetaMask

Brings Ethereum to your browser

MetaMask

1. MetaMask is a lightweight Chrome browser-based extension that helps in interacting with Ethereum networks.
2. It is also a wallet that helps in sending and receiving Ether.
3. It is able to connect to a variety of Ethereum nodes and test blockchains.
4. Since MetaMask runs in a browser, it does not download the entire chain data locally; instead, it stores it centrally and helps users connect to their store using the browser.

Install MetaMask

1. Install MetaMask extension in browser:
    a. https://metamask.io/

Getting Started with MetaMask

1. Once MetaMask is installed you should see a new icon in your browser's toolbar.
2. Click on it to get started.
3. You will be asked to accept the terms and conditions and then to create your new Ethereum wallet by entering a password

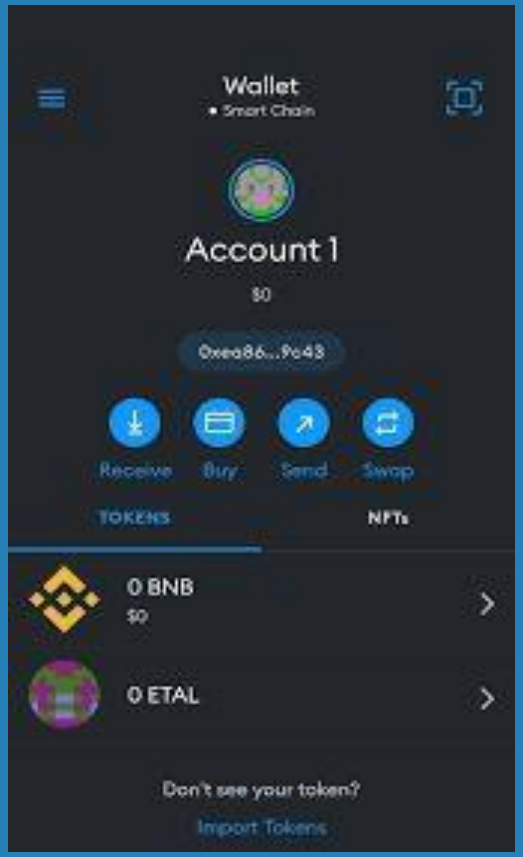
Switching Networks

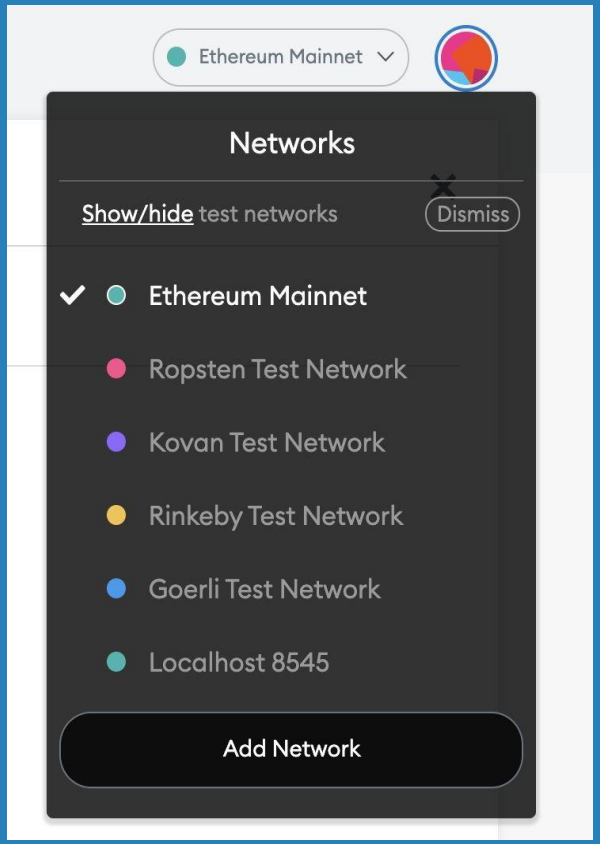
1. **Main Ethereum Network**
   a. By default, MetaMask will try to connect to the main public network.
   b. Real ETH, real value, and real consequences.
2. **Ropsten Test Network**
   a. Ethereum public test blockchain and network.
   b. ETH on this network has no value.
3. **Kovan Test Network**
   a. Ethereum public test blockchain and network using consensus protocol - Proof of authority ETH on this network has no value. The Kovan test network is supported by Parity only.

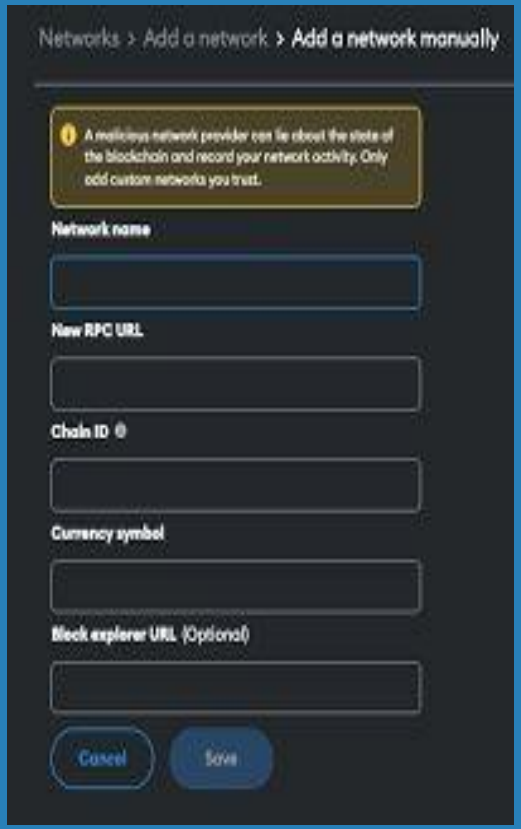
Switching Networks

4. **Rinkeby Test Network**
    a. Ethereum public test blockchain and network, using consensus protocol - proof of authority
    b. ETH on this network has no value.
5. **Localhost 8545**
    a. Connects to a node running on the same computer as the browser.
    b. The node can be part of any public blockchain (main or testnet), or a private testnet.
6. **Custom RPC**
    a. Allows you to connect MetaMask to any node with a Geth-compatible Remote Procedure Call (RPC) interface. The node can be part of any public or private blockchain

Demo MetaMask


Wallet
Smart Chain
Account 1
$0
0xea86...9c43
Receive
Buy
Send
Swap
TOKENS
NFTs
0 BNB
$0
0 ETAL
Don't see your token?
Import Tokens


Ethereum Mainnet
Networks
Show/hide test networks
Dismiss
Ethereum Mainnet
Ropsten Test Network
Kovan Test Network
Rinkeby Test Network
Goerli Test Network
Localhost 8545
Add Network


Networks > Add a network > Add a network manually
A malicious network provider can lie about the state of the blockchain and record your network activity. Only add custom networks you trust.
Network name
New RPC URL
Chain ID
Currency symbol
Block explorer URL (Optional)
Cancel
Save

Remix

Browser-based compiler and IDE

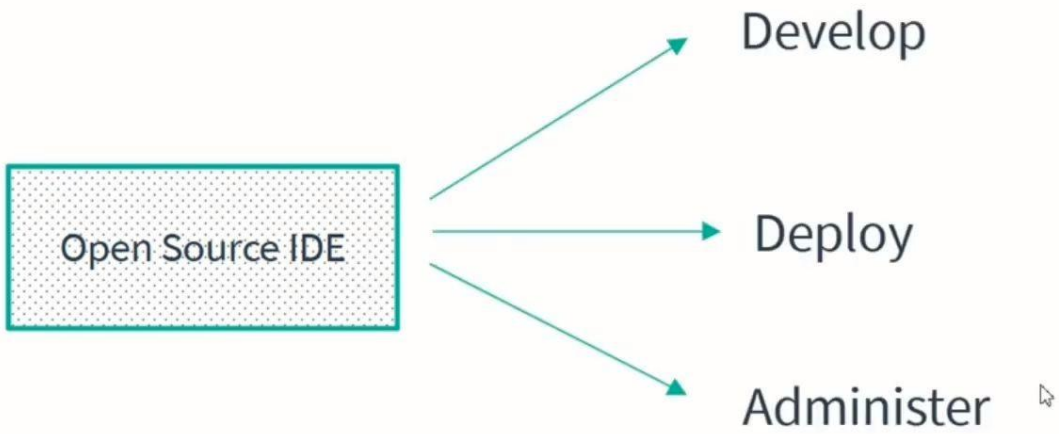
Remix

1. The easiest and fastest way to develop smart contracts is to use a browser-based tool known as Remix.
2. Remix is available on http://remix.ethereum.org.
3. Remix is a new name and was earlier known as browser-solidity.
4. Remix provides a rich integrated development environment in a browser for authoring, developing, deploying, and troubleshooting contracts written using the Solidity language.
5. All contract management related activities such as authoring, deploying, and troubleshooting can be performed from the same environment without moving to other windows or tabs

Remix

1. Remix is a browser-based compiler and IDE that enables users to build Ethereum contracts with Solidity language and to debug transactions.
2. Remix IDE is an IDE for Solidity dApp developers, powered by Remix.
3. Online version is available at https://remix.ethereum.org.
4. You can also install remix on you machine
    a. npm install remix-ide -g

Remix IDE



Remix IDE

Some important to know about Remix IDE-

- **Language Support -** Solidity and Vyper
- **Written in -** JavaScript
- **Modules -** Testing , Debugging ,Deploy

Demo
Remix

Thanks

End of Module-2 (Class-3)