

# What are Chain Signatures?

Chain signatures enable NEAR accounts, including smart contracts, to sign and execute transactions across many blockchain protocols.

This unlocks the next level of blockchain interoperability by giving ownership of diverse assets, cross-chain accounts, and data to a single NEAR account.

Looking for code? To get started using Chain Signatures in your project see [Create a Chain Signature](#).

## How It Works

Controlling accounts and their assets on other blockchain platforms is made possible thanks to the interaction between three elements:

1. [Derivation Paths](#)
2.
  - A deterministic way to derive multiple addresses from one NEAR account
3. [Multichain Smart Contract](#)
4.
  - Receives requests to sign a transaction for other blockchains
5. [Multiparty Computation Service](#)
6. Third-party service providing signatures to the contract

### Derivation Paths: One Account, Multiple Chains

Chain Signatures link NEAR accounts to other blockchain accounts using [Additive Key Derivation](#) (a simple mechanism for deriving many subkeys from a single master key). These keys are generated using derivation paths (or paths for short).

A derivation path is simply a string (e.g. `ethereum-1`, `ethereum-2`, etc) that in conjunction with the NEAR account derives a unique address on the target blockchain.

For example, we can derive multiple Ethereum accounts from `example.near` by using different paths:

1. `example.near`
2. `+ethereum-1`
3. `=0x1b48b83a308ea4beb845db088180dc3389f8aa3b`
4. `example.near`
5. `+ethereum-2`
6. `=0x99c5d3025dc736541f2d97c3ef3c90de4d221315`
7. `example.near`
8. `+...`
9. `=0x...`

This external address is deterministically derived using the path (`example.near +ethereum-1`) and the MPC service's public key.

See [Create a Chain Signature - how the derivation is implemented](#) for an example implementation

### Multichain Smart Contract

A deployed multichain smart contract is used to request signatures for transactions on other blockchains.

This contract has a `sign` method that takes two parameters:

1. The payload
2. (transaction) to be signed for the target blockchain
3. The path
4. that identifies the account you want to use to sign the transaction.

For example, a user could request a signature to send 0.1 ETH to `0x060f1...` (transaction) using the `ethereum-1` account (path).

After a request is made, the `sign` method starts recursively calling itself to wait while the [MPC signing service](#) signs the transaction.

Once the signature is ready, the contract gains access to it and returns it to the user. This signature is a valid signed transaction that can be readily sent to the target blockchain to be executed.

A Contract Recursively Calling Itself? NEAR smart contracts are unable to halt execution and await the completion of a process. To solve this, one can make the contract call itself again and again checking on each iteration to see if the result is ready.

Note: Each call will take one block which equates to ~1 second of waiting. After some time the contract will either return a result that an external party provided or return an error running out of GAS waiting. info See [Create a Chain Signature - requesting the signature](#) for an example implementation

## Multi-Party Computation Service

The essence of Multi-Party Computation (MPC) is to enable independent parties to perform shared computations on private information without revealing secrets to each other. In practice, this system can be used with blockchain platforms to safely sign a transaction on behalf of a user without ever having to expose a private key.

NEAR's MPC service is comprised of several independent nodes, none of which can sign by itself, but instead creates signature-shares that are aggregated through multiple rounds to jointly sign a transaction.

This service continuously listens for signature requests (i.e. users calling the `sign` method on the `multichain` smart contract) and when a call is detected the MPC service:

1. Asks its nodes to jointly derive a signature for the payload
2. using the account identified by the path
3. Once complete, call the `multichain`
4. contract to store the resulting Signature

A Custom MPC Service Generally, MPC signing services work by sharing a master key, which needs to be re-created each time a node joins or leaves.

NEAR's MPC service allows for nodes to safely join and leave, without needing to re-derive a master key tip Want to learn more about the mathematics that enable MPC? [Check this awesome article](#)

## Concluding Remarks

Chain Signatures are a powerful tool that allows NEAR accounts to control accounts on other blockchains. This is a fundamental step towards enabling true ownership of cross-chain data and assets.

For the user, the process is made completely on chain, since they only need to make a call to a smart contract and wait for the response.

Thanks to derivation paths, a single NEAR account can control multiple accounts on different blockchains, and thanks to the MPC service, the user can be sure that nobody but themselves can request signatures for those accounts. [Edit this page](#)  
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