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[#Copy link](https://ida.interchain.io/academy/2-cosmos-concepts/3-transactions.html#transactions) **Transactions**



In this section you will dive into the various functions and features of making transactions in the Interchain:

* Transactions and Messages
* Signing Transactions
* Generating Transactions
* Broadcasting Transactions
* Introducing the CLI, the gRPC service, the REST API, and the CometBFT RPC service

Transactions are objects created by end-users to trigger state changes in applications. They are comprised of metadata that defines a context, and one or more [sdk.Msg (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/types/tx_msg.go#L11-L22) that trigger state changes within a module through the module’s Protobuf message service.

[#Copy link](https://ida.interchain.io/academy/2-cosmos-concepts/3-transactions.html#transaction-process-from-an-end-user-perspective) Transaction process from an end-user perspective

While there is much to explore as you journey through the stack, begin by understanding the transaction process from a user perspective:

****

**Decide**

**Decide** on the messages to put into the transaction. This is normally done with the assistance of a wallet or application and a user interface.

****

**Generate**

**Generate** the transaction using the Cosmos SDK's TxBuilder. TxBuilder is the preferred way to generate a transaction.

****

**Sign**

**Sign** the transaction. Transactions must be signed before a validator includes them in a block.

****

**Broadcast**

**Broadcast** the signed transaction using one of the available interfaces.

**Deciding** and **signing** are the main interactions of a user. **Generating** and **broadcasting** are attended to by the user interface and other automation.

[#Copy link](https://ida.interchain.io/academy/2-cosmos-concepts/3-transactions.html#transaction-objects) Transaction objects

Transaction objects are Cosmos SDK types that implement the [Tx (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/types/tx_msg.go#L39-L46) interface. They contain the following methods:

* [GetMsgs (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/types/tx_msg.go#L41): unwraps the transaction and returns a list of contained [sdk.Msg (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/types/tx_msg.go#L11-L22). One transaction may have one or multiple messages.
* [ValidateBasic (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/types/tx_msg.go#L45): includes lightweight, stateless checks used by the ABCI messages' CheckTx and DeliverTx to make sure transactions are not invalid. For example, the [Tx (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/types/tx/tx.pb.go#L32-L42) [ValidateBasic (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/types/tx/types.go#L38) function checks that its transactions are signed by the correct number of signers and that the fees do not exceed the user's maximum.



This function is different from the [ValidateBasic (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/types/tx_msg.go#L16) functions for sdk.Msg, which perform basic validity checks on messages only. For example, runTX first runs ValidateBasic on each message when it checks a transaction created from the auth module. Then it runs the auth module's [AnteHandler (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/types/handler.go#L8), which calls ValidateBasic for the transaction itself.

You should rarely manipulate a Tx object directly. It is an intermediate type used for transaction generation. Developers usually use the [TxBuilder (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/client/tx_config.go#L36-L46) interface.

[#Copy link](https://ida.interchain.io/academy/2-cosmos-concepts/3-transactions.html#messages) Messages



Transaction messages are not to be confused with ABCI messages, which define interactions between CometBFT and application layers.

Messages or [sdk.Msg (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/types/tx_msg.go#L11-L22) are module-specific objects that trigger state transitions within the scope of the module they belong to. Module developers define module messages by adding methods to the Protobuf Msg service and defining a MsgServer. Each sdk.Msg is related to exactly one Protobuf Msg service RPC defined inside each module's tx.proto file. A Cosmos SDK app router automatically maps every sdk.Msg to a corresponding RPC service, which routes it to the appropriate method. Protobuf generates a MsgServer interface for each module's Msg service and the module developer implements this interface.

This design puts more responsibility on module developers. It allows application developers to reuse common functionalities without having to repetitively implement state transition logic. While messages contain the information for the state transition logic, a transaction's other metadata and relevant information are stored in the TxBuilder and Context.

[#Copy link](https://ida.interchain.io/academy/2-cosmos-concepts/3-transactions.html#signing-transactions) Signing Transactions

Every message in a transaction must be signed by the addresses specified by its [GetSigners (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/types/tx_msg.go#L21). The Cosmos SDK currently allows signing transactions in two different ways:

* [SIGN\_MODE\_DIRECT (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/types/tx/signing/signing.pb.go#L36) (preferred): the most used implementation of the Tx interface is the [Protobuf Tx (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/types/tx/tx.pb.go#L32-L42) message, which is used in SIGN\_MODE\_DIRECT. Once signed by all signers, the BodyBytes, AuthInfoBytes, and [Signatures (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/types/tx/tx.pb.go#L113) are gathered into [TxRaw (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/types/tx/tx.pb.go#L103-L114), whose [serialized bytes (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/types/tx/tx.pb.go#L125-L136) are broadcast over the network.
* [SIGN\_MODE\_LEGACY\_AMINO\_JSON (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/types/tx/signing/signing.pb.go#L43): the legacy implementation of the Tx interface is the [StdTx (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/x/auth/legacy/legacytx/stdtx.go#L77-L83) struct from x/auth. The document signed by all signers is [StdSignDoc (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/x/auth/legacy/legacytx/stdsign.go#L42-L50), which is encoded into [bytes (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/x/auth/legacy/legacytx/stdsign.go#L53-L78) using Amino JSON. Once all signatures are gathered into StdTx, StdTx is serialized using Amino JSON and these bytes are broadcast over the network. **This method is being deprecated**.

[#Copy link](https://ida.interchain.io/academy/2-cosmos-concepts/3-transactions.html#generating-transactions) Generating transactions

The TxBuilder interface contains metadata closely related to the generation of transactions. The end-user can freely set these parameters for the transaction to be generated:

* [Msgs (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/client/tx_config.go#L39): the array of messages included in the transaction.
* [GasLimit (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/client/tx_config.go#L43): an option chosen by the users for how to calculate the gas amount they are willing to spend.
* [Memo (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/client/tx_config.go#L41): a note or comment to send with the transaction.
* [FeeAmount (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/client/tx_config.go#L42): the maximum amount the user is willing to pay in fees.
* [TimeoutHeight (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/client/tx_config.go#L44): the block height until which the transaction is valid.
* [Signatures (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/client/tx_config.go#L40): the array of signatures from all signers of the transaction.

As there are currently two modes for signing transactions, there are also two implementations of TxBuilder. There is a wrapper for SIGN\_MODE\_DIRECT and the [StdTxBuilder (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/8fc9f76329dd2433d9b258a867500de419522619/x/auth/migrations/legacytx/stdtx_builder.go#L18-L21) for SIGN\_MODE\_LEGACY\_AMINO\_JSON. The two possibilities should normally be hidden because end-users should prefer the overarching [TxConfig (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/client/tx_config.go#L24-L30) interface. TxConfig is an [app-wide (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/client/context.go#L50) configuration for managing transactions accessible from the context. Most importantly, it holds the information about whether to sign each transaction with SIGN\_MODE\_DIRECT or SIGN\_MODE\_LEGACY\_AMINO\_JSON.

A new TxBuilder will be instantiated with the appropriate sign mode by calling txBuilder := txConfig.NewTxBuilder(). TxConfig will correctly encode the bytes either using SIGN\_MODE\_DIRECT or SIGN\_MODE\_LEGACY\_AMINO\_JSON once TxBuilder is correctly populated with the setters of the fields described previously.

This is a pseudo-code snippet of how to generate and encode a transaction using the TxEncoder() method:



Copy

txBuilder := txConfig.NewTxBuilder()

txBuilder.SetMsgs(...) // and other setters on txBuilder

[#Copy link](https://ida.interchain.io/academy/2-cosmos-concepts/3-transactions.html#broadcasting-the-transaction) Broadcasting the transaction

Once the transaction bytes are generated and signed, there are **three primary ways of broadcasting** the transaction:

* Using the command-line interface (CLI).
* Using gRPC.
* Using REST endpoints.

Application developers create entrypoints to the application by creating a command-line interface typically found in the application's ./cmd folder, gRPC, and/or REST interface. These interfaces allow users to interact with the application.

[#Copy link](https://ida.interchain.io/academy/2-cosmos-concepts/3-transactions.html#cli) CLI

For the command-line interface (CLI) module developers create subcommands to add as children to the application top-level transaction command [TxCmd (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/x/bank/client/cli/tx.go#L29-L60).

CLI commands bundle all the steps of transaction processing into one simple command:

* Creating messages.
* Generating transactions.
* Signing.
* Broadcasting.

[#Copy link](https://ida.interchain.io/academy/2-cosmos-concepts/3-transactions.html#grpc) gRPC

The principal usage of gRPC is in the context of module query services. The Cosmos SDK also exposes other module-agnostic gRPC services. One of these is the Tx service, which exposes a handful of utility functions such as simulating a transaction or querying a transaction, and also one method to [broadcast transactions (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/master/docs/docs/run-node/03-txs.md#broadcasting-a-transaction-1).



See this [code example (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/master/docs/docs/run-node/03-txs.md#programmatically-with-go) for more insight.

[#Copy link](https://ida.interchain.io/academy/2-cosmos-concepts/3-transactions.html#rest) REST

Each gRPC method has its corresponding REST endpoint generated using gRPC-gateway. Rather than using gRPC, you can also use HTTP to broadcast the same transaction on the POST /cosmos/tx/v1beta1/txs endpoint.



See this [code example (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/master/docs/docs/run-node/03-txs.md#using-rest) for more details.

[#Copy link](https://ida.interchain.io/academy/2-cosmos-concepts/3-transactions.html#cometbft-rpc) CometBFT RPC

The three methods presented previously are higher abstractions on the CometBFT RPC /broadcast\_tx\_{async,sync,commit} endpoints. You can use the [Tendermint RPC endpoints (opens new window)↗](https://docs.tendermint.com/v0.34/tendermint-core/rpc.html) to directly broadcast the transaction through CometBFT if you wish to.



CometBFT supports the following RPC protocols:

* URI over HTTP.
* JSONRPC over HTTP.
* JSONRPC over WebSockets.

For more information on broadcasting with CometBFT RPC, see the documentation on [Tendermint RPC transactions broadcast APIs (opens new window)↗](https://docs.tendermint.com/v0.34/tendermint-core/rpc.html).

[#Copy link](https://ida.interchain.io/academy/2-cosmos-concepts/3-transactions.html#code-example) Code example

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[Previously](https://ida.interchain.io/academy/2-cosmos-concepts/1-architecture.html), the ABCI application knew of a single transaction type: a checkers move with four int. This is no longer sufficient with multiple games. You need to conform to its Tx expectations, which means that you must create messages which are then placed into a transaction. See the [section on messages](https://ida.interchain.io/academy/2-cosmos-concepts/4-messages.html) to learn how to do that.

synopsis

To summarize, this section has explored:

* How transactions are objects created by end-users to trigger state changes in an application module through that module's Protobuf message service.
* How transaction messages are not to be confused with ABCI messages, which define interactions between CometBFT and application layers.
* How *deciding* and *signing* transactions are the main interactions of a user, whereas *generating* and *broadcasting* transactions are attended to by the user interface and other automation.
* How the modular nature of the Cosmos SDK places more responsibility on *module* developers to effectively code transaction processes, so *application* developers can reuse common functionalities without having to repetitively implement state transition logic.

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