

# Submitting data blobs to Celestia

To submit data to Celestia, users submit blob transactions (BlobTx). Blob transactions contain two components, a standard Cosmos-SDK transaction called `MsgPayForBlobs` and one or more Blobs of data.

## Fee market and mempool

Celestia makes use of a standard gas-priced prioritized mempool. By default, transactions with gas prices higher than that of other transactions in the mempool will be prioritized by validators.

### Fees and gas limits

As of version v1.0.0 of the application (celestia-app), there is no protocol enforced minimum fee (similar to EIP-1559 in Ethereum). Instead, each consensus node running a mempool uses a locally configured gas price threshold that must be met in order for that node to accept a transaction, either directly from a user or gossiped from another node, into its mempool.

As of version v1.0.0 of the application (celestia-app), gas is not refunded. Instead, transaction fees are deducted by a flat fee, originally specified by the user in their tx (where  $\text{fees} = \text{gasLimit} \times \text{gasPrice}$ ). This means that users should use an accurate gas limit value if they do not wish to over pay.

Under the hood, fees are currently handled by specifying and deducting a flat fee. However gas price is often specified by users instead of calculating the flat fee from the gas used and the gas price. Since the state machine does not refund users for unused gas, gas price is calculated by dividing the total fee by the gas limit.

### Estimating PFB gas

Generally, the gas used by a PFB transaction involves a static fixed cost and a dynamic cost based on the size of each blob in the transaction.

#### NOTE

For a general use case of a normal account submitting a PFB, the static costs can be treated as such. However, due to the description above of how gas works in the Cosmos-SDK this is not always the case. Notably, if a vesting account or thefeegrant modules are used, then these static costs change. The fixed cost is an approximation of the gas consumed by operations outside the function `GasToConsume` (for example, signature verification, tx size, read access to accounts), which has a default value of 65,000 gas.

#### NOTE

The first transaction sent by an account (sequence number == 0) has an additional one time gas cost of 10,000 gas. If this is the case, this should be accounted for. Each blob in the PFB contributes to the total gas cost based on its size. The function `GasToConsume` calculates the total gas consumed by all the blobs involved in a PFB, where each blob's gas cost is computed by first determining how many shares are needed to store the blob size. Then, it computes the product of the number of shares, the number of bytes per share, and the `gasPerByte` parameter. Finally, it adds a static amount per blob.

The [blob.GasPerBlobByte](#) and [auth.TxSizeCostPerByte](#) are parameters that could potentially be adjusted through the system's governance mechanisms. Hence, actual costs may vary depending on the current state of these parameters.

### Gas fee calculation

The total fee for a transaction is calculated as the product of the gas limit for the transaction and the gas price set by the user:

## Total Fee

Gas Limit  $\times$  Gas Price

The gas limit for a transaction is the maximum amount of gas that a user is willing to spend on a transaction. It is determined by both a static fixed cost (FC) and a variable dynamic cost based on the size of each blob involved in the transaction:

## Gas Limit

$$FC + \sum_{i=1}^n SSN(B_i) \times SS \times GCPBB$$

Where:

- F
- C
- = Fixed Cost, is a static value (65,000 gas)
- $\sum$
- i
- =
- 1
- n
- S
- S
- N
- (
- B
- i
- )
- = SparseSharesNeeded for the i
- th Blob, is the number of shares needed for the i
- th blob in the transaction
- S
- S
- = Share Size, is the size of each share
- G
- C
- P
- B
- B
- = Gas Cost Per Blob Byte, is a parameter that could potentially be adjusted through the system's governance mechanisms.

The gas fee is set by the user when they submit a transaction. The fee is often specified by users directly. The total cost for the transaction is then calculated as the product of the estimated gas limit and the gas price. Since the state machine does not refund users for unused gas, it's important for users to estimate the gas limit accurately to avoid overpaying.

For more details on how gas is calculated per blob, refer to the [PayForBlobs function](#) that consumes gas based on the blob sizes. This function uses the [GasToConsume function](#) to calculate the extra gas charged to pay for a set of blobs in a `MsgPayForBlobs` transaction. This function calculates the total shares used by all blobs and multiplies it by the `ShareSize` and `gasPerByte` to get the total gas to consume.

For estimating the total gas required for a set of blobs, refer to the [EstimateGas function](#). This function estimates the gas based on a linear model that is dependent on the governance parameters: `gasPerByte` and `txSizeCost`. It assumes other variables are constant, including the assumption that the `MsgPayForBlobs` is the only message in the transaction. The `DefaultEstimateGas` function runs `EstimateGas` with the system defaults.

## Estimating gas programmatically

Users can estimate an efficient gas limit by using this function:

```
go import ( blobtypes
```

```
" github.com/celestiaorg/celestia-app/x/blob/types " ) gasLimit := blobtypes.DefaultEstimateGas ([] uint32 { uint32  
(sizeofDataInBytes) }) import ( blobtypes
```

```
" github.com/celestiaorg/celestia-app/x/blob/types " ) gasLimit := blobtypes.DefaultEstimateGas ([] uint32 { uint32  
(sizeofDataInBytes) })
```

If using a celestia-node light client, then this function is automatically called for you when submitting a blob. This function works by breaking down the components of calculating gas for a blob transaction. These components consist of a flat costs for all PFBs, the size of each blob and how many shares each uses and the parameter for gas used per byte. More information about how gas is used can be found in the [gas specs](#) and the exact formula can be found in the [blob module](#).

## Submitting multiple transactions in one block from the same account

The mempool Celestia uses works by maintaining a fork of the canonical state each block. This means that each time we submit a transaction to it, it will update the sequence number (aka nonce) for the account that submitted the transaction. If users wish to submit a second transaction, they can, but must specify the nonce manually. If this is not done, the new transactions will not be able to be submitted until the first transaction is reaped from the mempool (i.e. included in a block), or dropped due to timing out.

By default, nodes will drop a transaction if it does not get included in 5 blocks (roughly 1 minute). At this point, the user must resubmit their transaction if they want it to eventually be included.

As of v1.0.0 of the application (celestia-app), users are unable to replace an existing transaction with a different one with higher fees. They must instead wait 5 blocks from the original submitted time and then resubmit the transaction. Again, community members have already suggested solutions and a willingness to accept changes to fix this issue.

## API

Users can currently create and submitBlobTx s in four ways.

### The celestia-app consensus node CLI

```
bash celestia-appd
tx
blob
PayForBlobs
< hex-encoded
namespace
< hex-encoded
data
[flags] celestia-appd
tx
blob
PayForBlobs
< hex-encoded
namespace
< hex-encoded
data
[flags]
```

### The celestia-node light node CLI

Using blob.Submit :

```
bash celestia
blob
submit
< hex-encoded
namespace
< hex-encoded
data
celestia
blob
submit
< hex-encoded
```

namespace

< hex-encoded

data

Learn more in the [node tutorial](#) .

## GRPC to a consensus node via the user

package

```
go import ( " context " " fmt "
```

```
" github.com/celestiaorg/celestia-app/app " " github.com/celestiaorg/celestia-app/app/encoding " "  
github.com/celestiaorg/celestia-app/pkg/appconsts " " github.com/celestiaorg/celestia-app/pkg/namespace " "  
github.com/celestiaorg/celestia-app/pkg/user " blobtypes
```

```
" github.com/celestiaorg/celestia-app/x/blob/types " " github.com/cosmos/cosmos-sdk/crypto/keyring " tmproto
```

```
" github.com/tendermint/tendermint/proto/tendermint/types " " google.golang.org/grpc " "  
google.golang.org/grpc/credentials/insecure " )
```

// SubmitData is a demo function that shows how to use the signer to submit data // to the blockchain directly via a celestia node. We can manage this keyring // using the celestia-appd keys OR celestia keys sub commands and load this // keyring from a file and use it to programmatically sign transactions. func

```
DemoSubmitData (grpcAddr string , kr keyring.Keyring) error { // create an encoding config that can decode and encode all  
celestia-app // data structures. ecfg := encoding.MakeConfig (app.ModuleEncodingRegisters ... )
```

```
// create a connection to the grpc server on the consensus node. conn, err := grpc.Dial (grpcAddr, grpc.  
WithTransportCredentials (insecure.NewCredentials ())) if err !=
```

```
nil { return err } defer conn.Close ()
```

```
// get the address of the account we want to use to sign transactions. rec, err := kr.Key ( "accountName" ) if err !=
```

```
nil { return err }
```

```
addr, err := rec.GetAddress () if err !=
```

```
nil { return err }
```

```
// Setup the signer. This function will automatically query the relevant // account information such as sequence (nonce) and  
account number. signer, err := user.SetupSigner (context.TODO (), kr, conn, addr, ecfg) if err !=
```

```
nil { return err }
```

```
ns := namespace.MustNewV0 ([] byte ( "1234567890" ))
```

```
fmt.Println ( "namespace" , len (ns.Bytes ()))
```

```
blob, err := blobtypes.NewBlob (ns, [] byte ( "some data" ), appconsts.ShareVersionZero) if err !=
```

```
nil { return err }
```

```
gasLimit := blobtypes.DefaultEstimateGas ([] uint32 { uint32 ( len (blob.Data))})
```

```
options := []user.TxOption{ // here we're setting estimating the gas limit from the above estimated // function, and then  
setting the gas price to 0.1 utia per unit of gas. user.SetGasLimitAndFee (gasLimit, 0.1 ), }
```

```
// this function will submit the transaction and block until a timeout is // reached or the transaction is committed. resp, err :=  
signer.SubmitPayForBlob (context.TODO (), [] *tmproto.Blob{blob}, options ... ) if err !=
```

```
nil { return err }
```

```
// check the response code to see if the transaction was successful. if resp.Code !=
```

```
0 { // handle code fmt.Println (resp.Code, resp.Codespace, resp.RawLog) }
```

```
// if we don't want to wait for the transaction to be confirmed, we can // manually sign and submit the transaction using the  
same package. blobTx, err := signer.CreatePayForBlob ([] *tmproto.Blob{blob}, options ... ) if err !=
```

```
nil { return err }
```

## resp, err

```
signer. BroadcastTx (context. TODO (), blobTx) if err !=
```

```
nil { return err }
```

```
// check the response code to see if the transaction was successful. Note // that this time we're not waiting for the transaction to be committed. // Therefore the code here is only from the consensus node's mempool. if resp.Code !=
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github.com/celestiaorg/celestia-app/pkg/user " blobtypes
```

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```
0 { // handle code fmt. Println (resp.Code, resp.Codespace, resp.RawLog) }
```

```
return err }
```

## RPC to a celestia-node

Using the JSON RPC API, submit data using the following methods:

- [blob.Submit](#)
- [state.SubmitPayForBlob](#)

Learn more in the [celestia-node API docs](#) . [\[ \[ Edit this page on GitHub \]](#) Last updated: [Previous page Build modular Next](#)  
[page Transaction resubmission guidelines](#) [\[](#)