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[#Copy link](https://ida.interchain.io/hands-on-exercise/2-ignite-cli-adv/8-gas-meter.html#incentivize-players) **Incentivize Players**



Make sure you have everything you need before proceeding:

* You understand the concept of gas.
* Go is installed.
* You have the checkers blockchain codebase with the integration tests. If not, follow the [previous steps](https://ida.interchain.io/hands-on-exercise/2-ignite-cli-adv/7-integration-tests.html) or check out the [relevant version (opens new window)↗](https://github.com/cosmos/b9-checkers-academy-draft/tree/integration-tests).



In this section, you will:

* Add transaction fees.
* Set fees and add metering.
* Do integration tests.

Players can start playing checkers with your Cosmos blockchain. Transaction fees are paid by the players themselves, at least the fee related to transporting the serialized bytes and the other gas-metered parts like bank.

Your blockchain is taking shape, but you need to take care of peripheral concerns. For instance, how do you make sure that participants pay their fair share of the costs they impose on the network?

Next, you should add your own gas metering to reflect the costs that different transactions impose, or you can add costs to discourage spam.

[#Copy link](https://ida.interchain.io/hands-on-exercise/2-ignite-cli-adv/8-gas-meter.html#some-initial-thoughts) Some initial thoughts

To continue developing your checkers blockchain:

* At what junctures can you charge gas?
* At what junctures can you **not** charge gas, and what do you do about it?
* Are there new errors to report back?
* What event should you emit?

[#Copy link](https://ida.interchain.io/hands-on-exercise/2-ignite-cli-adv/8-gas-meter.html#code-needs) Code needs

Before diving into the specifics, ask yourself:

* What Ignite CLI commands, if any, will assist you?
* How do you adjust what Ignite CLI created for you?
* Where do you make your changes?
* How would you unit-test these new elements?
* How would you use Ignite CLI to locally run a one-node blockchain and interact with it via the CLI to see what you get?

[#Copy link](https://ida.interchain.io/hands-on-exercise/2-ignite-cli-adv/8-gas-meter.html#new-data) New data

These values provide examples but you can, and should, set your own. To get a rule-of-thumb idea of how much gas is already consumed without your additions, look back at your previous transactions. Save your pick of the values as new constants:



Copy

const (

CreateGameGas = 15000

PlayMoveGas = 1000

)

x /

checkers /

types /

keys.go

[View source→](https://github.com/cosmos/b9-checkers-academy-draft/blob/gas-meter/x/checkers/types/keys.go" \l "L65-L68" \t "_blank)

Here are the debatable rationales for these values:

1. Creating a game imposes a large cost because it creates a brand new entry in storage, which contains many fields. This new storage entry is stored on all nodes.
2. Playing a game imposes a smaller cost because it makes changes to an existing storage entry, which was already paid for. On the other hand it costs some computation and pushes back the time by when the game expires.

When looking at all the actions a user can take, you can also consider a gas refund – in particular if the action is beneficial to the network. For instance, removing an item from storage entirely can be considered beneficial. In a situation like this, you can consider a gas refund (i.e. a negative gas cost). This gas refund will offset part or all of the gas cost already expended as part of the message.

As the checkers blockchain creator, your goal may be to have as many on-going games as possible. Adding costs sounds counter to this goal. However, here the goal is to optimize potential congestion at the margin. If there is little network activity then the gas price will go down, and these additional costs will be trivial for players anyway. Conversely, if there is a lot of network activity the gas price will go up, and whether you have put additional costs or not players will still be less likely to participate.

[#Copy link](https://ida.interchain.io/hands-on-exercise/2-ignite-cli-adv/8-gas-meter.html#add-handling) Add handling

Add a line that consumes or refunds the designated amount of gas in each relevant handler:

1. When handling a game creation:



Copy

...

k.Keeper.SetSystemInfo(ctx, systemInfo)

+ ctx.GasMeter().ConsumeGas(types.CreateGameGas, "Create game")

...

x /

checkers /

keeper /

msg\_server\_create\_game.go

[View source→](https://github.com/cosmos/b9-checkers-academy-draft/blob/gas-meter/x/checkers/keeper/msg_server_create_game.go" \l "L46" \t "_blank)

1. When handling a move:



Copy

...

k.Keeper.SetSystemInfo(ctx, systemInfo)

+ ctx.GasMeter().ConsumeGas(types.PlayMoveGas, "Play a move")

...

x /

checkers /

keeper /

msg\_server\_play\_move.go

[View source→](https://github.com/cosmos/b9-checkers-academy-draft/blob/gas-meter/x/checkers/keeper/msg_server_play_move.go" \l "L90" \t "_blank)

In this example, when handling a move the gas is measured towards the end of the function's body. This is a design decision, and you may arrive at a different conclusion.



In the current arrangement, if a player hits an error (such as a failure to pay the wager, or making an illegal move) then the code will return an error *before* the gas metering line. This means the player making the error will only pay the gas already metered by the rest of the Cosmos SDK.

If you decide to move the gas metering line closer to the beginning of the function's body, then you will charge the player extra gas for any move that contains errors *despite the fact that the requested move will not be accepted*.

This alternate approach would certainly dis-incentivize players from submitting erroneous moves, but it also risks alienating them through financial punishment for accidental mistakes. Better is to implement a feature that allows players to check a move is valid *before* they pay the cost of handling. This is explored in the [next section](https://ida.interchain.io/hands-on-exercise/2-ignite-cli-adv/9-can-play.html).

You are free to consider charging different gas costs for when a player *plays a regular legal move* and for when a player *plays a winning move*. After a win the board is cleared, and you therefore may want to exact a smaller cost (or even a gas refund) in this situation.



You do not meter gas in your EndBlock handler because it is **not** called by a player sending a transaction. Instead, this is a service rendered by the network.



If you want to account for the gas cost of game expiration, you have to devise a way to pre-collect it from players as part of other messages. You could even imagine a reputation system: the next time a forfeiter plays on a game, the *past* cost of their forfeit is taken as part of the current *play move* transaction.



As part of your code optimization, avoid calling ConsumeGas with a fixed gas cost (for instance k) from within a loop. Each pass of the loop uses computation resources (c) on each node. If you know the number of times your code loops (n), you know that running the full loop will use n\*c computation resources.   
  
Now consider the case of a user who sent a transaction without enough gas. The transaction will fail anyway, but at what point will it fail?

1. If you call ConsumeGas(k) *within* the loop, the transaction will fail during one of the passes (the mth pass). This means that the node has already used m\*c computation resources.
2. If you call ConsumeGas(n\*k) once *before* the loop, the transaction will fail immediately, and the node will have used 0 computation resources.

Choosing option 2 improves the effectiveness of your blockchain, and potentially protects it from spam and denial-of-service attacks.

Additionally, making only a single call to ConsumeGas slightly saves computation resources of the node.

[#Copy link](https://ida.interchain.io/hands-on-exercise/2-ignite-cli-adv/8-gas-meter.html#unit-tests) Unit tests

Now you must add tests that confirm the gas consumption. However, it is not possible to differentiate the gas cost that BaseApp is incurring on your messages from the gas cost your module imposes on top of it. Also, you cannot distinguish via the descriptor [unless it panics (opens new window)↗](https://github.com/cosmos/cosmos-sdk/blob/v0.45.4/store/types/gas.go#L90-L101). Nevertheless, you can add a lame test like:



Copy

func TestCreate1GameConsumedGas(t \*testing.T) {

msgSrvr, \_, context := setupMsgServerCreateGame(t)

ctx := sdk.UnwrapSDKContext(context)

before := ctx.GasMeter().GasConsumed()

msgSrvr.CreateGame(context, &types.MsgCreateGame{

Creator: alice,

Black: bob,

Red: carol,

Wager: 45,

})

after := ctx.GasMeter().GasConsumed()

require.GreaterOrEqual(t, after, before+25\_000)

}

x /

checkers /

keeper /

msg\_server\_create\_game\_test.go

[View source→](https://github.com/cosmos/b9-checkers-academy-draft/blob/gas-meter/x/checkers/keeper/msg_server_create_game_test.go" \l "L119-L131" \t "_blank)

Now add another test for [play (opens new window)↗](https://github.com/cosmos/b9-checkers-academy-draft/blob/gas-meter/x/checkers/keeper/msg_server_play_move_test.go#L176-L192).

These new tests are lame, because their 5\_000 or 25\_000 values cannot be predicted but have to be found by trial and error.

[#Copy link](https://ida.interchain.io/hands-on-exercise/2-ignite-cli-adv/8-gas-meter.html#interact-via-the-cli) Interact via the CLI

Here, you want to confirm that gas is consumed by different actions. The difficulty is that Alice's and Bob's balances in stake tokens change not only because of the gas used but also depending on the gas price. An easy measurement is to use --dry-run:

**Local**

**Docker**



Copy

$ checkersd tx checkers create-game \

$alice $bob 1000000 \

--from $alice \

--dry-run

Copy

$ docker exec -it checkers \

checkersd tx checkers create-game \

$alice $bob 1000000 \

--from $alice \

--dry-run

Say this returns 69422, which is the estimated gas used. Now comment out the .ConsumeGas line in msg\_server\_create\_game.go, save it, wait a few minutes for Ignite CLI to rebuild, and try again:

**Local**

**Docker**



Copy

$ checkersd tx checkers create-game \

$alice $bob 1000000 \

--from $alice \

--dry-run

Copy

$ docker exec -it checkers \

checkersd tx checkers create-game \

$alice $bob 1000000 \

--from $alice \

--dry-run

Say, this time you get 54422. This is good: the 15000 gas is no longer part of the estimation, as expected. Uncomment the .ConsumeGas line. You can try --dry-run on play too.

Estimating with --dry-run is a good start. Now have Alice create a game and check the gas used in the transaction:

**Local**

**Docker**



Copy

$ checkersd tx checkers create-game \

$alice $bob 1000000 \

--from $alice

Copy

$ docker exec -it checkers \

checkersd tx checkers create-game \

$alice $bob 1000000 \

--from $alice

This mentions:



Copy

...

gas\_used: "69422"

...

You could impose a --gas-prices and then check balances, but this would obfuscate the gas consumption which is what you want to confirm.

As before, comment the .ConsumeGas line msg\_server\_create\_game.go and wait for Ignite CLI to rebuild. Then try again:

**Local**

**Docker**



Copy

$ checkersd tx checkers create-game \

$alice $bob 1000000 \

--from $alice

Copy

$ docker exec -it checkers \

checkersd tx checkers create-game \

$alice $bob 1000000 \

--from $alice

This mentions:



Copy

...

gas\_used: "65540"

...

There is only a difference of 4000. The rest of the system likely had some under-the-hood initializations, such as Merkle tree creations, which may *falsify* the early results. Create 10 more games without .Consumeing gas and only look at the gas\_used. It should stabilize at a certain value:

**Local**

**Docker**



Copy

$ checkersd tx checkers create-game \

$alice $bob 1000000 \

--from $alice -y | \

grep gas\_used

Copy

$ docker exec -it checkers \

bash -c "checkersd tx checkers create-game $alice $bob 1000000 --from $alice -y | grep gas\_used"

This mentions:



Copy

gas\_used: "65507"

Put back the .ConsumeGas line and rebuild. Then try again:

**Local**

**Docker**



Copy

$ checkersd tx checkers create-game \

$alice $bob 1000000 \

--from $alice -y | \

grep gas\_used

Copy

$ docker exec -it checkers \

bash -c "checkersd tx checkers create-game $alice $bob 1000000 --from $alice -y | grep gas\_used"

It now consistently mentions a difference of 15000:



Copy

gas\_used: "80507"

That is sufficient confirmation.

Do not worry if you do not get the same values. At least try multiple times to see if the values look like each other on your system.

synopsis

To summarize, this section has explored:

* How to add gas metering to your application so participants contribute toward the cost of the work being demanded of the network by gameplay, and add costs to discourage spam.
* What new data constants need to be added, such as fees for creating games or playing moves, and gas consumption lines for handlers relating to these gameplay aspects.
* Best practices for gas metering, including where not to call fixed gas costs and the implications of a user sending transactions without enough gas to process them.
* What texts to add that confirm gas consumption, acknowledging the limitations on precision that the use of BaseApp and your module also imposes on understanding how much gas is used by various transactions.
* How to interact via the CLI to confirm that gas is being consumed by different actions, acknowledging the additional complications arising from variable account balances and gas price.

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[](https://ida.interchain.io/hands-on-exercise/2-ignite-cli-adv/7-integration-tests.html)

**[Integration tests](https://ida.interchain.io/hands-on-exercise/2-ignite-cli-adv/7-integration-tests.html)**

up next

**[Help Find a Correct Move](https://ida.interchain.io/hands-on-exercise/2-ignite-cli-adv/9-can-play.html)**

[[](https://ida.interchain.io/hands-on-exercise/2-ignite-cli-adv/9-can-play.html)](https://ida.interchain.io/hands-on-exercise/2-ignite-cli-adv/9-can-play.html)

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