

Prefixed Storage

Why Is Prefixed Storage Needed?

Before we understand what the `PrefixedStorage` struct is, we should first understand the problem they attempt to solve. We may be tempted to think that the key-value model as described in [Storage](#) solves all our storage needs. And we'd technically be correct in thinking that. It is possible to efficiently store vast amounts of user data by just using the methods described in that page. However, we will see that doing this would be cumbersome for the developer in many cases. That's why there are many additional storage structures built on top of the methods described in [Storage](#). Prefixed storage is an additional structure built on top of these methods for the convenience of the developer.

The Problem

We will go over a storage problem and discuss how we might tackle it with the methods we learnt in [Storage](#) to get to the root of what prefixed storage actually is. Suppose that we have a contract that stores a different password (String) for each wallet address that interacts with it (so that the wallets can later give that password when querying the contract). How would we want to store all these passwords so that they can be checked when it is time for queries?

The Naive Approach

Our first approach might be to use a hashmap that stores all the passwords, and save it as binary using the methods we already know. So we would add the following lines to the init

```
...
```

```
Copy let passwords: HashMap<[u8], String> = HashMap::new();
```

```
save(&mut deps.storage, PASSWORDS_KEY, &passwords)?;
```

```
...
```

And then we can proceed to load, and add each user's password whenever a user sends the `create_password` `HandleMsg`. Note that I'm assuming we would generate the `[u8]` key for the hashmap from the user's wallet address. This approach has a huge problem! That is whenever we want to add another wallet's password to the hashmap, we must load the entire hashmap with all the passwords stored inside it. This will increase gas costs as we gain thousands of users. Moreover, loading the hashmap for queries will strain the node.

The Reasonable Approach

We now realize that we can actually generate `[u8]` storage keys for each user wallet and save the password directly to `deps.storage` as described in [Storage](#). This way, we can use `may_load` to check if a user has a password, and if he does, learn what it is without loading all the other passwords. Then we would use the following lines of code to save a password

```
...
```

```
Copy let key: [u8] = env.message.sender.to_string().as_bytes(); save(&mut deps.storage, key, &msg.password)?;
```

```
...
```

This method does work! However, what if we want to save additional things that are associated to each user, such as token balances. Then using `save` on the same key would overwrite our previous data. The solution is to add a prefix to the storage key so that we know it belongs to the password property. One way to implement this is the following:

```
...
```

```
Copy let prefix: String = "passwords".to_string(); let key: [u8] = (prefix + env.message.sender.to_string()).as_bytes();  
save(&mut deps.storage, key, &msg.password)?;
```

```
...
```

This works but can be cumbersome and ugly, especially if you need to build more functionalities around this idea. This is exactly what prefixed storage does in the background! Prefixed Storage is built to solve this problem while hiding away all the ugliness.

What Is Prefixed Storage?

`PrefixedStorage` is a struct that keeps track of all the storage keys that are used to store various data under a shared namespace similar to described [above](#). Prefixed storage is often used to keep track of storage keys of `deps.storage`, but it can in fact be used to store the keys of other storage structures.

The compiler only allows one mutable reference to the underlying storage to be valid at one point. Thus, you cannot have more than one mutable Prefixed Storage objects at the same time.

Example

Let's solve [the password problem](#) that was mentioned above with prefixed storage. The solution to this problem resembles [viewing keys for permissioned viewing](#). You will learn more about this in the coming sections. We first define a namespace (prefix) `instate.rs`.

...

```
Copy pubconst PREFIX_PASSWORDS:&[u8]=b"passwords";
```

...

The idea then is that all the wrapper functions that we've learnt in [Storage](#) also work on prefixed storage. We will only demonstrate `save` and `may_load` by example.

Saving To Prefixed Storage

We would instantiate a mutable `PrefixedStorage` object using the following lines of code to save a new password

...

```
Copy let mut password_store = PrefixedStorage::new(PREFIX_PASSWORDS, &mut deps.storage); let key: &[u8] = env.message.sender.to_string().as_bytes(); save(&mut password_store, key, &msg.password)?;
```

...

Notice that we are using the same storage wrapper functions from [Storage](#) on prefixed storage. The reason why we can use the same wrapper functions is because `PrefixedStorage` implements the `Storage` trait, even though most of what it's doing is to add a prefix on top of the keys we provide to it.

Loading From Prefixed Storage

We may use both `load` and `may_load`. We may load data from a mutable `PrefixedStorage` instance with the following lines of code

...

```
Copy let mut password_store = PrefixedStorage::new(PREFIX_PASSWORDS, &mut deps.storage); let key: &[u8] = env.message.sender.to_string().as_bytes(); // Throws error if there is no password saved before let password: String = load(&password_store, key)?;
```

...

In queries, we don't want to use `PrefixedStorage` struct. Instead we use `ReadonlyPrefixedStorage` struct. It works in the exact same way, except that you cannot save to it.

...

```
Copy let password_store = ReadonlyPrefixedStorage::new(PREFIX_PASSWORDS, &deps.storage); let key = address.to_string().as_bytes(); let may_password: Option = may_load(&password_store, key)?;
```

...

You can have as many `ReadonlyPrefixedStorage` objects as you want at the same time, unlike `PrefixedStorage`.

Removing From Prefixed Storage

We can use the `remove` wrapper function for this.

...

```
Copy let mut password_store = PrefixedStorage::new(PREFIX_PASSWORDS, &mut deps.storage); let key: &[u8] = env.message.sender.to_string().as_bytes(); remove(&mut password_store, key);
```

...

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