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5th Scientific School on Blockchain & DLTs

# IOTA Move Smart Contracts

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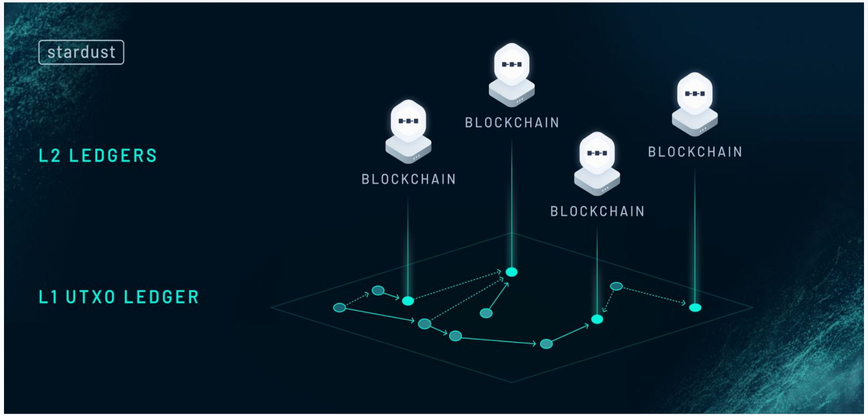
# IOTA Smart Contracts

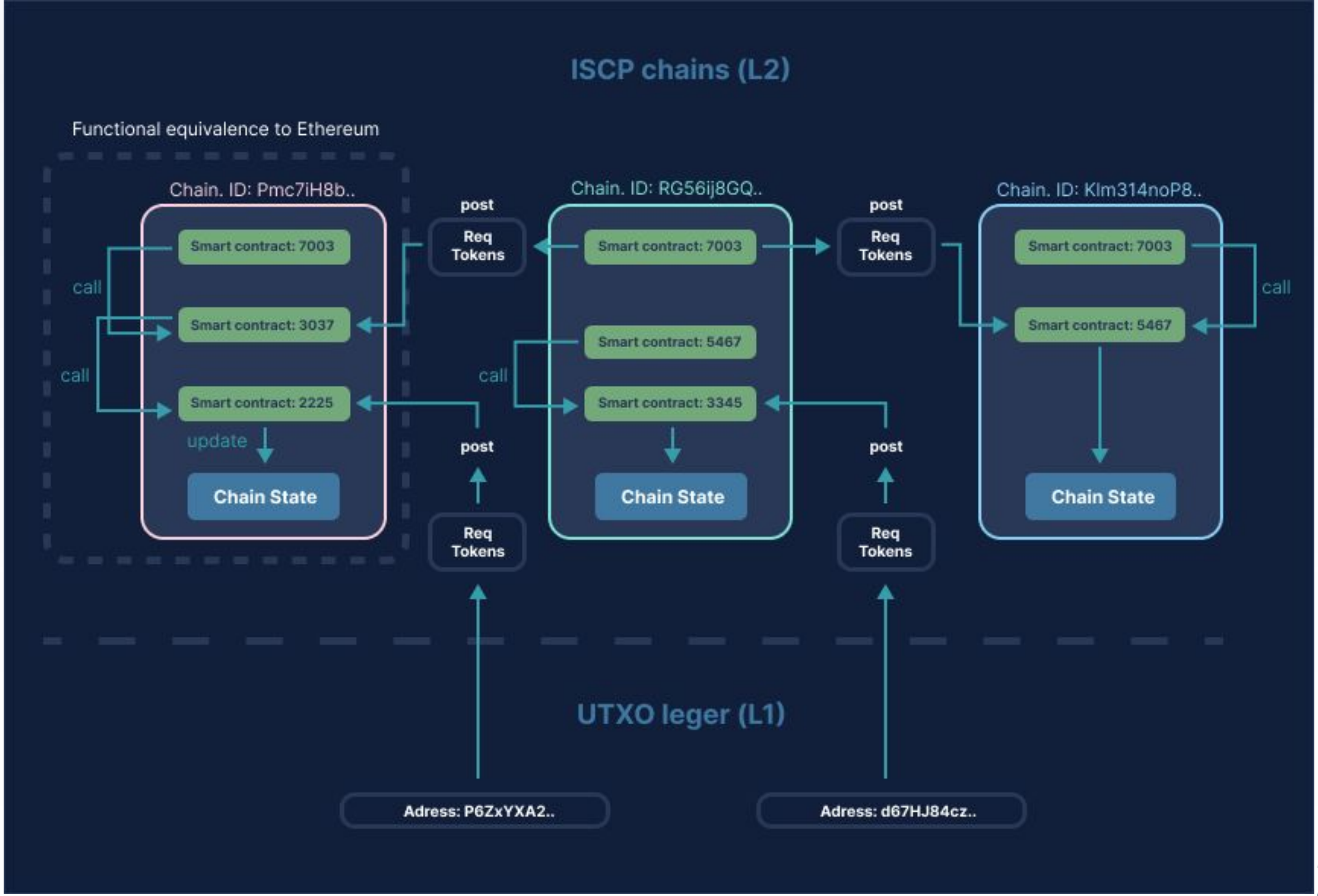
# Current Solution: IOTA EVM

- It's a **Layer 2 (L2) solution** where smart contracts are handled off-tangle in their dedicated blockchain
- The blockchain is run by a permissioned committee of nodes.
- Uses Ethereum technology (EVM)
- Periodically commits the state to the **L1**




- **Layer 1** -> **Stardust VM**
- limited in its capabilities: you can't write your own apps, but you can:
  - Create fungible tokens
  - Create NFTs
  - Store data and/or commitments on-tangle.
- Enhancing L1 with a better operating system -> **increases network's utility**

https://wiki.iota.org/learn/smart-contracts/core_concepts/smart-contracts/




https://wiki.iota.org/learn/smart-contracts/core_concepts/smart-contracts/

# Sui Move Flavor

# Move Virtual Machine

- **Blockchain agnostic:** we define how accounts and transactions work

- Core VM is **easily extensible** with:
    - Cryptography, signature schemes, ZKP verifiers
    - Blockchain specific features (mana generation, system transactions, account concept, etc. )

- Built-in **gas metering and safe math**: no undefined behavior is possible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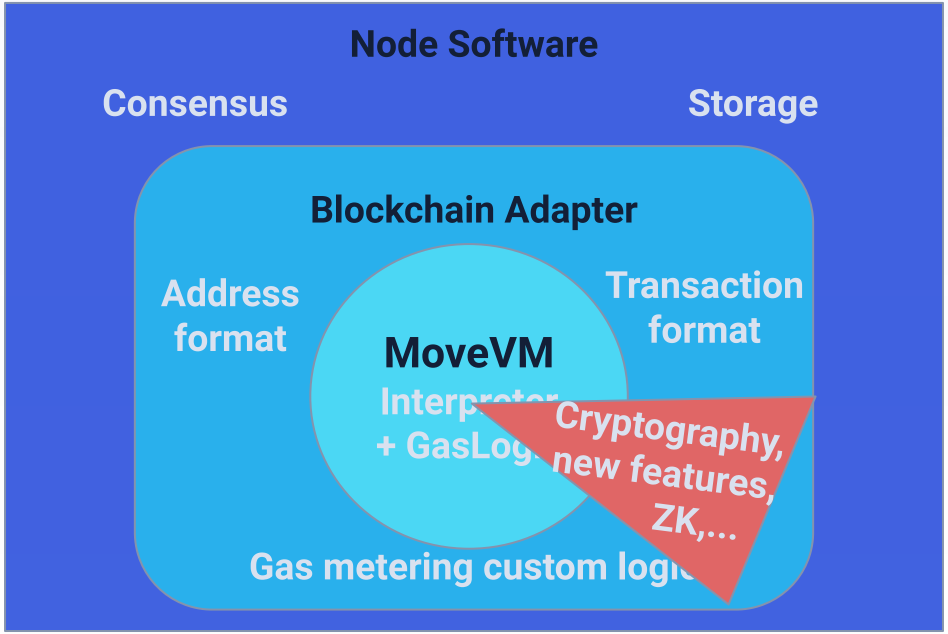
# Move Modularity



# Move on Account vs Object Ledger

- **Unified Memory - Account Based Ledger**: EVM, WASM, ISC, Aptos, Core Move
    - Only sequential* execution
    - Convenient as you can access any memory location without prior request
- **Partitioned Memory - Object Based Ledger**: Sui Move, Cardano, Radix, Stardust, etc.
    - Parallel execution is possible, as **each SC names which objects it will touch**
    - Heavy usage of a particular SC doesn't degrade others
    - Execution needs only a fraction of the memory
    - UTXO is a special case of the object ledger

# Move in Aptos vs Sui

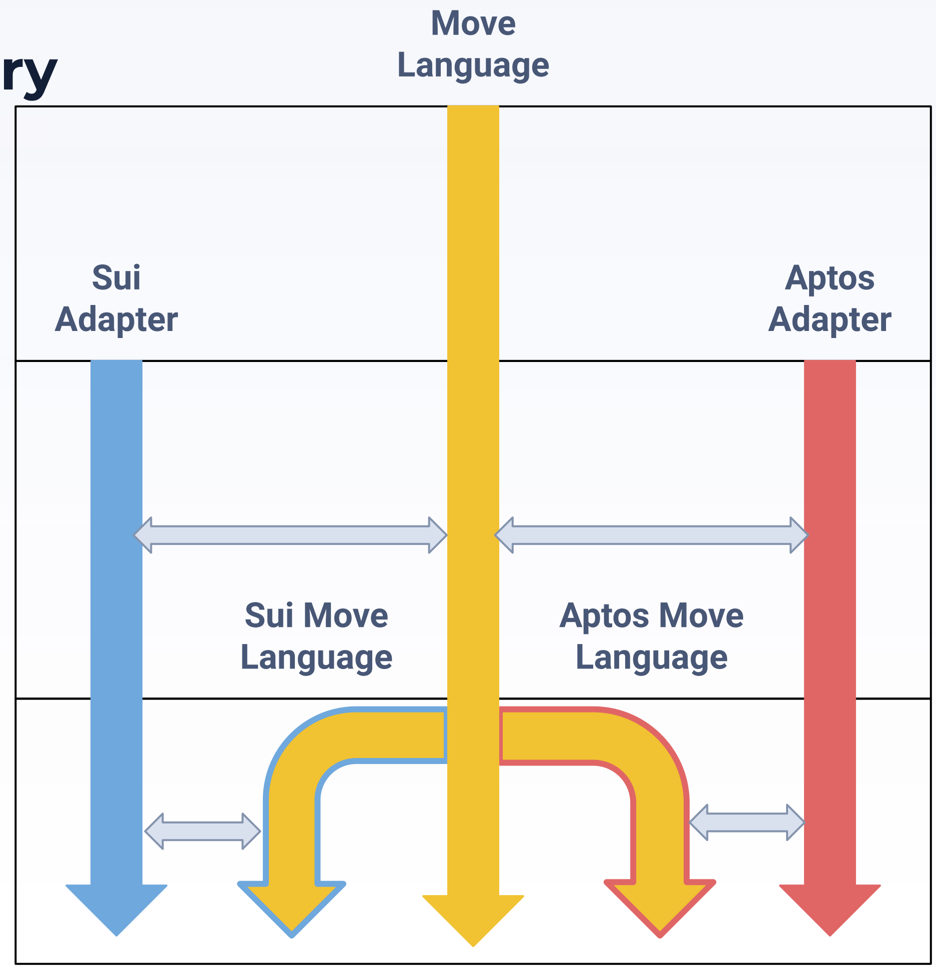

https://academy-public.coinmarketcap.com/srd-optimized-uploads/a60864117eaa4a1b83631cc3cacd53fc.png

# Move History

**Early Move**
***Libra/Diem***
2018-2021

**Move Adapters**
***Sui & Aptos***
2022-2023

**Move 2024**
***Sui & Aptos Forks***



# IOTA flavored Move

# Key differences between (Diem/Aptos) Move and IOTA/Sui Move (1/2)

- **Object-Centric Global Storage**
  - In (Diem) Move, transactions can **freely access resources,** *move_to* and *move_from*.
  - In IOTA Move transaction inputs are *explicitly specified using unique identifiers* for **objects** (as opposed to resources) and **packages** (sets of modules).
- **Addresses Represent Object IDs**
  - IOTA repurposes the address type as a **32-byte identifier** used for both *objects (object id)* and *accounts (address)*.
- **Objects with Key Ability and Globally Unique IDs**
  - In (Diem) Move, the *key ability* indicates that a type is a **resource**, which, along with an account address, can serve as a key in global storage.
  - In IOTA Move, the *key ability* denotes an **object type** and requires the struct's first field to be ***id: UID*** (which becomes the object id).

https://docs.iota.org/developer/iota-101/move-overview/

# 0. Basics - Custom Types

A **structure** in IOTA Move is a *custom type* that contains *key-value pairs*, where the key is the name of a property, and the value is what's stored.

## Struct

```
struct Color {
    red: u8,
    green: u8,
    blue: u8,
}
```

https://docs.iota.org/developer/iota-101/objects/object-model

# 0. Basics - Abilities

- Abilities are keywords in IOTA Move that define **how types behave at the compiler level**
    - ***copy***: the value of this type can be copied
        - usually basic types: Coin is an asset type that should not be duplicated, so it should not have copy ability
    - ***drop***: the value of this type can be automatically destroyed at the end of the scope
        - for types without drop ability, not destroying them manually will cause a compilation error.
    - ***key***: a type that can appear as a key in global storage
    - ***store***: the value of this type can be stored (for example, in another struct)

- Custom types that have the abilities *key* and *store* are considered to be **assets** in IOTA Move.
    - Assets are stored in global storage and can be transferred between accounts.

https://docs.iota.org/developer/getting-started/create-a-module

# 1. Object Basics

- The first field of the **struct** must be the id of the object with type **UID**

**Struct**

```
struct Color {
    red: u8,
    green: u8,
    blue: u8,
}
```

**Object**

```
struct ColorObject has key {
    id: UID,
    red: u8,
    green: u8,
    blue: u8,
}
```

https://docs.iota.org/developer/iota-101/objects/object-model

# 1. Object Basics - Key

- In Move the **key** ability denotes a type that can appear as a key in global storage
- Diem Move uses a **(type, address)-indexed map**
- IOTA Move uses a **map keyed** by **object IDs**.

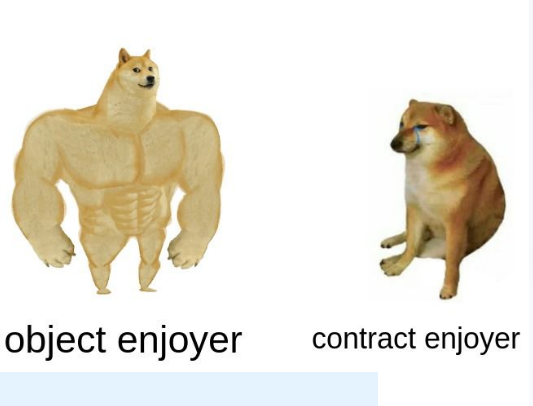
```
use iota::object::UID;

struct ColorObject has key {
    id: UID,
```

https://docs.iota.org/developer/iota-101/objects/object-model

# 1. Object Basics - Create an Object

- The only way to create a new UID for a IOTA object is to call **object::new**.




```
use iota::object;
// tx_context::TxContext creates an alias to the TxContext struct in the tx_context module.
use iota::tx_context::TxContext;


fun new(red: u8, green: u8, blue: u8, ctx: &mut TxContext): ColorObject {
    ColorObject {
        id: object::new(ctx),
        red,
        green,
        blue,
    }
}
```

https://docs.iota.org/developer/iota-101/objects/object-model

# 1. Object Basics - Store an Object

- The constructor puts the object value in a local variable.
- The object can then be placed in persistent global storage.

```
public entry fun create(red: u8, green: u8, blue: u8, ctx: &mut TxContext) {
    let color_object = new(red, green, blue, ctx);
    transfer::transfer(color_object, tx_context::sender(ctx))
}
```

https://docs.iota.org/developer/iota-101/objects/object-model

# 2. Owned, Shared and Immutable Objects

- Objects in IOTA can have different types of **ownership**, with three categories:
    - **Owned mutable** object -> is owned by an address/object
    - **Shared mutable** object -> anyone can use it in a transaction
    - **Immutable** object -> an object that can't be mutated, transferred or deleted.

- In other blockchains, ***every object is shared***
    - In IOTA Move programmers have the choice to implement a particular use-case using **shared objects, owned objects, or a combination**.

- In IOTA, a transaction that touches a shared object needs to pass through the consensus mechanism. Whilst, a transaction that touches only owned objects does not need it.

https://docs.iota.org/developer/iota-101/objects/shared-owned

# 2. *Owned*, Shared and Immutable Objects

- **Address Owned object:** *exclusively accessible to their owner*
  - The owner is a 32-byte user address or object ID
  - Does not require consensus to be modified

```
module examples::custom_transfer {
  // Error code for trying to transfer a locked object
  const EObjectLocked: u64 = 0;

  public struct O has key {
    id: UID,
    // An `O` object can only be transferred if this field is `true`
    unlocked: bool
  }

  // Check that `O` is unlocked before transferring it
  public fun transfer_unlocked(object: O, to: address) {
     assert!(object.unlocked, EObjectLocked);
     iota::transfer::transfer(object, to)
  }
}
```

https://docs.iota.org/developer/iota-101/objects/object-ownership/address-owned

# 2. Owned, *Shared* and Immutable Objects

- **Shared object:** *anyone can read or write this object.*
  - mutable owned objects are single-writer
  - shared objects require to sequence reads and writes

```
/// Init function is often ideal place for initializing
/// a shared object as it is called only once.
fun init(ctx: &mut TxContext) {
    transfer::transfer(ShopOwnerCap {
        id: object::new(ctx)
    }, tx_context::sender(ctx));

    // Share the object to make it accessible to everyone!
    transfer::share_object(DonutShop {
        id: object::new(ctx),
        price: 1000,
        balance: balance::zero()
    })
}
```

https://docs.iota.org/developer/iota-101/objects/object-ownership/shared

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# 2. Owned, Shared and *Immutable* Objects

- Immutable objects have no owner, so anyone can use them without the need for ordering
  - packages are immutable objects
  - you can freeze an initially mutable object

```
public entry fun freeze_object(object: ColorObject) {
    transfer::freeze_object(object)
}
```

https://docs.iota.org/developer/iota-101/objects/object-ownership/immutable

# 3. Using Objects

- IOTA Move **authentication mechanisms** ensure ***only you can use objects owned by you*** or ***shared*** in function calls.
- The object can be passed as a parameter to a function in two ways (core Move):
  - Pass by reference
    - *&ColorObject*
    - *&mut ColorObject*
  - Pass by value
    - *ColorObject*

https://docs.iota.org/developer/iota-101/objects/object-ownership/address-owned

# 3. Using Objects - Pass by Reference

- **Read-only references** (&) allow you to read data from the object
- **Mutable references** (&mut) allow you to mutate the data in the object.

```
/// Copies the values of `from_object` into `into_object`.
public entry fun copy_into(from_object: &ColorObject, into_object: &mut ColorObject) {
    into_object.red = from_object.red;
    into_object.green = from_object.green;
    into_object.blue = from_object.blue;
}
```

https://docs.iota.org/developer/iota-101/objects/object-ownership/address-owned

# 3. Using Objects - Pass by Value

- Pass objects by value into an entry function means the **object is moved out of storage**.
- Objects **cannot** be arbitrarily **dropped** and must be either consumed (e.g., transferred) or deleted

```
    public entry fun delete(object: ColorObject) {
        let ColorObject { id, red: _, green: _, blue: _ } = object;
        object::delete(id);
    }


public entry fun transfer(object: ColorObject, recipient: address) {
    transfer::transfer(object, recipient)
}
```

# 4. Object Wrapping

- In IOTA Move, you can organize data structs by putting a field of **struct** type in another
- To embed a struct type in an object struct (with a key ability), the struct type must have the **store ability**.

```
struct Wrapping has key {
    id: UID,
    obj: Wrapped,
}

struct Wrapped has key, store {
    value: u64,
}
```

https://docs.iota.org/developer/iota-101/objects/object-ownership/wrapped

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# 4. Object Wrapping

- When an object is **wrapped** into another object:
  - it **no longer exists independently** on the ledger; it becomes part of the data of the object that wraps it;
  - is no longer **findable** by its *objectID*;
  - is no longer passable as an argument in transactions procedures calls; the only access point is through the wrapping object (you need to pass this as argument).
- **Unwrapping**
  - you can then take out the wrapped object and transfer it to an address;
  - when an object is unwrapped, it becomes an independent object again;
  - **wrapped objects cannot be unwrapped unless the wrapping object is destroyed**

https://docs.iota.org/developer/iota-101/objects/object-ownership/wrapped

# 4. Object Wrapping

```
struct ObjectWrapper has key {
    id: UID,
    original_owner: address,
    to_swap: Object,
}
public entry fun request_swap(object: Object, service_address: address, ctx:
    let wrapper = ObjectWrapper {
        id: object::new(ctx),
        original_owner: tx_context::sender(ctx),
        to_swap: object,
    };
    transfer::transfer(wrapper, service_address);
}
 public entry fun execute_swap(wrapper1: ObjectWrapper, wrapper2: ObjectWrap
    // Unpack both wrappers, cross send them to the other owner.
    let ObjectWrapper {
        id: id1,
        original_owner: original_owner1,
        to_swap: object1,
    } = wrapper1;

    let ObjectWrapper {
        id: id2,
        original_owner: original_owner2,
        to_swap: object2,
    } = wrapper2;

    // Perform the swap.
    transfer::transfer(object1, original_owner2);
    transfer::transfer(object2, original_owner1);
}
```

https://docs.iota.org/developer/iota-101/objects/object-ownership/wrapped

# 5. Dynamic Fields

- IOTA Move provides **dynamic fields** with arbitrary *names*, added and removed on-the-fly (not fixed at publish), which can store heterogeneous values.

- This approach overcomes the following limitations:
  - Object's have a finite set of fields, fixed when its module is declared.
  - Objects can become very large if they wrap several other objects (high gas fees).
  - It is not possible to store a collection of objects (e.g., vector) of heterogeneous types.

https://docs.iota.org/developer/iota-101/objects/dynamic-fields/

# 5. Dynamic Fields - Add field

- This function takes the **Child object** *by value* and makes it a *dynamic field* of the **Parent object** with **name *b"child"***;
  - sender address owns the Parent object;
  - the Parent object owns the Child object, and can refer to it by the name *b"child"*.

```
use iota::dynamic_object_field as ofield;

public fun add_child(parent: &mut Parent, child: Child) {
    ofield::add(&mut parent.id, b"child", child);
}
```

https://docs.iota.org/developer/iota-101/objects/dynamic-fields/

# 5. Dynamic Fields - Access field

```
use iota::dynamic_object_field as ofield;

public fun mutate_child(child: &mut Child) {
    child.count = child.count + 1;
}

public fun mutate_child_via_parent(parent: &mut Parent) {
    mutate_child(ofield::borrow_mut(
        &mut parent.id,
        b"child",
    ));
}
```

https://docs.iota.org/developer/iota-101/objects/dynamic-fields/

# 5. Dynamic Fields - Remove field

```
use iota::dynamic_object_field as ofield;

public fun delete_child(parent: &mut Parent) {
    let Child { id, count: _ } = reclaim_child(parent);

    object::delete(id);
}

public fun reclaim_child(parent: &mut Parent, ctx: &mut TxContext): Child {
    ofield::remove(
        &mut parent.id,
        b"child",
    );

}
```

https://docs.iota.org/developer/iota-101/objects/dynamic-fields/

# 6. Transfer to Object

- *Transfer objects to an object ID* works in the **same way as an object transfer to an address** (using the same functions)

- Transfering an object to another object means establishing a form of **parent-child** authentication relationship.
  - Objects transferred to another object can be **received** by the owner of the parent object.
  - The **parent** (receiving) object **module defines the access control** for receiving a child obj.

```
// Transfers the object `b` to the address 0xADD
iota::transfer::public_transfer(b, @0xADD);

// Transfers the object `c` to the object with object ID 0x0B
iota::transfer::public_transfer(c, @0x0B);
```

https://docs.iota.org/developer/iota-101/objects/transfers/transfer-to-object

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# 6. Transfer to Object - Receive

- After an object *c* has been sent to another object *p*, *p* must then receive *c* to do anything with it.
- The module of the type of *p* defines access control policies and other restrictions on *c*

```
/// This function will receive a coin sent to the `Account` object and then
/// join it to the balance for each coin type.
/// Dynamic fields are used to index the balances by their coin type.
public fun accept_payment<T>(account: &mut Account, sent: Receiving<Coin<T>>) {
    // Receive the coin that was sent to the `account` object
    // Since `Coin` is not defined in this module, and since it has the `store`
    // ability we receive the coin object using the `transfer::public_receive` function.
    let coin = transfer::public_receive(&mut account.id, sent);
    let account_balance_type = AccountBalance<T>{};
    let account_uid = &mut account.id;

    // Check if a balance of that coin type already exists.
    // If it does then merge the coin we just received into it,
    // otherwise create new balance.
    if (df::exists_(account_uid, account_balance_type)) {
        let balance: &mut Coin<T> = df::borrow_mut(account_uid, account_balance_type);
        coin::join(balance, coin);
    } else {
        df::add(account_uid, account_balance_type, coin);
    }
}
```

https://docs.iota.org/developer

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# 7. One-Time Witness (OTW)

- Special type guaranteed to have **at most one instance**: useful for limiting certain actions to only happen once (e.g., creating a coin). The only instance is passed to its module's init function when its package is published. In Move, a type is considered a OTW if:
  - Its name is the **same as its module's names**, all **uppercased**.
  - It has **ONLY** the **drop ability**
  - It has **no fields**, or a single bool field.

```
module examples::mycoin {

    /// Name matches the module name
    struct MYCOIN has drop {}

    /// The instance is received as the first argument
    fun init(witness: MYCOIN, ctx: &mut TxContext) {
        /* ... */
    }
}
```

https://docs.iota.org/developer/iota-101/move-overview/one-time-witness

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# 8. Generics

- Generics are **abstract stand-ins *for concrete types*** or other properties.

```
struct Box<T> {
    value: T
}
```

- **Conditions** to enforce that the type passed into the generic *must have certain abilities*.

```
// T must be copyable and droppable
struct Box<T: store + drop> has key, store {
    value: T
}
```

- Using generics in functions

```
public fun create_box<T>(value: T): Box<T> {
        Box<T> { value }
    }
```

```
// value will be of type storage::Box<bool>
    let bool_box = storage::create_box<bool>(true);
// value will be of the type storage::Box<u64>
    let u64_box = storage::create_box<u64>(1000000);
```

https://intro.sui-book.com/unit-three/lessons/2_intro_to_generics.html#intro-to-generics

# 9. Hot Potato Pattern

1. This pattern requires that **function B** must be called ***immediately after*** **function A**, when **function A** returns a **hot potato** and **function B** consumes it.
2. Flash loan:
    a. create a **`Receipt` struct** that
        - cannot be discarded because it does not have `drop`,
        - cannot be put in persistent storage because it does not have `key`,
        - cannot be transferred or wrapped because it does not have `store`.

    b. Have a **`loan`** function that requests a loan of `amount` from `lender` and returns the **`Receipt`**
    c. the only way to get rid of it is to call **`repay`** at some point forcing to pay back the debt.

https://docs.iota.org/developer/iota-101/move-overview/patterns/hot-potato

# 10. Capability Pattern

- This pattern enables the **authorization of specific actions with an object**.
  - e.g., the UpgradeCap is used to authorize the upgrading of packages.
  - e.g. the TreasuryCap grants the authority to manage a Coin treasury functions.

```
/// Type representing the capability to create new `Item`s.
public struct AdminCap has key { id: UID }

/// Custom NFT-like type representing an item.
public struct Item has key, store { id: UID, name: String }

/// Module initializer, called once during the module's deployment.
/// This function creates a single instance of `AdminCap` and assigns it to the publisher.
fun init(ctx: &mut TxContext) {
    transfer::transfer(AdminCap {
        id: object::new(ctx)
    }, tx_context::sender(ctx))
}

/// Function to create a new `Item`. It requires `AdminCap` to authorize the action.
public fun create_item(_: &AdminCap, name: String, ctx: &mut TxContext): Item {
    let item = Item {
        id: object::new(ctx),
        name,
    };
    item
```

https://docs.iota.org/developer/iota-101/move-overview/patterns/capabilities

# Interacting with a IOTA Move Module

# 0. Create a IOTA Move Package - Modules file

https://docs.iota.org/developer/getting-started/create-a-package

# 0. Write a IOTA Move Package

```
module my_first_package::my_module {

    // Imports
    use iota::object::{Self, UID};
    use iota::transfer;
    use iota::tx_context::{Self, TxContext};

    // Struct definitions
    struct Sword has key, store {
        id: UID,
        magic: u64,
        strength: u64,
    }

    struct Forge has key, store {
        id: UID,
        swords_created: u64,
    }

    // Module initializer to be executed when this module is published
    fun init(ctx: &mut TxContext) {
        let admin = Forge {
            id: object::new(ctx),
            swords_created: 0,
        };
        // Transfer the forge object to the module/package publisher
        transfer::public_transfer(admin, tx_context::sender(ctx));
    }

    // Accessors required to read the struct attributes
    public fun magic(self: &Sword): u64 {
        self.magic
    }

    public fun strength(self: &Sword): u64 {
        self.strength
    }

    public fun swords_created(self: &Forge): u64 {
        self.swords_created
    }

    // Public/entry functions

    // Private functions
}
```

https://docs.iota.org/developer/getting-started/create-a-module

# 1. Build and Publish a IOTA Move Package

```
$ iota move build
$ iota move test
$
$
$ iota client publish --gas-budget 5000000
```

```
#[test]
public fun test_sword() {
    // Create a dummy TxContext for testing.
    let mut ctx = tx_context::dummy();

    // Create a sword.
    let sword = Sword {
        id: object::new(&mut ctx),
        magic: 42,
        strength: 7,
    };

    // Check if accessor functions return correct values.
    assert!(magic(&sword) == 42 && strength(&sword) == 7, 1);
}
```

https://docs.iota.org/developer/getting-started/build-test
https://docs.iota.org/developer/getting-started/publish

# 2. Interact with a Package

- Now that the package is on chain you can use the `$ iota client call` command to make individual calls to package functions

```
iota client call \
--package
0x83a30c4c3cbdd33068d36fc18d1f097f9196b79a475b7fe69f517063b376dd23 \
--module luckyplumber \
--function get_mad \
--type-args
0xd95b4510206e13fbe9413bc61183ac3b8375c8971adc54c81eeb9c96d61b5ff1::btfa
::BTFType \
--args 44
0x59f9ed7d8f7c7ed490a63e572c87705e2366757056425le3a20ceedf9c8f961d
--gas-budget 50000000 \
```

https://docs.iota.org/references/cli/client

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# 2. Interact with a Package - PTB

- You can construct more advanced blocks of transactions using the `$ iota client ptb` command.

- In general, transactions on IOTA are composed of:
  - a number of **commands**
  - that execute on **inputs**
  - to define some **results**

# 3. Programmable Transaction Blocks

- The **inputs value** of a PTB is value is a vector of arguments, either *objects* or *pure values*
- The **commands value** of a PTB  is a vector of commands using *inputs* or *results* to execute code
  - *TransferObjects* sends (one or more) objects to a specified address
  - *SplitCoins* splits off (one or more) coins from a single coin. It can be any iota::coin::Coin<_>
  - *MergeCoins* merges (one or more) coins into a single coin
  - *MakeMoveVec* creates a vector of Move values
  - ***MoveCall*** invokes either an *entry* or a *public* Move function in a published package.
  - *Publish* creates a new package and calls the init function of each module in the package.
  - *Upgrade* upgrades an existing package.
- The **result values** is a vector of values that can be produced by each command; the type of the value can be any arbitrary Move type, not limited to objects or pure values.
- A PTB can perform up to 1,024 unique operations in a single execution.

https://docs.iota.org/developer/iota-101/transactions/ptb/prog-txn-blocks

# 3. Programmable Transaction Blocks

```
$ iota client ptb \
--move-call 0xd95b4510206e13fbe9413bc61183ac3b8375c8971adc54c81eeb9c96d61b5ff1::pkg::func
"<0xd95b4510206e13fbe9413bc61183ac3b8375c8971adc54c81eeb9c96d61b5ff1::pkg1::TYPE1,0xd95b451
0206e13fbe9413bc61183ac3b8375c8971adc54c81eeb9c96d61b5ff1::pkg2::TYPE2>"
@0x0b72fb4d8106699c773bf58fd0a49ffe3a08bdd58f245946d160ed5463f7ba47 99 true \
--assign result_variable \
--move-call iota::tx_context::sender \
--assign sender \
--transfer-objects "[result_variable.2]" sender \
--move-call 0xd95b4510206e13fbe9413bc61183ac3b8375c8971adc54c81eeb9c96d61b5ff1::pkg::func2
"<0xd95b4510206e13fbe9413bc61183ac3b8375c8971adc54c81eeb9c96d61b5ff1::pkg1::TYPE1"
@0x0b72fb4d8106699c773bf58fd0a49ffe3a08bdd58f245946d160ed5463f7ba47 result_variable.0 \
--gas-budget 50000000
```

https://docs.iota.org/references/cli/ptb

# 4. *public* vs *entry* functions

- The **public** modifier allows a function to be *called from a PTB* and also *from other modules*
    - NO restrictions on parameters

- The ***entry*** modifier allows a function to be called directly from a PTB as a module "entrypoint".
    - entry functions **parameters must be inputs** to the PTB (not results of previous command)
    - only allowed to return types that have drop

- Use the *entry* modifier when:
    - You want strong guarantees that your function is not being combined with third-party module functions (e.g., swap protocol that does not want a flash loan)
    - *public* function signatures must be maintained by upgrades (entry function not).
    - It is also possible to create a *public entry* function, can be called by other modules

https://docs.iota.org/developer/iota-101/move-overview/entry-functions

# 5. Binary Canonical Serialization (BCS)

- BCS is a **serialization format** developed in the context of the Diem blockchain
  - now extensively used in most of the blockchains based on Move (IOTA, Sui, Aptos, 0L).
- BCS is *not only used in the Move VM*, but also used in **transaction and event coding**.

```
var { bcs, fromHEX } = require('@mysten/bcs');
const Calzone = bcs.struct('Calzone', {
    flour: bcs.u16(),
    tomato_sauce: bcs.u16(),
    cheese: bcs.u16(),
});
const hex = "0a00030062027201120 0c800b4000000"
const calzone = Calzone.parse(fromHEX(hex));
```

https://docs.iota.org/references/ts-sdk/bcs
https://github.com/zefchain/bcs
https://www.npmjs.com/package/@mysten/bcs

# What’s left?

- Collections
- Events
- Package upgrades
- Proper Testing
- Clock and Random objects
- …

- https://docs.iota.org/developer/iota-101/move-overview/
- https://docs.iota.org/references/cli/client
- https://intro.sui-book.com/unit-one/lessons/1_set_up_environment.html

# Thank you!

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