POD2

Outline

- The problem
- POD2 description
- Some technical details

Problem

- Interoperability of programmable cryptography
  - Selective disclosure (reveal some part of signed data)
  - Private property proofs (reveal some property of signed data)
  - Properties of mixed data (I have this government ID & this ethereum key)
- User friendly
  - As a user I want to see the properties, not a zk circuit
  - Can run it on my phone
- Dev friendly
  - Framework for interoperable data
  - No need to write new circuits for combinations of properties
  - Future use-cases without changing the framework

Problem: Examples

1. Make an app that requires proving that you're over 18 according to your government: OK, I can use privado ID.

2. Make an app that requires proving you have some tokens: OK, I can write a circuit using a storage proof circuit library.

- Make an app that requires (1) or (2), without disclosing which one: uh...
- Wouldn't it be great if the check result of (1) and (2) wasn't "terminating" and we could continue making new checks out of them?

Problem: Examples

Online game with API to query player stats and facts (with some private info via player API key)

- Building meta-games on top of the game, considering player privacy

POD2: What is it?

- Interoperable cryptographic data format
- Extendable
- With programmable privacy
- Client (smartphone) friendly

SignedPod

- Signed key-value object

```
{
    _type: Signed
    _signer: 0xGov
    birth_year: 1989
    name: “Alice”
} + signature
```

MainPod

- Proved private/public statements

```
[
    exists verified gov_pod: SignedPod
    gov_pod[“_signer”] in WHITELIST
    gov_pod[“birth_year”] < (2025-21)
    gov_pod[“name”] == “Alice”
] + proof
```

Introduction Pods

- Adapter for foreign cryptographic data to pod format

```
{
   _type: Ed25519
   ed25519_pk: 0xpublic_key
   signed_msg: 0xmsg_hash
} + proof
```

Custom Predicates

- The MainPod supports a fixed set of native predicates:
  - Equal, NotEqual, LtEq, Lt, Contains, NotContains, Sum, Product, Max, Hash
- Extendable Custom Predicates:
  - Conjunction (AND) of statements
  - Disjunction (OR) of statements

Custom Predicates: Example

```
// src, dst: PubKey, attetation_pod: Pod
eth_dos_friend(src, dst, private: attestation_pod) =
AND(
    ValueOf(?attestation_pod[KEY_TYPE], SIGNATURE)
    Equal(?attestation_pod[KEY_SIGNER], src)
    Equal(?attestation_pod["attestation"], dst)
)
```

```
// src, intermed, dst: PubKey, distance, shorter_distance: Int
eth_dos_distance(src, dst, distance,
                 private: shorter_distance, intermed) =
OR(
    AND(
        eth_dos_distance(?src, ?intermed, ?shorter)
        SumOf(?distance, ?shorter_distance, 1)
        eth_friend(?intermed, ?dst)
    )
    AND(
        Equal(?src, ?dst)
        Equal(?distance, 0)
    )
)
```

Recursion

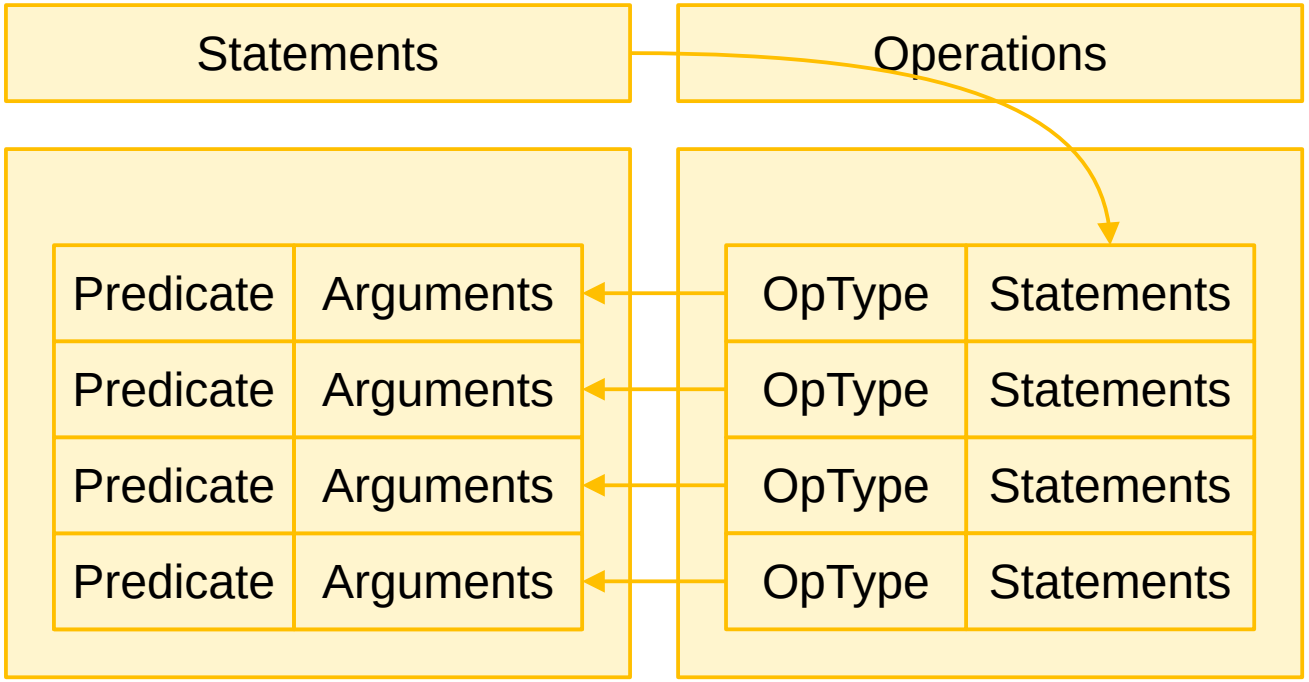
- The MainPod can take other MainPods or intro pods as inputs

```
[
   exists verified pod_a: Ed25519Pod
   exists verified pod_b: Sha512Pod
   pod_a[“signed_msg”] == pod_b[“sha512_image”]
   pod_b[“sha512_preimage”] == “Hello World”
   pod_a[“ed25519_pk”] in AUTH_LIST
] + proof
```

Stack

- Plonky2
  - Very fast recursion
  - Succint proofs
  - Client friendly (CPU & RAM)

Circuit design



Example:

Statements		Operations
0: None	←	None
1: Equal(x, 10)	←	NewEntry
2: Equal(y, 20)	←	NewEntry
3: Lt(x, y)	←	LtFromEntries 1 2
4: NotEqual(x, y)	←	LtToNotEqual 3

Repositories

- Main repository
  - https://github.com/0xPARC/pod2
- Some Introduction pods
  - https://github.com/0xPARC/introduction-pods

Example code

- https://github.com/0xPARC/pod2/blob/main/examples/main_pod_points.rs