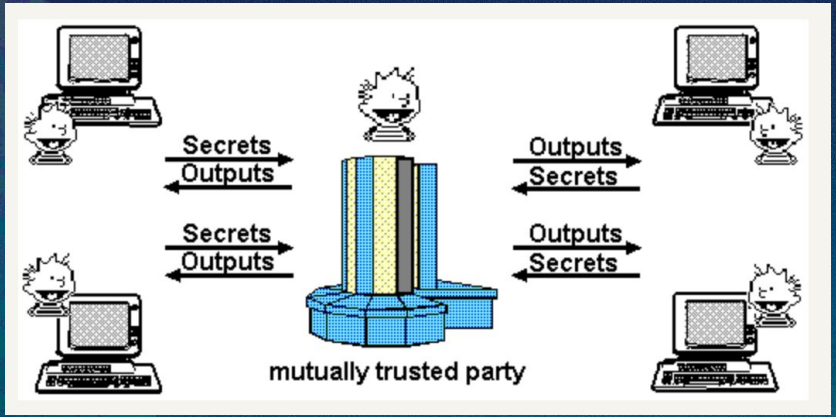

Phantom zone
Janmajaya Mall
phantom.zone

Globally mutually trusted 3rd party

3 guarantees

- Keeps your information private
- Wouldn’t let poke its state
- Computes arbitrary function with proper authorisation



It’s a mutually trusted shared computer

The God protocol

To guarantee 3 guarantees globally we require cryptography

We started to build Phantom-zone to build the god protocol

But could only build an abridged version

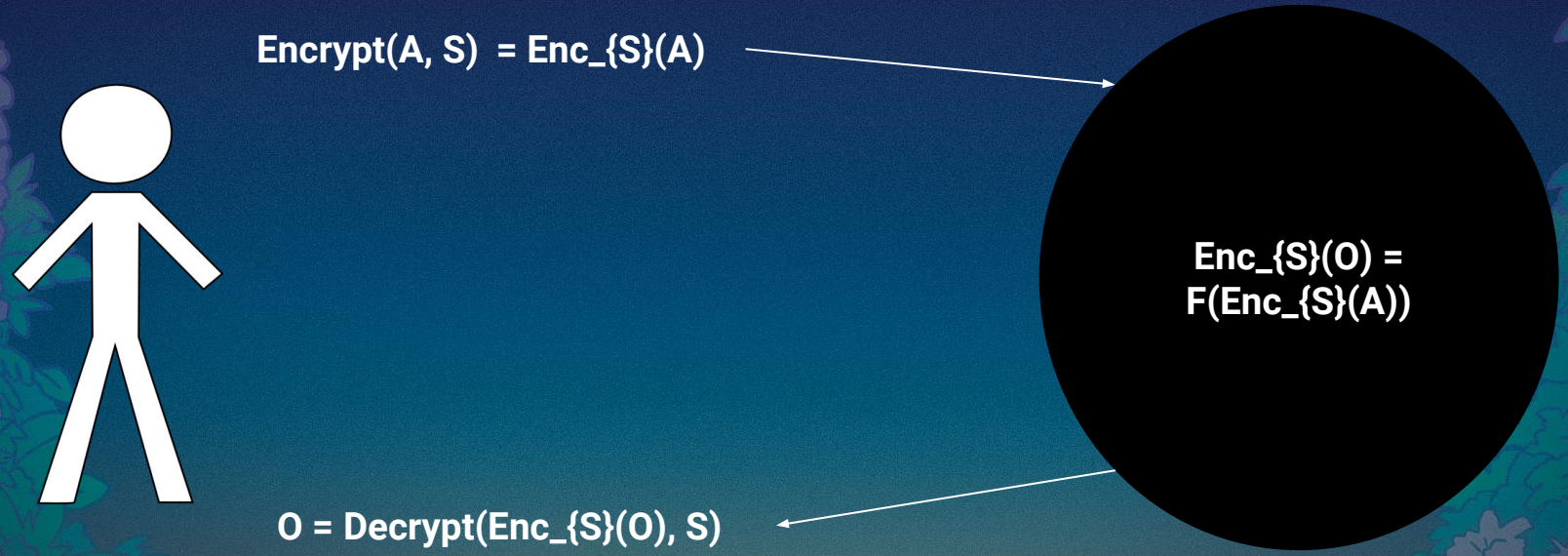
Outline

- What’s phantom-zone? Why is it abridged?
- How can we push frontiers and build the god protocol?

Phantom zone (abridged version)

Key idea: Multi-party FHE

Before multi-party FHE comes Single-party FHE

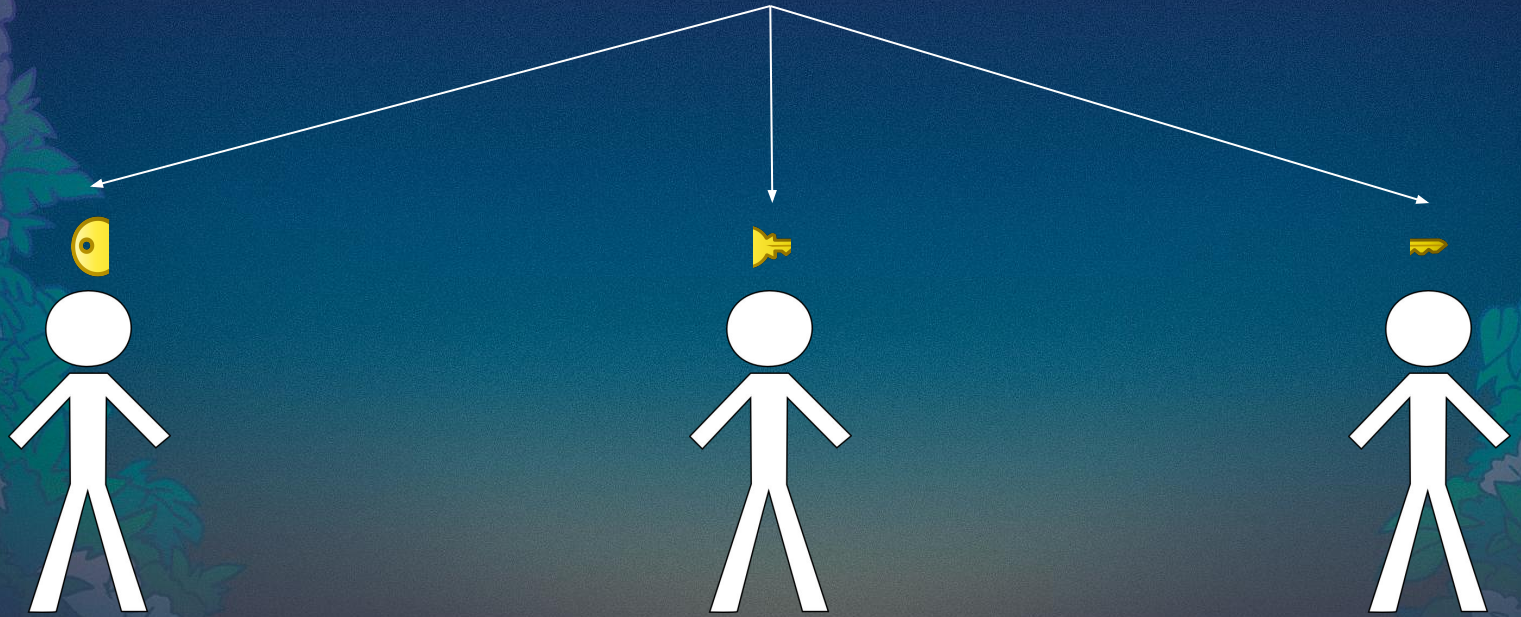


Multi-party FHE

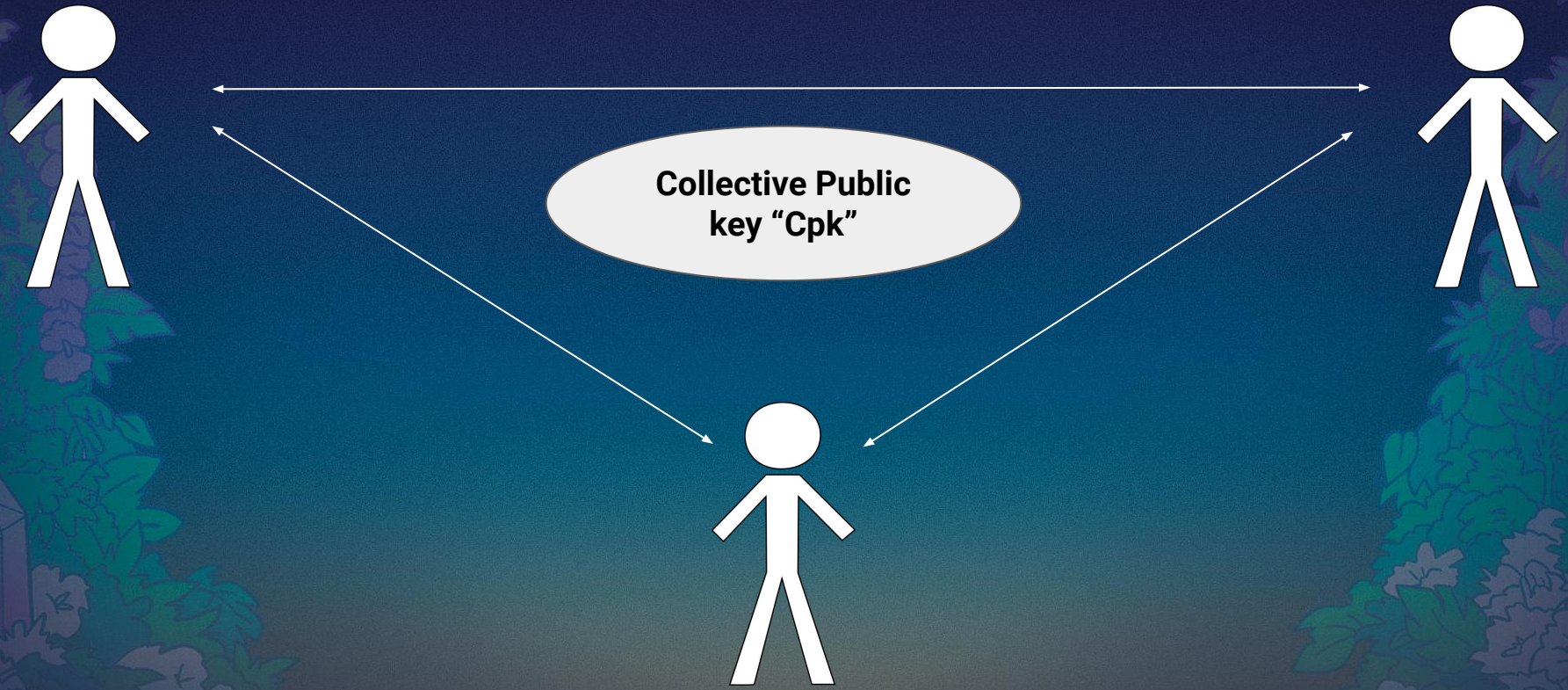
Key idea: split the secret!

Ideal secret key `S`

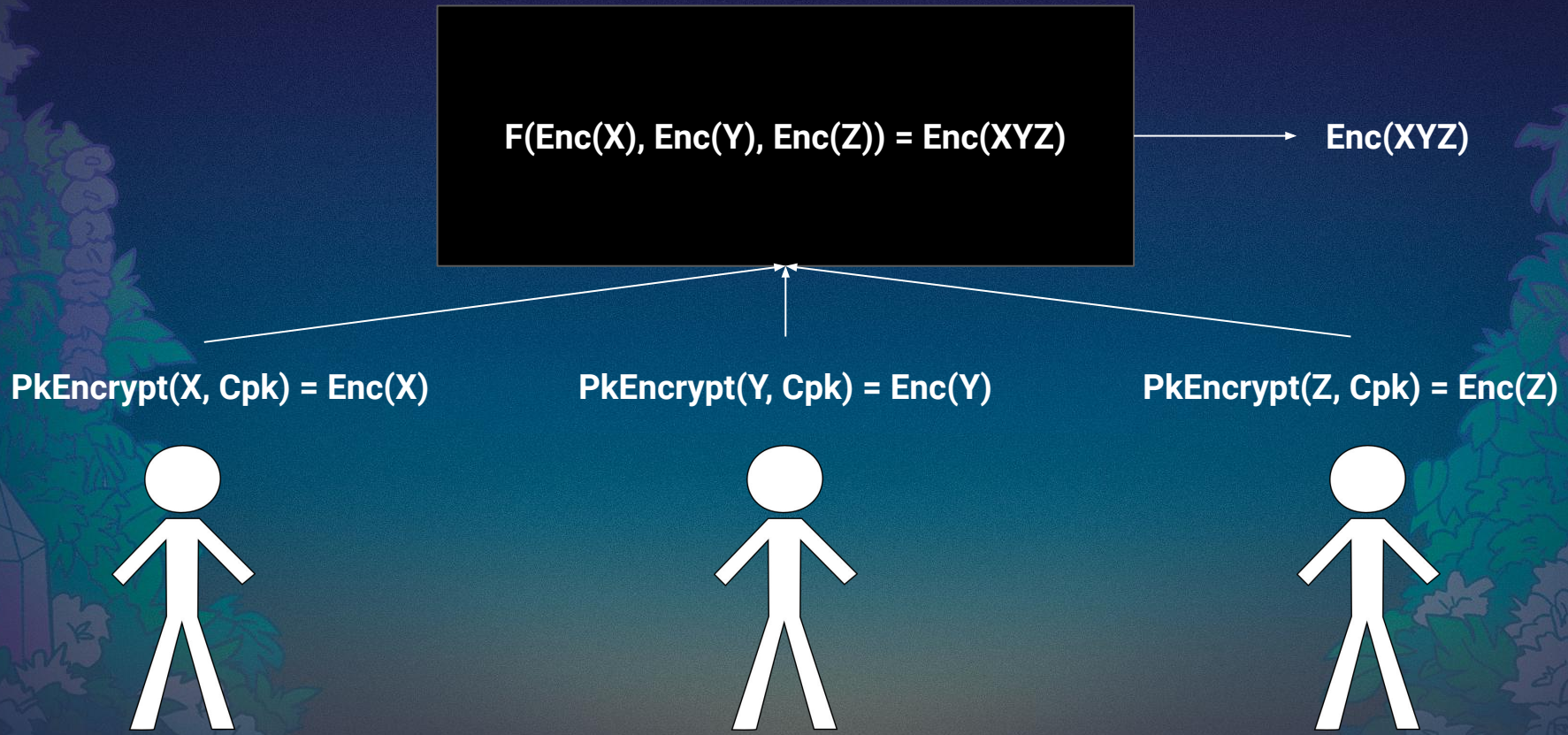
S = S0 + S1 + S2



Step 1: Generate collective public key



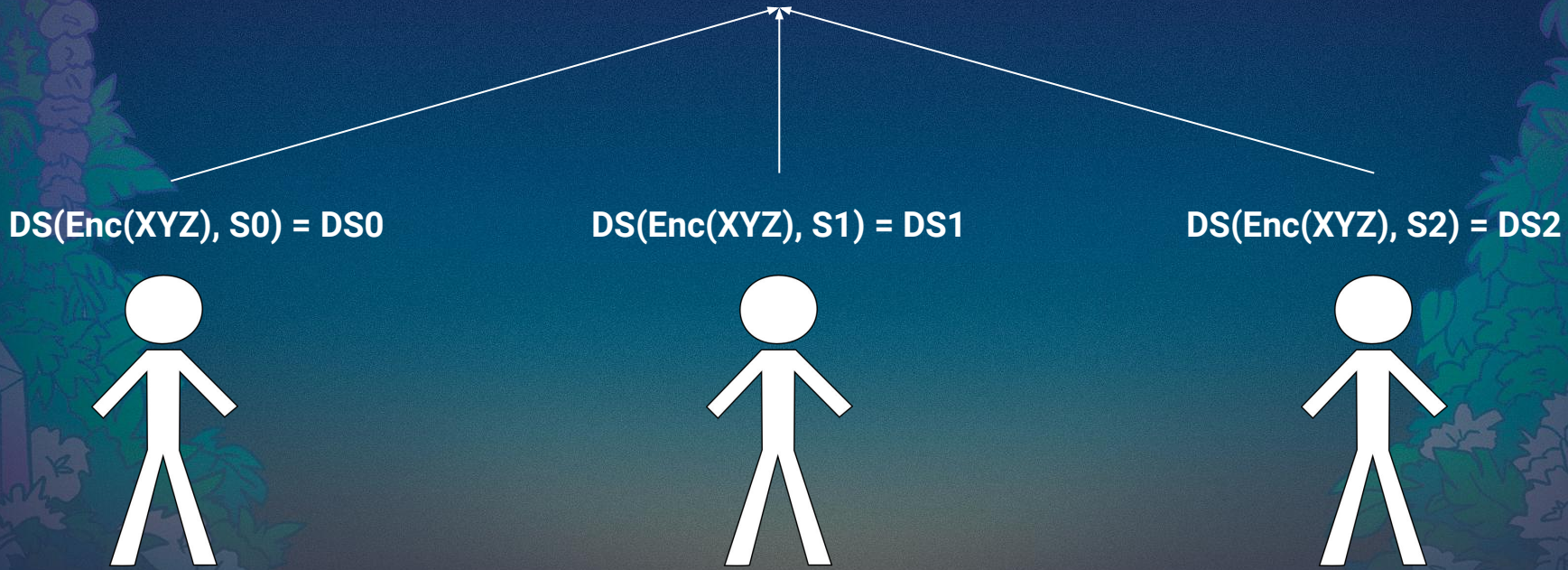
Step 2: Server evaluates an arbitrary function



Step 3: Multi-party decryption

DS(): DecryptionShare()

MPDecrypt(Enc(XYZ),[DS0, DS1, DS2]) = XYZ



Why an abridged version?

Because phantom zone, with publicly verifiable FHE, can guarantee the 3 guarantees to only the holders of the secret shards. It cannot go “global”

How to build towards “the god protocol”

Program obfuscation

What's Program obfuscation / iO?

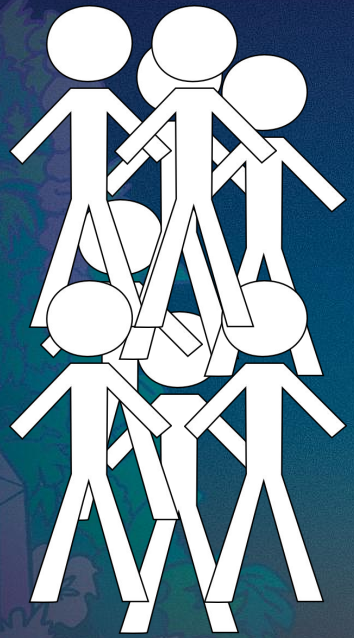
Assume we can only build program obfuscation for a very limited class of functions

Here’s one way to build the God protocol

Step 1: Modify FHE scheme to be publicly verifiable and fix FHE circuit for a publicly known function F(x)

Evaluation of FHE circuit on input x outputs
(1) output ciphertext
(2) proof π of correct evaluation

Step 2: Replace collective keygen with trusted setup



MPC to generate FHE keys (public key, bootstrapping key, etc.)

Public key

Bootstrapping key

No-one knows the ideal secret key

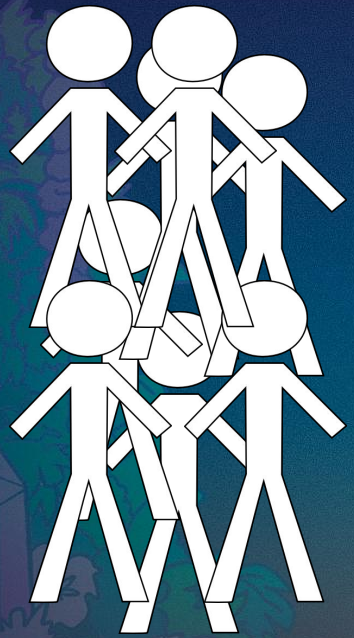
Step 3: Modify trusted setup to also output an obfuscated “conditional” decryption oracle with ideal secret key embedded inside

Obfuscated conditional decryptor

```
fn conditional_decrypt(ciphertext x, proof π) {
        If verify(π, x) == true {
                return Decrypt(x, S)
        }else {
                return null
        }
}
```

Obfuscated conditional decryptor circuit with ideal secret key embedded inside

End to End flow: Part 1



MPC to generate

(1) FHE keys (public ey, bootstrapping key, etc.)

(2) Obfuscated conditional decryptor with ideal secret embedded inside

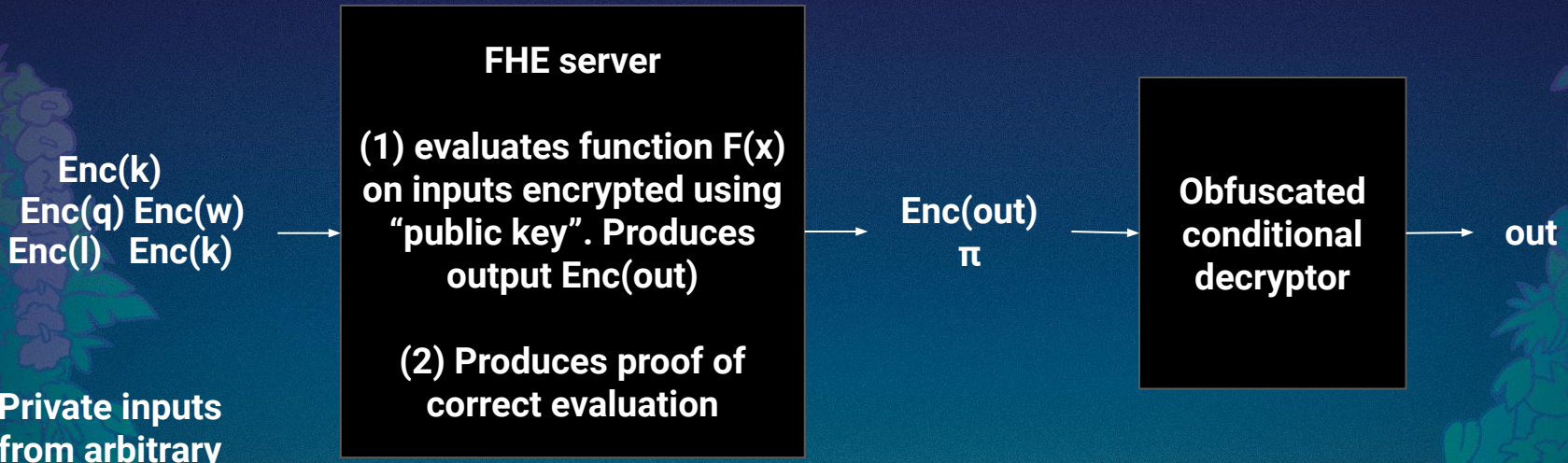
No-one knows the ideal secret key

Public key

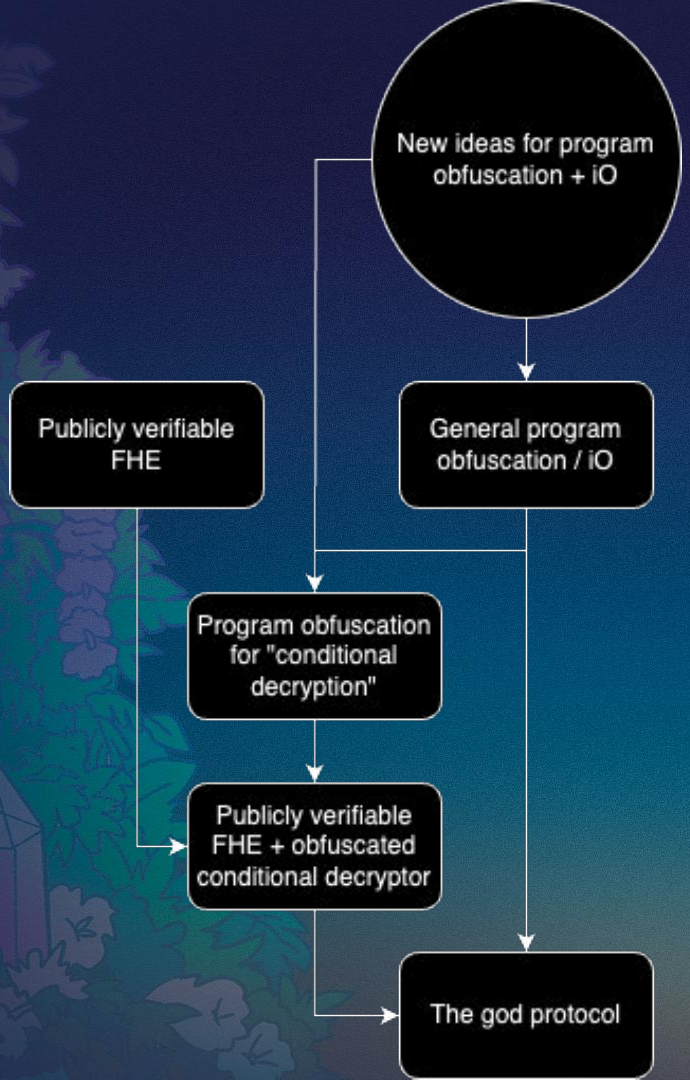
Bootstrapping key

Obfuscated conditional decryptor

End to End flow: Part 2



Private inputs from arbitrary no. of parties encrypted using the “public key”



Public verifiable FHE + practical PO for proof verification + linear decryption is just 1 way.

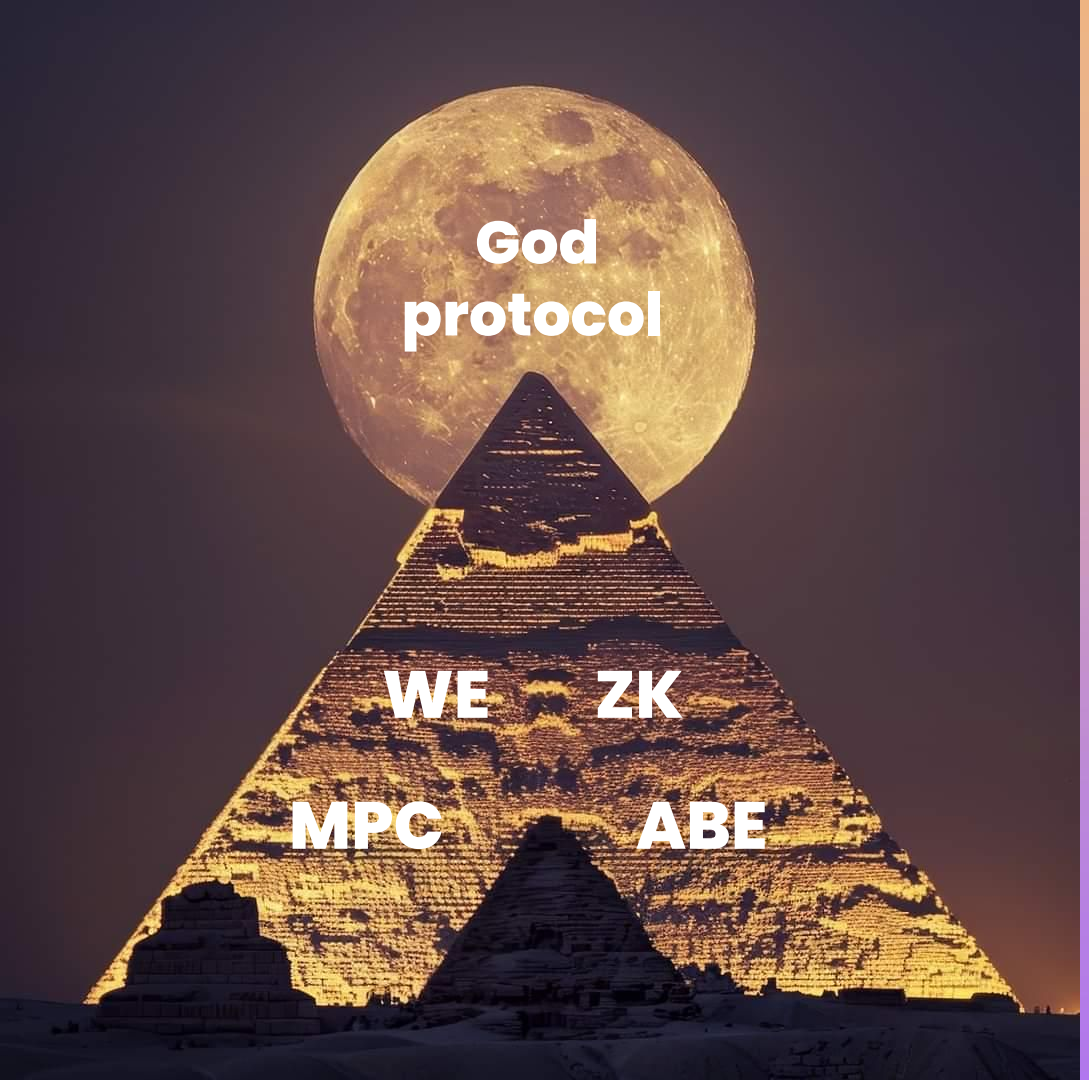
We need new ideas to push the frontiers for general PO / iO

Key observation: Efficient program obfuscation from “standard assumptions” is hard. We inevitably need to rely on exotic assumptions

We should start testing & breaking exotic assumptions, so that in few years we’ve candidate assumptions to build PO

Bounty to break “Program obfuscation via local mixing”

- Goal: We’ve provided obfuscated circuit with 237,224 gates. Find the original circuit with 1014 gates.
- Bounty amount: 10,000 USD
- More details: **obfustopia.io**

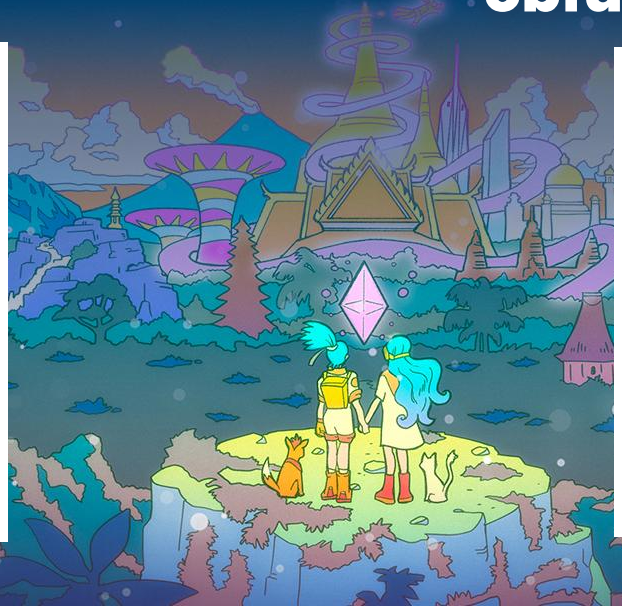


God protocol is the “convergence”

Thank you!

phantom.zone

obfustopia.io (bounty)



Section 2 title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

- Sollicitudin
- Consectetur
  - Condimentum
    - Magna
    - Ligula

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

- Sollicitudin
- Consectetur
  - Condimentum
    - Magna
    - Ligula

Enter your main point / statement here.

Section 1 details with a main point. Enter title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Section 2 details with a main point. Enter title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Enter your main point / statement here.

Enter your main point / statement here.

Section 3 details with a main point. Enter title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Section 4

Section 4 title here.

Section 4 details with a main point. Enter title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur. Excepteur sint occaecat cupidatat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Enter your main point / statement here.

Enter your main point / statement here.

Here’s the timeline.

Event 1

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam.

Event 2

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam.

Event 3

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam.

99.99%

“Number rules the universe.”

— Pythagoras

Enter your slide title here

Your slide subtitle here.

Your Name
Your title, your organization

Section 1

Section 1 title here.

Section 1 details with an image. Enter title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur.

Section 1 title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

- Sollicitudin
- Consectetur
    - Condimentum
        - Magna
        - Ligula

Enter your main point / statement here.

Section 1 details with a main point. Enter title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur.

Section 2

Section 2 title here.

Section 2 title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

- Sollicitudin
- Consectetur
  - Condimentum
    - Magna
    - Ligula

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

- Sollicitudin
- Consectetur
  - Condimentum
    - Magna
    - Ligula

Section 2 details with an image. Enter title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur.

Section 2 details with a main point. Enter title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur.

Enter your main point / statement here.

Section 3

Section 3 title here.

Enter your main point / statement here.

Section 3 details with a main point. Enter title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur.

Section 4

Section 4 title here.

Section 4 details with a main point. Enter title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur.

Enter your main point / statement here.

Enter your main point / statement here.

Here’s the timeline.

Event 1

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam.

Event 2

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam.

Event 3

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam.

99.99%

“Number rules the universe.”
— Pythagoras

Thank you!

Your Name
Your title, your organization
your@email.address
@youraccount

Enter your slide title here

Your slide subtitle here.

Your Name

Your title, your organization

Section 1

Section 1 title here.

Section 1 title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

- Sollicitudin
- Consectetur
  - Condimentum
    - Magna
    - Ligula

Section 1 details with an image. Enter title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur.

Enter your main point / statement here.

Section 1 details with a main point. Enter title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur.

Section 2

Section 2 title here.

Section 2 title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

- Sollicitudin
- Consectetur
  - Condimentum
    - Magna
    - Ligula

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua.

- Sollicitudin
- Consectetur
  - Condimentum
    - Magna
    - Ligula

Section 2 details with an image.
Enter title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur.

Section 2 details with a main point. Enter title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur.

Enter your main point / statement here.

Section 3

Section 3 title here.

Enter your main point / statement here.

Section 3 details with a main point. Enter title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur.

Section 4

Section 4 title here.

Section 4 details with a main point. Enter title here.

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur.

Enter your main point / statement here.

Enter your main point / statement here.

Here's the timeline.

Event 1

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam.

Event 2

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam.

Event 3

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Ut enim ad minim veniam.

99.99%

“Number rules the universe.”
— Pythagoras

Thank you!

Your Name

Your title, your organization

your@email.address

@youraccount