Circom

November 28, 2024

Distributed Lab

zkdl-camp.github.io
github.com/ZKDL-Camp

Plan

Introduction

Why do we need ZK?

Why do we need ZK?

Option

Solution to privacy

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Option

Solution to privacy

Example

1. *I know the private key that corresponds to this public key*
2. *I know a private key that corresponds to a public key from this list*

Why do we need ZK?

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Option

Solution to scalability

Why do we need ZK?

Option

Solution to privacy

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1. *I know the private key that corresponds to this public key*
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Option

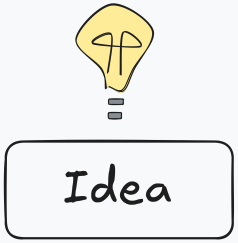
Solution to scalability

Example

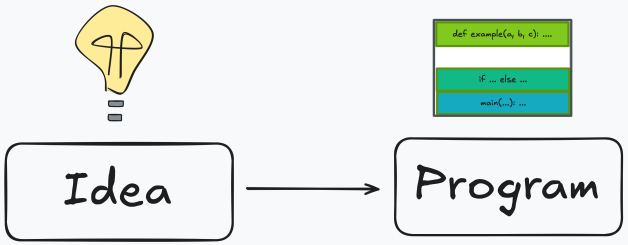
This is the hash of a blockchain block that does not produce negative balances

Using ZKP

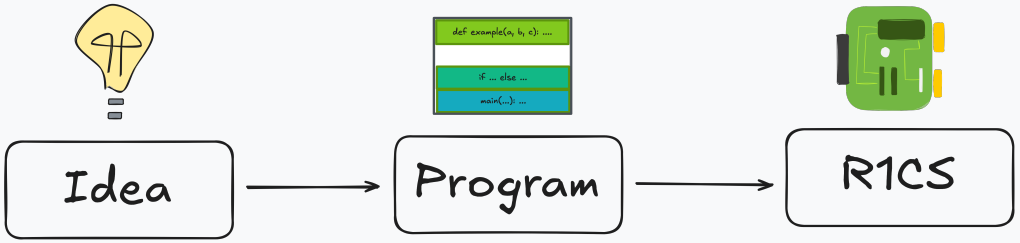
Using ZKP



Using ZKP



Using ZKP



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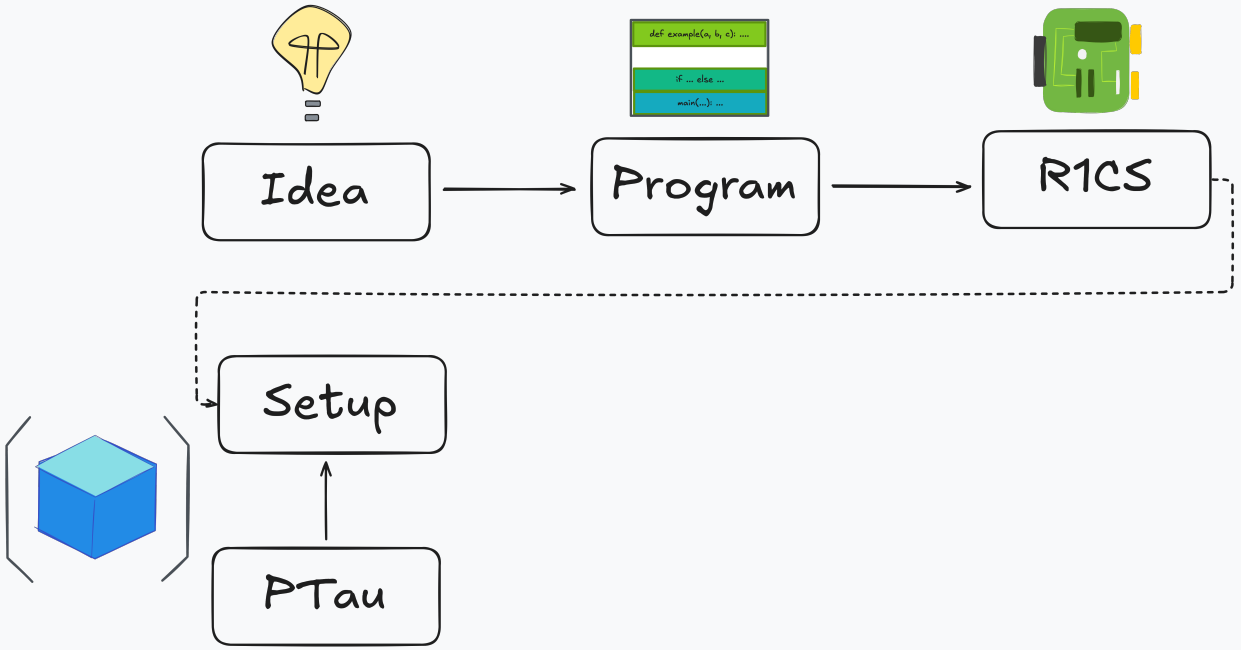

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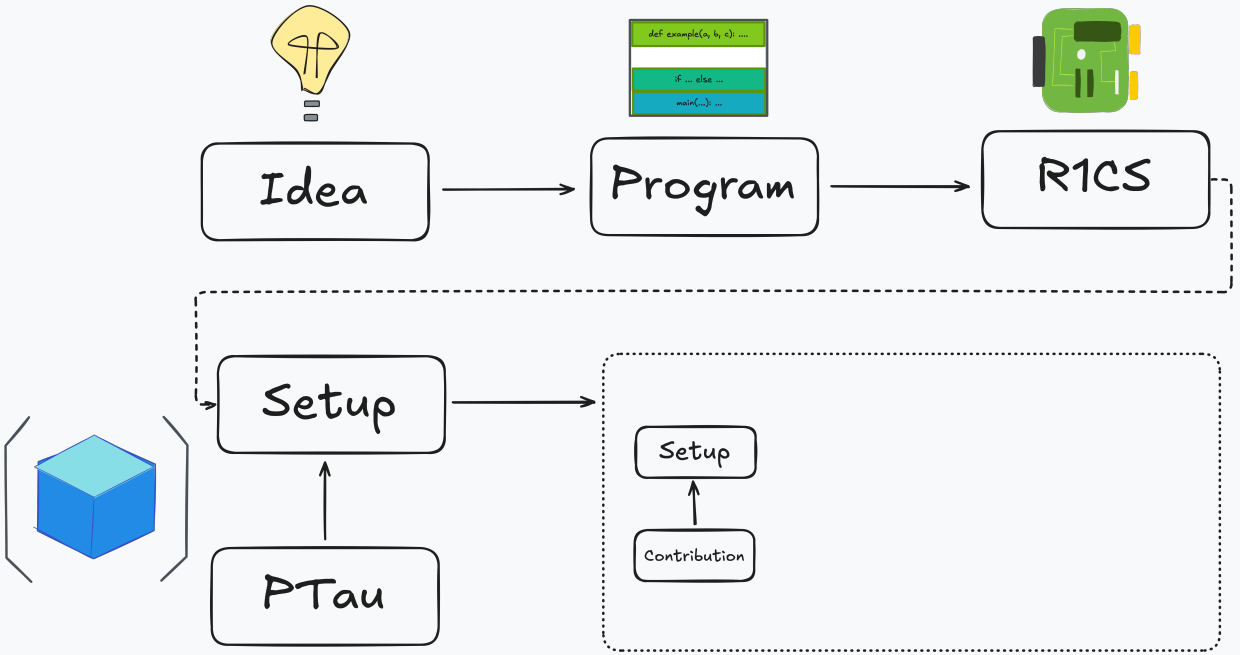

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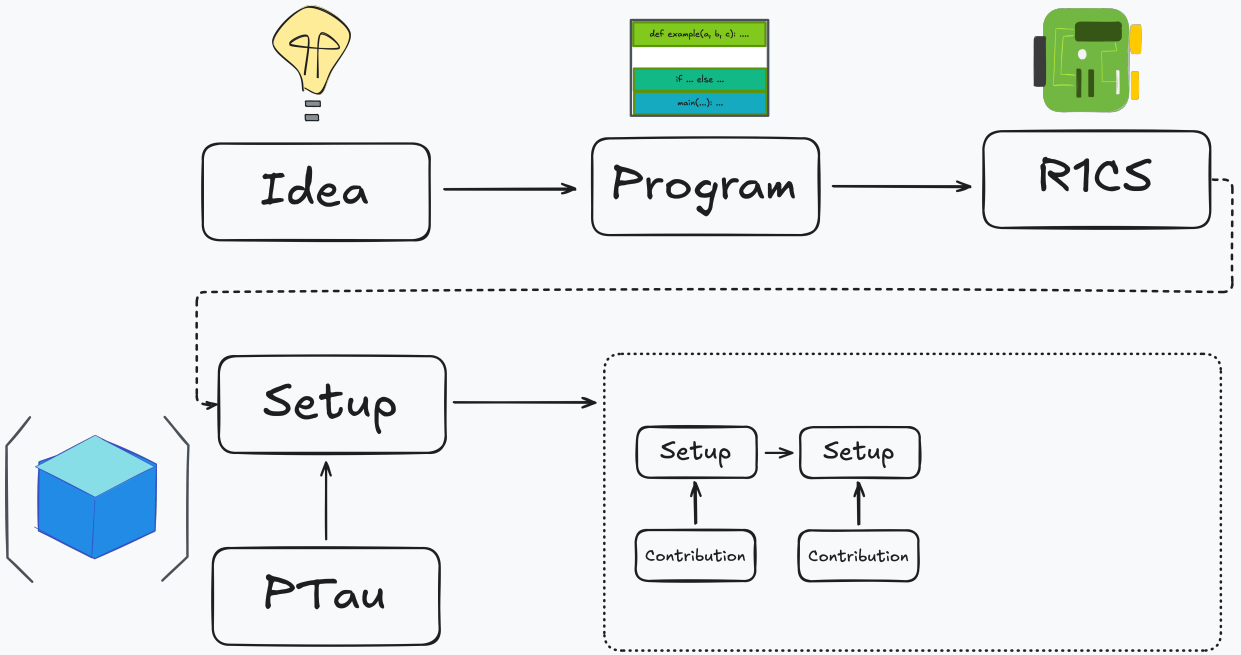
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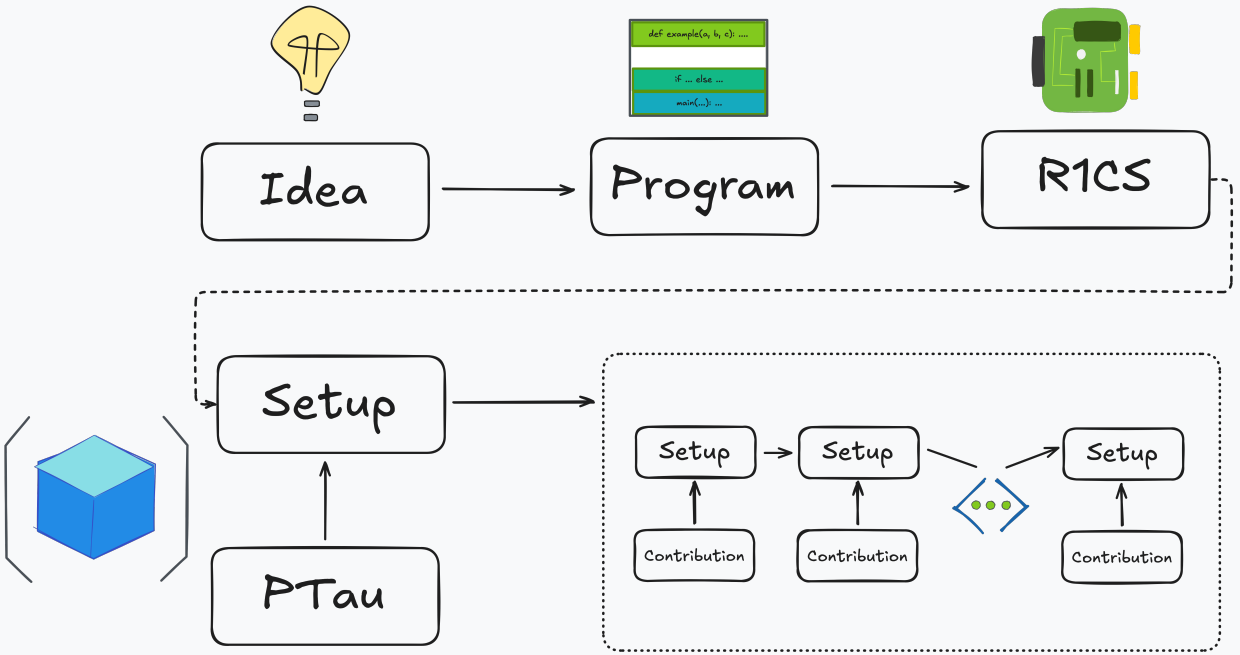
Using ZKP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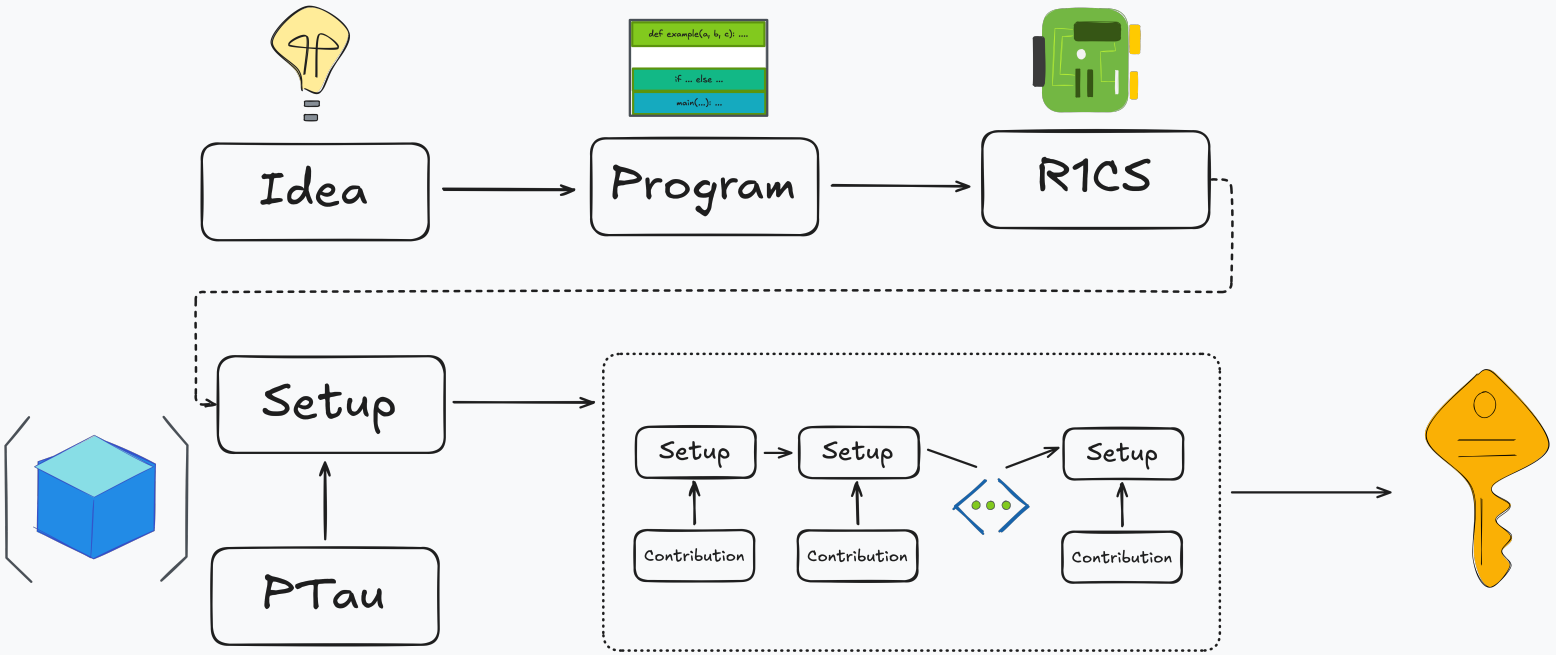
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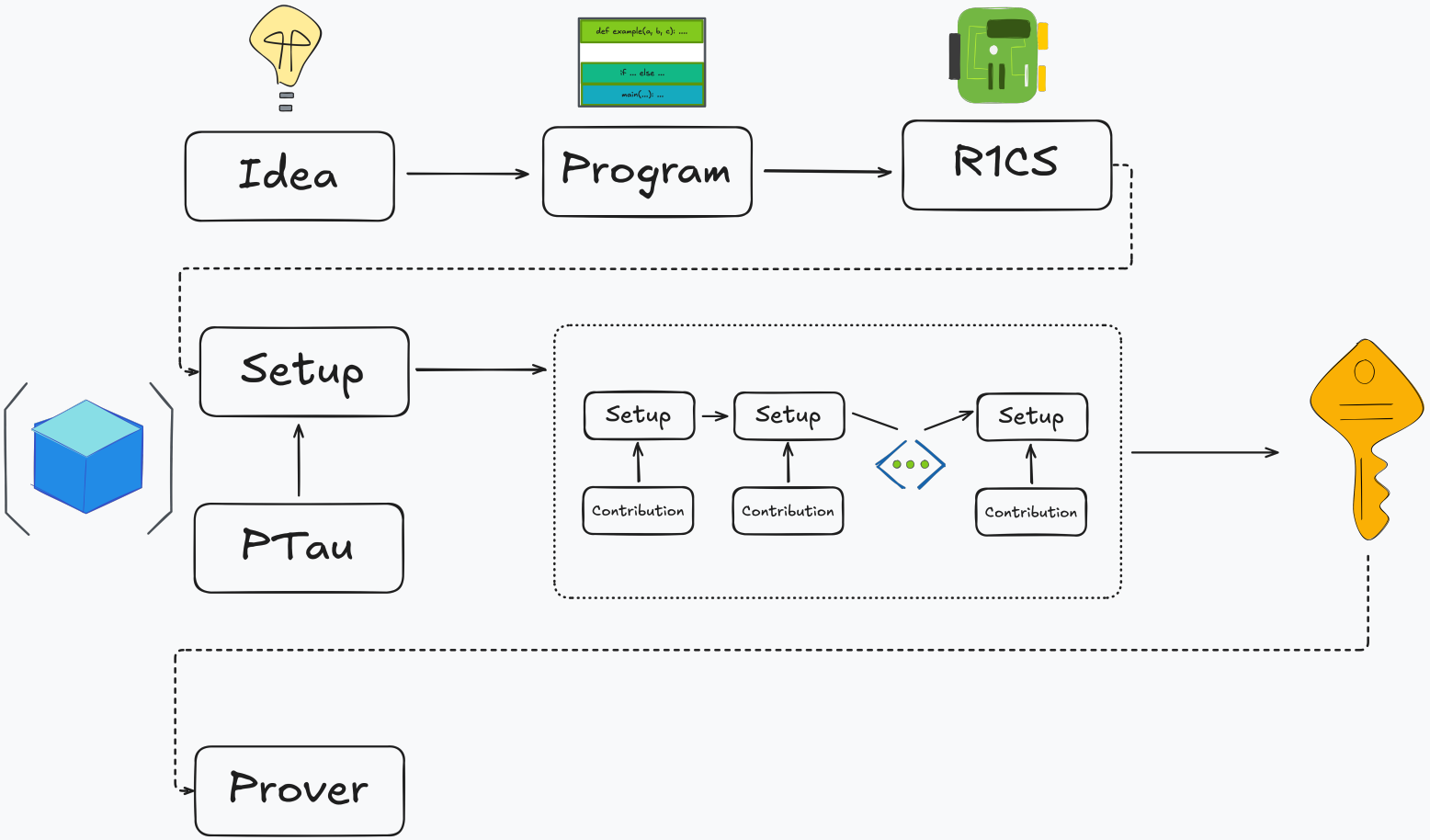
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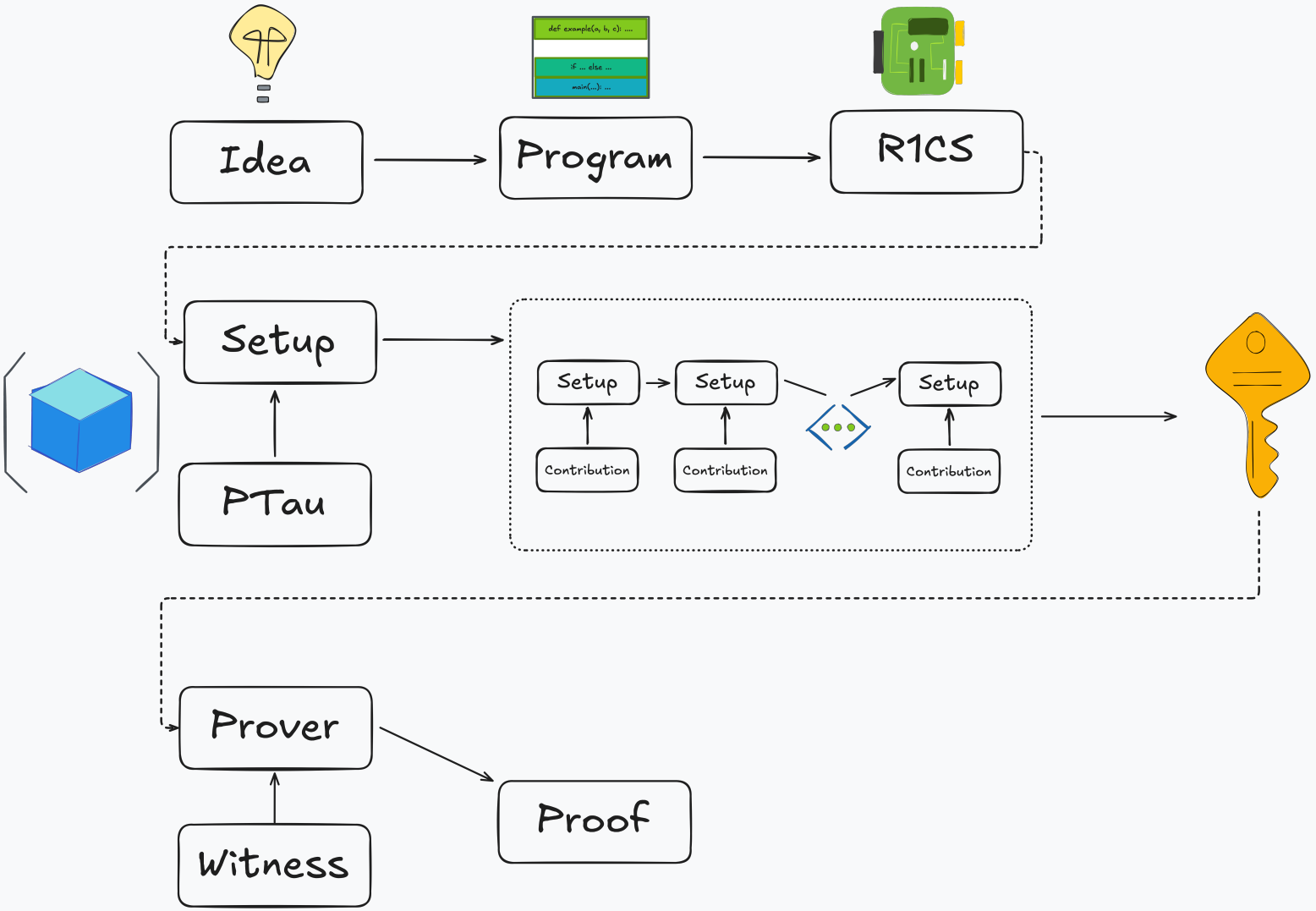
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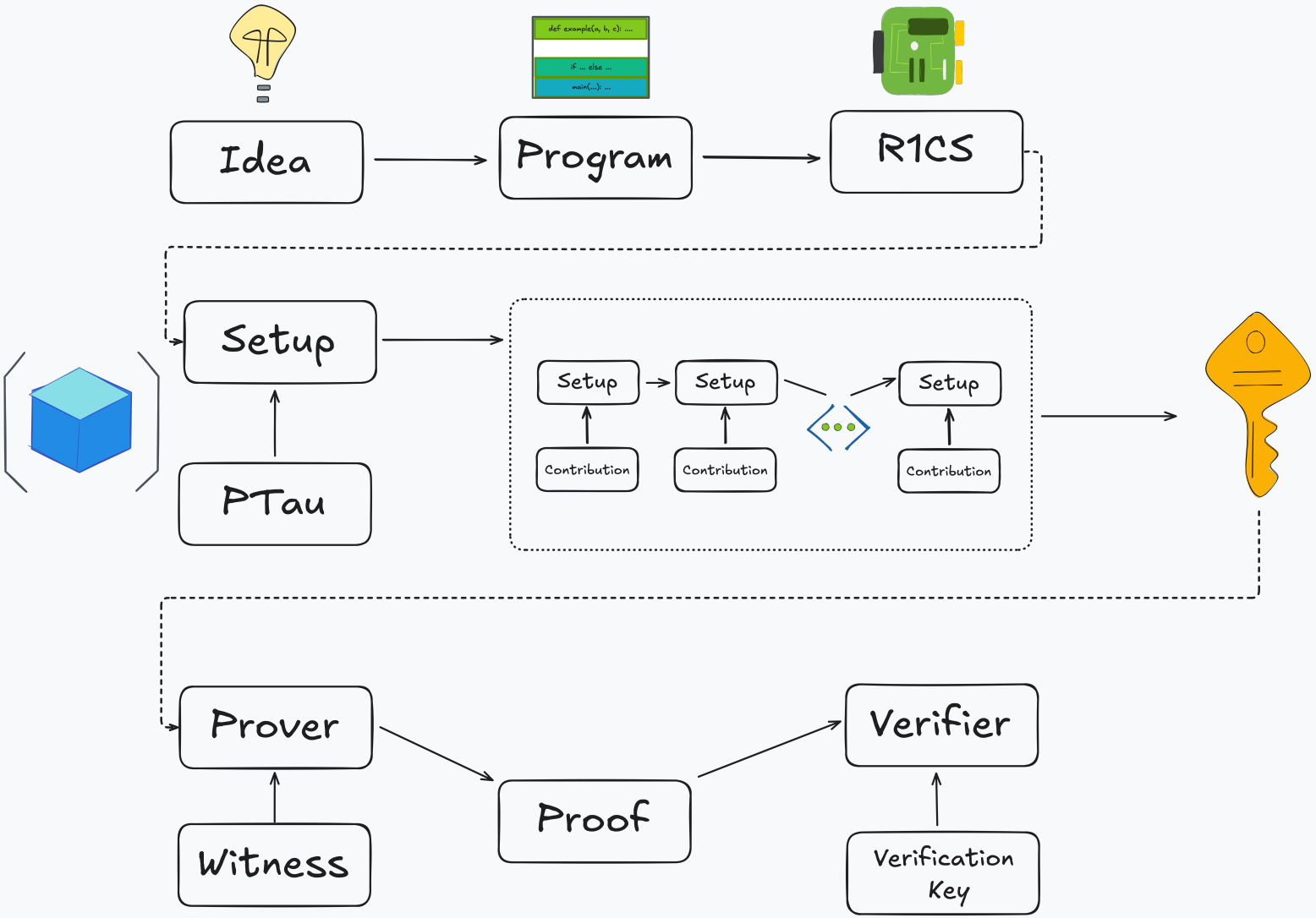
Using ZKP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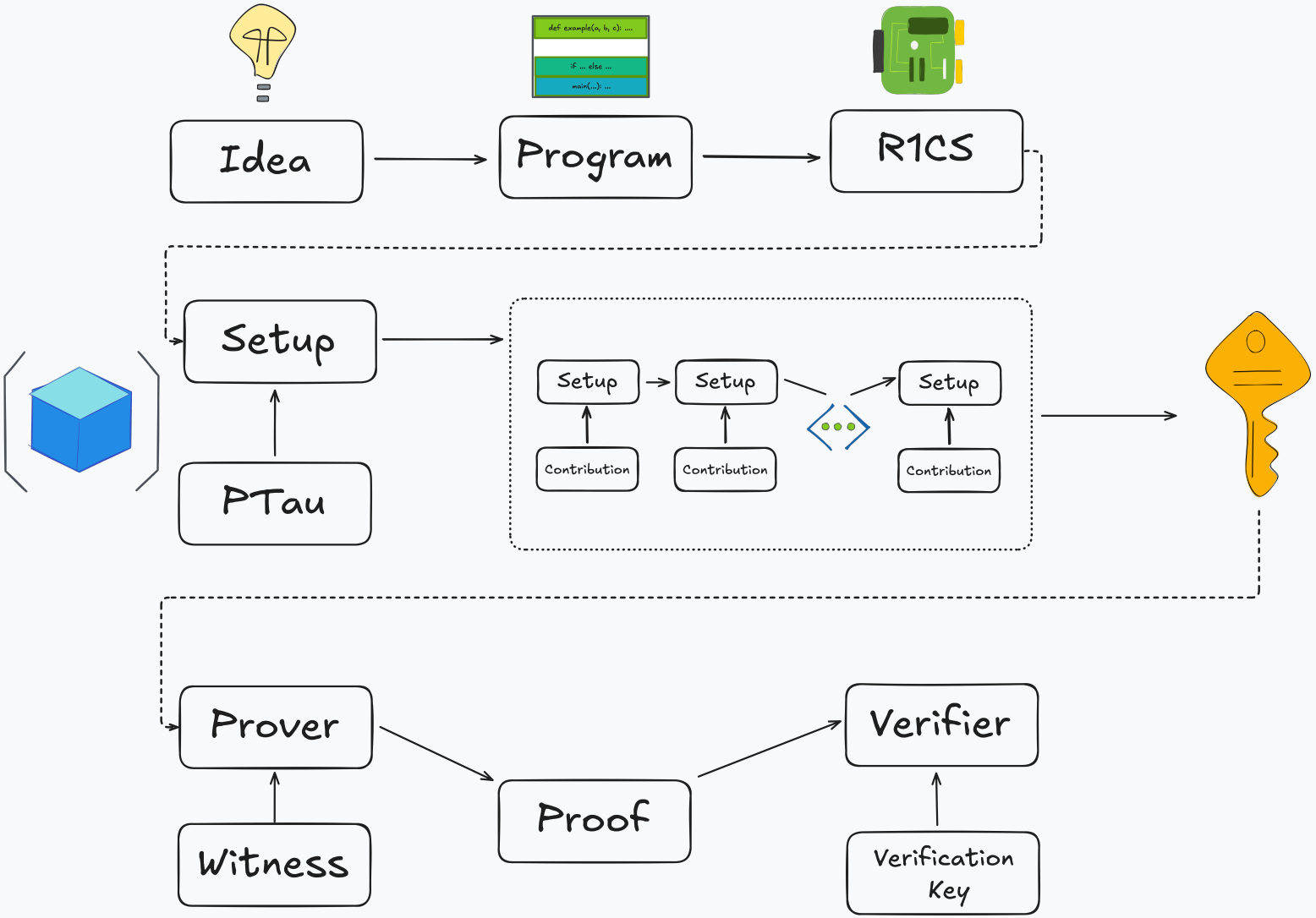
Verification Key

Toolchain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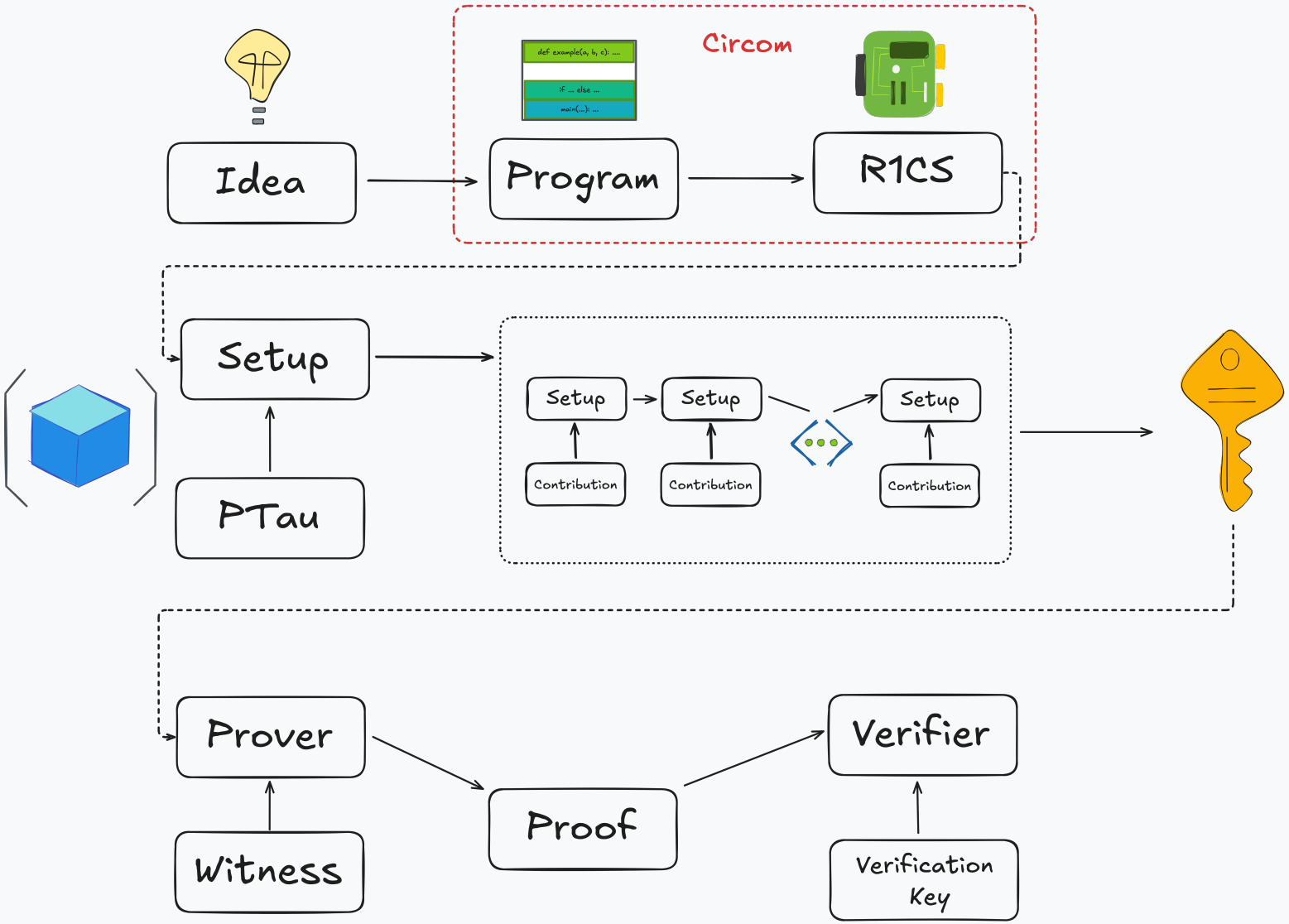
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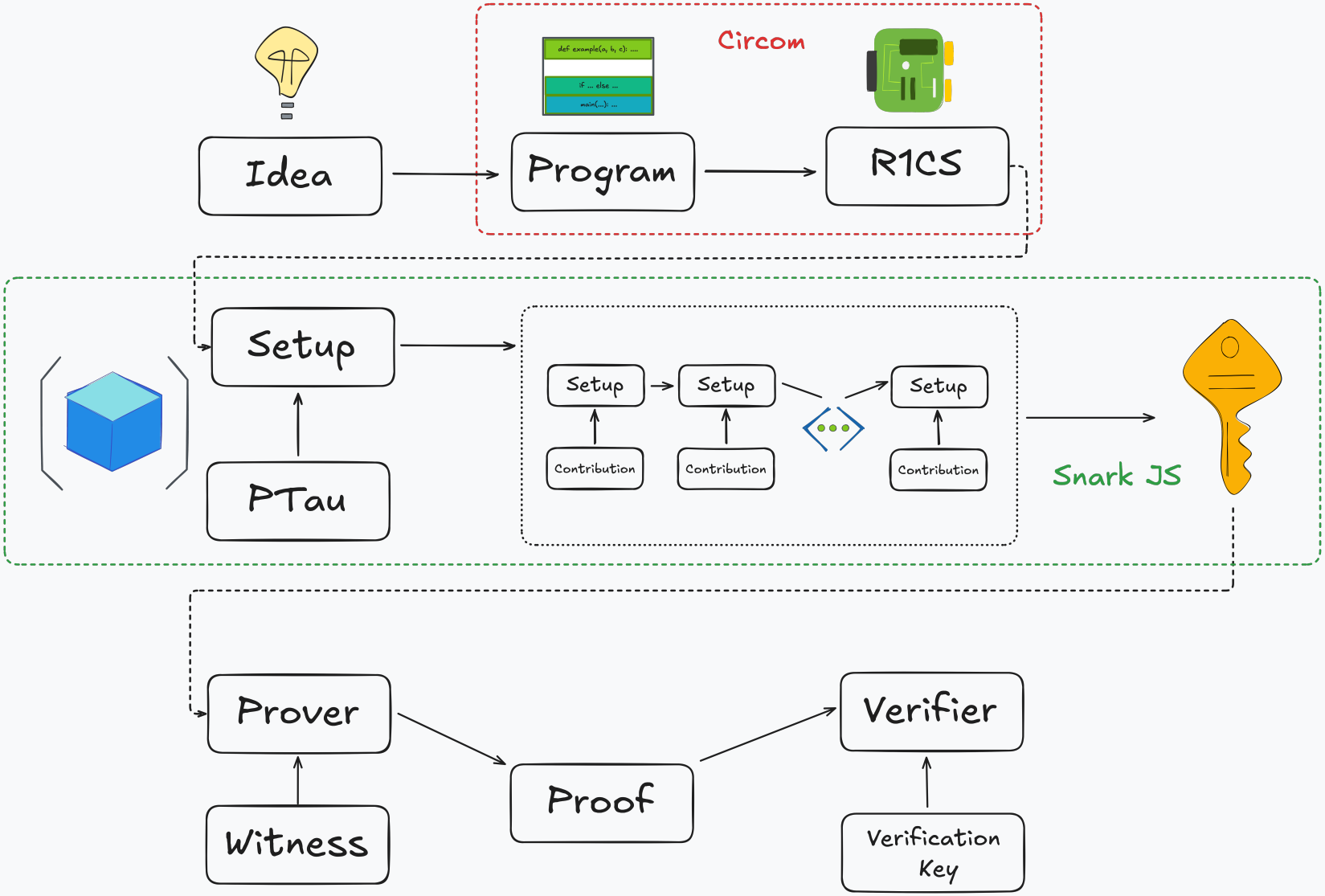
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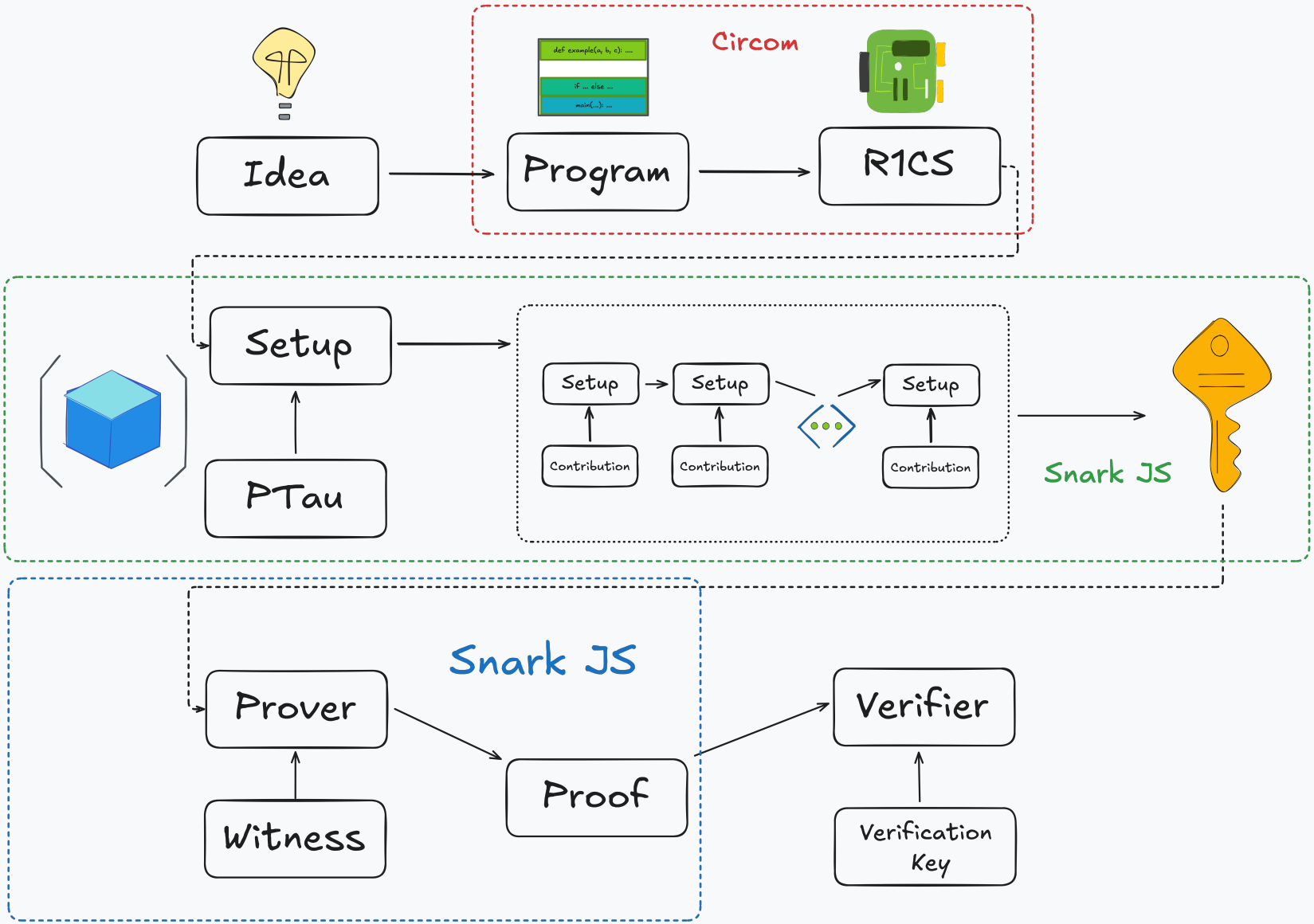
Idea
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def example(a, b, c): ....
if ... else ...
main(...): ...
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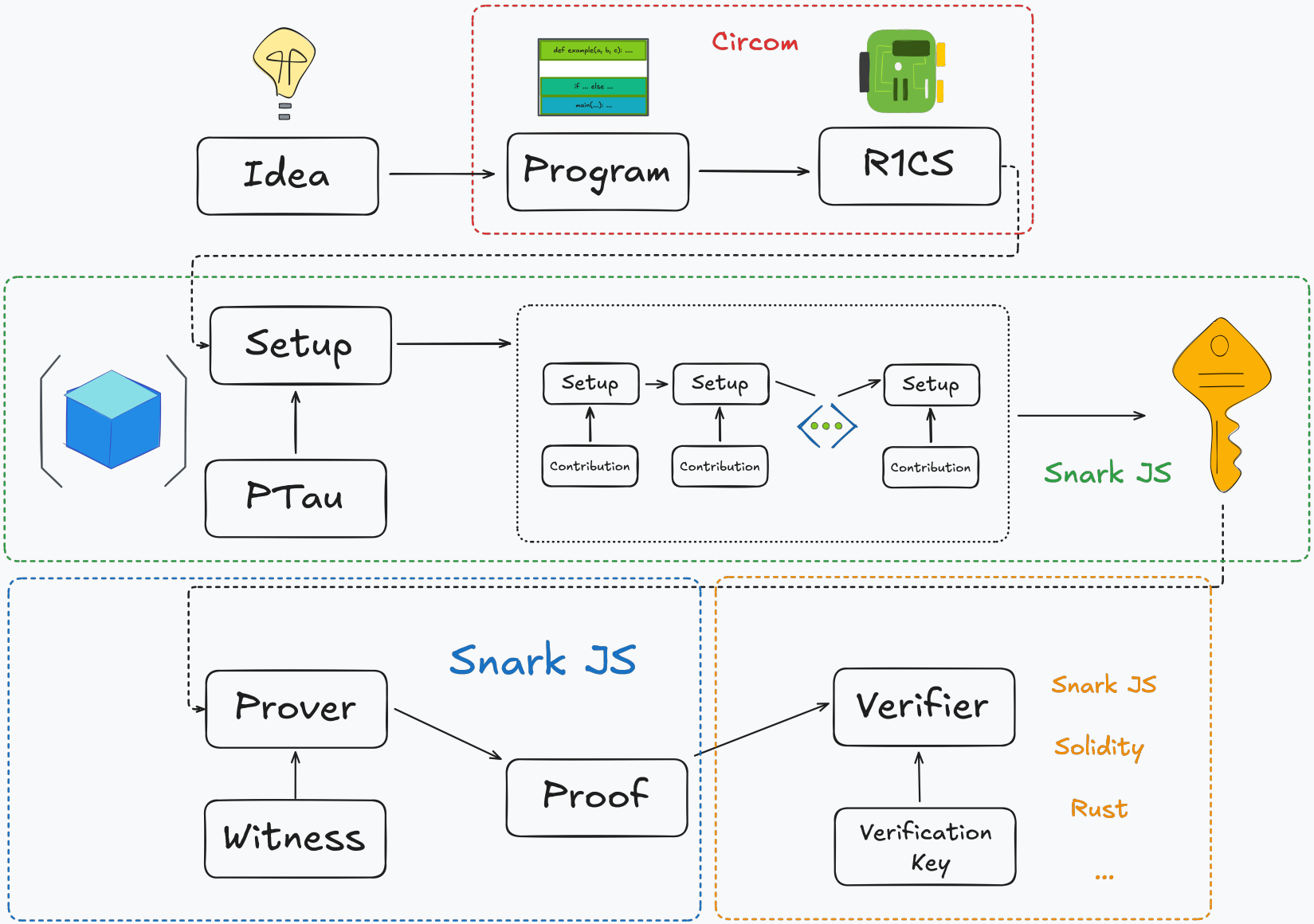
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Verifier
Verification Key
Snark JS
Solidity
Rust
...

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It looks good, as long as all I need is to look at it.

Trusted Setup:

$\tau, \alpha, \beta_L, \beta_R, \beta_O, \gamma \xleftarrow{R} \mathbb{F}$, $\{\{g^{\tau^i}, g^{\alpha\tau^i}\}_{i\in[d]}$, $\{g^{\beta_L L_i(\tau)}, g^{\beta_R R_i(\tau)}, g^{\beta_O O_i(\tau)}\}_{i\in[n]}\}$,
$\{g^{Z(\tau)}, g^{\alpha}, g^{\beta_L}, g^{\beta_R}, g^{\beta_O}, g^{\beta_L\gamma}, g^{\beta_R\gamma}, g^{\beta_O\gamma}, g^{\gamma}\}$, **delete**$(\tau, \alpha, \beta_L, \beta_R, \beta_O, \gamma)$.

✓ $H(x) = \frac{L(x)\times R(x) - O(x)}{Z(x)}$.

✓ Sample $\delta_L, \delta_R, \delta_O \xleftarrow{R} \mathbb{F}$, compute:

$$\pi_L \leftarrow g^{L(\tau)}(g^{Z(\tau)})^{\delta_L}, \pi'_L \leftarrow g^{\alpha L(\tau)}(g^{\alpha Z(\tau)})^{\delta_L},$$
$$\pi_R \leftarrow g^{R(\tau)}(g^{Z(\tau)})^{\delta_R}, \pi'_R \leftarrow g^{\alpha R(\tau)}(g^{\alpha Z(\tau)})^{\delta_R},$$
$$\pi_O \leftarrow g^{O(\tau)}(g^{Z(\tau)})^{\delta_O}, \pi'_O \leftarrow g^{\alpha O(\tau)}(g^{\alpha Z(\tau)})^{\delta_O},$$
$$\pi_H \leftarrow g^{H(\tau)}(g^{\delta_O})(g^{R(\tau)})^{\delta_L}(g^{L(\tau)})^{\delta_R}(g^{Z(\tau)})^{\delta_L\delta_R}$$
$$\pi_\beta = \dots$$

✓ $e(\pi_L, \pi_R) \stackrel{?}{=} e(\mathsf{com}(Z), \pi_H) \cdot e(\pi_O, g)$.

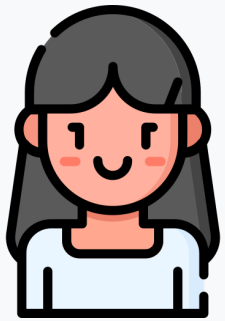
✓ Proof of Exponent:

$$e(\pi_L, g^\alpha) = e(\pi'_L, g),$$
$$e(\pi_R, g^\alpha) = e(\pi'_R, g),$$
$$e(\pi_O, g^\alpha) = e(\pi'_O, g),$$
$$e(\pi_H, g^\alpha) = e(\pi'_H, g).$$

✓ $e(\pi_L, g^{\gamma\beta_L}) \cdot e(\pi_R, g^{\gamma\beta_R}) \cdot \cdot e(\pi_O, g^{\gamma\beta_O}) = e(\pi_\beta, g^\gamma)$

Prover $\mathcal{P}$

$\boldsymbol{\pi} = (\pi_L, \pi_R, \pi_O, \pi_H, \pi'_L, \pi'_R, \pi'_O, \pi'_H, \pi_\beta)$



Verifier $\mathcal{V}$

Something we can touch.

```
pragma circom 2.1.6;

template Math() {
    signal output res;

    signal input a;
    signal input b;
    signal input c;

    a * (1 - a) === 0;

    signal mul1 <== a * b;
    signal mul2 <== a * c;
    signal res1 <== mul1 * mul2;

    signal res2 <== (1 - a) * (b + c);

    res1 + res2 ==> res;
}
```

Practice

Thank you for your attention

zkdl-camp.github.io

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