Lesson 14

Today's Topics

- Privacy on Solana
- Anchor design examples
- Versioned transactions
- Solidity and other languages

Privacy on Solana

See this overview

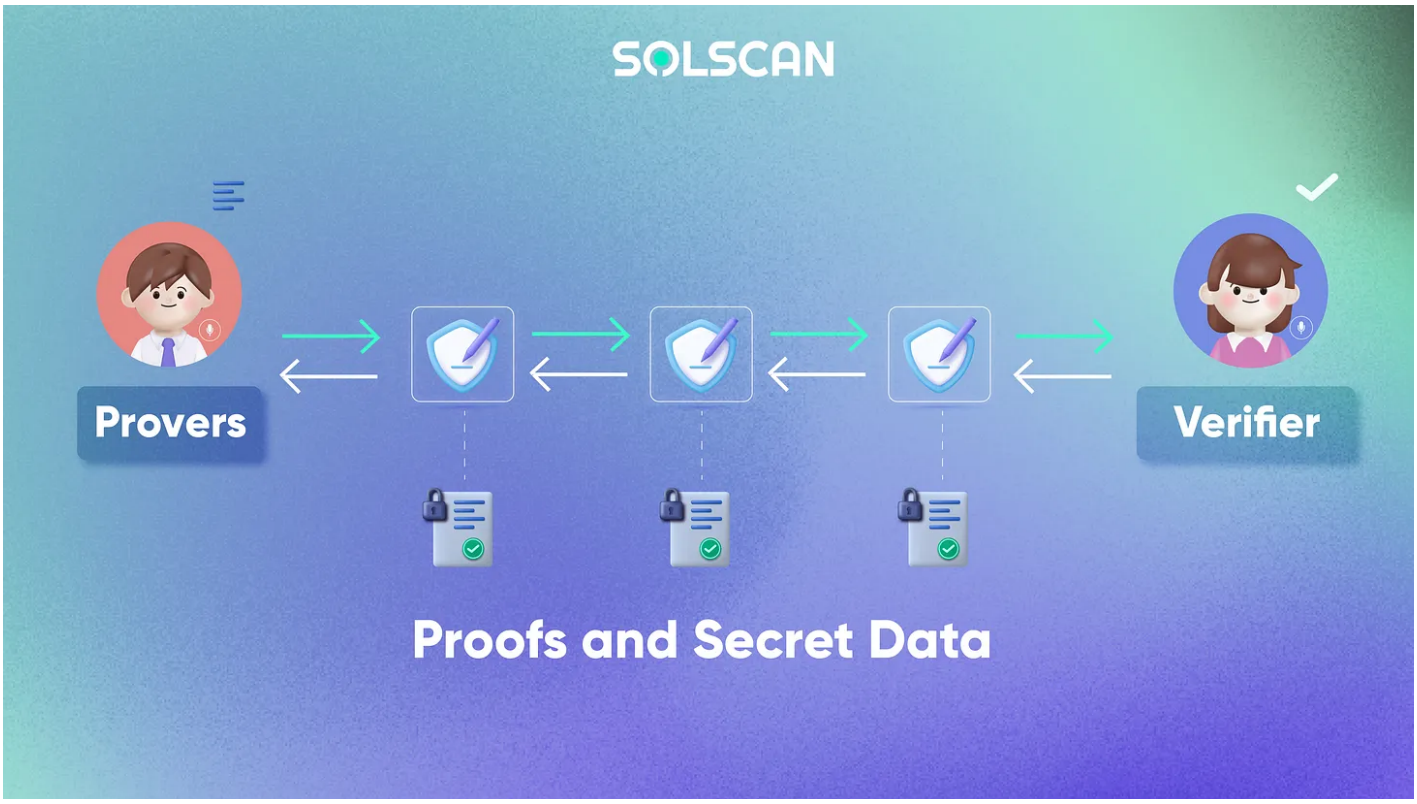
Nullifiers

This is a general pattern used in cryptography, where we wish to show that an event has happened or that a resource has been consumed. It for example allows us to prevent double spends in confidential tokens such as ZCash.
The general pattern is

- You have some means of identifying a resource, for example by taking a hash
- When that resource is consumed, you create a nullifier from the hash. This is stored as part of the application state and indicates that the resource has been consumer.
- The hiding properties of a hash function allow some confidentiality in the process.

An example of this is in this project

Zero Knowledge Proofs



See our introduction to ZKPs

ZKP technology is used to take advantage of 2 of its features

- Privacy
- Proof of computation

ZKPs and Solana

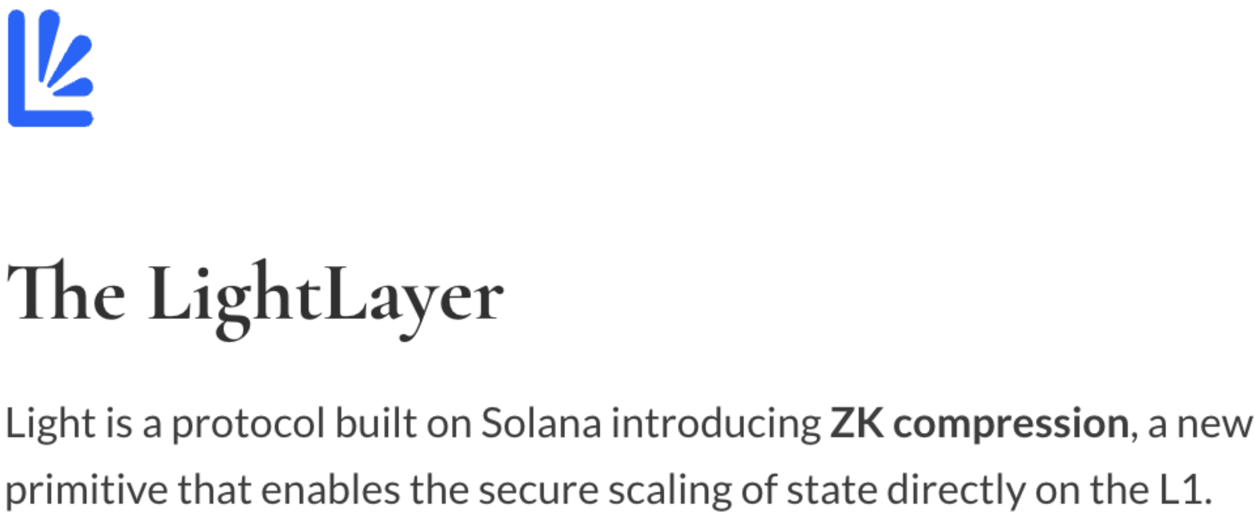
From overview
"Utilizing zero-knowledge proof in the same way that zk-rollups are moving towards is not ideal for Solana, due to the extra computational requirements added to the monolithic chain.
Solana’s design, first and foremost, is to squeeze out the power of hardware to provide the performance required. Implementing ZKP for privacy, however, is an endeavour worth taking."

Light Protocol and Private Solana Programs

Light protocol is designed to enhance developers' ability to create private Solana programs, known as PSPs. These programs operate similarly to standard Solana programs but with the addition of private state transitions alongside the public ones. Currently available on Solana's DevNet, PSPs are expected to significantly influence sectors like DeFi and gaming by enabling private trade execution and on-chain gaming mechanics such as fog of war or hidden information in card games, without relying on off-chain servers.

Light Protocol

See Docs



The LightLayer

Light is a protocol built on Solana introducing **ZK compression**, a new primitive that enables the secure scaling of state directly on the L1.

Compressed State

Solana users and program developers can opt-in to compress their on-chain state via the LightLayer smart contracts. This reduces state cost by orders of magnitude while preserving the security, performance, and composability of the Solana L1.
All state that is compressed via the LightLayer natively enables efficient computation via ZKPs.

If you can describe or translate your computation into a groth16 circuit, you can run that computation over all Solana L1 state that was compressed via the LightLayer.

Elusiv

Elusiv is being sunsetted, see announcement

Incognito <> Solana Bridge

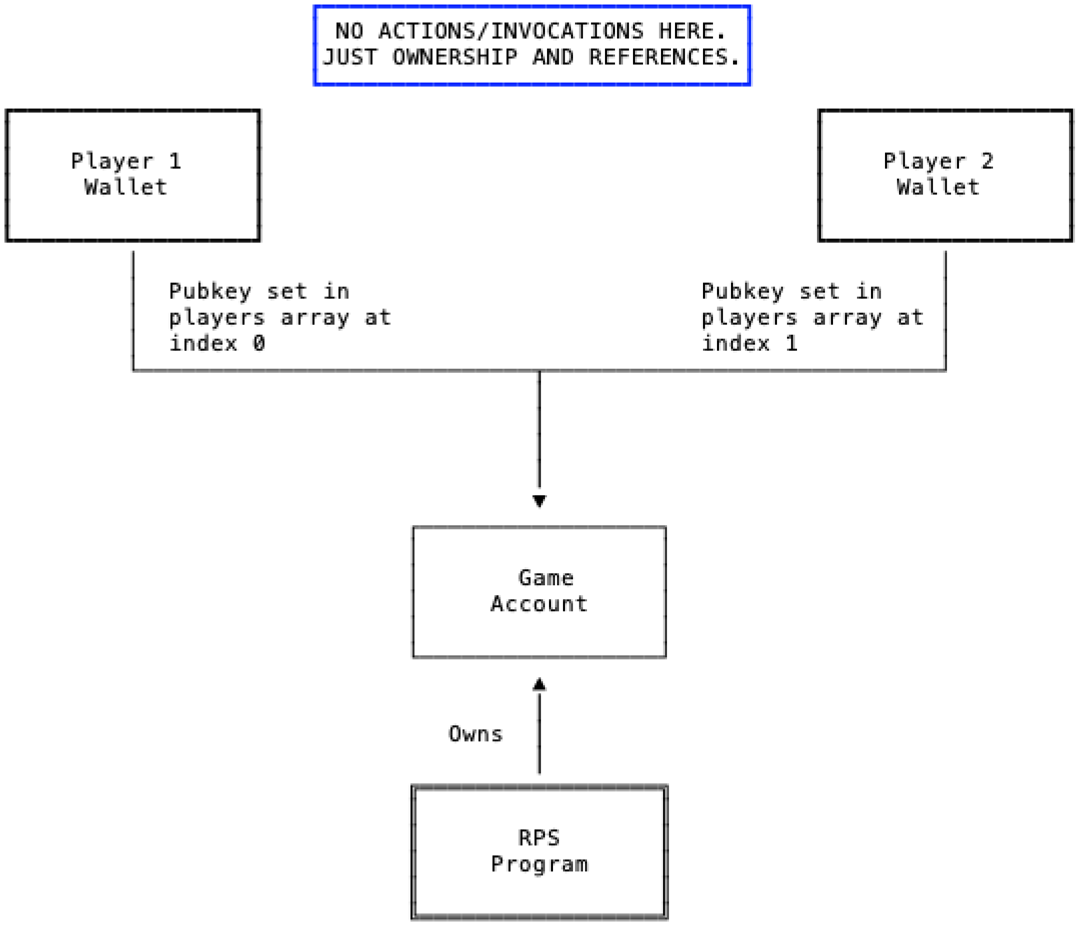
> See Repo
> Attempt to bring shielded assets to Solana
>
> Article from HOPR mixnet about privacy concerns on Solana.

Anchor examples

Rock Paper Scissors example

Program that implements rock-paper-scissors game.

Account diagram:


NO ACTIONS/INVOCATIONS HERE.
JUST OWNERSHIP AND REFERENCES.
Player 1 Wallet
Player 2 Wallet
Pubkey set in players array at index 0
Pubkey set in players array at index 1
Game Account
Owns
RPS Program

Flow:

1. Create game account: `new_game`

```
#[account]
pub struct Game {
    players: [Pubkey; 2],
    hashed_hand: [[u8; 32]; 2],
    hash_submitted: [bool; 2],
    hand: [Hand; 2],
    hand_submitted: [bool; 2],
    winner: String,
}
```

This account will store the state necessary for a single game such as:

- players public keys (array)

>   - hashes of hands (array)
>   - hands with salt (array)
>   - hands enum (array)
>   - flag for providing hash (array)
>   - winner
>
> **2. Player *X* submits hash containing their upcoming hand**
> **3. Player *Y* submits hash containing their upcoming hand**
> **4. Player *X* submits string containing their hand and the salt**
> **5. Player *Y* submits string containing their hand and the salt**
>
> There is no required order for who submits hash first, but hands/salt strings can't be submitted until both hashes have been provided.

Versioned Transactions

See Proposal

Because of restrictions on the size of messages passed around the network, typically we cannot include more than 35 accounts or equivalent in a single transaction.

A Proposed solution is to

1. Allow address look up tables
2. Add a new transaction format to handle these.

After addresses are stored on-chain in an address lookup table account, they may be succinctly referenced in a transaction using a 1-byte u8 index rather than a full 32-byte address. This will require a new transaction format to make use of these succinct references as well as runtime handling for looking up and loading addresses from the on-chain lookup tables.

Address lookup tables must be rent-exempt when initialized and after each time new addresses are appended. Lookup tables can either be extended from an on-chain buffered list of addresses or directly by appending addresses through instruction data.

Once an address lookup table is no longer needed, it can be deactivated and closed to have its rent balance reclaimed.

Versioned Transactions

In order to support address table lookups, the structure of serialized transactions must be modified. The new transaction format should not affect transaction processing in the Solana program runtime, invoked programs will be unaware of which transaction format was used.

The message header encodes `num_required_signatures` as a `u8`. Since the upper bit of the `u8` will never be set for a valid transaction, we can enable it to denote whether a transaction should be decoded with the versioned format or not.

Limitations

- Max of 256 unique accounts may be loaded by a transaction because `u8` is used by compiled instructions to index into transaction message `account_keys`.
- Address lookup tables can hold up to 256 entries because lookup table indexes are also `u8`.
- Transaction signers may not be loaded through an address lookup table, the full address of each signer must be serialized in the transaction. This ensures that the performance of transaction signature checks is not affected.
- Hardware wallets will not be able to display details about accounts referenced through address lookup tables due to inability to verify on-chain data.
- Only single level address lookup tables can be used. Recursive lookups will not be supported.

Solidity On Solana

See Solang Article

Hyperledger have introduced a Solidity compiler for Solana
It features

- Support for Solana programs such as SPL
- Anchor Development
- Support for Accounts and PDAs
- Compatibility with Solidity 0.8

Compiling a language is relativelt srtaight forward, what is more difficult is integrating the Solana account model into Solidity.
This is mainly done via adding annotations to existing Solidity code.

Example Code

```
@program_id("F1ipperKF9EfD821ZbbYjS319LXYiBmjhzkkf5a26rC")
contract starter {
    bool private value = true;

    @payer(payer)
    constructor(address payer) {
        print("Hello, World!");
    }

    /// A message that can be called on instantiated contracts.
    /// This one flips the value of the stored `bool` from `true`
    /// to `false` and vice versa.
    function flip() public {
            value = !value;
    }

    /// Simply returns the current value of our `bool`.
    function get() public view returns (bool) {
            return value;
    }
}
```

Important differences

1. The `@program_id` annotation:
   The `@program_id` annotation is used to specify the on-chain address of the program.

```
@program_id("F1ipperKF9EfD821ZbbYjS319LXYiBmjhzkkf5a26rC") // on-chain program address
```

2. The `@payer` annotation:

   When storing data on-chain, a certain amount of SOL needs to be allocated to cover the storage costs. The `@payer` annotation specifies the user that will pay the SOL required to create the account for storing the state variable.

```
@payer(payer) // payer for the "data account"
constructor(address payer) {
    print("Hello, World!");
}
```

Storing data

- EVM smart contracts can directly store state variables.
- Solana on-chain programs, on the other hand, create separate accounts to hold state data. These are often referred to as "data accounts" and are "owned" by a program.

Installation

The first part of the installation is the same as installing Anchor, but I will detail the steps here anyway.
Requirements
- Rust
- Node.js
- WSL for Windows users

1. Install the Solana Tool Suite
   `sh -c "$(curl -sSfL https://release.solana.com/v1.17.14/install)"`
   or
   `cmd /c "curl https://release.solana.com/v1.17.14/solana-install-init-x86_64-pc-windows-msvc.exe --output C:\solana-install-tmp\solana-install-init.exe --create-dirs"` on Windows
2. Install Anchor with
   `cargo install --git https://github.com/coral-xyz/anchor anchor-cli --locked --force`

Creating a new project

```
anchor init project_name --solidity
```

The example solidity code you get is

```

@program_id("F1ipperKF9EfD821ZbbYjS319LXYiBmjhzkkf5a26rC")
contract my_prog {
    bool private value = true;

    @payer(payer)
    constructor(address payer) {
        print("Hello, World!");
    }

    /// A message that can be called on instantiated contracts.
    /// This one flips the value of the stored `bool` from `true`
    /// to `false` and vice versa.
    function flip() public {
            value = !value;
    }

    /// Simply returns the current value of our `bool`.
    function get() public view returns (bool) {
            return value;
    }
}
```

More insight is gained by looking at typescript code used to test this

```
import * as anchor from "@coral-xyz/anchor";
import { Program } from "@coral-xyz/anchor";
import { my_prog } from "../target/types/my_prog";

describe("my_prog", () => {

// Configure the client to use the local cluster.
const provider = anchor.AnchorProvider.env();
anchor.setProvider(provider);

const dataAccount = anchor.web3.Keypair.generate();
const wallet = provider.wallet;
const program = anchor.workspace.my_prog as Program<my_prog>;

it("Is initialized!", async () => {

// Add your test here.

const tx = await program.methods.new(wallet.publicKey)
.accounts({ dataAccount: dataAccount.publicKey })
.signers([dataAccount]).rpc();

console.log("Your transaction signature", tx);

const val1 = await program.methods.get()
.accounts({ dataAccount: dataAccount.publicKey })
.view();



console.log("state", val1);
await program.methods.flip()
.accounts({ dataAccount: dataAccount.publicKey })
.rpc();



const val2 = await program.methods.get()
.accounts({ dataAccount: dataAccount.publicKey })
.view();

console.log("state", val2); });

});
```

Example Token Creation

```

import "../libraries/spl_token.sol";
import "../libraries/mpl_metadata.sol";

@program_id("8eZPhSaXfHqbcrfskVThtCG68kq8MfVHqmtm6wYf4TLb")
contract create_token {

    // Creating a dataAccount is required by Solang
    // The account is unused in this example
    @payer(payer) // payer account
    constructor() {}

    function createTokenMint(
        address payer, // payer account
        address mint, // mint account to be created
        address mintAuthority, // mint authority for the mint account
        address freezeAuthority, // freeze authority for the mint account
        address metadata, // metadata account to be created
        uint8 decimals, // decimals for the mint account
        string name, // name for the metadata account
        string symbol, // symbol for the metadata account
        string uri // uri for the metadata account
    ) public {
        // Invoke System Program to create a new account for the mint account
and,
        // Invoke Token Program to initialize the mint account
        // Set mint authority, freeze authority, and decimals for the mint
account
        SplToken.create_mint(
            payer,            // payer account
            mint,            // mint account
            mintAuthority,   // mint authority
            freezeAuthority, // freeze authority
            decimals         // decimals
        );
```

> ```
>         // Invoke Metadata Program to create a new account for the metadata account
>         MplMetadata.create_metadata_account(
>             metadata, // metadata account
>             mint,  // mint account
>             mintAuthority, // mint authority
>             payer, // payer
>             payer, // update authority (of the metadata account)
>             name, // name
>             symbol, // symbol
>             uri // uri (off-chain metadata json)
>         );
>     }
> }
> ```
>
> The token library is here

Other Languages

Seahorse

Docs

Seahorse lets you write Solana programs in Python. It is a community-led project built on Anchor.

Install with

```
cargo install seahorse-lang
```

It is also available in the Solana playground.