Decentralized Timeline

Large Scale Distributed Systems
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Requirements

Problem description and
project “Rules”

Requirements

Goal: Decentralized timeline service.

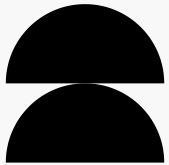
Each user:

a. Has an identity;

b. Publishes and deletes small text messages in their local machine;

c. Subscribes other user's timelines and accesses their messages;

d. Helps to store and forward subscribed users' timelines.



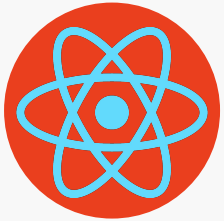
02 Technology

Frameworks and Packages

Technology used

Gun

Decentralized graph database

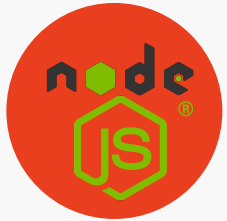


React

JavaScript library for building user interfaces

WebRTC

Real-time communication for the web

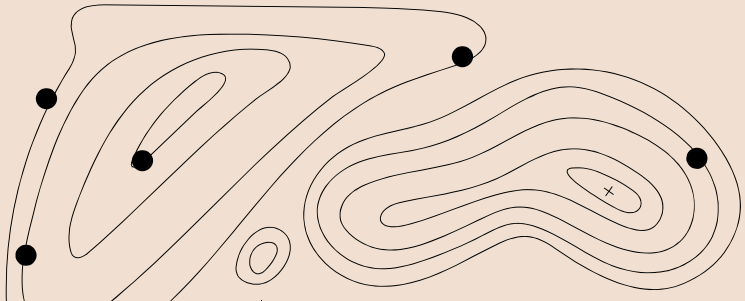


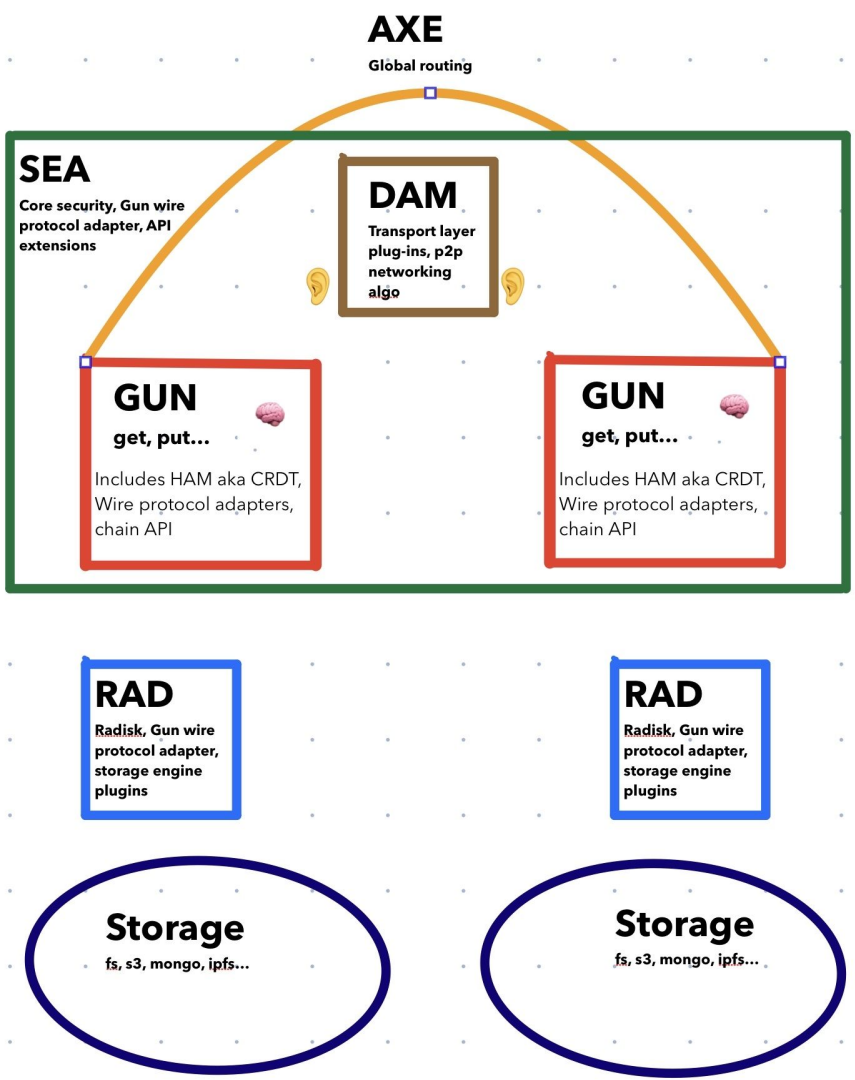
Node.js

Open source server environment

GUN 03

How Gun works and Graph Structure

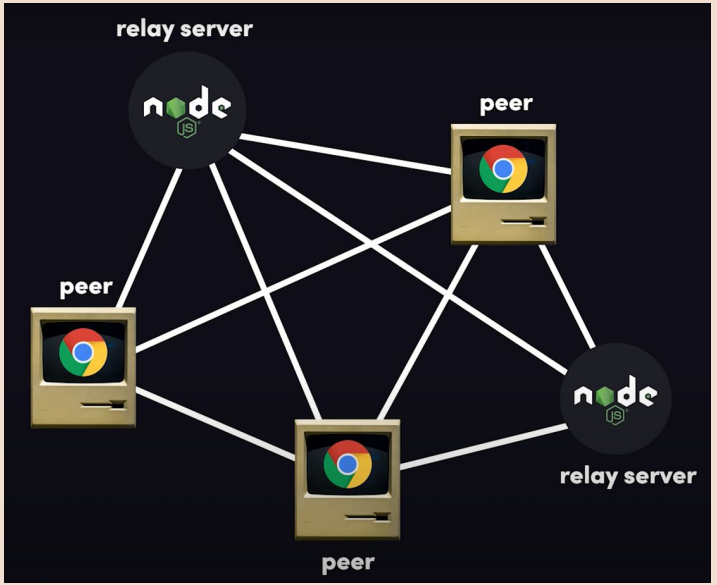




Gun Ecosystem

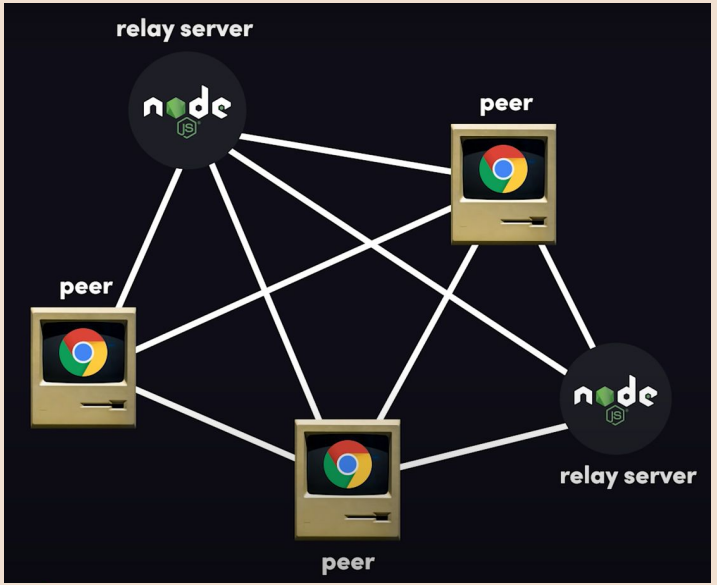
Gun

- **Decentralized graph** database.
- Data is distributed across **multiple peers** (or users) through WebRTC.
- Each peer stores the data it needs in the browser's **local storage.**



Gun

- And then **sync changes** with the other peers in the network.
- A peer can be a **user** or a **relay server** that makes the system more reliable.
- A relay server allows **persistent storage** and makes the network **more robust.**

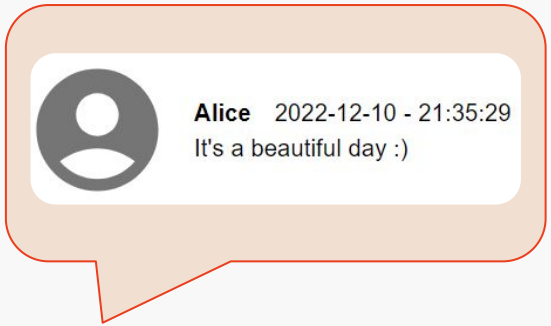


Gun - Graph Structure

Node

Each node can reference another node allowing circular dependencies.

The “Data” field in this project consists in the **followed** users and the posts **timeline** of each user.



A post consists in a **message**, a **date** and an **author.**

Gun - Database

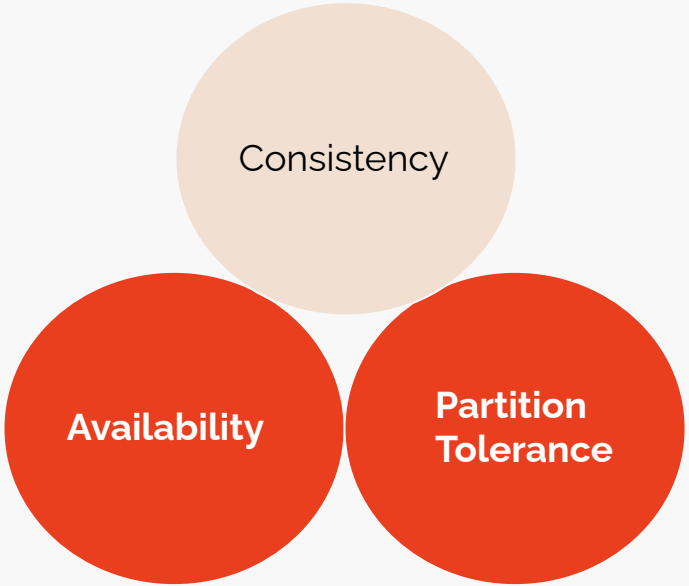
Users

User -> publicKey

```
Timeline: {
        key1: post1
        key2: post2
            ...
}
```

```
Follows: {
        userName1: publicKey1
        userName2: publicKey2
            ...
}
```

Gun - CAP Theorem

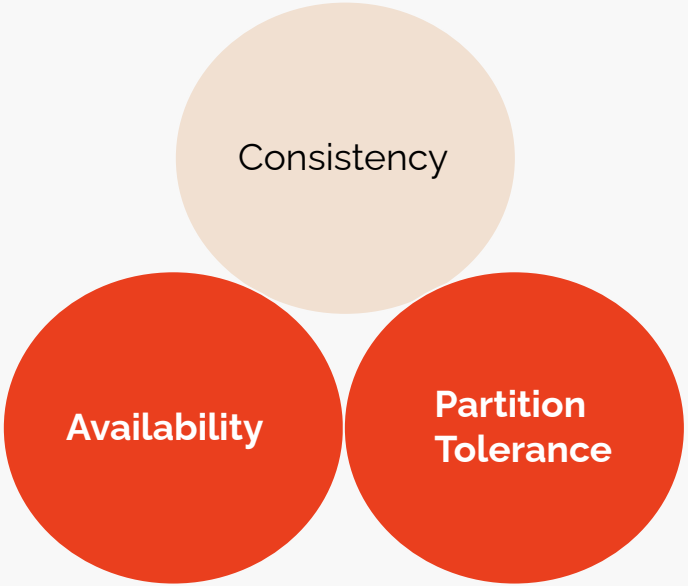


Users can find a **replica of data** even in case of partial node failures.

Peers can successfully **read and write** data even if other peers are **offline**.

GUN is **AP** with eventual consistency.

Gun - CAP Theorem



Regarding consistency, GUN opts for **eventual consistency** instead of strong consistency.

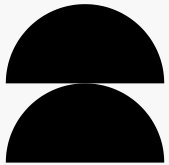
When connectivity becomes available again, GUN will synchronize data at **low latency** using at least once delivery to guarantee that all peers will deterministically **converge to the same data within a time frame**, without any extra coordination or gossip.

GUN is **AP** with eventual consistency.

Gun - CRDT

- The **conflict resolution algorithm** is at the center of everything gun does: it's how peers eventually arrive at the same state, and how offline edits are merged.
- Because graphs only contain nodes, and nodes only contain key-value pairs our goal is to merge **key-value pairs**.
- Choosing which key-value to keep requires an extra bit of metadata, called **state**.
- State is used to determine ordering of updates, and is always relative to the machine which receives it.

```
{
    "name": {
        "value": "Alice",
        "state": 10
    }
}
```



```
{
    "name": {
        "value": "Allison",
        "state": 8
    }
}
```

Gun - CRDT

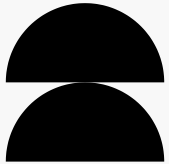
And if we get an update with the **same state** as us, but with a conflicting value?

```
{
    "name": {
        "value": "Alice",
        "state": 10
    }
}
```

```
{
    "name": {
        "value": "Allison",
        "state": 10
    }
}
```

This conflict is resolved by comparing their **string** values with JSON.stringify, choosing the **greater** of the two.

Lexical sort is only used if there is a conflict on the exact **same value** at the exact **same time**.



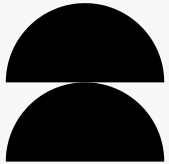
Gun - CRDT

How do we prevent a devious user from submitting an update with a state of 10 zillion?

```
{
    "name": {
        "value": "Alice",
        "state": 10
    }
}
```

```
{
    "name": {
        "value": "Allison",
        "state": 10000…
    }
}
```

- The solution is to simply wait until your machine reaches the state of 10 zillion before acknowledging the update.
- If an update isn't acknowledged, it never escapes volatile memory onto disk.



Gun - DAM

DAM is Gun's default **transport layer** abstraction and **P2P networking** algorithm.

How it works:

-> GET requests out to all peers it is connected

-> each peer receives that request, checks the message ID and deduplicates against it (if it has seen it before, it ignores it)

-> if it hasn't seen it before:

- it rebroadcasts out the message to all of its peers
- processes the message by seeing if it has the requested data that it can ACK back

DAM also adds the IP/url/ID of the peers the current peer is connected to to each message

Functionalities

Authentication, Posting and Following

04

Authentication

Regarding the authentication, we need to instantiate ***Gun*** and then reference ***user()***

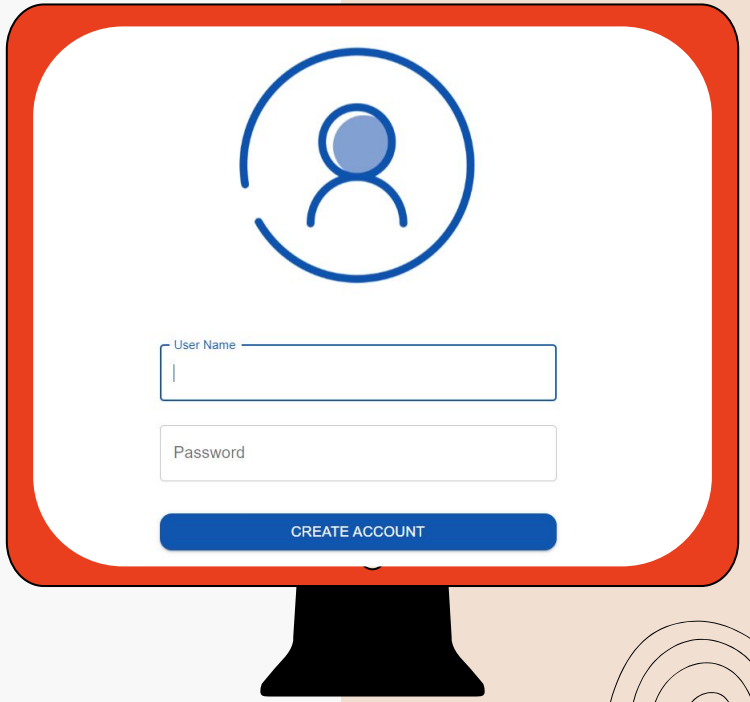
```
const gun = Gun();
const user = gun.user().recall({ sessionStorage: true });
```

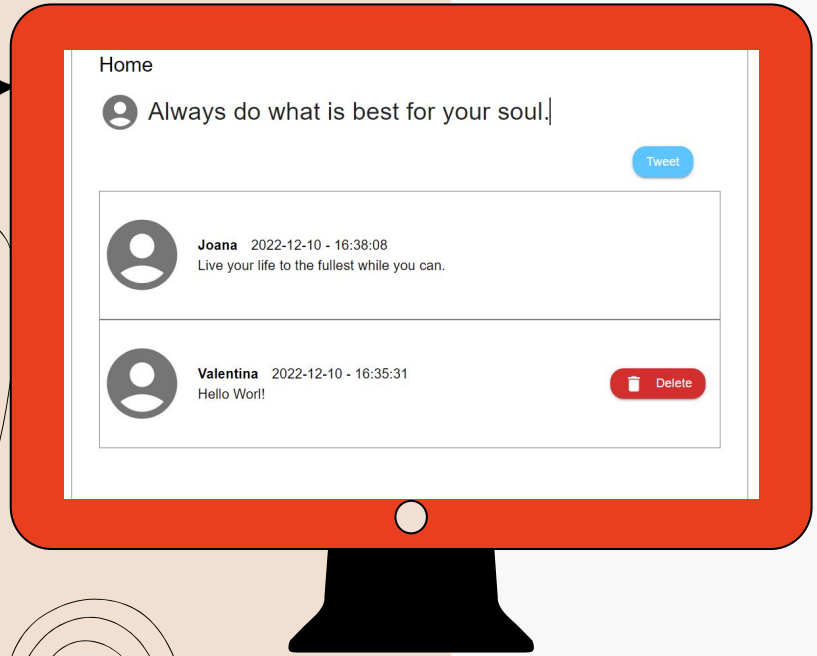
Create Account

When you create a new user, a cryptographic secure key pair is generated

The **username** is associated with the **public key**, so messages can be found

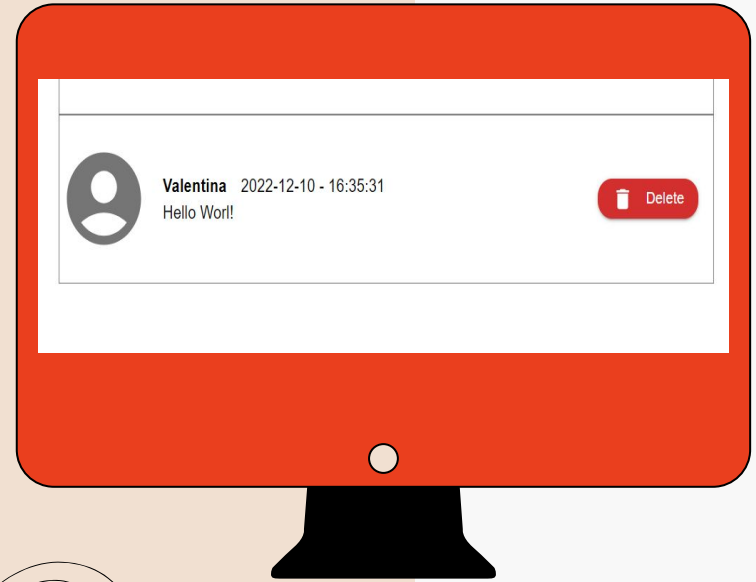
The **password** is a proof of work seed used to decrypt access to the account's **private key**





Post

When a user posts a message, the data is **saved** into gun and **synchronized** with the connected peers.

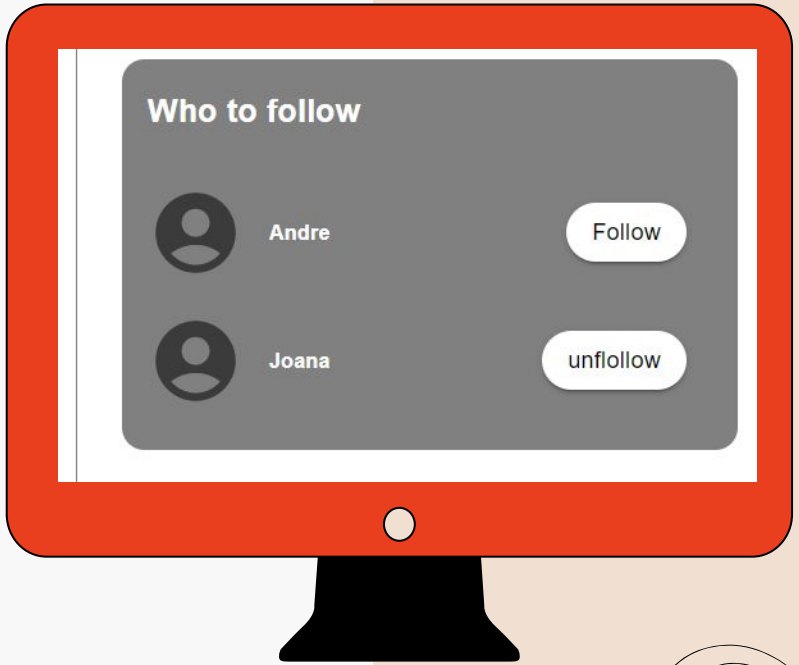


Delete Post

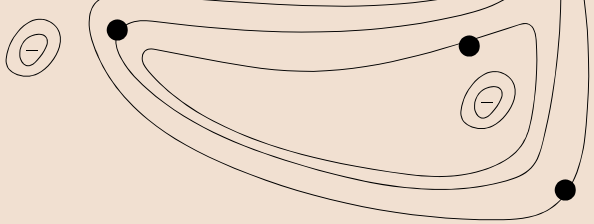
When a user deletes a post, the **reference** to the node's message becomes **null**.

Follow and Unfollow

Following an user, consists in adding a new entry (with **userName**) to the node's **Follows reference**.
To unfollow, that reference becomes **null**.

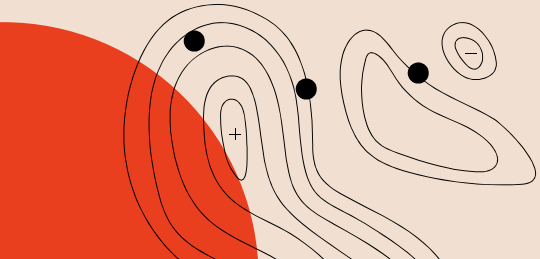
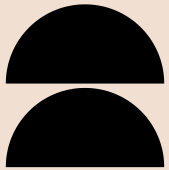
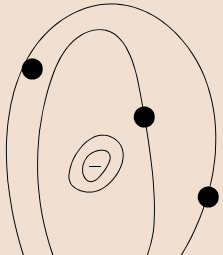






The messages from subscribed sources are **ephemeral** and only stored and forwarded for a given **time period**.

This is a consequence of the **browser's local storage** (up to 5MB) and GUN's work.

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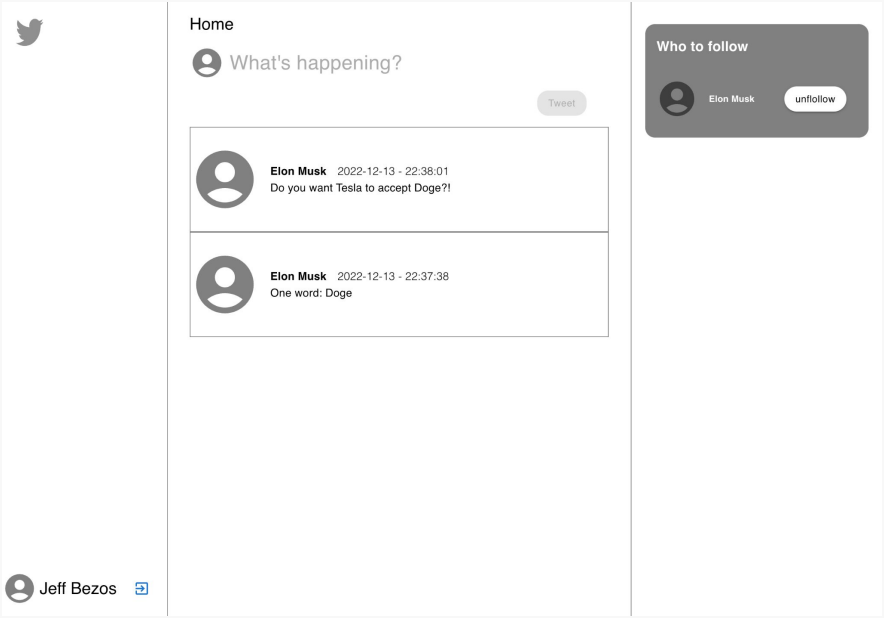
Demo

Project demonstration and interfaces

Demo



https://www.youtube.com/watch?v=vnDk2BjTk3Y

06

Limitations

Limitations and Future Work

Limitations and Future Work

- Avoid relay servers, and only use “normal” peers.
- Storage of posts and timelines in a persistent way (in the disc) in all the peers.
- Use SEA - Security, Encryption, & Authorization - API to encrypt data.

Thanks!

Do you have any questions?