Workspace

Local-first Collaborative Editing over NDN

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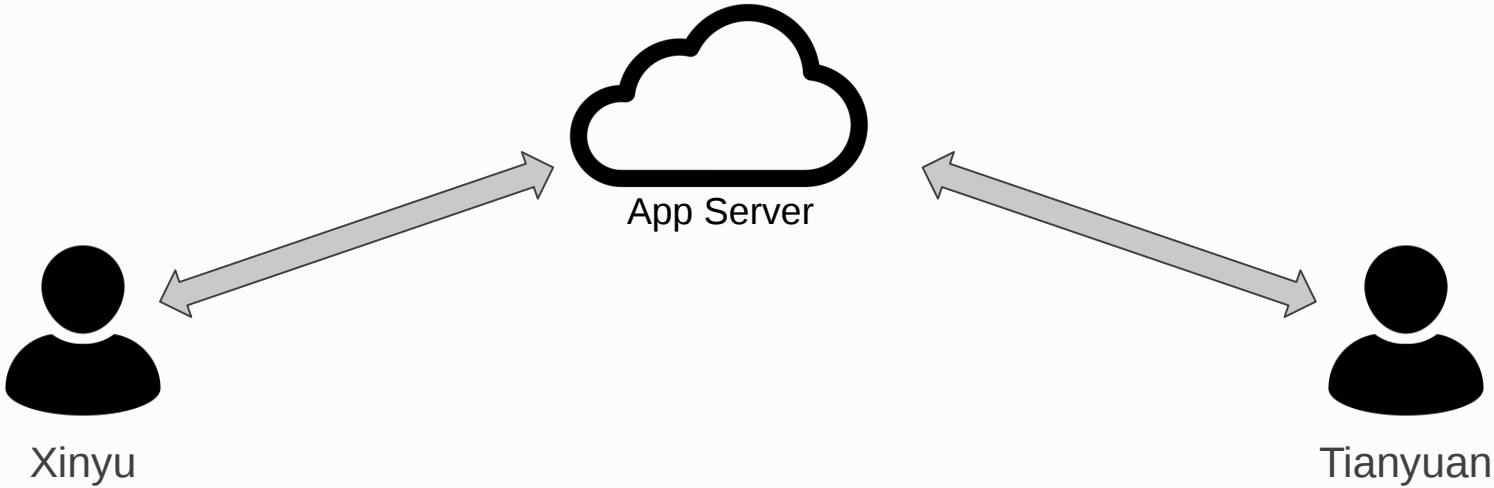
Local-First Software

- Presented by Martin at last DINRG meeting
- Local-first software provides
  - Availability when offline
  - Direct user communications
  - End-to-end security and encryption
- CRDT merges concurrently changes from peers
- Workspace is a local-first collaboration application
- This talk shares development experience and lessons learned

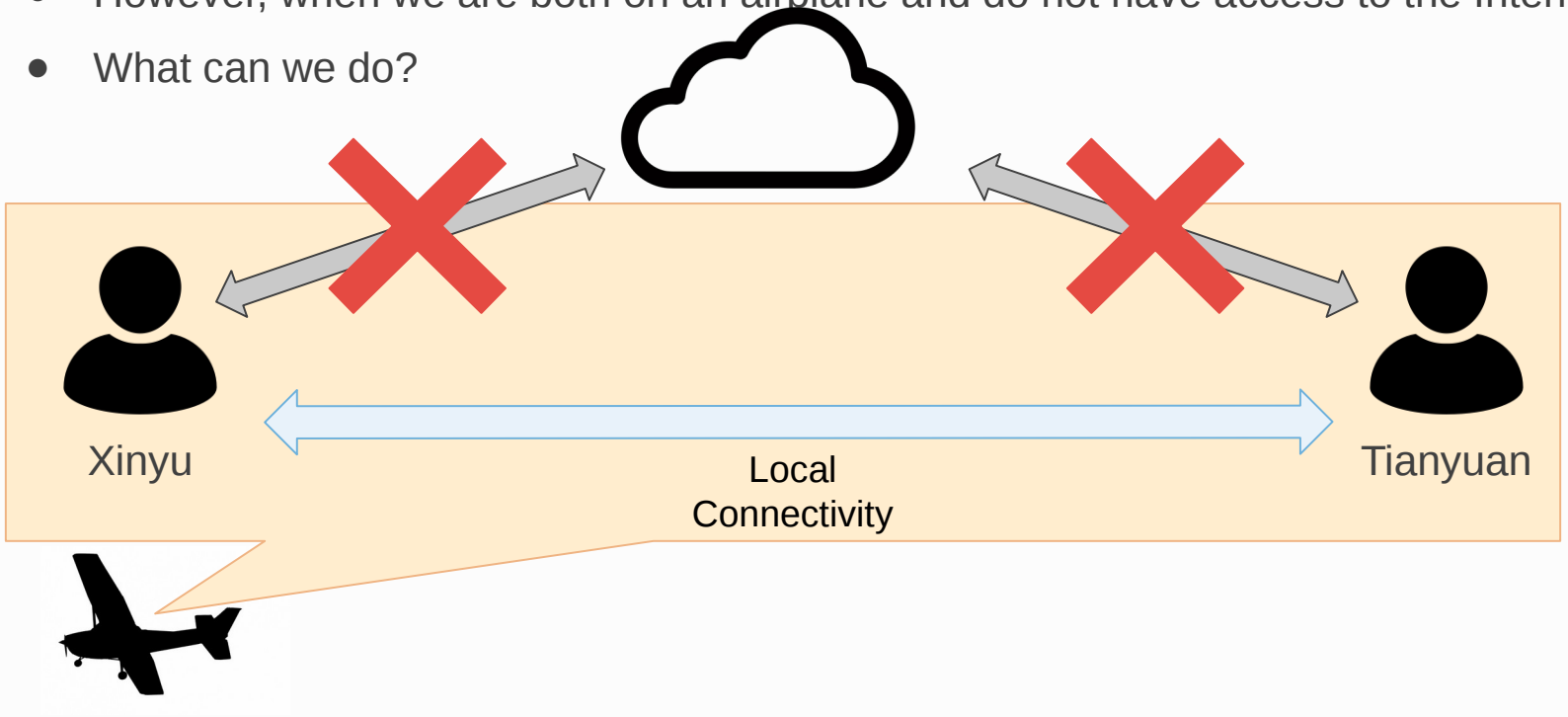
Scenario

- Suppose Tianyuan and Xinyu are writing a paper together
- We use collaborative apps to resolve conflicts



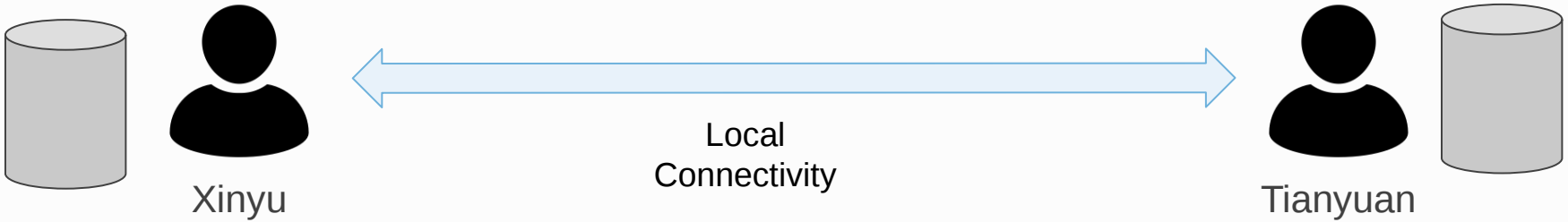
Scenario

- However, when we are both on an airplane and do not have access to the Internet
- What can we do?



Scenario

- However, when we are both on an airplane and do not have access to the Internet
- We need a new collaborative editing app that
  - Allows access data offline
  - Users directly exchange secured data



In an open environment, how can a device trust received data?

Direct user-to-user security

User Identity

- Requirements:
  - Unique: one identifier one user
  - Verifiable: verify ownership in the internet identification space
  - Semantic meaningful
    - Users need to know who they are talking to, beyond key hashes
- Semantic identifiers come from today’s Internet
  - Semantically identifying an entity: DNS name owner, organization, etc
  - Email addresses: xinyu.ma@cs.ucla.edu
  - Platform usernames: tianyuan129 in github.com

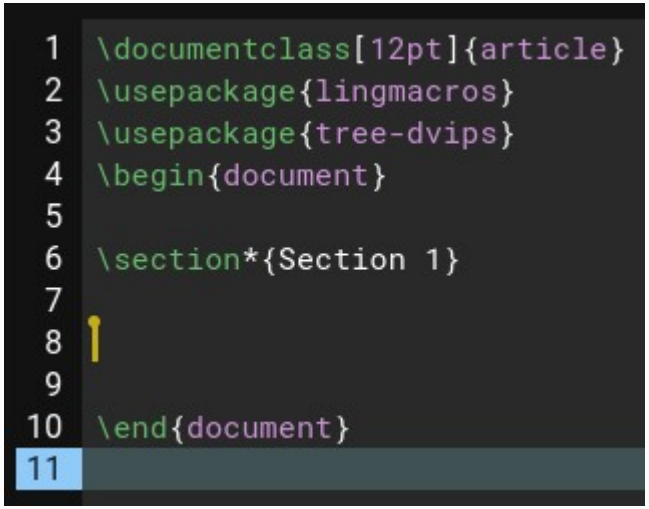
Direct User Data Security

- Identifiers cannot stand alone, need binding with key pairs
- The workspace owner authenticate users by identifiers
  - Then issues a certificate to the key-identifier binding
    - /workspace/xinyu.ma@cs.ucla.edu/KEY/v1
    - Signature: by /workspace/KEY/v1

How does the Workspace work?

Demonstrate *data-centric communication* by an example

Data Model: Event Sourcing



```
1  \documentclass[12pt]{article}
2  \usepackage{lingmacros}
3  \usepackage{tree-dvips}
4  \begin{document}
5
6  \section*{Section 1}
7
8
9
10 \end{document}
11
```

Change xinyu/1
Insert: “\docu…”
Author: Xinyu

Change tianyuan/1
Insert: “\sect…”
Author: Tianyuan

Change xinyu/2
Insert: “\end{...”
Author: Xinyu

- **Securely** tracking who did what
- **Sync**: when getting same set of changes => same version

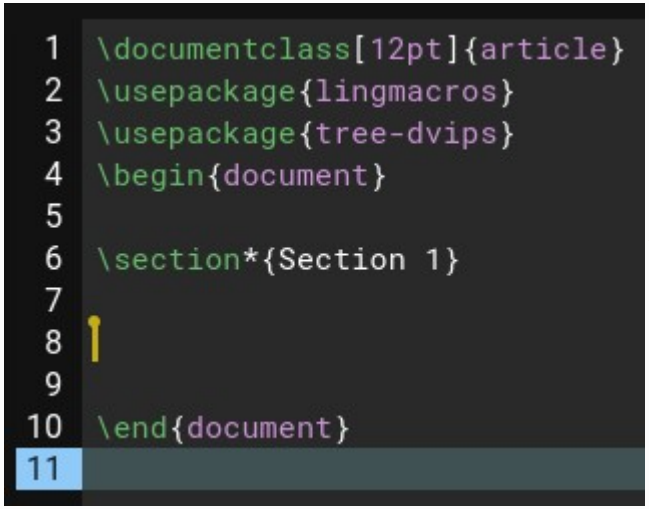
The Document

- Mutable
- Multiple authors
- Viewed in the frontend

Changes

- Immutable
- Single producer
- Persistent in storage
- Propagated in the network

Eventual Consistency: CRDT



The Document

CRDT

Change xinyu/1
Insert: “\docu…”
Author: Xinyu

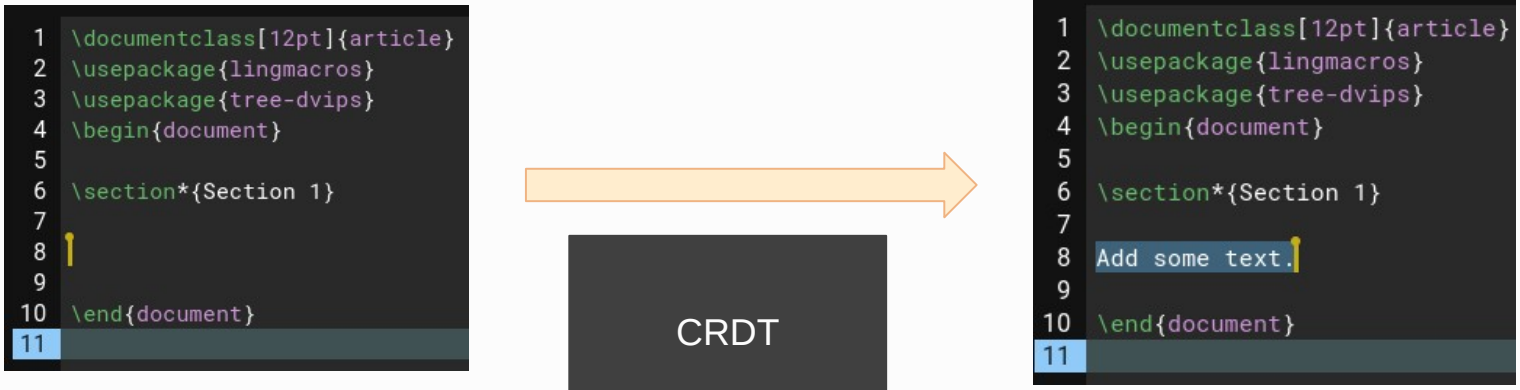
Change tianyuan/1
Insert: “\sect…”
Author: Tianyuan

Change xinyu/2
Insert: “\end{...”
Author: Xinyu

Changes

- **Sequentialize** changes to solve conflicts
- Mature algorithms and implementations

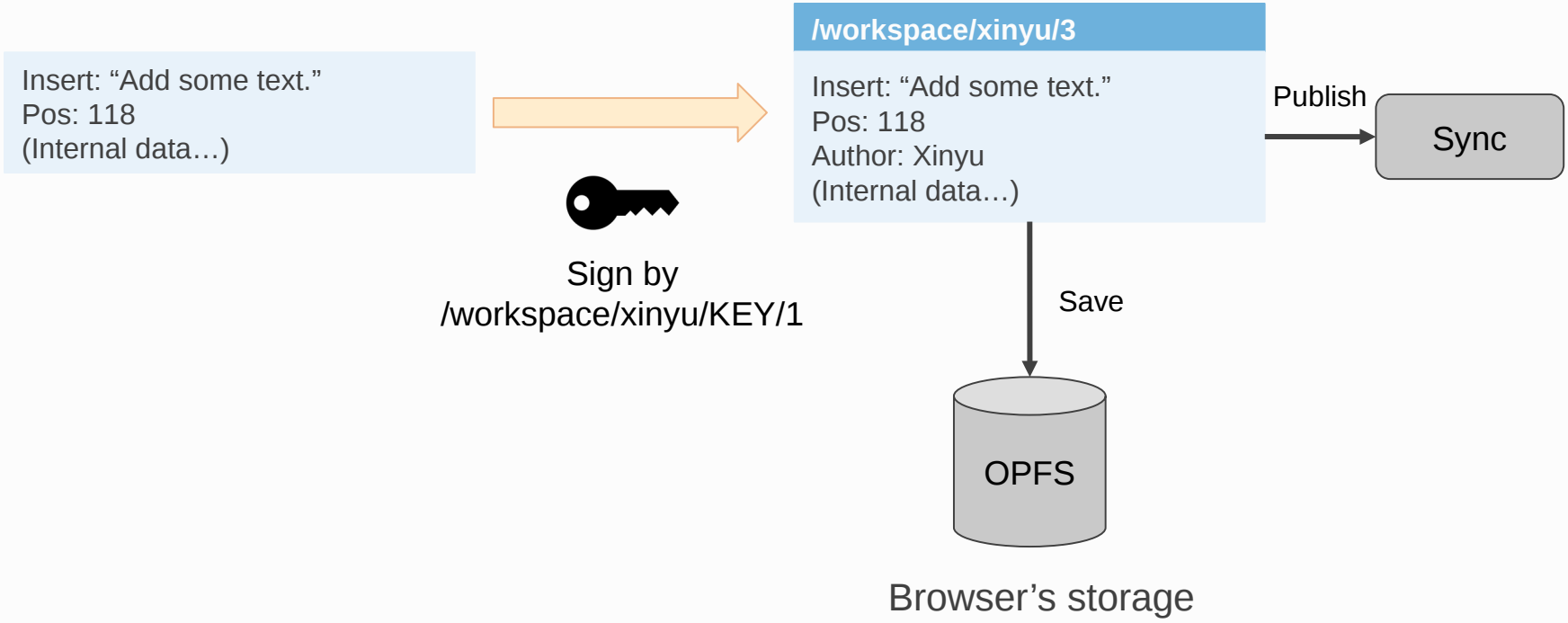
When I make a change …



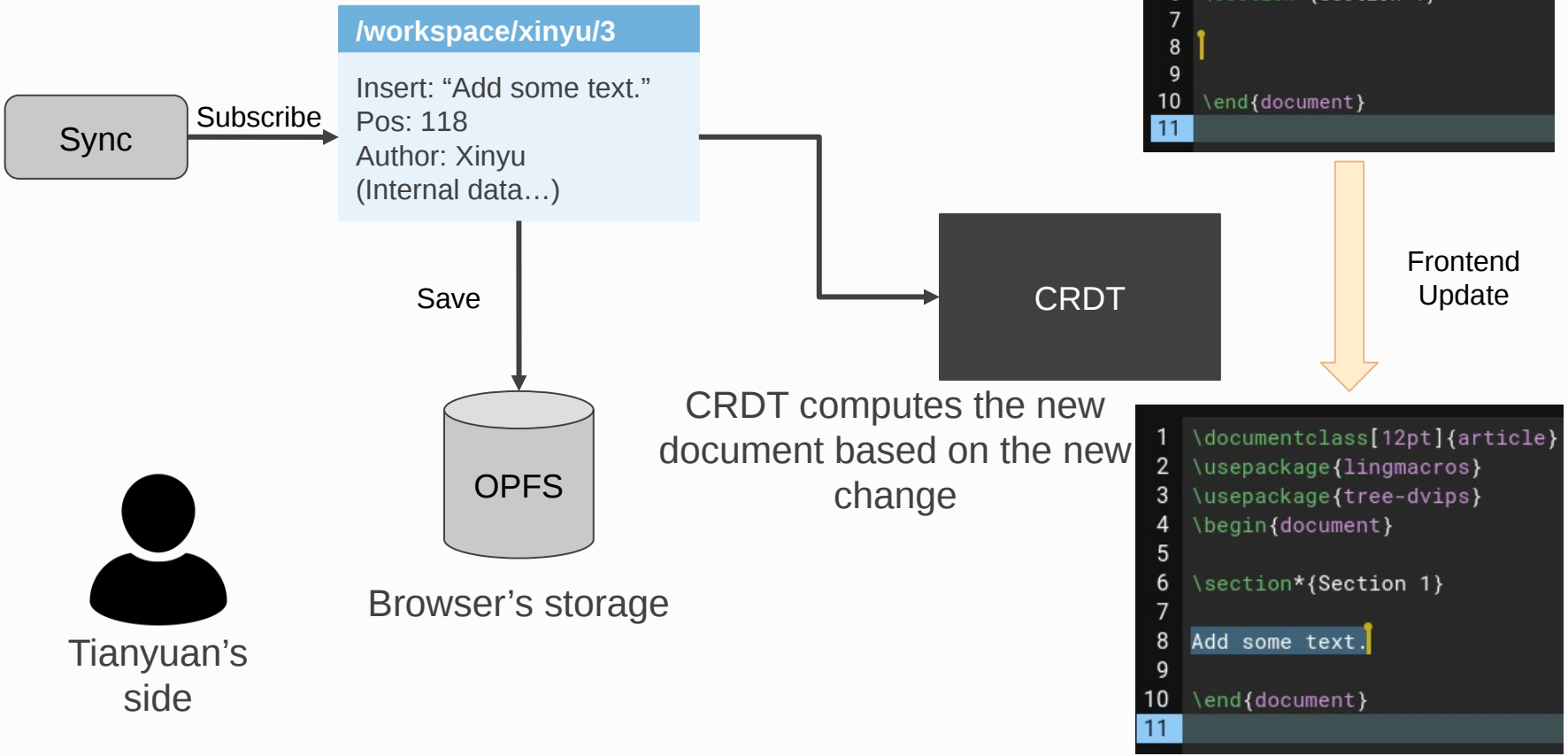
CRDT captures this edit and outputs a new **change**

Insert: “Add some text.”
Pos: 118
(Internal data…)

Exchanging **Semantically Named, Secured** Data



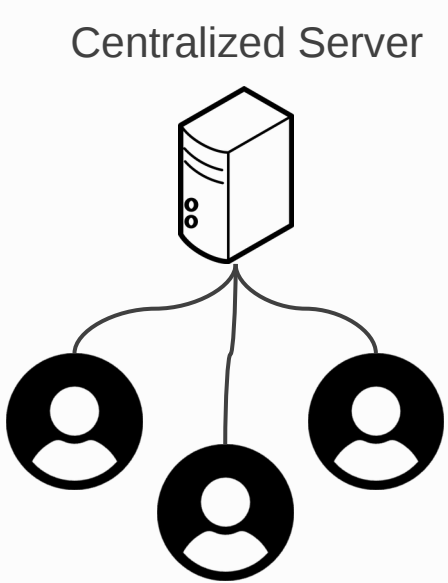
Apply the change

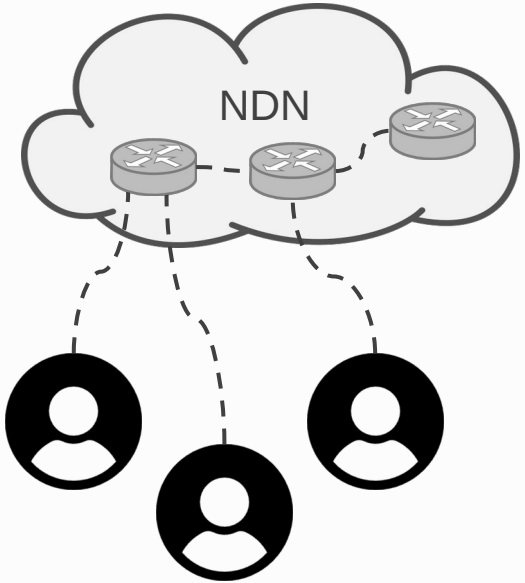


How do users exchange data?

NDN Testbed for rendezvous

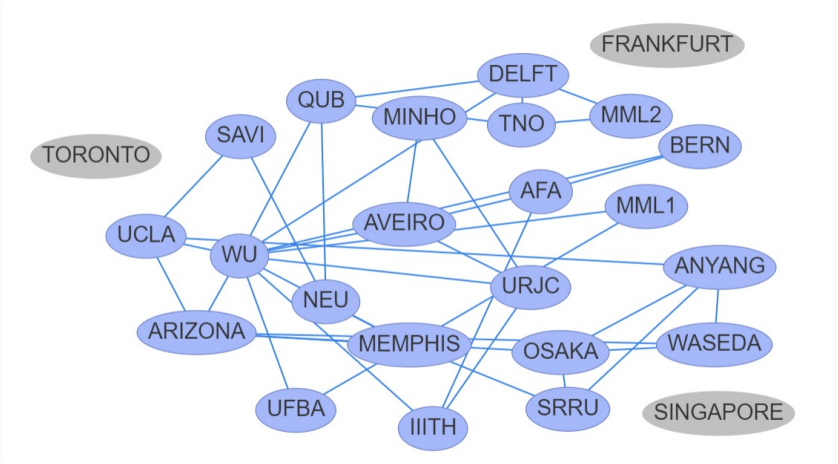
Rendezvous in the air





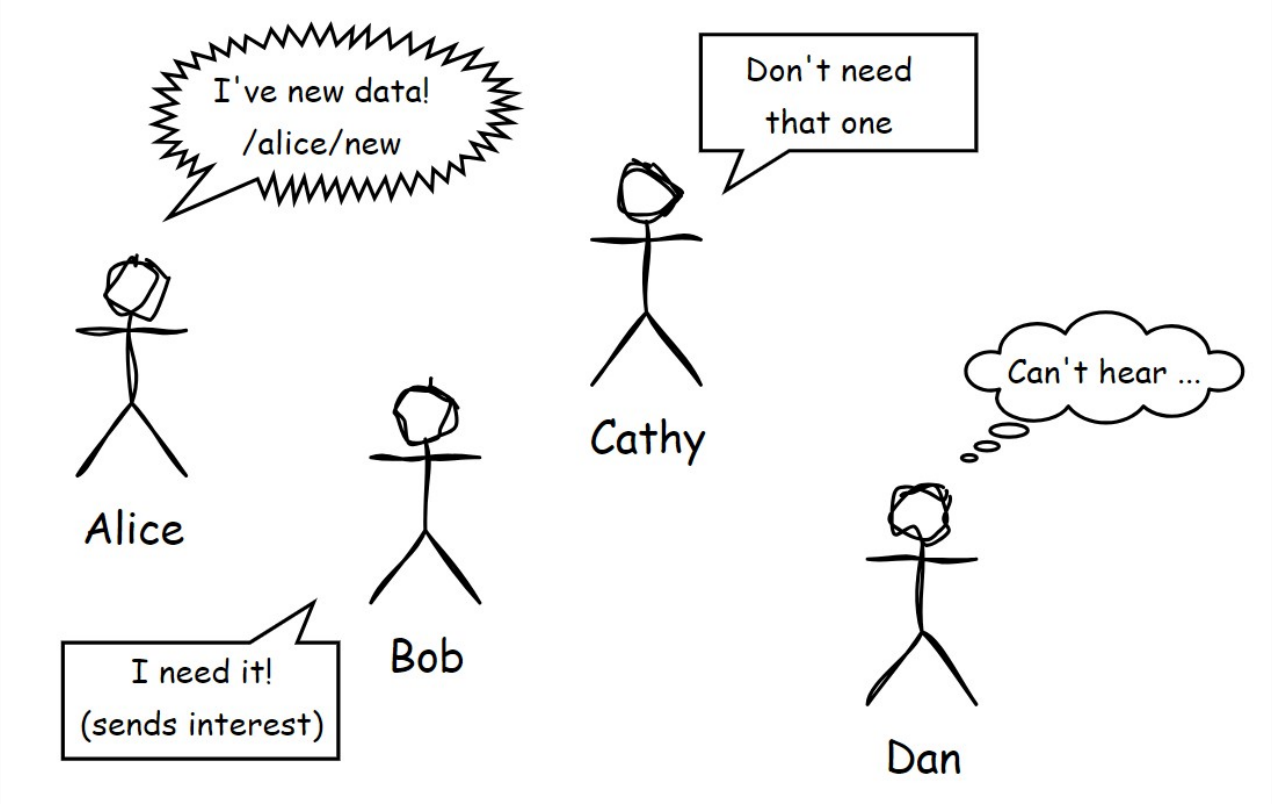
NDN Testbed to support named data communication

- Infra for exchanging named data efficiently
  - Does not (need to) see or understand data
  - Not specific to application
- Multi-continent network **ready for use** today
  - Run by volunteer organizations
  - Anybody (you) can join!
  - Using the testbed is (very) easy



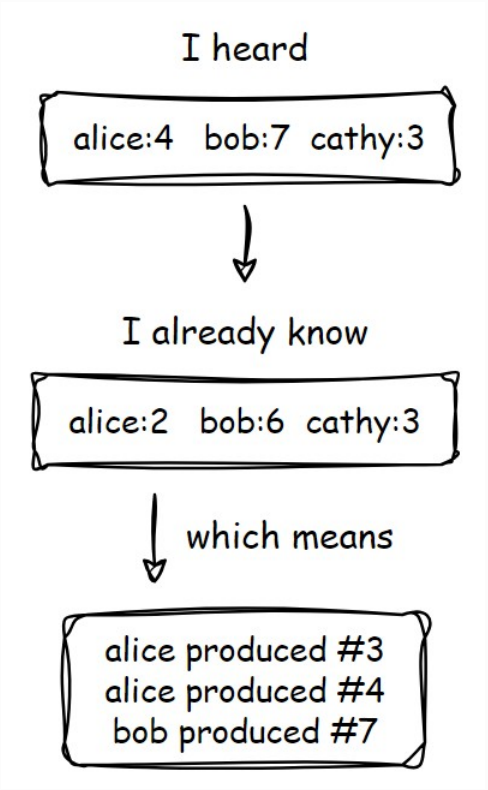
https://101.named-data.net/testbed/

Getting notified for new data



Sync – NDN Transport

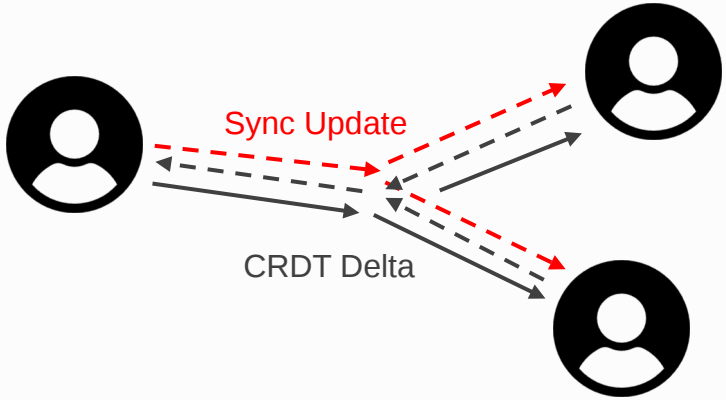
- “Distributed Dataset Synchronization”
- Synchronize the set of produced data names
  - Producers serve their own data
  - Network lets consumers fetch data directly
- State Vector Sync Protocol



https://named-data.github.io/StateVectorSync/
https://github.com/named-data/ndn-svs

CRDT over NDN Sync

- Versioning: Sync state
- Updates as patches
  - CRDT deltas wrapped as Sync data
- Subscriptions: joining a *Sync group*
- Merge Types: CRDT

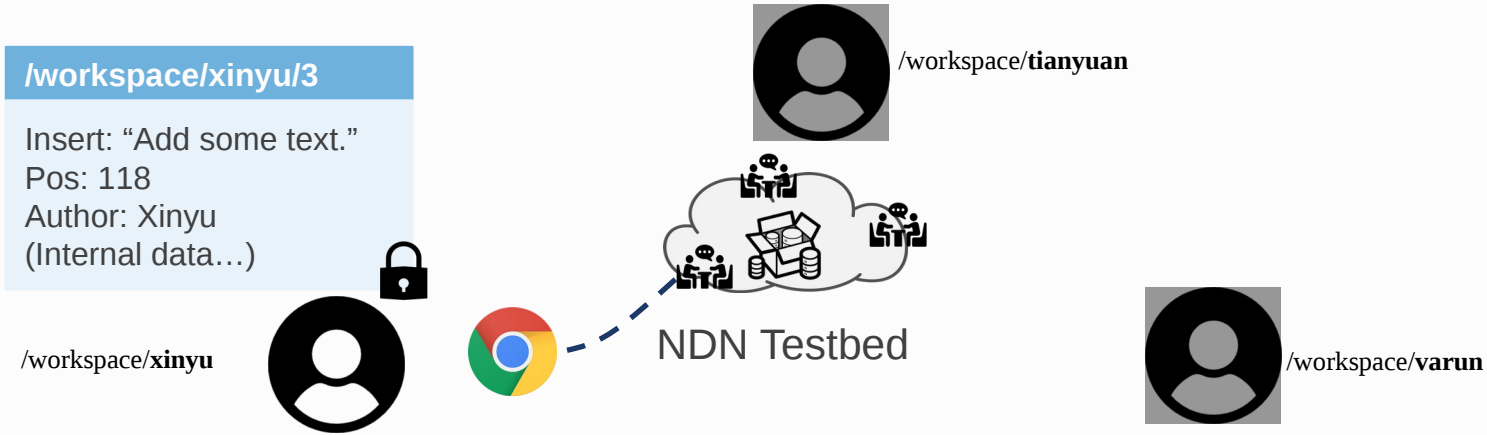


But users may not be online simultaneously

Asynchronous communication with Repo, a generic in-network *storage*

In-network Data Storage

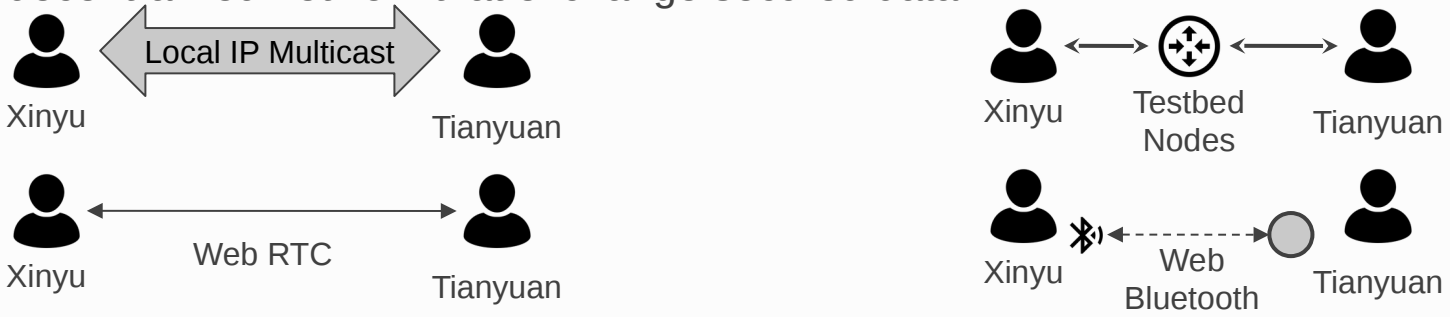
- Generality as network service
- Agnostic to application security
- Does not see or understand the stored data



Summary

Basic Components of Workspace

- Semantic user identifiers originating from today's Internet
  - Unique, verifiable, and semantic meaningful
- Data signature and end-to-end encryption
- A decentralized network that exchange secured data



The high-level design is generic and applicable to other apps (e.g., chat)

Low Entry Bar for Developers

- An undergrad from Shanghai, Xinchen, felt Workspace is interesting
  - With little knowledge about NDN, security, or the NDN testned.
  - Spent a few days of learning CRDT libraries
- Developed a chat app for Workspace very easily
  - One week: coding, pull request, code merged
  - Yjs + a bit front end work
- Workspace provides API to build local-first, decentralized app with **security built-in**
  - Write app just as writing plain CRDT apps
    - Make changes on shared data structures
  - Workspace backend exchanges secured CRDT updates

Takeaways

- Fundamental building blocks of decentralized app
  - **Security**, **Sync**, **Storage**
    - Users need to have semantic identifiers
    - Data-centric security enables secure communication independent of the channel
    - **Semantically named and secured** data objects allow generic network services
      - Synchronization and data storage

Workspace URL: https://ndn-workspace.web.app/

Contributions are welcome