Access Control in a Decentralized Collaboration Platform

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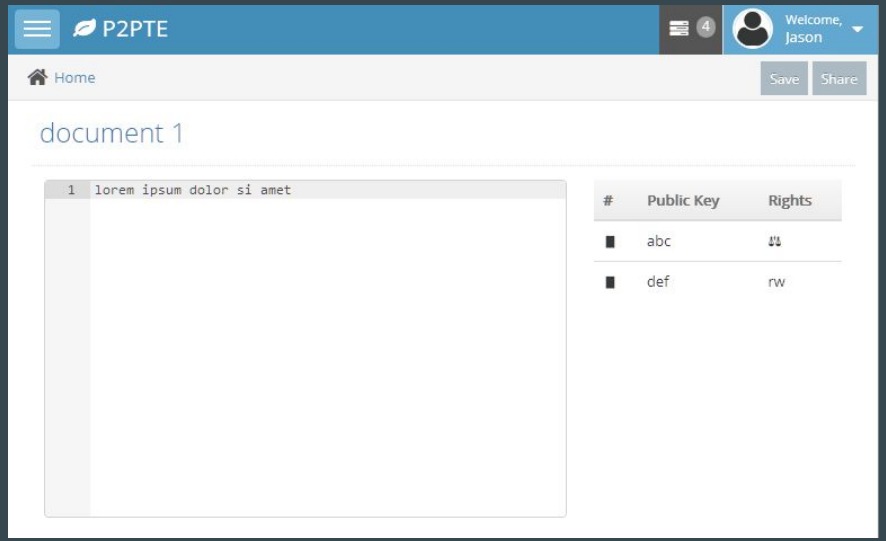
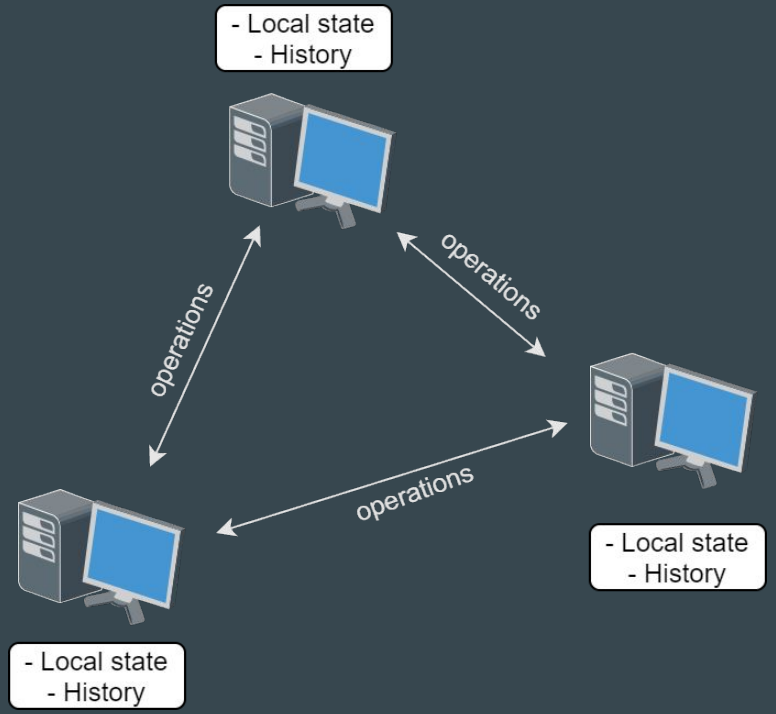
Nicolas Ritter

Professor:
Bryan Ford
DEDIS

Supervisor:
Kirill Nikitin
DEDIS

Introduction - Peerdoc platform





Introduction - The cost of centralization

- Having to share potentially sensitive data with a third party which may or may not be trustworthy
- Having to rely on a central server, which is a single point of failure
- Not having local control and ownership of the data

A decentralized, peer-to-peer approach removes the central server in favor of peers keeping a local state of the document. But this comes with challenges...

Challenges of decentralized access control

- No central authority to check users' permissions
- Possibility of network partition
- Modifications might not be received in the right order

The state of the system needs to eventually converge regardless of these challenges.

Goals

- Access control
  - Users need permissions to edit/view a document
  - Permissions can be added/removed
- Recovering from partitions and dynamically joining the network
  - Catching up on the state of the document
- General improvements
  - Database
  - Communications
  - Switching between documents

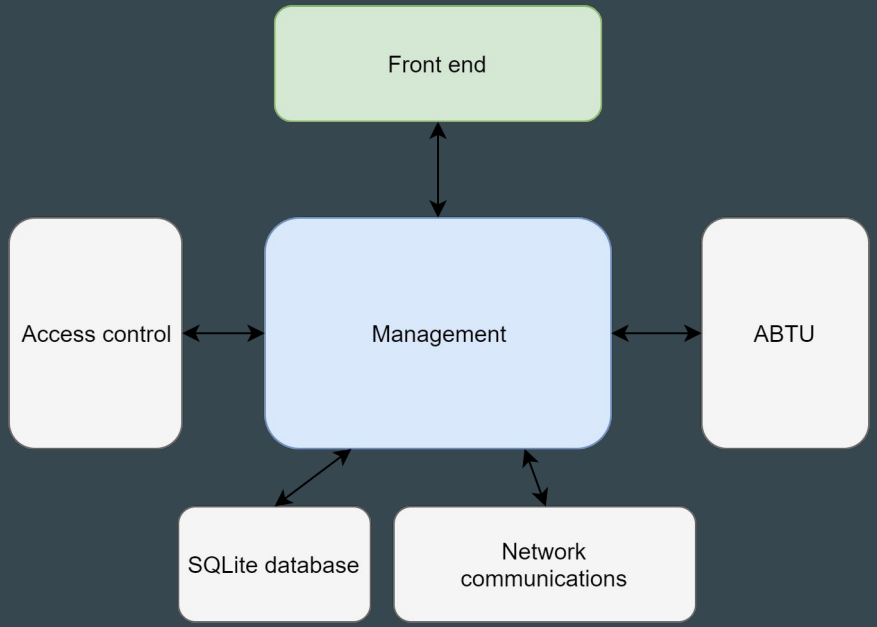
Structure of the system

ABTU implemented by Damien Aymon

Web interface by Rehan Mulakhel

Changes from previous work:

- Access control
- Back-end database
- Redone network communications



Background

Operational transformation: Modifications to the document are expressed in terms of operations (e.g. “insert ‘a’ at position 1”)

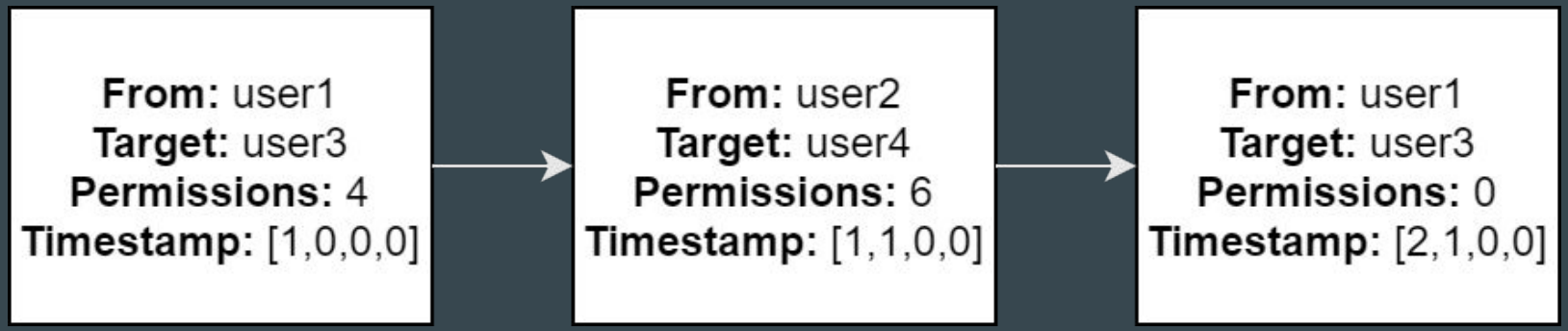
ABTU algorithm: ABTU orders and integrates text operations from multiple sources which can be concurrent

Optimistic acceptance: Operations are applied optimistically, and rolled back if necessary

Access control design

- Access control operations and text operations do not wait on each other
- Text operations are accepted/rejected based on the local access control state for the document
- Access control operations specify the point at which they become effective (relative to text operations)

Access control operation



Access control operation - Permissions

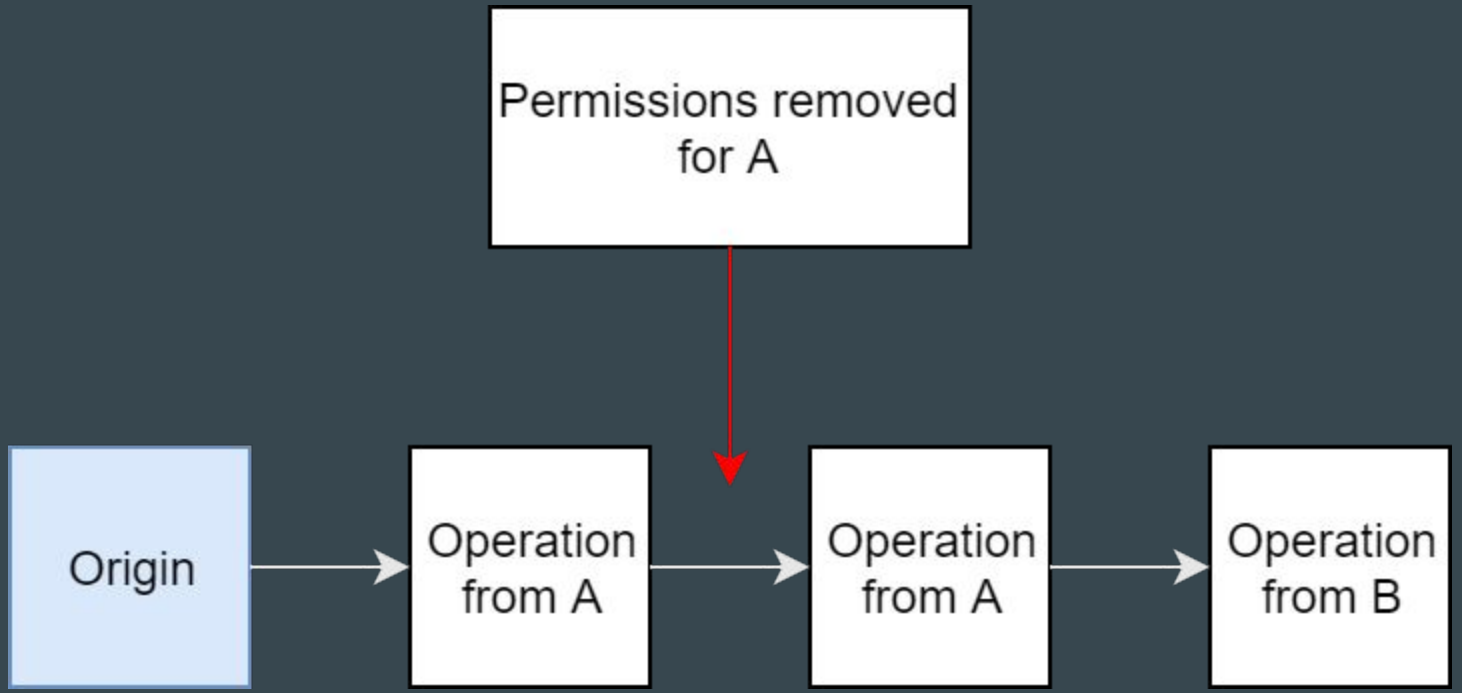
4 - Read-only

6 - Read/write

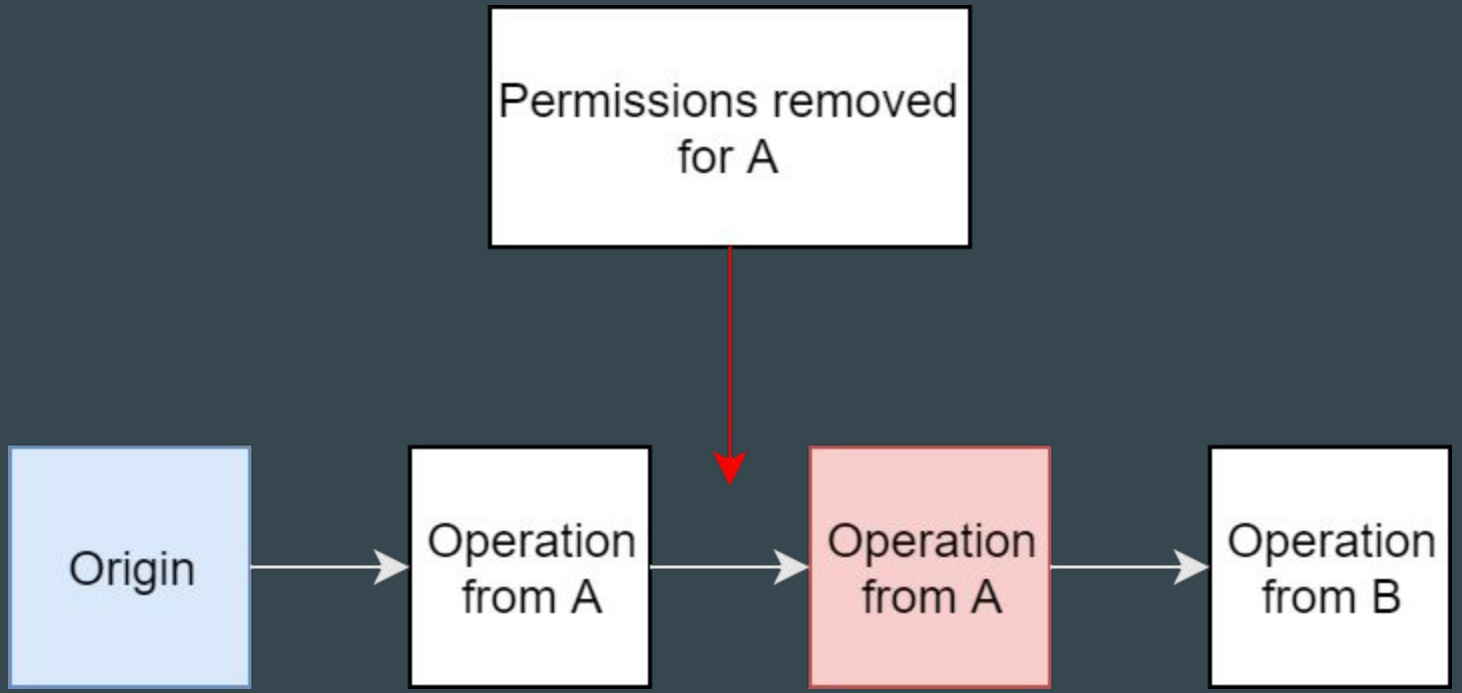
7 - Administrator

0 - None (removal)

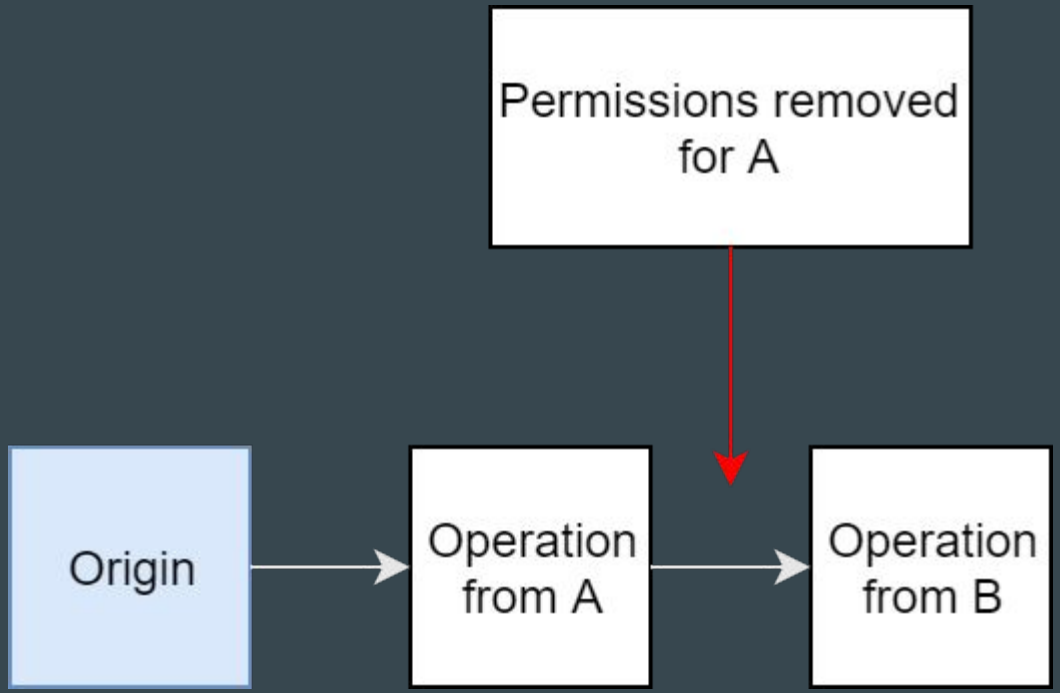
Operation canceling



Operation canceling



Operation canceling



Joining or recovering from partitions

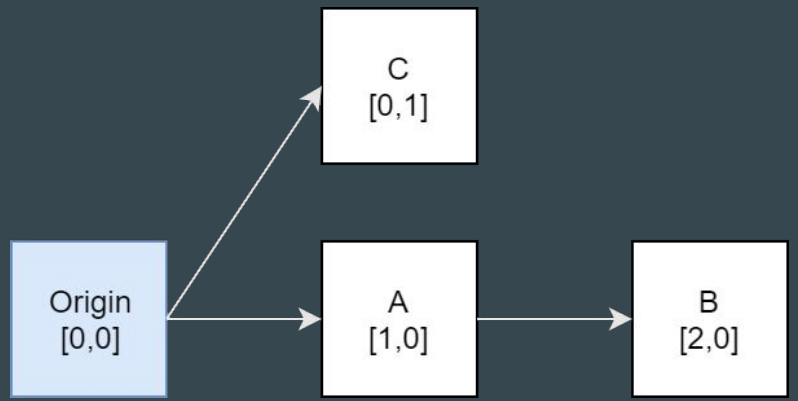
Catch-up mechanism based on statuses:

- A status contains the state of the local vector clock
- Upon receiving a status, a peer sends its source the operations they lack
- Peers send their status when joining, or when another peer is ahead of them
- This allows peers to catch up with the state of the document when joining or when a network partition is reconnected

Concurrent operations

This can happen when operations are generated simultaneously at different sites, but also when there is a network partition

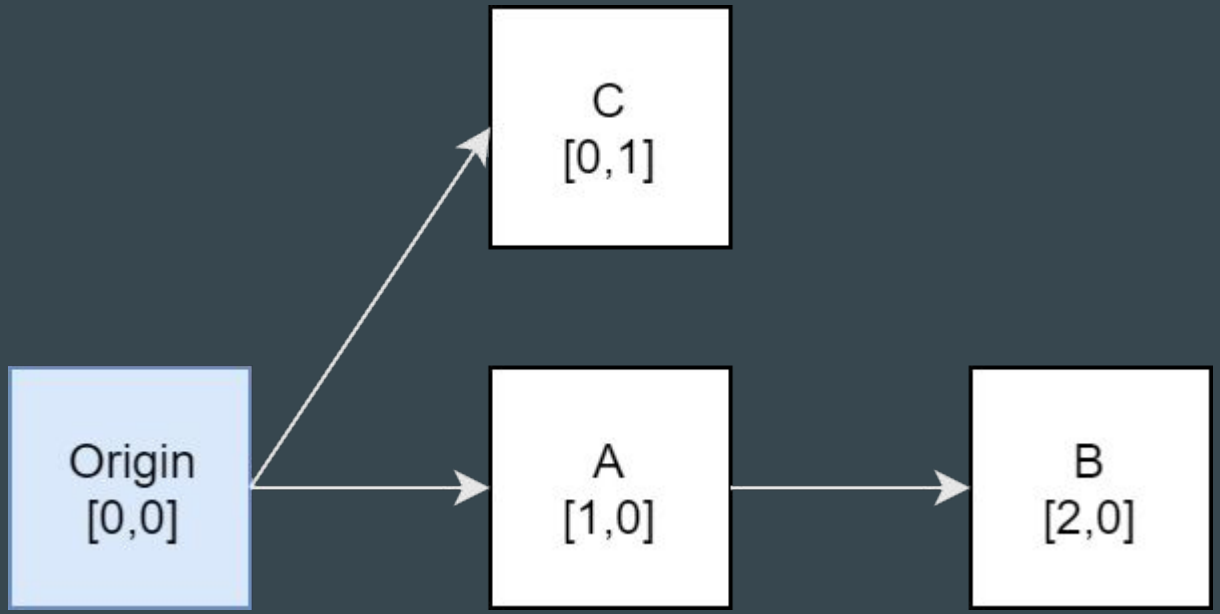
ABTU handles these cases for text operations, but what about access control? We need *deterministic* rules for ordering concurrent access control operations.



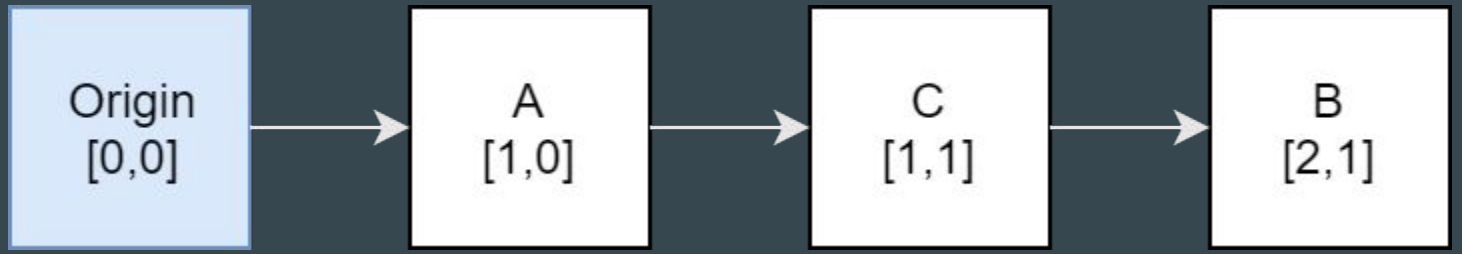
Priority rules for access control

- Priority to operations that are closer to the origin (time 0)
- Stricter permissions override higher permissions in case of conflict
- If possible, execute an operation from peer i before an operation which removes peer i's rights
- Use lexicographic order on the source of the operation as last resort

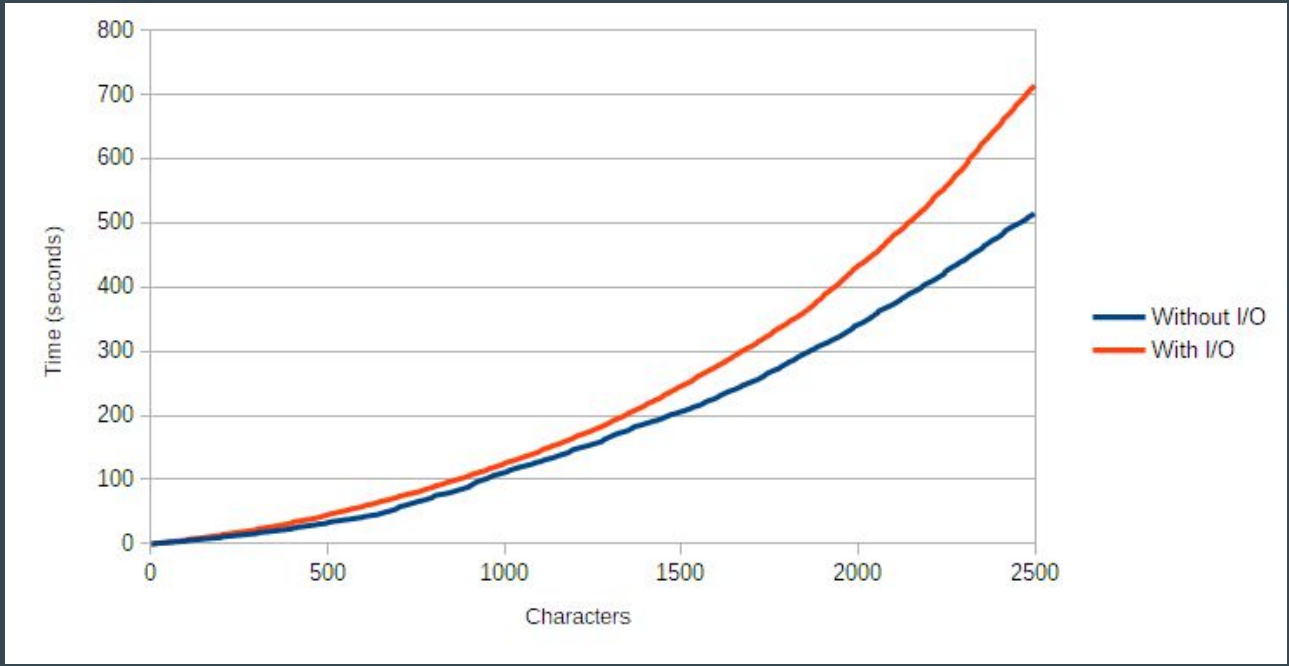
Integrating concurrent operation - example



Integrating concurrent operation - example



Catch-up performance



Future work

- Performance
  - Optimize communication between back-end and front-end and between peers
  - State snapshots instead of keeping track of the entire history of operations
  - Reduce database writes
- Encryption
  - Document-specific symmetric key
  - Ability to change the key when a user is removed
- Interface and usability
  - Logging in
  - Sharing documents