Ensuring β-Availability in P2P Social Networks

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  - Uses user data for their profit, *e.g.*, in advertisement
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- Existing OSNs have a centralized view from outside
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  - Uses user data for their profit, *e.g.*, in advertisement
  - Users have to agree to future changes in terms of service
- How to overcome these shortcomings ?
  - Decentralize the OSN infrastructure. Do social networking in a more P2P way
  - Diaspora, PeerSon, SafeBook, SuperNova, Cachet, PrPl are a few approaches to decentralize OSN

The Problem

- One important question still remains to be answered
  - *How to ensure 24 x 7 content availability with minimal replication overhead ?*
- Existing Solutions
  - *The DOSNs are still in early stage and does not provide enough discussion about ensuring availability*

Our Contribution

- We propose
  - The notion of β-availability
    - At least beta members of a replication group will be online
  - S-DATA protocol
    - A time based replication group formation protocol to ensure β-availability
    - Uses structured overlay, *i.e.*, Distributed Hash Table (DHT) to maintain replication groups, advertise availabilities, and resolve queries

Availability Representation

a_{ix} = the probability of user x being online during time slot **x, 1 <= x <= 24**

Availability vector (A)

0.2	0.1	…	0.9	0.9	…	0.1	0.0

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Encoded **A** into Linear Binary Code
- Take pair wise average in A
- Encode each element to 2-bit binary

Availability pattern

0 0 … 1 1 … 0 0

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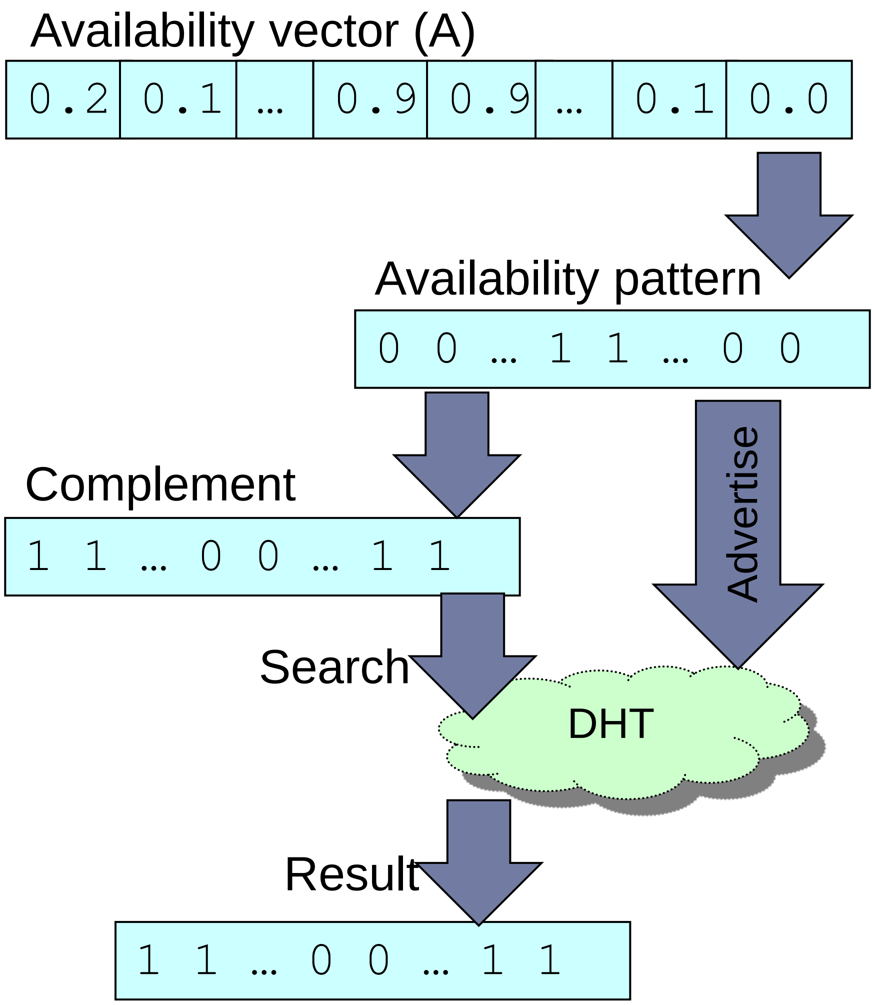


System Architecture

- Three major conceptual components
  - Group Index Overlay (GIO)
  - Content Index Overlay (CIO)
  - Replication Groups

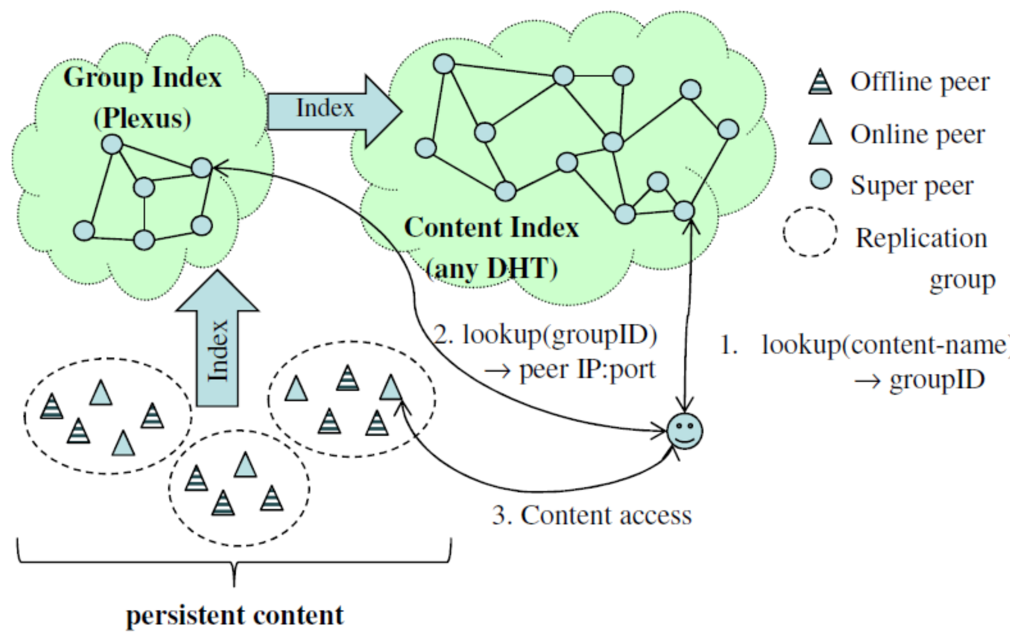
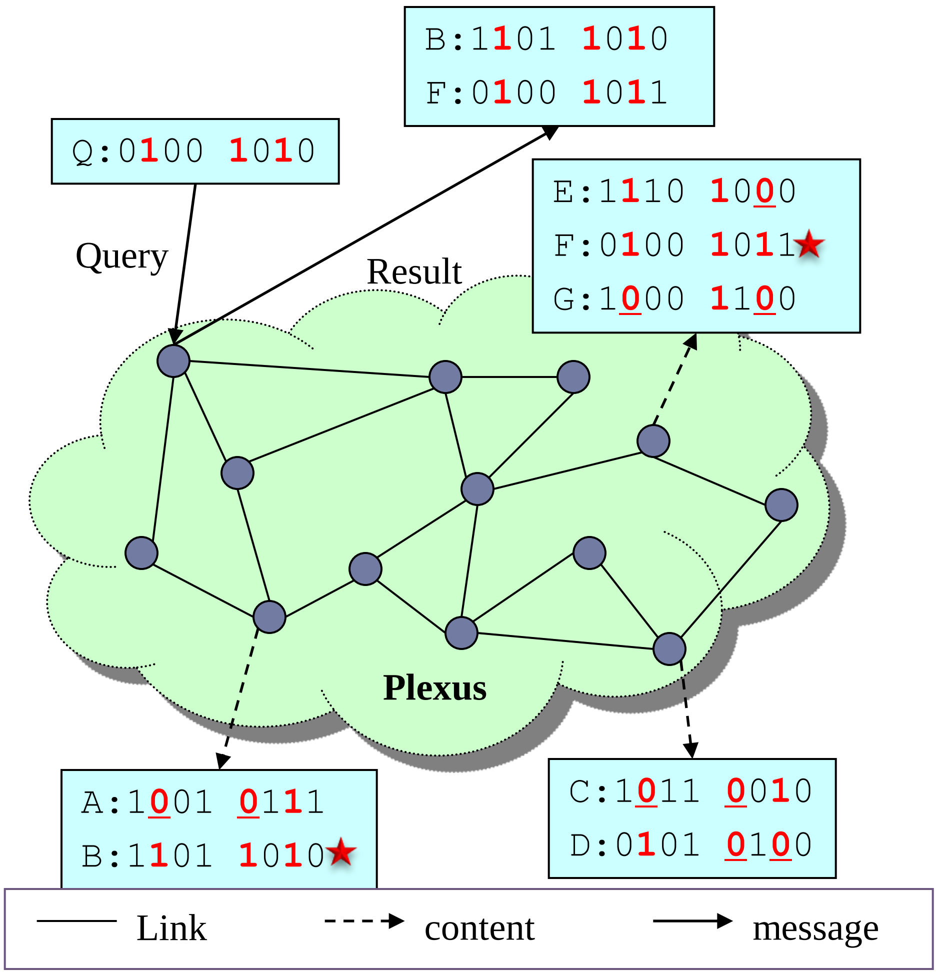


Fig. 1. Conceptual Architecture of S-DATA

System Architecture: GIO

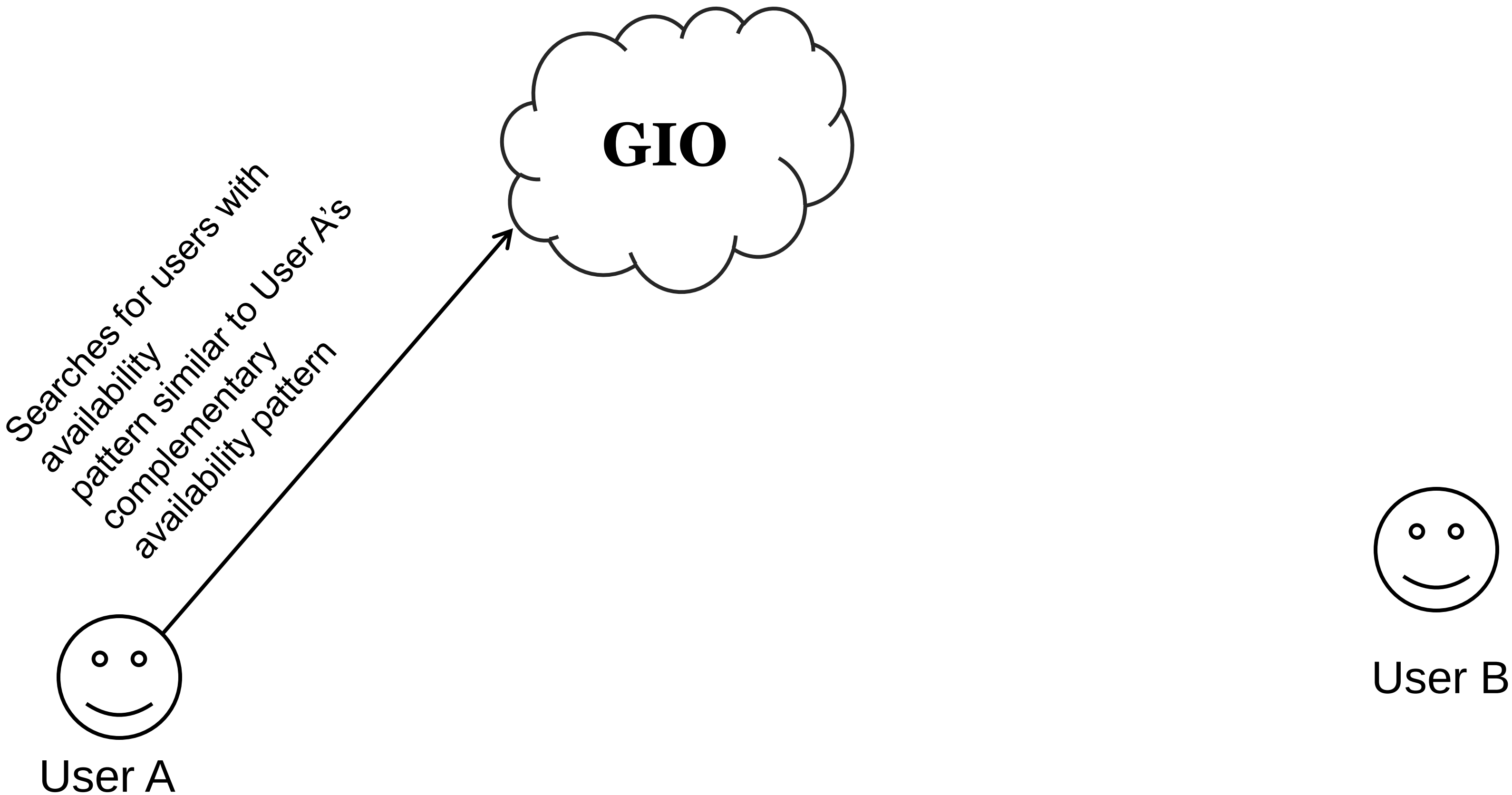
- Stores mapping for group ID to its member peers
- Acts as distributed matchmaking agent
  - Given a user's availability pattern, find other users with complementary availability patterns
- Given a user's availability bit pattern, we need to perform partial matching in the GIO DHT
  - Till date, only Plexus (*Ahmed et al. TON 2009*) is known to have this capability
  - Therefore, we use Plexus as GIO



System Description: CIO and Replication Groups

- CIO
  - Maps content names to group IDs
  - Out of the paper’s scope
- Replication Groups
  - Users are clustered based on their diurnal availability patterns
  - All members of the group replicate each others contents

Protocol Description



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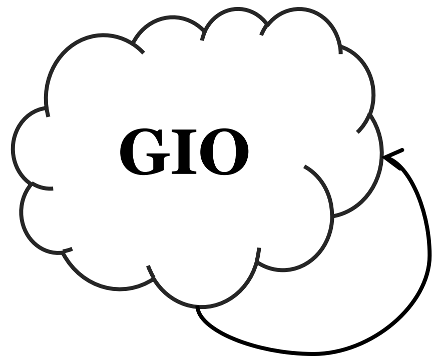
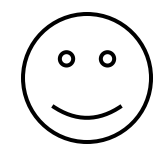
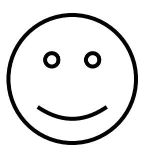


Performs partial search in Plexus DHT to find users with availability
pattern similar to User A's complementary availability pattern

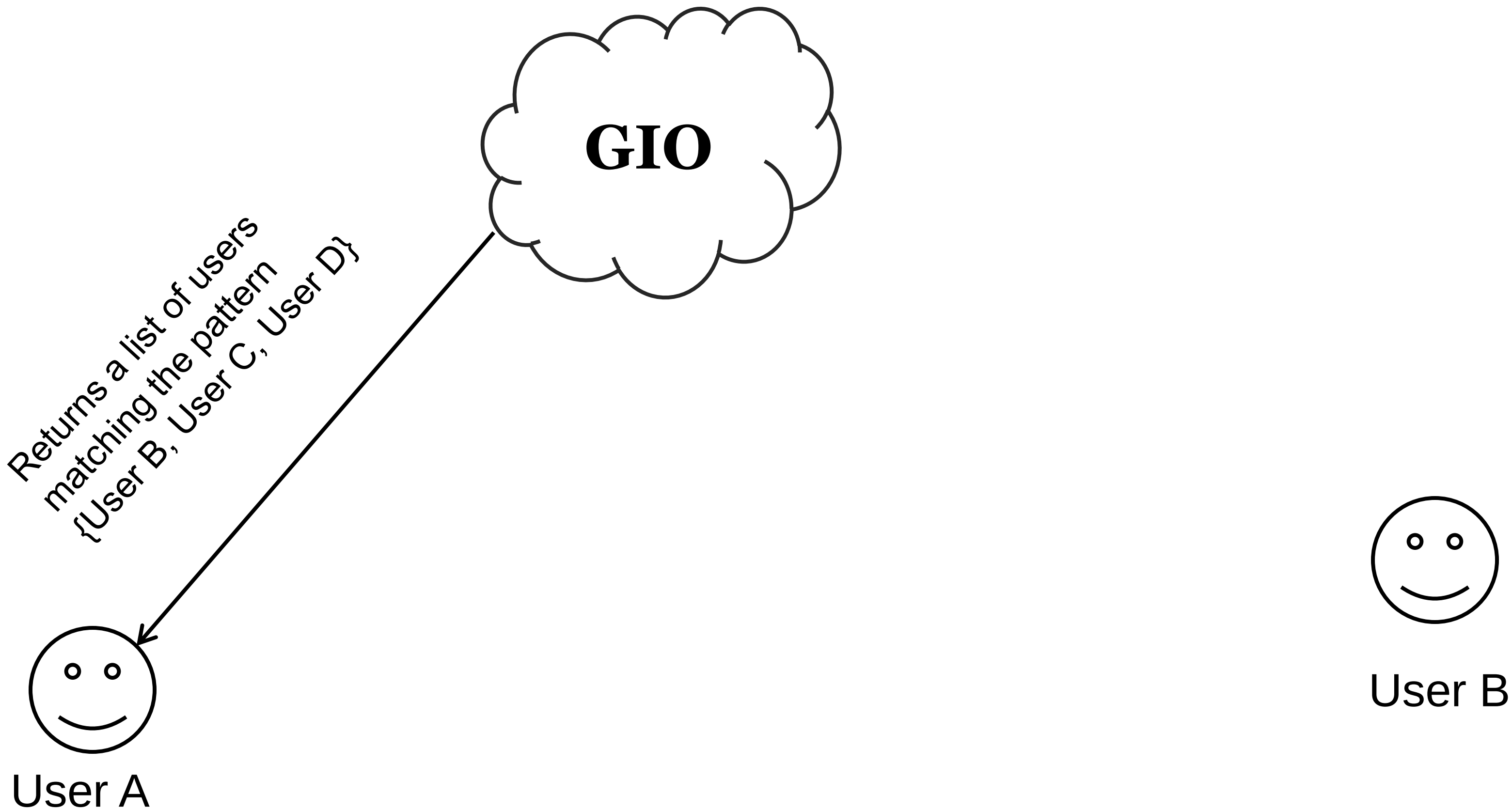


User B



User A

Protocol Description



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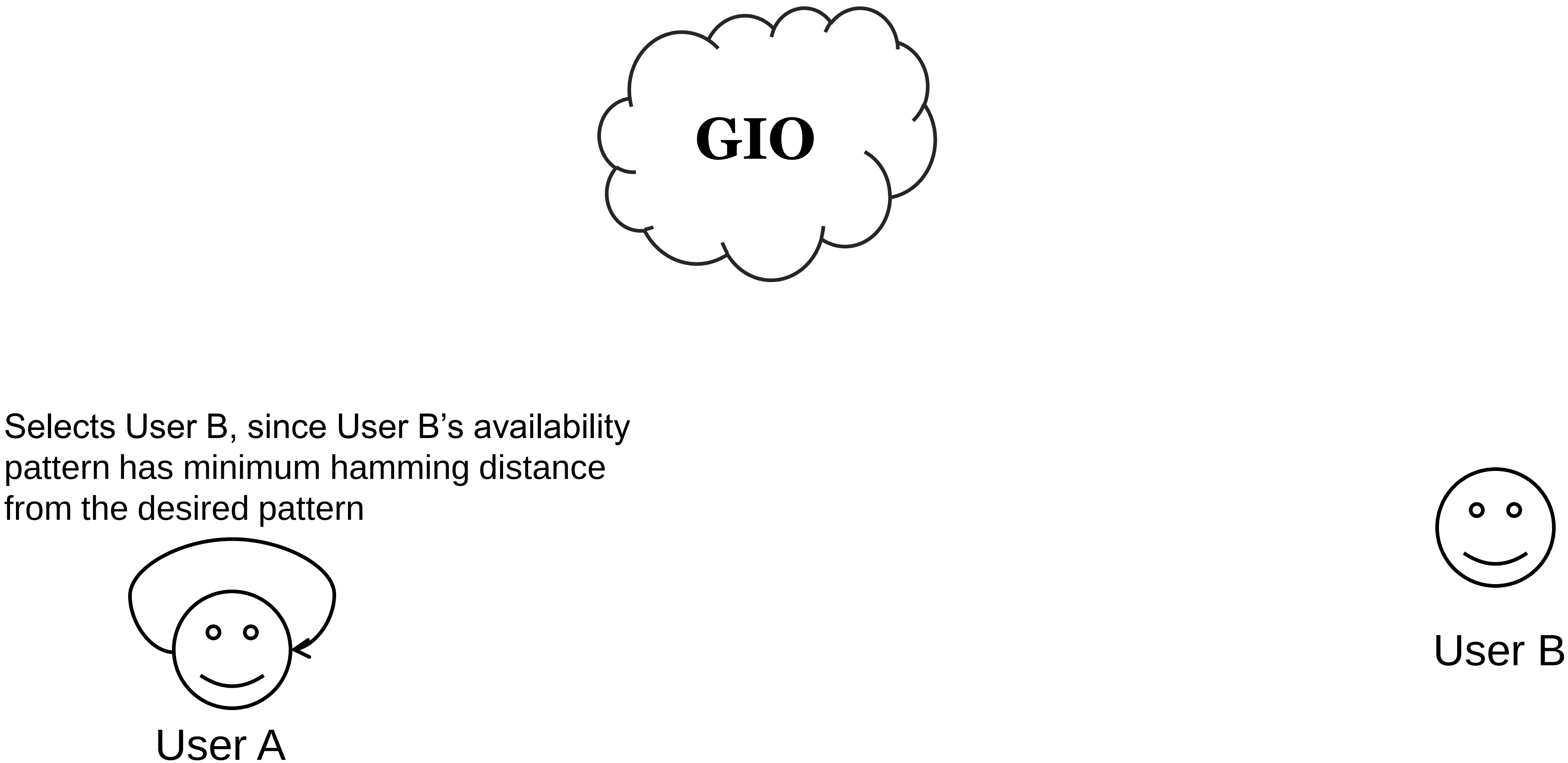

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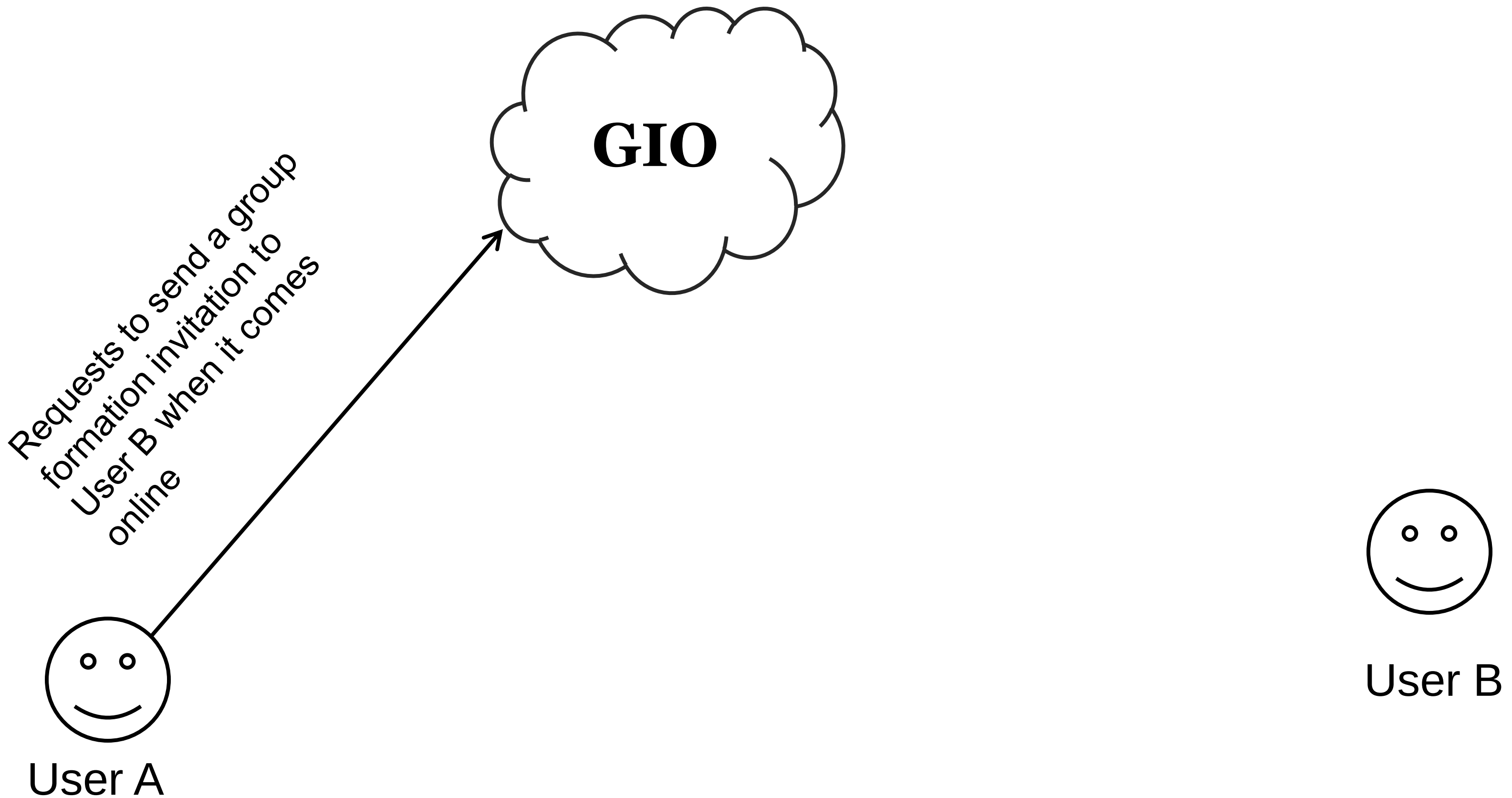

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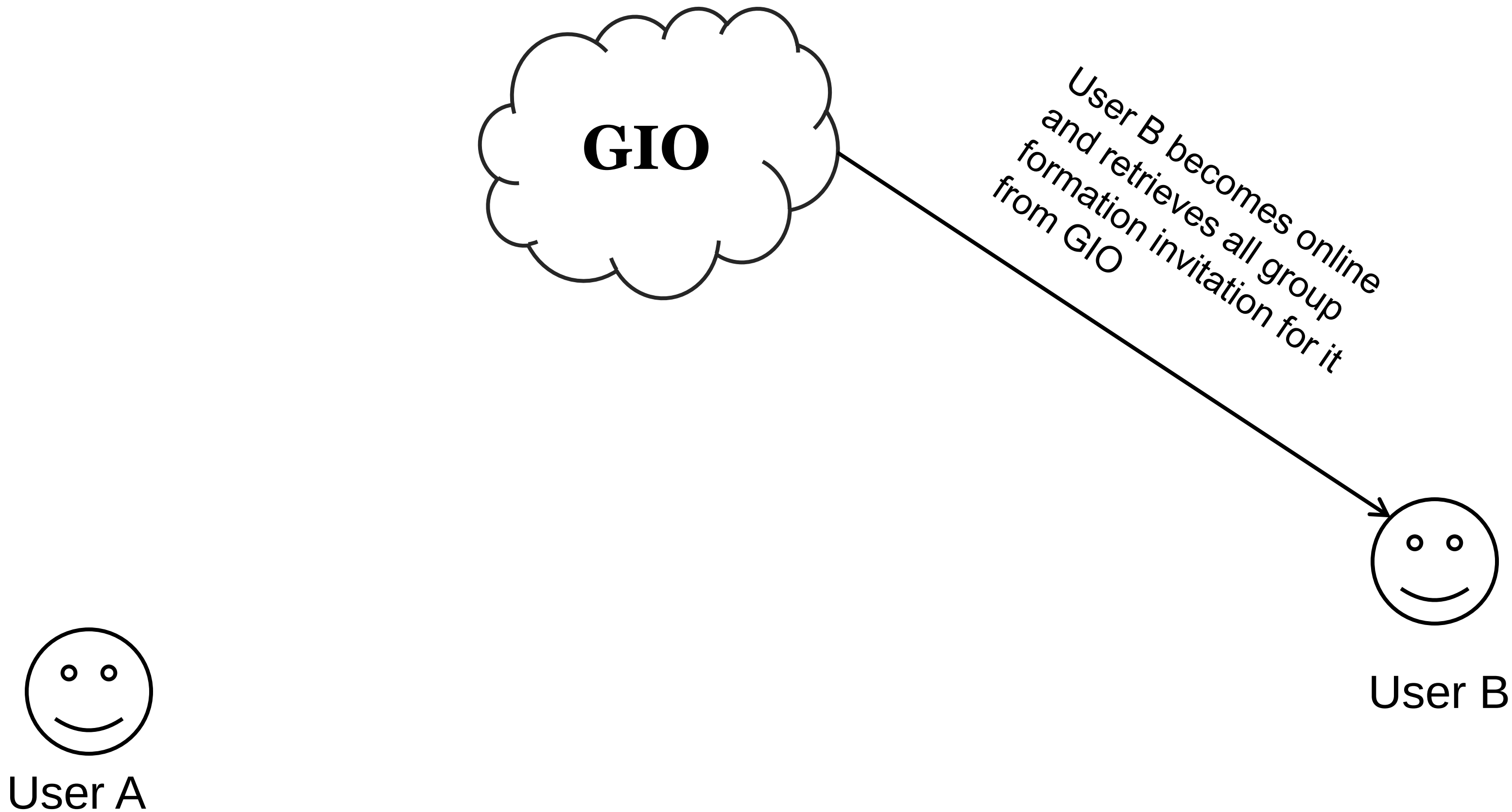

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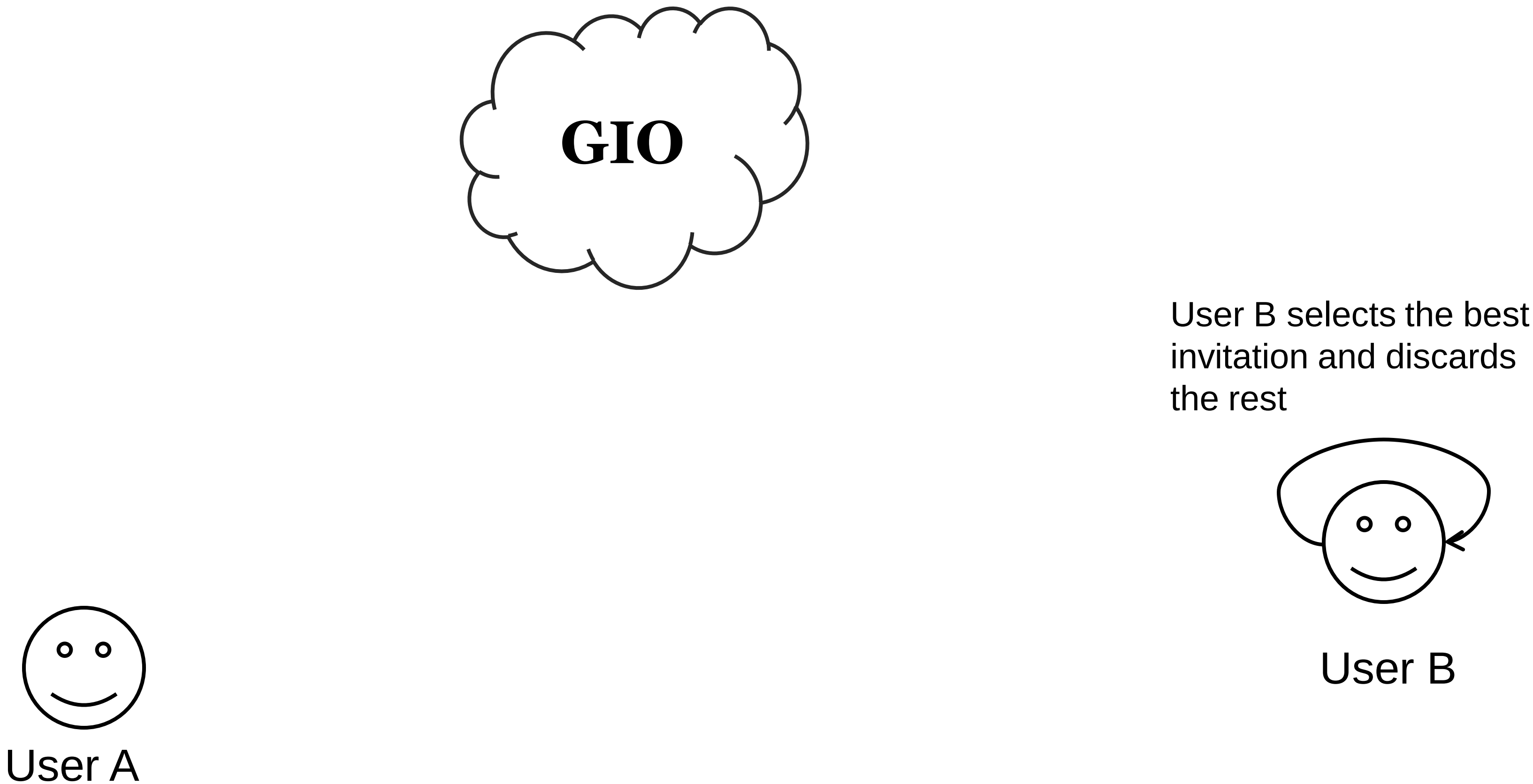

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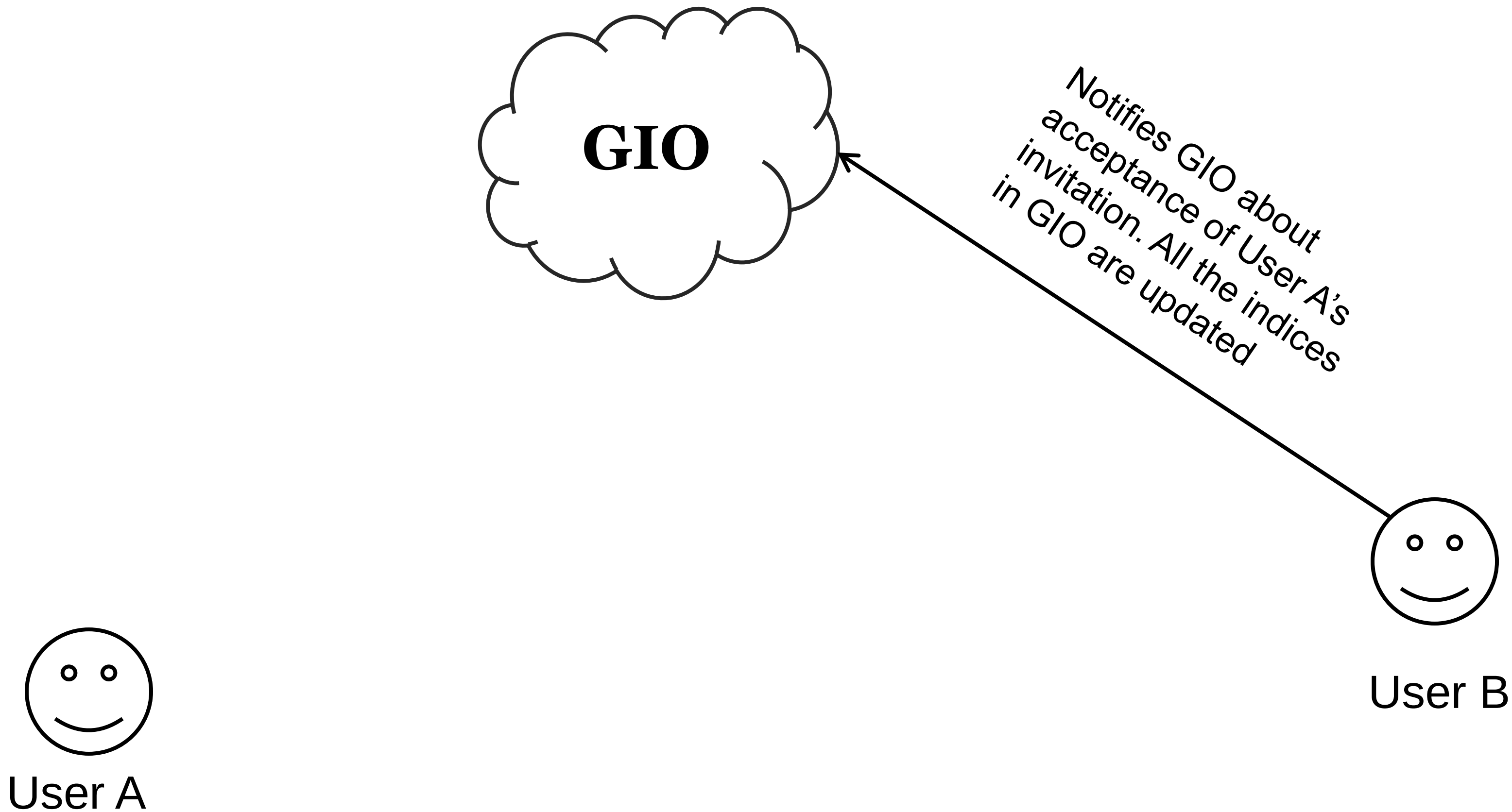

Evaluation

- Setup
  - We used **PeerSim** to simulate the protocol
  - **Pareto distribution** was used to generate availability vectors
  - **Extended Golay Code** used for encoding
- We measured
  - Normalized Messaging Overhead
    - Number of invitations required for forming a single group
    - Compared it with Random, Central and Unstructured grouping approaches
  - System Availability
    - Probability of having at least one online user from a group at any given time
  - Effect of Failure
    - Probability of having at least one member of a group online when certain percentage of users do not become online in their expected online slot

Evaluation: Results

- Normalized Messaging Overhead
  - Network size increased from **5000** to **30000** in steps of **5000**
  - Central approach is baseline
  - Our approach has overhead very close to the central approach
  - Very little effect of the network size

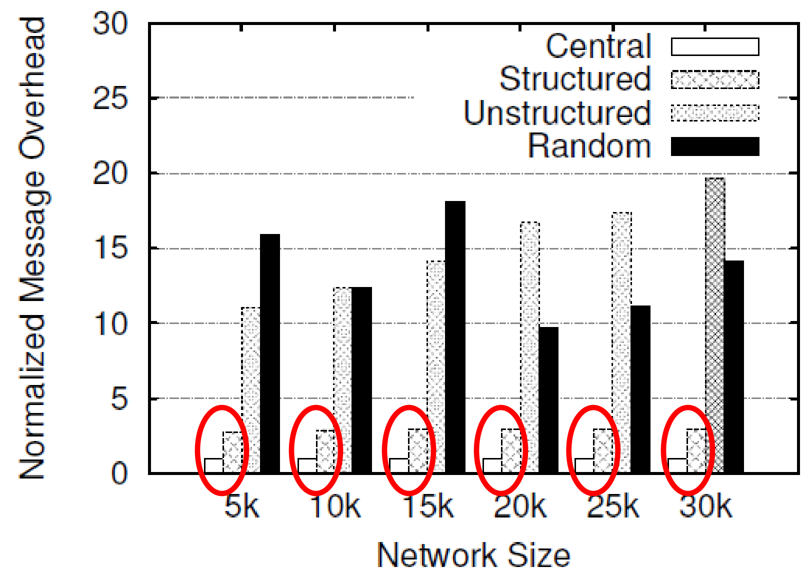

Fig. 3. Normalized Message Overhead

Evaluation: Results (cont..)

- System Availability
  - A **significant improvement** in system availability when **β increases from 1 to 2**
  - Improvements for higher beta are very less

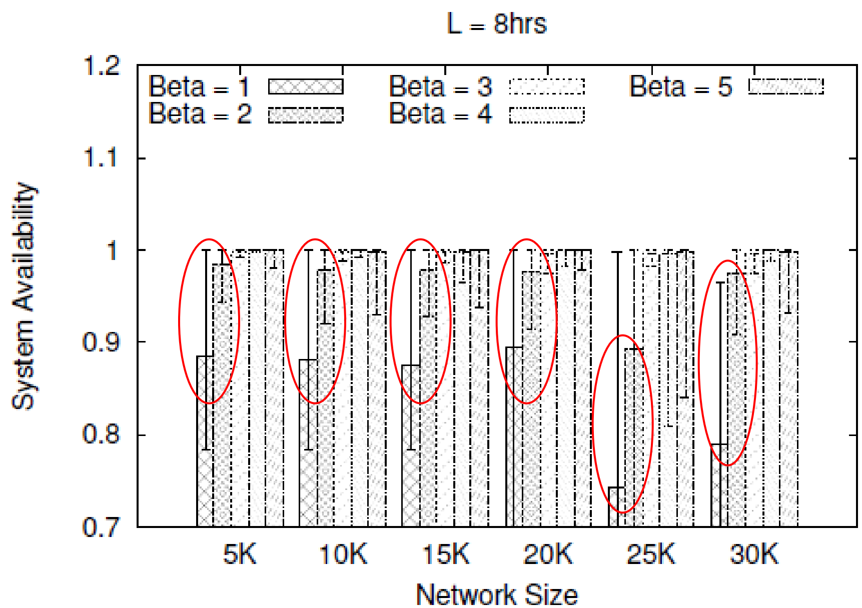

Fig. 4. System Availability

Evaluation: Results (cont..)

- Effect of Failure
  - For **beta >= 2**, more than **93%** groups are available even after **50% users failing** to be online in their expected period

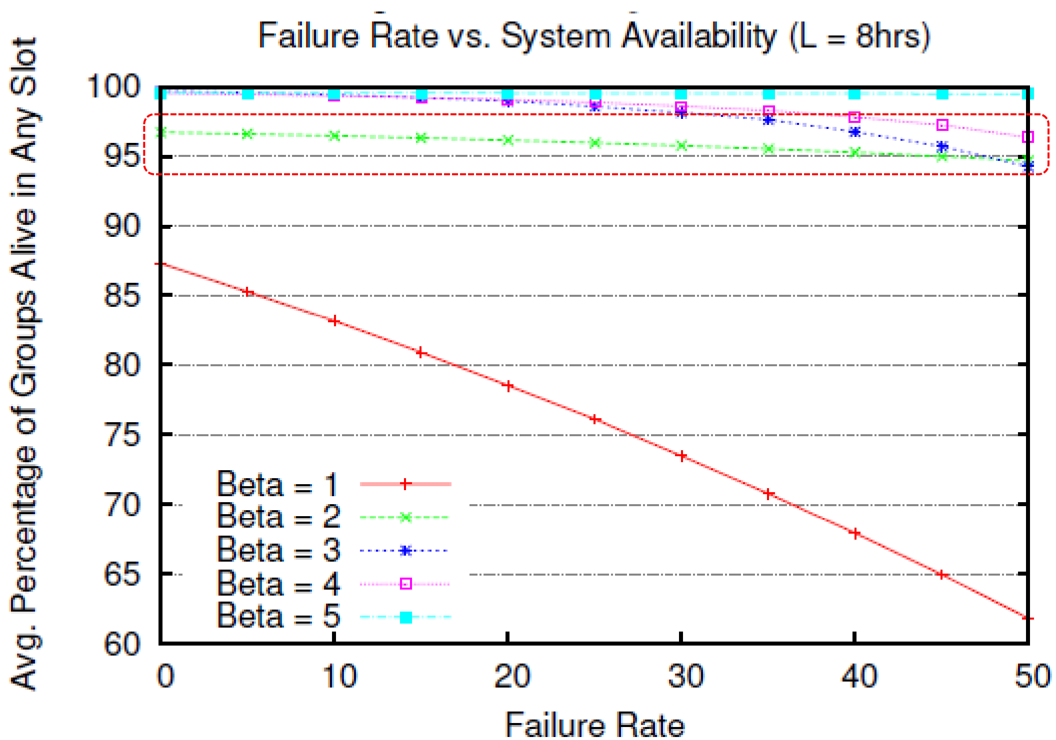

Fig. 6. Effect of Failure on System for Different β

Evaluation: Take Away

- **β = 2** is a good operating point
  - Can achieve high system availability
  - Lower overhead
  - **93% groups** are online even after **50% nodes failing**

Conclusion & Future Work

- Ensuring availability in a decentralized social network with not so stable users and taking the social relationship of the peers is challenging.
- We take a **first step** towards solving the problem and **solve it without considering social relationships**.
- We also **introduce** the notion of **beta-availability**.
- In the **next step** we are considering **social relationships.**
- Simulation results show **β = 2 is a good operating point.**

Questions?