FriendFinder: A Privacy Aware Grid Based Location Service

Ove Andersen Laurynas Siksnys Jeppe R. Thomsen

Aalborg University
Department of Computer Science
Selma Lagerløfs Vej 300, DK-9220 Aalborg Ø
Denmark

December 8, 2008

Introduction

- Project about a friend finding location based service (LBS).
- Notify a mobile user when any of his friends are within a certain distance.
- Dealing with location privacy issue.
- The server is said to be untrustworthy.
- Users do not want the LBS to know anything about their positions.
- Issuing continuous queries on private data.

Motivation

- How can location privacy be obtained if the LBS is untrusted?
- Can an anonymizer, which will be a single point of attack, be excessed?
- Is it possible to both retain sufficient privacy requirements and keep communication costs at a minimum?
- Not much work done on querying private data - most related work only considers private queries on public data.

Anonymizers are not Necessary

Private Queries in Location Based Services: Anonymizers are not Necessary.

- Proposes a framework to support private location-dependent queries.
- Does not require an anonymizer, since it's a single point of attack.
- Uses cryptographic techniques to ensure privacy.
- Communication and CPU intense, because of encryption.

Buddy Tracking

Buddy tracking - efficient proximity detection among mobile friends.

- Proposes a centralized server and a peer-to-peer method for tracking friends.
- Using the strips on the peer-to-peer algorithm - ensures privacy and reduces communication cost.
- Using a quadtree algorithm for the centralized algorithm.
- Still lot of communication using the peer-to-peer algorithm.
- Centralized server algorithm.has a lot of overhead and is outperformed when lots of users has joined the service.
- Privacy is not discussed in this article.

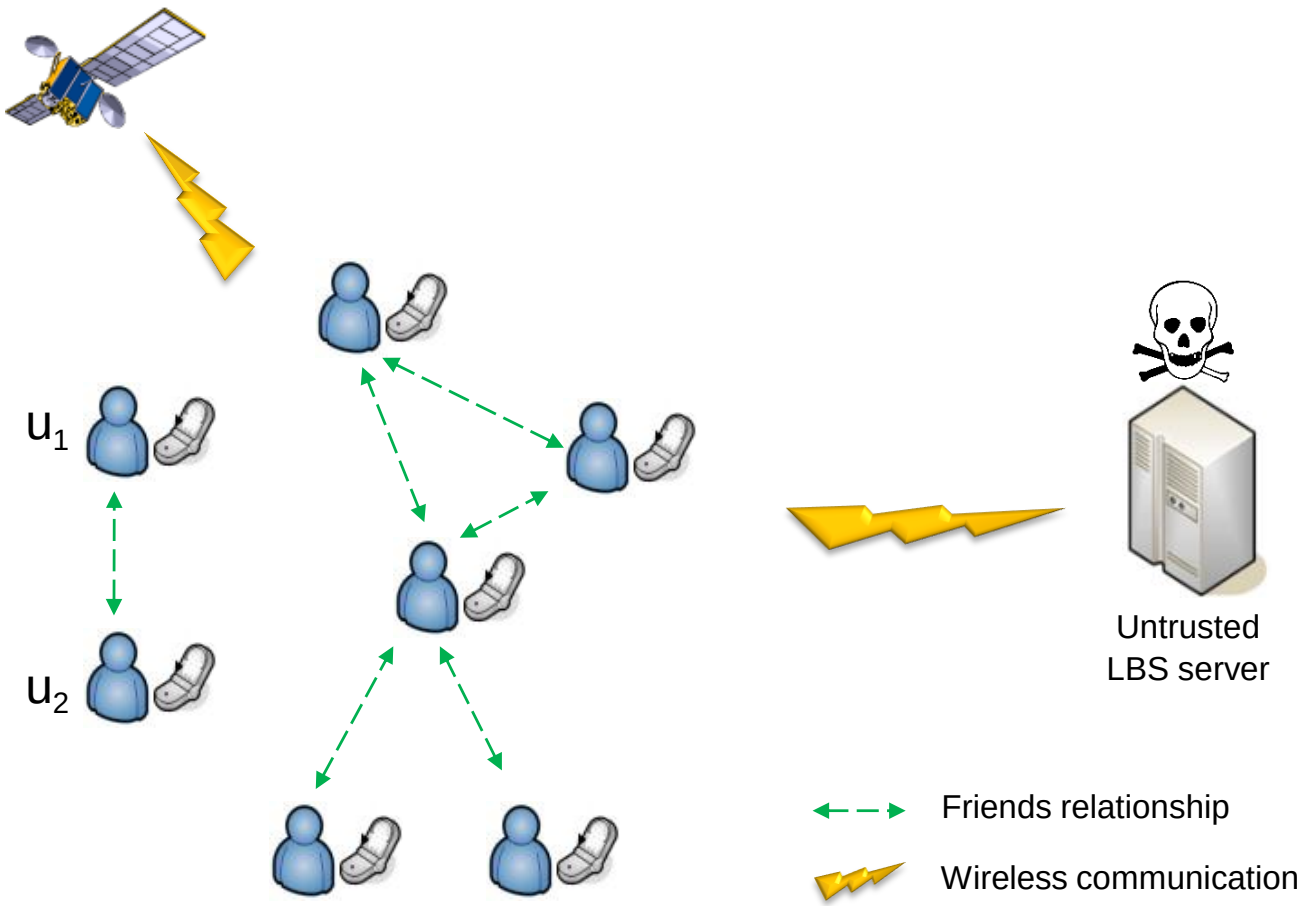
The contribution

- Agreed on the problem and its setting
- Develop a user location secure proximity detection approach
- Designed a Friend-finder service
- Develop a prototype
- Performed a prototype testing

The Problem Definition

- We want a solution for friend-finder LBS
- Solution must be strong against attempts to intercept exact locations of any user
- The solution must be practical

The Setting of the Problem



Example of the Proximity Detection

LBS server

Example of the Proximity Detection

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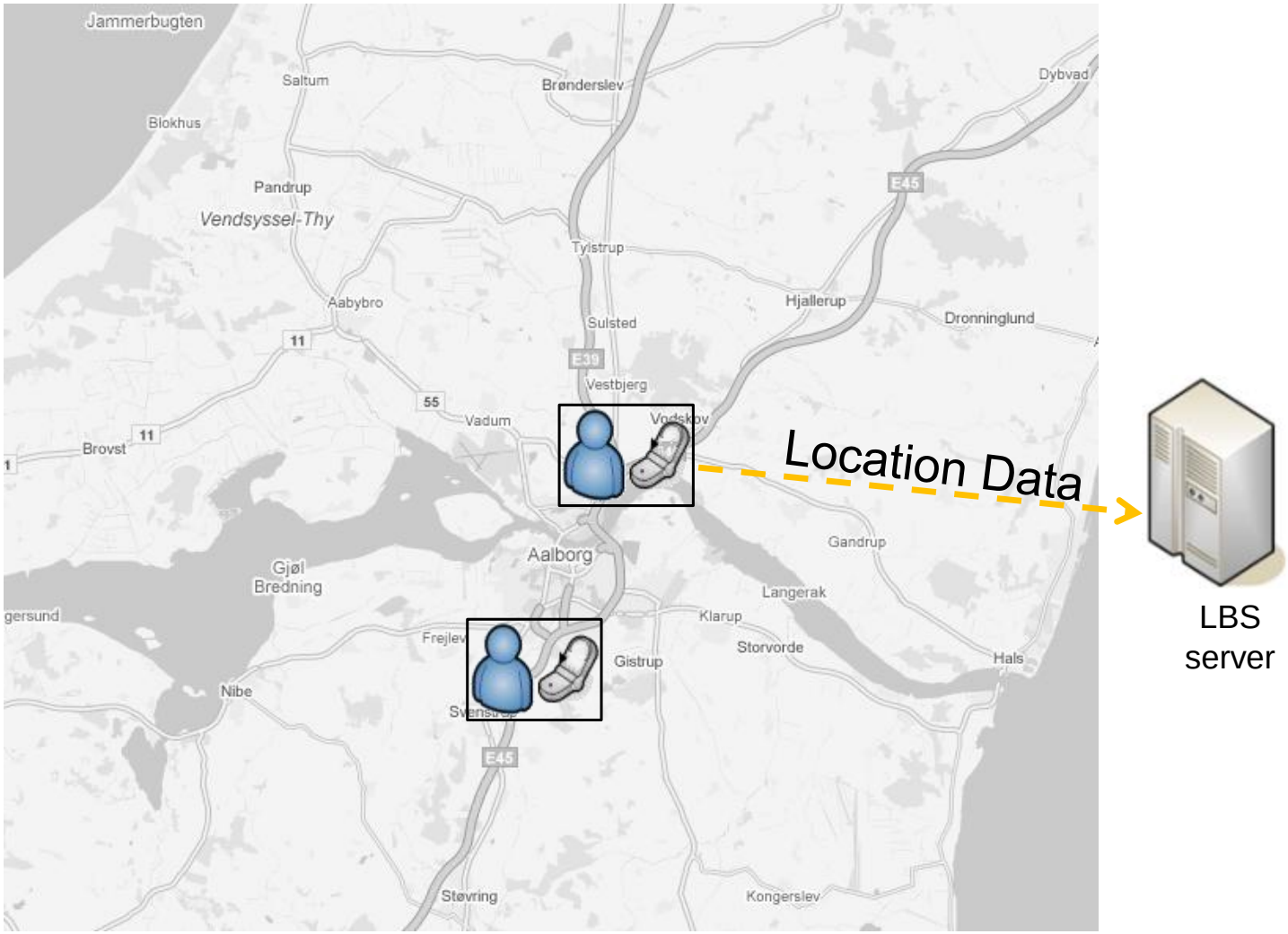

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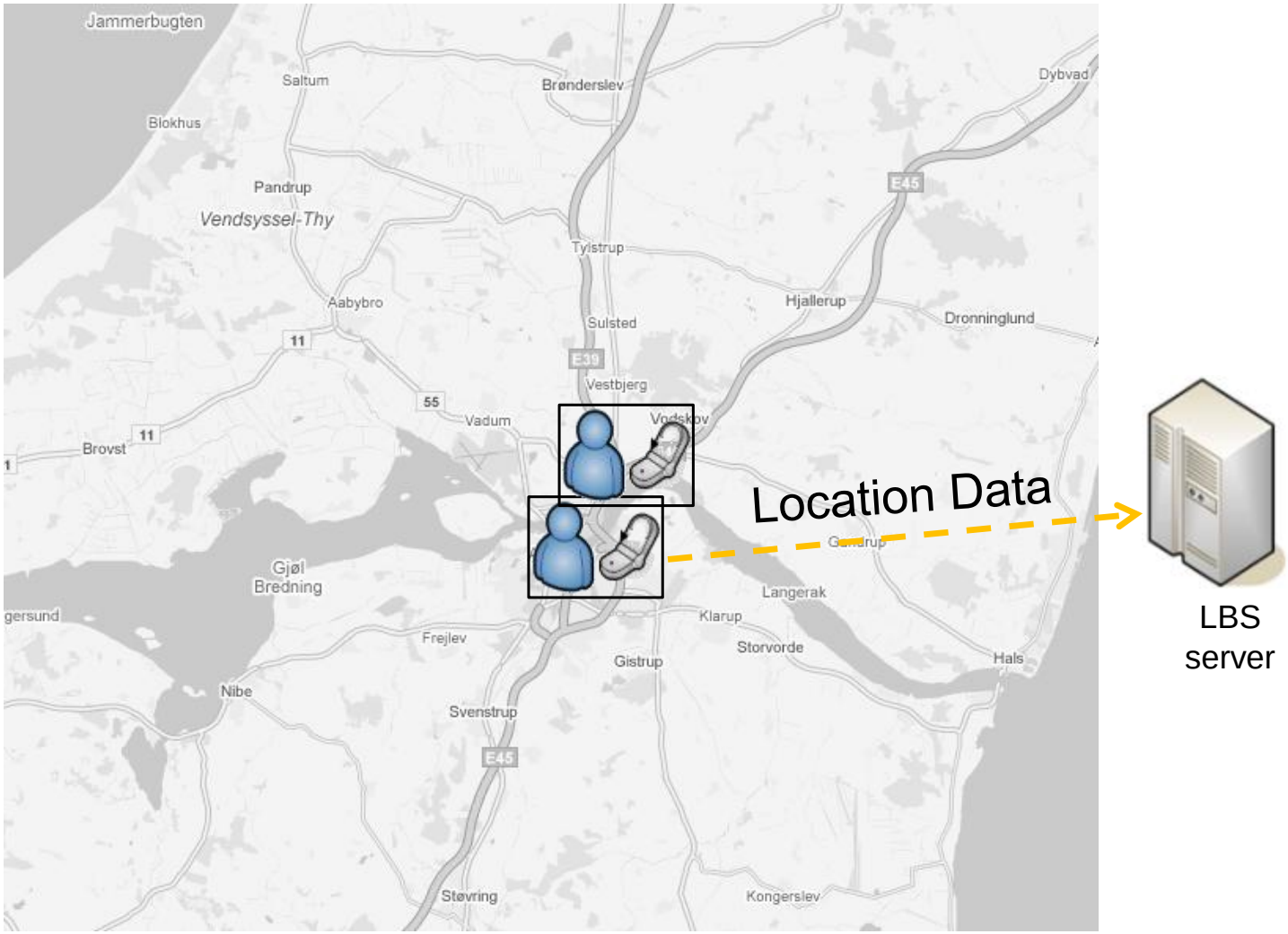

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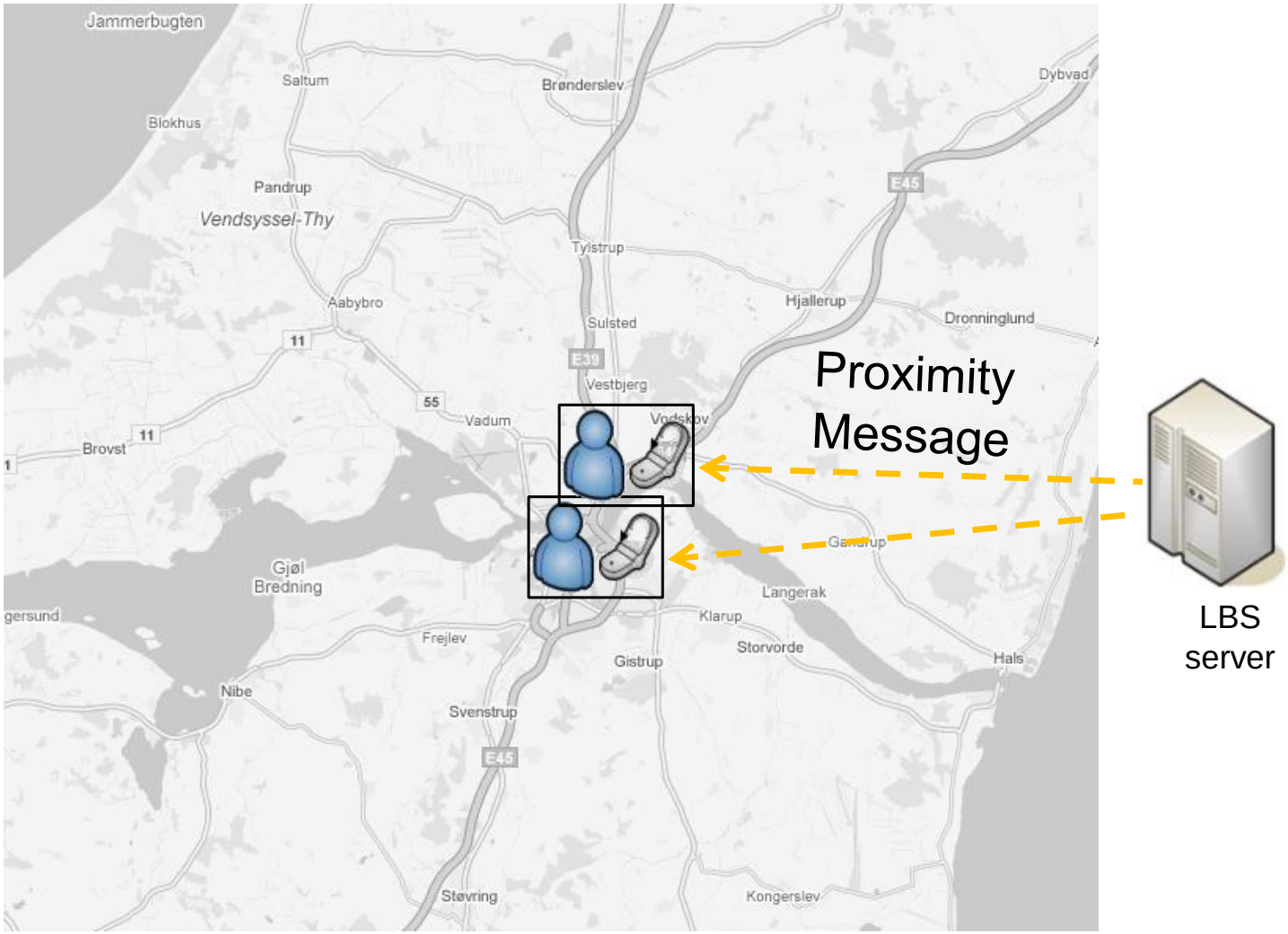
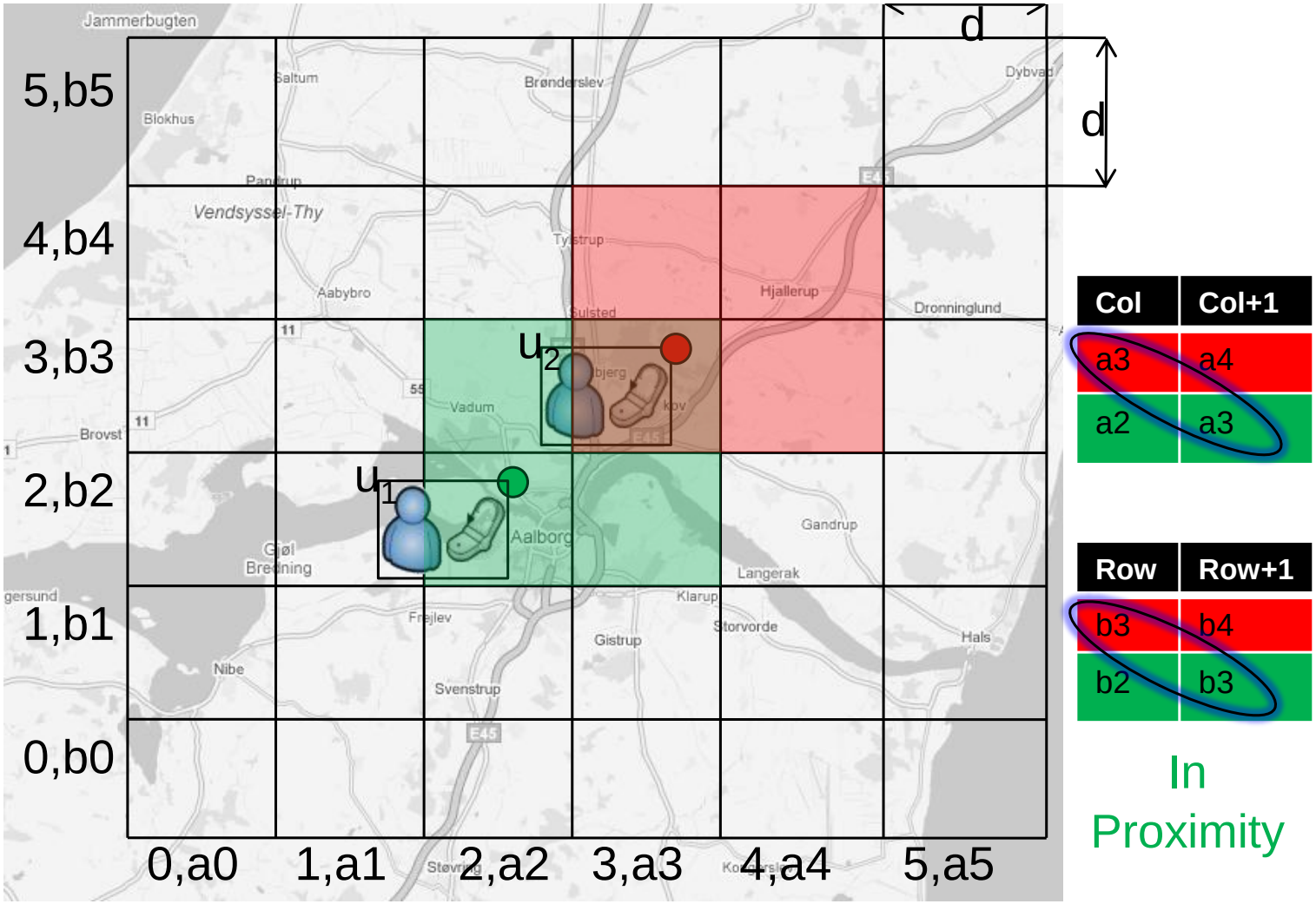


Privacy-aware Proximity Detection Idea



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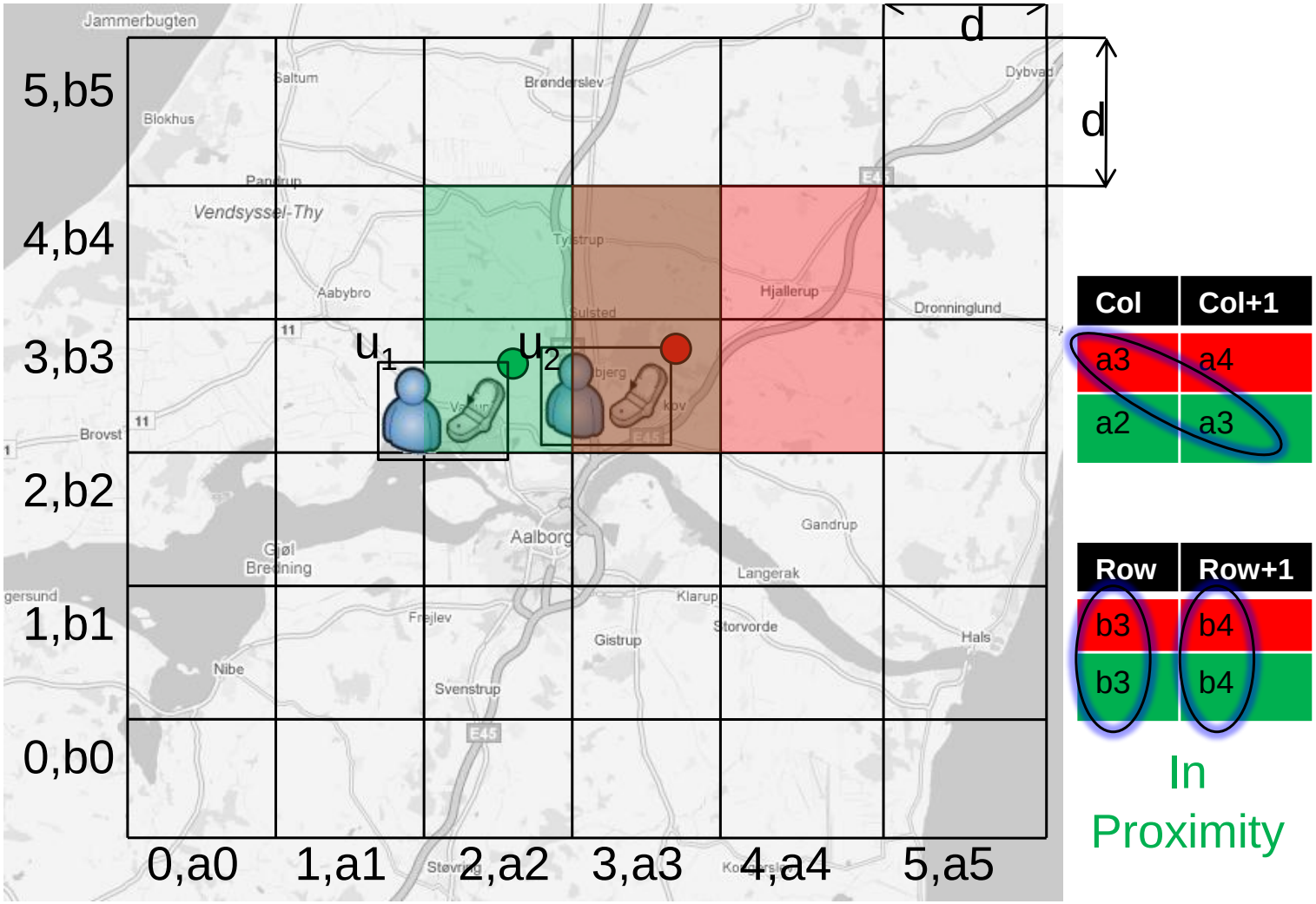

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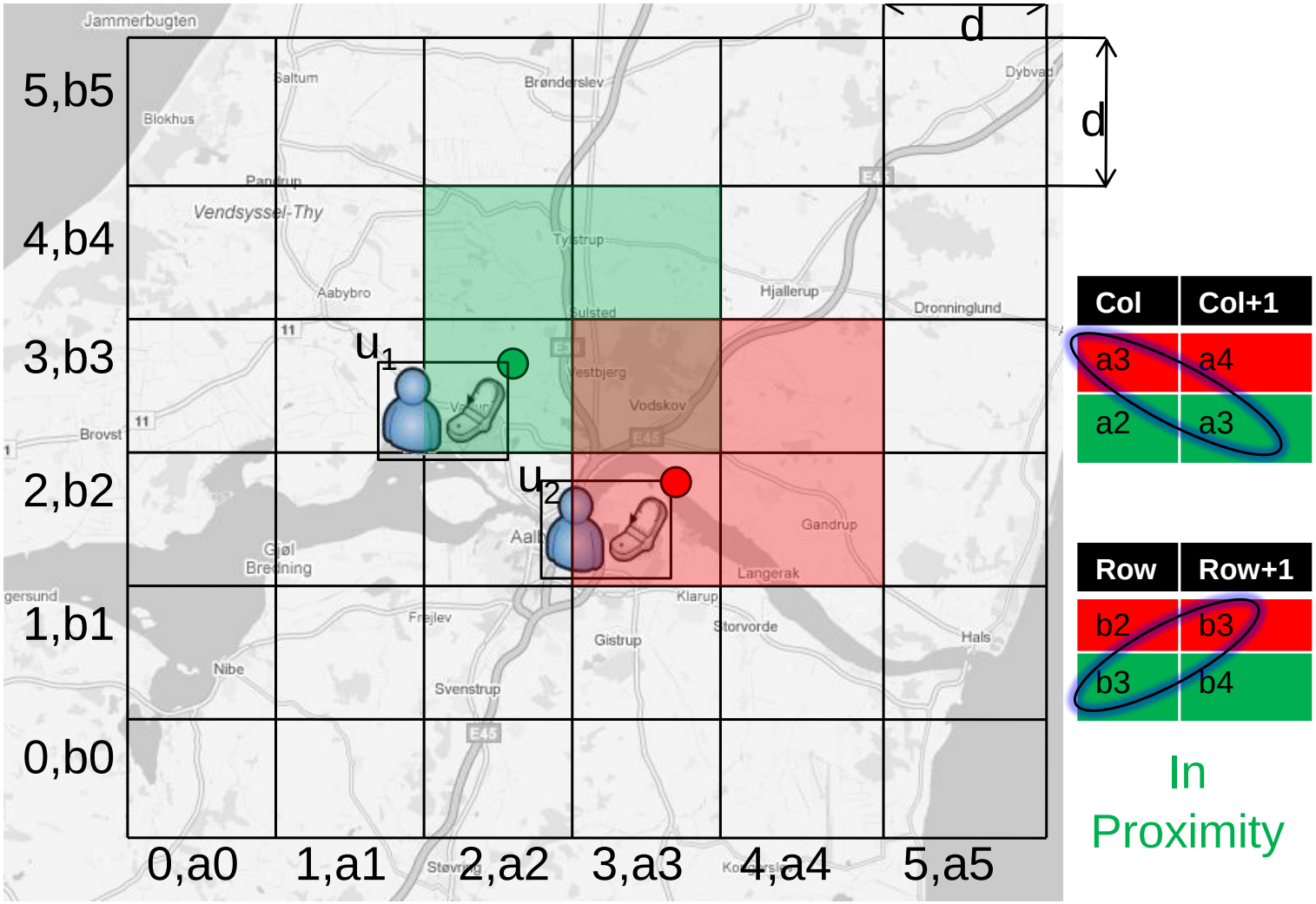

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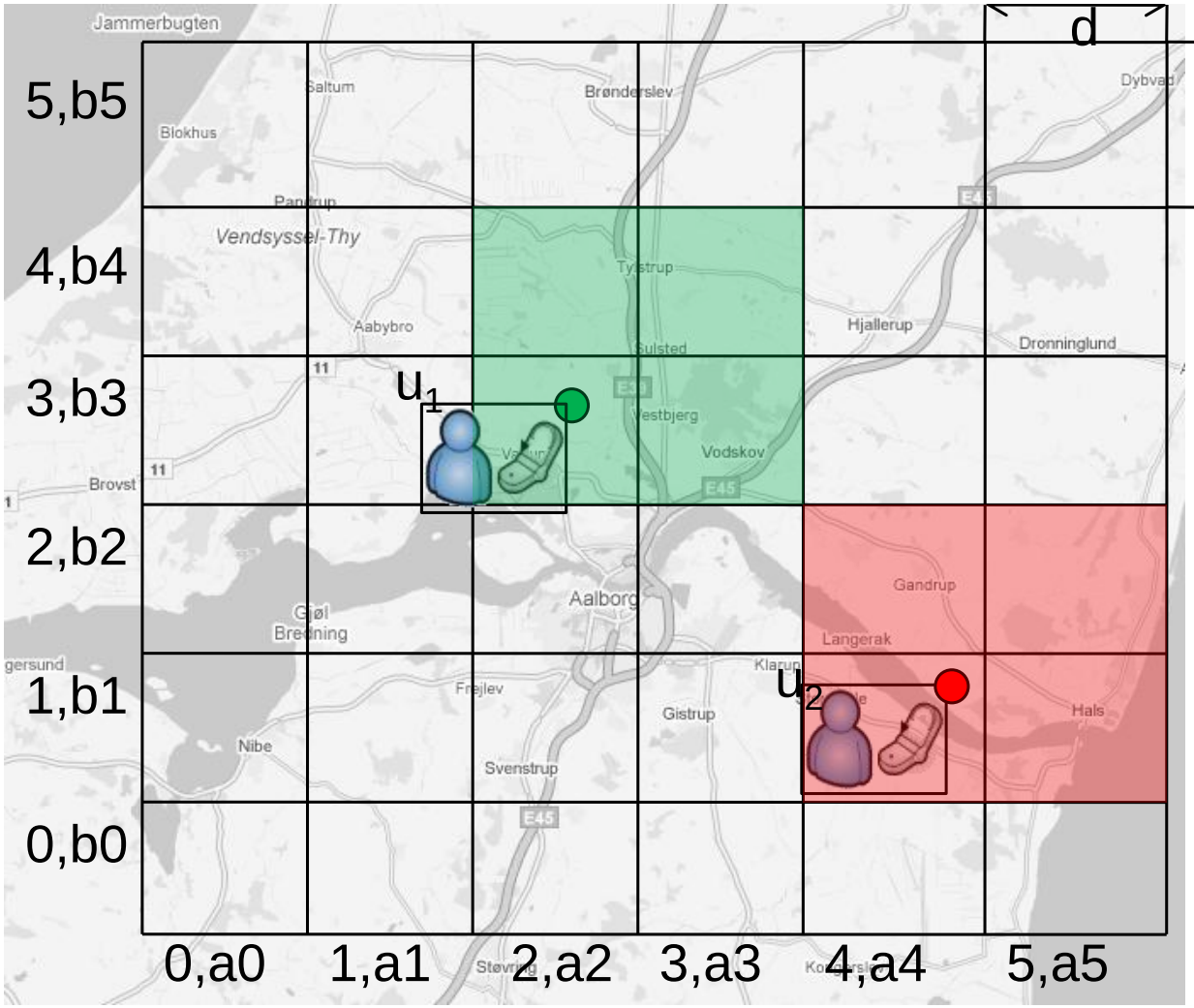


Col	Col+1
a3	a4
a2	a3

Row	Row+1
b1	b2
b3	b4

In Separation

Limitation and solutions of this approach

Limitations of this approach:

1. It is inefficient for big number of users
2. A proximity detection distance is fixed $(2d\sqrt{2})$

Solutions for problems:

1. Grouping of friends
2. Dynamic grid approach

Grouping of friends

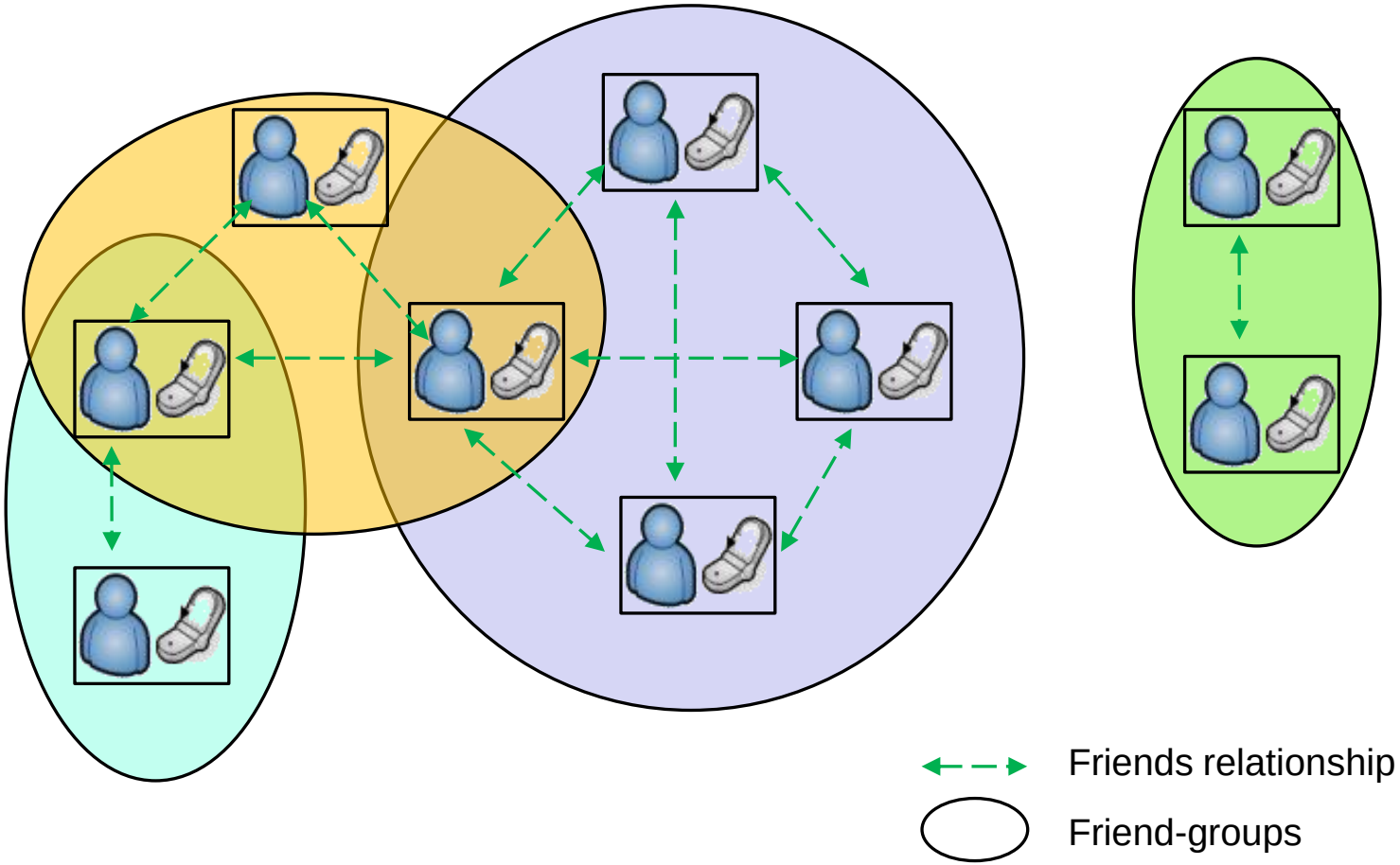
The solution:

- Users are grouped into friend-groups
- A single grid is assigned for every friend-group

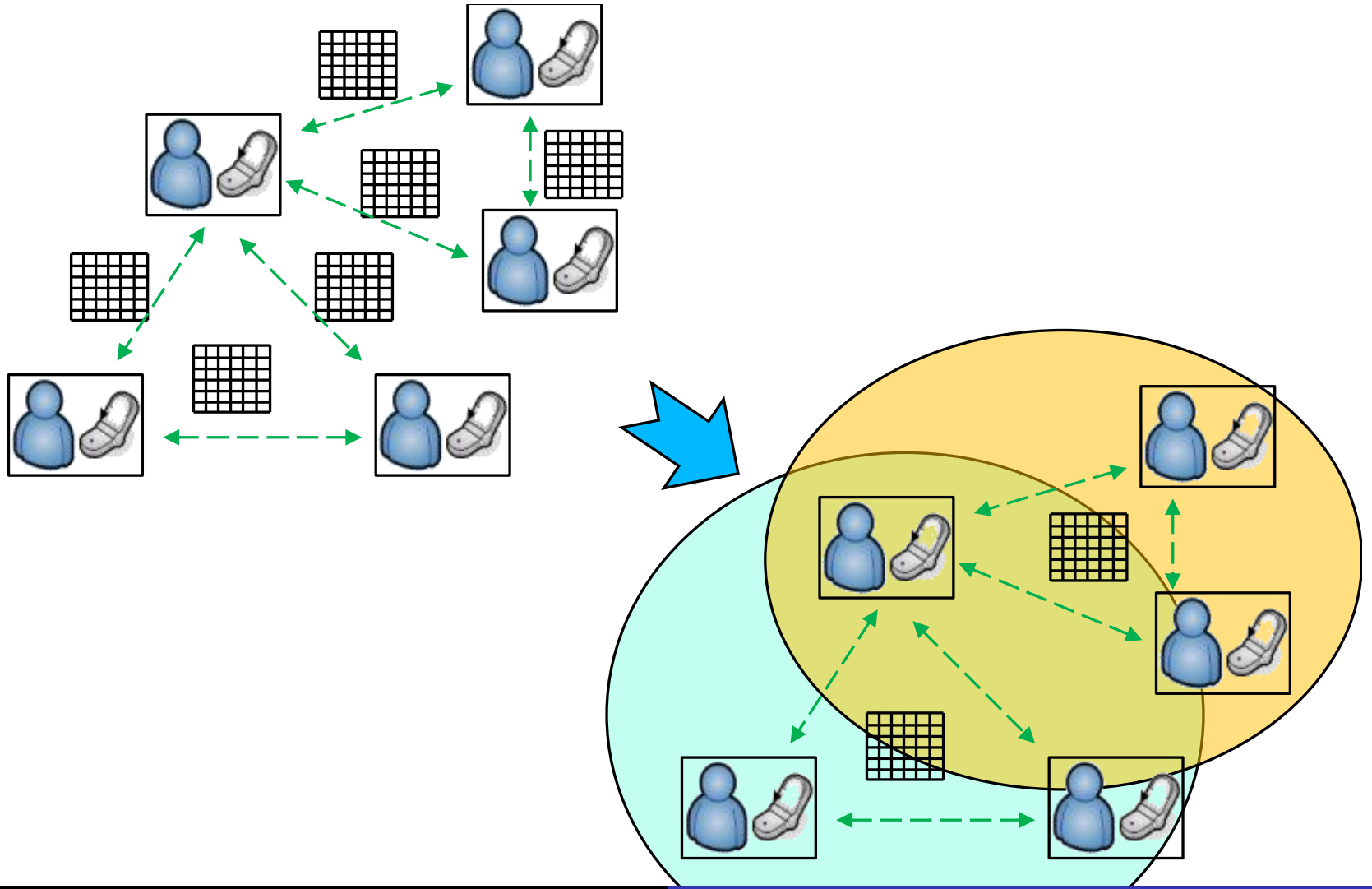
Consequences:

- When user location changes, less secret values must be delivered to LBS server

Grouping of friends



Grouping of friends



Dynamic Grid Approach

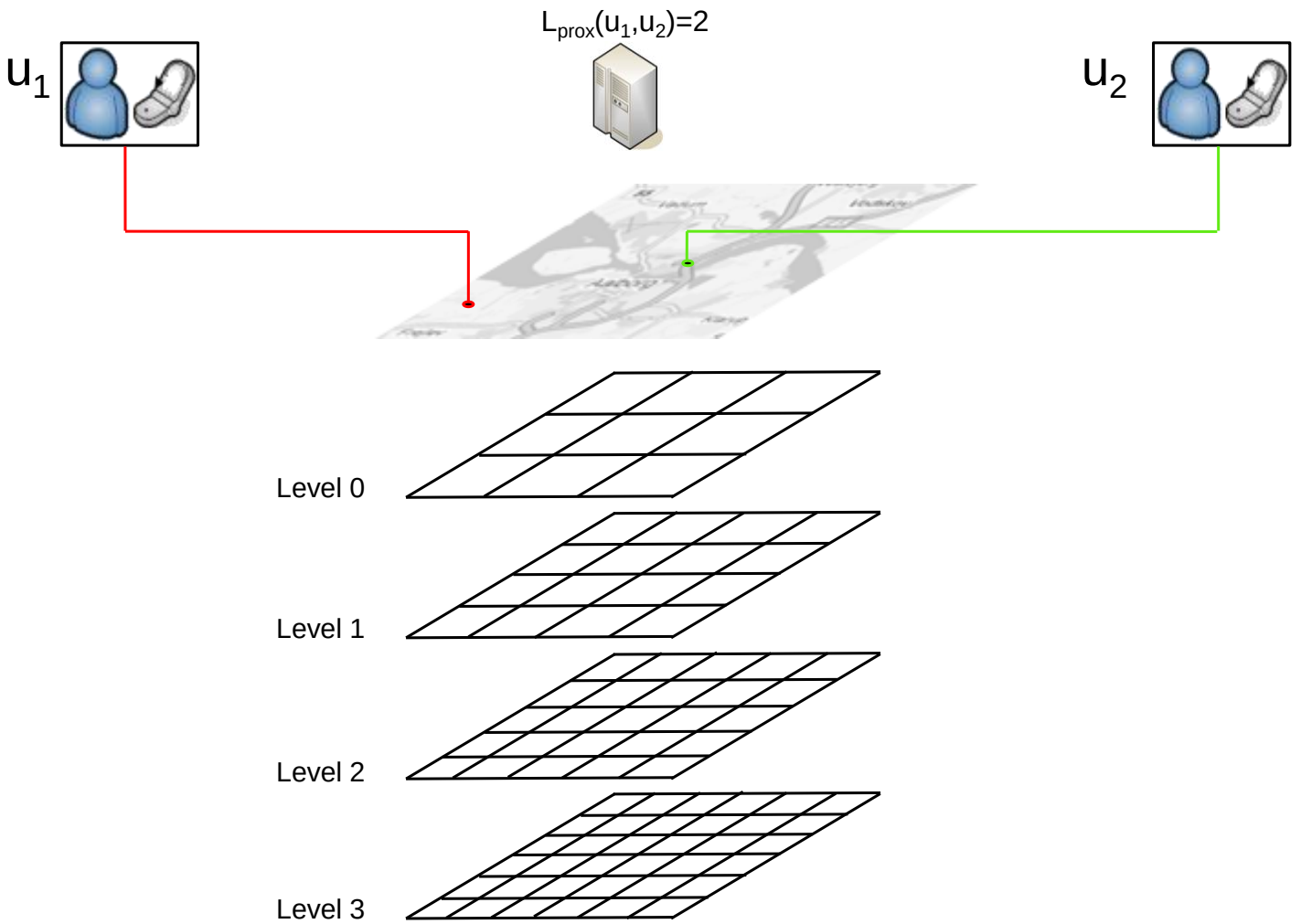
The solution:

- Assign a stack of grids with decreasing cell size for every friend-group
- Extend a basic proximity detection approach to support stack of grids

Consequences:

- Any pair of friends in friend-group will be able to choose a prefered proximity distance from a list

Dynamic Grid Approach



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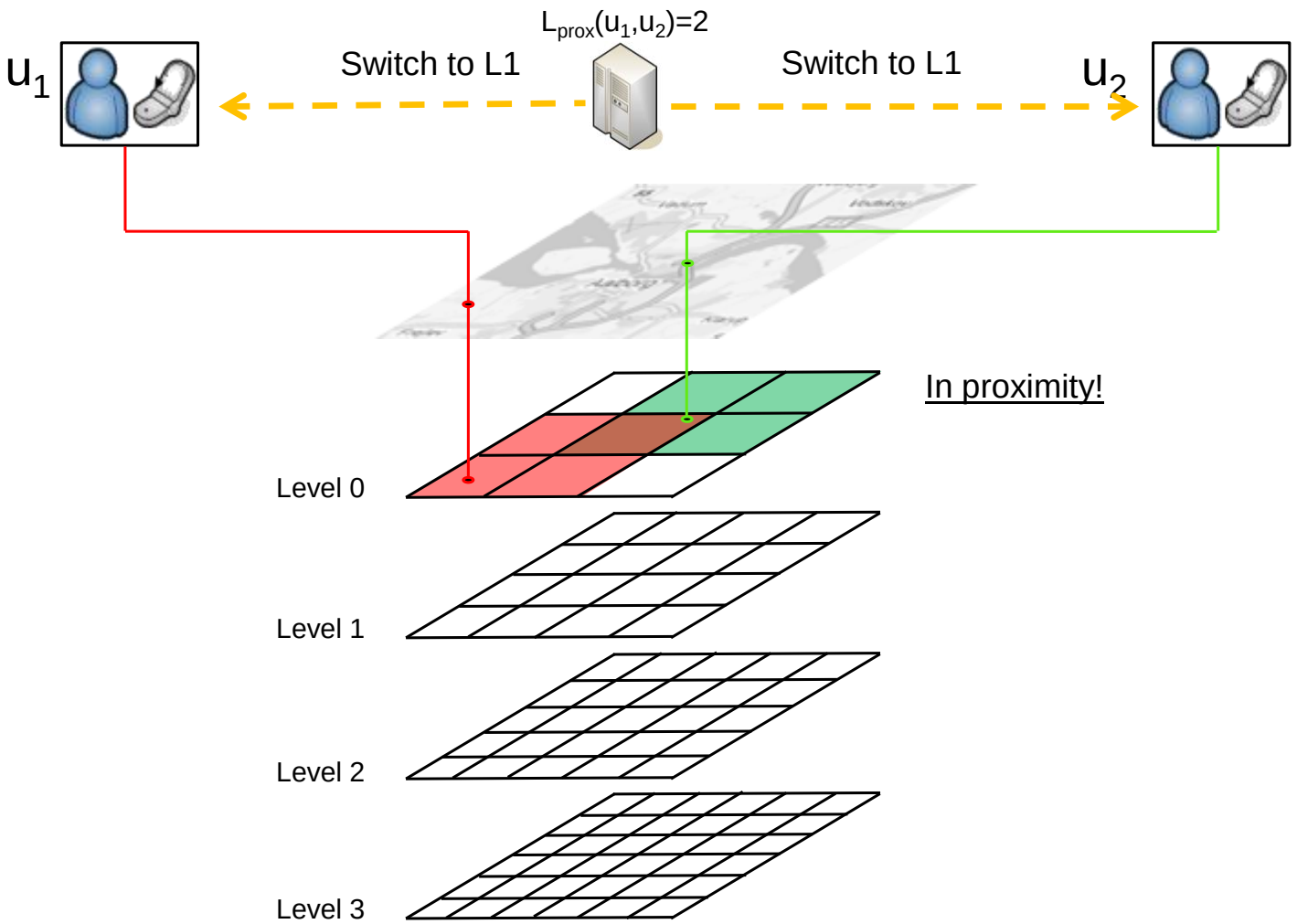

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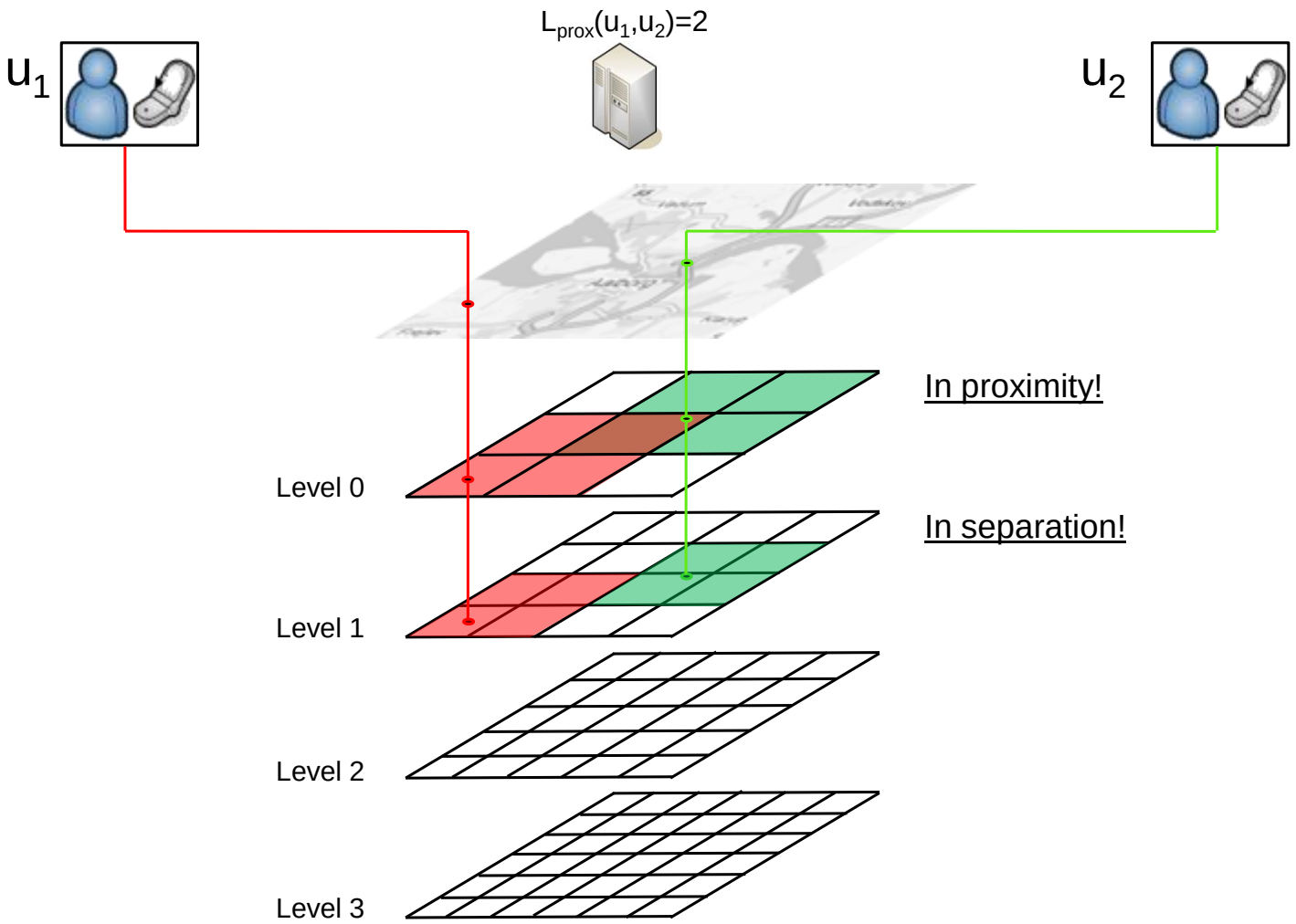

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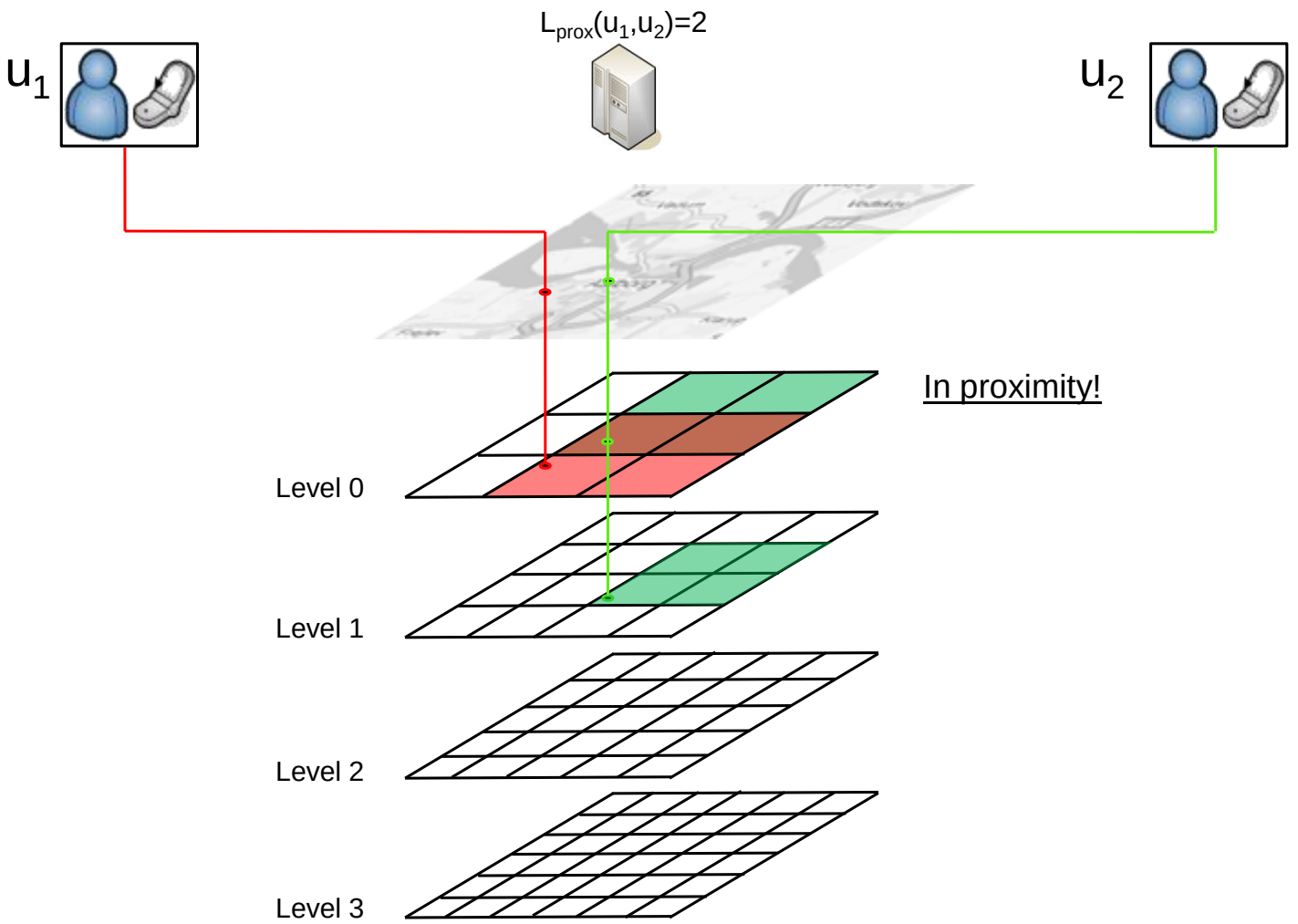

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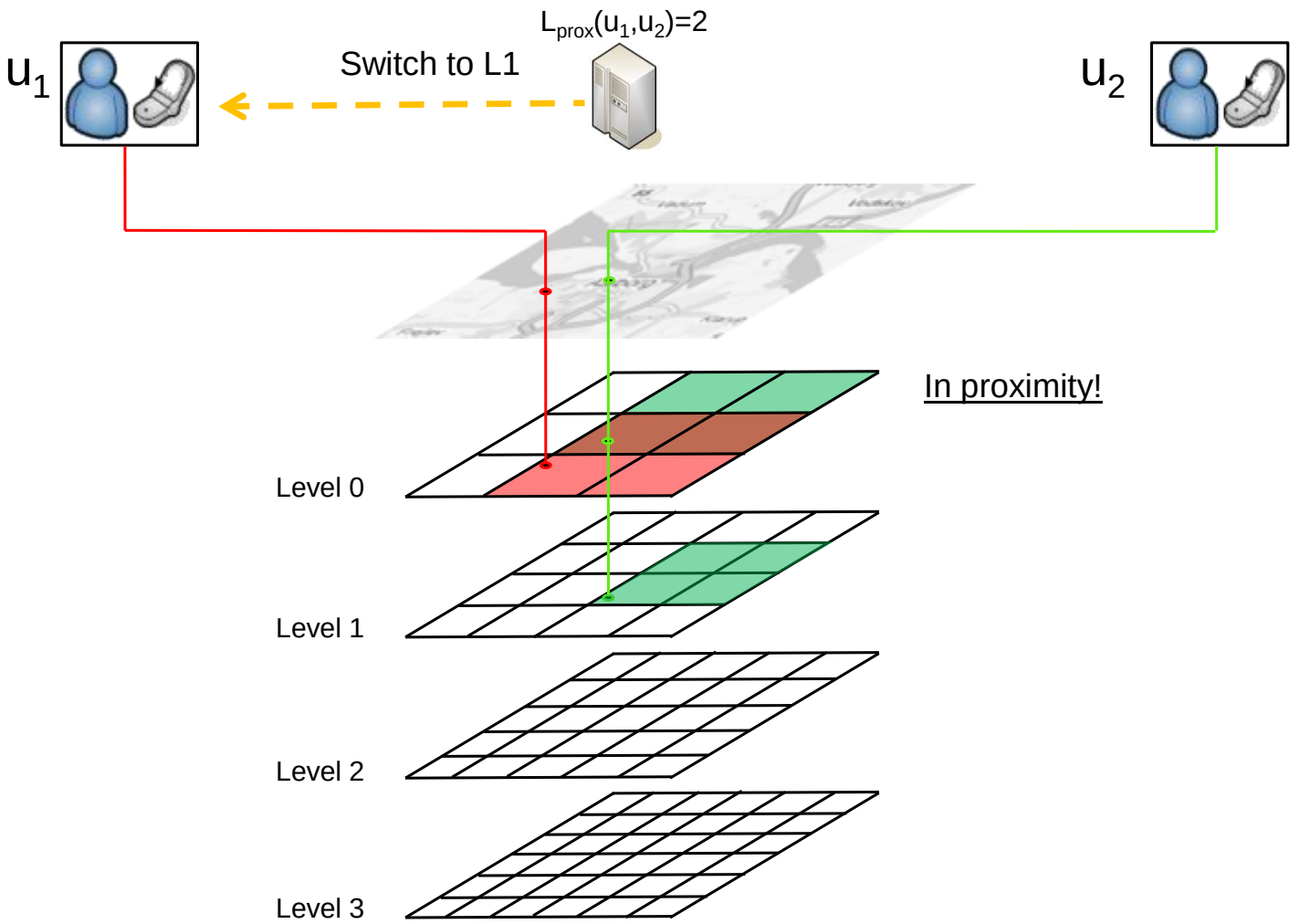

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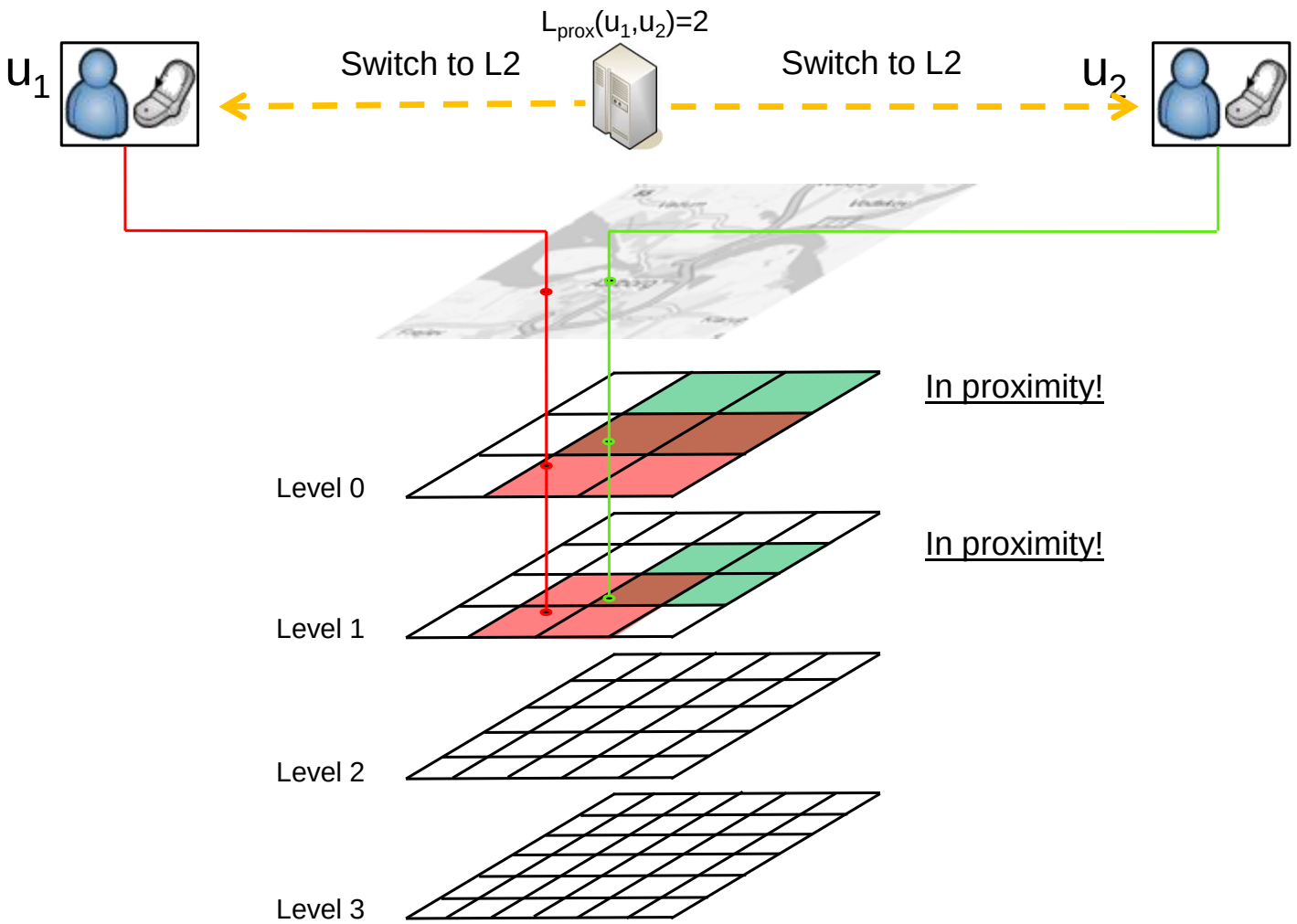

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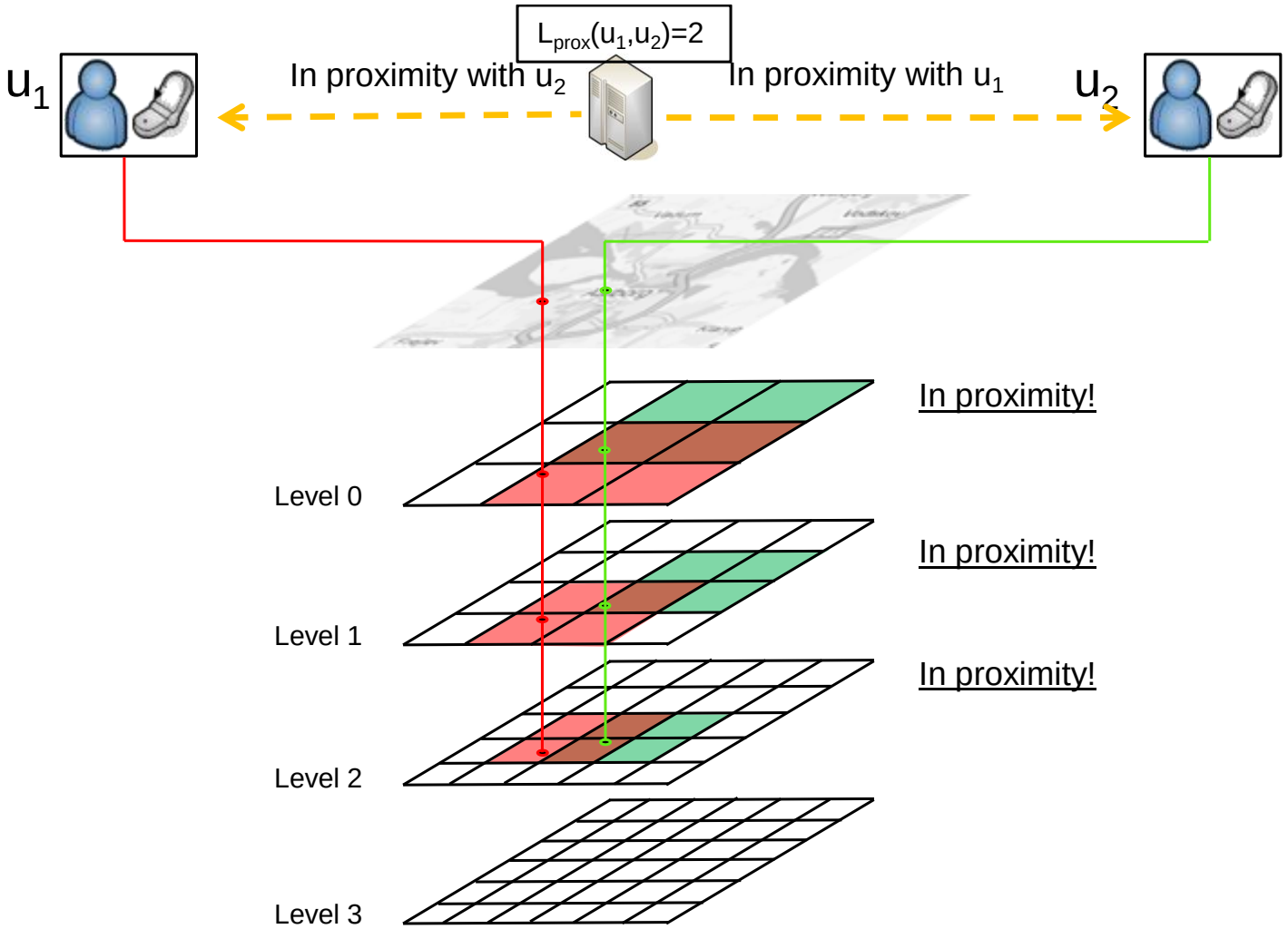


Friend-finder service designs

Two Friend-finder service designs:

- Basic Design
  - Uses basic proximity detection approach
- Dynamic Grid Design
  - Uses dynamic grid approach

Features:

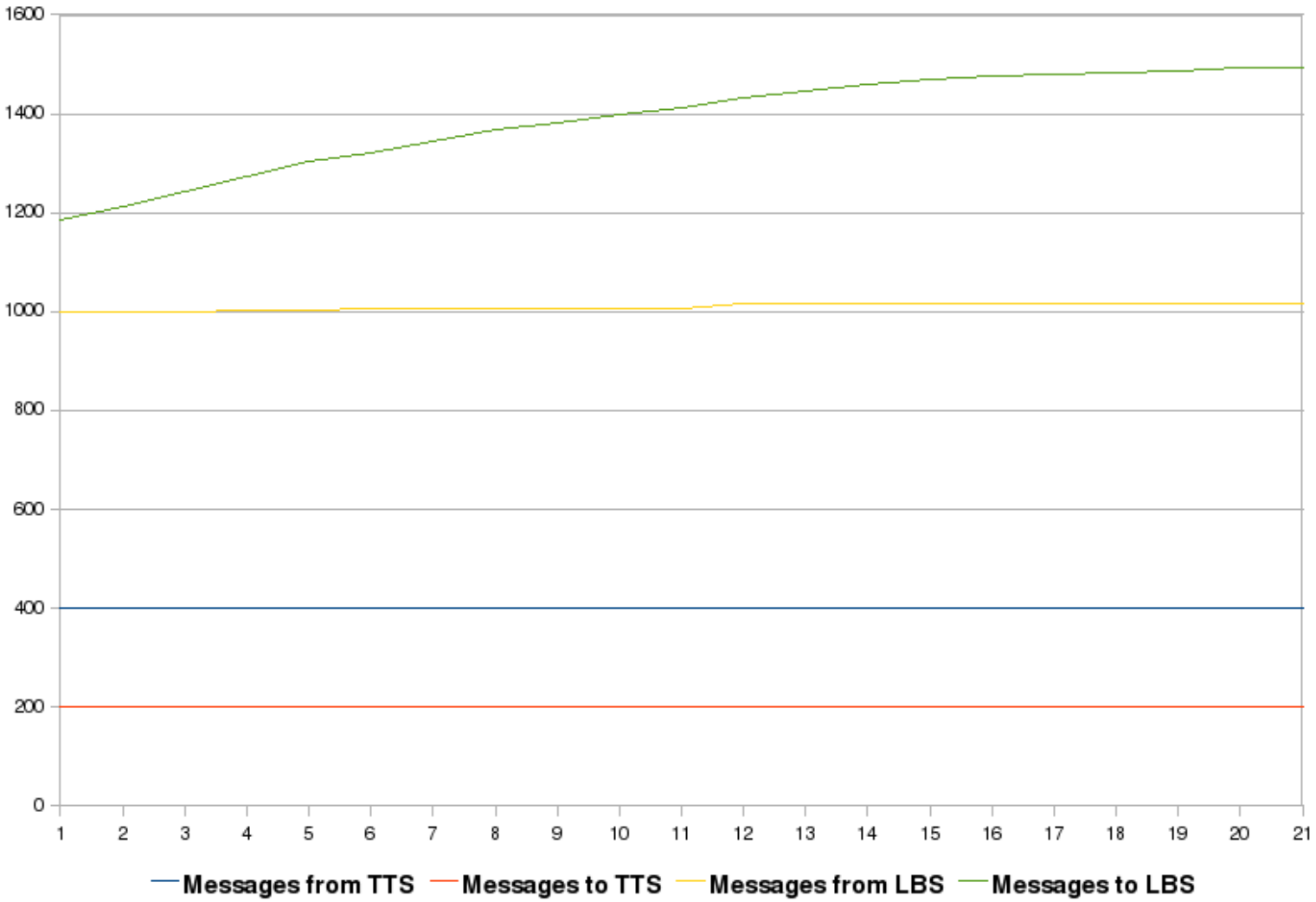
- Employs users grouping into friend-groups
- Assumes an existence of trusted 3rd party server

Testing Methodology

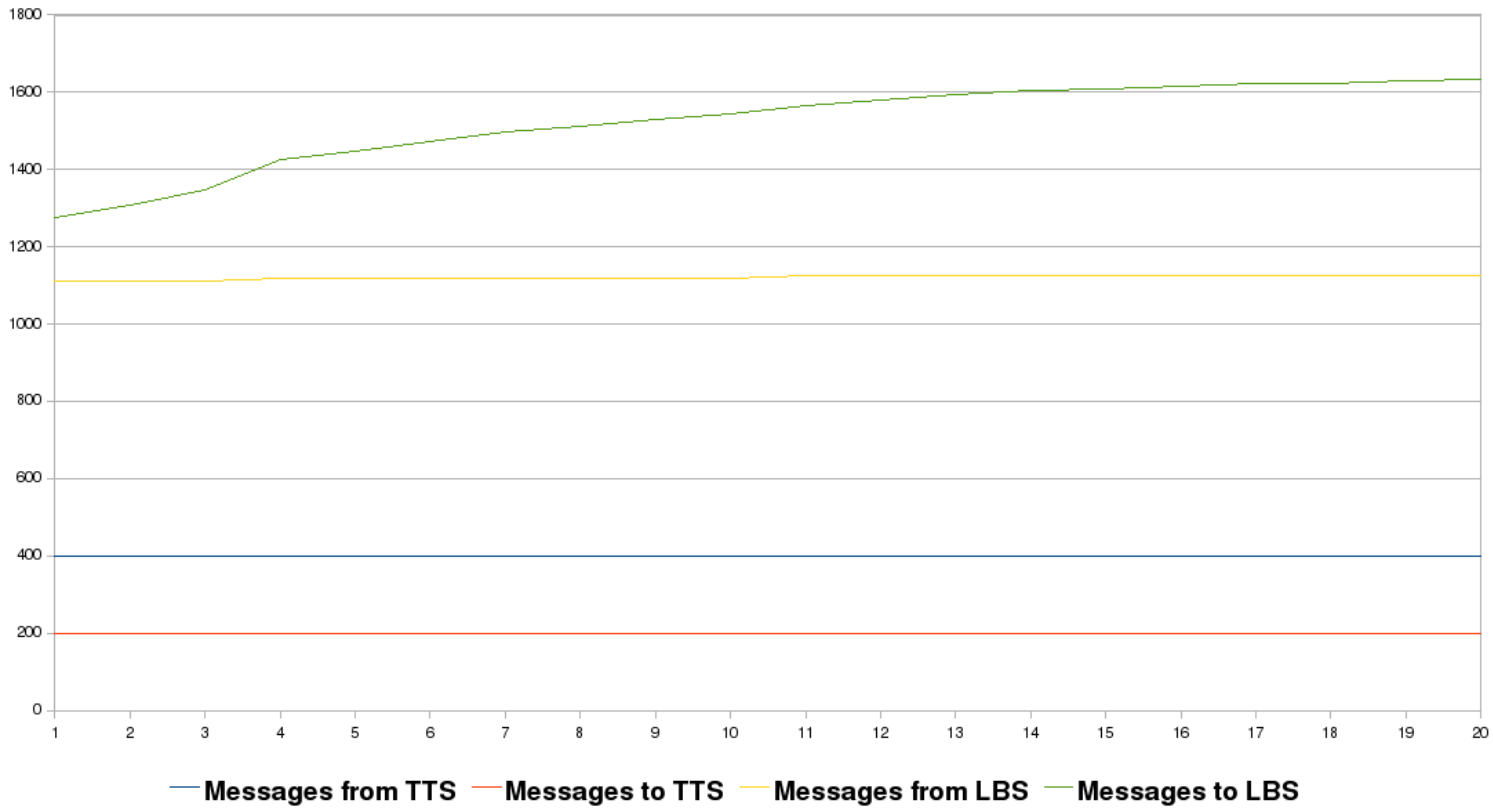
System Test Settings

- 200 users.
- 20 Position Points per user.
- Each user only in one group.
- Proximity level: 6
- Four data sets
  - 5 Users per Group (40 Groups).
  - 10 Users per Group (20 Groups).
  - 20 Users per Group (10 Groups).
  - 50 Users per Group (4 Groups).

5 Users in each Group / 40 Groups



10 Users in each Group / 20 Groups



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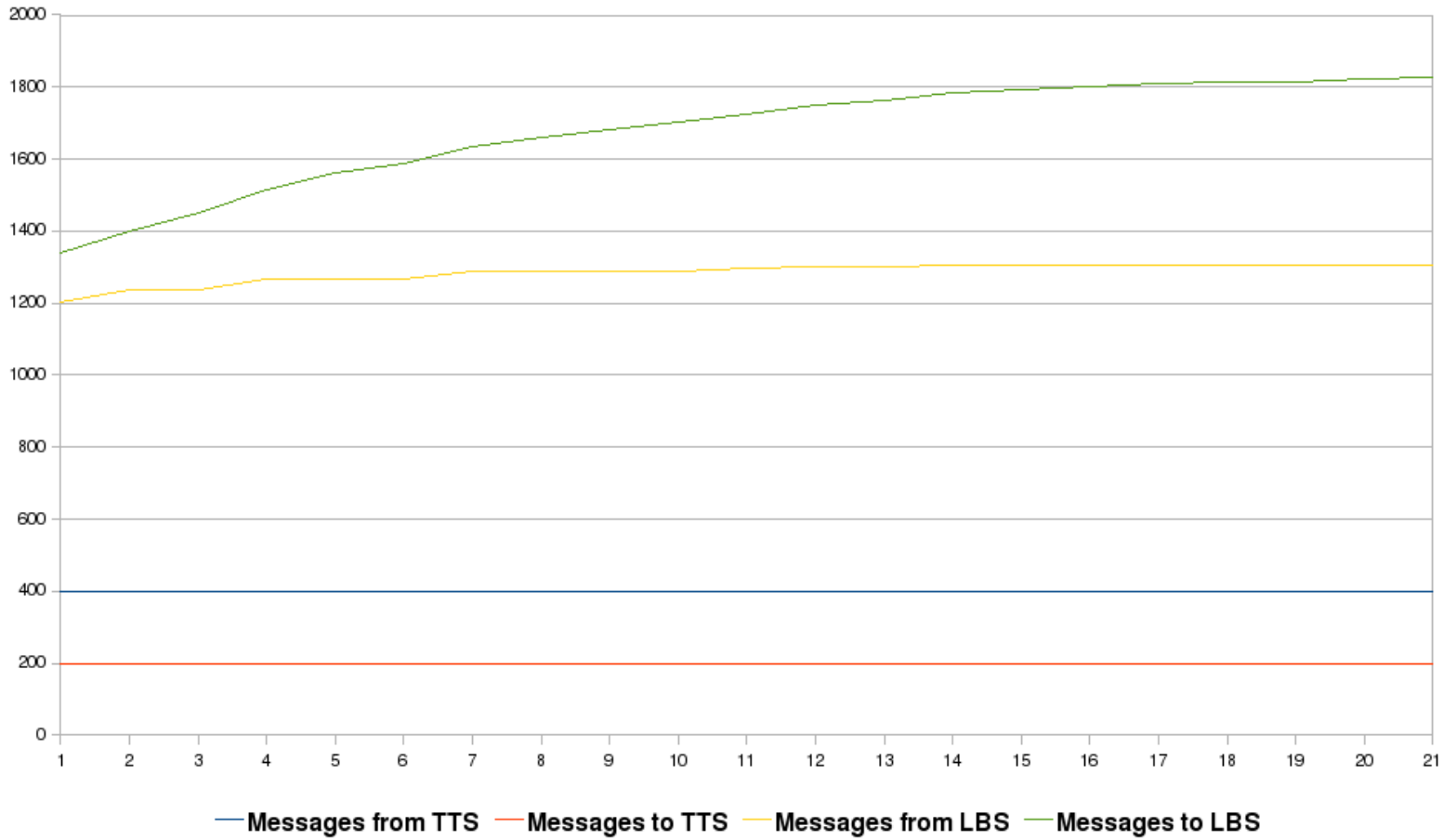
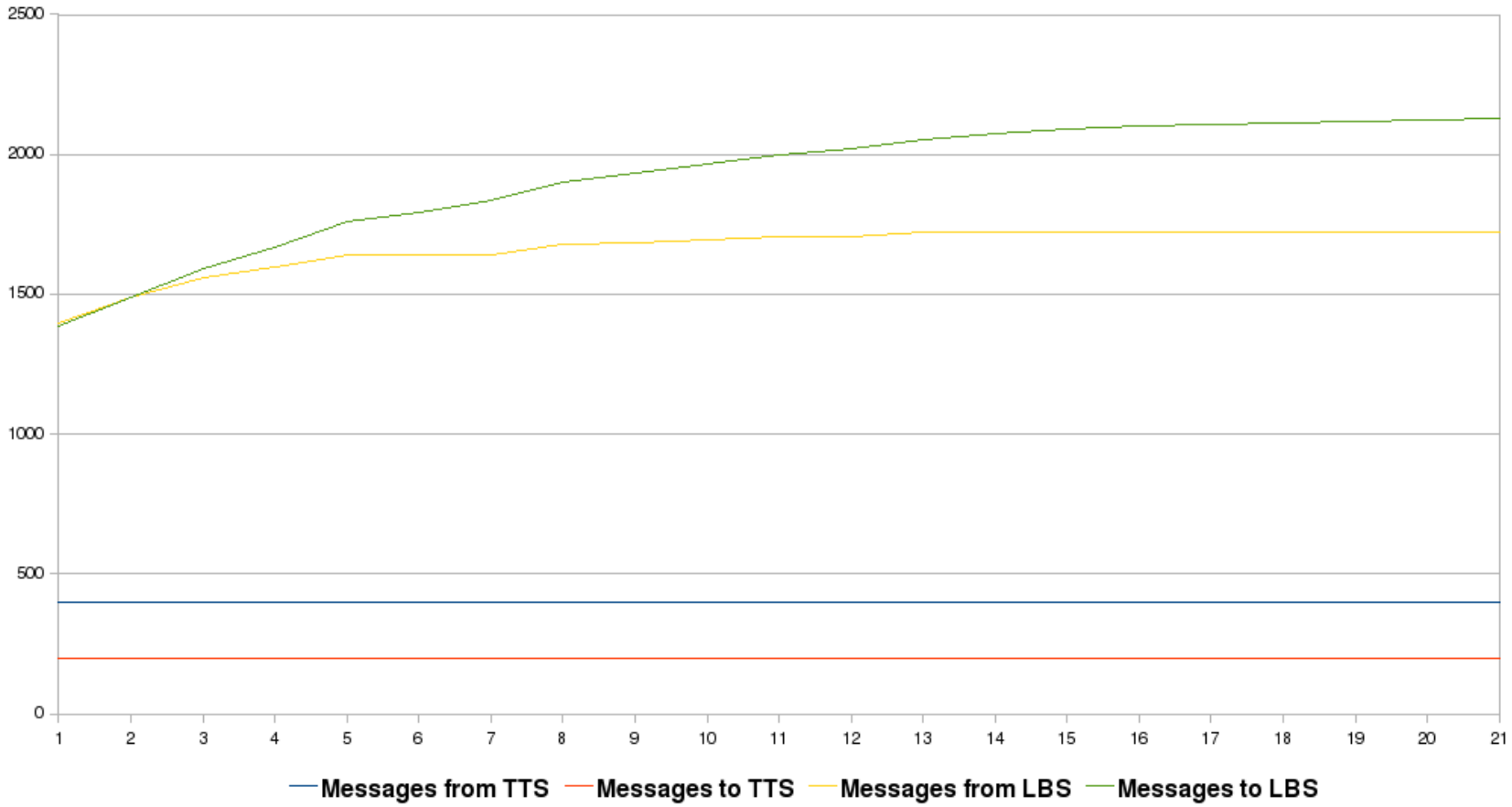
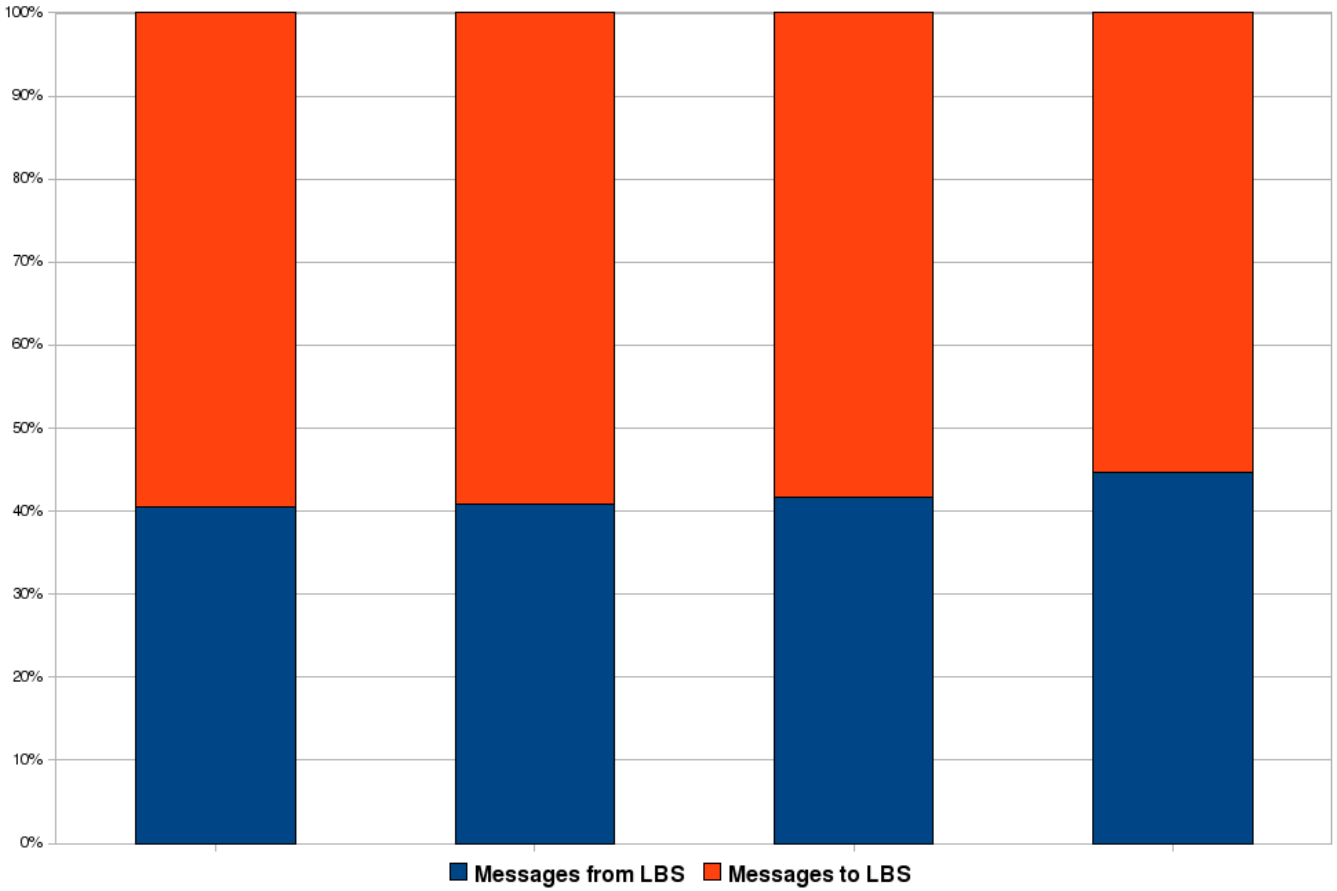


50 Users in each Group / 4 Groups



Total Messages, Percent-wise distribution



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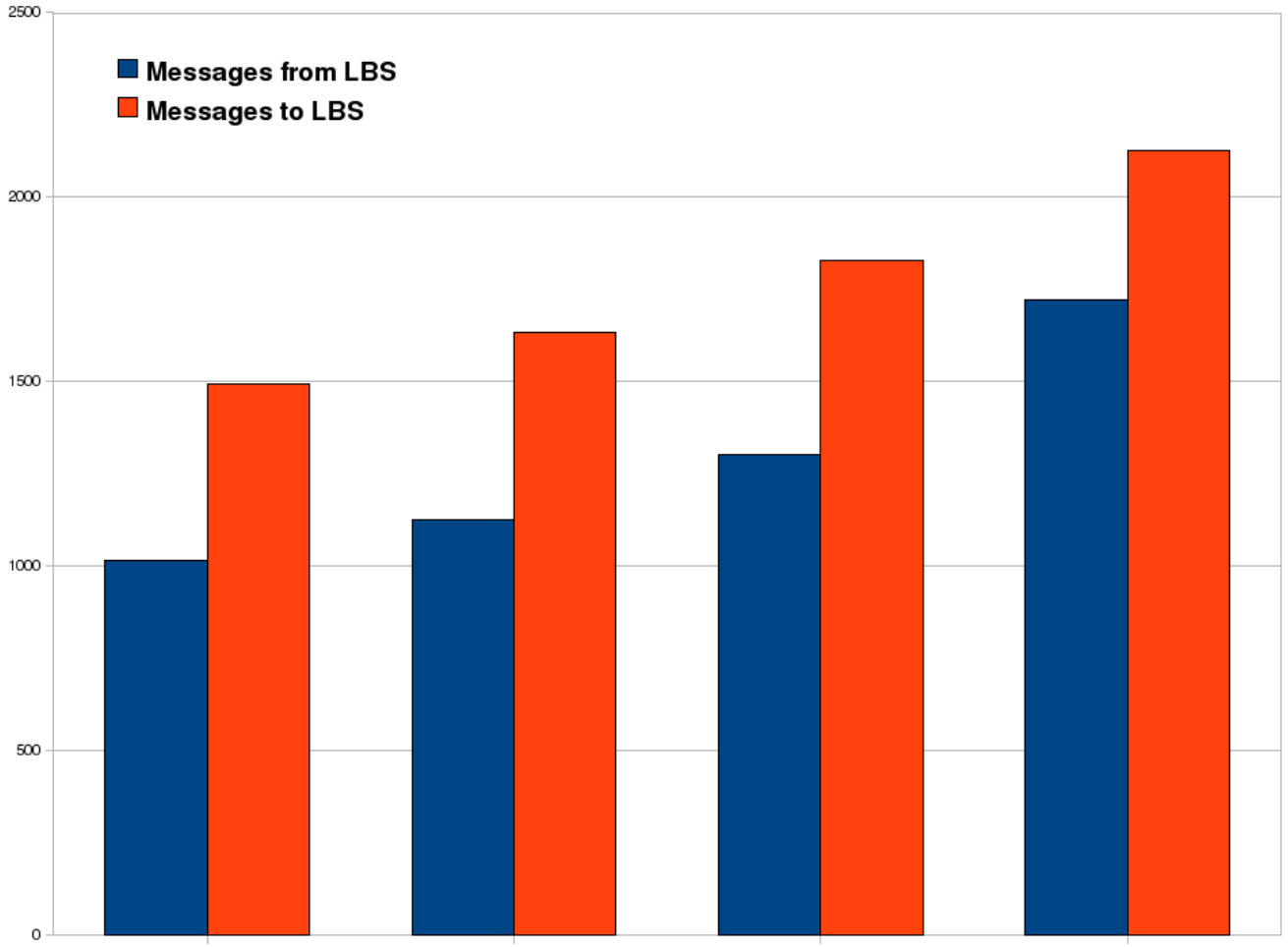

Conclusion

- Novel approach.
- System has a very low running cost in terms of messages
- Very resilient to attacks.

Future Work

Possible extensions

1. Different grid cell shapes.

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Other Directions

1. Analyze user-levels on Server to find congested areas.

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2. History analysis of user grid patterns, e.g to find carpooling opportunities.

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Other Directions

1. Analyze user-levels on Server to find congested areas.
2. History analysis of user grid patterns, e.g to find carpooling opportunities.
3. Make the idea fully or partially peer-to-peer

Questions

- Interesting future work?
- Would you use such a system?
- How can a group of friends, through an untrusted server, exchange private information (e.g. an encryption key)