GWT
The Google Web Toolkit

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January 22, 2010

Content Of The Thesis

Two novel privacy-aware proximity detection approaches:

- FriendLocator (FL)
  - Article of 18 pages. Submitted to SSTD 2009
  - Article of 6 pages. Accepted to SSTD 2009
- VicinityLocator (VL)
  - Article is not yet submitted

Privacy-Aware Proximity Detection Services

Functions:

- Track objects in the real-time.
  - Positioning technology, e.g. GPS, Wi-Fi
  - Wireless communication, e.g. GPRS, 3G
- Determines if two objects are close to each other.
  - Notifies users
  - Generates event
- Guarantees that object exact location is secured.
  - Prevent crime possibilities

Applications:

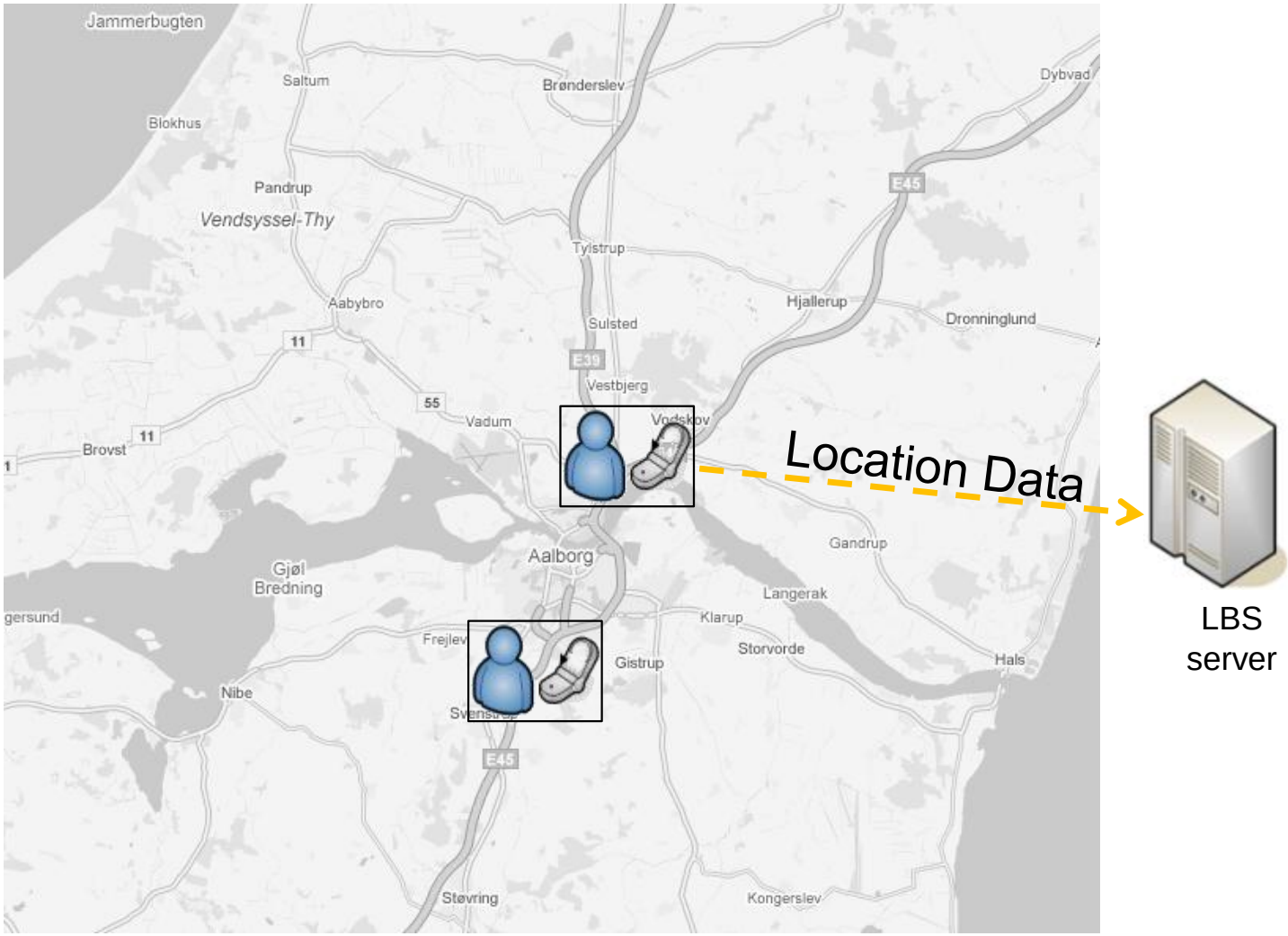
- Nearby friends identification in mobile social networks
- Collision detection
- Advertising

Example of the Proximity Detection

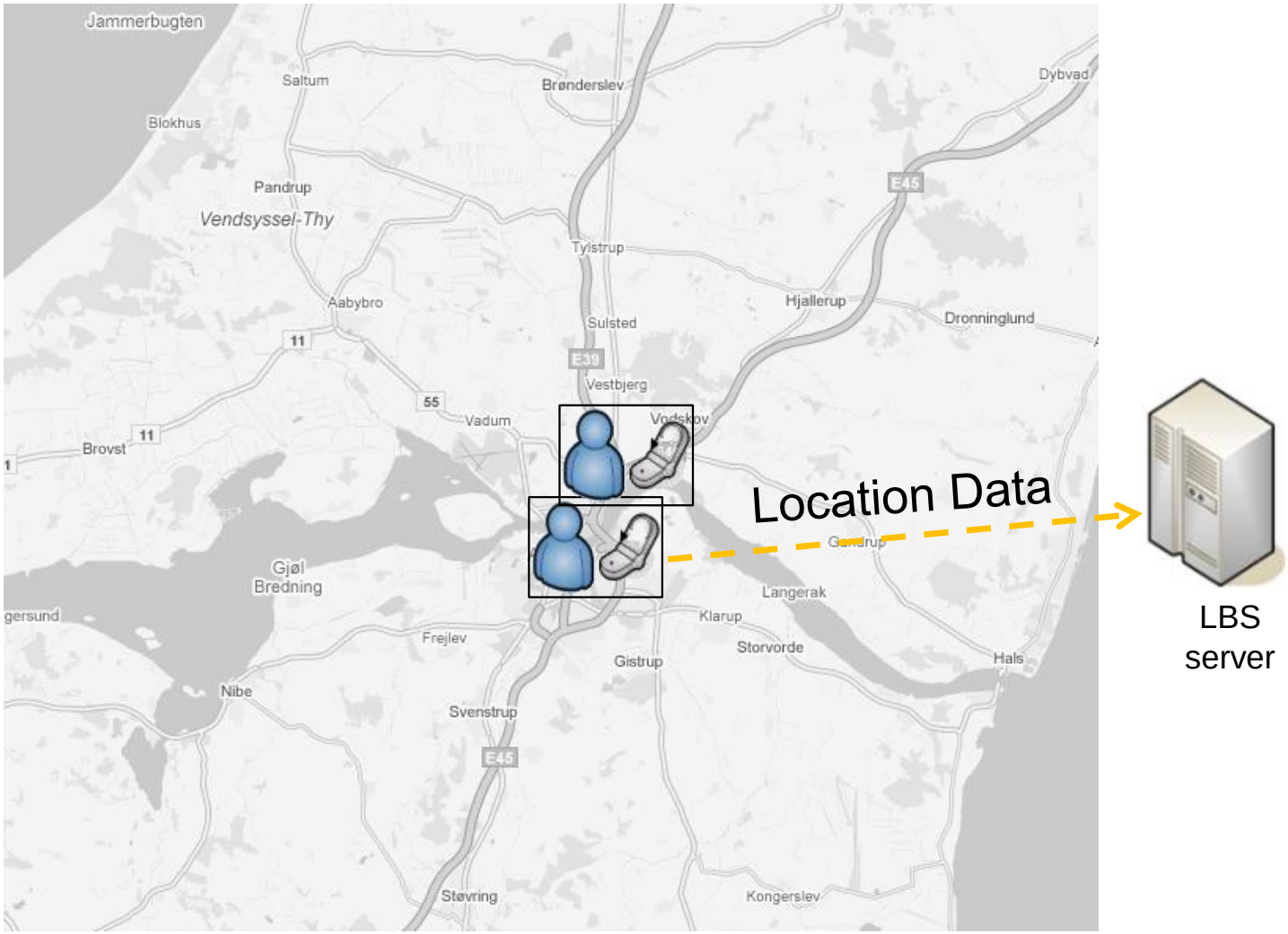
LBS server

Example of the Proximity Detection

Example of the Proximity Detection



Example of the Proximity Detection



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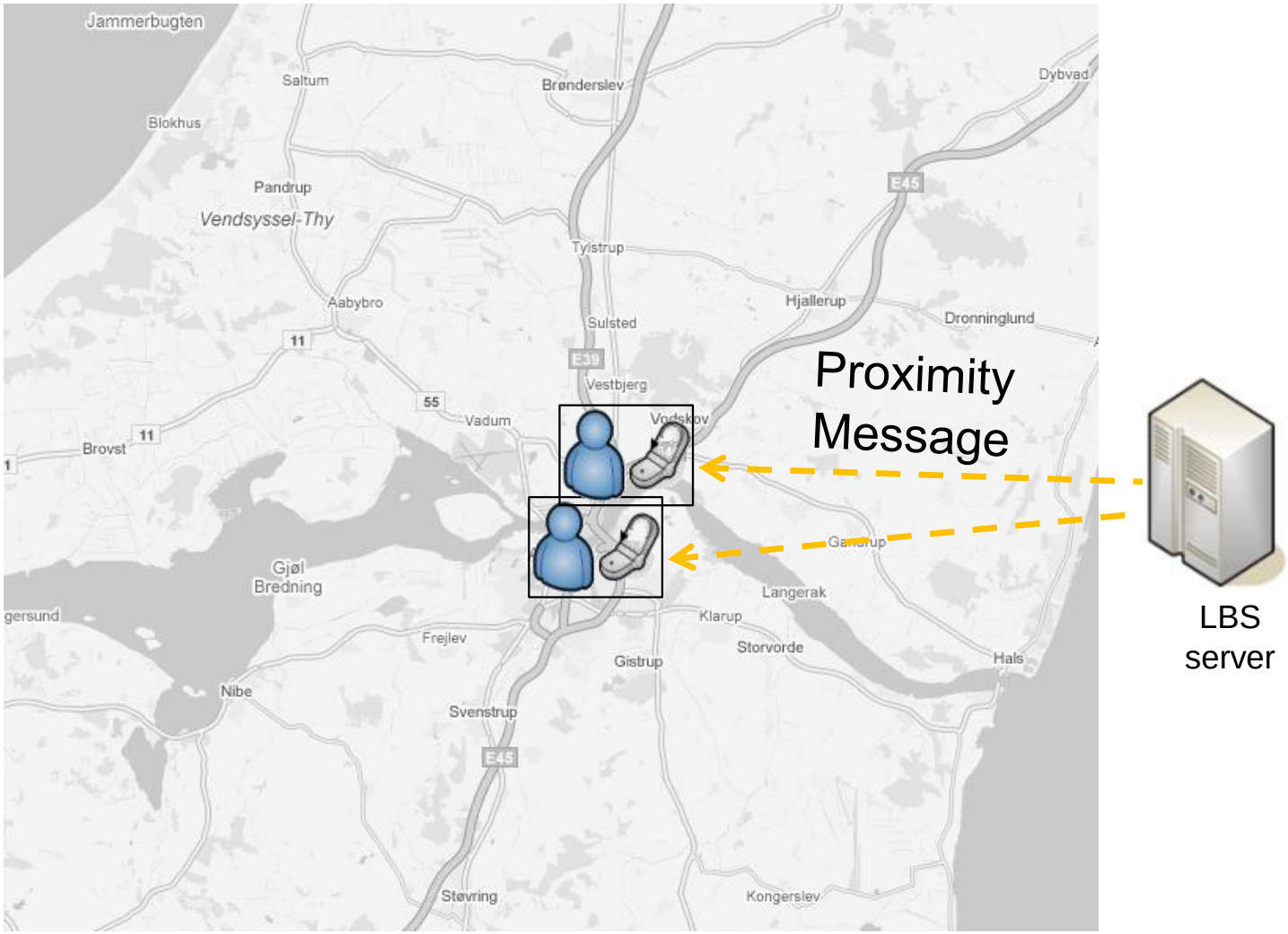


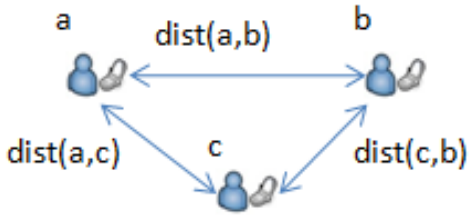
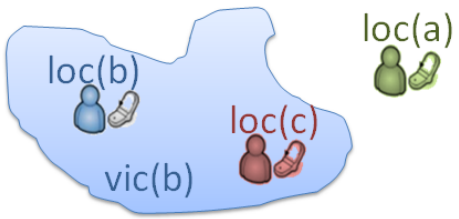
Our vs. Existing Approaches

FL&VL versus existing privacy-aware proximity detection approaches:

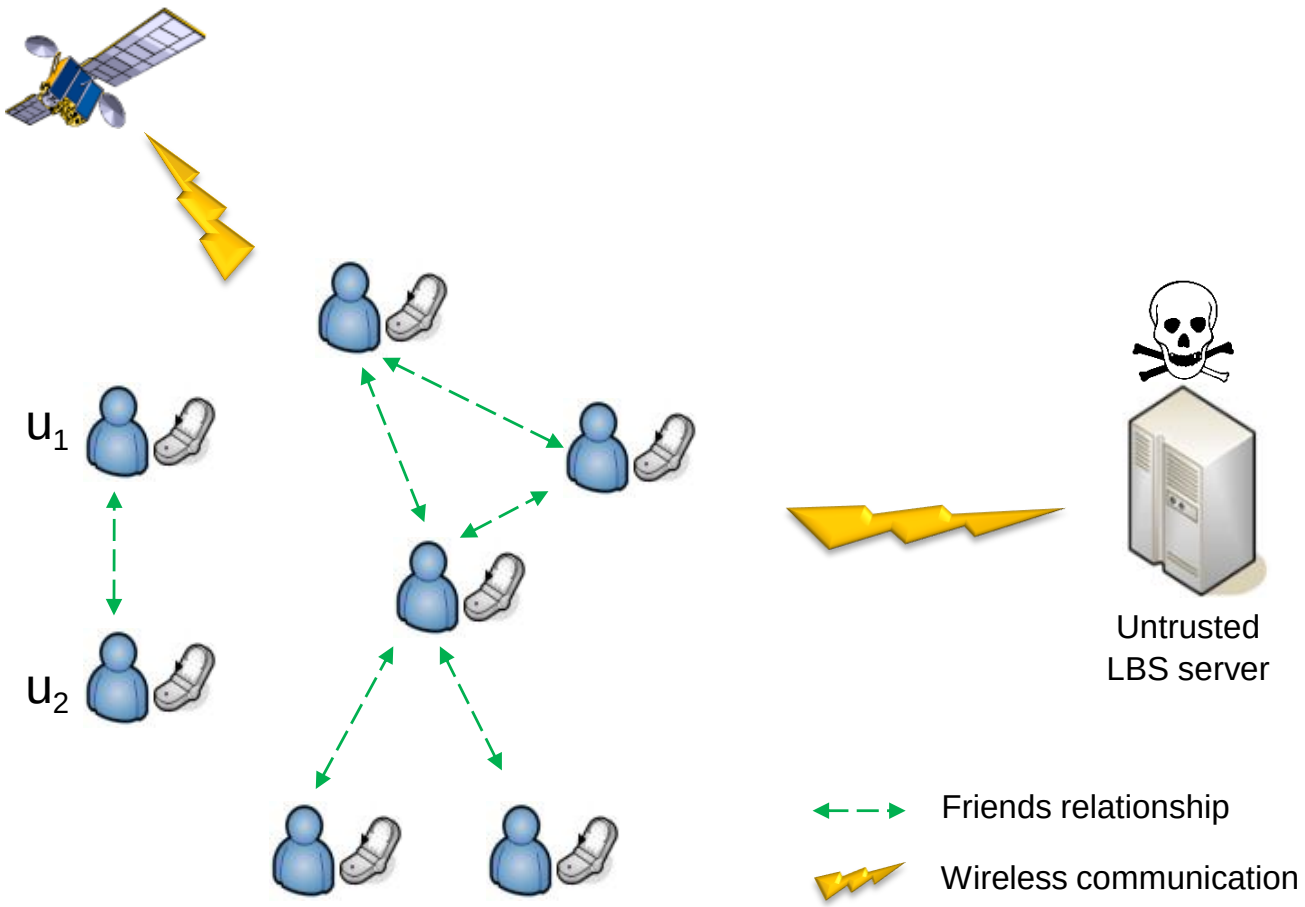
Feature	**FL&VL**	**Solution 1**	**Solution 2**
P2P comm.			+
Client-server comm.	+	+	+
Strength of privacy	strong	weak	average
User settings flexibility	high	average	average

FL vs. VL

Differences between FRIENDLOCATOR and VICINITYLOCATOR:

Feature	**FriendLocator**	**VicinityLocator**
Notion of proximity	$dist(a,b) < \epsilon$ 	$loc(a) \in vic(b)$ 
User settings	$\forall(a,b) : \epsilon_{a,b}$	$\forall a : vic(a)$, $\lambda(a)$,
Quality of service (precision)	Depends on $\epsilon_{a,b}$	$min(\lambda(a), \lambda(b))$
Communication is traded for	ϵ and precision	Precision

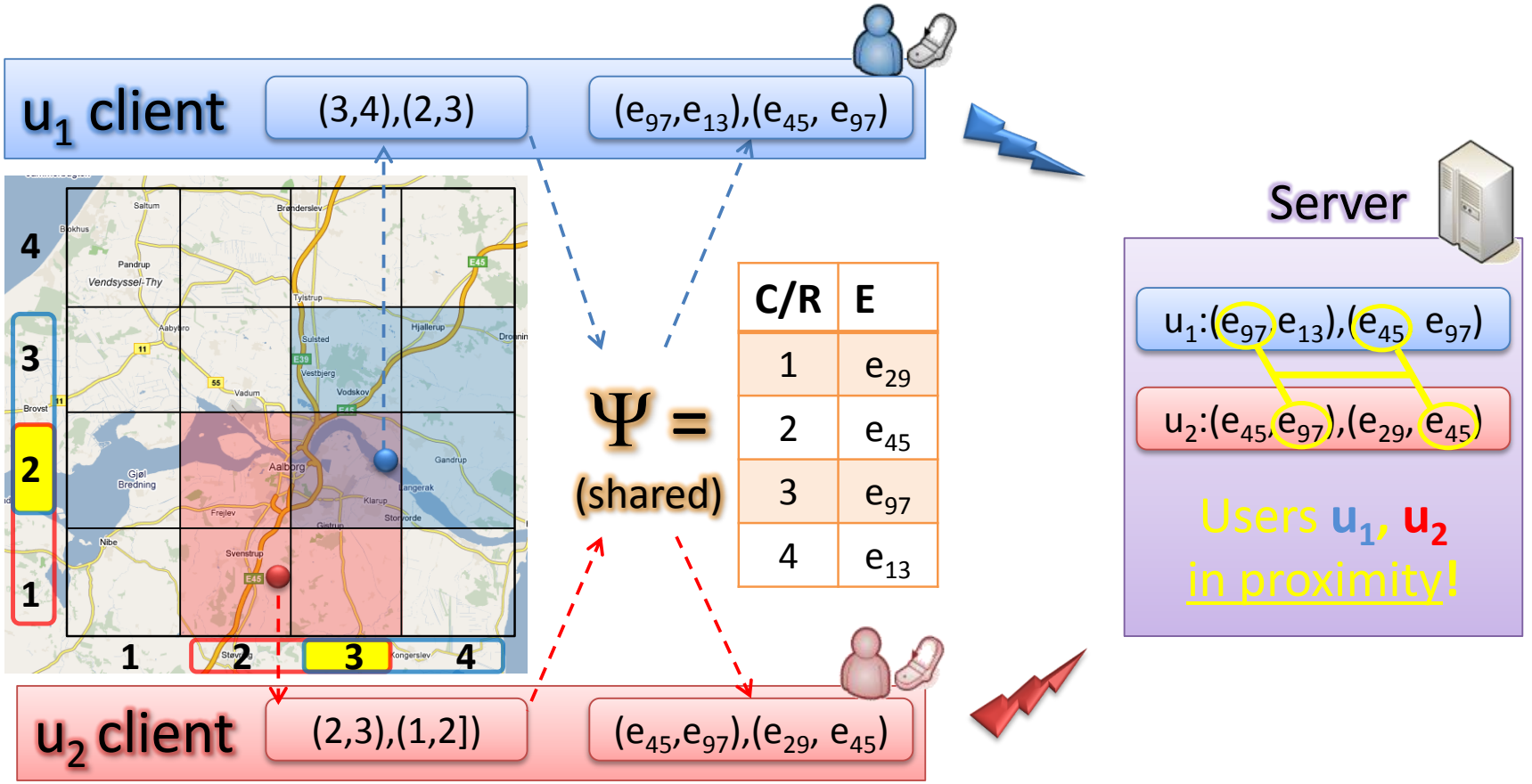
Problem setting



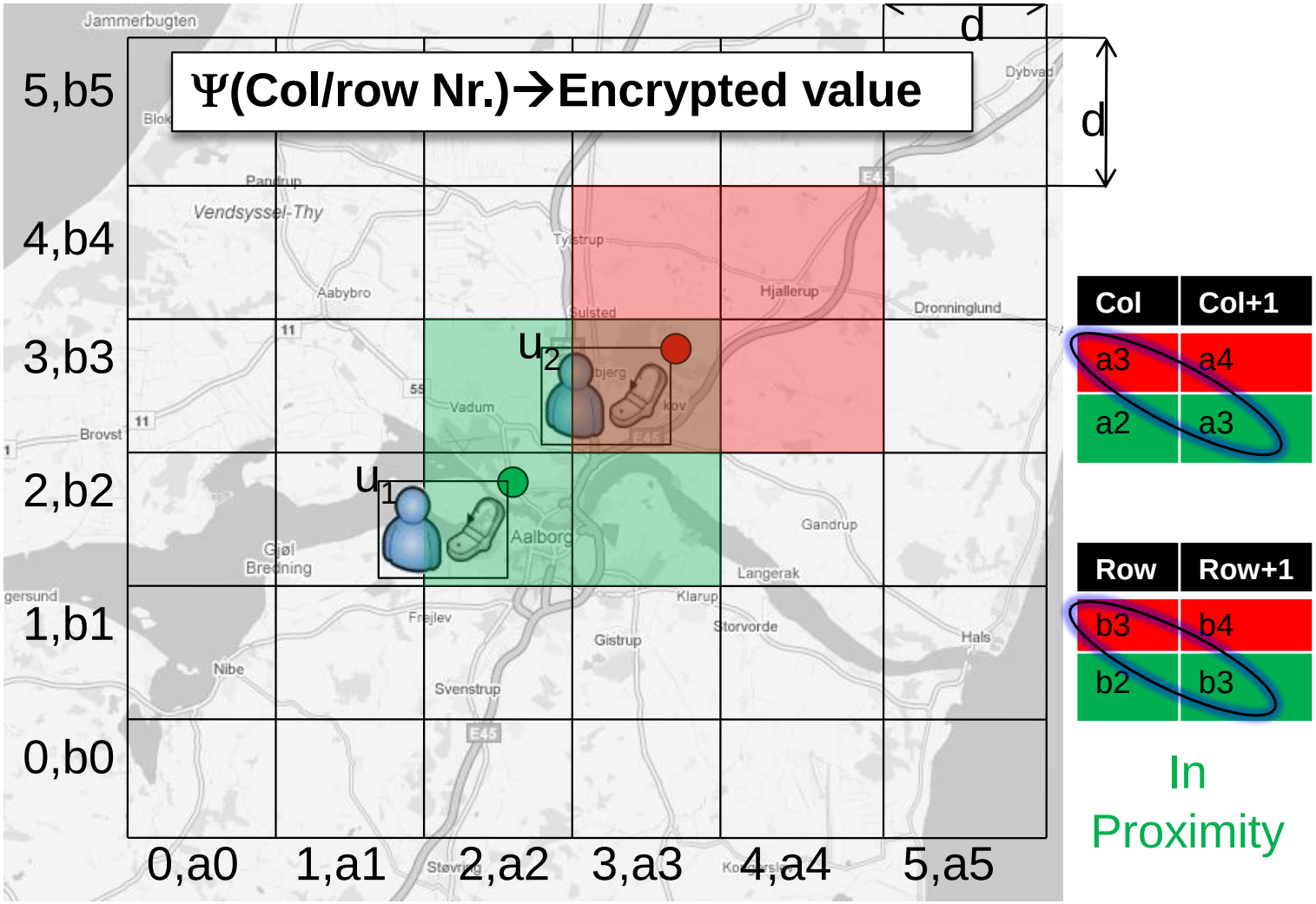
FriendLocator

FriendLocator - A Location Privacy Aware Friend Locator

Core idea of FriendLocator



Core idea of FriendLocator



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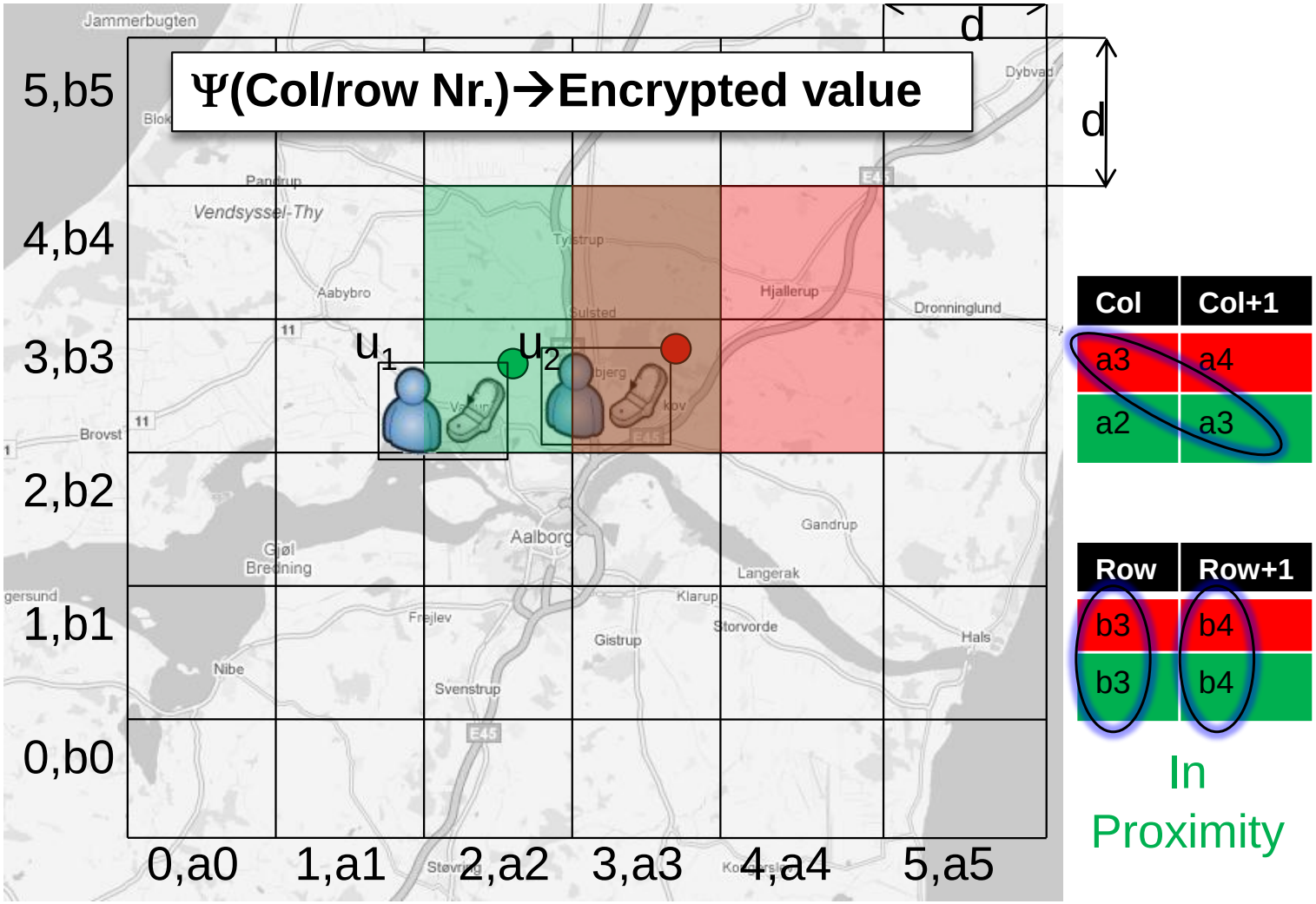
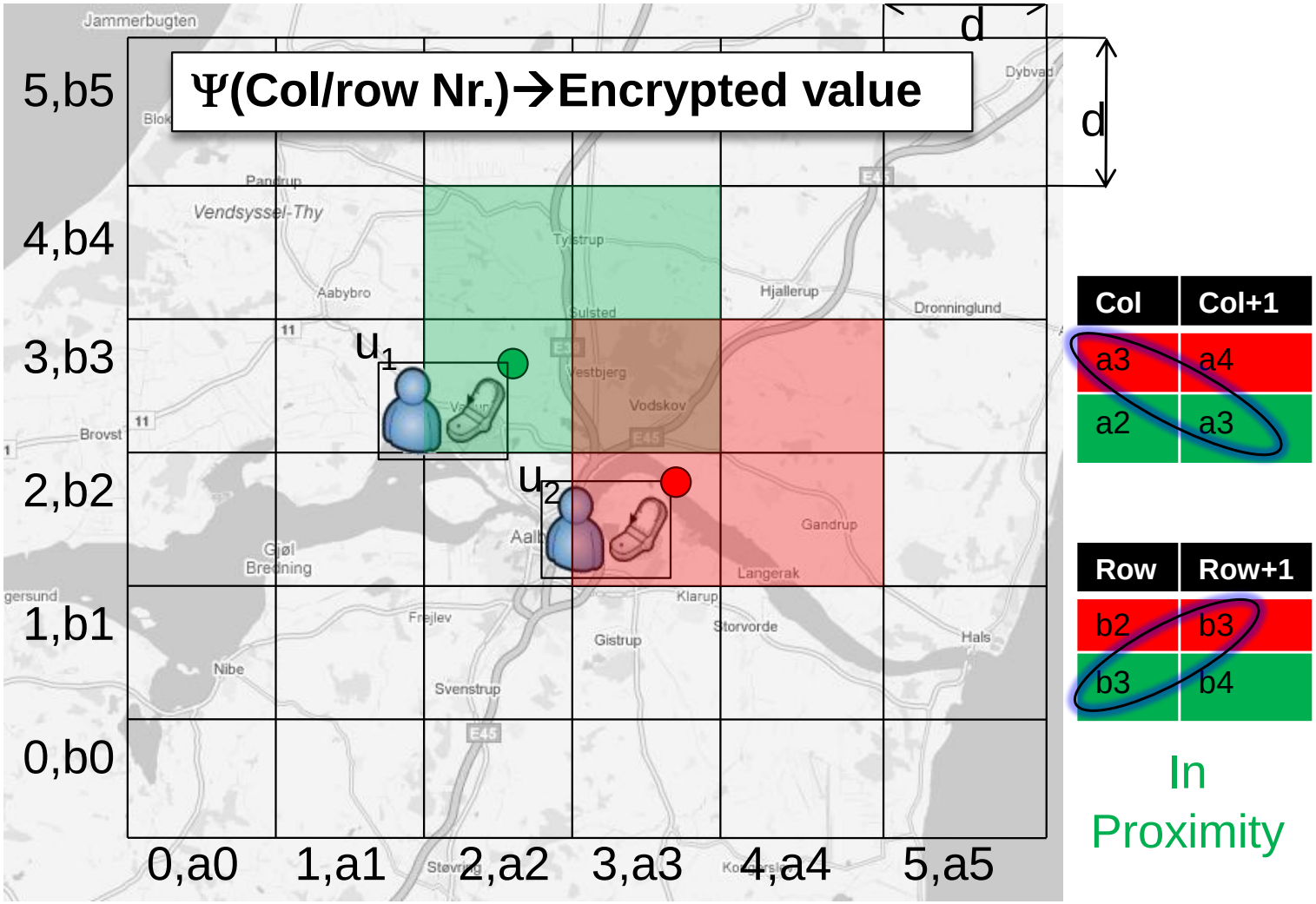
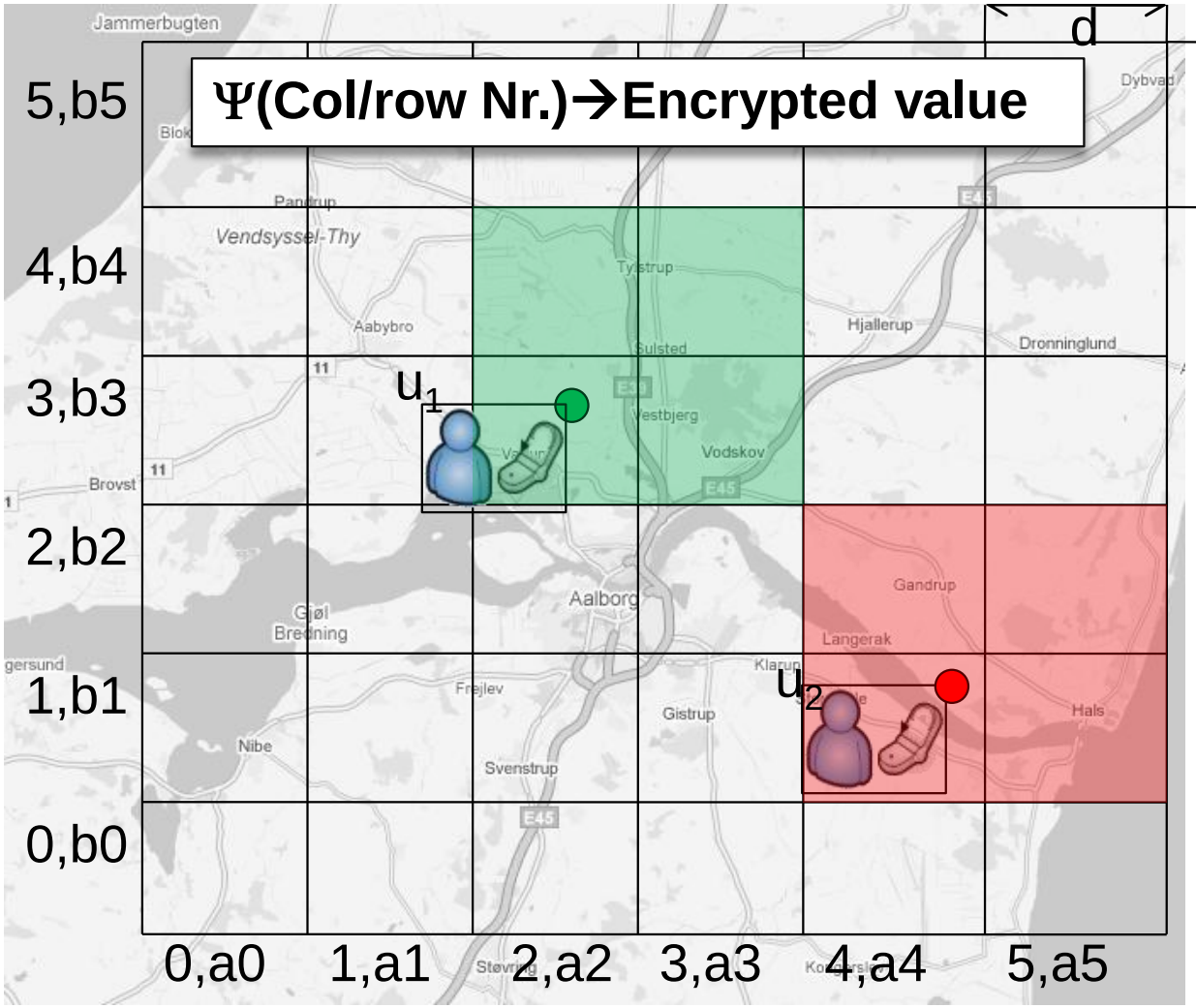


Core idea of FriendLocator



Core idea of FriendLocator



Col	Col+1
a3	a4
a2	a3

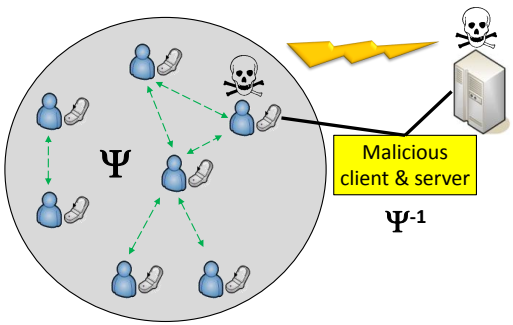
Row	Row+1
b1	b2
b3	b4

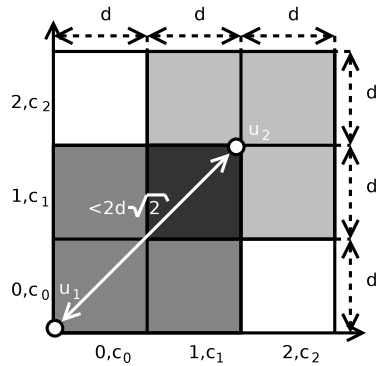
In Separation

Limitation and extensions of the idea

Limitations of the core idea:

1. Intercepted Ψ opens location privacy leakage possibility
2. A proximity detection distance is fixed $(2d\sqrt{2})$





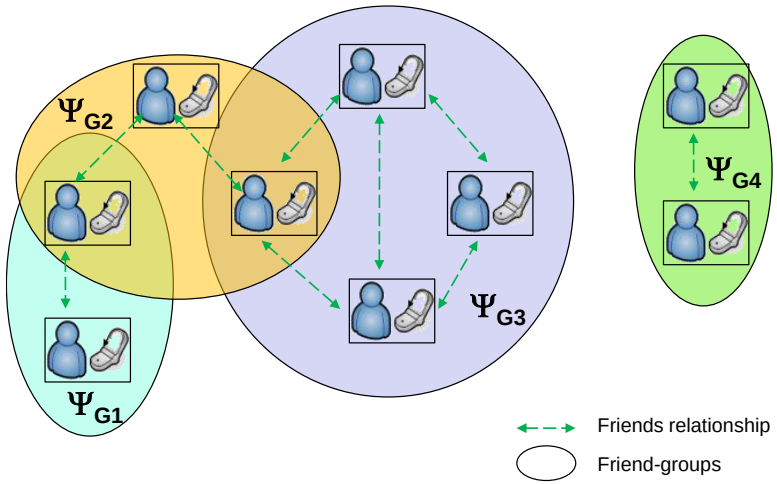
Extensions, supported by FriendLocator:

1. Grouping of friends
2. Incremental Proximity Detection Approach

Grouping of friends

Solution:

- Users are grouped into friend-groups
- A distinct Ψ is assigned for every friend-group



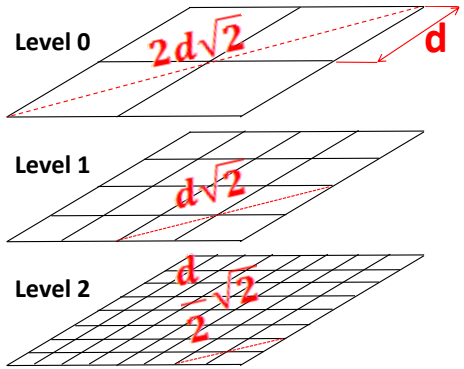
Consequences:

- When user becomes malicious, users from common groups are endangered

Incremental Proximity Detection Approach

The solution:

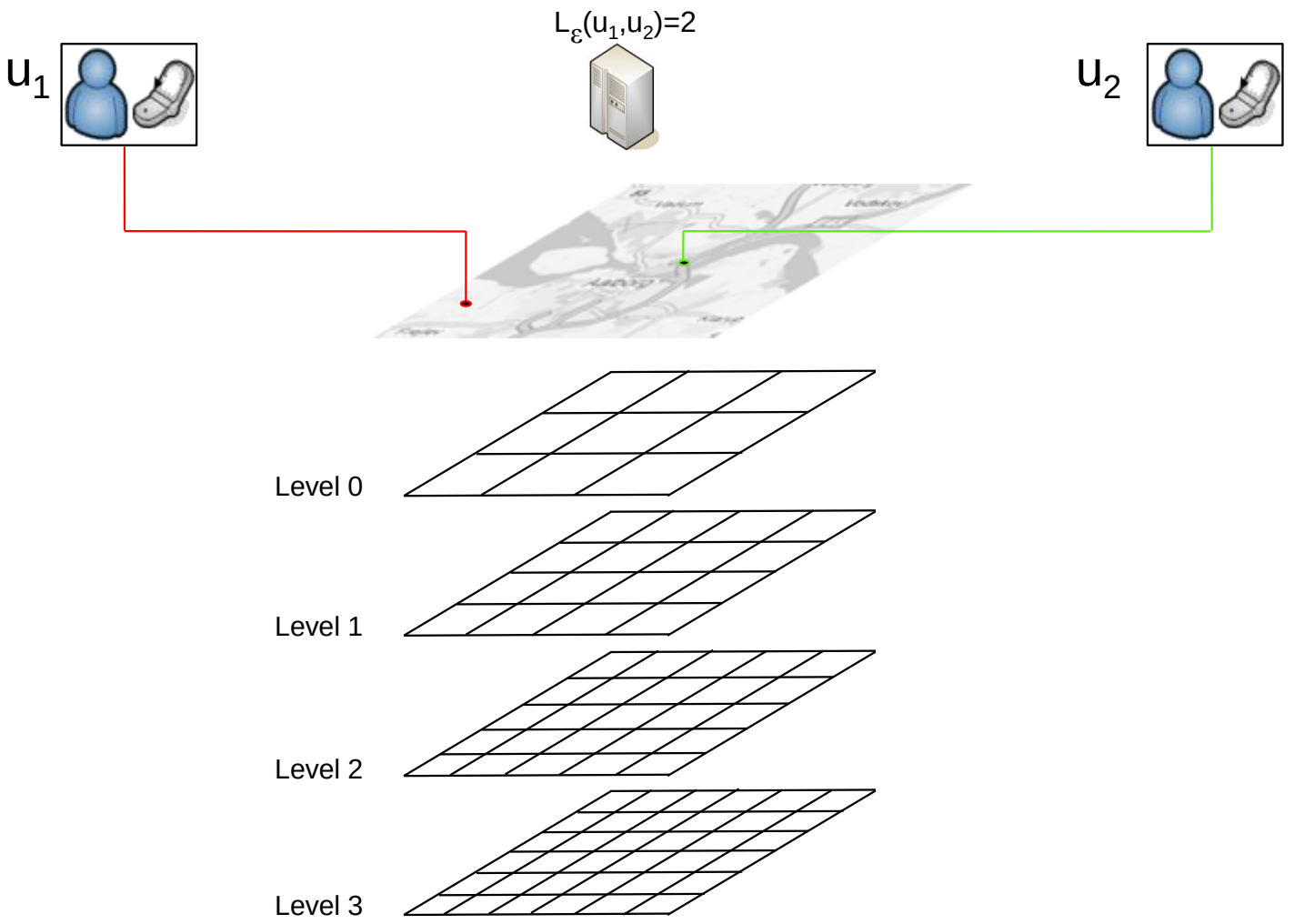
- A list of grids with decreasing cell size is assigned for every friend-group



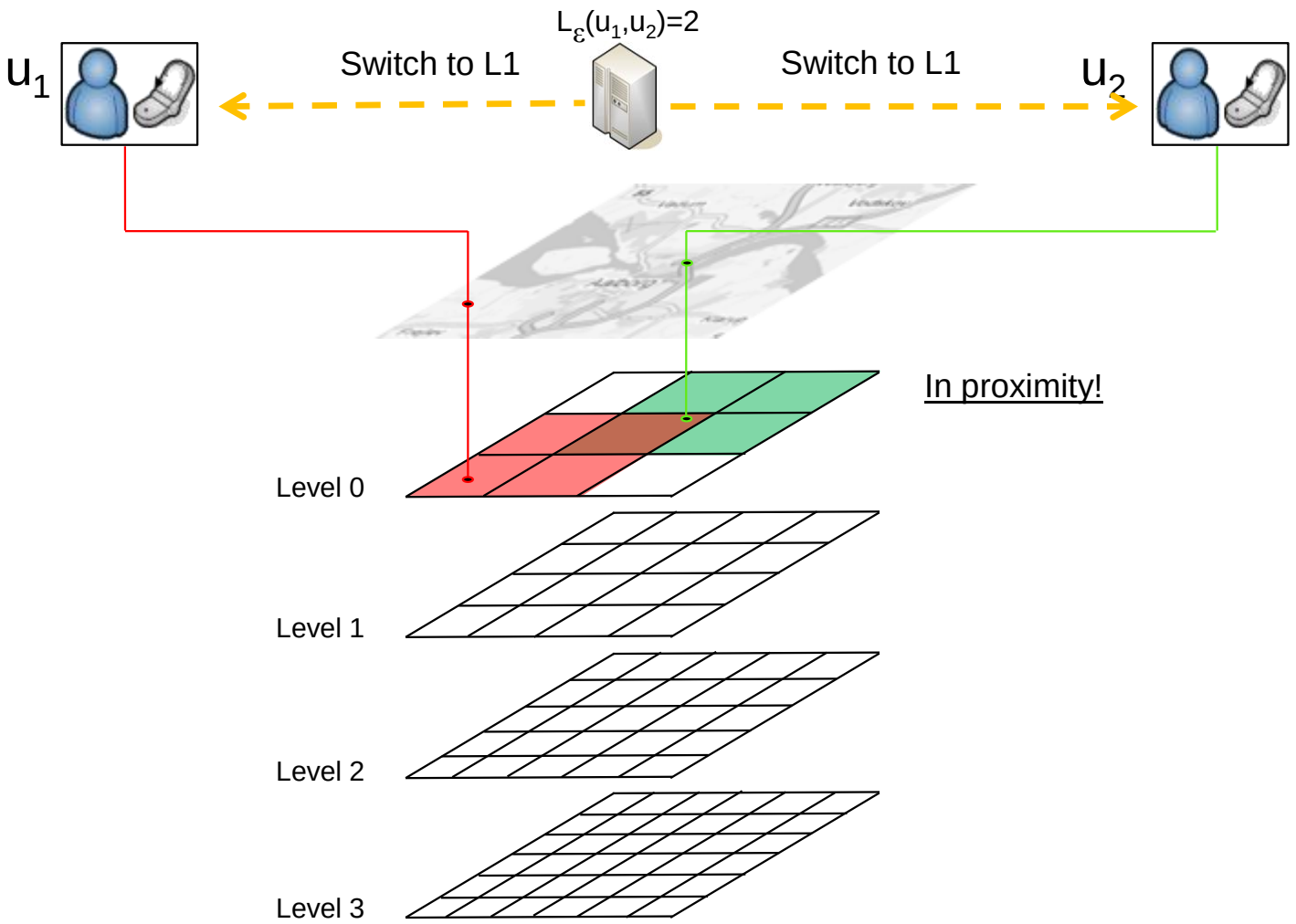
Consequences:

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

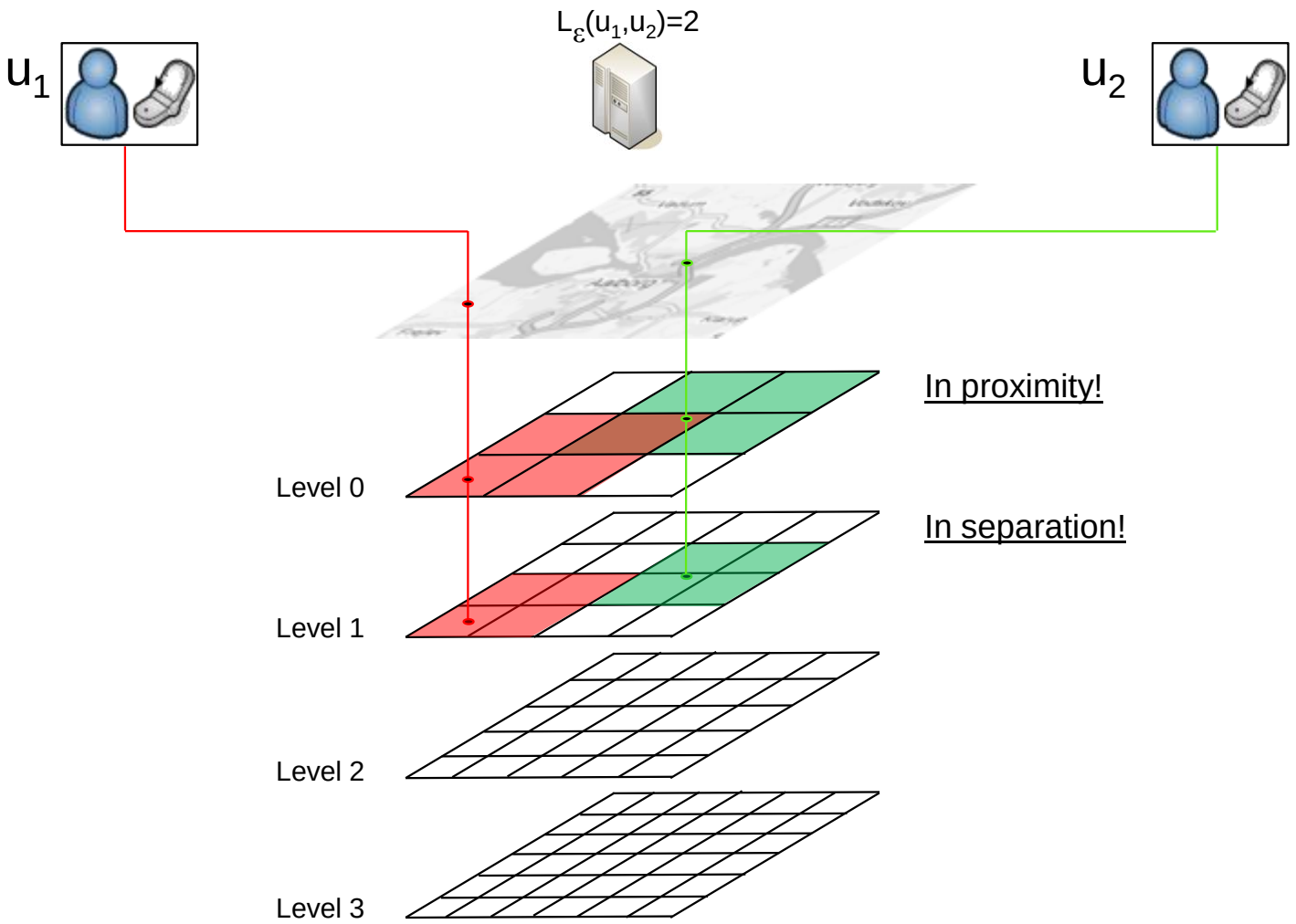
Incremental Proximity Detection Approach



Incremental Proximity Detection Approach



Incremental Proximity Detection Approach



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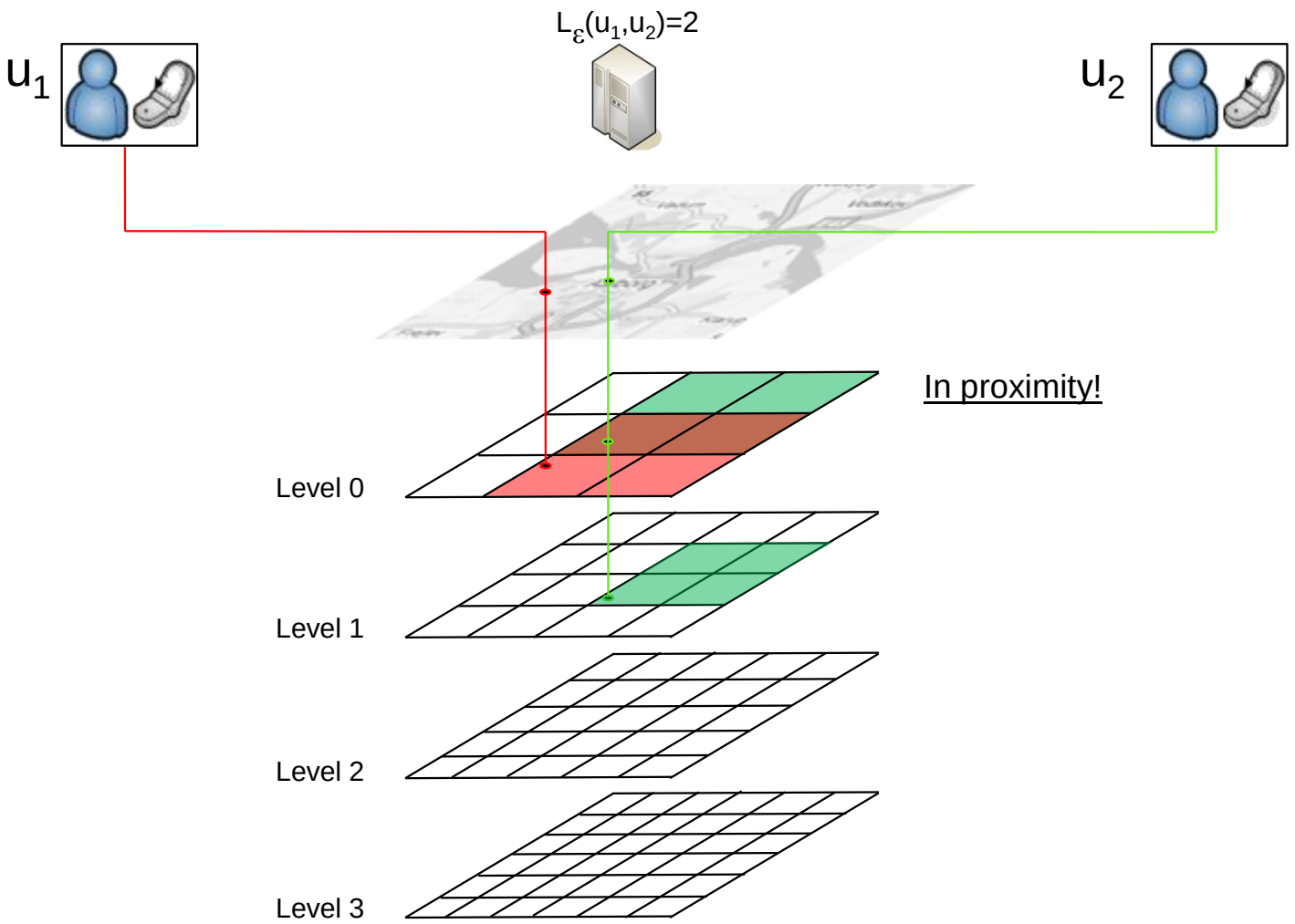

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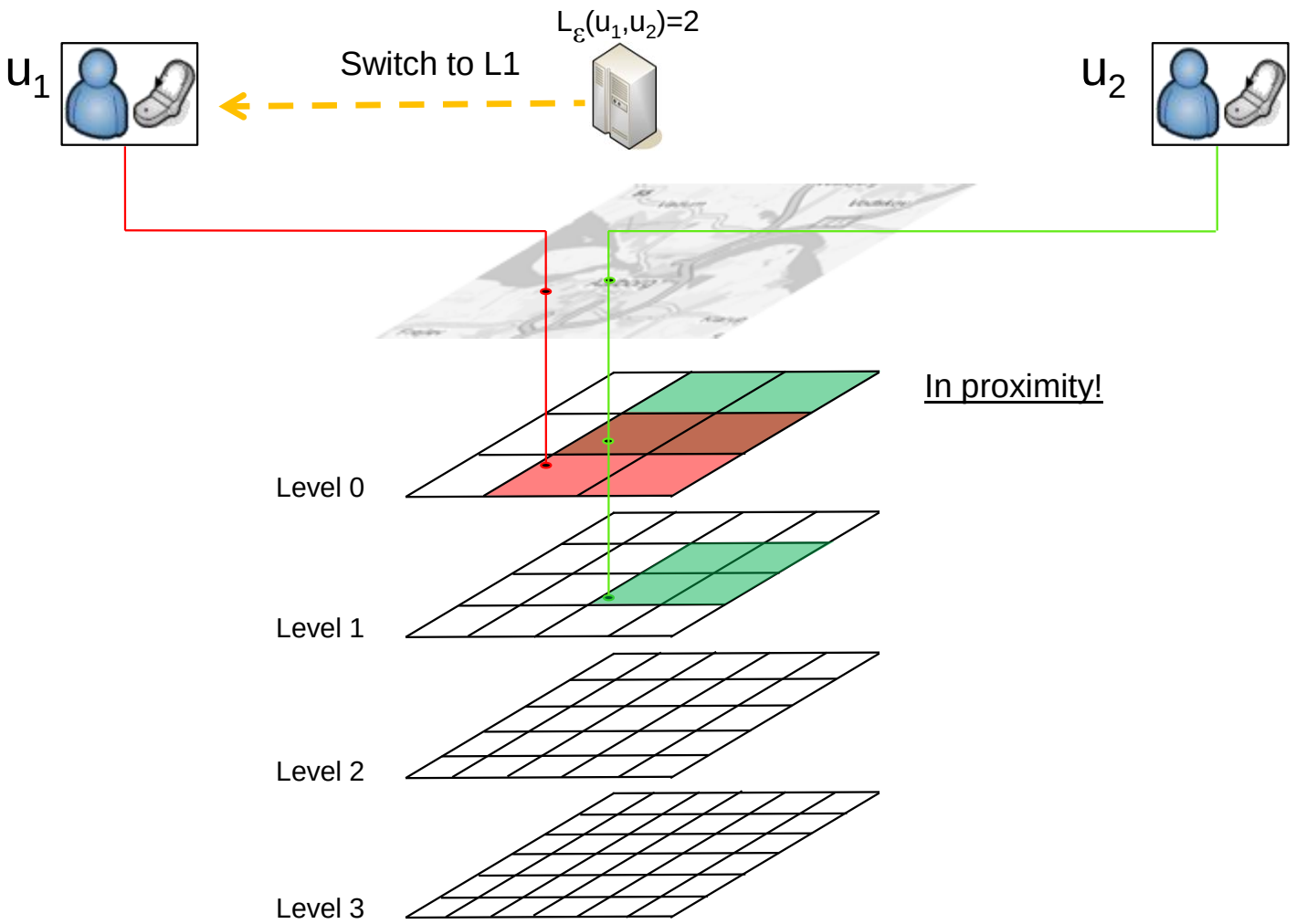

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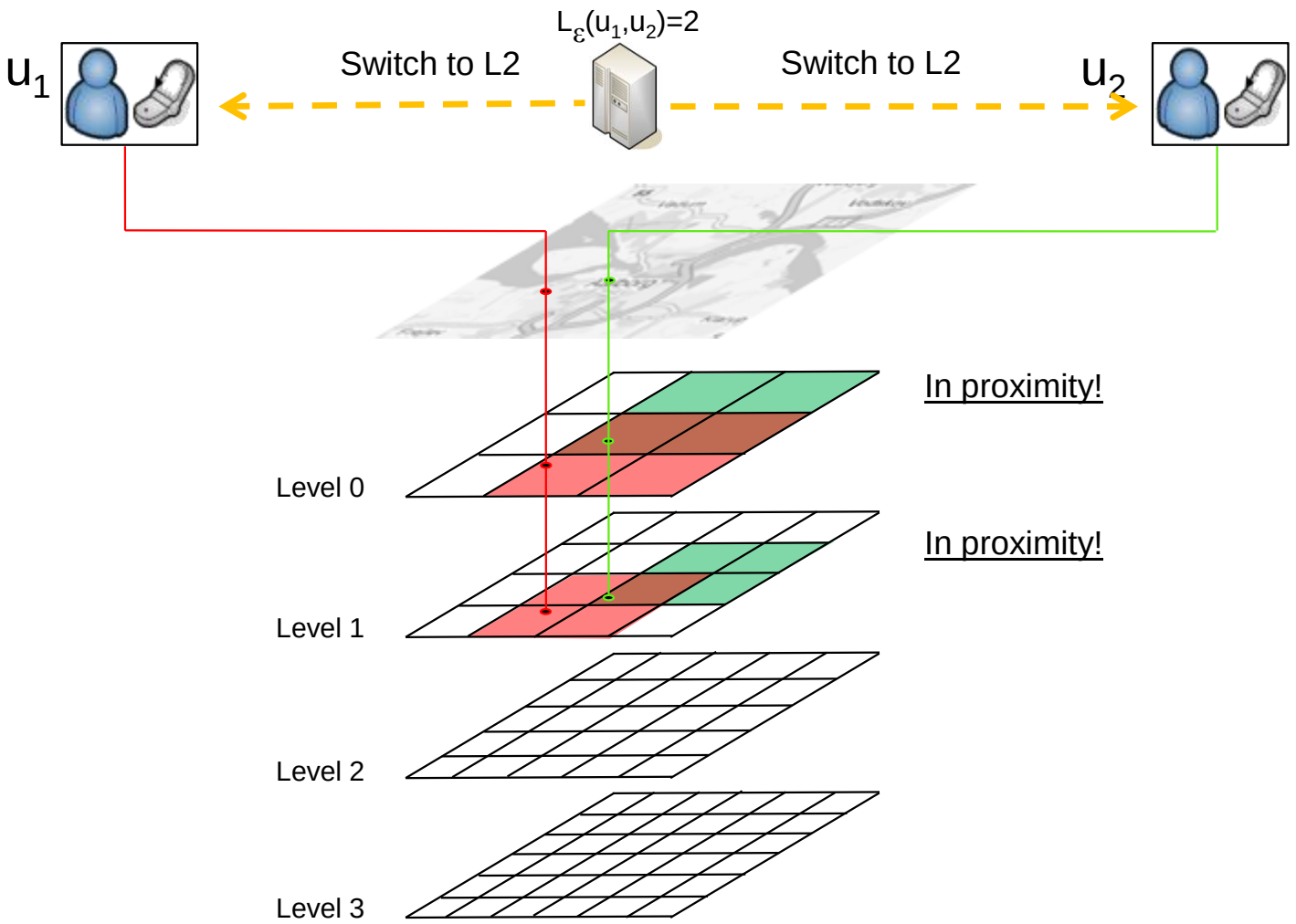

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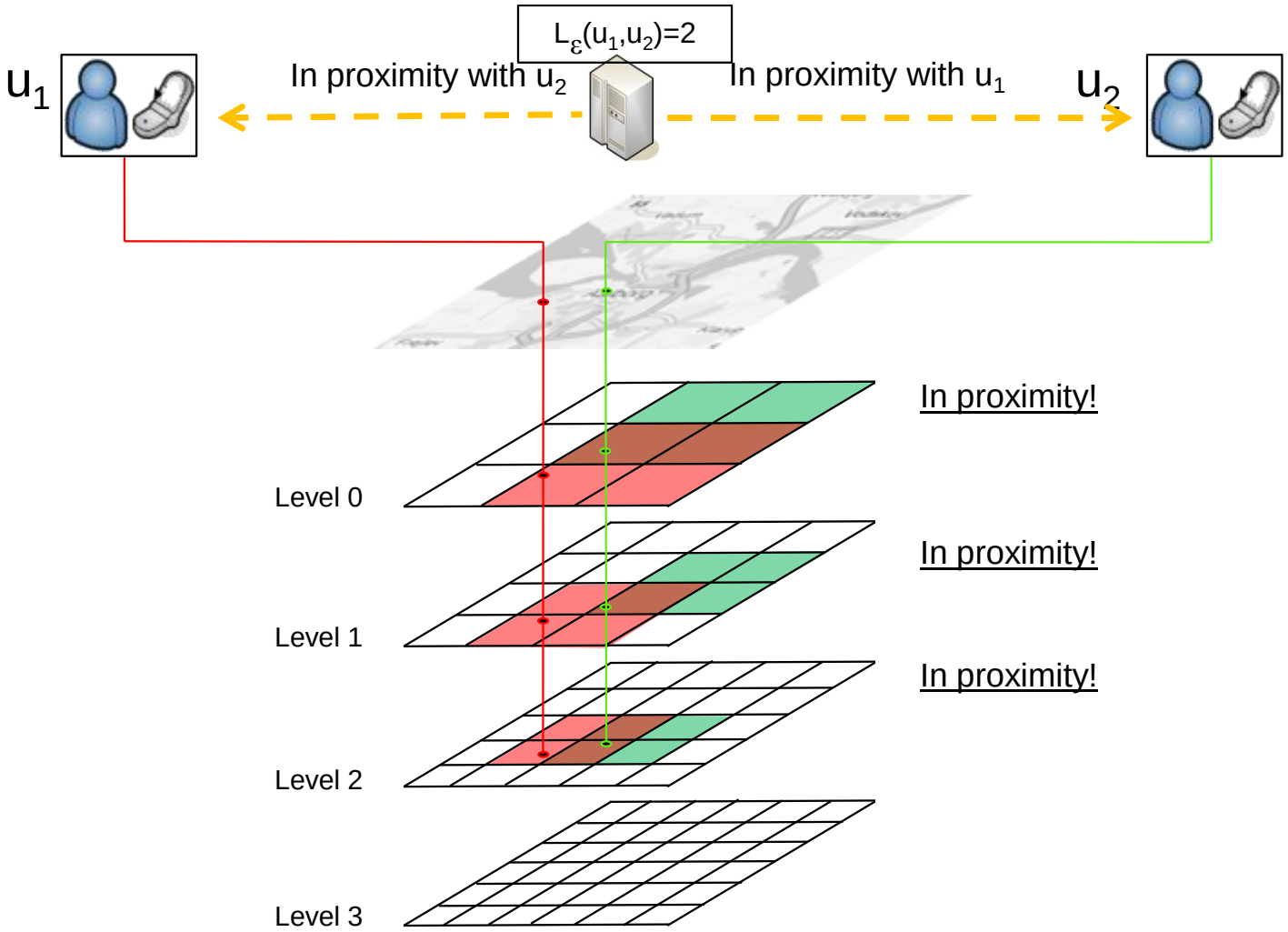
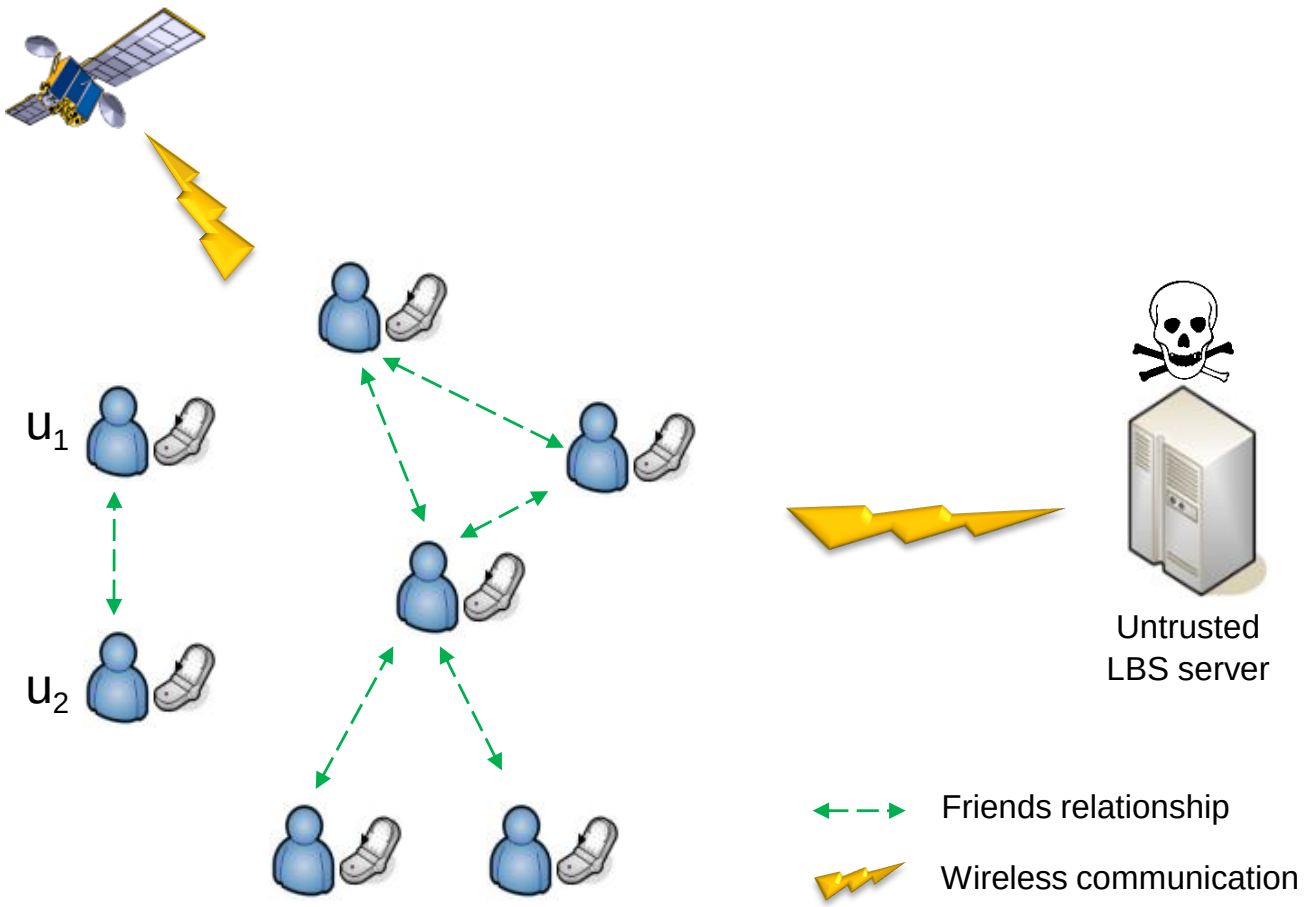


Problem setting



VicinityLocator

VicinityLocator

-

Flexible Proximity Detection In Mobile Social Networks

Motivation

FriendLocator

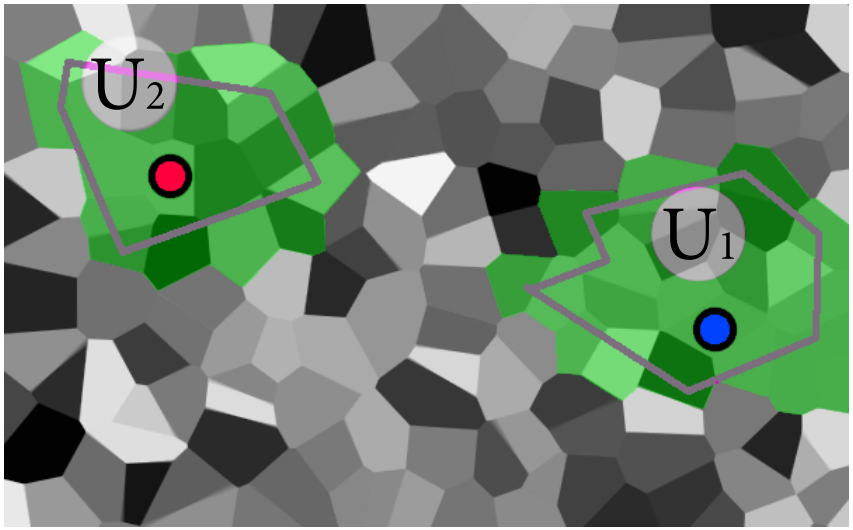
- the Proximity Detection Guaranties is to weak $(2d\sqrt{2})$
- is too inflexible - privacy & precision not independent.

Want solution independent of how the space it partitioned

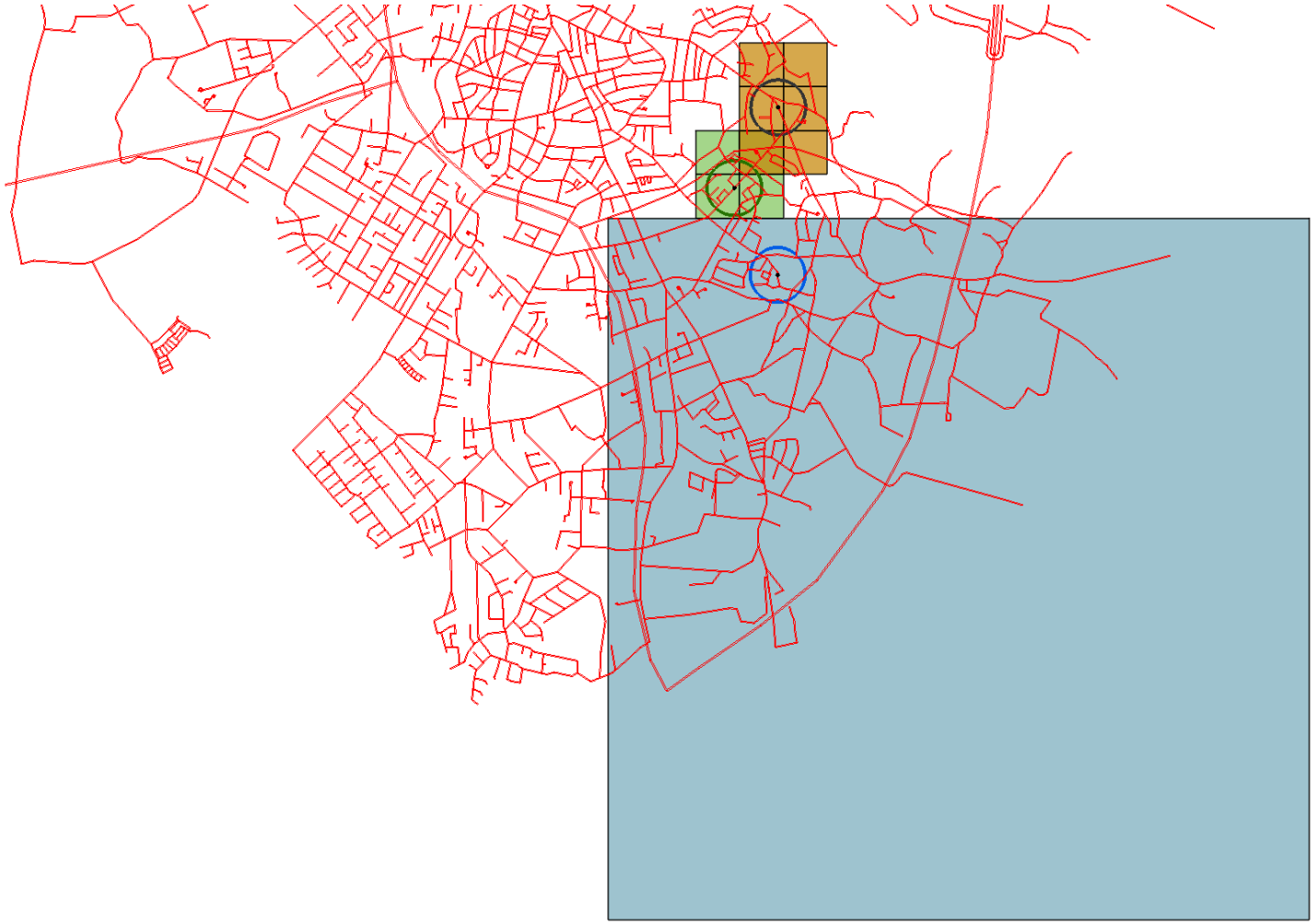
Improvements

New features and improvements in VicinityLocator

- Granules (and rasterasation)
- Better guaranties
- Ajustable vicinity



Demo of VicinityLocator



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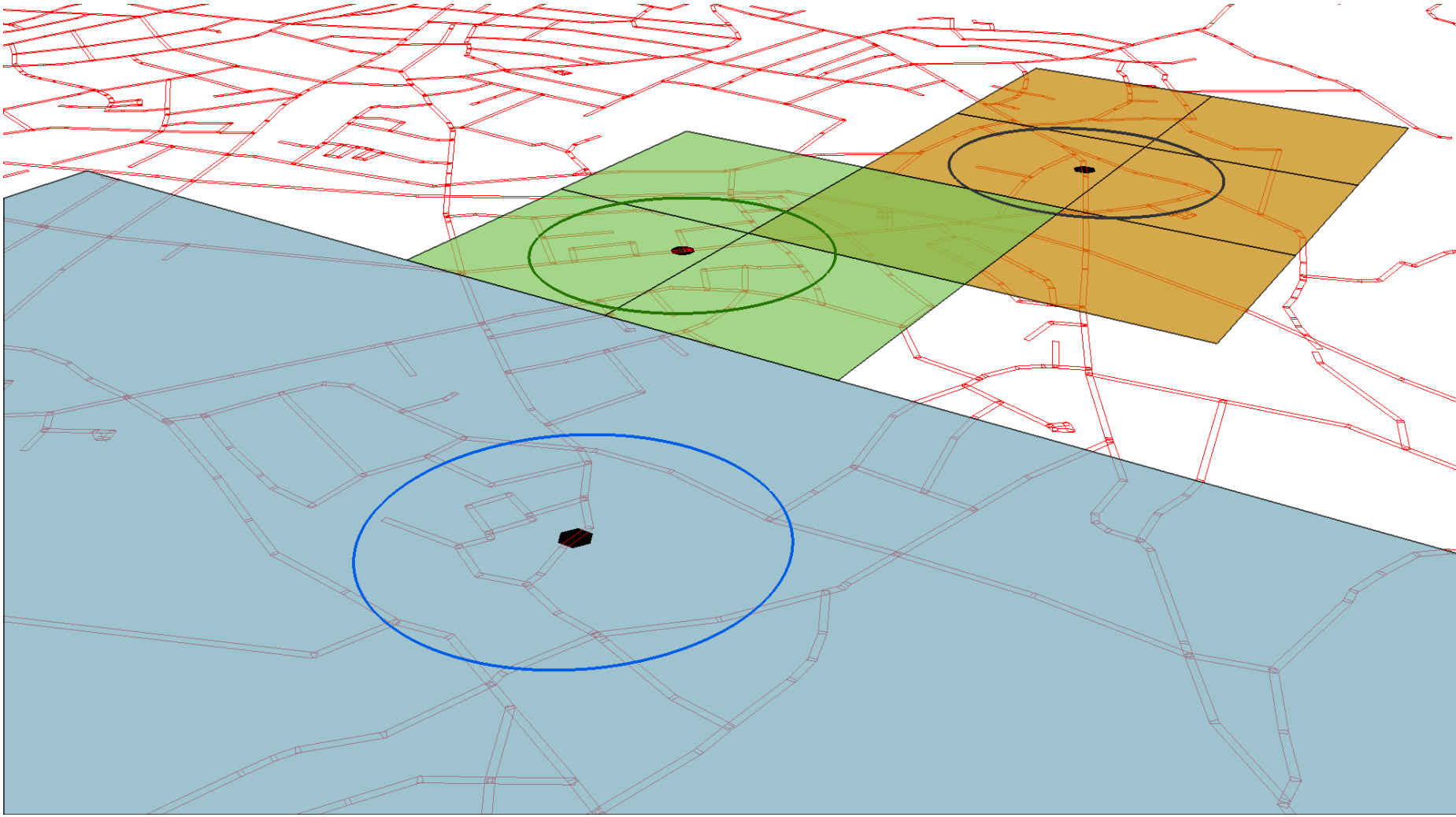

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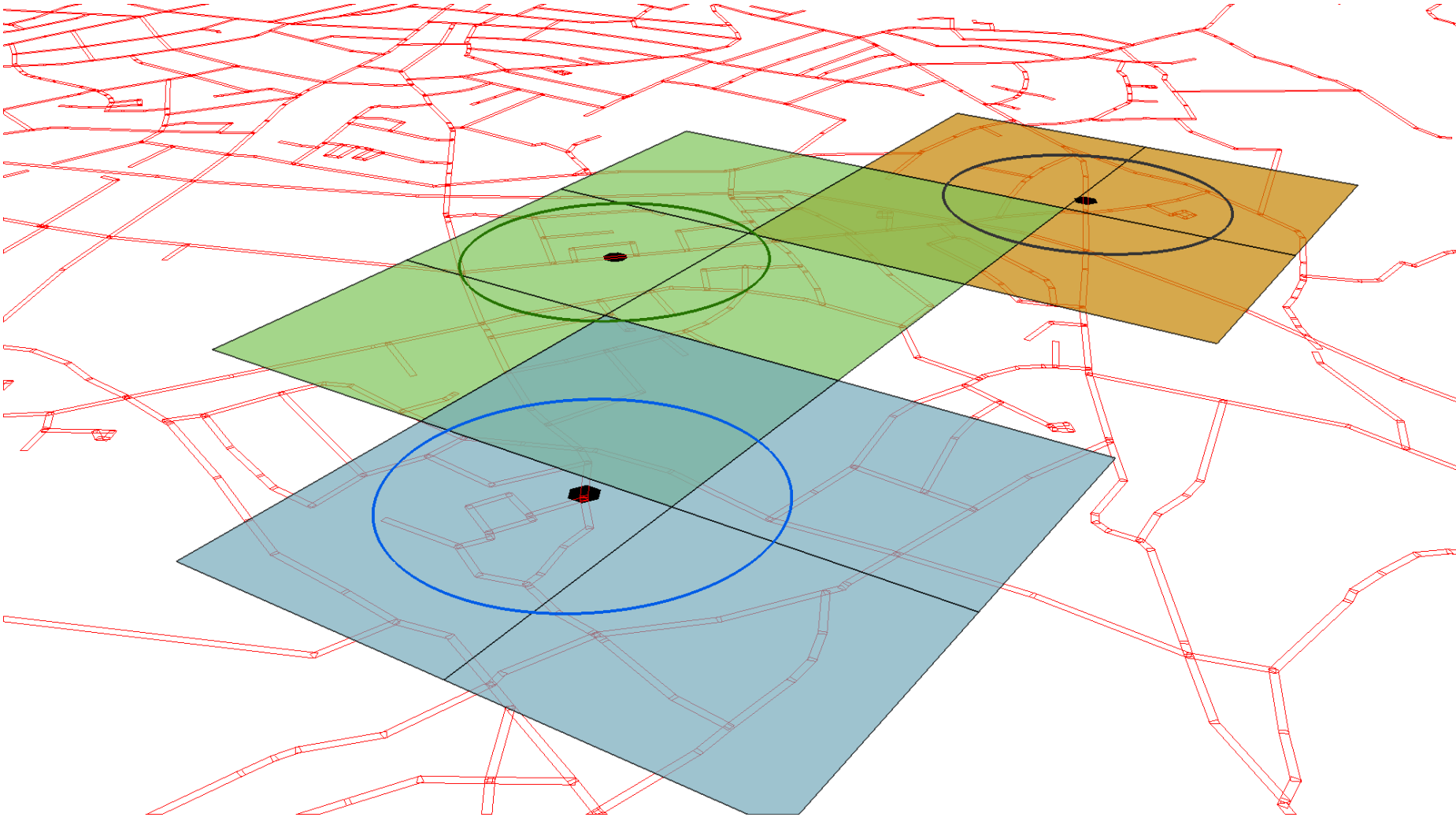

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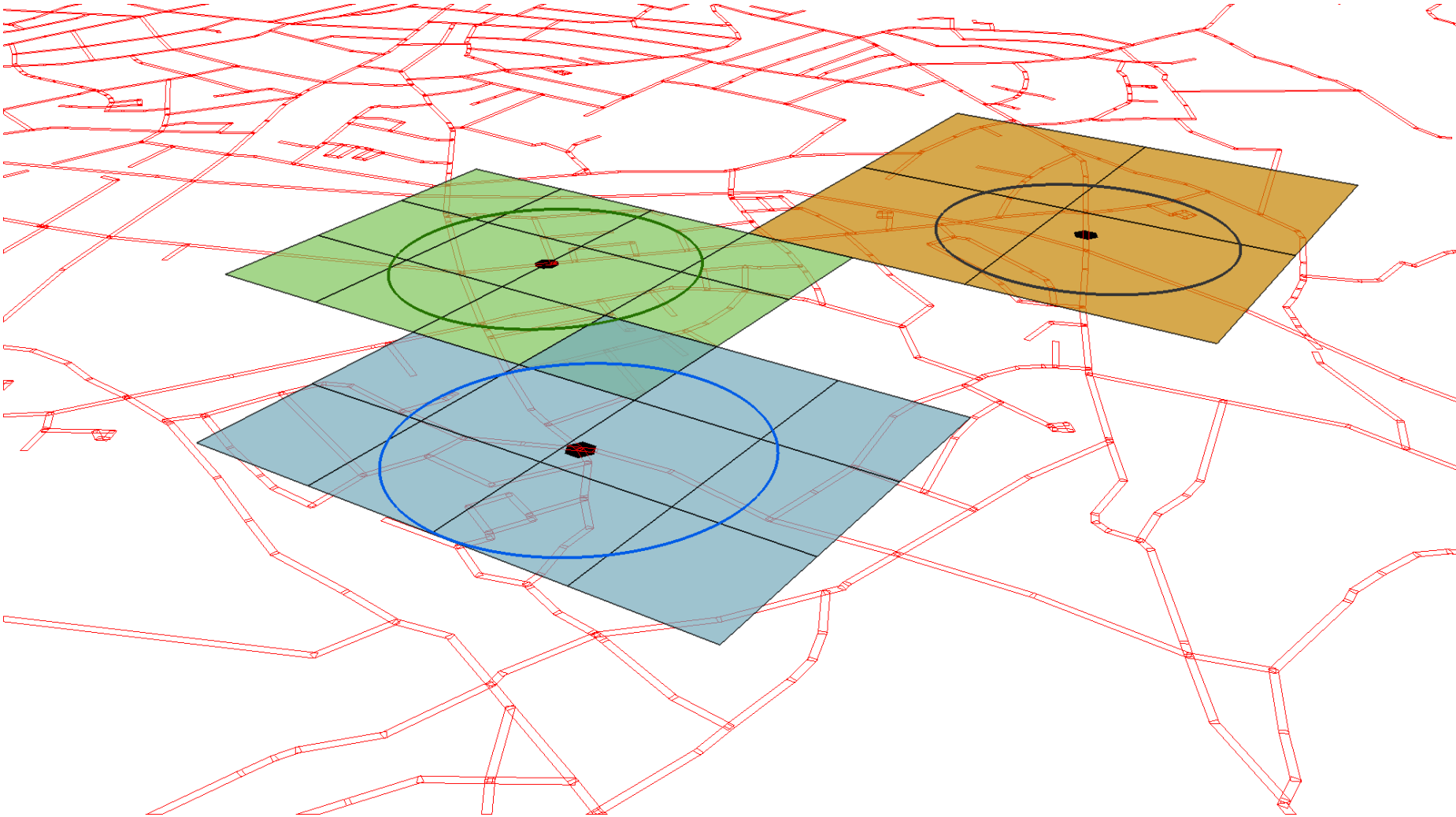

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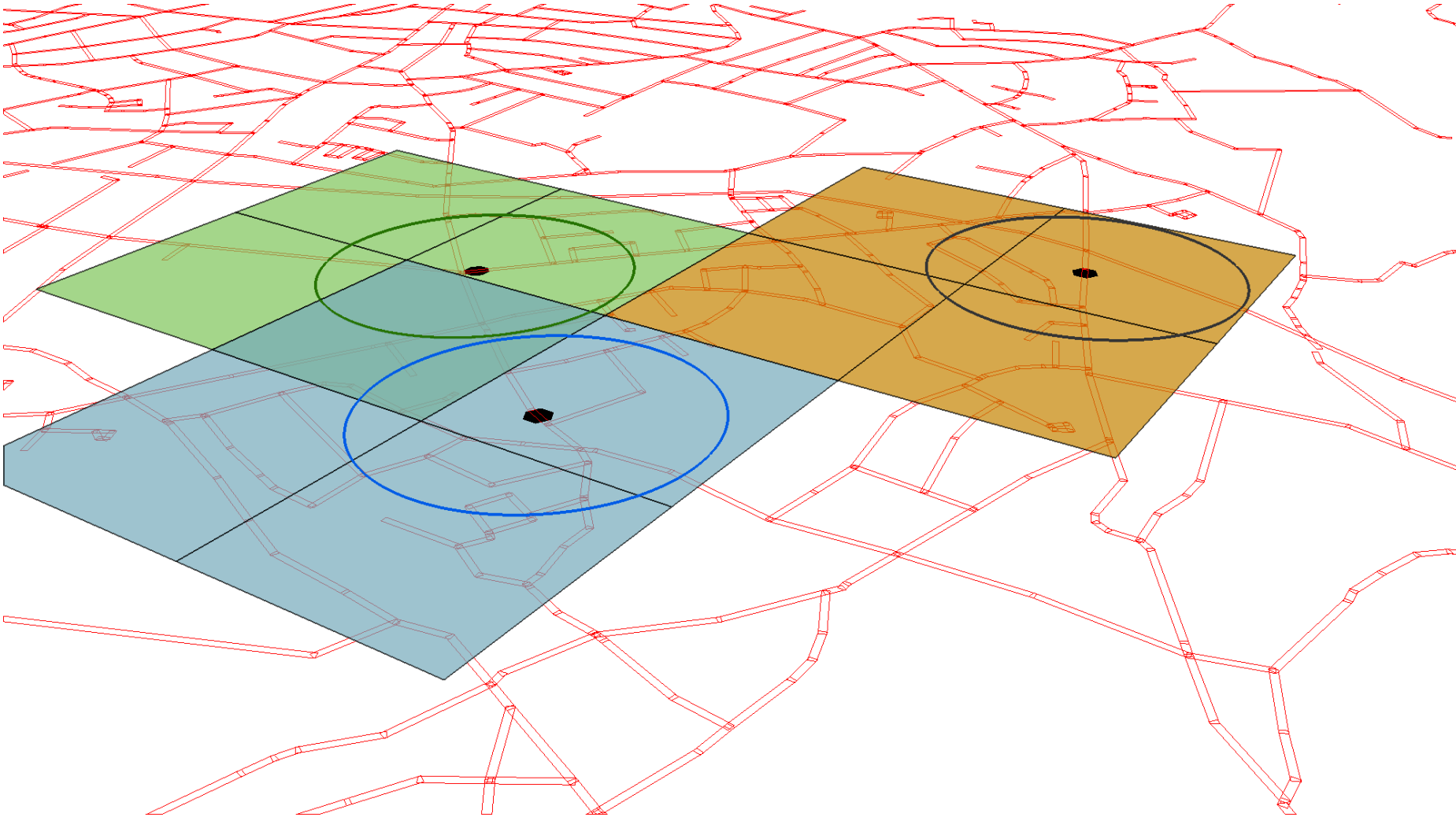

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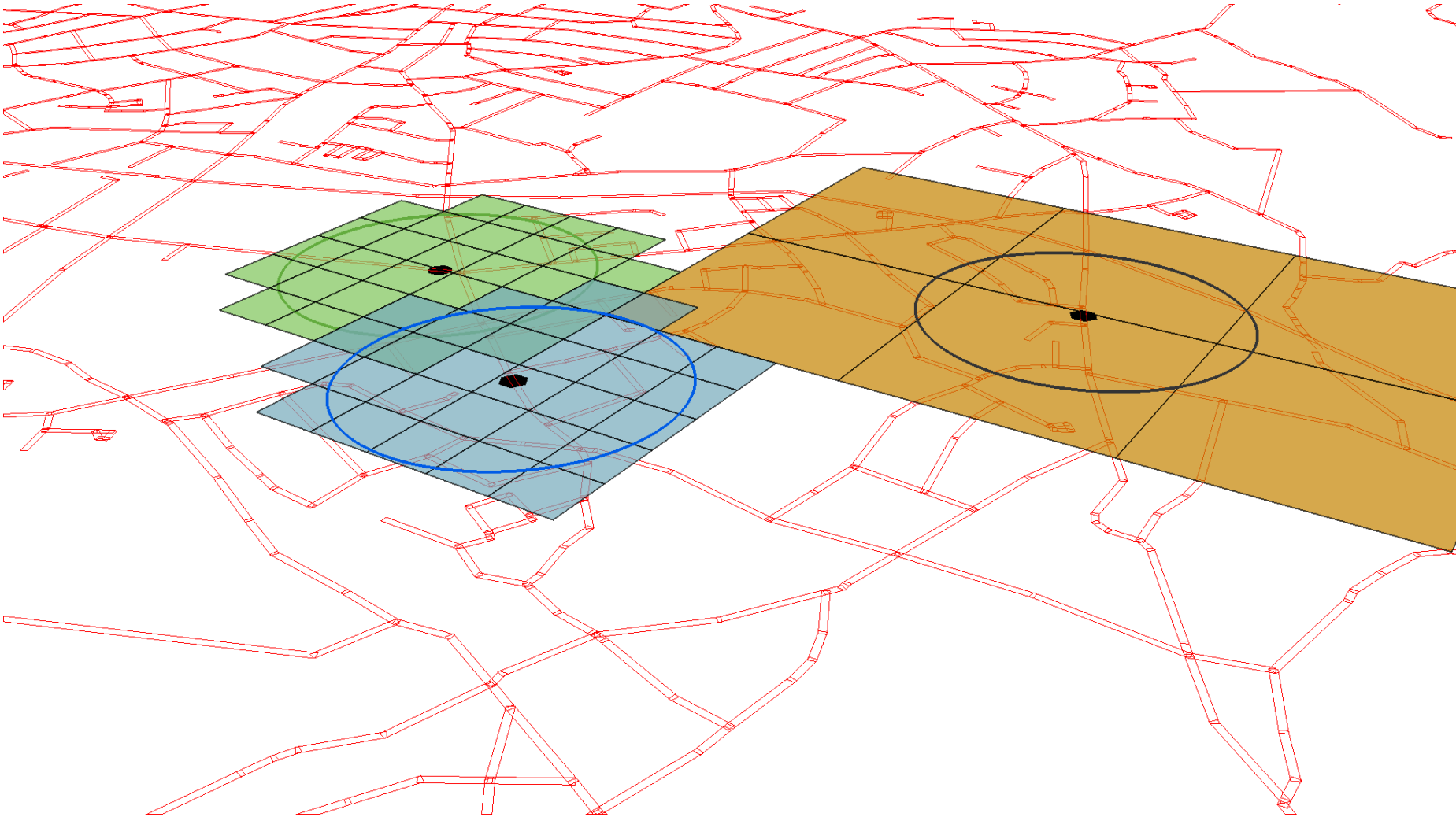

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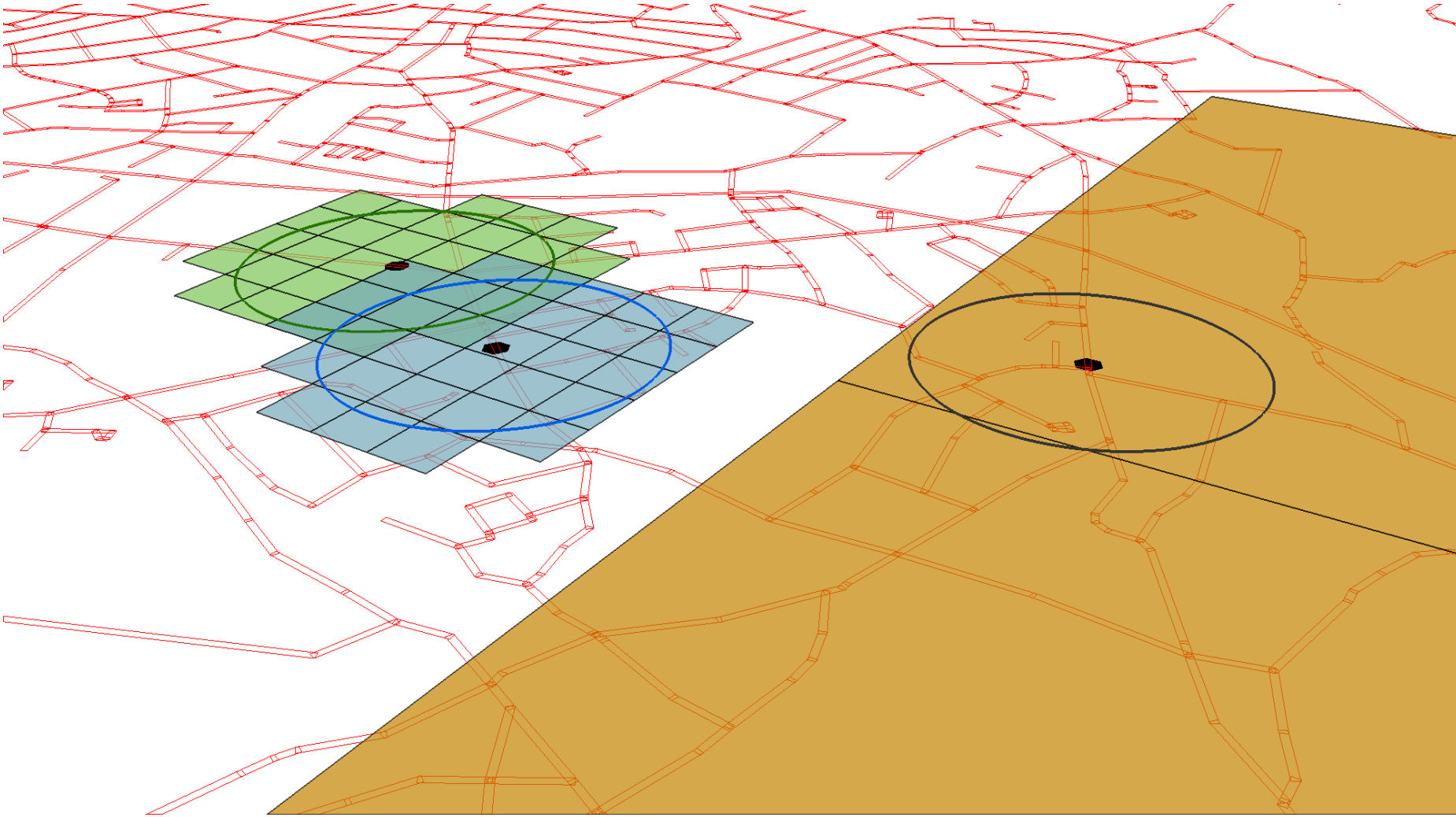

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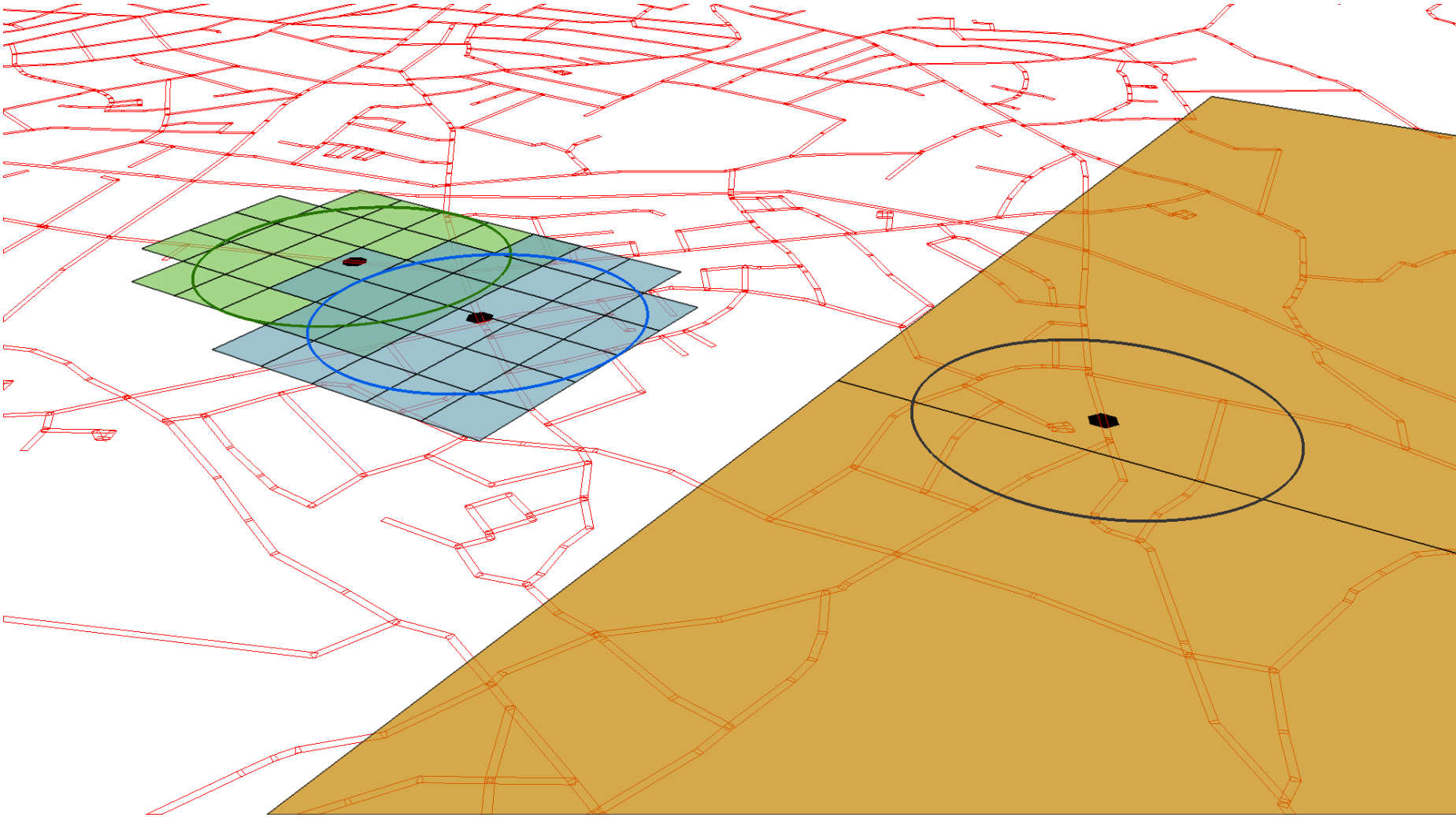
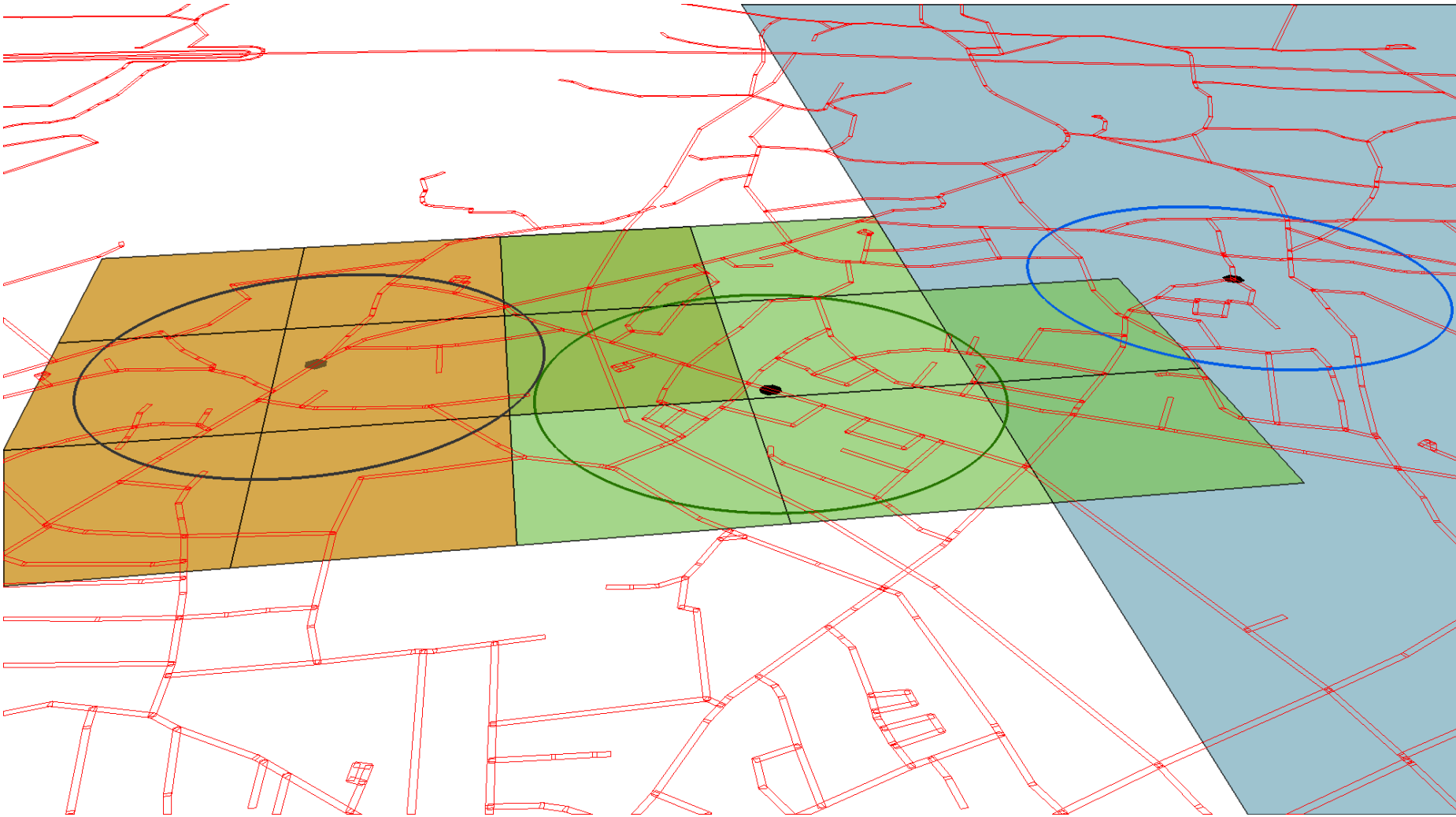


VicinityLocator with Roadnetwork Filter

Demo of VicinityLocator with Roadnetwork Filter



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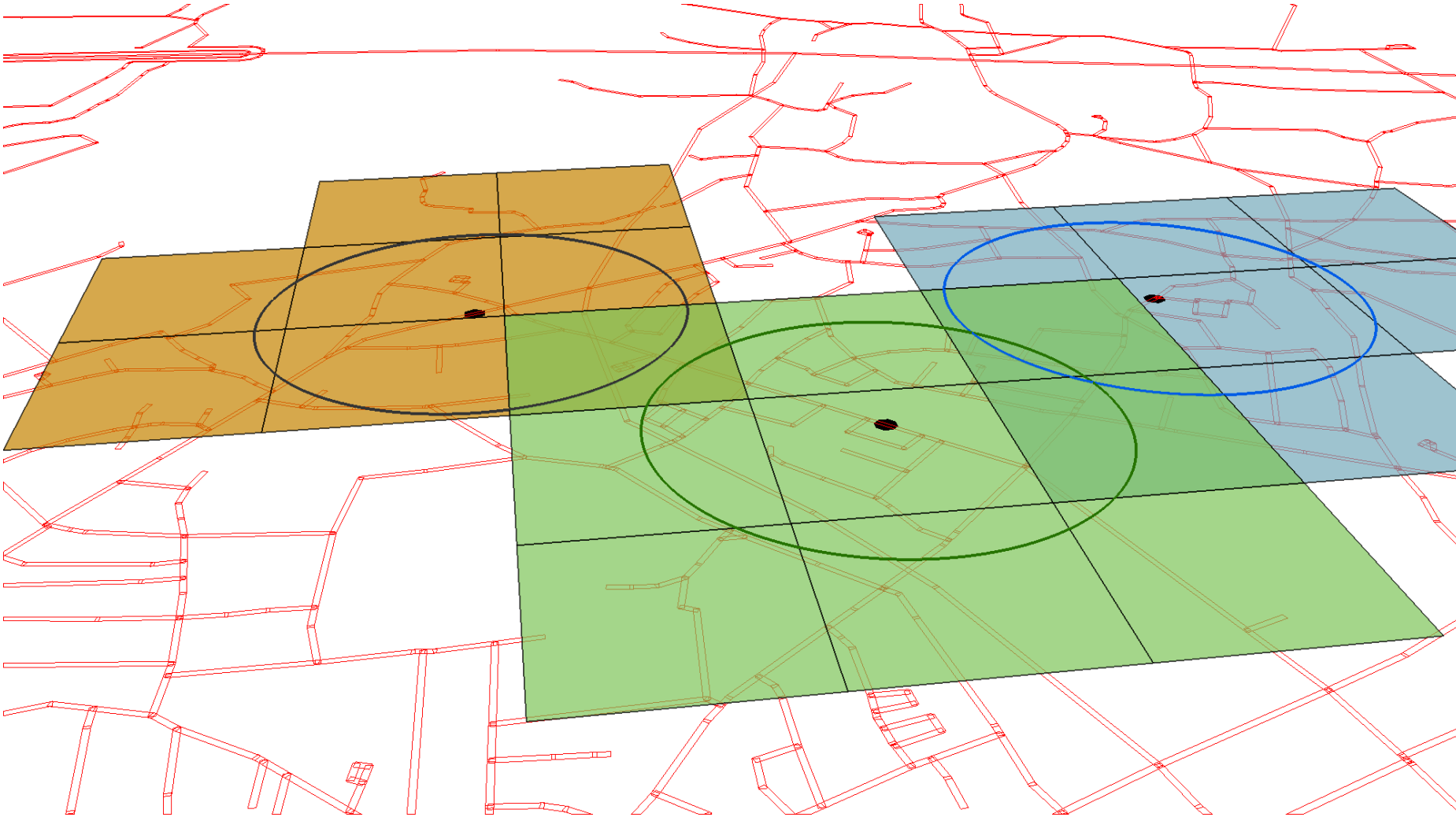

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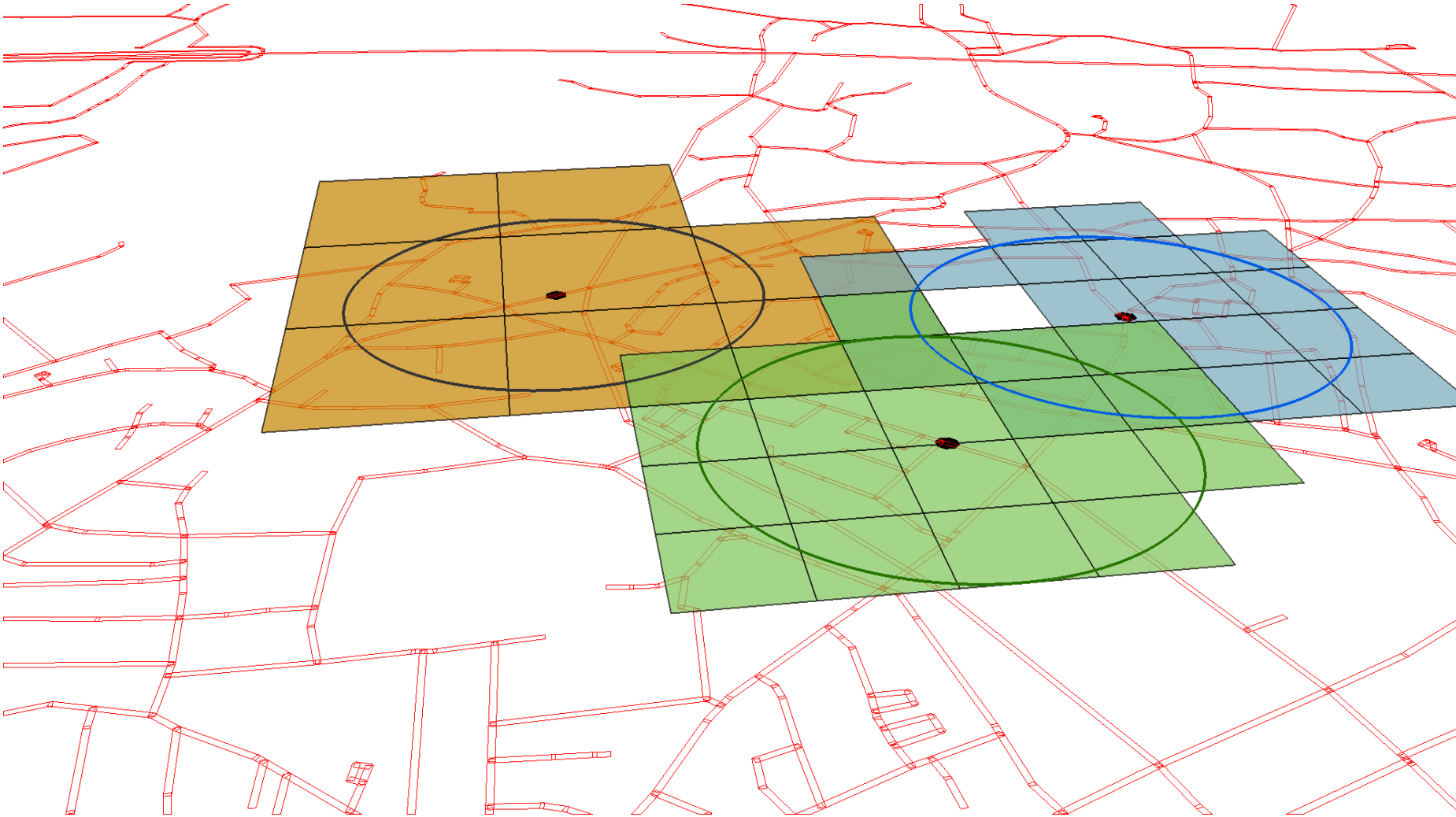

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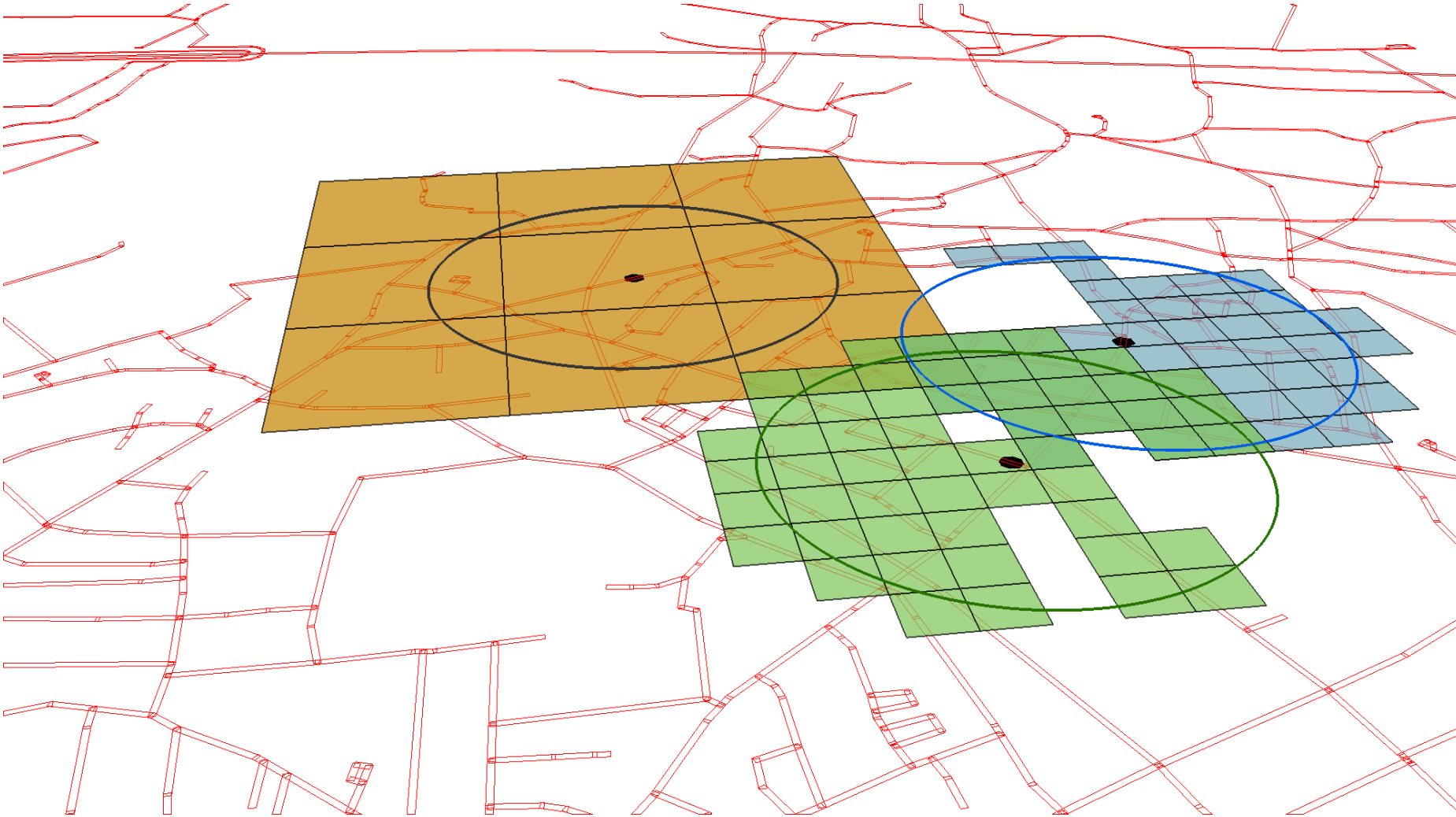

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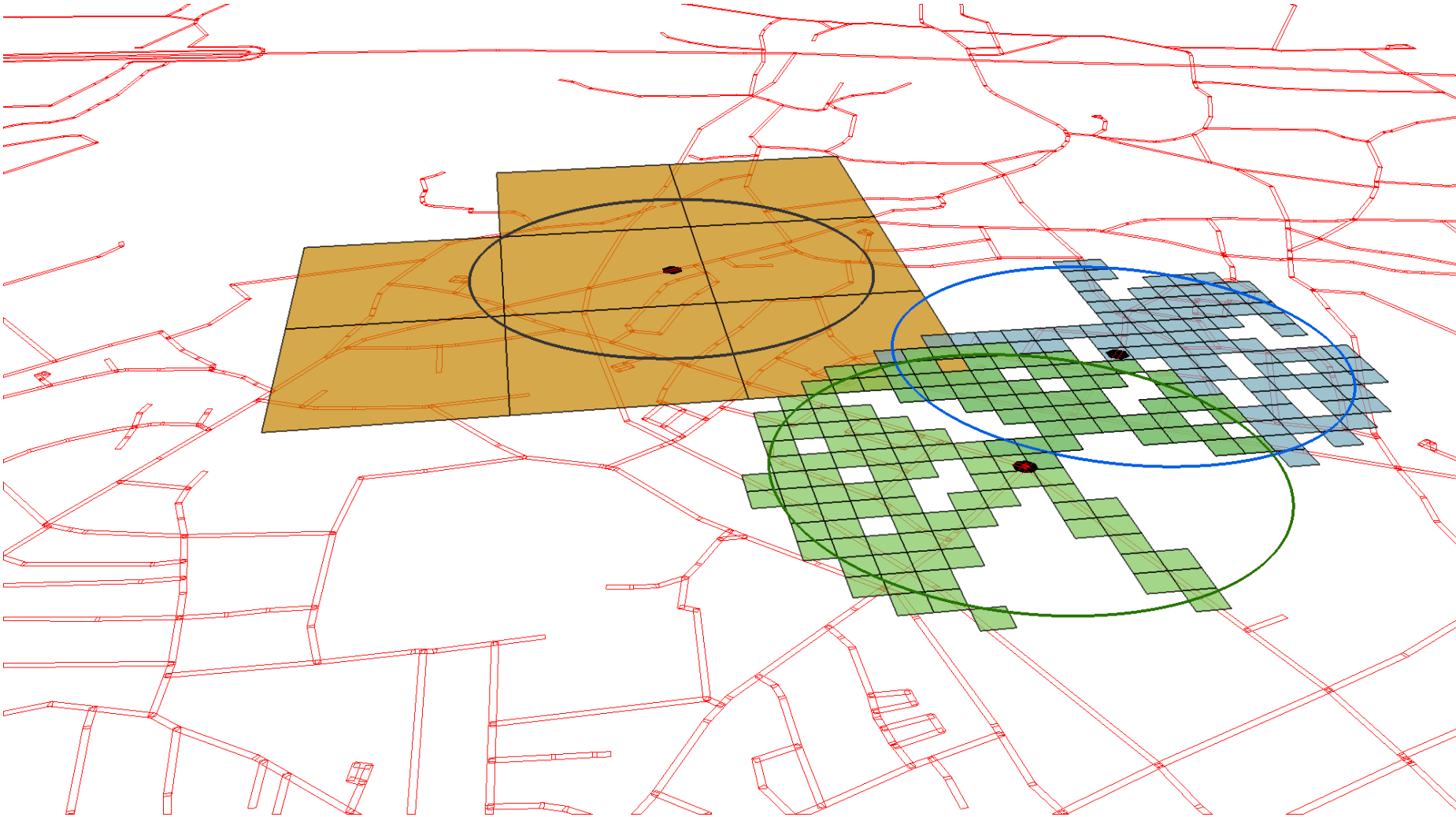

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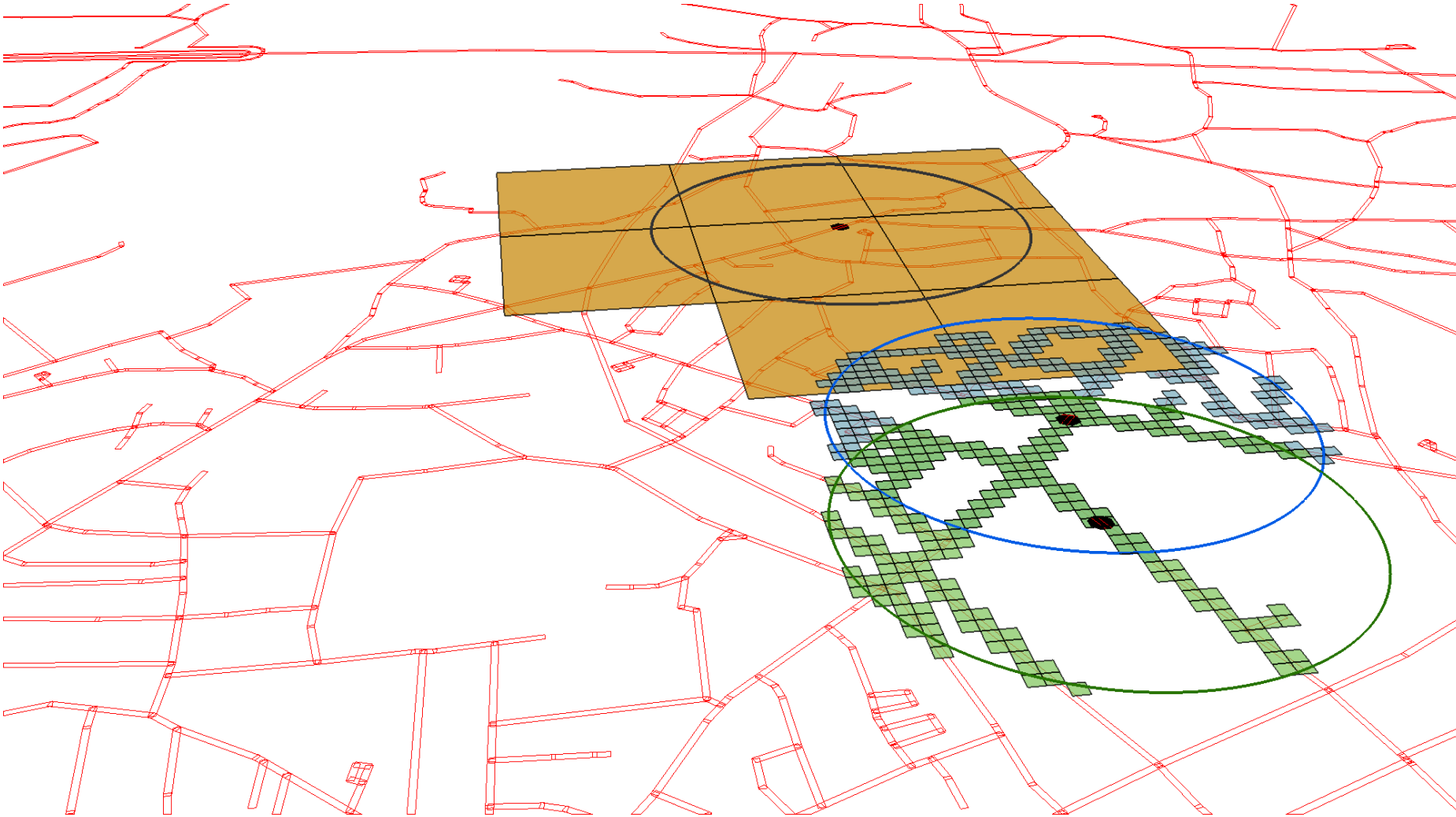
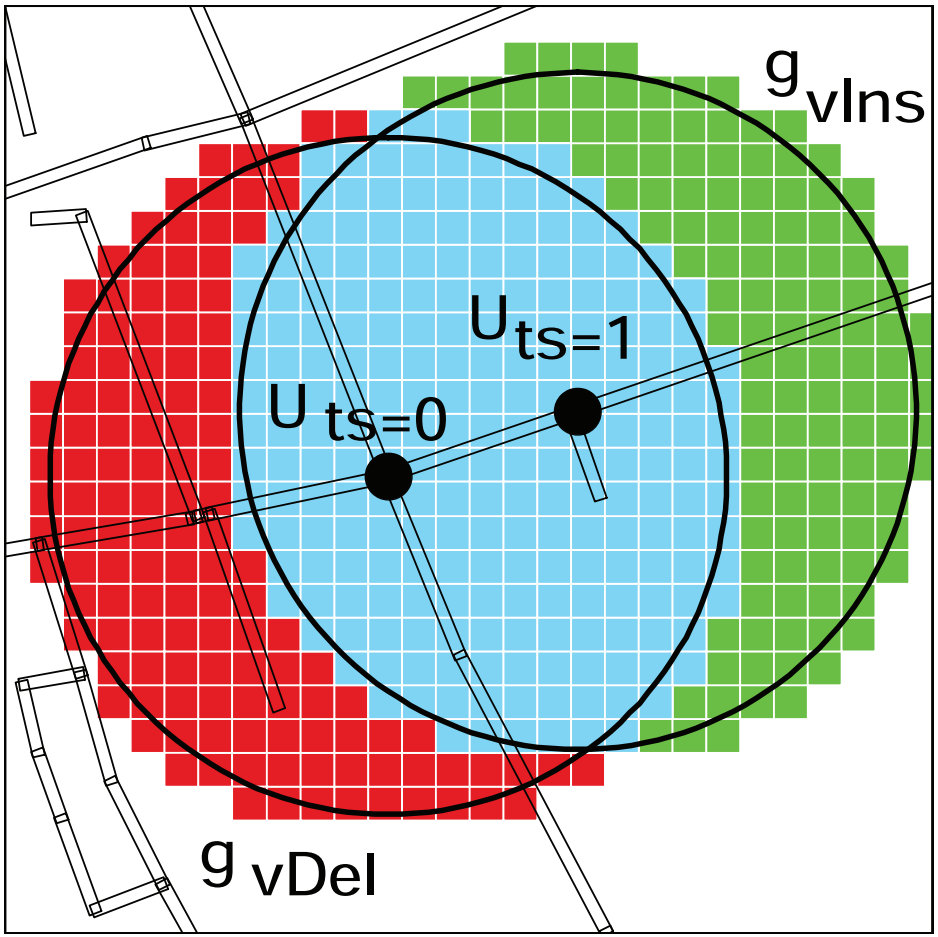


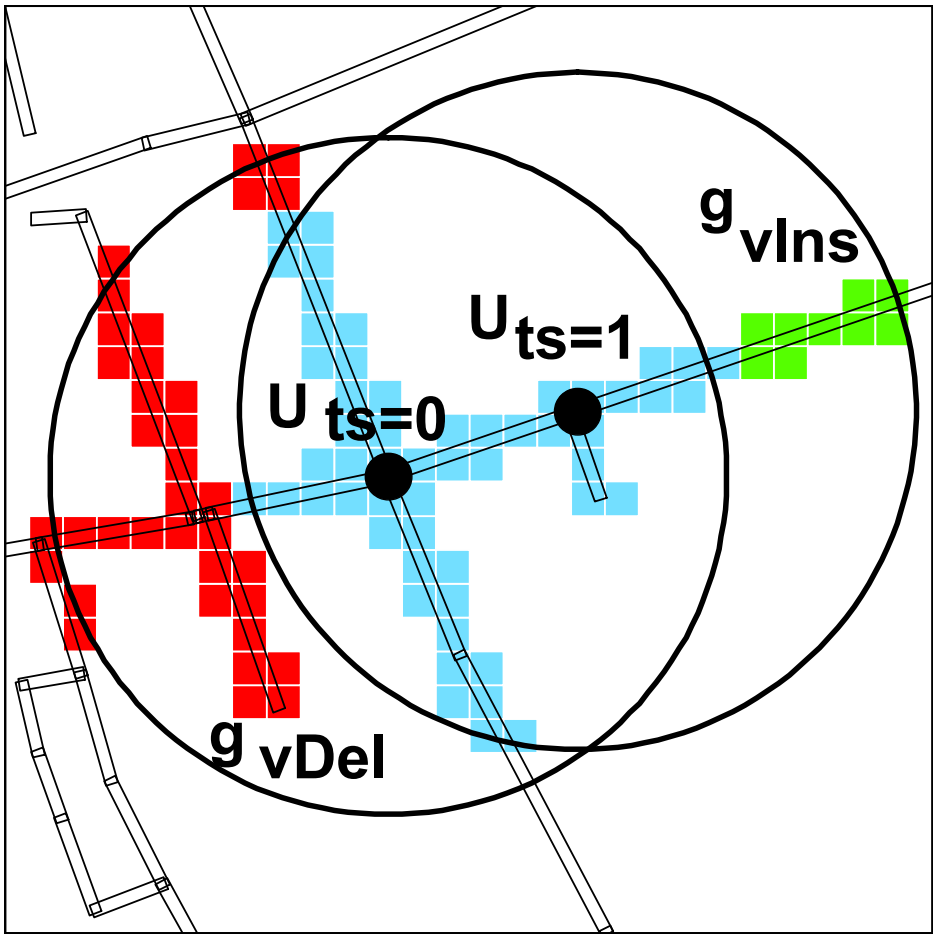
VicinityLocator with Incremental Update

- Incremental Update



VicinityLocator with Incremental Update

- Incremental Update & Roadnetwork Filter



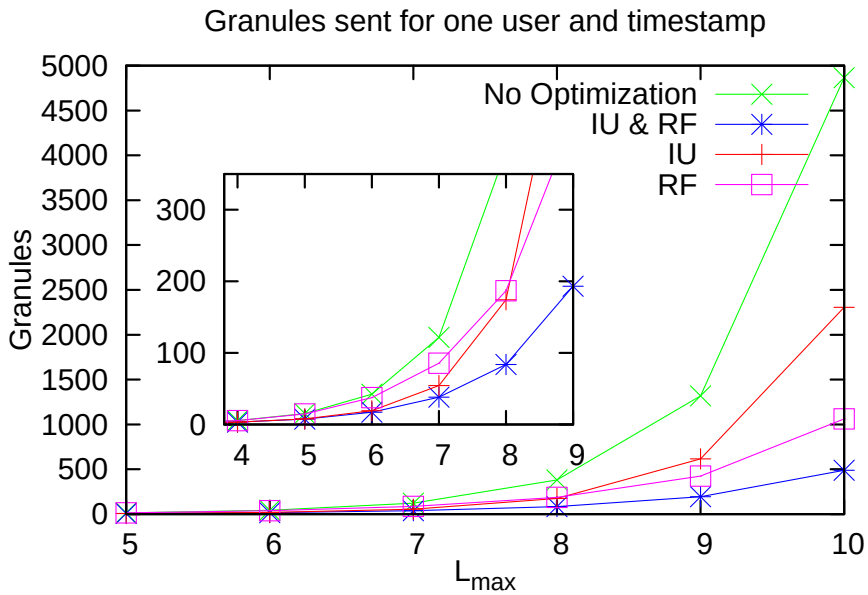
Testing Methodology

System Test Settings

- 50000 users.
- 40 timestamps per user.
- All users partitioned into disjoint groups.
- L_ϵ & L_{max}: 6
- ϵ & $B(L_{max})$: 200 units

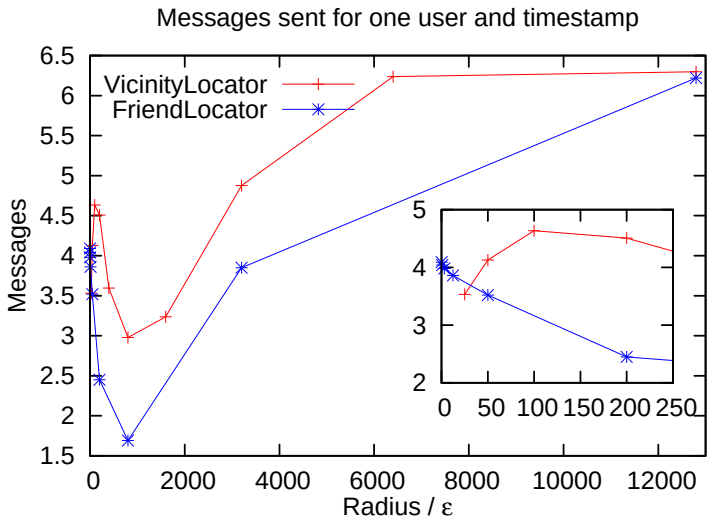
Comparative message development

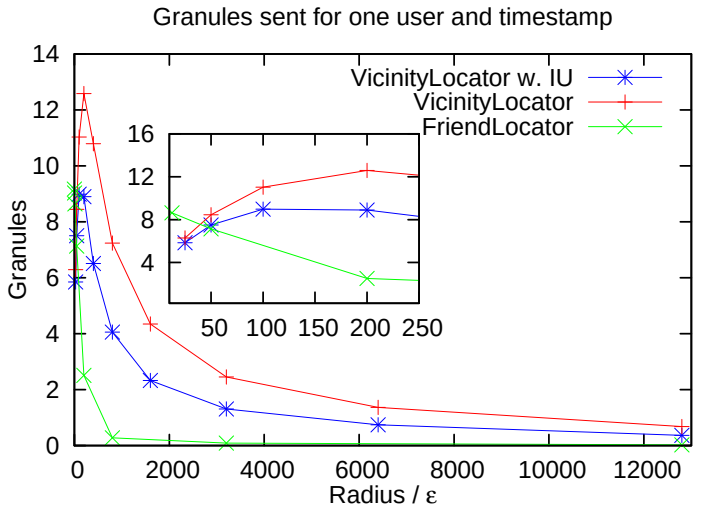
- Small groups, better message ratio
- Communication efficient
- Total messages per user, per update
  - 0.0805, 0.0935, 0.1463, 0.2663



Messages to LS

- less updates over time, on this data

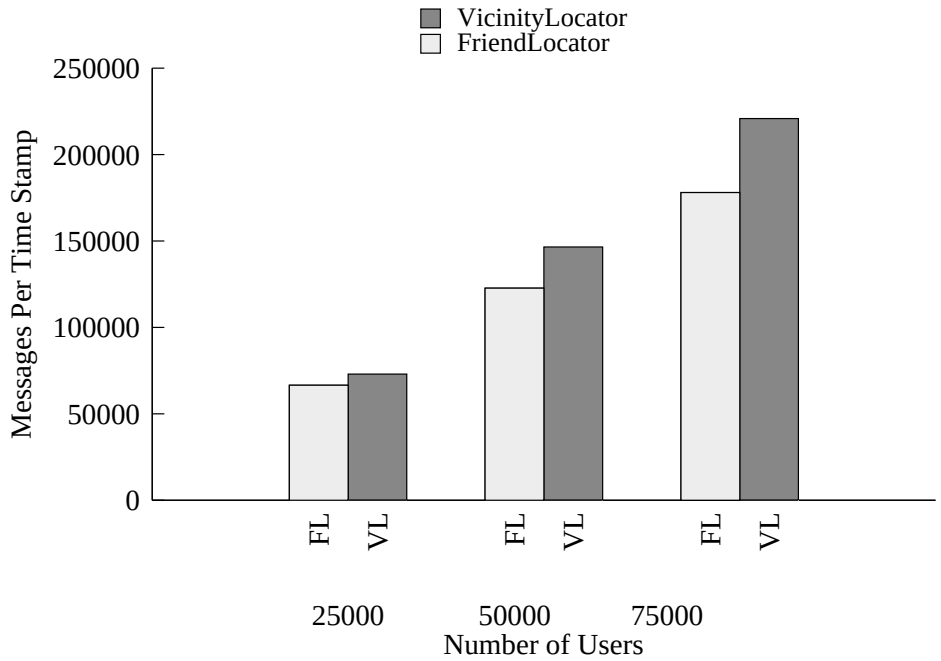




Effect of ϵ_L

- Levels calculated
- Higher ϵ_L, more communication
- Higher ϵ_L, better tracking

User count	Messages	
	FL	VL
25000	2.69	2.92
50000	2.46	2.93
75000	2.38	2.94



Conclusion

- Novel privacy preserving approaches.
- 2 Solutions developed:
  VicinityLocator & FriendLocator
- Gives strong privacy guaranties
- Both approaches strong against attacks
- Both approaches have low operating cost in terms of messages
- Messages vs. Flexibility
  - VicinityLocator offers more flexibility
  - FriendLocator has lower communication cost.

Future Work

Possible extensions
Other Directions

End of Presentation

Thank You For Listening