

# LoSeRO: A Locality Sensitive Routing Protocol in Opportunistic Networks

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# Outline

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- **Opportunistic Networks**
  - Introduction
- **LoSeRO**
  - How it works
  - Network and Mobility details
  - Experiments
- **Conclusion**

# Opportunistic Network

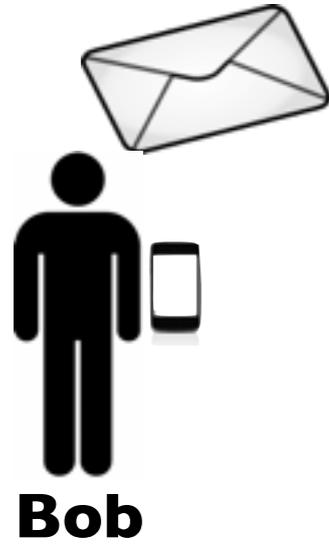
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- **Opportunist networks** are characterised by the presence of mobile devices, like:
  - ▶ SmartPhones;
  - ▶ Tablets;
- Messages are spread using the **Store, Carry** and **Forward** technique;

# Opportunistic Network - Contacts

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Forward



# LoSeRO

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- It is a **routing** protocol that uses the **most frequented** places of users to propagate messages.
- Locations inside an area are uniquely identified by any user, e.g., **cell-ID**.
- Each user independently builds her mobility profile, called ***MobyZone***, considering her own past mobility traces
- The MobyZone of a user is the set of her most visited places.

# LoSeRO - Forwarding condition

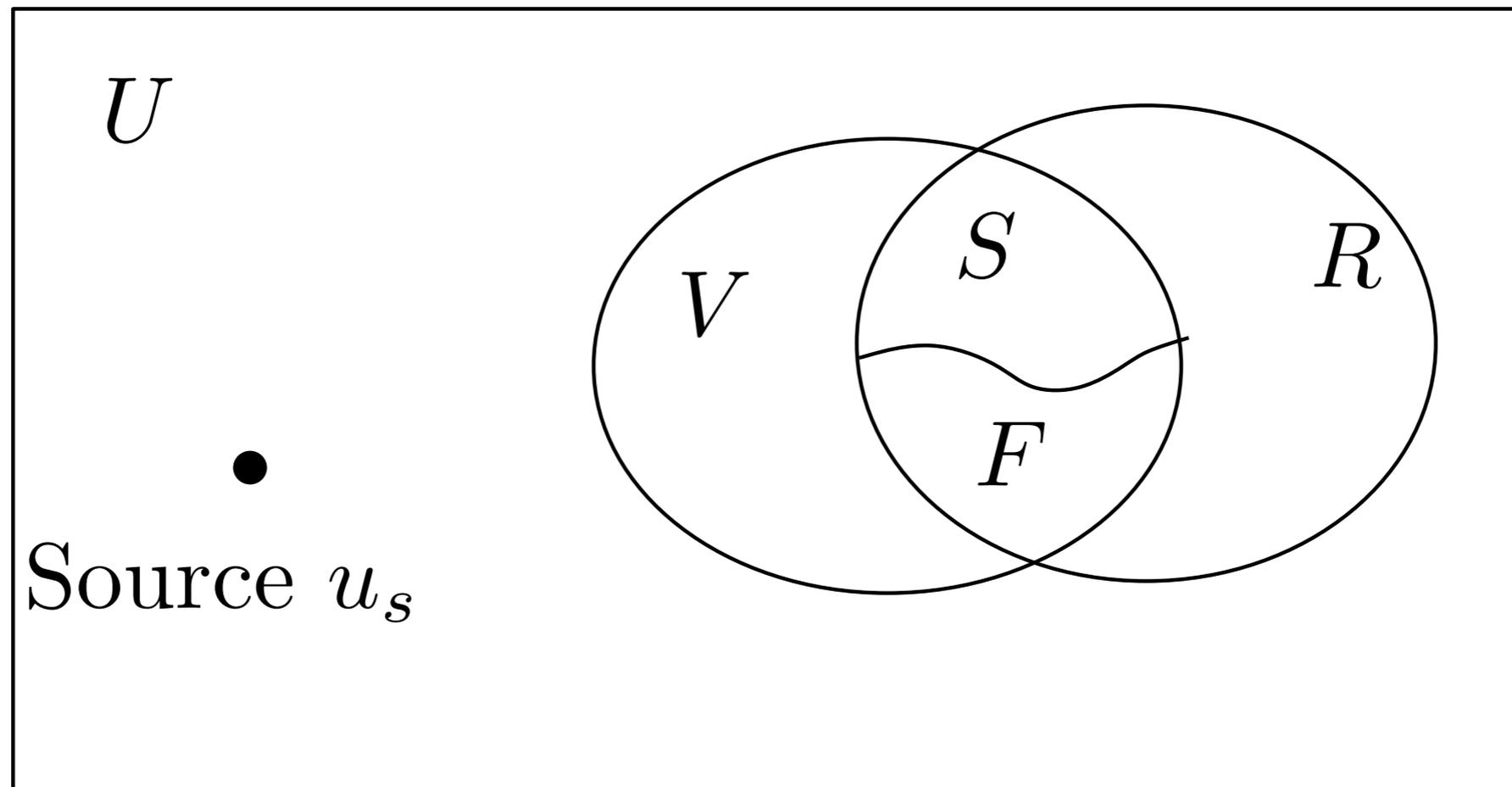
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$$\mathit{Belongs}(\mathcal{D}(M), Z_k) = \begin{cases} \mathit{true} & \text{if } \mathcal{D}(M) \subset Z_k \\ \mathit{false} & \text{Otherwise} \end{cases}$$

Where,  $\mathbf{Z}_k$  is the MobyZone of an agent  $u_k$ , and  $\mathbf{D(M)}$  the set of places indicated in a message  $M$ .

# LoSeRO

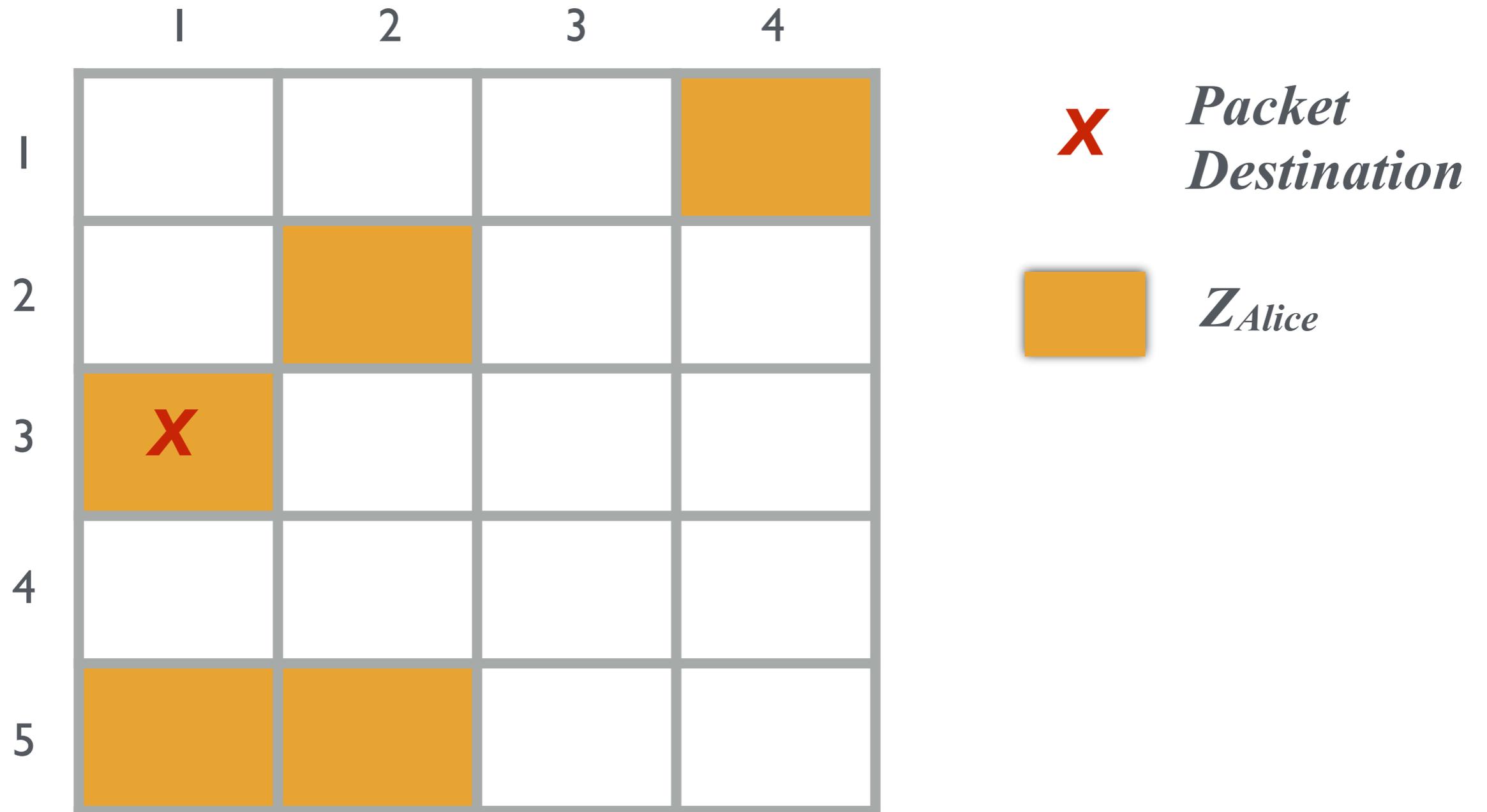
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- **V**: users who **visited** the destination place;
- **R**: users who **received** the messages;
- **S**: users who **delivered** the messages to the destination place;
- **F**: users who **did not** delivered the message to the destination place;

# Network details

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# Mobility Model

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- Every agent visits a location and **waits** at that location for a period of time.
- Once the waiting time at the current location is finished, the **agent visits a new location** with a probability:

$$Pr_{new} = \rho S^{-\gamma}$$

- **S** represents the number of **distinct locations** that a user has already visited.
- The parameters  **$\rho$**  and  **$\gamma$**  controls the probability of exploring an unvisited location.

# Experiments

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- We considered an area of **1000x1000**m with a cell size of 50m, i.e., **40cells**;
- The size of the **MobiZone** is 10;
- The number of agents **ranges from** 100 to 1000;
- Generated packet have **a single cell** of destination delivery, for a total of 20messages generated per simulation;

# Experiments - Metrics

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$$\textit{Coverage} = \frac{|R(\mathcal{M}_c^i) \cap V(\mathcal{M}_c^i)|}{|V(\mathcal{M}_c^i)|}$$

$$\textit{Precision} = \frac{|R(\mathcal{M}_c^i) \cap V(\mathcal{M}_c^i)|}{|R(\mathcal{M}_c^i)|}$$

$$\textit{F-Score} = 2 \cdot \frac{\textit{prec} \times \textit{cov}}{\textit{prec} + \textit{cov}}$$

$V(\mathbf{M}_c^i)$  is the set of agents that visited to all the places in  $D(\mathbf{M}_c^i)$ .

$R(\mathbf{M}_c^i)$  is the set of agents that received  $\mathbf{M}_c^i$  in the course of its spreading in a network.

# Experiments - Metrics

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$$SuccessRate = \frac{|S(\mathcal{M}_c^i)|}{|R(\mathcal{M}_c^i) \cap V(\mathcal{M}_c^i)|}$$

$$Cost = \frac{|R(\mathcal{M}_c^i)|}{n-1}$$

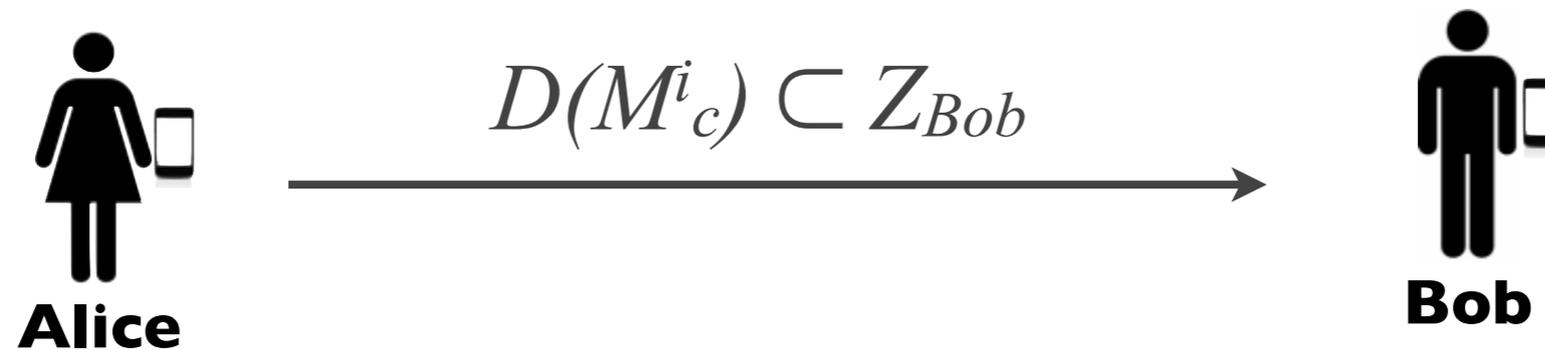
$|S(\mathcal{M}_c^i)|$  is the number of successful delivery.

$R(\mathcal{M}_c^i)$  is the set of agents that has received  $\mathcal{M}_c^i$  in the course of its spreading in a network.

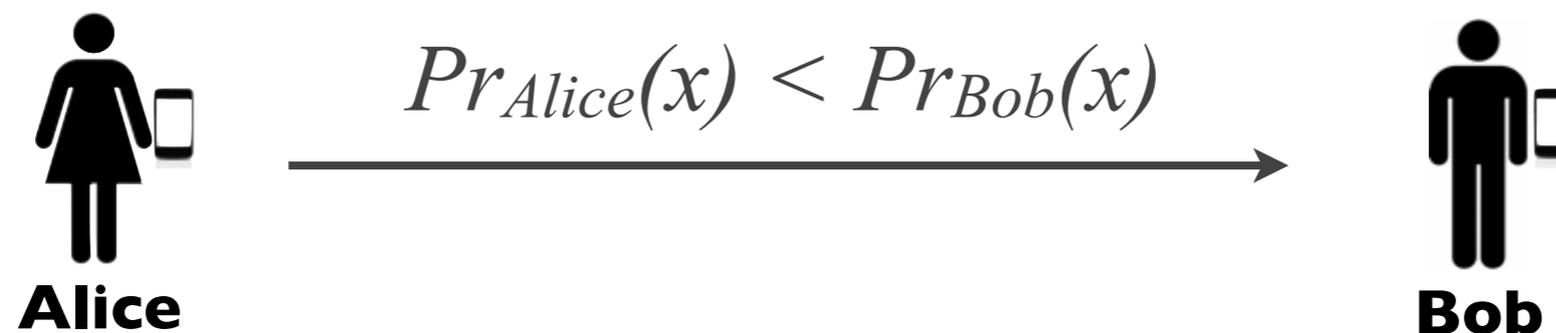
# Experiments - Routing Protocols

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## Direct Delivery (DD)



## Probabilistic Forwarding (Pr)



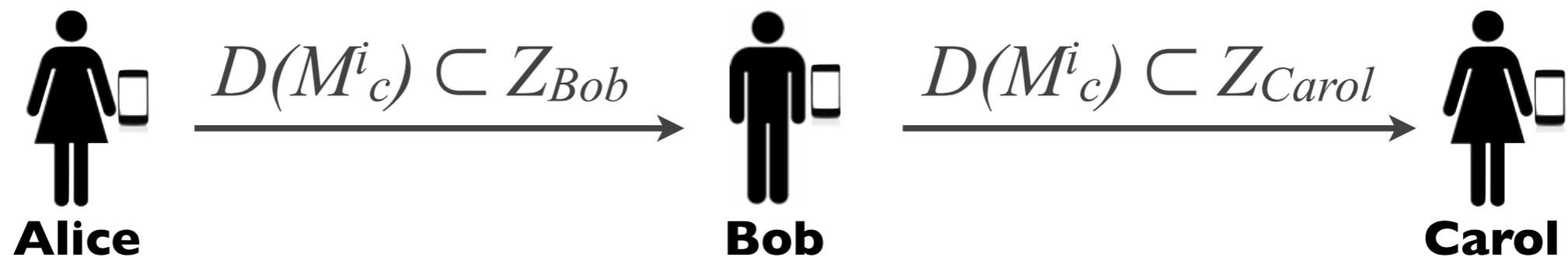
## Epidemic Protocol (EP)



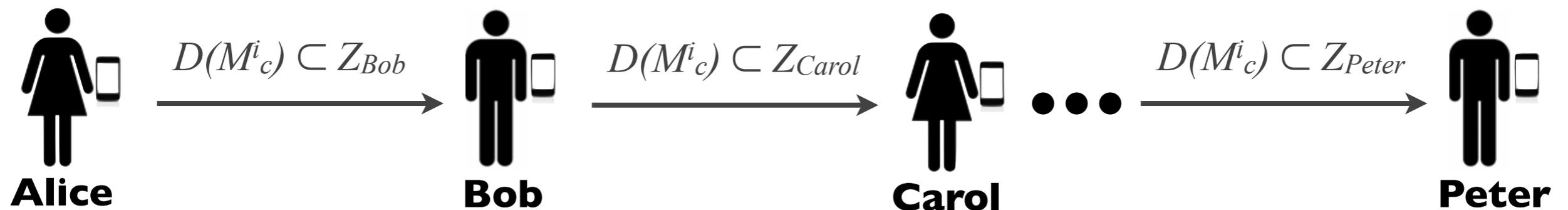
# Experiments - Routing Protocols

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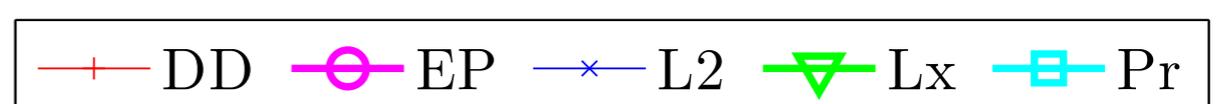
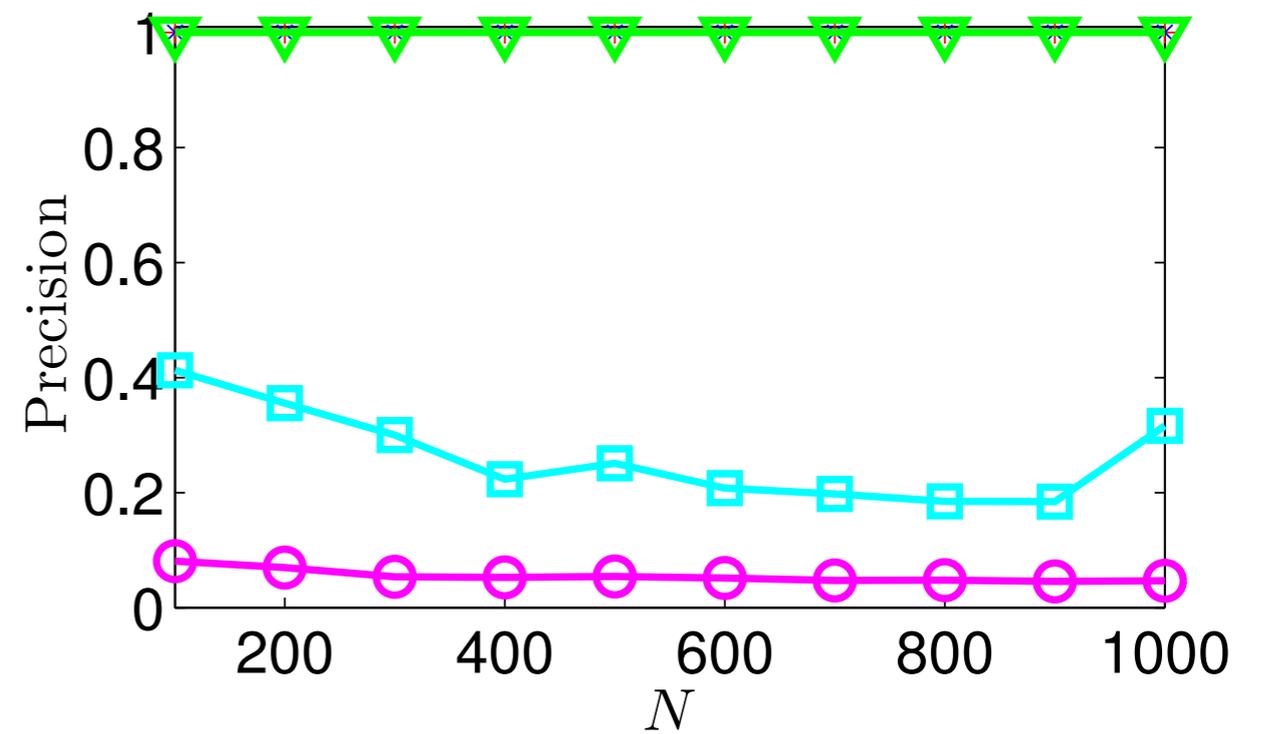
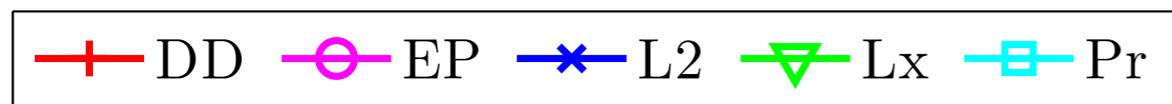
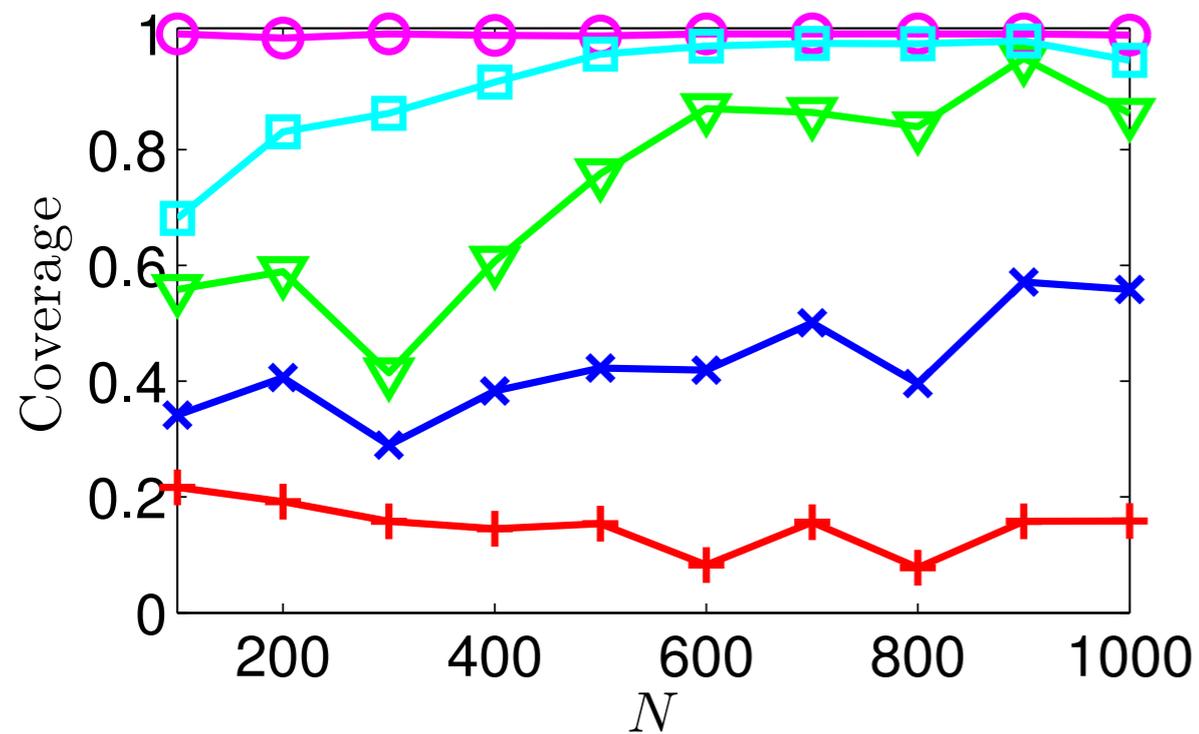
## LoSeRo with 2hops (L2)



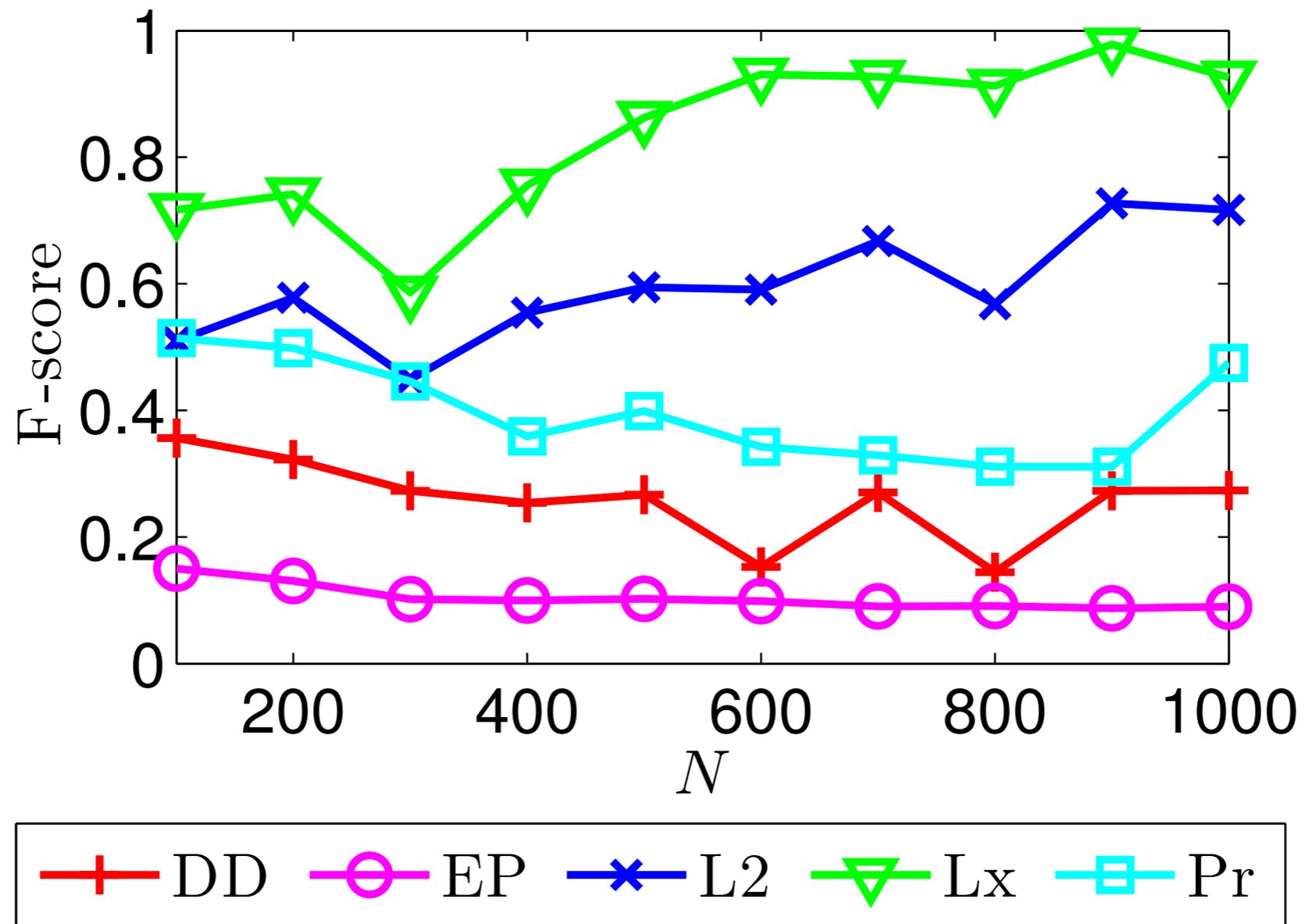
## LoSeRo with any number of hops (Lx)



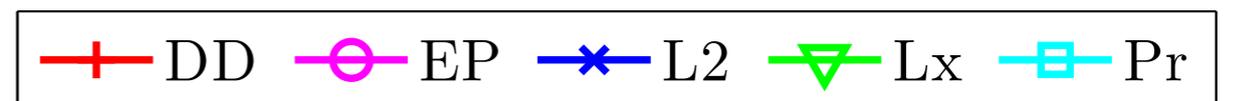
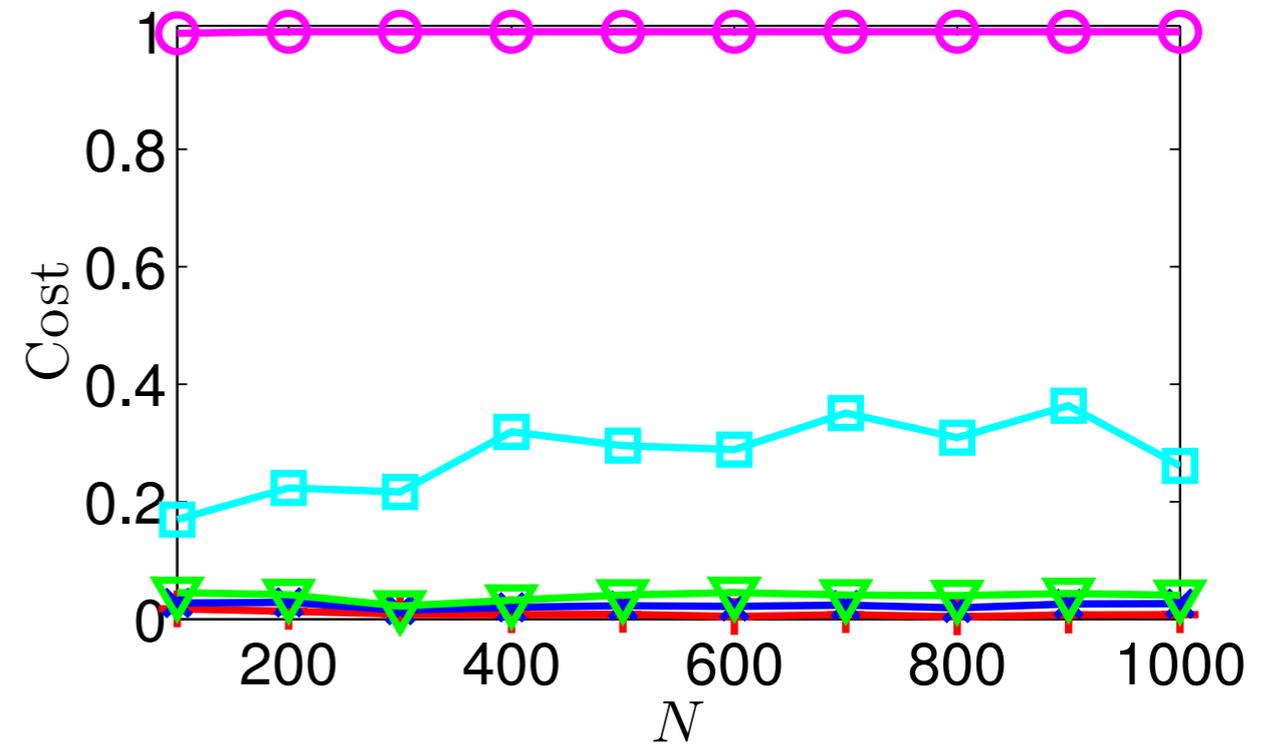
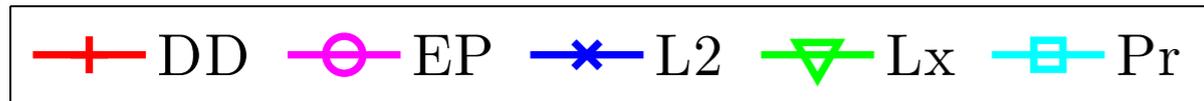
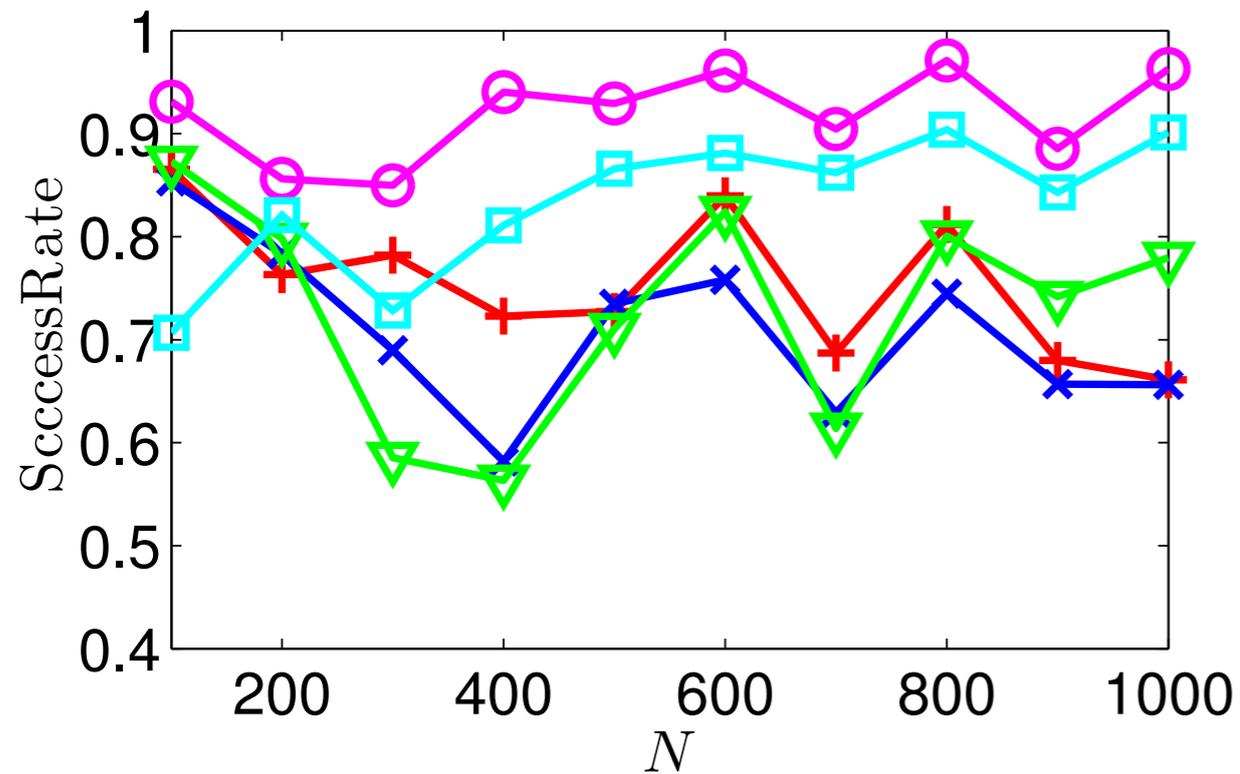
# Experiments - Results - Coverage & Precision



# Experiments - Results - F-Score



# Experiments - Results - SuccessRate & Cost



# Conclusion

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- We have presented a routing protocol based on **the most frequent places** of users
- Our experimental results show that LoSeRO **outperforms** all other protocols in terms of F-score and reaches a good level of **SuccessRate**
- As future work we would like to tackle the **privacy issue** that happens when devices disclose out their MobiZone

