Social-Tie-Based Information Dissemination in Mobile Opportunistic Social Networks

Yunsheng Wang and Jie Wu

Department of Computer and Information Sciences

Temple University

Outline

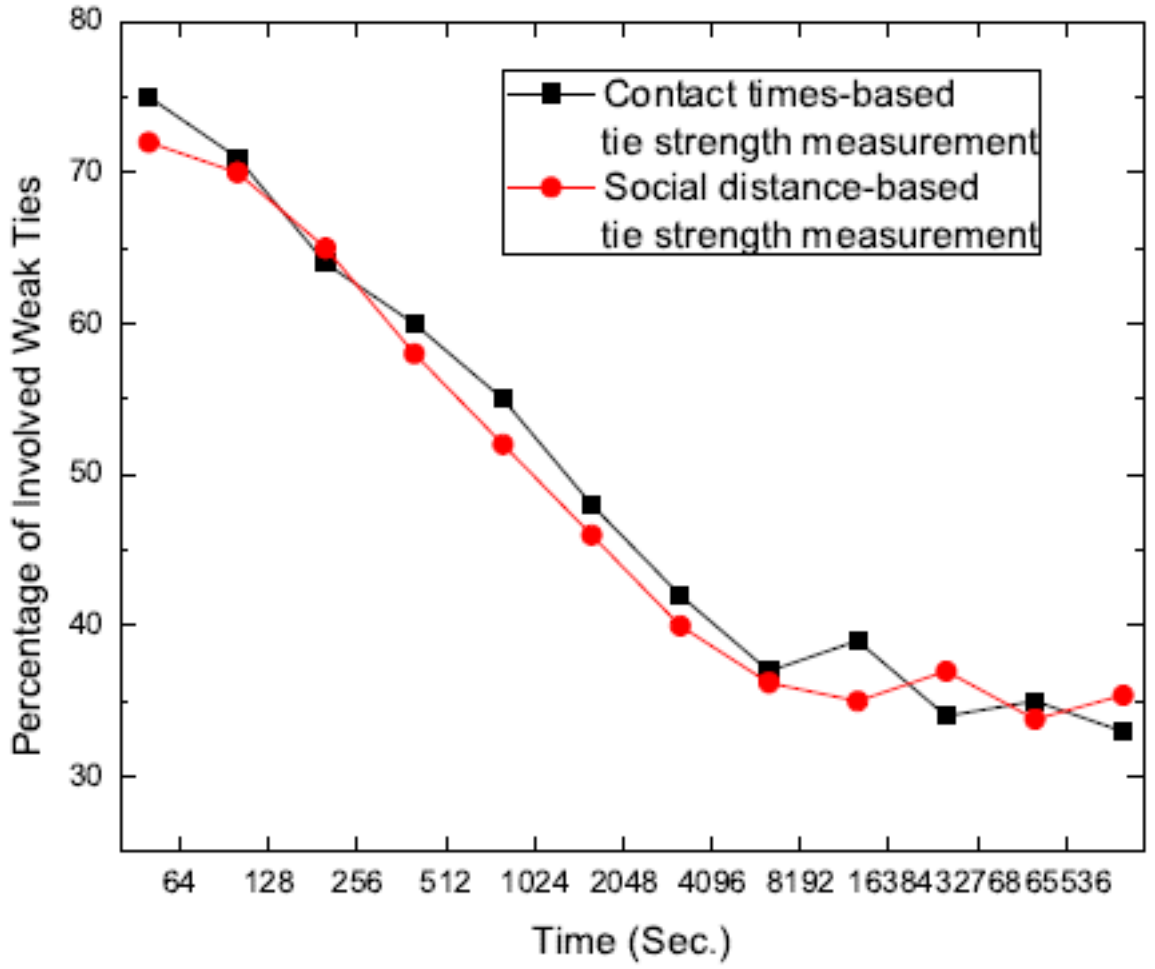
- Mobile Opportunistic Social Networks
- Motivation
- Social-Tie-based Information Dissemination
  - Tie Strength Calculation
  - Two-Phase Token-based Message Forwarding
  - Simulation
- Conclusion

Mobile Opportunistic Social Networks

- Limited End-to-End Connectivity
  - Due to mobility, power saving, or unreliable networks
- Combined the properties of social networks and opportunistic networks

Motivation

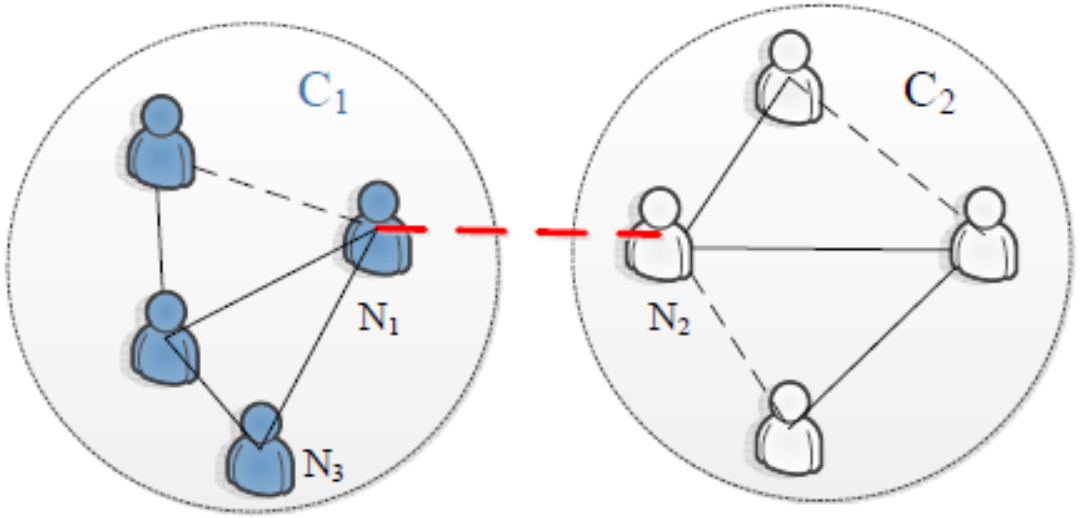
- "The Strength of Weak Ties": Mark Granovetter 1973
- The majority of the novel information dissemination is generated by weak ties.



The percentage of involved weak ties in MIT reality mining data.

Local Bridge

- Easley and Kleinberg claimed that: "If a node in a network ratifies the Strong Triadic Closure Property and is involved in at least two strong ties, then any local bridge it is involved in must be a weak tie."



Tie Strength

- The strength of a tie is a (probably linear) combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie.

Datasets

- MIT reality mining data
- Infocom2006 trace

- Contact information: activity-based (the number of contacts)
- Social information: survey-based (social features)

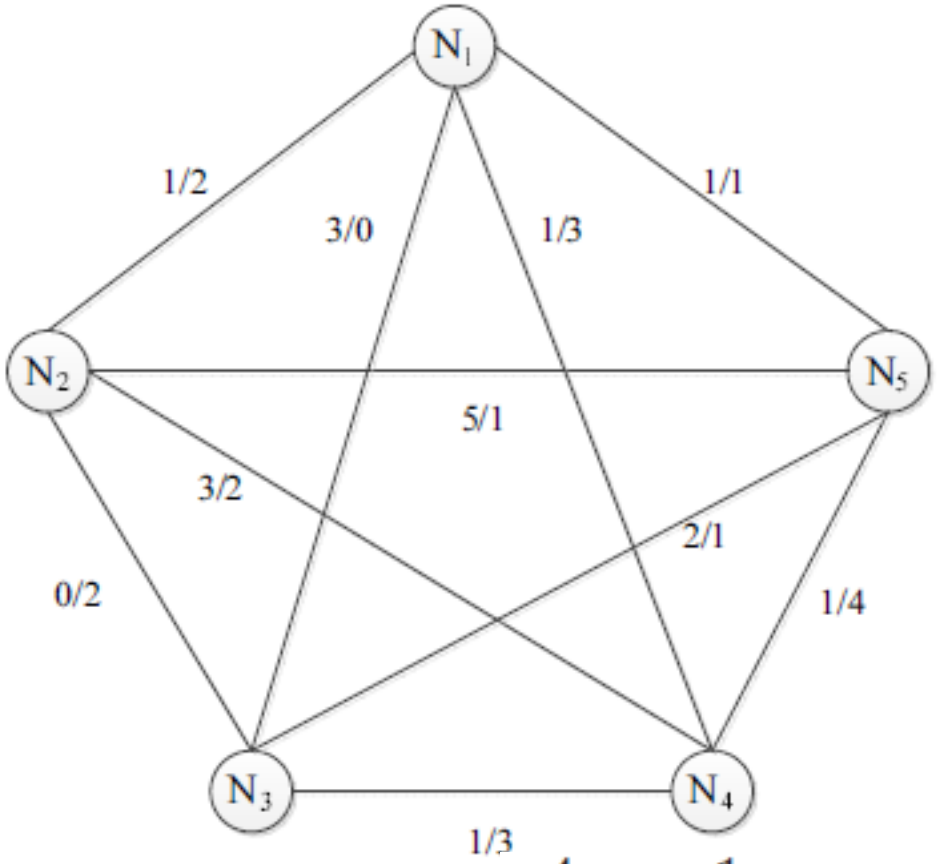
Tie Strength Calculation

$$w_{ij} = \alpha C_{ij} + \beta \frac{1}{1 + D_{ij}}$$

- w_{ij}: tie strength of nodes N_i and N_j
- C_{ij}: normalized number of contacts
- D_{ij}: social feature distance
- α / β : impact of contact information/social feature information

Strong and Weak Ties

- We used as a threshold the 59th percentile of the link weights cumulative distribution
  - Links weighted higher than or equal to the threshold were considered as strong ties;
  - Links with a weight less than the threshold were marked as weak ties.



$$\begin{bmatrix} 0 & \frac{4}{15} & \frac{4}{5} & \frac{9}{40} & \frac{7}{20} \\ \frac{4}{15} & 0 & \frac{1}{6} & \frac{7}{15} & \frac{3}{4} \\ \frac{4}{5} & \frac{1}{6} & 0 & \frac{9}{40} & \frac{9}{20} \\ \frac{9}{20} & \frac{7}{15} & \frac{9}{40} & 0 & \frac{1}{5} \\ \frac{7}{20} & \frac{3}{4} & \frac{9}{20} & \frac{1}{5} & 0 \end{bmatrix}$$

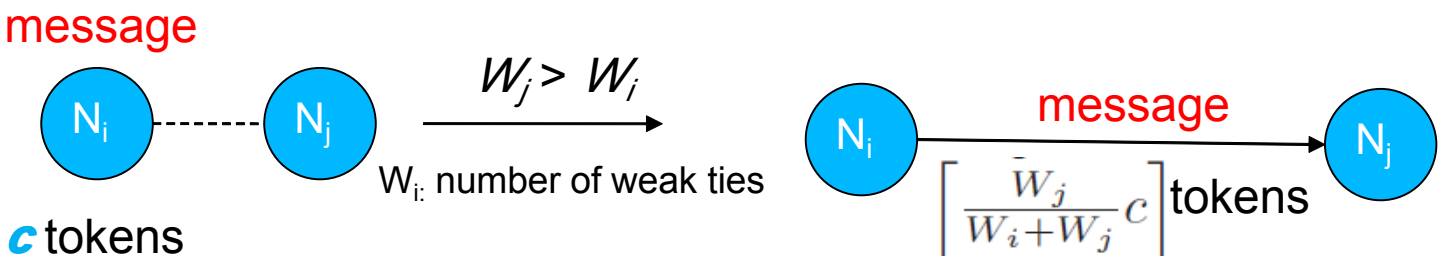
- Threshold: $(\frac{4}{5} - \frac{1}{6}) \times 59\% \approx 0.374$
- Strong ties: (N1,N3), (N2,N4), (N2,N5), (N3,N5)
- Weak ties: (N1,N2), (N1,N4), (N1,N5), (N2,N3), (N3,N4), (N4,N5)

Influential and Susceptible Nodes

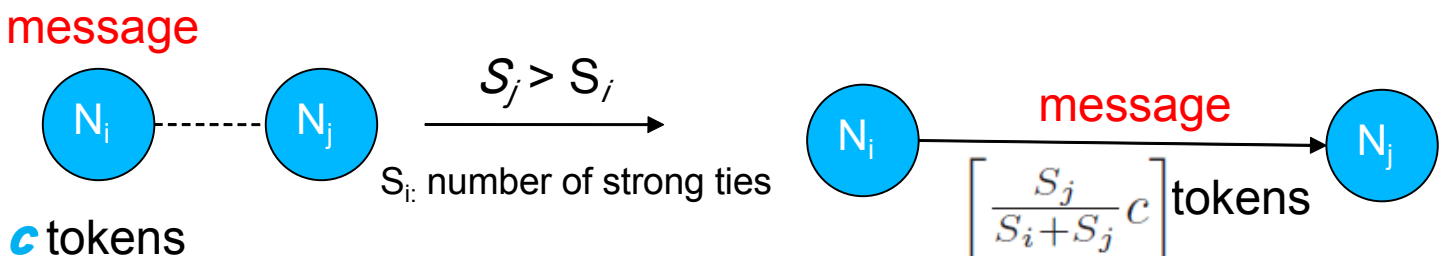
- The *susceptible* nodes with many weak ties have high probability, located on the local bridges, which play a key role in novel information dissemination.
- *Influential* nodes, with more strong ties, are more important to deliver the message to the group members.

Two-Phase Token-based Message Forwarding

- Weak tie-driven forwarding



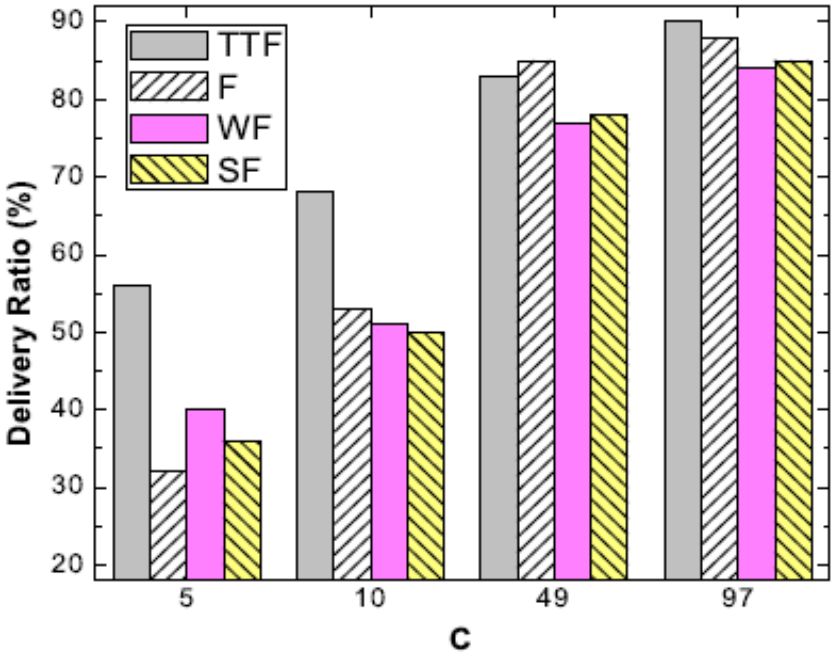
- Strong tie-driven forwarding

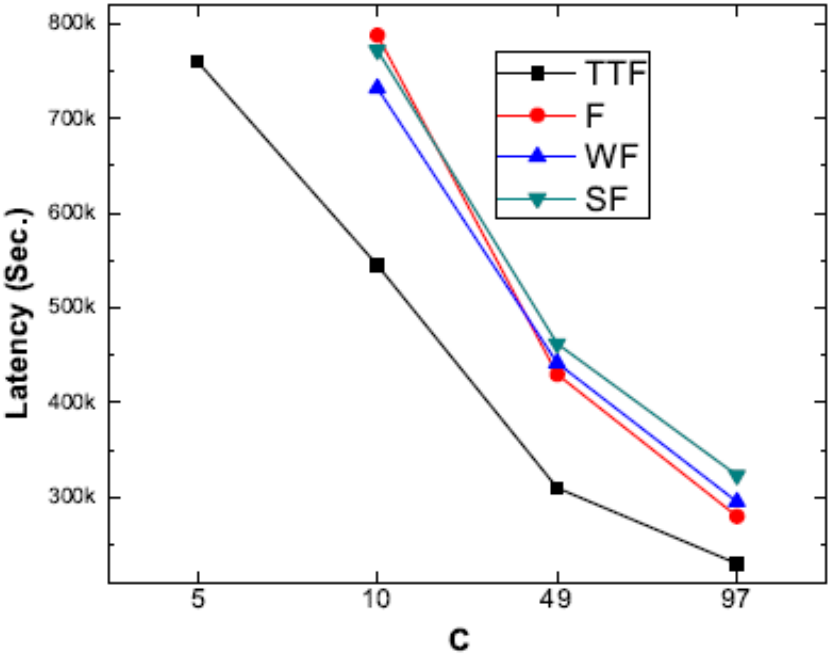


Simulation

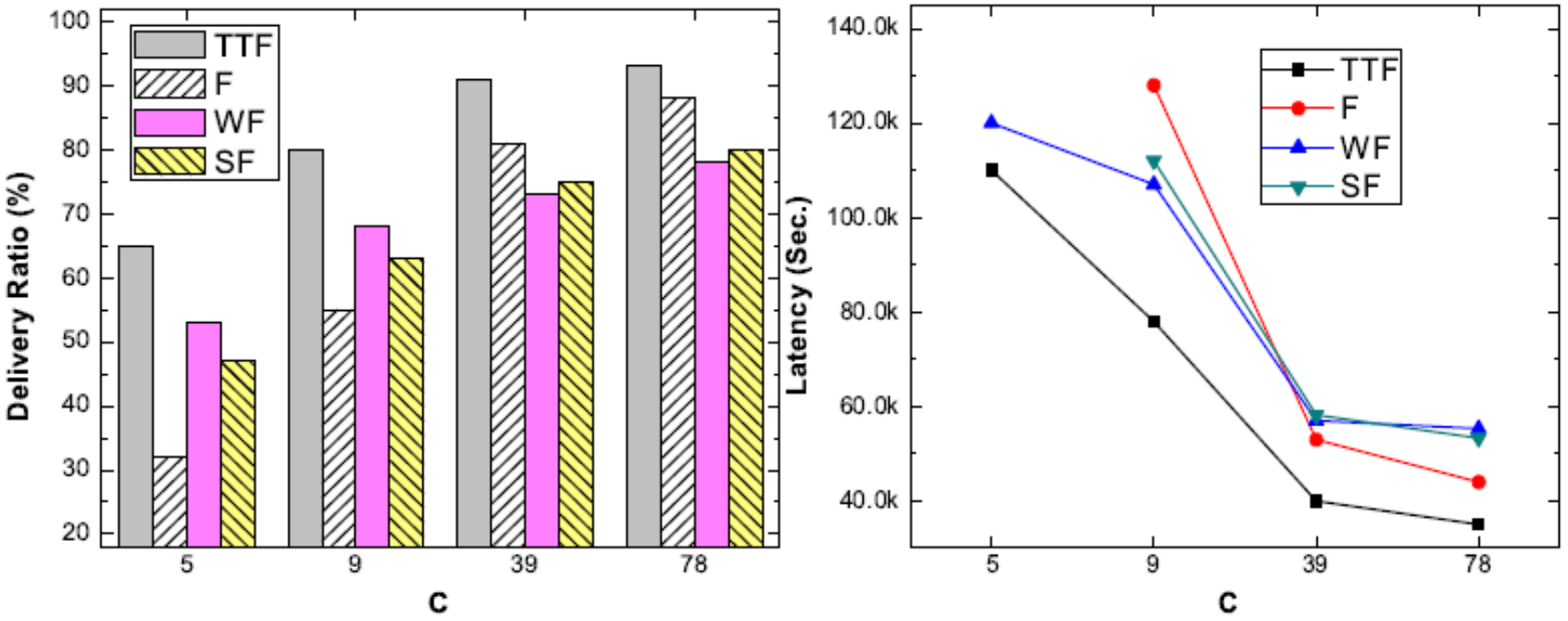
- Comparison schemes
  - Two-phase token-based message forwarding scheme (**TTF**)
  - Flooding (**F**)
  - Weak tie-driven forwarding (**WF**)
  - Strong tie-driven forwarding (**SF**)

MIT reality mining trace





Infocom2006 trace



Summary of Simulation Results

- ***TTF*** has a much higher delivery ratio compared with the other three forwarding schemes, especially when the initial number of tokens is smaller.
- ***TTF*** can dramatically reduce the latency in all conditions.

Conclusion

- The Strength of Weak Ties
- Influential and Susceptible Nodes
- Two-Phase Token-based Message Forwarding

Questions ?