Effect of Locality of Node Mobility on Epidemic Broadcasting in DTNs

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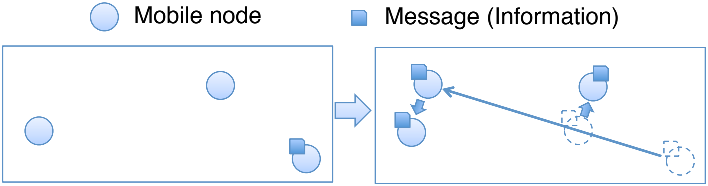
DTNs and Epidemic Broadcasting

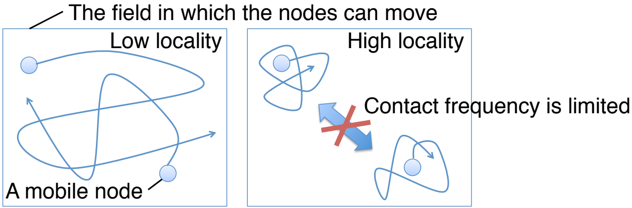
- DTNs, represented by MANET, where nodes are sparse, have attracted considerable attention.
- Epidemic broadcasting is method for one-to-all communication in DTNs composed of mobile nodes.
  - In epidemic broadcast, nodes carrying a message (infected nodes) forward the message when they enter the communication range of other nodes.



An infected node forwards a message if it is in contact with other nodes.

Locality of Node Mobility

- Generally, node mobility affects the communication performance of DTNs, where nodes communicate through epidemic broadcasting or other manner.
- When nodes movement has spatial locality, in the field, it is expected that the message dissemination speed is heavily restricted.



There has been no research focusing on effect of locality of node mobility on message dissemination.

Objectives and Our Approach

Objectives

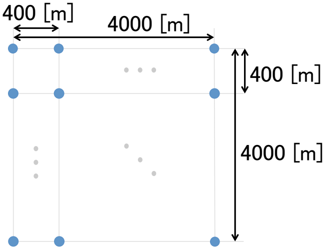
We evaluate the effect of locality of node mobility on message dissemination in epidemic broadcasting.

1. We express the locality of node mobility through the shape of the positional distribution of nodes.
2. We quantify the intensity of locality as $\mathrm{E}[L]$.
   - L denotes the distance from the center (mean/mode) point to the current node position.
3. We analytically derive the message dissemination speeds from the stationary positional distribution of the nodes.
4. We compare message dissemination speeds for various $\mathrm{E}[L]$.

Parameter Setting of Experiments

Assumption

- Each node is distributed around each point as shown in the figure.
- Node position follows two-dimensional normal distribution.

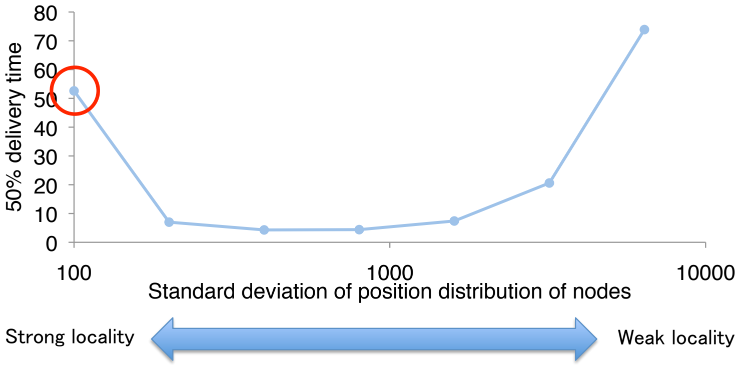


- We compared message dissemination speeds for various standard deviations.

Velocity : Uniform distribution on [0, 8000) [m/h]   Communication range : 50 [m]

Standard deviation of normal distribution : 100, 200, 400, 800, 1600, 3200, 6400 [m]

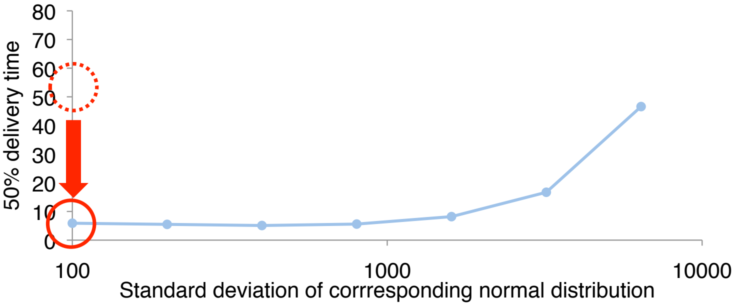
Experiment using Normal Distribution



- The message dissemination speed is considerably lower when the standard deviation is small.
  - A smaller standard deviation leads to stronger locality of node mobility.

Experiment using Cauchy Distribution

- We replaced normal distribution with Cauchy distribution.
  - The pdf of Cauchy distribution is bell-shaped, similarly to the pdf of a normal distribution.
  - It is a heavy-tailed distribution and $\mathrm{E}[L]$ is infinity.



- The message dissemination speed is almost unrestricted.

Conclusion

- We evaluated the effect of locality of node mobility on message dissemination speed in epidemic broadcasting.
  - The message dissemination speed is considerably restricted when the locality of node mobility is strong.
  - A heavy-tailed positional distribution leads to a weak locality of node mobility and entails mostly unrestricted message dissemination speed.

These results suggest that when the motion patterns of nodes follow a heavy-tailed positional distribution, messages can be disseminated within a reasonable period of time even if the density of nodes is low.

Thank you for your kind attention.