CMSC 628 – Spring 2019

Assignment #2

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CMSC 628- Mobile Networks

VCU

School of Engineering | Computer Science

Assignment #2

- The goal of this assignment is to let you understand the encounter dynamics in a mobile network within the context of understanding the performance of DTN routing algorithms.

- There are two parts:
  - Expected Hitting/Meeting Time - Sim vs. Theory comparison
  - Expected Delay of a Routing Algorithm
    - Formula derivation
    - Sim vs. Theory comparison

Due: Tue March 12th, 2019

Upload to BB before class and bring a printed copy to the class.

Part I. Expected Hitting and Meeting Times

- In DTNs, communication opportunity between nodes could be modeled based on Expected Hitting and Meeting times, which are defined as follows:
- Expected Hitting Time (ET):
  - Average time it takes for a randomly moving node to be in range of a static node for a communication opportunity
- Expected Meeting Time (EM):
  - Average time it takes for a randomly moving node to be in range of another randomly moving node for a communication opportunity

Part I. Expected Hitting and Meeting Times

- For nodes moving on a torus based on Random Direction (RD) mobility model, these can be calculated [1] as follows:

$$ET_{rd} = \left(\frac{N}{2K\overline{L}}\right)\left(\frac{\overline{L}}{\overline{v}} + \overline{T}_{stop}\right)$$

$$EM_{rd} = \frac{ET_{rd}}{p_m \hat{v}_{rd} + 2(1 - p_m)}$$

where, N is network size (√N by √N), K is transmission range, L and v are expected epoch and node speeds, T_{stop} is avg pause time, v_{rd} is normalized relative speed for RD and p_m is the probability that a node is mobile at a time $p_m = T/(T+T_{stop})$.

[1] Spyropoulos, Thrasyvoulos, Konstantinos Psounis, and Cauligi S. Raghavendra. "Performance analysis of mobility-assisted routing." *Proceedings of the 7th ACM international symposium on Mobile ad hoc networking and computing*. ACM, 2006.

Part I. Expected Hitting and Meeting Times

- Set your values required for RD model and run simulations (in Java) to get expected ET and EM values.
  - Run many simulations and get average (report how many).

- Compare and plot theoretical values vs. simulation results for
  - different N values (while keeping others the same)
  - different T_{stop} values (while keeping others the same)

  for both ET and EM, separately.

  Check [1] for further settings needed.

Part II: Delay of DTN Routing Algorithms

- Let M nodes move according to a given mobility model (mm) with exponentially distributed meeting times. Then, the expected message delivery time of any routing algorithm ED is [1]:

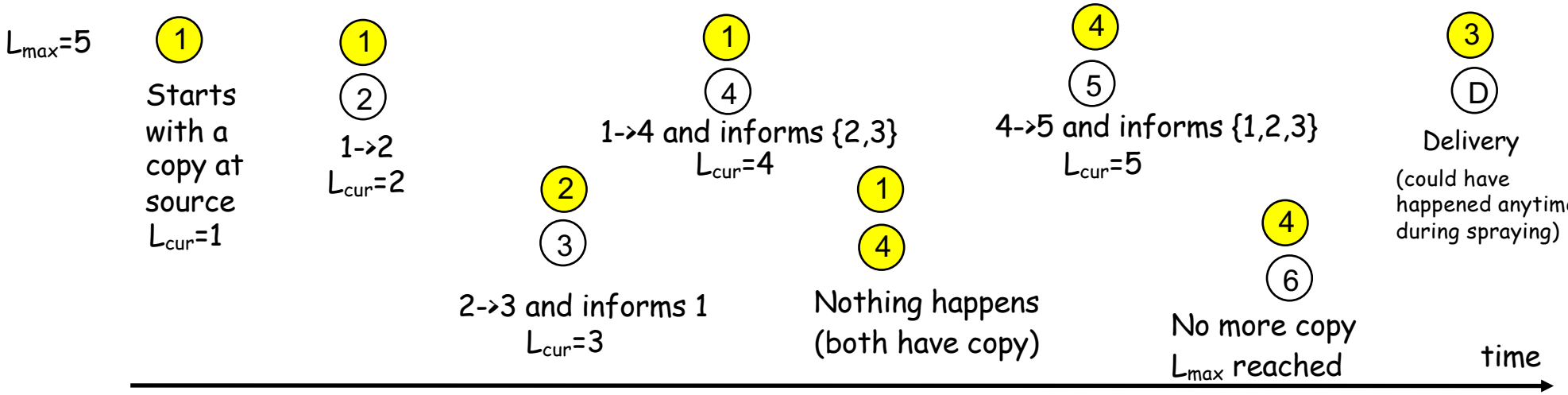
$$\frac{H_{M-1}}{(M-1)} EM^{mm} \leq ED \leq EM^{mm}$$

where H_n is the n^{th} Harmonic number, and could be approximated as $\Theta(\log n)$.

- Here the left/lower bound is the expected delay from epidemic routing, and the right/upper bound is expected delay from direct delivery.

Part II: Delay of DTN Routing Algorithms

- Assume a modified L-copy routing protocol in which the nodes carrying a copy can inform each other (e.g., through a large range radio) when they give a copy to other encountered nodes. This allows spraying of copies to the network in the minimum time.



a) Derive/Explain the expected delay (ED) formula for this protocol.
   - Check [1] and Paper6 (spray and wait) to get help.

b) Simulate this algorithm for different L values and compare the average delay from simulation with the calculation from your theoretical formula.