SPRAY ROUTING IN INTERMITTENTLY CONNECTED NETWORKS

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SIMULATION TOOLS TO BE USED:

Network Simulator 2 .34

BACKGROUND:

Intermittently connected mobile networks are wireless networks, where a complete path from the source to the destination does not exist most of the time. Conventional routing schemes fail, because they try to establish complete end-to-end paths, before any data is sent. To deal with such networks researchers have suggested to use flooding based routing schemes. However, they waste a lot of energy and suffer from severe contention, which degrades their performance seriously. With this in mind, we introduce a new family of routing schemes that "spray" a few message copies into the network, and then route each copy independently towards the destination.

PREVIOUS ALGORITHMS:

1. *SPRAY AND WAIT:*
   - ✓ *Spray phase*: for every message originating at a source node, L message copies are initially spread – forwarded by the source and possibly other nodes receiving a copy – to L distinct "relays". (Details about different spraying methods will be given later.)
   - ✓ *Wait phase*: if the destination is not found in the spraying phase, each of the L nodes carrying a message copy performs direct transmission (i.e. will forward the message only to its destination).

2. *BINARY SPRAY AND WAIT:*
   - ✓ The source of a message initially starts with L copies; any node A that has n > 1 message copies (source or relay), and encounters another node B (with no copies), hands over to B _n/2_ and keeps _n/2_ for itself; when it is left with only one copy, it switches to direct transmission.

Brief Concept of the Project:

Spray routing in intermittently connected mobile networks (ICMNs), consists of two phases:

- *Spray phase*: For every message originating at a source node, L message copies are initially spread—forwarded by the source and possibly other nodes receiving a copy—to L distinct “relays”.
- *Focus phase*: Let $U_x(Y)$ denote the utility of node X for destination Y; a node A, carrying a copy for destination D, forwards its copy to a new node B it encounters, if and only if, $U_B(D) > U_A(D) + U_{th}$, where (utility threshold) where U_{th} is a parameter of the algorithm.

Our problem set up consists of a number of nodes moving inside a bounded area according to a stochastic mobility model. Additionally, we assume that the network is disconnected at most times, and that transmissions are faster than node movement (i.e., it takes less time to transmit a message using the wireless medium—ignoring queuing delay—than to move it physically for the same distance using node mobility).

In this algorithm each node maintains a timer value for every other node in the network. This timer value captures the time elapsed since the two nodes last met each encountered each other (i.e. came within the transmission range). These timers are similar to the age of the last encounter. The timer values indirectly give us an idea about the relative positions of the nodes in the network. A smaller timer value is a strong indication of smaller distance from the node. The utility function obeys the transitive relation for timer values.

Plan of Work:

NS-2.34 Tool will be used to stimulate spray routing protocol. The following assumptions are made:

- *Network:* M nodes move on a two-dimensional torus. Each node can transmit up to distance K ≥ 0 meters away, where K is smaller than the value required for connectivity. Further, links are bidirectional and each message transmission takes one unit of time.

- *Mobility Models*: We assume that all nodes move according to some stochastic mobility model (“MM”), whose “meeting times” are approximately exponentially distributed or have an exponential tail with expected meeting time equal to EM_{mm}. Mobility Models like Random Walk exhibit such characteristics.

- *Contention:* We assume that bandwidth and buffer space are infinite. In other words, we assume that there is no contention for these resources. Spraying schemes perform only a handful of transmissions most of the time. Also, in networks that are quite sparse, we expect that only a few nodes would be close enough each time to compete for the same bandwidth.

The algorithm for initial spray phase will be same as that of Binary Spraying. The algorithm for the spraying phase is:

- The source of a message initially starts with L copies;
- Any node A that has n > 1 message copies (source or relay), and encounters another node B (with no copies), hands over to B n/2 of its copies and keeps n/2 for itself.
- When it is left with only one copy, it switches to Direct Transmission or Utility-based routing,

CHOOSING THE VALUE OF 'L':

We use the following lemma for choosing the initial value of 'L', the proof of which is beyond the scope of this discussion.

"The minimum number of copies L_{min} needed for Spray and Wait to achieve an expected delay at most a.ED_{opt} is independent of the size of the network N and transmission range K, and only depends on a and the number of nodes M."

Finding the value of 'L' theoretically is a very rigorous and involved process. It involves solving the following equation.

$$({H_M}^3 - 1.2)L^3 + \ ({H_M}^2 - \frac{\pi^2}{6})L^2 + \left(a + \frac{2M-1}{M(M-1)}\right)L = \frac{M}{M-1}$$

Instead it can be shown that the delay of the Spray and Wait is also an upper bound on the delay of spray and focus. As a result we can find the value of L for spray and wait and then use a value $\frac{L}{2}$ or $\frac{L}{3}$ for the spray and focus.

The following table provides the value of L_{min} for M=100.

Table 1: minimum L to achieve expected delay

a	1.5	2	3	4	5	6	7	8	9	10
exact	21	13	8	6	5	4	3	3	3	2
bound	N.A.	N.A.	11	7	6	5	4	3	3	2
taylor	N.A.	N.A.	10	7	5	4	3	3	3	2

References:

Thrasyvoulos Spyropoulos, Student Member, IEEE, Konstantinos Psounis, Member, IEEE, and Cauligi S. Raghavendra, Fellow, IEEE,

1. "*Efficient Routing in Intermittently Connected Mobile Networks - Multiple Copy Case",* 2006.
2. *"Spray and Focus: Efficient Mobility-Assisted Routing for Heterogeneous and Correlated Mobility",* 2006.