Abstract:

Controlled mobility was recently shown to be an effective approach to support routing in sparse ad hoc or sensor networks. We propose a scheme utilizing mobile elements that cooperate in collecting and delivering the data. We analyze the performance of the scheme and establish bounds on the average and worst-case delay in delivering the data. We establish that under our scheme, constant per-node throughput is achievable within constant maximum (worst-case) delay as the network size grows. Using simulation, we compare the proposed scheme with a scheme proposed earlier in the literature. The results show that our scheme dominates the alternative.

Our contribution:

Proposing a scheme that:
- efficiently utilizes the interactions between the mobile elements to minimize delay
- enjoys bounds on the average and worst-case delays
- extends the capacity result of ad hoc networks under controlled mobility

Motivation:

Difficulties with traditional approach for data relaying in wireless networks:
- It involves multi-hop communication from data sources to data destinations. Relaying data over a large number of hops reduces the life time of the nodes.
- Communication between two nodes requires connectivity along the path connecting those nodes at the instance of communication. In many situations, existing damaged infrastructure (e.g., in disaster relief situations) or due to limited wireless range (e.g., sparse networks deployed in large areas such as battlefields and surveillance applications) end-to-end paths between pairs of nodes may not exist consistently.

Controlled Mobility: A crazy idea!

Using mobile elements as mechanical carriers of data, aka “Message Ferrying”, “data MULE”, “Actor”, and “Actuator”

Examples realizing the idea:

“ZebraNet”, “Manatee project”, “DakNet”,…

A generic network model:

Each node wishes to send data to multiple (or possibly all) other nodes with known (and possibly different) rates

“Noncontiguous” Vs. “Contiguous” partitioning:

(a) an example of a contiguous partitioning

(b) Central Ferry Relaying (CFR): an example of noncontiguous partitioning

Simulation results:

Uniform data model

Non-uniform data model

Theorem III.6 [Scalability of CFR] Assume N nodes are placed arbitrarily on a unit square, each of which transmitting with a total rate λ to all other nodes such that the data rate between any pair of nodes is the same. If M = αN for some positive constant α, then constant (in M and N) per node throughput with constant worst-case delay is achievable using the CFR scheme.