Orbital Mobility Profile based Routing in Intermittently Connected Mobile Ad hoc Networks (ICMAN)

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Key Concepts
- Users’ movements are often socially influenced.
- “hubs” – places of social interest to users.
- User mobility – an “orbit” involving a list of hubs.
- Mobility profile – a list of hubs likely to be visited.

Remarks
- User mobility profiles exist but difficult to obtain.
- Usefulness for routing in MANET and ICMAN and Mobile wireless applications.

Recent Results on Mobility Profiling
- CSE Dept. TR # 2005-27, SUNY Buffalo, 2005

Related Publications on SOLAR in MANET
- Paper in Elsevier Journal on Ad hoc Networks, ’05
- Paper in IEEE Broadnets ’06
- Poster in ACM Mobihoc ’05

Benefits of Profile-based Routing

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Applications of Orbital Mobility Profiles
- Anomaly based intrusion detection → unexpected movement (in time or space) sets off an alarm.
- Customizable traffic alerts → alert only the individuals who might be affected by a specific traffic condition.
- Targeted inspection → examine only the persons who have routinely visited specific regions upon re-entrance.
- Environmental/health monitoring → identify travelers who can relay data sensed at locations with no APs.

Challenges in Routing in ICMAN
- May not have an end-to-end path from source to destination at any given point in time (intermittently connected).
- Conventional MANET routing strategies fail.
- User mobility may not be deterministic or controllable.
- Devices are constrained by power, memory, etc.
- Applications need to be delay/disruption tolerant.

Future Work
- Collect and analyze user location-based traces.
- Apply advanced clustering/profiling techniques.
- Optimization techniques for profile information management.
- Design and analyze routing algorithms.
- Experimenting with Applications.

Visit Project SOLAR’s Website for More Information
http://www.cse.buffalo.edu/~jjoyghosh/solar.html

SOLAR Profiles shown useful for hub-level location prediction
- on average, 20% more accurate than statistical prediction

Orbital Mobility Profiling
- Obtained a daily list of hubs visited by each user.
- Considered a N-dimensional space → N is the total number of hubs, and each hub list generates a point in the plane.
- Clustered hub lists using the Expectation Maximization (EM) algorithm based on the Mixture of Bernoulli’s distribution.
- Defined each mobility profile to be the cluster mean, that is, a weighted (or probabilistic) hub list.
- User mobility aptly described via a probabilistic mixture of profiles.
- Profiling techniques applied to traces from ETH Zurich.
- Experiments by Intel Research at Berkeley (HAGGLE).
- Profiling techniques applied to traces from ETH Zurich.
- Experimenting with Applications.

User-level Routing Strategy
- Deliver packets to the destination itself.
- Intermediate users store-carry-forward the packets.
- Mobility profiles used to determine delivery probabilities (DP), not the visit probability of a user to a given hub.
- Fractional data delivered to each hub proportional to the probability of finding the destination in it.

Routing Protocol – S-SOLAR-KSP (static)
- Source always considers the current set of neighbors.
- Forwards only to max k users of the chosen set.
- Forwards only to max k users with higher DP to destination.

User-level Routing Strategy
- Deliver packets to the destination itself.
- Intermediate users store-carry-forward the packets.
- Mobility profiles used to compute pair wise user contact probability (CP) to form weighted graph.
- Apply modified Dijkstra’s to obtain k-shortest paths (KSP) with corresponding delivery probability (DP).
- Routing Protocol – S-SOLAR-KSP (static)
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