

Profile-cast: Behavior-Aware Mobile Networking

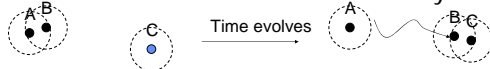
Wei-jen Hsu¹, Debojyoti Dutta², Ahmed Helmy¹

¹Dept. of Computer and Information Science and Engineering, U. of Florida, ²Cisco Systems, Inc.

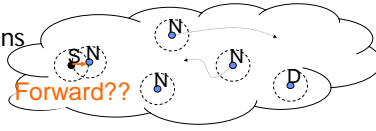
wjhsu@ufl.edu, dedutta@cisco.com, helmy@ufl.edu <http://nile.cise.ufl.edu/MobiLib>

1. Introduction (Routing in Delay Tolerant Networks)

- Delay tolerant networks (DTNs) are mobile network with sparse, intermittent network connectivity.
- Messages are stored in non-volatile memory of nodes and moved across the network with nodal mobility.



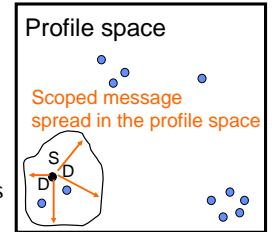
- Encounter events provide the communication opportunities among nodes
- Message-forwarding decisions
 - De-centralized, based on locally available information
 - Impact performance (success rate, overhead, delay)



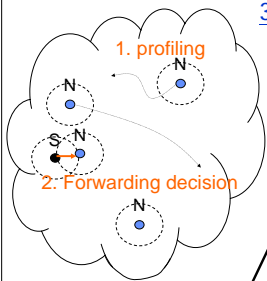
Contribution: Show-casing the potential of improving DTN routing protocols when user behavioral patterns are considered.

2. Target Application: Profile-cast

- We focus on message delivery to a group of hosts with similar characteristics (profile-cast)
 - (v.s. multi-cast) Group membership is implicit
- Each node characterized by its unique property in the profile space
 - Similar nodes are close to each other, dissimilar nodes are far apart
- We use mobility profile as an example
 - Targeted announcement, lost-and-found
 - (v.s. geo-cast) Definition of user group based on long-run mobility characteristics



3. Similarity-based Forwarding Protocol

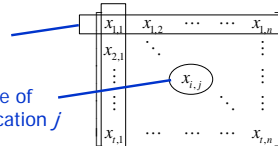


1. Each node keeps its summarized mobility profile as it moves to various locations.
2. When nodes meet, they exchange the summarized mobility profile to determine their similarity.

Profiling User Mobility

- Mobility of a node is represented by an *association matrix*.
- Singular value decomposition provides a summary of the matrix (Eigen-behavior vectors)

Each row represents an association vector for a time slot



An entry represents the percentage of online time during time slot i at location j

Determining User Similarity

- Similarity of user mobility are evaluated by weighted inner products of eigen-behaviors $Sim(U, V) = \sum_{i,j} w_i w_j |u_i \cdot v_j|$
- Message forwarded if $Sim(U, V)$ is larger than a threshold

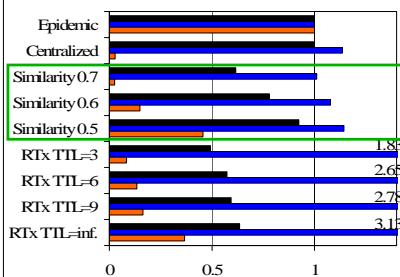
4. Evaluation

- Based on USC WLAN trace for realistic user mobility (2006 spring, 94 days, 5000 users)
- We use hierarchical clustering to identify 200 distinct groups based on mobility profile[2], focus on groups with 5 or more members and randomly pick 20% of the members in these groups as message senders.
- We compare the similarity-based protocol against
 - Routing with centralized knowledge of user grouping (The ideal case - nodes know which group they are in through an oracle)
 - Epidemic routing
 - Random transmission
- We compare protocol performances based on Success rate, Overhead, and Delay.

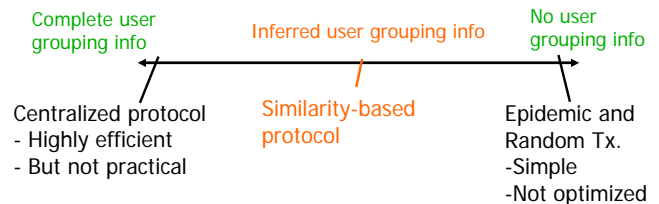
5. Simulation Results

Normalized performance metrics

■ Success rate ■ Delay ■ Overhead



- Behavior-aware protocol design shows performance improvement over behavior-oblivious protocols
- Compare with epidemic
 - 45% of overhead with 92% of success rate (similarity 0.5)
 - 3% of overhead with 61% of success rate (similarity 0.7)
- Compare with random trans.
 - Better success rate under similar overhead (similarity 0.6 v.s. RTx TTL=9)
- Flexible overhead-performance tradeoff



6. Future Work

- Extend the mobility profile to include the encounter pattern
- Profile-cast with other attributes (e.g. interests of users)
- Experiments with other realistic data sets and test bed implementation

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[1] Full version of technical report available at <http://arxiv.org/abs/cs/0606002>
[2] W. Hsu, D. Dutta, and A. Helmy, "Extended Abstract: Mining Behavioral Groups in Large Wireless LANs," in Proceedings of MOBICom 2007.