MobiPING: Pinging in Mobile Social Networks

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I. Introduction

The wide-scale adoption of wireless devices may enable a new platform for peer-to-peer opportunistic networking. One potential framework, termed *mobile social networks* (MSNs), is beginning to receive research attention. Mobile social networks comprise of mobile wireless devices that are not necessarily connected to each other. Messages progress from a source to its destination by opportunistically exploiting wireless connectivity as well as physical node mobility. Intermediate nodes receive batches of messages, store and carry them in their local memory, and forward them either to better relays or to their final destinations. Of course, relying on physical node mobility for message transport can considerably increase the latency of communication[1]. However, the increasing density of wireless devices, and the inherent diversity in user mobility may serve to bound this latency to reasonable limits. Several applications, such as instant messaging, peer-to-peer file sharing, mobile sensor networks, etc. may be tolerant to such latencies. Mobile social networks may empower this class of applications.

Problem Formulation: Translating the intuition of MSNs into an usable system is a non-trivial research problem. One important challenge pertains to pinging a desired target that may not be reachable over wireless transmissions alone. Clearly, traditional route-discovery schemes (such as those based on flooding) will not work – *in a MSN, a flooded packet will only reach nodes that are in wireless reach of the originator.* Moreover, even if a route is discovered, the route may quickly become invalid at the next message transmission time instant. We argue that locating a node, every time a message needs to be sent, may not be scalable. Instead, we propose a proactive location service that can serve as the basis for PINGing any destination node from a given source.

Our Broad Approach: We assume that nodes are equipped with GPS-type location information – cellular phones are already emerging with such capabilities. In the proposed scheme, each node records its encounters with other nodes, while they move around in the network. The details of these encounters are cached at each node, and the caches are exchanged periodically with other nodes that are encountered later. Due to these proactive exchanges, any node in the network is likely to be partially aware of any other node's whereabouts. This is a result of an interesting phase transition property of MSNs, wherein, a specific information can quickly reach a large fraction of others nodes, in a reasonably short duration. This property is shown in Figure 1. Capitalizing on this property, we design our communication framework – MobiPING – for mobile social networks.

[1]In particular, when mobility is unpredictable, a message may get carried further away from the destination, further increasing the delay in delivery.

The partial awareness of a destination's location – called *hint* – can be used for connecting a source-destination pair. For instance, if node X receives a message destined for node D, and if node X had encountered D at location (x, y), at time t_D^X in the past, then node X can geographically forward the message toward coordinates (x, y). The value of t_D^X can be included in the message as a measure of confidence. Downstream nodes that receive this message, continue to forward it toward location (x, y), unless they had encountered D later than t_D^X, in which case, they redirect the message toward the location stored in their own cache. As we show later, the trajectory of a message can quickly converge to its destination because network nodes are capable of providing progressively good hints. Percolating hints, and using them for PINGing node pairs, forms the core of our protocol.

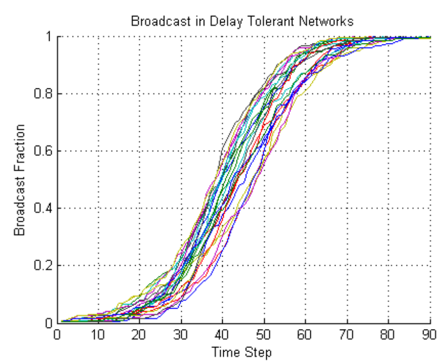

Fig. 1. A large fraction of the nodes receive the packet within a short time-window. The network exhibits a phase transition property.

Ongoing Work: Several challenges need to be addressed. (1) How frequently must nodes exchange their cached information, without sacrificing the accuracy of location information? (2) Are there social relationships between users that can be leveraged for better connectivity – we envision an anycasting scheme, wherein, messages are anycast to a "buddy list" of the destination? (3) Can user behavior be leveraged for mobility prediction, in turn reducing the latency of MobiPING? (4) Can assistive infrastructure (such as storage buffers) be scattered in the network to improve the latency of communication over this opportunistic MSN framework? Our ongoing work aims to address these challenges, and develop a mobile social network of cellular phones through device virtualization.