A Routing Protocol for Mobile Peer-to-Peer Nano-Networks

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ABSTRACT

Wireless nano-communication will be a key-enabler of exotic applications in medicine and industrial manufacturing. However, it poses extreme power supply and computational power restrictions, especially in the mobile peer-to-peer nano-networking case. We propose a communication protocol tailored to these restrictions. The proposed scheme follows a two-phase approach consisting of node-neighborhood status update and next relay node selection. We evaluate our scheme via simulations and preliminary results indicate improved network performance in terms of packet delivery and energy expenditure, when compared to the packet flooding approach.

KEYWORDS

Nano-networks, mobile, multi-hop, peer-to-peer, routing.

1 Introduction

Electromagnetic nano-networks comprise miniaturized computers and wireless transceivers at the scale of 100-1000 nm. They are envisioned to enable groundbreaking applications in medicine and industrial manufacturing, exemplary allowing for targeted drug delivery at cellular level [1], cancerous cell detection and extermination [1], industrial materials with real-time adaptive electromagnetic behavior [2] and more [3, 4].

While related studies have considerably explored the physical-layer design of nano-networks, the research on higher level protocols that will enable the envisioned applications is limited to specific domains [5, 6]. New routing schemes are needed for nano-networks, which will be able to tackle the challenges of the nano-scale. Specifically, sophisticated routing is highly challenging, especially in dense nano-networks deployments, owed to the little setup overhead allowed due to energy restrictions. Nano-routing protocols have to combine low-complexity, scalability, energy efficiency and adequate performance.

In this poster we propose a routing protocol that is fit for generic applications of nano-networks. Each node chooses its next packet relay as the neighbor node with the maximum energy level.

2 The Proposed Routing Scheme

The proposed routing scheme assumes a set of mobile nodes, which are identical in terms of hardware and have the same short wireless connectivity radius. When a node receives a data-packet, it behaves like a source node in order to forward data to the next-hop node. A data packet is expected to reach its destination after many hops in general. The proposed scheme has two phases:

Phase 1. Estimating the energy levels of all one-hop receivers. The source node sends a broadcast request packet to inform its neighbors about its intend to send data. The broadcast packet includes a randomized (and hence probabilistically unique) *packet_ID*, enabling neighbors that have previously retransmit the packet to skip this request, avoiding loops in the network and conserving energy. All candidate nodes send a reply packet to the source node, including information about their energy status level and their *node_ID*.

Phase 2. Determine the next data hop. The source node chooses the next hop-node, which is either the final receiver node or the node with the highest energy levels among its one-hop neighbors.

3 Simulations

We simulate a nano-network in the AnyLogic platform [7]. 150 nodes float within a 2D space with dimensions 0.7mm x 0.5mm Each node has circular shape with radius 100nm (collisions and elastic bouncing is considered). Each node has an initial speed of 10nm/sec and random direction. The node communication and energy parameters are: connectivity range: 10μm, power per packet transmission: 200pJ, battery capacity: 800pJ. We pick 10 random node pairs to communicate one packet, and repeat the simulation 100 times for dependable results.

Compared to the scheme [7], we obtain 16 % better packet delivery ratio (i.e., the ratio of successful packet deliveries between random sender/receiver node pairs) and 20% better node battery depletion ratio. (When the residual energy of nodes is less than 200pJ we consider it to be depleted, since it cannot forward any more packets).

4 Conclusion

We presented a novel routing protocol for mobile ad hoc nano-networks. The novel scheme is generically applicable across domains and combines energy efficiency with considerable networking performance.

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