ADHOP: an Energy Aware Routing Algorithm for Mobile Wireless Sensor Networks

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Summary

Sensor nodes usually propagate data packets in a multi-hop fashion. However, in the most of routing protocols, the optimal routes are likely to be used for the following transmissions. As a result, the optimal routes tend to accelerate the energy depletion of nodes, especially in low-power networks which are noisy and error-prone. ADHOP is a low overhead routing algorithm which is able to adapt to dynamic topologies. Such protocol is designed to use metrics as heuristic information to support routing decisions according to the network needs, such as distance, latency, residual energy, and/or signal strength. Our approach aims at using residual energy as a metric in ADHOP to distribute the network traffic load thus balancing the energy consumption among nodes without compromising communication. Such method allows us to also achieve a routing algorithm powerful enough to reduce the energy consumption per delivered data in high data loss scenarios.

Motivation

Maximizing the network lifetime and balancing the energy consumption have raised some attention and effort on several approaches[1] of routing in Wireless Sensor Networks (WSNs). Hence, many proposals for routing protocols have been specifically made to handle energy depletion, although few consider mobile sensor nodes. In the past, WSNs are all considered static to continuously collect information from the environment. By introducing mobility to WSNs[2], the network capability can be improved in many aspects, such as automatic node deployment, flexible topology adjustment, and rapid event reaction, resulting in several emerging applications for WSNs. However, dealing with the limited energy resources of sensor nodes in mobile WSNs becomes a major challenge in the design of routing protocols.

Results

The results were obtained using the OMNeT++ simulator (see Fig. 1). Each simulation scenario was run for a total of 900 seconds in an environment of high mobility that is conducive to high data loss. In these mobile scenarios, as the number of nodes increases, the energy consumption of sensor nodes also tends to increase (see Fig. 2). Such behavior happens due to the bit rate of IEEE 802.15.4 nodes which makes the connectivity worse in higher speeds[3]. This means greater competition for the medium implying in collisions, congestions, data loss, and greater energy consumption for mobile, dense, and scalable networks, causing the depletion of energy on the routes (see Fig. 3). In such scenario, our approach which uses residual energy as metric can reduce the average energy consumption by approximately 6% compared to the ADHOP which uses latency as metric and can also reduce approximately 7% compared to AODV. AOER is an efficient energy aware routing protocol for ad hoc networks which reduces the average power consumed by approximately 13% compared to our approach. Although AOER has better average energy consumption, our approach produces better results in the energy consumption per delivered data by approximately 89% (see Fig. 4). We can notice that energy aware ADHOP is able to improve energy use while reducing the energy consumption without compromising data delivery ratio.

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[1] Anastasi, G.; et al., “Energy conservation in wireless sensor networks: A survey,” Ad Hoc Networks, vol.7, n.3, p.537-568, 2009.

[2] Okazaki, A.M.; Fröhlich, A.A., "Ant-based Dynamic Hop Optimization Protocol: A routing algorithm for Mobile Wireless Sensor Networks," GLOBECOM Workshops, p.1139-1143, 2011.

[3] Zen, K.; et al., "Performance evaluation of IEEE 802.15.4 for mobile sensor networks," WOCN '08, p.1-5, 2008.

Figures

Parameters	
Area	1200m X 1200m
Max Speed	5 m/s
App. Msg. Length	32 B
App. Msg. Frequence	2 s
UDP Header Length	8 B
IP Header Length	20 B
Netmask	255.255.0.0
ADHOP Header Length	20 B
IEEE 802.15.4 ACK	TRUE
IEEE 802.15.4 Header Length	22 B
IEEE 802.15.4 Max Frame Size	102 B
Phy. Transmitter Power	1 mW
Phy. Sensitivity	-85 dBm
Phy. Thermal Noise	-110 dBm
Channel Carrier Frequency	2.4 GHz
Battery Capacity	850 mAh
Battery Voltage	3 V
Usage Radio Sleep	0.001 mA
Usage Radio Rx	22 mA
Usage Radio Tx	29 mA

Fig. 1: Simulation Parameters.

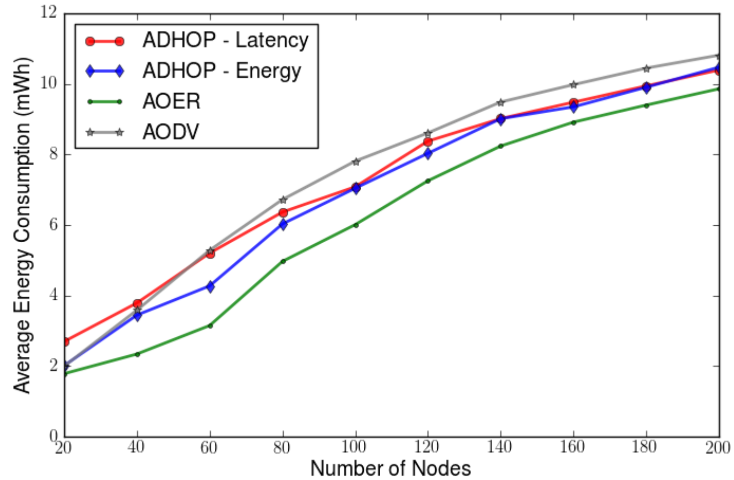

Fig. 2: Average Energy Consumption.

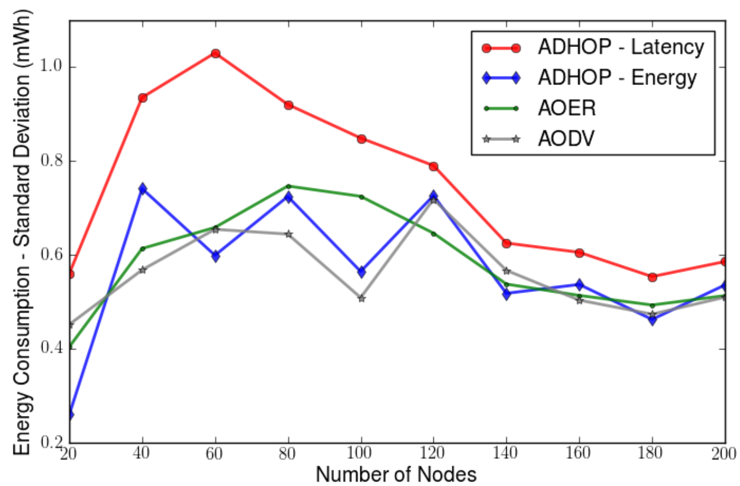

Fig. 3: Energy Consumption - Standard Deviation.

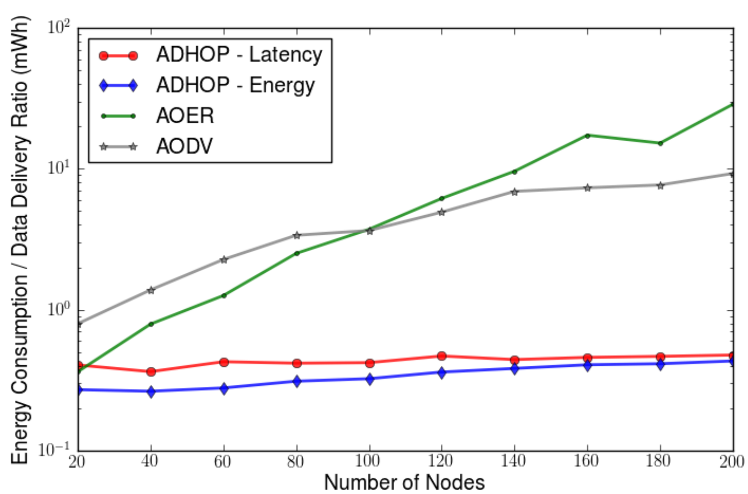

Fig. 4: Energy Consumption per Delivered Data.