1S-07

Performance Evaluation of Intermittent Wireless Multihop Transmissions by Probabilistic Routing

Sho Kumagai and Hiroaki Higaki

Department of Robotics and Mechatronics, Tokyo Denki University

1 Introduction

Intermittent communication technique is widely introduced in wireless ad-hoc networks for reduction of power consumption. In order to realize the intermittent communication, it is difficult for each intermediate node to synchronize with its previous- and next-hop nodes. Intermittent Receiver-driven Data Transmission (IRDT) is an asynchronous intermittent communication protocol for wireless ad-hoc networks [3]. However, it is difficult for conventional ad-hoc routing protocols to be applied since the protocols are designed to support only wireless networks consisting of always-on stationary wireless nodes.

2 IRDT-GEDIR

In IRDT [3], a current-hop node N_c waits for receipt of a polling message from its next-hop node N_n as in Figure 1. Every node switches between its active and sleep modes and broadcasts a polling message with its ID each time when it changes its mode active. Then, it waits for a transmission request message *Sreq* from its previous-hop node in its active mode. If it does not receive *Sreq*, it goes into its sleep mode. Otherwise, N_n transmits an acknowledgement message *Rack* back to N_c and data messages are transmitted from N_c to N_n.

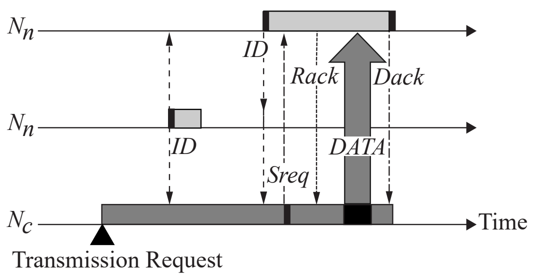

Fig 1: IRDT Protocol.

In the original IRDT, each wireless nodes are assumed to maintain its routing table up-to-date. However, it is difficult to exchange control messages with neighbor wireless nodes for the maintenance since all the wireless nodes work intermittently. Thus, this paper proposes a combination IRDT-GEDIR of IRDT and GEDIR [4]. For next-hop selection, IRDT-GEDIR introduces a novel criterion *pseudo speed* of data message transmission which is achieved by division of difference of distance to the destination node. In addition, neighbor nodes get active one by one and an intermediate node with data messages in transmission can evaluate the pseudo speed of data messages to them at that time as shown in Figure 2. It should immediately determine whether it selects the currently active neighbor node as its next-hop node or not even though it cannot evaluate the pseudo speed of data messages to the forthcoming active neighbor nodes. Thus, the solution of our next-hop selection problem is expected to be achieved based on the secretaries problem [2]. N_c evaluates the pseudo speed sv where it forwards a data message to N from which N_c receives a polling message and the expected pseudo speed $\overline{sv}$ where it forwards it not to N but to one of the later activating nodes. If $sv > \overline{sv}$, N_c transmits an *Sreq* message to N; i.e., it selects N as its next-hop node. Otherwise, i.e., N_c does not transmit an *Sreq*.

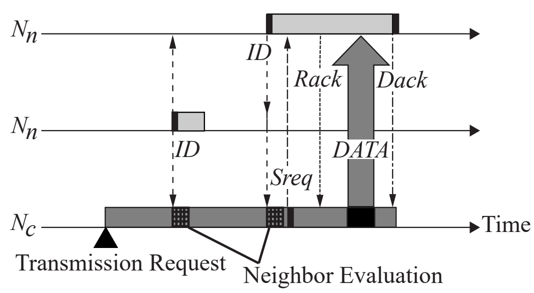

Fig 2: IRDT-GEDIR Protocol.

3 Evaluation

This section evaluates the transmission performance in wireless multihop networks. In a 100m × 100m square simulation field, 1,000 stationary wireless nodes with 10m wireless signal transmission range are randomly distributed according to the unique distribution randomness. It is assumed that the interval of activations in each node is 1.0s, communication overhead for 1-hop transmission is 0.1s and the activation time offset is randomly determined in each node according to the unique distribution in [0s, 1s). A location of a destination node is also randomly determined and is assumed to be advertised to all the nodes in advance. End-to-end transmission delay, hop counts of a data message and battery power consumption are evaluated in IRDT-GEDIR, the simple secretary problem solution with n/e observation [1],

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確率アルゴリズムによる間欠的無線マルチホップ通信の評価
熊谷　翔　　桧垣 博章
東京電機大学大学院 未来科学研究科 ロボット・メカトロニクス学専攻

Greedy Conventional[1], Conservative Conventional[2], GEDIR and Locally Optimum[3].

Figures 3, 4 and 5 show the simulation results of 1,000 trials of end-to-end transmission delay, hop counts and battery power consumption, respectively. The x-axis represents distances between a source node and the destination node. The Local Optimum requires the shortest end-to-end transmission delay, the least hop counts and battery power consumption. However, since it assumes that all the wireless nodes have achieved the location information of all their neighbor wireless nodes, it is unrealistic in intermittent wireless multihop communication environments. As shown in Figure 3, IRDT-GEDIR requires the shorter end-to-end transmission delay than the others. Its average transmission delay is only 24.6% longer than that of the Local Optimum. Hence, our proposed probabilistic next-hop selection based on pseudo transmission speed contributes the reduction of end-to-end transmission delay. Figure 4 shows that IRDT-GEDIR does not reduce hop counts of wireless multihop transmissions though it is based on GEDIR, i.e., its next-hop selection is based on the location information. This is because the design of IRDT-GEDIR is under consideration of transmission delay in the intermittent wireless multihop communication environments. n/e, Conservative Conventional and GEDIR require less hop counts than IRDT-GEDIR; however, these methods require much longer end-to-end transmission delay than IRDT-GEDIR. Finally, as shown in Figure 5, IRDT-GEDIR requires less battery power consumption than the others. IRDT-GEDIR requires only 53.5% additional battery power in comparison with that of the Local Optimum. Therefore, IRDT-GEDIR realizes shorter delay and less battery power consuming intermittent wireless multihop transmissions than the conventional methods.

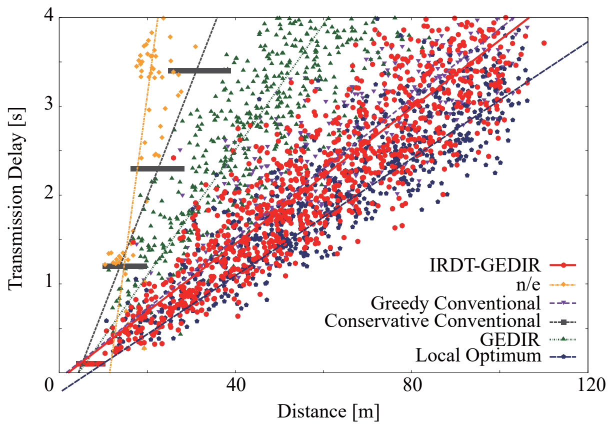

Fig 3: End-to-End Transmission Delay.

[1] An intermediate wireless node N fowards a data message to the neighbor node which transmits the first polling message after the transmission request in N.

[2] N fowards a data message to the neighbor node which provides the highest pseudo speed determined after receiving polling messages from all the neighbor nodes of N

[3] N fowards a data message to the neighbor node which provides the highest pseudo speed determinde by the information of locations and activation times in all the neighbor nodes.

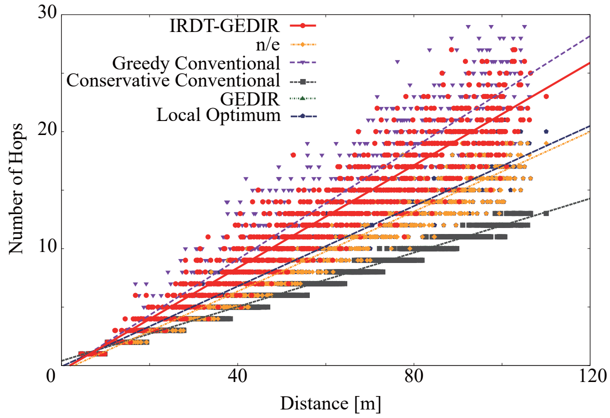

Fig 4: Hop Counts.

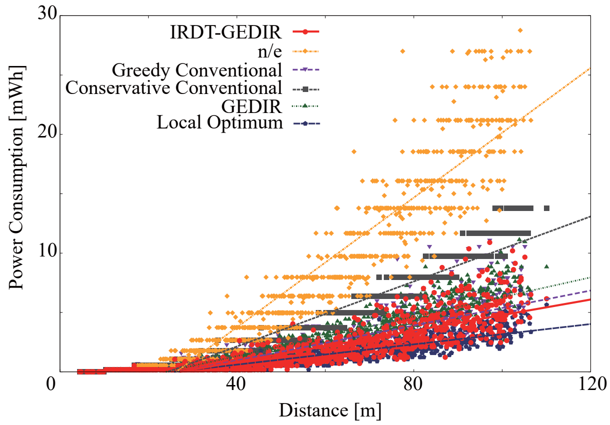

Fig 5: Battery Power Consumption.

4 Conclusion

This paper proposes IRDT-GEDIR which is combination of IRDT intermittent communication protocol with lower power consumption and GEDIR location-based message-by-message ad-hoc routing protocol. By a probabilistic solution of the secretaries problem and a pseudo speed criterion, a novel next-hop selection is induced. The simulation experiments show that IRDT-GEDIR requires shorter end-to-end transmission delay and less battery power consumption.

References

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