Study of Mobility in Routing Protocols:

Dr. Anoop Sharma, Dr. Mukesh Yadav
*Assistant Professor, Singhania University, Rajasthan, India

Abstract:
This paper addresses mobility control routing in wireless networks. The data flow request between a source-destination pair, the problem is to move node to node towards the best placement, the performance of the wireless network is improved. Our purpose is to find the best nodes selection depending on the minimization of the maximum distance that nodes have to travel to reach their final position. We propose mobility in routing protocol, the Routing Protocol based on Controlled Mobility, where the chosen nodes' path minimizes the total travelled distance to reach destination. Specifically, controlled mobility is intended as a new design dimension wireless network allowing driving nodes to specific best position in order to achieve some common objectives. The main aim of this paper is to show the effectiveness of mobility when it is used as a new design dimension in wireless networks. Extensive simulations are conducted to evaluate the proposed routing algorithm. It show how our protocol Outperforms a well-known routing protocol, the Ad hoc On Demand Distance Vector routing (AODV), in terms of throughput, average end-to-end data packet delay and energy spent to send a packet unit.

Keywords: MANET, AODV, Mobility

Introduction

There are many challenges to face while designing wireless networks and protocols, such as obtaining a good throughput, minimizing data delay, and minimizing energy waste. In fact, most of the wireless networks are characterized by battery equipped
Devices; thus the minimization of the energy consumption is a key factor. With the
miniaturization of computing elements, we have seen many mobile devices appear in the market that can collaborate in an ad hoc fashion without requiring any previous infrastructure control. This gave birth to the concept of self-organization for wireless networks, which is intrinsically tied to the capability of the nodes to move to different placements. In the last few years, the research community has become interested in the synergic effect of mobility and wireless networks. Controlledmobility is a new concept for telecommunication research field and can be defined as a kind of mobility where mobile devices are introduced in the network and move to specified destinations with defined mobility patterns for specific objectives. In practice, controlled mobility is a new design dimension of the networks. The use of controlled mobility as a new design dimension to enhance performance of wireless networks represents a recent, innovative, and revolutionary concept. In fact, while opportunistic use of external mobility has been extensively investigated, the use of controlled mobility is largely unexplored. This new design dimension can effectively be used to improve system performance by allowing devices equipped with mobility support to reach favorable locations. Although many communication protocols for wireless networks have been proposed, to the best of our knowledge there is no routing protocol based on controlled mobility. In fact, in authors consider jointly mobility and routing algorithms but the solution they propose is for Wireless Sensor Networks (WSNs) and only the base station is mobile. Among the main routing protocols proposed for Mobile Ad hoc Networks (MANETs), we have the Ad hoc On Demand Distance Vector (AODV) routing and the Temporally Ordered Routing Algorithm (TORA). Both are examples of demand driven algorithms that eliminate most of the overhead associated with table update in high mobility scenarios. Our system is quasi-static, in the sense that the only mobility we consider is controlled mobility, which is used by nodes to reach specific locations; then, for energy efficiency matters, it is convenient to use a table-driven system. Another interesting routing protocol where the minimum metric paths are based on two different power metrics:
(i) Minimum energy per packet,

(ii) Minimum cost per packet.

However, this routing algorithm does not take into account the mobility as a new design dimension. In this paper, we take the controlled mobility into account by investigating the performance of a wireless network, where all the devices are equipped with mobility unit. The idea is to use existing multi hop routing protocol; specifically we consider the well-known routing algorithm AODV and achieve further improvements in terms of network performance as throughput, data delay, and energy spent per packet, by explicitly exploiting mobility capabilities of the wireless devices. Previous analytical results formulated in suggest that controlled mobility of nodes helps to improve network performance. Based on these results, we consider jointly controlled mobility and routing strategies. We perform simulations through a well known simulation tool to quantify the throughput, delay, and energy spent per packet compared with wireless network where AODV is used.

2. Related Work

In past few years, the researcher's investigated thoroughly the delay-throughput trade-off and some interesting results have been obtained. In fact, determined the throughput-delay trade-off in a fixed and mobile ad hoc network. He showed that, for $n$nodes, the following statement holds $D(n) = \Omega(nT(n))$, where $D(n)$ and $T(n)$ are the delay and the throughput, respectively. For a network consisting of mobile nodes, he showed that the delay scales as$\Omega(n1/2/v(n))$, where $v(n)$ is the velocity of the mobile nodes. In the trade-off between delay and throughput has been characterized and showed that there is a trade-off among mobility, capacity, and delay in ad hoc networks. A first step in taking advantage of the possibilities that mobility introduces has been made by the research community when predictable mobility became an important research focus. In fact, researchers studied many specific network objectives, under a random mobility-based communication paradigm; nevertheless the mobility of the sinks, for example in military applications, is based on soldier or fire fighter movements, and thus, it is predictable, in substance. Generally, the existing research in wireless sensor networks considers sink movement based on random mobility. However, the trajectories of the sink, in many practical applications, can be determined in advance. Predictable mobility of nodes has also been exploited to help in packets delivering. This work, nodes routing tables are updated with link state and trajectory information, which are received from other nodes. The problem of routing related to the predictable mobility has also been analyzed. The paths are created by the movements of nodes, which will deliver the message they are carrying when they find other suitable nodes. The space-time routing framework it proposed leverages the predictability of nodes motion. Controlled mobility has been a hot research topic of the robotics community for many years. It concerns the motion coordination of a group of robots for a common objective, typically the coverage of a geographical area. Their approach is based on a potential-field approach and nodes are treated as virtual particles, subject to virtual forces. The concept of controlled mobility is also used by considering a hybrid network with both static and mobile nodes, which fully exploits the movement capability of the sensors.

3. A New Routing Protocol Based on Controlled Mobility (RPCM)

The network scenario we consider consists of all nodes able to move and control their movements. The communication strategy used in this work considers different paths for each pair source destination nodes and the best path is selected to be used for data communication. The choice of the best path is based on a metric. Specifically, in this context we consider the path whose nodes have to travel the total minimum distance to reach the evenly spaced positions on the straight line between the source-destination pair. The same metric has been determines the placement that minimizes the total travelled distance of the sensor nodes. This kind of movement could be useful in all situations where mobility too high can be dangerous or difficult because of a high presence of obstacles.

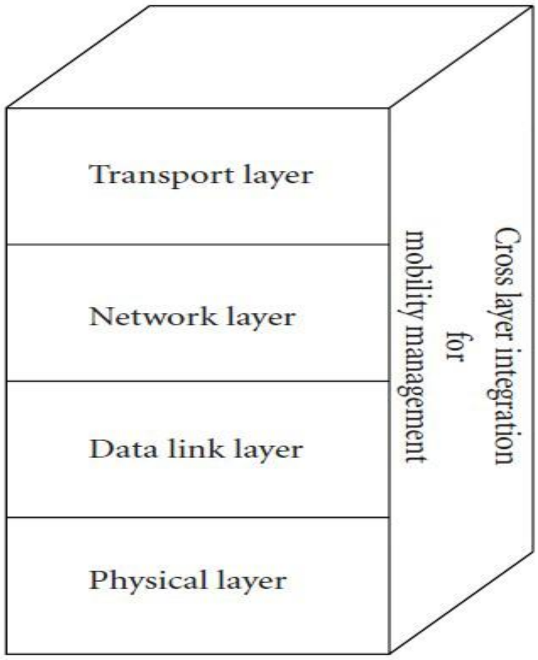

Figure 1: Protocols' stack integrated with mobilitymanagement.

3.1. Assumptions. Assume that *n* nodes deployed randomly in a square area. All the nodes have the same transmission range. If two nodes are within each other's transmission range, they can communicate directly and they are *neighbors*. Otherwise they have to rely on intermediate nodes to relay the messages for them. Any node in the network may have data to be sent to any other node. The path from a source to a destination may not be direct but involves other intermediate nodes. We assume that several paths, from the source *s* to the destination *d*, have already been discovered by a routing protocol. Specifically, we apply the Route Request phase of the AODV protocol, with some additional information such as the nodes' position. We need this information for implementing our protocol as explained in the follow. We also assume that nodes move only in order to reach specific locations when they belong to a path. Our mobility control scheme is not directly incorporated into a specific layer of the classical ISO/OSI layer structure but is orthogonal to this kind of subdivision as we can observe in Figure 1. In fact, controlled mobility could be exploited at different levels.

4. Routing Protocol Based on Controlled Mobility.

Assume that a source node *s* needs to establish a communication with a node *d*. The source node will broadcast a Request Packet, which will be forwarded by its neighbors. Each node includes in the request packet its geographical coordinates in the network. Once the Request Packet reaches the correct destination, the node *d* will not send a Reply Packet immediately, but it will wait for processing other requests. In order to avoid un-useful delay, a destination node will wait for a specific time, and then it will send a reply packet by building the best selected path. The metric we introduced to evaluate the goodness of a path is based on the total travelling distance. In practice, the algorithm will choose the path that minimizes the sum of nodes 'travelled distances. Other metrics, such as them inimization of the maximum travelled distance, could be considered and implemented.

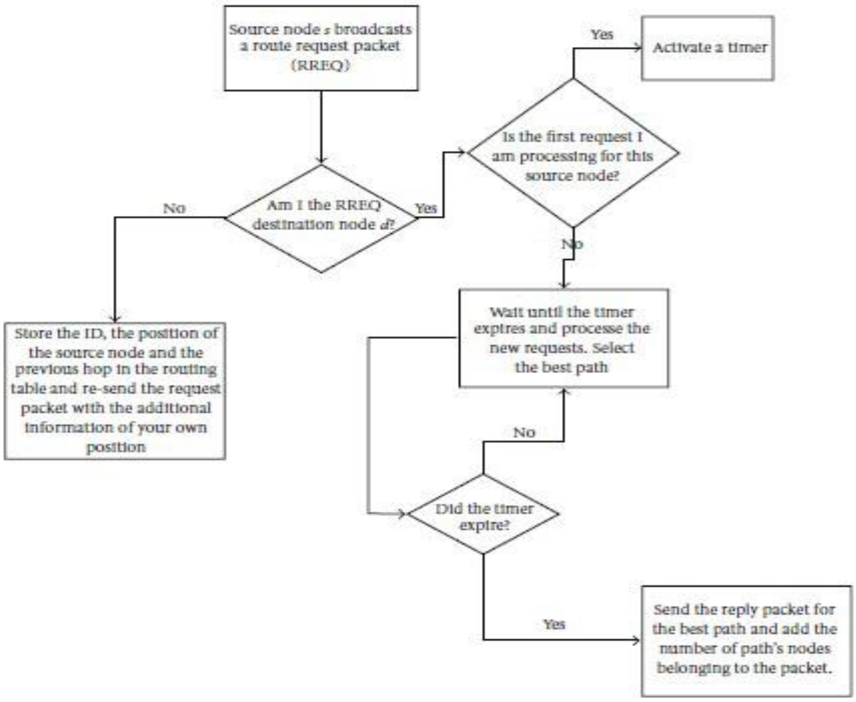

Figure: 2 Routing Request Phase of RCPM

In Figure 2 the request phase of the routing protocol is explained. We can observe that the source nodes tarts a request phase by sending a Route Request and every intermediate node stores the position of the previous node, the ID of the previous node, and rebroadcasts the request packet. The mechanisms to avoid loop and control packet storms are the same as in AODV. Once the Request Packet reaches the destination node, if the request is processed for the first time, the destination node *d* activates a timer and continues to process other Request Packets of the same source node *s*. Otherwise; *d* compares the previous path with the current path and selects the best one. Once the timer expires, *d* sends a Reply Packet to the first node of the selected path in the backward direction. This node computes its new position depending on the number of nodes involved in the path (this information is sent from the *d* node) and forwards the Reply Packet to the following node in the backward direction (this information has been stored in the Routing Table during the Route Request phase). Hence, this node will move to theevenly spaced position on the straight line between the source and the destination.

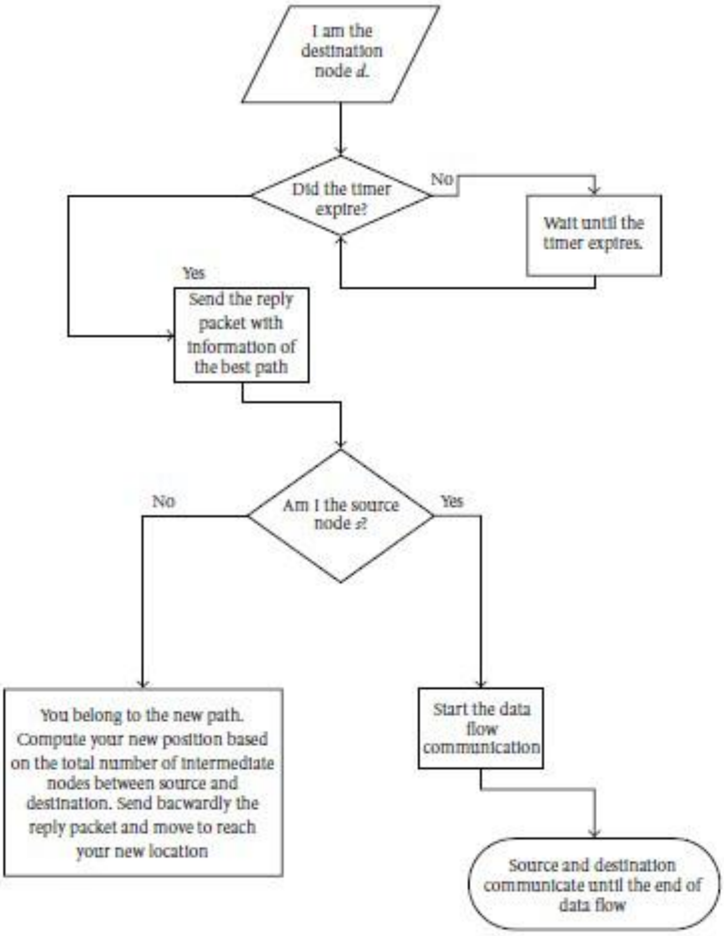

Figure: 3 Reply Phase of RCPM

5. Simulation and Results

As we already said in the previous subsections, the optimization model including the minimization of the nodes' total travelled distances along with other possible metrics has been introduced. Unfortunately in that analytical work, many practical details could not be taken into consideration. For this reason, we chose to implement one of those possible metrics in a complete routing algorithm and simulate its behavior in a well-known network emulator: ns2, in order to evaluate the realistic effects of controlled mobility in the routing process in comparison with the AODV protocol.

***5.1. Reference Environment*.** All the most important environment and simulator parameters are reported. We chose to implement our algorithm in a square area of 500m×500 m, where a variable number of wireless nodes has been randomly deployed, according to the reported nodes density(2, 3, 4, 5, 6 (nodes/m2), which correspond to 50,75, 100, 125, 150 nodes). Also the number of concurrent flows is considered variable. Depending on the density, nodes have a different transmission area to cover. All nodes have initially the same energy and transmit at the same transmission rate; when they move, the energy expenditure *EM* is proportional to the travelled distance *d* by a movement factor *k*. When nodes mobility is allowed, the set of limitations becomes enriched with new elements. In fact, the definitions of an energy model related with the motion of nodes and of another model related with the communication needed for their coordination are required. For the former as implified model is a distance proportional model $EM(d) = kd + \gamma$, where *d* is the distance to cover, *k*[J/m] takes into account the kinetic friction; while *γ*[J] represents the energy necessary to win the static friction, both these constants depend on the environment (harsh or smooth ground, air, surface or deep water). For the latter, usually the energy

required to send one bit at the distance *d* is $EC(d) = \beta d\alpha$, where $\alpha$is the exponent of the path loss ($2 \leq\alpha\leq 4$) depending on the environment and $\beta$is a constant [J/(bits $m\alpha$)]. Regarding the simulator, we used a two-ray ground propagation model and both the simulated routing protocols (AODV and RPCM) are mounted on top of the IEEE 802.11 MAC. The energy spent in sleep, wake-up, and active mode is reported in the table. The output parameters taken inconsideration are as follows:
(i) Throughput,
(ii) Delay,
(iii) Energy spent for received packet.

6. Conclusion

In this work we focused on both the novel concept of controlled mobility and the routing algorithms. The concept of controlled mobility has been introduced in some previous recent work, but it has only been considered from an analytical point of view or in a marginal fashion, such as only a mobile base station in the network. In this paper we focus on the controlled mobility as a new design dimension and we exploit it by implementing a new routing protocol based on controlled mobility. The most important aspect of this is related to the evaluation performance based on the usage of a well-known simulation tool, ns2. In fact, in previous works the analytical approach limited the use of controlled mobility while in this context, thanks to the simulator, we have been able to consider many realistic aspects of the network, while a routing protocol is implemented. Extensive simulations have been conducted and simulation results have shown how the new routing protocol outperforms a well-known routing algorithm, the AODV. Furthermore, results obtained suggest that other metrics can be easily realized and tested by simulation. In fact, as future works, we intend to study other optimization metrics such as the maximization of the network lifetime or the minimization of the average (or the maximum) distance travelled by nodes belonging toa path.

References

1. J. Luo and J.-P. Hubaux, "Joint mobility and routing for lifetime elongation in wireless sensor networks," in Proceedings of the 24thAnnual Joint Conference of the IEEE Computer and Communications Societes(INFOCOM '05), vol. 3, pp. 1735–1746, Miami, Fla, USA, March 2005.
2. C. E. Perkins, E. M. Belding-Royer, and I.Chakeres, "Ad hoc on-demand distance vector (AODV) routing," in IETF Internet draft, draft-perkins-manet-aodvbis-00.txt,October 2003.
3. V. D. Park and M. S. Corson, "A highly adaptive distributed routing algorithm for mobile wireless networks," in Proceedings of the 16th Annual Joint Conference of the IEEE Computer and Communications Societes (INFOCOM '97), vol. 3, pp. 1405–1413, Kobe, Japan, April 1997.
4. S. Singh, M. Woo, and C. S. Raghavendra,"Power-aware routing in mobile ad hoc networks," in Proceedings of the 4th AnnualIEEE/ACM International Conference on Mobile Compuetr and Network (MOBICOM'98), pp. 181–190, Dallas, Tex, USA, October 1998.
5. E. Natalizio, V. Loscr'ı, and E. Viterbo,"Optimal placement of wireless nodes for maximizing path lifetime," IEEECommunications Letters, vol. 12, no. 5, pp. 362–364, 2008.
6. E. Natalizio, V. Loscr'ı, F. Guerriero, and A.Violi, "Energy spaced placement for bidirectional data flows in wireless sensor network," IEEE Communications Letters, vol. 13, no. 1, pp. 22–24, 2009.
7. V. Loscr'ı, E. Natalizio, C. Costanzo, F.Guerriero, and A. Violi, "Optimization models for determining performance benchmarks in wireless sensor networks," in Proceedings of the 3rd International Conference on Sensor Technologies AndApplications (SENSORCOMM '09), pp.333–338, Athens, Greece, June 2009.
8. http://www.isi.edu/nsnam/ns/.
9. M. Grossglauser and D. N. C. Tse, "Mobility increases the capacity of ad hoc wireless networks," IEEE/ACMTransactions on Networking, vol. 10, no. 4, pp. 477–486,

2002.
10. A. Hjghj El Gamal, J. Mammen, B. Prabhakar, and D. Shah, "Throughput-delay trade-off in wireless networks," in Proceedings of the 23th Annual Joint Conference of the IEEE Computer and Communications Societes (INFOCOM '04),vol.1, pp. 464–475, Hong Kong, March 2004.
11. N. Bansal and Z. Liu, "Capacity, delay and mobility in wireless ad hoc networks," in Proceedings of the 22th Annual Joint Conference of the IEEE Computer and Communications Societes(INFOCOM '03), vol. 2, pp. 1553–1563, San Francisco, Calif,USA, March-April 2003.
12. R. M. de Moraes, H. R. Sadjadpour, and J. J. Garcia-Luna-Aceves, "Mobility-capacitydelay trade-off in wireless ad hoc networks," Ad Hoc Networks, vol. 4, no. 5, pp. 607– 620, 2006.
13. E. Lee, S. Park, D. Lee, Y. Choi, F. Yu, and S.-H. Kim, "A predictable mobility-based communication paradigmfor wireless sensor networks," in Proceedings of Asia-Pacific Conference on Communications (APCC '07), pp. 373–376, 2007.
14. Z. Zhi, D. Guanzhong, L. Lixin, and Z. Yuting, "Relaybased routing protocols forspace networks with predictable mobility," in International Conference on Space Information Technology, vol. 5985 of Proceedings of SPIE, 2005.
15. S. Merugu, M. Ammar, and E. Zegura, "Routing in space and time in networks with predictable mobility," Tech. Rep. GITCC- 04-07, Georgia Institute of Technology, Atlanta, Ga, USA, 2004.