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# Finding Current specific Location of each Node and Updating the Location Server in MANET

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***ABSTRACT--****We consider the location service in a mobile ad-hoc network(MANET), where each node needs to maintain its location information by 1)frequently updating its location information within its neighboring region, which is called neighborhood update (NU), 2)Occasionally updating its location information to certain distributed location server in the network, which is called location server update(LSU). The tradeoff between the operation costs in location updates and the performance losses of the target application due to location inaccuracies imposes a crucial question for nodes to decide the optimal strategy to update their location information, where the optimality is in the sense of minimizing the overall costs. This chapter reviews research on routing in ad hoc and sensor wireless networks in the view of node mobility, changes in node activity, and availability of methods to determine absolute or relative coordinates of each node. Various approaches in literature are classified according to some criteria. Mobility is apparently a very difficult problem to handle in ad hoc networks, and all proposed solutions have significant drawbacks. Additional problems arise with 'sleep' period operation, that is changes in node's activity status with or without mobility. While significant progress has been made on the routing with known destination location, location updates issue to enable efficient routing requires further investigation. A trade-off exists between the costs in location update operations, on one hand, and the additional incurred costs in (position-based) routing due to location errors, on the other hand. In this paper, Under a Markovian mobility model, the location update decision problem is modeled as a Markovian Decision Process (MDP).*

**Index Terms-** Location update, mobile ad hoc network,MDP, routing algorithm, LSU and NU

## 1. INTRODUCTION

A mobile ad hoc network (MANET) is becoming available for various applications. This location information not only provides one more degree of freedom in designing network protocols [1], but also is critical for the success of many military and civilian applications [2],[3]. There are two basic location update operations at a node to maintain its up-to-date location information in the network [4]. One operation is toupdate its location information within a neighboring region is not necessarily restricted to one hop neighboring nodes [5]. We call this operation location server update(LSU), which is usually implemented by unicast or multicast of the location information message via multi hop routing in MANETs. The success of position-based strategies heavily relies on the availability of accurate location information of nodes. In a MANET, since the locations of nodes are not fixed, a node needs to frequently update its location information to some or all other nodes. In this chapter we consider the routing task, in which a message is to be sent from a source node to a destination node. Due to propagation path loss, the transmission radii are limited. Thus, routes between two hosts in network may consist of hops through other hosts in the network. In this paper we provide a stochastic decision frame work to analyze the location update problem in MANETs. We formulate the location update problem at a node as a Markov Decision Process(MDP)[9], under a widely used Markovian mobility model [10],[11]. Instead of solving the MDP model directly, the objective is to identify some general and critical properties of the problem of the problem structure and the optimal solution that-could be helpful in providing insights into practical protocol design. We first investigate the solution structure of the model by identifying the monotonicity properties of optimal NU and LSU operations.

## 2. Problem formulation

### 2.1 Network Model

We consider a MANET in a finite region. The whole region is partitioned into small cells and the location of a node is identified by the index of the cell it resides in. the size of the cell is set to be sufficiently small such that the location difference within a cell has little impact on the performance of the target application. the individual node point of view, i.e., each node independently chooses its location update strategy with its local information.

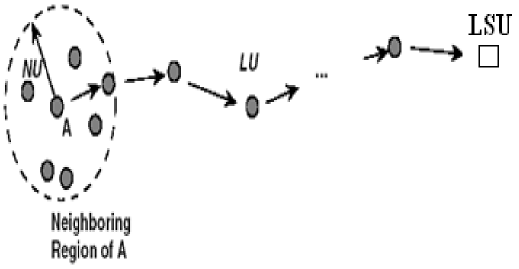
The distance between any two points in the region is discretized in units of the minimum distance between the centers of two cells. Since the area of the region is finite, the maximum distance between the centers of two cells is bounded. For notation simplicity, we map the set of possible distances between cell centers to a finite set {0,1,……..d,}, where 1 stands for the minimum distance between cells. Thereafter, we use the nominal value $d(m,m')\varepsilon\{0,1\ldots\ldots d\}$to represent the distance between two cells m and $m'$.

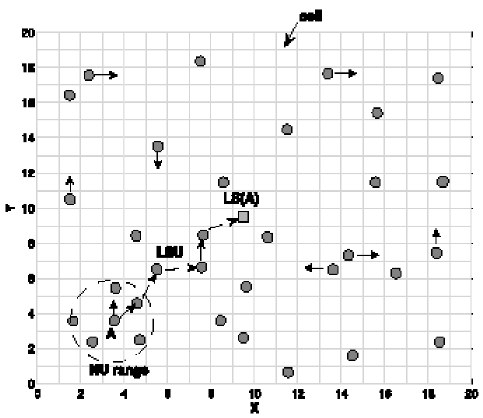
We assume that the time is slotted. In this discrete time setting, the mobility model can be represented by the conditional probability $p(m'/m)$,ie., the probability of the node's position at cell $m'$ in the next time slot given that the current position is at cell m. given a finite maximum speed on nodes' movement, when the duration of a time slot is set to be sufficiently small, it is reasonable to assume that

$p(m'/m)=0,\ d(m,m')>1$

Each node in the network needs to update its location information within a neighboring region and to one location server (LS) in the network. The LS provides a node’s location information to other nodes, which are outside of the node’s neighboring region. There might be multiple LSs in the network. We emphasize that the “location server” defined here does not imply that the MANET needs to be equipped with any “super-node” or base station to provide the location service.

There are two types location in accuracies about the location of a node. One is the location error within the node’s neighboring region, due to the node’s mobility and insufficient NU operations.




- Local application Cost: This portion of application cost only depends on the node’s local location error, which occurs when only the node’s location information within its neighborhood is used. For instance, in a localized communication between nodes within their NU update ranges, a node usually only relies on its stored location information of its neighboring nodes, not the ones stored in distributed LSs[6].

- Global application cost: This portion of application cost depends on both the node's local location error and global location ambiguity, when both location information of the node within its neighborhood and that at its LS are used.

### *2.2 Classification of routing algorithms*

- *Demand-based operation*. Routing algorithms can be classified as *proactive* or *reactive*. Proactive protocols maintain routing tables when nodes move, independently of traffic demand, and thus may have unacceptable overhead when data traffic is considerably lower than mobility rate.

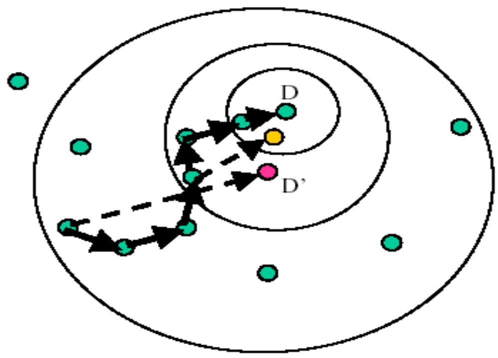
- *Distributed operation*. We shall divide all distributed routing algorithms into *localized* and *non-localized.* Localized algorithms [22] are distributed algorithms that resemble greedy algorithms, where simple local behavior achieves a desired global objective. In a localized routing algorithm each node makes decision to which neighbor to forward the message based solely on the location of itself, its neighboring nodes, and destination. While neighboring nodes may update each other location whenever an edge is broken or created, the accuracy of destination location is a serious problem.

- *Location information.* Most proposed routing algorithms do not use the location of nodes, that is their coordinates in two or three dimensional space, in routing decisions. The distance between neighboring nodes can be estimated on the basis of incoming signal strengths (if some control messages are sent using fixed power). Relative coordinates of neighboring nodes can be obtained by exchanging such information between neighbors. Alternatively, the location of nodes may be available directly by communicating with a satellite, using GPS (Global Positioning System), if nodes are equipped with a small low power GPS receiver.

### *2.3 Doubling circles routing*

Amouris, Papavassiliou and Lu [21] presented a position based multi-zone routing protocol for wide area mobile ad-hoc networks. Their algorithm is based on position updates within circles of increasing radii. Each node updates its location to all nodes located within circle of radii *P, 2P, 4P, 8P,…* (each subsequent circle has twice larger radius than previous one). Whenever a given node *A* moves outside one of these circles of radius *2tP* for some *t,* node *A* broadcasts its location update to all nodes located inside of circle centered at current node position, and with radius *2t+1P*. The routing toward destination then follows these circles of last updates. Source nodes send message toward the last reported position of destination (using the *DIR* method), which since the last report has moved within the circle of some radius. As routing message moves

closer to destination, the information about position of destination becomes more precise, and nodes are able to send message toward center of circles with twice smaller radius than previously, until the node is eventually reached. This process is illustrated in **Fig. 1**. The source *S* sends message towards *D',* the last known position of destination *D.* The routing is later redirected towards newer position *D'* and finally exact position *D.* This method is very interesting and certainly competitive. We observe that the radius of larger circles may encompass almost all nodes of the network, and that the routing paths discovered by the algorithm do not have near optimal hop counts (which may be important in quality of service applications). However, if the path quality is important, one can consider this algorithm only as the destination search step in the three phase routing algorithm described above. A similar algorithm, using squares instead of circles, and additional sophisticated techniques, is proposed in [20].
The location update techniques discussed so far include occasional flooding of location information to all or large portion of nodes in the network. In the next two sections, methods that never use such flooding are discussed.




Routing from S toward D', D" and D

***2.4 Quorum based strategies***

The main problem with described quorum based strategies is that quorums are themselves fixed, and movement of nodes can make nodes in the same quorum far apart from each other,
with unclear way of visiting them all in order to find destination information that may be no more difficult to find than the other nodes in the same quorum. A different quorum based strategy, that deals with network dynamic, is proposed in [17]. In [18], nodes in ad hoc network do not stay in the same 'column', and the distributed information may easily disperse due to node movement. Moreover, it is not clear what the 'column' is, and how all the nodes in a column, once defined, will receive latest updates. Nevertheless, we believe that this idea is worth pursuing. The main location update method is to forward the new location information (and node's identifier) within a 'column' in the network, in the following way. Each node uses a counter to count the number of previously made changes in edge existence (the number of created or broken edges). When the counter reaches a fixed threshold value *e,* location information is forwarded along the 'column', and *e* is reset to 0. The 'column' may have arbitrary 'thickness', but we shall assume, for clarity, thickness 1 here, which means that created column is a single path in north south direction, including neighbors of nodes in that path. *A* initiates two

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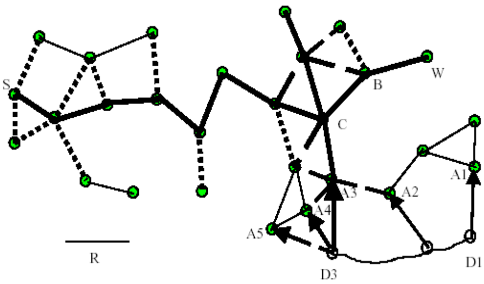
routing messages, in the directions north and south, while other nodes follow only one of directions. Each follows variation of the *MFR* algorithm [23], with destination always to the north (south, respectively) of current node, as follows. Current node *B* transmits update information to all its neighbors, and indicates, in the same message, which of them is its northernmost (southernmost, respectively) neighbor. That node will, in turn, do the same, until a node is reached with does not have such a neighbor.




Location update from D3 and destination search from S

## 3. An MDP model

As the location update decision needs to be carried out in each time slot, it is natural to formulate the location update problem as a discrete-time sequential decision problem. Under the given Markovian mobility model, this sequential decision problem can be formulated with a MDP model [16]. An MDP model is composed of a 4-tuple {S,A,P(./s,a),r(s,a)}, where S is the state space, A is the action set, P(./s,a) is a set of state and action-dependent state transition probabilities, and r(s,a) is a set of state and action dependent instant costs. In the location update problem, we define these components as follows.

### 3.1 State space

A state of the MDP model as s=(m,d,q) ε S, where is the current location of the node d(>=0) is the distance between the current location and the location in the last NU operation and q is the time elapsed since the last LSU operation

### 3.2 The Action Set

As there are two basic location update operations NU and LSU, we define an action of a state as a vector a=($a_{NU}$,$a_{LSU}$)ε A, where $a_{NU}$ ε {0,1} and $a_{LSU}$ ε {0,1}, with "0" standing for the action of "not update" and "1" as the action of " update" the action set A = {(0,0),(0,1),(1,0),(1,1)} is identical on all states s ε S

### 3.3 State Transition Probabilities

Under the given Markovian mobility model, the state transition between consecutive time slots is determined by the current state and the action. That is, given the current state $s_t$=(m,d,q) and the action $a_t=(a_{NU},a_{LSU})$, the probability of the next state $s_{t+1}=(m',d',q')$ is given by $P(s_{t+1}/ s_t, a_t)$. Observing that the transition from q to q' is deterministic for a given $a_{LSU}$

q' = { min{q+1,**q**inset bar}, $a_{LSU}=0$,

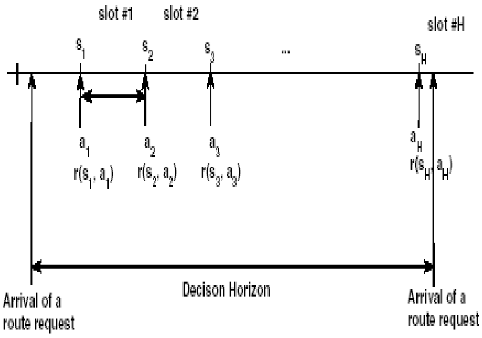
{1, $a_{LSU}=1$,

We have

$P(P(s_{t+1}/ s_t, a_t)=P(m',d',q'|m,d,q, a_{NU},a_{LSU})$,

$=P(d'|m,d,m', a_{NU})P(q'|q, a_{LSU}) P(m',m)$,

$=P\{p(d'|m,d,m') p(m'|m), a_{NU}= P(m'|m),$ $a_{NU}=1$,




### 3.4 An MDP Model for the NU Decision Sub problem

In the NU decision subproblem (p1), the objective is to balance the cost in NU operations and the local application cost to achieve the minimum sum of these two costs in a decision horizon. An MDP model for this problem can be defined as the 4-tuple { $S_{NU},A_{NU},P(.|s_{NU},a_{NU}),r$

$(s_{NU},a_{NU})$}. Specifically, a state is defined as $s_{NU}=(m,d)$ ε $S_{NU}$ , the action is $a_{NU}$ ε {0,1}, the state transition probability $P((s'_{NU}|s_{NU},a_{NU})$ follows for $s_{NU}=(m,d)$ and $s'_{NU}=(m',d')$, where $d'=d(m,m')$ if $a_{NU}=1$ and the instant cost is $r_{e,NU}(m,d,a_{NU})$.

Similar to the procedure described in the MDP model with the expected total cost criterion for the NU decision sub problem can also be transformed into an equivalent MDP model with the expected total discounted cost criterion. The optimality equations are given by

$v_{NU}(m,d)=\min a_{NU}$ ε $\{0,1\}\{r_{e,NU}(m,d,a_{NU})+(1-\lambda) \sum P(m',d'|m,d,a_{NU}) v_{NU}(m',d')\}$

$=\min\{E(m,d),F(m)\}$,

Where $v_{NU}(m,d)$ is the optimal value of the state (m,d)

$E(m,d) \triangleq c_1(m,d,0)+(1-\lambda) \sum P((m',d')|(m,d)\ v_{NU}(m',d'))$,

$F(m) \triangleq c_{NU}(1)+( 1-\lambda) \sum P(m'|m)|v_{NU}(m',d(m,m'))$

**4. An MDP model for LSU Decision Supproblem**

In the LSU decision sub problem, the objective is to balance the cost in LSU operations and the global application cost to achieve the minimum sum of these two costs in a decisions horizon. An MDP model for this problem can be defined as the 4tuple $\{ S_{LSU},A_{LSU,}P(.|s_{LSU},a_{LSU}),r$

$(s_{LSU},a_{LSU})\}$. Specifically a state is defined as $s_{LSU}=(m,q)\ \varepsilon\ S_{LSU,}$ the action is $a_{LSU}\ \varepsilon\ \{0,1\}$, the state transition probabilities $P(s'_{LSU}|s_{LSU},a_{LSU})=P(m'|m)$ for the state transition from $S_{LSU}=(m,q)$ to $S'_{LSU}=(m',q')$, where q' is given in, and the instant cost is $r_{e,LSU}(m,q,a_{LSU})$

Similar to the procedure described in the MDP model with the expected total cost criterion for the LSU decision sub problem can also be transformed into an equivalent MDP model with the expected total discounted cost criterion. The optimality equations are given by

$V_{LSU}(m,q)=\min a_{LSU}\ \varepsilon\ \{0,1\}\ \{r_{e,LSU}(m,q,a_{LSU})+(1-\lambda) \sum P(m',q'|m,q,a_{LSU})\ v_{LSU}(m',q')\}$

$=\min\{G(m,q),H(m)\}$

Where $v_{LSU}(m,q)$ is the optimal value of the state (m,q)

$G(m,q) \triangleq \lambda c_q(m,q)+(1-\lambda) \sum P((m'|m)\ v_{NU}(m',\min\{q+1, \bar{q}\})$,

$H(m) \triangleq c_{LSU}(m,1)+( 1-\lambda) \sum P(m'|m)|v_{LSU}(m',1)$.

## CONCLUSION

We have developed a stochastic sequential decision frame work to analyze the location update problem in MANETs. The existence of the monotonicity properties of optimal NU and LSU operation. Location inaccuracies have been investigated under a general cost setting. The proposed MDP model for the location update problem in MANETs can be extended to include more design features for the location service in practice. We therefore expect that the research on location updates for efficient routing in wireless network will continue, and hope that this chapter will provide valuable source of information and directions for future work and experimental designs.

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