International Journal of Electronics Communication and Computer Engineering
Volume 5, Issue (4) July, Technovision-2014, ISSN 2249–071X

Technovision-2014: 1st International Conference at SITS, Narhe, Pune on April 5-6, 2014

A Survey: An Optimal Path Determination of Moving Beacons using Localized Directional Routing Protocol in Mobile Ad-hoc Network

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Abstract **–The prior communication between the mobile nodes (beacons) in the network is not possible in some situations. As the network topologies and the network traffic conditions vary, the optimum position of the neighbour node should be determined. Localization is one of the fundamental problems in wireless ad-hoc networks, since locations of the mobile nodes are critical to both network operations and most application level tasks. Localization accuracy and reduction in the number of position information messages can be achieved, in real-time, by determining the optimal position from where the beacon should transmit its next position information. We present the survey on issues in wireless ad-hoc network. The RREQ sent by the sender is broadcasted leading to the flooding of the information messages. Directional Routing Protocol floods the RREQ packet in the network. We, first outline localized directional routing protocol to unicast the RREQ messages. For this an advisory can keep track of nodes using three hop concept. Furthermore the pseudo formation control flow algorithm is formulated as an unconstrained optimization problem under the free space propagation model.**

Keywords **– Localization, Optimization, Trajectory, RREQ.**

I. Introduction

Mobile Ad-Hoc Networks (MANETs) by definition are a kind of nodes capable of moving in a bounded or unbounded area [1]. These nodes can form ad hoc or decentralized networks without the support of any infrastructure. With the aid of this network (MANET) formation, the nodes of the network can communicate with the other nodes in the network. The nodes equipped with sensors and smart computing processors can sense the ambience for useful information, further aggregate and process the information and transmit the data to other nodes. The mobility of nodes, collection and aggregation of information, processing of data, localizing the other nodes and communication plays a crucial part in designing of the network. The possibility of existence of a prior communication network in a battlefield is very low, it necessitates deployment of an ad hoc network comprised of a number of small robots known as nodes with limited mobility to act as communication relays [2]. The deployed nodes should adjust their individual positions in a cooperative manner based on certain constraints (radio propagation characteristics, backbone formation and energy consumption) to establish a communication infrastructure. Localization [3] based routing protocols require the addition of new hardware. This hardware, attached to each node, provides each node with its own point of reference. This hardware is often in the form of a GPS locater. In general, the addition of new hardware to sensor nodes decreases their lifespan by increasing their operating cost (power consumption).Also important, when GPS devices are used, each node does not need to be configured to have a unique identifier, because their position can be used as a unique identifier (beacons).

Flooding is a technique that relays message from the source node to all other nodes in the network. Network flooding is the common and the most important algorithm that it is used in almost every higher routing protocol. The main drawback of flooding is redundancy of messages, complexity and it is not energy aware. Messages can become duplicated in the network further increasing the load on the network bandwidth as well as requiring an increase in processing complexity to disregard duplicate messages. Duplicate packets may circulate forever, unless certain precautions are taken:

i) Use a hop count or a time to live count and include it with each packet. This value should take into account the number

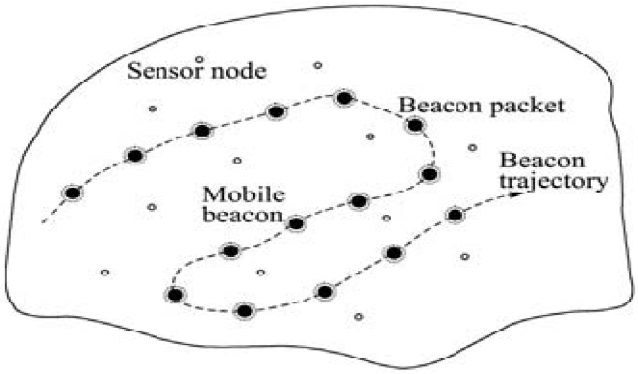

Fig.1. Beacon path determination of nodes that a packet may travel on the way to its destination.

ii) Have each node to keep track of every packet seen and only forward each packet once

iii) No loop formation in the network topology.

Range-free localization depending only on connectivity may underutilize the proximity information embedded in neighbourhood sensing. DRP is an on-demand directional routing protocol[4].DRP closely couples the routing layer with the MAC layer and assumes a cross-layer interaction between some of the modules .In DRP the Directional Routing Table (DRT) is local to routing layer and maintains the routing information to different destination. The Directional Neighbour Table (DNT) on the other hand is shared with MAC. Reactive protocols[5]employ a lazy approach whereby nodes only discover routes to destinations on demand, i.e., a node does not need a route to a destination until that destination is to be the sink of data packets sent by the node. Reactive protocols often consume much less bandwidth than proactive protocols, but the delay to determine a route can be significantly high and they will typically experience a long delay for discovering a route to a destination prior to the actual communication.

First, packet forwarding at each hop has to contend for channel resource with other traffic in the neighbourhood. Second, inter contention not only appears when several flows pass through the same forwarding node, but also exists when the flows paths are close to each other such that the MAC layer only allows one transmission at a time to avoid collisions. Third, once the congestion occurs, MAC layer contentions become severe so that the MAC layer throughput decreases due to the increasing collision probability. An omni directional DSR protocol running over a single switched beam directional antenna system is considered which lead to the foundation of Directional Routing Protocol (DRP).In a single switched beam directional antenna systems, sweeping is needed across all antenna beams in order to cover a node's one hop neighbour. But this adds to both packer redundancy and delay. Hence a specific direction is set by determining the optimal route to the destination.

II. Literature Review

TianHe, Chengdu Huang et.al proposed the APIT algorithm based on the triangles formed by reached anchors. When a normal node is reached by a set of anchor nodes, it randomly chooses three of them and tests whether it is inside the triangle region formed by those three anchors. When all combinations have been used, the node can obtain a set of possible triangles it may reside in. By intersecting these triangles, a possible smaller area will represent the v_nal estimation. Though it seems straight in the beginning, one difficulty is the Position in Triangle (PIT) test because the node has no knowledge of its own position. In [6], the authors use neighbourhood information to help the test. The algorithm assumes if two nodes receive signals from the same transmitter, the node that gets stronger signal (with higher energy) is closer to that transmitter. APIT algorithm performs badly when the anchor number (heard by a normal node) is below 8. When anchor number increases, APIT works comparably as Nagpal et al.'s Amorphous localization algorithm in uniform deployment networks (with estimation error of less than 50 % radio range).

Niculescu et al[7] found that locally positioning only the nodes involved in communication, instead of trying to construct a relative relationship for the whole network, is good enough.The proposed local positioning systems (LPS) works similar as SPA algorithm with these differences:
- LPS is dynamic and only involves a subset of nodes in the network;
- LPS is coordinated at the packet originator instead of the center of the local reference group LRG as in SPA;
- To improve the performance, LPS uses both angle and distance measurement to the construction of the positioning system.

The authors of [8], considered the limits and communication constraints of wireless ad hoc networks, and extend the classical multidimensional scaling algorithm with more advanced features. Specifically[9] provides iterative multidimensional scaling (IT-MDS) and simulated annealing multidimensional scaling (SA-MDS). The ITMDS algorithm considers the constraints from communicating neighbours, and embeds these constraints into the MDS algorithms in order to minimize the estimate errors iteratively. Huan-Qing CUI et.al considered the network based technologies [10] for obstacle in trajectory determination using combinational techniques 1)Time of Arrival (TOA). This technology worked by measuring the arrival time of a known signal sent from a (mobile) node received at three or more measurement units. Synchronization of the measurement units was essential. Therefore, this method required additional measurement unit hardware in the network at the geographical vicinity of the (mobile) node so as to accurately measure the TOA of the signal bursts. It was reported that the accuracy of TOA was about 100- 200m.2) Time Difference of Arrival (TDOA):It worked similar as TOA in that both technologies utilize signal propagation time. In TDOA, however, two types of signals were selected so that their propagation speeds were significantly different. When a transmitter sent two types of signals simultaneously, the receiver could easily detect the difference in the time of arrival between the two types of signals. The time difference could then be used to compute the distance between the communication pairs. To deal with multipath problems, TDOA systems historically have been based on wideband radio technology. The known accuracy was about 100-200m.3)Received Signal Strength Indicator (RSSI): This method measured the strength of the received signal in order to deduce the possible range the signal has propagated from the sender to the receiver. V.Bhanumathiet.al [11] proposed RSS based energy efficient scheme, for reducing the amount of overhearing the rebroadcast in MANET. A cross layer framework was designed by combining the physical MAC and Network Layer. In order to reduce the energy consumption, 802.11 PSM was integrated with DSR .Overhearing in DSR has improved the routing efficiency by expending some amount of energy. The main causes for energy consumption were unconditional overhearing and unnecessary rebroadcast of RREQ to the nodes which having less Received Signal Strength (RSS). RSS was used to predict the mobility of nodes. Probability of overhearing was determined (POR) in order to limit the amount of hearing for the unicast packets. The proposed mechanism R-ROR avoided unnecessary overhearing and rebroadcast using cross layer design which acheived energy consumption. Dinesh RatanGautam, Sanjeev Sharma and Santosh Sahu in their paper[12] have discussed the issues of power consumption in MANETS. They also proposed a technique to conserve the power of nodes by varying the input power to the transmitting antenna which will vary the range of the node according to the distance of communication. A systematic geometric approach to increase the range of a node was discussed. The concept is to temporarily arrange the nodes in specific formations so that the range of any node in the network can be extended virtually, making the data routing efficient in terms of energy consumption, delay, reduce error occurrences and time complexity.

Farah Mourad, HichemSnoussi et.al[13]proposed an original algorithm for self-localization in mobile ad-hoc networks. The proposed technique, based on interval analysis, was suited to the limited computational and memory resources of mobile nodes. The incertitude about the estimated position of each node has been propagated in an interval form. The propagation was based on a state space model and formulated by a constraints satisfaction problem. Observations errors as well as anchor nodes imperfections were taken into account in a simple and computational consistent way. A simple Waltz algorithm was then applied in order to contract the solution, yielding a guaranteed and robust online estimation of the mobile node position.

The proposed Guaranteed Boxed Localization (GBL) technique was based on propagating a set of constraints defined by the prior mobility model of the moving nodes and the information messages communicated by the neighbouring anchors(moving or static nodes equipped with positioning systems). Therefore, only the individual prior moving model was used and the problem was reduced to separable self-localization problems. The computation times needed to accomplish the localization for the 3 were respectively 0.3590s, 0.6390s and 0.7180s and the relative errors were respectively 1.98 %,1.78%and 1.78%. Ravishankar, Rakesh V, Praveen Kumar K[14] proposed a new localized routing protocol, called localized energyaware restricted neighbourhood routing (LEARN). In LEARN, whenever possible, the node selects the neighbor inside a restricted neighbourhood that has the largest energy mileage (i.e., the distance travelled per unit energy consumed) as the next hop node which was a variation of classical greedy routing. In greedy routing, current node us elects its next hop neighbour based purely on its distance to the destination, i.e., it sends the packet to its neighbour who is closest to the destination. Fabio Pozzo, LucioMarcenaro, Carlo Regazzoni et.al [15] implemented Location Aware Optimized Link State Routing Protocol (OLSR) protocol, based on the introduction of the Perceived Coverage Radius and the Perceived Coverage Area concepts. Each node supposed to have information about its positioning and to periodically communicate it to the adjacent nodes. A method to evaluate the above mentioned quantities and to transmit the positioning information has been proposed. The approach has been tested and validated by simulations and the results show that the Location Aware OLSR protocol has proven to be very effective in the performance improvement over the Standard OLSR protocol, in all the considered environment, in terms of packet-loss and delay, with a negligible impact over signalling overhead. Location Aware OLSR protocol achieves a packet loss percentage smaller than 3% where the correspondent rate for standard routing protocol is higher than 60%.

Hung-Chin Jang, Chih-Chia Hung [16] proposed a Directive Location-Aided Routing (DLAR) protocol , an enhancement of the well-known Location-Aided Routing (LAR) protocol that uses location information to reduce routing overhead of the ad-hoc network. DLAR retrieves node position through GPS and calculates its moving direction. DLAR will then select the next relay node based on the moving direction of the source node. DLAR has increased packet delivery ratio by 6%-55%, increase bandwidth by 40%, largely reduced broadcast storm probability, and reduced end-to-end delay by 20%.

Qinli An, Jianfeng Chen[17] proposed a range-free localization scheme for wireless sensor networks (WSNs) using four beacon nodes (BNs) equipped with a directional antenna with special transmission capabilities for sending wireless beacon signals throughout the sensor network. Each beacon node rotates with a constant angular speed and broadcasts its angular bearings. A sensor node can determine its location by listening to wireless transmissions from the four fixed beacon nodes. The proposed method was based on an angle-of-arrival estimation technique that does not increase the complexity or cost of construction of the sensor nodes. Error analysis and the best positions of beacon nodes were identified in the proposed method.

III. Issues

A. Require global information of the network and centralized computation

In the network consisting of the mobile nodes, the network topology may change due to mobility of the node.

B. Channel Fading

Multi-path fading is one of the most common phenomena in wireless systems. It is due to the constructive and destructive combination a number of multi-paths received at the receiver with random attenuations and delays. This type of fading affects the signals transmitted through wireless channels and causes the short-term signal variations.

C. Energy saving with delay/precision of the tracking trajectories

One drawback of these is that they require learning of, e.g., the relationship between acceleration patterns and velocity or positioning accuracy for a location.

D. Traffic Overhead

The traffic overhead introduced by the topology state advertisement may lead to performance degradation and consume battery power.

E. Flooding of the request which is broadcasted

Flooding is redundancy of messages, complexity and it is not energy aware. Messages can become duplicated in the network further increasing the load on the networks bandwidth as well as requiring an increase in processing complexity to disregard duplicate messages. RREQ is flooded by source node with leads to unnecessary information position messages to broadcast to each node.

F. Constraints for the shape, signal strength, radio propagation characteristics.

In range free propagation models, various constraints are considered for finding the position of unlocalized nodes. The random or sweep trajectory is considered which leads to position message broadcasts, slow convergence and increased energy consumption. Specific shape for confining area is predetermined such as wedge, triangular,bounding box.The deployed nodes should adjust their individual positions in a cooperative manner based on certain constraints to establish a communication infra-structure.

IV. Objectives

A. Design a localized directional routing protocol

In the routing protocol, the RREQ is broadcasted by the sender which leads to the flooding of the messages. With the purpose of localization, applied on the sender (beacon), the request can be unicasted. The number of position information messages will be reduced.3-Hop method can be used to avoid flooding .DRP is a cross interaction between MAC layer and routing layer. Directional Routing Table (DRT) maintains the information of destination route (node and beam id) and Directional Neighbour Table (DNT) maintains the information of the next neighbour.

B. Identification of unlocalized nodes

The optimal trajectory is used for identification of the position from where the moving beacon must send the message. The position of the beacon must be nearer to the circumference which indicates the exact position of the beacon, thus enables identification of unlocalized nodes. There is no requirement for a particular shape of the confining area. In the routing protocol, the network topology and the traffic condition changes, so finding the optimum position of the beacon is necessary.

C. Free space propagation with no constraints

Range free propagation is considered where the each node (beacon) uses the signal from more than one beacon to calculate its accurate position. The algorithm enables the deployed nodes to adjust their individual position in a co-operative fashion without any constraints. Deterministic approaches select a few forwarding nodes to achieve full delivery. Each node determines its status based on its 3-hop neighbourhood information.

D. Energy efficient localized routing

A smaller-sized forwarding node set is considered to be more efficient due to the reduced number of transmissions in the network, which helps to alleviate interference and also conserve energy. Therefore, by reducing the total number of transmission sectors of the forwarding nodes in the network, the interference can be alleviated, as well as the energy consumption. Localized Directional Routing Protocol (LDRP) is energy efficient i.e., when LDRP routing finds a path from the source node to the target node, the total energy consumption of the found path is within a constant factor of the optimum.

V. Proposed Work

Directional Routing protocol is an on-demand routing protocol. To find the information of the neighbour node directional routing table (DRT) and directional neighbor table (DNT) are constructed. It is a cross interaction between MAC layer and routing layer. DRT provides the respective destination to which message is forwarded and the route (route indicates the respective neighbour node and the beam id) and the DNT indicates the neighbour information. Range free propagation with nodes divided into different lobes (four quadrant). To overcoming the flooding of route request in DRP, for a given source X(considered as beacon) and the destination Y(beacon),if Y is not in the DNT of X,X floods a RREQ packet in the network. To reduce the broadcasting of the packets the localization technique is applied on the source The beacon X will construct the three hop table formation. In the first hop the nodes which are closest two the X are determined. Then in the second hop the nodes which are slight faraway are determined. Then in the third hop all the other nodes can be determined .But in the scenario if still Y is not in the three hop table, then only X will broadcast the RREQ. In the method if a node receives multiple packets from the same node, it maintains and rebroadcasts the one with the least hop counts while ignoring all the rest. This optimization will eventually lead to a shortest path to the beacons. Thus reducing the flooding.

For the source beacon selecting the optimal route to identify unlocalized nodes a specific angle is to be determined by the source node. The nodes which are confining with the area set by the direction angle (θ)are considered for the table construction. The angle can be determined by the respective (X, Y) co-ordinates of the source node(beacon). In the scenario all the nodes are considered to be mobile nodes for which base stations can be considered to maintain the current position of the mobile nodes. Due to localization technique the optimal position of the neighbour node from which the moving beacon should send the further request can be determined. The number of information position messages will be reduced by selecting only those neighbor nodes which are lying in the confining area of the source and destination and it should be nearer to the circumference of the confining area .Beacon entering into different states before locating the exact position and no requirement for formation of particular shape.

Table 5.1: Directional Routing Table at Node A

Beam	Node ID
1	
2	
3	
4	B

Table 5.2: Directional Neighbour Table at Node A

Destination	Route
E {B(2),D(3),E(3)}	

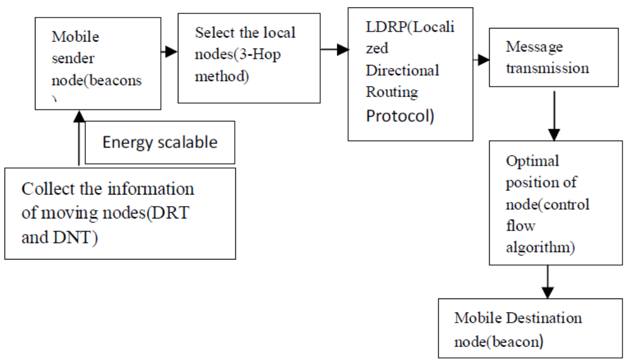

Fig.5.1. Workflow of Localized Directional Routing Protocol

Figure 5.1 shows the working of Localized Directional Routing Protocol (LDRP).In the scenario all the nodes are considered as beacons (GPS in built) are all are considered as mobile nodes. The sender node (beacon) wants to find the exact position from where the node to send the next message to the destination. The aim is to find the maximum number of unlocalized nodes with less power consumption .While the DRP Route discovery, a given source node(beacon) and the destination ,if destination is not in the Directional neighbour Table (DNT) of source, the source floods a RREQ packet in the network .To avoid flooding the 3-Hop neighbour table is maintained. In the first hop the nodes nearer to the source are determined. In the 2-hop, the nodes slight farther from the source nodes are determined and those not determined in 2-hop are determined in the 3-hop table.

While determination, one angle (θ) is set and the nodes lying in that direction are considered as neighbour nodes. As a result if the destination node is not present in any of 3-hop table, then only source node (mobile beacon)will flood RREQ. As the nodes are mobile, base stations are considered for storing the information of changing positions of nodes. The exact position of the unlocalized node is identified once it is nearer to the circumference of the confining area (intersection of two transmission areas of nodes).

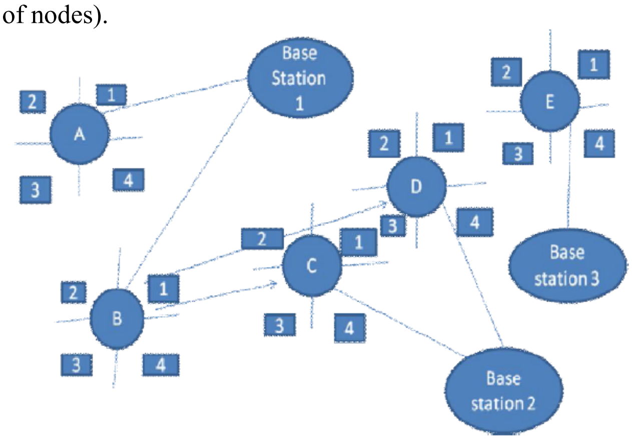

Fig.5.2. Scenario of Mobile Nodes (beacons) with base stations

The beacon enters into various phases before finding the optimal position for the unlocalized nodes The beacon processor after performing initialization tasks will enter START phase. This in turn will cause the first position message to be transmitted in Generate Packet stage, and then transit to the Generate/Receive state. In the Generate/Receive state, the processor will receive ack messages from the ULNs and increment a NodeCount counter only if the ag value of the received ack messages indicates that the ULNs are in the estimate state. Second determination is of trajectory determination ,in this phase, the next beacon position is determined along the straight line with a predetermined slope and direction .Using the estimated positions of the UNLs and the current position of the beacon ,the next beacon position is determined. The beacon is first moved to the optimal position previously determined in the Optimal Position state. Once the beacon reaches to the Optimal state and the node is nearer to the circumference the exact position is found.

VI. PROGRESS WORK

We stimulated LDRP using ns-3.25 stimulator.

Fig.6.1. Stimulation between various nodes(0 till 29)

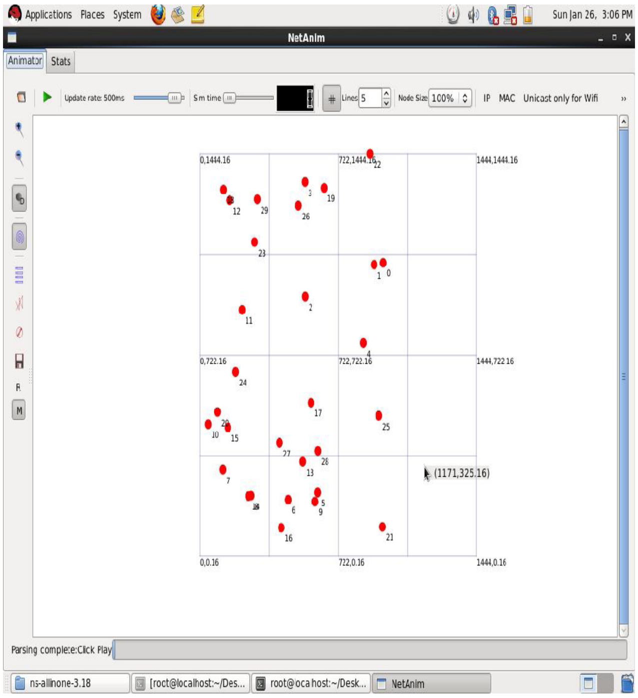

Fig.6.2. Scenario of 30 beacons at different positions

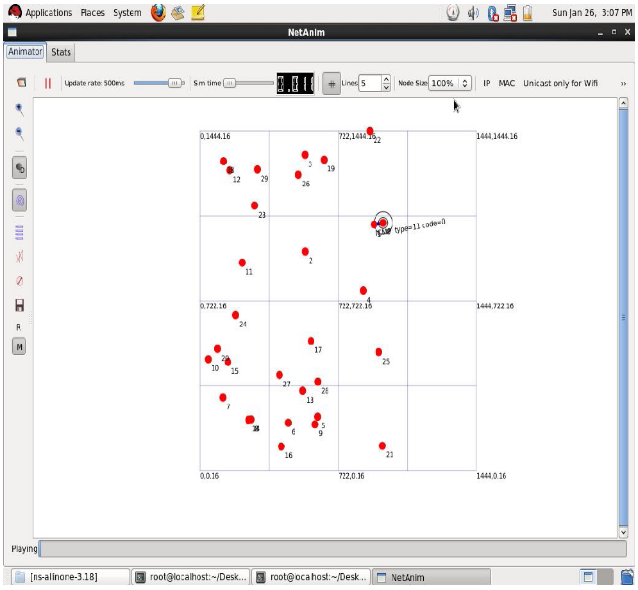

Fig.6.3. Transmission between two beacons (0 & 1)

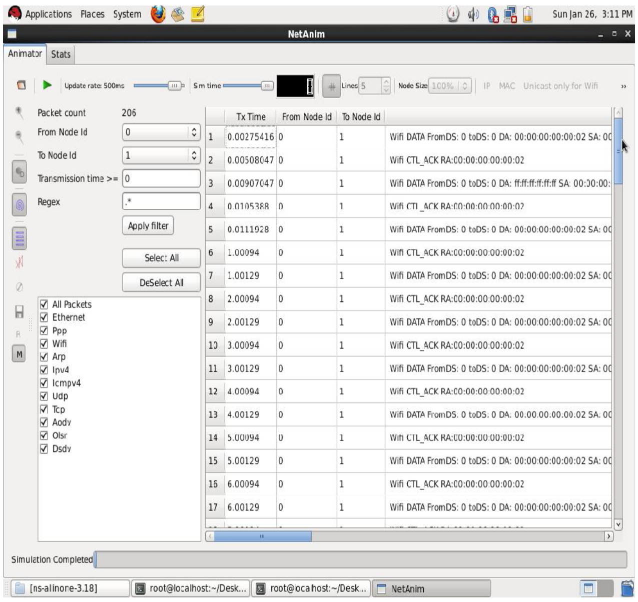

Fig.6.4. 2-hop table creation for beacons 0 &1

VII. CONCLUSION

In this paper, we proposed new pseudo formation control based algorithm to determine an optimal trajectory for the moving beacon to improve the localization accuracy. The basic idea is to determine a beacon position such that the ULNs are located close to the circumference of the circular transmission. We also have shown that with an increase in the deployment area, the localization accuracy remains the same with our algorithm whereas it reduces with both random and sweep trajectories. In this paper, we have demonstrated the pseudo formation control based algorithm mun-der free space propagation model. One of the approaches we are exploring is to use a convex

International Journal of Electronics Communication and Computer Engineering
Volume 5, Issue (4) July, Technovision-2014, ISSN 2249–071X

hull to encompass an irregular propagation model and determine inter sections of convex hulls.

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