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Analysis of Landmark Based Wireless Sensor Routing protocols

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ABSTRACT

Landmark, a new social-aware metric indicating the geographical location corresponding to a node interest or a node community. The landmark-centric routing protocol utilizing the metric to accurately predict node mobility geographically. Landmark is utilized to assist message forwarding in DTMSNs. Simulation results show that the protocol achieves the highest packet delivery ratio outperforming Social Cast and doubling SGBR with more than 50% delivery cost reducing.

Key words: NS2, OTCL, LCRP, DTMSN, SGBR, CMM, HCMM

1. INTRODUCTION

To develop an efficient DTMSN routing protocols follow Social network routing technique for determining the path for data transfer based on social behaviour patterns of the nodes. Landmark is a distributed routing protocol designed for large networks with loose administrative domains and changing topology. Landmark creates and maintains a hierarchy of nodes that reflects network topology. DTMSN routing protocols follow Social network routing technique for determining the path for data transfer based on social behavior patterns of the nodes. A wireless sensor network (WSN) of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, also enabling control of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on. The WSN is built of "nodes"–from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. A sensor node might vary in size from that of a shoebox down to the size of a grain of dust, although functioning "motes" of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from a few to hundreds of dollars, depending on the complexity of the individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth. The topology of the WSNs can vary from a simple star network to an advanced multi-hop wireless mesh network. The propagation technique between the hops of the network can be routing or flooding. In computer science and telecommunications, wireless sensor networks are an active research area with numerous workshops and conferences arranged each year. The latest advances in distributed computing and micro

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electro mechanical systems have enabled in the past few years the emergence of a variety of wireless sensor network applications comprising military, disaster management, building, health, environment, industry, and domains. Wireless sensor network is a network of spatially distributed sensor nodes equipped with sensing, computing, power, and communication modules to monitor a certain phenomenon such as environmental data or object tracking. The nodes in such networks are characterized by limited power, processing, and memory resources. As the sensor nodes are powered by batteries, it is difficult to replace or recharge these batteries because of cost (e.g., cost of batteries and labor) or geographic (e.g., difficult or unfriendly terrain) reason.

1.1. Delay Tolerant Networks

Making effective use of the vast amount of data gathered by large-scale sensor networks requires scalable and energy-efficient data storage and data dissemination algorithms. Queries on sensor networks may be content-based, in that users are primarily interested in data satisfying certain attributes, not in the details of which node currently contains the data. An information producer generates data that may be of interest to multiple information consumers located in other parts of the network at a much later time. This separation of communication in space and time calls for an information brokerage scheme for sensor nets. Delay tolerant networks are sparse mobile wireless networks which lack continuous end-to-end connectivity from source to destination. Traditional routing protocols for wired and wireless networks fail to work in the DTN environment because they expect a well-established connection between source and destination. Routing protocols developed for DTN should be adapted to this challenging environment by sending multiple copies of data packets to increase delivery probability assuming at least one of the copies reaches the destination. A store and forward approach is used in DTN networks where Nodes receiving the packet copies store them until they meet other nodes or meet the destination node. Hence routing is a challenging job in delay tolerant environments. An information brokerage scheme is a mechanism that carries out data publication, data replication for the information producer.

1.2. Routing in Delay Tolerant Mobile Sensor Networks

Delay and disruption-tolerant networks (DTNs), are characterized by their lack of connectivity, resulting in a lack of instantaneous end-to-end paths. However, when instantaneous end-to-end paths are difficult or impossible to establish, routing protocols must take to a “store and forward” approach, where data is incrementally moved and stored throughout the network in hopes that it will eventually reach its destination. This is feasible only on networks with large amounts of local storage and inter node bandwidth relative to the expected traffic.

2. LITERATURE SURVEY

1. Hojjati (2013)have used two decision techniques for combination of antennas signals were used in each sensor: hard decision and soft decision. The OR rule is used for hard decision and Selection Combining (SC) and Equal Gain Combining (EGC). In each combination scheme, the problem was the sensor selection so that the energy consumption was minimized while detection performance was satisfied. The problem was solved based on the standard convex optimization method. Simulation results show that significant energy saving is achieved in comparison with the networks using Single-Input Single-Output (SISO) sensors specifically in low Signal to Noise Ratio (SNR) regime.
2. Dong Li (2013) used Cooperative multiple-input multiple-output (MIMO) based communication architecture is used for energy efficient communication in wireless sensor networks. Without increasing transmission energy consumption of nodes, MIMO technology can make use of the cumulative energy of the sender node to increase the sending signal to noise ratio, thus reducing the error rate and improve

the reliability of data communication. In the same transmit power and bit error rate situations, using MIMO technology can provide higher data rates, reduce the node sending time, thereby reduce the energy consumption.

3. Keyong Li (2010) use full distributional information on signal measurements at a set of discrete locations, termed landmarks. Positioning of a mobile device is done relative to the resulting landmark graph and the device can be found near a landmark or in the area between two landmarks. Key elements of our approach include profiling the signal measurement distributions over the coverage area using a special interpolation technique.

4. Harsha V. Madhyastha (2011) done the Landmark-based routing (LR) provides a promising approach for scalable point-to-point routing in wireless sensor networks (WSNs). Though various approaches have been proposed for landmark based routing, they either introduce significant computational complexity or are inefficient in realistic, dynamic environments. In this paper, we identify three design principles that form the basis of efficiency: algorithmic simplicity, update efficiency, and application awareness.

5. Jie Wu (2012) an efficient routing algorithm for DTNs, where nodes determine the probability distribution of future contact times and choose a proper next-hop in order to improve the end-to-end delivery probability. The algorithm is based on two observations: one is that nodes usually move around a set of well-visited landmark points instead of moving randomly; the other is that node mobility behavior is semi-deterministic and could be predicted once there is sufficient mobility history information. Specifically, our approach employs a time-homogeneous semi-Markov process model that describes node mobility as transitions between landmarks.

2.1. Existing system

Due to the characteristics of WSNs, there are common grounds among such applications. Specifically, issues like dynamic topologies, demand of efficient routing protocols and distributed information processing approaches, network connectivity, and information association are all major technical challenges in industrial wireless sensor networks (IWSNs), delay tolerant mobile sensor networks (DTMSNs), and other WSN fields. This paper will focus on a high-level information association issue (i.e., the metric we propose and the way we derive its information among different nodes on a social layer) and accordingly design an efficient routing protocol for DTMSNs. As the key problems this paper deals with are also major challenges in IWSNs, our research will be helpful in the study of corresponding fields in IWSNs.

Disadvantages:

- Low energy due to long path
- Doesn't Flexible
- Delay in data transfer
- Less efficient
- High Cost

2.2. Proposed system

To compensate for this deficiency, we exploit landmark, a mobility-associated social-aware metric that can be used to accurately predict node mobility geographically on the basis of social network analysis. To give an overview of the existing social-aware metrics (node community and node interest) and the newly proposed metric landmark, the positive (social interaction utility, content based multicast and geographical utility) and negative (extra cost) effects they bring to protocol performance. As can be seen, all of the three metrics can employ social interaction utility; node interest and landmark can utilize content-based multicast, but only landmark can make use of the advantage brought by the geographical prediction of node mobility. Our objective in this paper is to design a landmark-aware routing protocol which is more efficient than landmark-oblivious (but social-aware) protocols. To that end, we design landmark-centric routing protocol, which employs the geographical information of landmark to predict the mobility of nodes having strong social relationships with the landmark. We also employ social interaction utility and the content-based multicast scheme such that their positive effects on protocol performance can be preserved in our protocol.

Advantages

- It is Flexible
- It is Efficient
- Cost minimization
- Packets are very secured
- High Energy

2.3. Feasibility analysis

All projects are feasible, given unlimited resources and infinite time. Before going further in to the steps of software development, the system analyst has to analyze whether the proposed system will be feasible for the organization and must identify the customer needs. The main purpose of feasibility study is to determine whether the problem is worth solving. The success of a system is also lies in the amount of feasibility study done on it. Many feasibility studies have to be done on any system.

3. LANDMARK BASED DELAY TOLERANT MOBILE SENSOR NETWOK

3.1. Centric Architecture

DTMSN routing protocols follow Social network routing technique for determining the path for data transfer based on social behavior patterns of the nodes ie, social interest and relationships. They concentrate on the relationships between nodes to deliver messages to its destination by a series of relay nodes which have some social interactions. LCRP is a social aware landmark based routing protocol which not only concentrates on relationship between nodes but also takes geographical aspect into consideration which helps in finding the additional relay nodes which though does not belong to destination community but pass through the destination location provides significant help in transferring the message to the destination node or community. This helps in ensuring high packet delivery in lesser time. When a message is generated it is labeled with a destination community based on a particular node interest. Label (m) specifies the destination community of message m which helps in identifying whether the member nodes of a community should receive the message or not. Com (n) specifies the label of community that node n belongs to and this information is stored in the nodes n buffer. With the help of these two functions a node decides whether it should receive particular message m or not. If a node does not belong to destination community it chooses the next best carrier of the message through carrier selection method, which determines the relay of the message for each hop. The carrier selection in community structure or landmark has higher priority to determine the next carrier of the message as nodes of same community are more likely to meet each other than an ordinary node. When neither of the two meeting nodes belongs to the destination community then the carrier is chosen based on the landmark utility. This helps in bringing the message nearer to the destination node or destination community and after encountering the destination node at some point of time the message is transferred. This destination node carries the message till it expires.

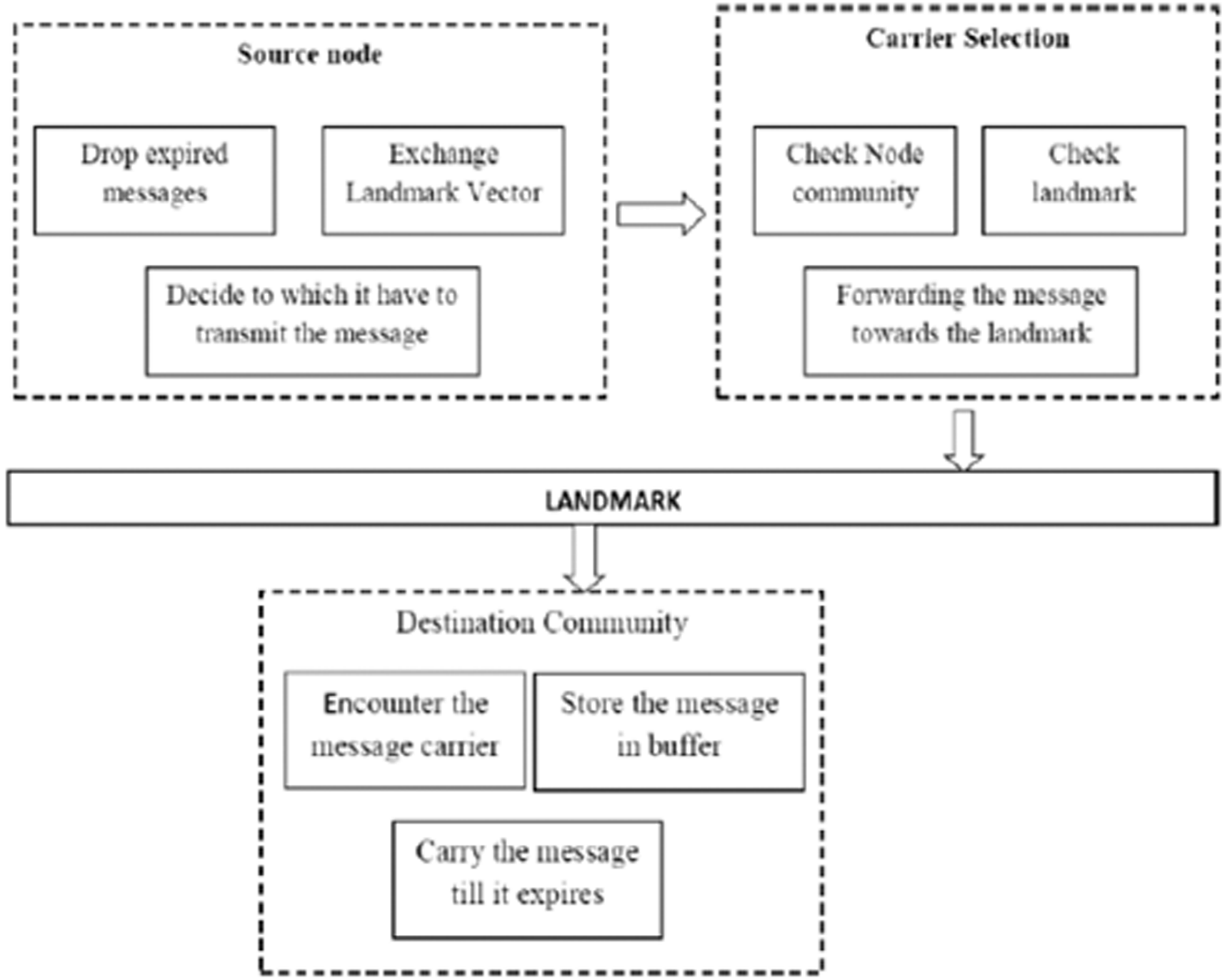

Figure 1: Landmark-centric Architecture

3.1.1. Message Delivery

When two nodes meet each other they first drop the expired messages and then exchange their Landmark Vector. Then, for each message, the protocol makes two decisions. If the node is the destination of the message, the message should be delivered to it, if not a new carrier of the message should be determined by using carrier selection method.

3.1.2. Carrier Selection

The carrier selection in community structure or landmark has higher priority to determine the next carrier of the message as nodes of same community are more likely to meet each other than an ordinary node. When neither of the two meeting nodes belongs to the destination community then the carrier is chosen based on the landmark utility. This helps in bringing the message nearer to the destination node or destination community and after encountering the destination node at some point of time the message is transferred. This destination node carries the message till it expires.

3.1.3. Input Design

Input Design is part of overall system design, which requires very careful attention. If the data going into the system is incorrect then the processing and output will magnify these errors.

The inputs in the system are of three types:

- External: which are prime inputs for the system.
- Internal: which is user communication with the system.
- Interactive: which are inputs entered during a dialog with the computer.

The above input types enrich the proposed system with numerous facilities that make it more advantageous in comparison with the exiting normal system. All the inputs entered are completely raw, initially, before being entered into a database, each of them available processing. The input format in this system has been designed with the following objectives in mind.

3.2. Network layers

3.2.1. Network Topology (Physical Layer)

The Physical Layer is the first and lowest layer in the seven-layer OSI model of computer networking. The implementation of this layer is often termed PHY. The Physical Layer consists of the basic hardware transmission technologies of a network. It is a fundamental layer underlying the logical data structures of the higher level functions in a network. Due to the plethora of available hardware technologies with widely varying characteristics, this is perhaps the most complex layer in the OSI architecture. The Physical Layer defines the means of transmitting raw bits rather than logical data packets over a physical link connecting networking nodes. The bit stream may be grouped into code words or symbols and converted to a physical that is transmitted over hardware.

3.2.2. Transport Connection (Transport Layer)

Transport layers are contained in both the TCP/IP which is the foundation of the INTERNET. and the OSI model of general networking. The definitions of the Transport Layer are slightly different in these two models. This article primarily refers to the TCP/IP model, in which TCP is largely for a convenient application programming interface to internet hosts, as opposed to the OSI model of definition interface. The most well-known transport protocol is the (TCP). It lent its name to the title of the entire internet protocol suite TCP/IP. It is used for connection-oriented transmissions, whereas the connectionless user datagram protocol (UDP) is used for simpler messaging transmissions. TCP is the more complex protocol, due to its state full design incorporating reliable transmission and data stream services.

3.2.3. Generate Traffic (Application Layer)

In TCP/IP, the Application Layer contains all protocols and methods that fall into the realm of process-to-process communications via an Internet Protocol (IP) network using the Transport layer protocols to establish underlying host-to-host connections. In the OSI model, the definition of its Application Layer is narrower in scope, explicitly distinguishing additional functionality above the Transport Layer at two additional levels: session layer and presentation layer OSI specifies strict modular separation of functionality at these layers and provides protocol for each layer.

4. SYSTEM IMPLEMENTATION

4.1. Modules

- Flooding
- Replication
- Forwarding

4.1.1. Flooding

Flooding families are extended the number of copies of each message to a group of nodes, this node works like relays. The relays stock up the message pending they connect with the target, at which the message is deliver. With this strategy the flooding families increase the packet delivery ratio, also try to decrease the packet delivery delay. Awareness about the network helps in deciding the best next hop. It is possible that the network has no knowledge about the network. Such schemes are called epidemic routing scheme. The epidemic routing is the simplest and earliest routing scheme for DTN. The basic concept of Epidemic routing is when two nodes encounter, they exchange messages each other and message will be propagated to the destination. Each node which receives a packet (queries/data) broadcasts it if the maximum hop-count of the packet is not reached and the node itself is not the destination of the packet.

4.1.2. Replication

Replication scheme insert multiple copies, or replicas of message into the network in order to increase the probability of message delivery that one of them will finds its way to the destination. This scheme further separated into two classes based on the no. of replicas created: Quota based and flooding based. In quota based protocol purposely limit the no. of replicas of message in the network. The quota of message is decided based upon certain quota allocation function. This function may be static or dynamic. Spray and wait, And EBR are the example of replication routing scheme. Quota allocation function i.e. binary value is used by spray and wait routing protocol in which it consist of two phase: spray phase and wait phase. In first phase it spread the sufficient no. of message copies.

4.1.3. Forwarding

In the Forwarding routing strategy, keep a single-copy message in the network and attempt to forward that copy through successive intermediate node to the destination. It takes more traditional approach on the basis of network topology knowledge to routing data in a DTN. And it select the best path to transmit message from node to node. A best route can be found by using Location-based routing, Per-hop routing, per-contact routing, and hierarchical routing protocol. Forwarding routing protocol such as MED, MEED.

4.2. Landmark centric routing protocol

Most existing human mobility models characterize a movement epoch as follows. At the beginning of a movement epoch, a node chooses a destination and moves to it at a speed. After arrival, the node stays at the destination spot for a time period which is known as pause time. Till the end of the pause time, the node

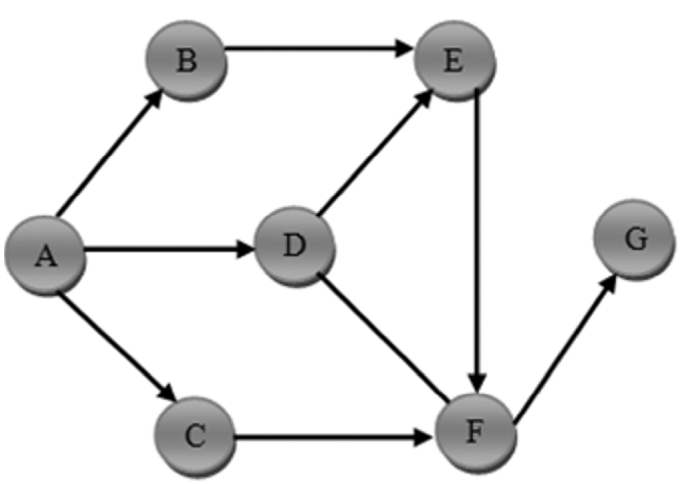

Figure 2: Flooding Diagram

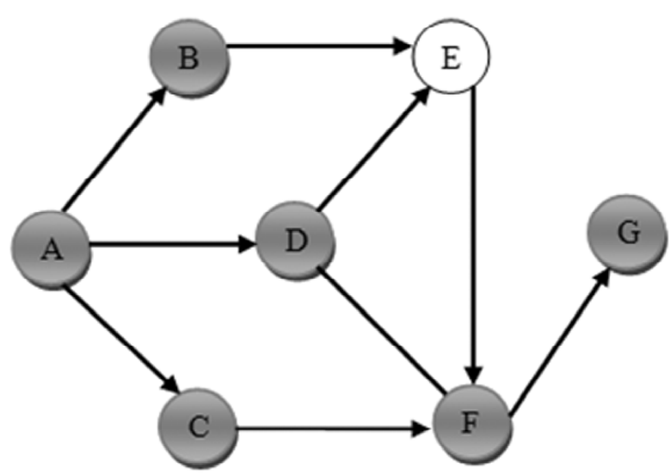

Figure 3: Replication Diagram

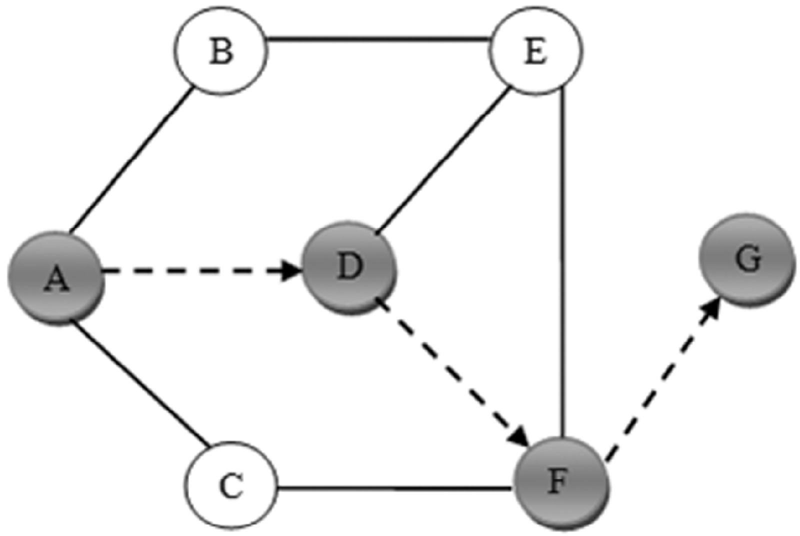

Figure 4: Forwarding Diagram

begins to choose a new destination and start the next movement epoch. In order to utilize landmark information during the pause time period, the ideal condition is that the pausing node knows where it will go in next movement epoch. Fortunately, this assumption might be reasonable because in real-life scenarios, human mobility is actually scheduled. LCRP works when a contact is happening when node i encounters node j, to employ the landmark utility, a piece of information called Landmark Vector should be exchanged before the data transfer. A Landmark Vector includes the node id *n*, **dest**(*n*, **distance**(*n*, *L*), **com**(*n*), the packet's id *m*, and **label**(*m*).

When two nodes meet each other, they firstly drop expired messages, followed with exchanging their Landmark Vector. Then, for each message in each node's buffer, the protocol makes two decisions. First, if the other node is the destination of the message, the message should be delivered to it. Second, the new carrier of the message should be determined, as the Carrier Selection indicates

5. SIMULATION RESULTS

We have taken HCMM as the human mobility model to represent the default network environment of LCRP. The network area is 5000 meters × 5000 meters with 100 nodes in the network, each node has a transmission range of 250 meters. These settings are able to provide a sufficiently sparse and disconnected network. We assume that half of the nodes are publishers and all nodes are subscribers, and messages are published during the interval [3000 s, 4000 s] over a total period of 28800 s, with a publishing interval of 60 s. The amount of node interests in the network is 4. When a node is moving, the speed is uniformly chosen at random over the range of 1 to 6 meters per second, and the pause time is set to be 10 seconds. Each node has a large enough buffer to store messages, unless the message gets expires it won't be discarded.

5.1. LCRP performance

LCRP utilizes a "one-to-community" multicast scheme which we consider as applicable in real-life scenarios. When a message is generated, it is labeled with the destination community. The main part of our protocol, namely, Carrier Selection, determines the relay of the message for each hop. As depicted in Carrier Selection the community structure has a higher priority (than the landmark) to determine the next carrier of the message, because a node's being in a message's destination community indicates that it will more probably meet other destination nodes than an ordinary node. When neither of the two meeting nodes is belonging to the destination community, the new carrier of the message then will be chosen based on the landmark

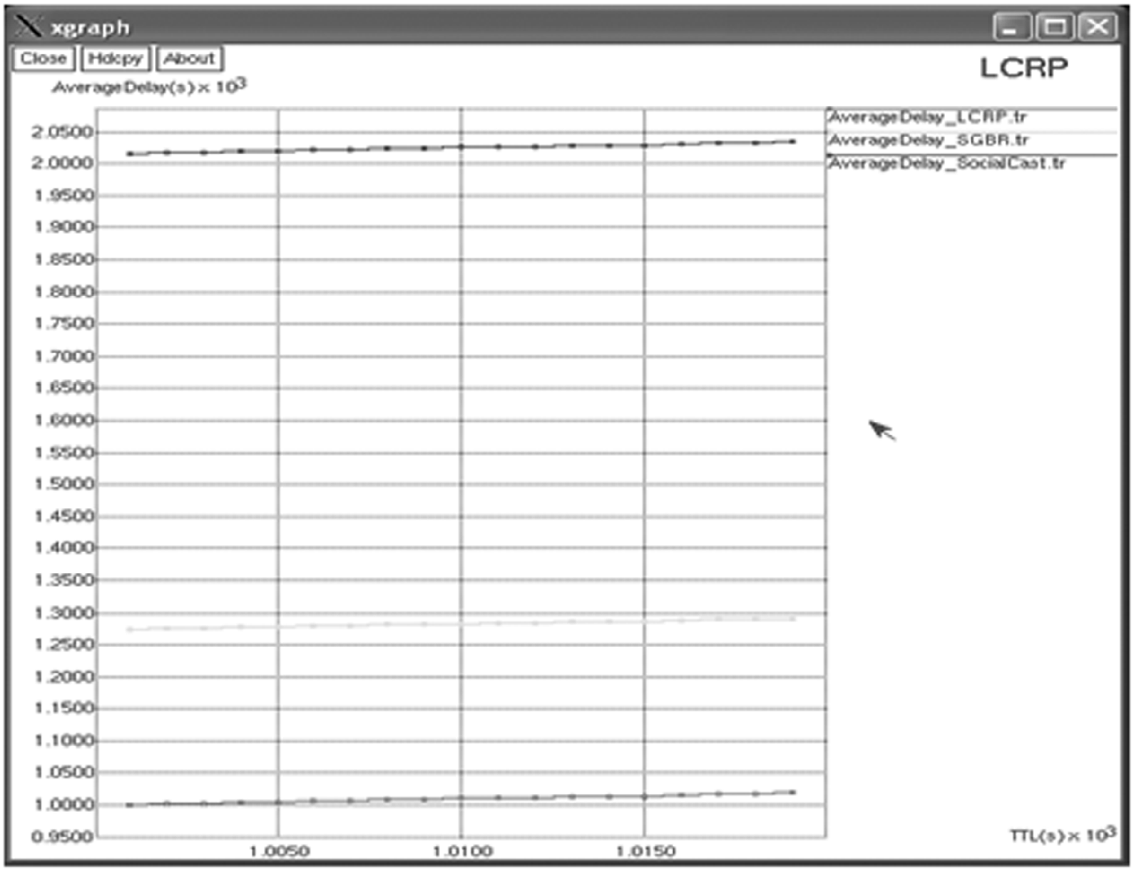

Figure 5: Comparison of Average Delay of Three Protocols

utility. In such a case, the message will be forwarded towards the geographical spot associated with the community, until one of the destination nodes receives it. After that, this destination node will carry the message till it expires. In order to facilitate the intercommunity's dissemination, the message replication strategy will accordingly be active when the carrier meets another destination node. Note that LCRP limits the amount of replicas for a specific message ID by setting it as a parameter.

5.1.1. LCRP vs SGBR Protocol

SGBR utilizes social interaction utility. Because of the absence of node interest, SGBR is a unicast protocol. For the consistency of the comparisons, in the following simulations, we extend SGBR to a multicast protocol; that is, we set the packet generation in SGBR the same as that in LCRP Since packets are routed individually in SGBR, this extension will not degrade its performance. The delivery cost is calculated by the ratio of "the amount of received control packets plus the amount of data packets" replicas' to "the amount of received data packets."

Packet delivery ratio is actually the successful rate of forwarding data packets and average delay indicates how long a data packet will be received by the destination node. Packet delivery ratio and average delay both account for the effectiveness of the protocol. Packet delivery ratio is calculated as the ratio of "amount of received data packets" to "amount of generated data packets". Average delay is calculated as the ratio of "sum of delay of all received data packets" to "amount of received data packets."

5.1.2. LCRP vs Social Cast Protocol

With a network environment similar to LCRP, Social Cast chooses CMM to evaluate its performance. However, CMM has been proved defective, that is, specifically, in the majority of configurations all users

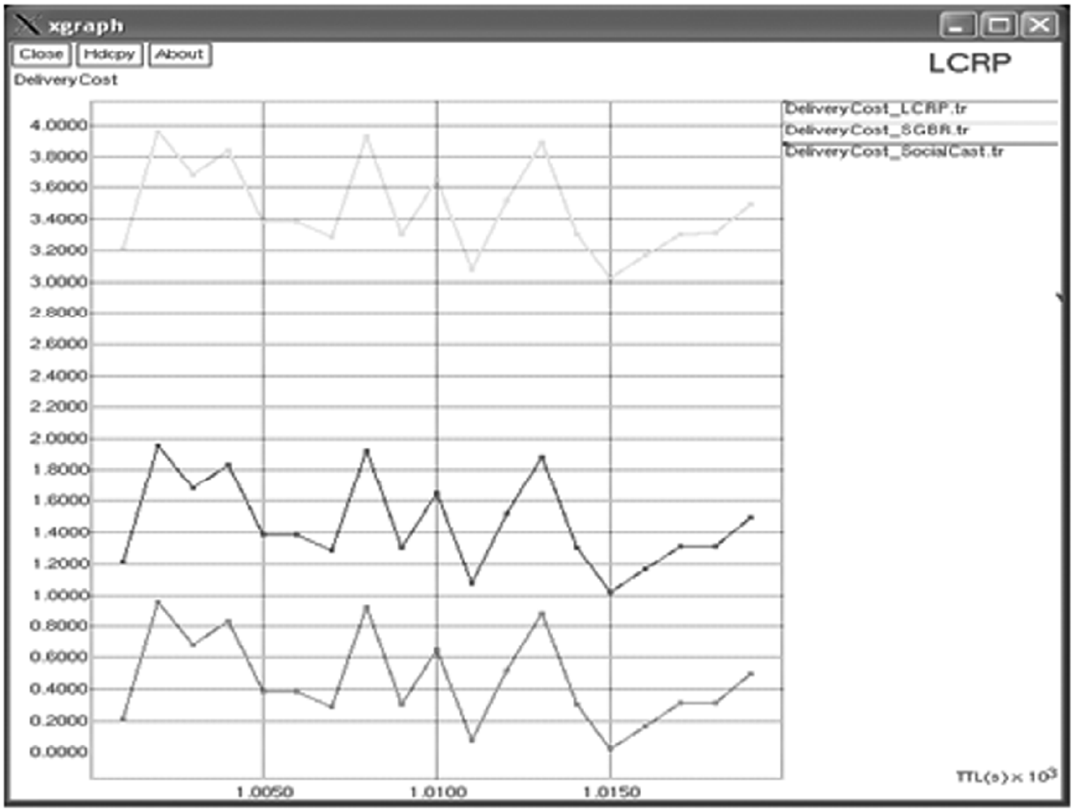

Figure 6: Comparing the Delivery Cost of Three Protocols

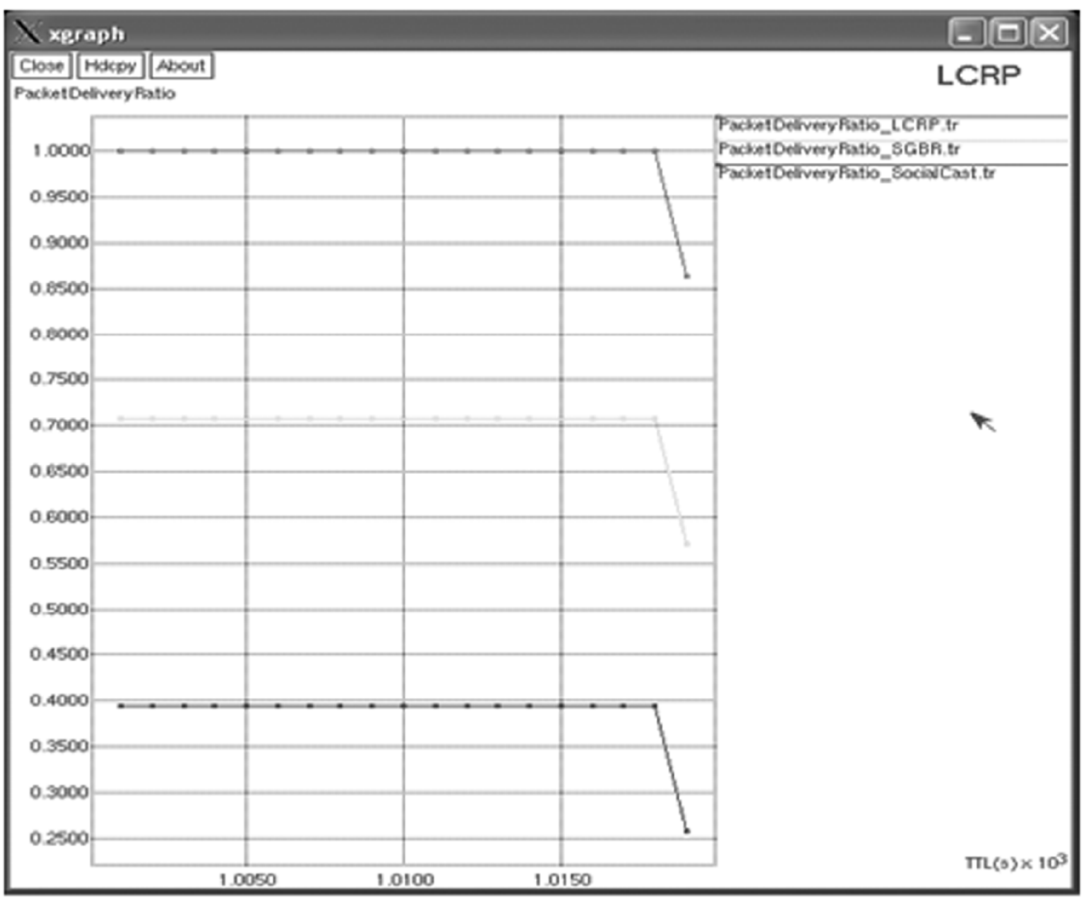

Figure 7: Comparison of Packet Delivery Ratio of Three Protocols

collapse into a single location; this practically overthrows the initial setting of the system. HCMM is subsequent to CMM and gets rid of this defect. Hence, we choose HCMM as the human mobility model to represent the default network environment of LCRP (i.e., “aware”). In HCMM, the network area is set to be 5000 meters × 5000 meters. There are 100 nodes in the network; each node has a transmission range of 250 meters. These settings are able to provide a sufficiently sparse and disconnected network. We assume that half of the nodes are publishers and all nodes are subscribers, and messages are published during the interval [3000 s, 4000 s] (500 s longer than) over a total period of 28800 s (8 hours), with a publishing interval of 60 s.

6. CONCLUSION

An exhaustive analysis on the effect of social network theory to forwarding scheme and node mobility in DTMSNs. We indicate that communities and interests are correlated with geographical locations in the network area and exploit the so-called landmark metric. To validate the landmark metric and our protocol, we evaluate the performance of LCRP in comparison with two outstanding DTMSN routing protocols. Simulation results indicate that our protocol outperforms the other two protocols with per exceeding Social Cast and doubling SGBR while reducing more than 50% cost.

For the “agnostic” network scenario, we roughly estimate the geographical landmark information to implement LCRP. Evidently, a more accurate estimation will lead to a better performance of LCRP, which will be left as future work.

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