Wireless Mobile Ad-hoc Shortest Path Routing in Delay Tolerant Networks

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***Abstract*– Opportunistic delay tolerant networks are organized by the sporadic connectivity between their nodes and the lack of stable paths from sender to receiver. Future connections are mostly unknown in these networks sending used to deliver the messages with effective forwarding data i.e., average intermeeting time between nodes to avoid risks or intrusion, attacks. Our proposed system analysis the novel metric conditional intermeeting average time computes duration of time between two nodes relative to meet the third node only local knowledge of past contacts. In this work we survey the routing protocols in wireless sensor networks, applications of MANETs and compares the metric based algorithms for delay tolerant networks is existing one.**

***Keywords*–** Wireless Sensor Networks, MANETs, Routing and Delay Tolerant Networks

I. INTRODUCTION

A wireless sensor network is composed of a large number of sensor nodes, which are densely deployed either inside the phenomenon [2]. A wireless sensor network (WSN) is a wireless computing devices network consisting of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, motion, intrusion or pollutants, at different locations. Wireless ad-hoc sensor networks are infra structure less wireless sensor networks. Here, wireless sensors are small, inexpensive, low power devices, which are deployed, in large numbers over an area in an ad hoc fashion. The low cost, ad hoc deployment, distributed sensing, and adaptability of wireless sensors have given them a big advantage over other methods [1], [3].Presences of large number of nodes which can co-ordinate amongst themselves give them huge advantage over centralized single sensor based techniques. A single node may leave a number of holes and shadows, which can be effectively, covered using a distributed deployment. Since they are used in large numbers they are able to record an event with greater redundancy i.e. if one sensor misses there are others, which can track the event [2], [3].

Routing is the process of sending the data through paths in network traffic. Routing is performed for many kinds of networks like telephone network, electronic data networks such as internet, transportation networks. In packet switching networks, routing directs forwarding, the transit of logically addressed packets from their source toward their ultimate destination through intermediate nodes; typically hardware devices called routers, bridges, gateways or switches. The routing process usually directs forwarding on the basis of routing tables which maintain a record of the routes to various network destinations. Thus, constructing routing tables, which are held in the routers' memory, becomes very important for efficient routing.

Routing of data has been one of the challenging areas in wireless sensor network research. It usually involves multi-hop communications and has been studied as part of the network layer problems. Despite the similarity between sensor and mobile ad-hoc networks, routing approaches for ad-hoc networks proved not to be suitable to sensors networks. This is due to different routing requirements for ad-hoc and sensor networks in several aspects. For instance, communication in sensor networks is from multiple sources to a single sink, which is not the case in ad-hoc networks. Moreover, there is a major energy resource constraint for the sensor nodes. As a consequence, many new algorithms have been proposed for the problem of routing data in sensor networks. These routing mechanisms can be classified as data-centric [4], hierarchical [5] or location-based [6]. Current research on routing of sensor data mostly focused on protocols that are energy aware to maximize the lifetime of the network, scalable for large number of sensor nodes and tolerant to sensor damage and battery exhaustion. Since the data they deal with is not in large amounts and flow in low rates to the sink, the concepts of latency, throughput, delay and jitter were not primary concerns in sensor networks. However, the development of video and imaging sensors requires the consideration of quality of service (QoS) in sensor networks, which magnifies the difficulties associated with the energy efficiency and awareness.

II. ROUTING

In wireless sensor networks or in networking sending the data or information in packets from source sender to receiver destination

A. Types of Routing

Sending data from sender side system to receiver side routing is classified into static and dynamic routing.

1) Static Routing: In this routing, information of all networks must be entered manually by the administrator on all routers. As routing data is entered by the administrator there is no

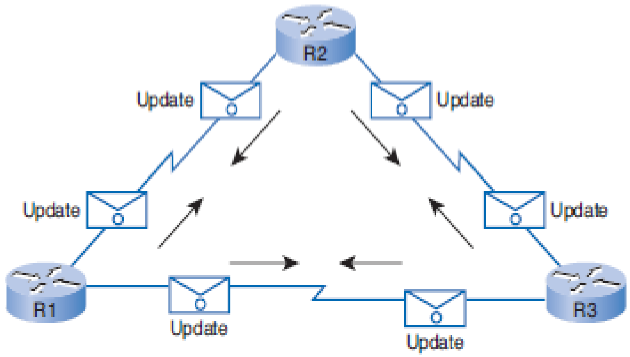

Fig. 1. Dynamic routers

requirement to perform any metric calculations to determine paths. Advantages of static routing are:

Doesn't exchange any routing tables hence it doesn't consume any bandwidth. Again the bandwidths which may be consumed in dynamic updates are saved.

Low processing power may suffice; hence we can use cheaper routers. Higher Security as there is no information being regarding routing on the connecting links.

Draw backs of static routing are

Each remote network information is written manually.

Reconfiguration is problematic and tedious if there is a change in the topology.

2) Dynamic Routing: routing protocols are used to facilitate the exchange of routing information between routers. Routing protocols allow routers to dynamically learn information of all remote networks and automatically add this information to their own routing.

Routing protocols determine the best path to each network, which is then added to the routing table. One of the primary benefits of using a dynamic routing protocol is that routers exchange routing information whenever there is a topology change. This exchange allows routers to automatically learn about new networks and also to find alternate paths if there is a link failure to a current network. Static routing over dynamic routing protocols require less administrative overhead. However, the expense of using dynamic routing protocols is dedicating part of a router's resources for protocol operation, including CPU time and network link bandwidth. Despite the benefits of dynamic routing, static routing still has its place. There are times when static routing is more appropriate and other times when dynamic routing is the better choice.

B. Routing protocols for Mobile Ad-hoc Networks

1) Wireless Sensor Routing Protocol: The Distance table of a node x contains the distance of each destination node y via each neighbor z of x. It also contains the downstream neighbor of z through which this path is realized. The Routing table of node x contains the distance of each destination node y from node x, the predecessor and the successor of node x on this path. It also contains a tag to identify if the entry is a simple path, a loop or invalid. Storing predecessor and successor in the table is beneficial in detecting loops and avoiding counting-to-infinity problems. The Link-Cost table contains cost of link to each neighbor of the node and the number of timeouts since an error-free message was received from that neighbor. The Message Retransmission list (MRL) contains information to let a node know which of its neighbor has not acknowledged its update message and to retransmit update message to that neighbor. Node exchange routing tables with their neighbors using update messages periodically as well as on link changes.

The nodes present on the response list of update message (formed using MRL) are required to acknowledge the receipt of update message. If there is no change in routing table since last update, the node is required to send an idle Hello message to ensure connectivity. On receiving an update message, the node modifies its distance table and looks for better paths using new information. Any new path so found is relayed back to the original nodes so that they can update their tables. The node also updates its routing table if the new path is better than the existing path. On receiving an ACK, the mode updates its MRL. A unique feature of this algorithm is that it checks the consistency of all its neighbors every time it detects a change in link of any of its neighbors. Consistency check in this manner helps eliminate looping situations in a better way and also has fast convergence.

2) Cluster Gateway Switch Routing Protocol: *M*obile nodes are grouped into clusters and a cluster-head is elected. All nodes that are in the communication range of the cluster-head belong to its cluster. A gateway node is a node that is in the communication range of two or more cluster-gateway. In a dynamic network cluster head scheme can cause performance degradation due to frequent cluster-head elections, so CGSR uses a Least Cluster Change (LCC) algorithm. In LCC, cluster-head change occurs only if a change in network causes two cluster-heads to come into one cluster or one of the nodes moves out of the range of all the cluster-heads. Algorithm works in the following. The source packet transmits the packet to its cluster-head. From this cluster-head, the packet is sent to the gateway node that connects this cluster-head and the next cluster-head along the route to the destination. The gateway sends it to that cluster-head and so on till the destination cluster-head is reached in this way. The destination cluster-head then transmits the packet to the destination. Fig. 3 shows an example of CGSR routing scheme.

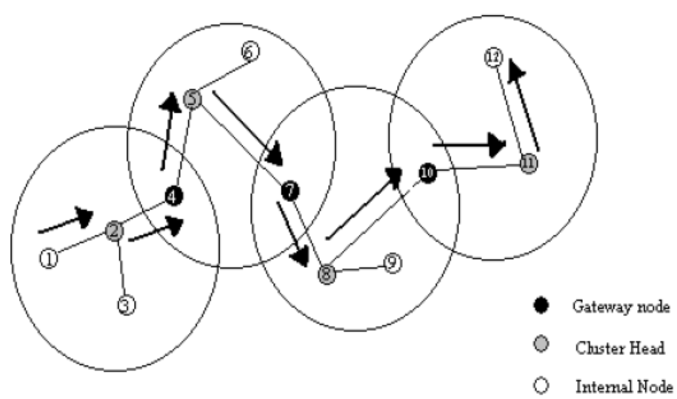

Fig. 2. A CGSR routing from node 1 to node 12

Each node maintains a cluster member table that has mapping from each node to its respective cluster-head. Each node broadcasts its cluster member table periodically and updates its table after receiving other node Æs broadcasts using the DSDV algorithm. In addition, each node also maintains a routing table that determines the next hop to reach the destination cluster. On receiving a packet, a node finds the nearest cluster-head along the route to the destination according to the cluster member table and the routing table. Then it consults its routing table to find the next hop in order to reach the cluster-head selected in step one and transmits the packet to that node.

III. MOBILE AD-HOC NETWORKS

Recent advancements such as Bluetooth introduced a new type of wireless systems known as mobile ad-hoc networks. Mobile ad-hoc networks or "short live" networks operate in the absence of fixed infrastructure. They offer quick and easy network deployment in situations where it is not possible otherwise. Ad-hoc is a Latin word, which means "for this or for this only." Mobile ad-hoc network is an autonomous system of mobile nodes connected by wireless links; each node operates as an end system and a router for all other nodes in the network.

Nodes in mobile ad-hoc network are free to move and organize themselves in an arbitrary fashion. Each user is free to roam about while communication with others. The path between each pair of the users may have multiple links and the radio between them can be heterogeneous. This allows an association of various links to be a part of the same network.

A. Delay Tolerant Networking Applications

1) Pocket Switched Networks in the Haggle: In this framework researchers analyzing the properties of pocket switched networks that opportunistic networks that can exploit any possible encountered device like cell phones users carry in their pockets to forward messages.

2) Wildlife Monitoring: It focuses on tracking wild species to deeply investigate their behavior and understand the interactions and influences on each other as well as ecosystem reaction changes caused by human activities. Systems for wildlife monitoring generally include special tags with sensing capacity to be carried by the animals under study. A network protocol also comprised to percolate the data from the tags towards the base station.

3) Networks for Developing Areas: Networks can provide intermittent internet connectivity to rural developing areas where they typically represents the only affordable way to help bridging the digital device. Application scenario has been investigated in the framework of the saami network connectivity project aimed at providing network connectivity to the nomadic saami population of the reindeer herders.

IV. PROBLEM DEFINITION

Wireless mobile ad-hoc networks became wide range vital role in the society. Generally routing is a sending data through the paths, if the router occurs risk or intrusion, attack

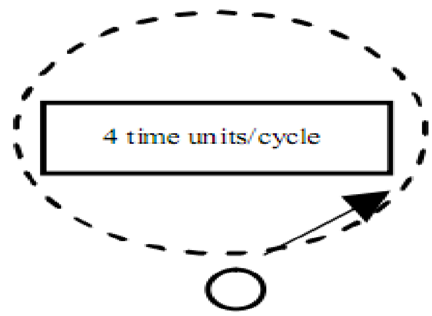

Fig. 3. The time period for routing

facing a problem to receive the data at destination. We find out the solution for this is a conditional shortest path routing, it based on average time per seconds cycle.

A. Types of Activities in the Solution Part

1) Networking Module: Client-server computing or networking is a distributed application architecture that partitions tasks or workloads between service providers (servers) and service requesters called clients. Often clients and servers operate over a computer network on separate hardware. A server machine is a high-performance host that is running one or more server programs which share its resources with clients. A client also shares any of its resources; Clients therefore initiate communication sessions with servers which await (listen to) incoming requests.

2) ***Shortest Path Module:*** In multi-hop wireless networks, packets are transferred through routes that could be composed of multiple relay nodes between sources and destinations. In many multi-hop wireless networks, shortest path routing is often used for its simplicity and scalability, and this is closely approximated by straight line routing for large multi-hop wireless networks. Thus, in this paper, we will focus on straight line routing for delivering packets from sources to destinations.

3) Straight Line Routing Module: Both simulations and analysis show that the relay load over the network, imposed by straight line routing, depends on the model of the traffic pattern. Even if the system settings are identical and straight line routing is commonly adopted, the relay load induced by “random” traffic could be distributed differently over the network. This paradoxical result is a consequence of the famous Bertrand’s paradox. Thus, in contrast to traditional belief, there are many scenarios in which straight line routing itself can balance the load over the network, and in such cases explicit load-balanced routing may not help mitigate the relaying load.

4) ***Multi-Hop Module:*** Analyze the load for a homogeneous multi-hop wireless network for the case of straight line routing in shortest path routing is frequently approximated to straight line routing in large multi-hop wireless networks. Since geographical and geometric attributes of nodes and routes affect the nodal load, we employ results from geometric probabilities to solve the problem. Based on our analytical results, we are able to show the precise relationship between the number of nodes and the load at each node, and the geographical distribution of the relaying load over the network for different scenarios. Interestingly, straight line routing itself can balance the relay load over the disk in certain cases.

B) Algorithm for Conditional Shortest Path Routing

Our algorithm basically finds conditional shortest paths (CSP) for each source-destination pair and routes the messages over these paths. We define the CSP from a node n0 to a node nd as follows:

$$CSP(n_0, n_d) = \{n_0, n_1, \ldots, n_{d-1}, n_d \mid \Re_{n_0}(n_1|t) + \sum_{i=1}^{d-1} \tau_{n_i}(n_{i+1}|n_{i-1}) \text{ is minimized.}\}$$

Here, t represents the time that has passed since the last meeting of node n_0 with n_1 and R_{n0} (n_1|t) is the expected residual time for node n_0 to meet with node n_1 given that they have not met in the last t time units. R_{n0} (n_1|t) can be computed as in with parameters of distribution representing the intermeeting time between n_0 and n_1. It can also be computed in a discrete manner from the contact history of n_0 and n_1.

Assume that node i observed d intermeeting times with node j in its past. Let $\tau_i^{1}(j), \tau_i^{2}(j) \ldots \tau_i^{d}(j)$ denote these values. Then:

$$\Re_i(j|t) = \frac{\sum_{k=1}^{d} f_i^k(j)}{|\{\tau_i^k(j) \geq t\}|} \text{ where,}$$

$$f_i^k(j) = \begin{cases} \tau_i^k(j) - t & \text{if } \tau_i^k(j) \geq t \\ 0 & \text{otherwise} \end{cases}$$

Here, if none of the d observed intermeeting times is bigger than t (this case occurs less likely as the contact history grows), a good approximation can be to assume R_i (j|t) = 0. We will next provide an example to show the benefit of CSP over SP. Consider the DTN (Fig. 4).

As Illustrated in the Fig. 4. The weights of edges (A, C) and (A, B) show the expected residual time of node A with nodes C and B respectively in both graphs. But the weights of edges (C, D) and (B, D) are different in both graphs. While in the left graph, they show the average intermeeting times of nodes C and B with D respectively[10], in the right graph, they show the average conditional intermeeting times of the same nodes with D relative to their meeting with node A. From the left graph, we conclude that SP (A, D) follows (A, B, D). Hence, it is expected that on average a message from

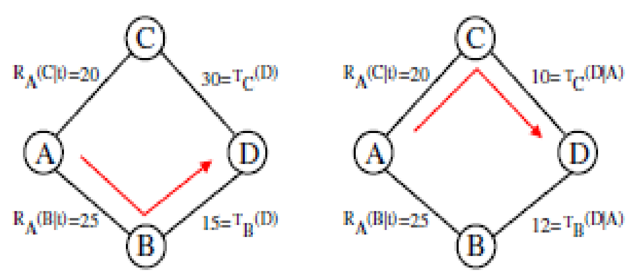

Fig. 4. A shortest path node can be different when conditional intermeeting times are used as the weights of links in the network graph.

node A will be delivered to node D in 40 time units. However this may not be the actual shortest delay path [11]. As the weight of edge (C, D) states in the right graph, node C can have a smaller conditional intermeeting time (than the standard intermeeting time) with node D assuming that it has met node A. This provides node C with a faster transfer of the message to node D after meeting node A. Hence, in the right graph, CSP (A, D) is (A, C, D) with the path cost of 30 time units. Each node forms the aforementioned network model and collects the standard and conditional intermeeting times of other nodes between each other through epidemic link state protocol. However, once the weights are known, it is not as easy to find CSP's as it is to find SP's where the CSP (A, E) follows, path 2 and CSP (A, D) follows (A, B, D). This situation is likely to happen in a DTN, if τD (E|B) ≥ τD (E|C) is satisfied. Running Dijkstra's or Bellman-ford algorithm on the current graph structure cannot detect such cases and concludes that CSP (A, E) is (A, B, D and E).

C. Metric-based Forwarding Algorithms

A common method of routing in delay tolerant networks is to forward the message to the encountered node that is more likely to meet with destination than the current message carrier. However, making effective forwarding decisions in single-copy based routing in DTNs is a challenging task. When two nodes meet, one of them forwards a message to the other one if it decides that the message will have a higher chance to be delivered to the destination at the other node. Existing work, depending on the observed contact history between nodes, several metrics have been used to define the delivery quality of nodes. Some of the popular ones are encounter frequency [9], time elapsed since last encounter, residual time, social similarity and location similarity. For example, in Prophet [9], messages are forwarded to the nodes that meet with the destination more frequently.

In most of the existing work, meetings of a node with other nodes are assumed independent from each other and the forwarding decision at the encounter of two nodes is made depending on their individual relations with the destination node. In some algorithms such as [9] with additional processing (i.e. applying transitivity) on pair wise meetings, more accurate metrics are used to reflect the effect of other nodes on the delivery quality of a node. However, these improvements can also be applied to all other metrics, including the one introduced in this chapter.

Our contribution is the introduction of a new metric having this property by default in its basic definition. To make forwarding decisions of these algorithms more effective, thus to improve their performance, we propose to use conditional intermeeting time as an additional delivery metric. That is, when two nodes meet, they will also compare their conditional intermeeting times with destination (depending on the condition that they met each other). If the current carrier of the message learns that other node also has a shorter remaining time (according to conditional intermeeting time) to meet the destination than itself, the message is forwarded. At first glance, this additional condition seems to cut down the number of times the message is forwarded so that the probability of delivery will be reduced. However, as simulation results show, the necessary numbers of hops are preserved and the less beneficial ones are not performed. Therefore, more effective forwarding decisions are made so that the cost of message delivery declines while the delivery ratio and average delay are maintained (in some cases, even the delivery ratio increases and average delay decreases).

D. Comparative Study

A Distributed adaptive fault- tolerant routing scheme is proposed for an injured hypercube in which each node is required to know only the condition of its own links**.** Despite its simplicity, this scheme is shown to be capable of routing messages successfully in an injured n-dimensional hypercube as long as the number of faulty components is less than n. Moreover, it is proved that this scheme routes messages via shortest paths with a rather high probability, and the expected length of a resulting path is very close so that of a shortest path. Since the assumption that the number of faulty components is less than n in an n-dimensional hypercube might limit the usefulness of the above scheme, a routing scheme based on depth-first search which works in the presence of an arbitrary number of faulty components is introduced. Due to the insufficient information on faulty components, however, the paths chosen by this scheme may not always be the shortest. In our system, defines the intermeeting time concept between nodes and introduces a new link metric called conditional intermeeting time.

It is the intermeeting time between two nodes given that one of the nodes has previously met a certain other node. This updated definition of intermeeting time is also more convenient for the context of message routing because the messages are received from a node and given to another node on the way towards the destination. Here, conditional intermeeting time represent the period over which the node holds the message. To show the benefits of the proposed metric, the project proposes conditional shortest path routing (CSPR) protocol in which average conditional intermeeting times are used as link costs rather than standard intermeeting times and the messages are routed over conditional shortest paths (CSP). By comparing CSPR protocol with the existing shortest path (SP) based routing protocol through real trace-driven simulations the results demonstrate that CSPR achieves higher delivery rate and lower end-to-end delay compared to the shortest path based routing protocols.

V. CONCLUSION

Our paper introduced a new routing technique called conditional intermeeting time, forwarding the messages with average time. Existing work showing that nodes intermeeting times are not memory less and that patterns of mobile nodes are frequently repetitive, then the analysis effects of this approach on shortest path based routing in opportunistic delay tolerant networks. We listed on routing protocols algorithms and different applications of MANETs. The proposed work updated the shortest path based routing algorithms using conditional intermeeting times and proposed to route the messages over conditional shortest paths. Finally, Compares with the DTN conditional shortest path routing and metric-based forwarding routing to analyze the proposed algorithm superiority of CSPR protocol over the existing shortest path routing algorithms.

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