Gossip Based Routing Protocol Design for Ad Hoc Networks

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Abstract

A spontaneously mannered decentralized network with no formal infrastructure and limited in temporal and spatial extent where each node communicate with each other over a wireless channel and is willing to forward data for other nodes is called as Wireless Ad Hoc network. In this research study, we proposed a routing strategy based on gossip based routing approach that follows the proactive routing with some treatment for wireless Ad Hoc network. The analytical verification of our proposed idea shows that it is a better approach based on gossip routing.

Keywords: *Decentralized, Ad Hoc Network, Gossip, Proactive Routing, Flooding.*

1. Introduction

By late nineties the term "Ad Hoc Network" was adopted by IEEE 802.11 subcommittee. Ad hoc network is a self-organized network and is a spontaneously mannered decentralized multi-hop wireless network and have many potential application in real life [1]. In Ad Hoc wireless networks each node forwards data to other nodes willingly. Each node communicates through wireless transmission of limited range in this kind of network, sometimes requiring the use of intermediate nodes to reach a destination. Usually the nodes are limited in power supply and bandwidth. Thus it complicates the system's mobility Ad hoc networks inherently have snags for instance, inappropriate boundary coverage demarcation, unpredictable time in-varying asymmetric channel, lossy link etc. like the other wireless communication networks have. With all these snags the issues like dynamic change in topology, multi hop network, location awareness, node state of agreement [2], [3], [4] and channel vulnerability were also there. So that wireless protocols simple in nature might not be a better choice for adaptation in Ad hoc networks without customization.

1.1 Example of Ad Hoc Routing protocols

Many researchers have been presented number of Ad Hoc routing protocols like LAR [5], DSR [6], AODV [7], DBF [8], GPSR [9], DREAM [10], ZRP [11], TORA [12] and a lot more.

The protocols like LAR [5], GPSR [9] and DREAM [10] assumes the nodes are provided GPS hardware and their location is known to them while some protocols like DSR [6], AODV [7], ZRP [11] and TORA [12] do not assumes this. The protocols that do not use GPS employ flooding with certain techniques of optimization.

2. What is routing?

The process of path selection and directing packets from a network source node to the destination node is called Routing and is an active area of research in ad hoc networks.

In a network source node sends packet to its neighboring node(s). This packet is further passed on to the node(s) closer to the destination node(s) [13]. This procedure is called forwarding and continues until the packet reaches to the destination. There may exist one-to-many or many-to-one or many-to-many relationship between source and

destination nodes. Due to which routing may follow static or dynamic path as well as it may be Unipath or Multipath depending on the designed algorithm and required scenario.

A routing algorithm determines the most appropriate path between the source and destination nodes. In their delivery semantics, routing schemes may differ that are defined as under [Figure 1]:

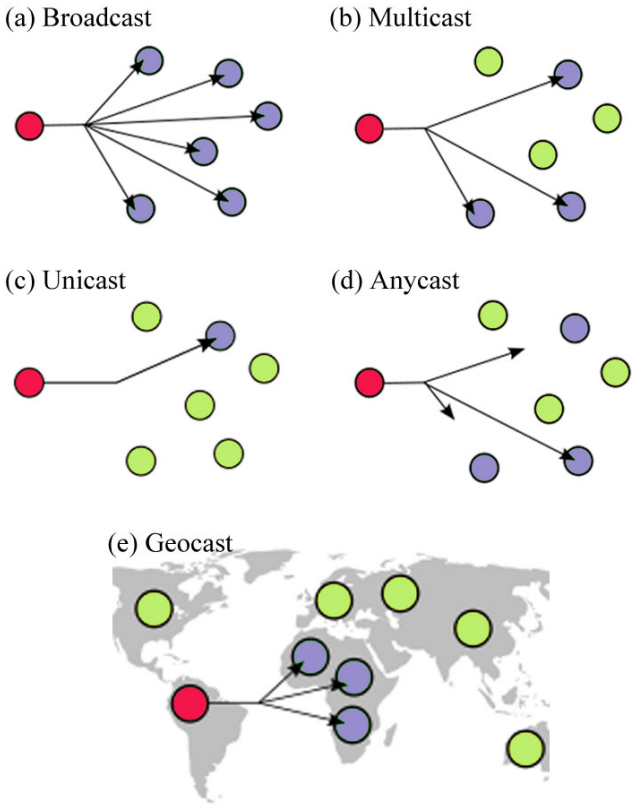

Fig. 1 Routing Schemes for Wireless Ad Hoc Network

2.1 Broadcast

Transmit the packet(s) to all nodes simultaneously [Figure 1(a)].

2.2 Multicast

Transmit the packet(s) to a specified group of interested nodes [Figure 1(b)].

2.3 Unicast

Transmit the packet(s) to a single specified node [Figure 1(c)].

2.4 Anycast

Transmit the packet(s) to any one nearest to the source out of a group of nodes [Figure 1(d)].

2.5 Geocast

Transmit the packet(s) to a group of destination in geographical locations [Figure 1(e)]

3. Flooding Routing Techniques

There exists a saturated container of routing algorithms but it still seems to "ask for more" to satisfy the requirements of a lot of hungry applications. The simplest one is to flood the network by sending an incoming packet to all the neighbors. As long as there does not exist deep network partitioning, the packet is sure to reach the destination.

Many ad hoc routing protocols use some kind of flooding technique to route the packets over the network. Royer et al. [14] classifies the routing protocols as:

3.1 Proactive Routing Protocol

It ensures maintaining the updated routing information and instantly provides the same on need. It is also called as Table-Driven Routing Protocols and is preferable in static network topology. Proactive routing protocol is used in DSDV [15] and OLSR [16].

3.2 Reactive Routing Protocol

It does not maintain updated routing table all the time but the routes are computed on demand. It is also called as On-Demand Routing Protocols. It is preferable in the scenario of frequently changing network topology. Reactive routing protocol is used in, DSR [6], AODV [7] and TORA [12].

This classification is of the time when the Wireless Ad Hoc Network Technology was at its infant stage and was not self-sufficient in the field of protocols.

With flooding every node in the network receives a message and retransmits that message exactly one. In ad hoc networks flooding has several helpful properties such as maximal coverage, distance preservation and redundancy. The refined flooding technique is to sending only the newly received packet and is called as controlled flooding.

A close counterpart of flooding technique is Gossip. Gossip [17] is a probabilistic retransmission algorithm. Gossip is same as flooding but with important distinction. The main objective of gossip protocol is to minimize the number of retransmissions, while maintaining the main benefits of flooding [18]. In gossip, when first time a node receives a packet, it starts a probabilistic process on that received packet to determine whether or not to retransmit. Essentially, gossip protocol retransmits a packet with some probability.

A generic gossip protocol is given as under:

For every node u do

If *u has a rumor* then

v ← Choice (); /* Choice of the receiver V

Send (*v*); /* "PUSH" the rumor to V

Gossip routing states the forwarding of packets to an arbitrary node on the basis of some calculated probability. Thus here the overhead is reduced as compared to flooding with improved performance [19], [20]. The packet randomly traverses the network in the hope of ultimately finding the destination. This technique is also termed as random walk routing. Bimodal behavior which is a well-known concept in the Percolation theory is the key observation for about all the routing methods following gossiping technique [21], [22], [23].

Probabilistic nature of Gossip protocol enables a node to select its partner node randomly, with which it wants to communicate. Every node sends only a limited number of messages, regardless of the number of nodes in the network making it scalable. A node receives copies of a message from different nodes in a network due to which fault tolerance is achieved. A node does not perform a particular role. If a node fails does not disrupt others from sending messages that is why failure detection or any recovery mechanism is not required.

4. Proposed Idea

Our proposed idea is for the network where deployment of nodes is in a static fashion [Figure 2]. Every node knows about its parent node that is why flooding can be controlled resulting in adapting the gossip routing technique. How much parents a node may have but it only transmit the packet to three of its parents. Although, a node may be a parent of multiple nodes yet it follows some specific strategy to lessen the burden. On receiving data from multiple child nodes, parent node performs some specific calculation on the receiving data and transmits the resulted data to its parent node instead of transmitting data received from its child nodes. This process continues and the resulted data ultimately catches the destination.

The optimal parent selection criterion is that the node which has maximum energy as well as in the coverage area is selected as a parent node in the network. More-over our proposed idea uses the proactive routing with some treatment. Routes are updated in advance but only when energy of the node touches the threshold level.

In Ad Hoc network energy of nodes is a constraint factor; therefore to efficiently manage the energy, updating is on some specific event instead of frequently updating the values. Also each node has information of more than one neighbor nodes. So at the time of failure, best alternate path can be adopted for further transmission of packet to the way of destination.

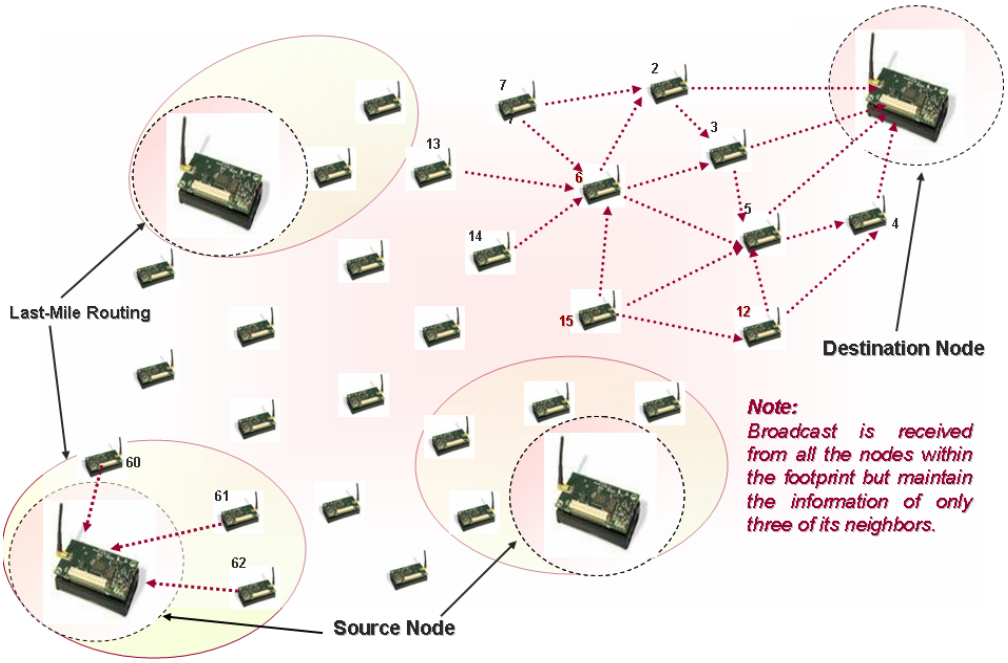

Fig. 2 A Typical Wireless Ad Hoc Sensor Network Static Deployment Scenario

5. Analytical Verification of Proposed Idea

Flooding is not only the wastage of precious resources of Ad Hoc network but also over burden the network. Gossip routing treats the above mentioned issue of flooding techniques in a most suitable manner. Our proposed idea presents the solution in a way that it only forwards the packet to the node which has maximum energy among its neighboring nodes. Moreover our idea uses the proactive routing with some treatment although proactive routing normally wastes the network energy due to its time to time updating of network table and others. However, proactive routing is preferable in static network topology while in the scenario of frequently changing network topology; reactive routing is a suitable option. But our proposed algorithm only updates the route in advance only when energy of the node touches the threshold level. This threshold level is defined each time after transmitting specific number of packet. On touching the defined threshold level, another threshold level is defined and on specific number of packets transmission counting that level is touched and network energy updating event occur. As a result another threshold level is defined. This process not only save the network energy but also reduces the burden of the network. A typical calculation for optimum forwarding node selection at node # 6 is given [Figure 3].

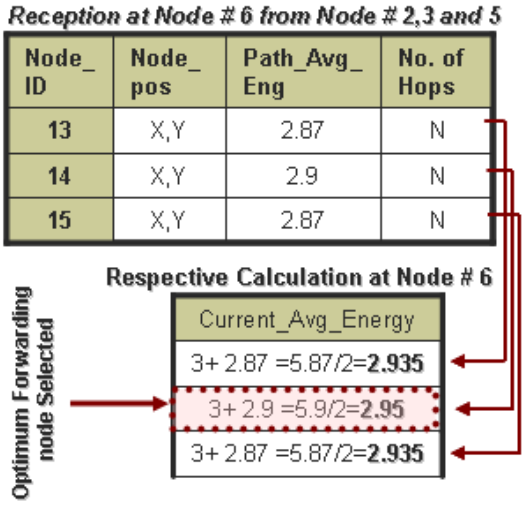

Fig. 3 Calculation for Optimum Forwarding Node

6. Conclusion

In static network topology, routing strategy based on gossip based routing following the proactive routing is a better approach. Flooding can be controlled by adapting the gossip routing technique. It saves the network energy also reduces the burden of the network.

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