SURVEY ON ROUTING TECHNIQUES FOR MANETS AND WIRELESS SENSOR NETWORKS: A COMPARISON

Poonam Thakur*, M.Vijaya Raju**

*Department of Computer Science and Engineering, Lovely Professional University, INDIA
Email: akku786@gmail.com

**Department of Computer Science and Engineering, Lovely Professional University, INDIA
Email: raju.vijay3@gmail.com

ABSTRACT

Wireless networks covers vast areas like sensors, Manets, wanets etc. Routing is a challenging issue in wireless network. A large number of different Routing techniques are used in these networks. This paper presents a review of routing protocols in two most discussed areas of wireless network: wireless sensor networks and mobile adhoc networks. A comparison on the basis of survey is also presented in the end. A few characteristics of routing protocols are also discussed. Much of the importance is given on the popular techniques like leach, spin, aodv, dsdv etc.

Keywords-- LEACH, SPIN, AODV, DSDV, ZRP.

I. INTRODUCTION

Wireless technologies are becoming quite common in our daily lives. They have been gaining popularity with the use of portable devices like laptop computers and mobile phones. Wireless networks include infrastructure-based networks and ad hoc networks. Guaranteeing delivery and the capability to handle dynamic connectivity are the most important issues for routing protocols in wireless networks. In this paper one can find routing protocols used in Manets and Wireless Sensor Networks. A wireless sensor network is a set of sensors deployed in a sensor field, to monitor specific characteristics of the environment, measure those characteristics and collect the data related to that phenomena. The design of WSN is constrained by various constraints like: battery powered sensor nodes, unreliable sensors, data redundancy, application specific, frequent topology change, sever energy, computation and storage constraints, security [7]. Mobile Ad Hoc Networks (MANETs) [1][2] can be characterized as having a dynamic, multihop, potentially rapid changing topology. MANET is
formed by a group of nodes that can transmit and receive data and also relay data among themselves [12]. The design of MANETs is also constrained by various constraints like: dynamic topology, reserved energy nodes, large networks, QoS, Limited physical security.

Therefore routing is a tough task in both of these networks.

The routing protocols in these wireless networks should be more dynamic so that they quickly respond to topological changes. No doubt WSN and Manets classify the routing protocols on the basis of their own requirements. Routing protocols can be classified as Proactive, Reactive and Hybrid, based on their mode of functioning and type of target applications. Routing protocols can be classified as Direct Communication, Flat and Clustering protocols according to the participation style of nodes. They can be classified as Hierarchical, Data Centric and location based, depending upon network structure. The routing protocols in the case of MANETs are classified as Proactive, Reactive, and Hybrid on the basis of gathering routing information. Another classification in this case is based on the roles which nodes may have in routing protocols. Another classification is evaluating topology, destination and location for routing. In this way various other classifications and different protocols under each of these classes can be found.

In this paper I intend to expose various routing protocols classified mainly on the mode of functioning in these two vast areas of wireless networks. Using this paper one can be made aware of almost all of the popular most preferred routing algorithms along with their pros and cons. Comparison between the routing algorithms is also given in the end. Characteristics of most routing protocols along with design issues in WSN are described in section II, section III describes MANETs and its routing protocols, and section IV describes WSN and its routing protocols. Section V gives a comparison between various routing protocols and finally conclusion is given in section VI.

II. ROUTING PROTOCOLS

Routing protocols for different types of wireless networks have been proposed by a number of researchers. Researchers traditionally classify these protocols as proactive protocols, reactive protocols, or hybrid of the two, based on the way they find new routes or update existing ones. Proactive routing protocols keep routes continuously updated, while reactive routing protocols react on demand. Routing protocols can also be classified as link state protocols or distance-vector protocols. Routers using a link state routing protocol maintain a full or partial copy of the network topology and costs for all known links. Routers using a distance-vector protocol keep only information about next hops to adjacent neighbors and costs for paths to all known destinations. Generally speaking, “link state routing protocols are more reliable, easier to debug and less bandwidth-intensive than distance-vector” protocols. Link state protocols are also more complex and more compute- and memory-intensive. Routing protocols can also be classified [14] as node centric, data-centric, or location-aware (geo-centric) and QoS based routing protocols. Most Ad-hoc network routing protocols are node-centric protocols where destinations are specified based on the numerical addresses (or identifiers) of nodes. In WSNs, node centric communication is not a commonly expected communication type. Therefore, routing protocols designed for WSNs are more data-centric or geocentric. In data-centric routing, the sink sends queries to certain regions and waits for data from the sensors located in the selected regions. Since data is being requested through queries, attribute based naming is necessary to specify the
properties of data. In location aware routing nodes know where they are in a geographical region. Location information can be used to improve the performance of routing and to provide new types of services. In QoS based routing protocols data delivery ratio, latency and energy consumption are mainly considered. To get a good QoS (Quality of Service), the routing protocols must possess more data delivery ratio, less latency and less energy consumption. The routing protocols for wireless networks have to work under various constraints especially for the sensor networks like [9] [12]:

Limited energy capacity: Almost all wireless nodes are battery powered, they have limited energy capacity. For example, a battlefield, where it is impossible to access the sensors and recharge their batteries. When the energy of a sensor reaches a certain threshold, the sensor will become faulty and will not be able to function properly, which will have a major impact on the network performance. Thus, routing protocols designed for wireless networks should be as energy efficient as possible to extend their lifetime.

Limited hardware resources: wireless nodes have limited processing and storage capacities, as compare to wired networks and thus can only perform limited computational functionalities. These hardware constraints present many challenges in software development and network protocol design for wireless networks.

Security: A wireless network usually operates in a dynamic and unreliable environment. Radio environments are prone to impersonation attacks. In order to ensure the behavior of the routing protocols, security measures like authentication and encryption through the distribution of keys among the nodes in the ad-hoc network is challenging.

Continuously changing topology: The topology of a network, defined by the wireless systems and the communication links between the nodes, changes frequently due to node addition, deletion, node failures, damages, or energy depletion. Also, the sensor nodes are linked by a wireless medium, which is noisy, error prone, and time varying. Therefore, routing paths should consider network topology dynamics due to limited energy and sensor mobility as well as increasing the size of the network to maintain specific application requirements in terms of coverage and connectivity.

Diverse application requirements: wireless networks have a wide range of diverse applications. No network protocol can meet the requirements of all applications. Therefore, the routing protocols should guarantee data delivery and its accuracy. These are a few things characteristics to be kept in mind while design of wireless routing protocols.

III. MANET ROUTING PROTOCOLS

Mobile Ad-hoc networks are self-organizing and self-configuring multihop wireless networks since, the structure of the network changes dynamically. This is mainly due to the mobility of the nodes. The prominent routing protocols for Manets are DSR, LSR, DSDV, GSR, FSR, WRP, AODV, TORA, ABR, ZRP a few to name [15].
A. DSDV

The destination sequenced distance vector routing protocol (DSDV) [3] is a proactive, unicast routing protocol. It is an extension of bellman ford routing scheme with few improvements. Routing information is stored inside routing tables of each node. Each routing table consists of, the address of the destination, the number of hops to reach destination, the sequence number of the destination and a new sequence number unique to broadcast. Sequence numbers are used in DSDV to distinguish stale routes from fresh ones. The route updates of DSDV can be either time-driven or event-driven. Every node periodically transmits updates including its routing information to its immediate neighbors. While a significant change occurs from the last update, a node can transmit its changed routing table in an event-triggered style. Moreover, the DSDV has two ways when sending routing table updates. One is "full dump" update type and the other is incremental update. In this way DSDV maintains a consistent network.

Pros and cons of DSDV

With the use of incremental update only changed table entries are transmitted over the network. It is an improvement over the earlier protocols, since less bandwidth is used. DSDV has high degree of complexity especially during link addition and deletion [1]. It works on bidirectional links which can lead to routing loops. The main weakness of DSDV is increased size of routing table and bandwidth required if the number of nodes is large. Security is also not good in this protocol. Fluctuation problem is also found in it.

B. AODV

Ad Hoc On-demand Distance Vector Routing protocol [4] is a reactive unicast/multicast routing protocol. It is a combination of DSR and DSDV. When a source node wants to send packets to the destination but no route is available, it broadcasts route request (RREQ) packets. A RREQ includes addresses of the source and the destination, the broadcast ID, which is used as its identifier, the last seen sequence number of the destination and source node’s sequence number. Sequence numbers ensures loop-free and up-to-date routes. A node discards RREQs that it has seen before and the expanding ring search algorithm is used in route discovery operation. The RREQ starts with a small TTL (Time-To-Live) value. If the destination is not found, the TTL is increased in following RREQs. Nodes receiving RREQ update their information and set-up backward pointers to the source node. When the source node receives the RREP it begins to forward data packets to the destination.

Pros and cons of AODV

Loop free structure. It provides quick convergence when the adhoc network topology changes. Quick response to link breakages in active routes is provided. It avoids Bellman-Ford “count to infinity” problem [4]. Use of periodic “hello message” causes network overhead. Poor scalability. Cannot utilize nodes with asymmetric links. The prior route discovery may degrade the performance. High network traffic due to query messages flooded over the network. AODV is unsuitable for real life applications due to additional latency and overhead penalty [1].

C. ZRP

Zone Routing Protocol (ZRP) is hybrid routing protocol combining proactive and reactive routing approaches. The network is divided into routing zones according to distances between mobile nodes. Given a hop distance d and a node N, all nodes within hop distance at
most d from N belong to the routing zone of N. ZRP consists of two sub-protocols, one is proactive approach used for routing inside a particular zone known as Intrazone Routing Protocol (IARP) and the another is a reactive approach used for routing between different zones i.e. Interzone Routing Protocol (IERP) [5]. Most of the existing proactive routing schemes can be used as the IARP. The IERP is responsible for finding global path. It uses the route query (RREQ), route reply (RREP) packets to discover a route.

Pros and Cons of ZRP

It reduces the control overhead of proactive approach and decrease the latency caused by route search operation in reactive approaches. The routing zone based broadcast efficiently guide route queries, rather than blind relay queries. The size and dynamics of the zone greatly affects the performance of ZRP. As the size increases ZRP could create unpredictable large overhead. It has high memory requirement since each node has high level topological information stored. ZRP does not provide an overall optimized shortest path if the destination has to be found through IERP.

IV. WIRELESS SENSOR NETWORK ROUTING PROTOCOLS

A WSN typically consists of a large number of low-cost, low-power, and multifunctional wireless sensor nodes, with sensing, wireless communications and computation capabilities [7]. 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. The WSN has a number of applications such as battlefield surveillance, industrial process monitoring and control etc which puts various constraints on it like energy efficiency, scalability autonomy etc. These constraints also effects the routing protocols designed for WSN. The popular routing protocols for WSN are SPIN, LEACH, TEEN, SAR, COUGAR, and GEAR etc [8].

A. LEACH

(Low Energy Adaptive Clustering Hierarchy) is designed for sensor networks where an end-user wants to remotely monitor the environment. It is a hierarchical routing algorithm [7]. Clusters of sensor nodes are made based on the received signal strength. Cluster heads are used as routers to the sink and all the transmissions are done by them. Optimal number of cluster heads is 5% of the total number of clusters. LEACH uses an aggregation technique that carries only meaningful data to the individual sensors. LEACH performs local processing reducing global communication. There is also randomized rotation of cluster-heads based on duration.

Pros and cons of LEACH

Redundancy is removed by the use of data aggregation. Energy efficient protocol reduces energy consumption [11]. LEACH improves system lifetime. Localized coordination and control reduces the amount of data transmitted to the sink and also makes routing more scalable and robust. The rotation of CH provides each node a chance to act as CH which avoids the battery depletion of individual sensor and its failure. LEACH achieves over a factor of 7 reduction in energy dissipation compared to direct communication and a factor of 4-8 compared to the minimum transmission energy routing protocol [you]. Its disadvantage is it uses single-hop routing which prevents it usage large networks. Dynamic clustering causes extra overhead like head changes, advertisements etc. LEACH does not guarantee good CH distribution.
B. SPIN
A family of adaptive protocols is called SPIN (Sensor Protocols for Information via Negotiation) [6]. It is a data centric routing mechanism. In this metadata (high-level data descriptions) is transmitted between the nodes. SPIN has three types of messages: ADV, REQ, and DATA. ADV message to allow a sensor to advertise a particular meta-data, REQ message to request the specific data and DATA message that carry the actual data. Four specific SPIN protocols are available: SPIN-1 (SPIN-PP and SPIN-EC), which are optimized for a point-to-point network, and SPIN-2 (SPIN-BC and SPIN-RL), which are optimized for a broadcast network [9].

Pros and Cons of SPIN
One of the advantages of SPIN is that topological changes are localized since each node needs to know only its single-hop neighbors. SPIN gives a factor of 3.5 less than flooding in terms of energy dissipation and meta-data negotiation almost halves the redundant data. The use of metadata allows data to be in application-specific format and requires less bytes. SPIN protocols can deliver 60% more data for a given amount of energy and 80% more data for a given amount of energy in a broadcast network. In terms of dissemination rate and energy usage, the SPIN protocols perform close to the theoretical optimum in both point-to-point and broadcast networks. One of the major advantages of these protocols is that nodes are only required to know its 1-hop neighborhood. The disadvantage of SPIN is it does not provide QoS and has limited scalability.

C. SPEED
It is a QoS routing protocol that provides soft end-to-end guarantees. It requires each node to maintain information about its neighbors and uses geographic forwarding to find the paths. SPEED strive to ensure a certain speed for each packet in the network so that each application can estimate the end-to-end delay for the packets by dividing the distance to the sink by the speed of the packet before making the admission decision. SPEED uses Stateless Geographic Non-Deterministic forwarding (SNFG) routing module and works with four other modules at network layer.

Pros and cons of SPEED
SPEED can provide congestion avoidance when the network is congested. SPEED performs better in terms of end-to-end delay and miss ratio [10]. The total transmission energy is less due to the simplicity of the routing algorithm, i.e. control packet overhead is less, and to the even traffic distribution. Such load balancing is achieved through the SNFG mechanism of dispersing packets into a large relay area [7]. SPEED does not consider any further energy metric in its routing protocol. It is not much energy efficient protocol.

IV. COMPARISON
MANETs (Mobile Ad-hoc Networks) and sensor networks are two classes of the wireless Adhoc networks with resource constraints. Differences:

1) MANETs typically consist of devices that have high capabilities, mobile and operate in coalitions. Sensor
2) Networks are typically deployed in specific geographical regions for tracking, monitoring and sensing.
3) MANETs are based on point-to-point communication as compared to WSNs which use broadcast communication.
4) Sensor nodes are much cheaper than nodes in a MANETs.
5) Sensors are deployed once in their lifetime, while nodes in MANETs move really in an Ad-hoc manner. There are few more differences in these two wireless networks.

Similarities: Both these wireless networks are characterized by their ad hoc nature that lack pre deployed infrastructure for computing and communication. Both shares some characteristics like network topology are not fixed, power is an expensive resource and nodes in the network are connected to each other by wireless communication links. Only a few protocols are compared here on basis of some criteria defined in the table shown below [8].

V. CONCLUSION AND FUTURE ENHANCEMENT

All the protocols discussed above are the prominently used ones. It has been made clear that in each of its own fields WSN and MANETs have successful protocols like AODV, DSR etc for MANETs and LEACH, SPIN, TEEN etc for WSN. No doubt there are a number of routing protocols which lack practical implementation and therefore lack much importance and research, due to various constraints on the wireless networks. It is an open area for future research, including options like using protocols of WSN in MANETs and vice versa successfully. The comparison has made it clear that only few protocols rule the routing world and much of them are still to explore.

REFERENCES


BIOGRAPHY

POONAM THAKUR

Educational background
- Bachelor of Engineering in Computer Science and Engineering, Sant Longowal Institute of Engineering and Technology, Sangrur, Punjab, India, 2011.
- Pursuing M tech in Computer Science and Engineering, Lovely Professional University, Punjab, India.

M.VIJAYA RAJU

Educational background
- Bachelor of Engineering in Computer Science and Engineering, Malviya National Institute of Technology, Jaipur.
- M tech in Computer Science and Engineering, Malviya National Institute of Technology, Jaipur.