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23 – 27

A Comparative Study on Routing schemes for Wireless Network

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***Abstract*—** Ubiquitous smart devices with embedded sensors are paving the way for mobile ad hoc networks (ad-hoc network) that enable users to communicate directly, thereby playing a key role in Smart City and Internet of Things applications. In such smart environments, people with smart devices (nodes) can freely self-organize and form self-configuring ad-hoc network to send and forward data packets to a destination over multiple hops via intermediate nodes. Wireless Networks includes a larger advantage in today's communication application like environmental, traffic, military, and health observation. To realize these applications it's necessary to possess a reliable routing protocol. The main motivation of this paper is to review various routing schemes in ad-hoc network that have recently been proposed to enhance throughput when transmitting and receiving packets during active communication. The review covers various state-of-the-art protocols for each category and highlights their operation concepts, design challenges and key features. In addition, the performance evaluation metrics are also discussed.

***Keywords*—** *ADHOC network; Routing protocols; Throughput; Bandwidth Aware.*

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I. INTRODUCTION

A wireless ad-hoc network is a collection of mobile/semi-mobile nodes with no pre-established infrastructure, forming a network, in which nodes communicate with each other via radio or infrared. PC or laptops directly communicates with each other. Generally, in ad-hoc network, nodes are mobile but also consists of stationary nodes [1]. Figure 1.1 shows simple ad-hoc network.

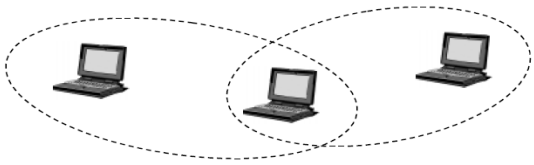

Figure 1.1 AD-HOC network with three nodes

An ad-hoc network has no centralized administration. This is to be sure that the network won't collapse just because one of the mobile nodes moves out of the transmission range of the nodes; multiple hops are needed to reach other nodes. Every node acts as a host or a router [2].

Today wireless networks are used daily by countless individuals. We tend to use this technology for wireless internet access with our laptop, for knowledge transfer between phones, and even to play multiplayer games with portable game consoles. However, hardly any of those wireless networks operate in ad hoc mode. These types of networks have several benefits over wired networks: ad hoc networks don't need infrastructure, they'll be deployed instantly and that they are extremely versatile. An ad-hoc network will increase each the range and also the entire coverage space of the network.

The situations during which this kind of networks are often used are varied, and also the application areas range from internet access to video streaming to measure conferencing up to disaster recovery. There are completely different technologies and protocols available that are appropriate for the utilization in ad-hoc networks. Notably compatible is that the IEEE 802.11 customary that meets all needs for a use in Ad-hoc mode. Today's Wi-Fi standards have a adequate transmission vary and a high rate. Future Wi-Fi standards can come through data rates, that have not been attainable previously.

However even older standards like Bluetooth have ad hoc capabilities that may be helpful for wireless data exchange. On the other hand, a transmission of information over a wireless medium involves adverse effects like noise, attenuation and interference that the nodes need to take care of. These effects reduce the effective bandwidth compared to a wired network association. There's a better overhead as a result of bigger headers, Interframe area times and collision treatment. The overhead is constant to extend, as soon as knowledge is transmitted on multiple hops in an ad-hoc network.

The recent evolution of ad hoc wireless technologies has allowed mobile ad hoc networks (MANET) to construct spontaneous connections among mobile devices with none infrastructure [1, 2]. Moreover, with the emergence of sensor-enabled smart mobile devices, ad-hoc network became a vital part within the infrastructure of smart city and internet of Things (IoT) situations as a result of individuals with smart devices will freely and dynamically kind a self-configuring ad-hoc network to send, receive and share data in an exceedingly restricted zone (as shown in figure 1.2) [3]. In an exceedingly such a smart environment, ad-hoc network, Wireless sensor Networks (WSNs) and Wireless Mesh Networks (WMNs)

 ISSN: 2454-4248
23 – 27

represent key technologies providing many IoT applications and services to users. moreover ad-hoc network have found a range of applications in health care, battlefield communications, disaster recovery, crisis management services education organizations, ad hoc cooperative computing, social activities and conference halls.

Despite the attractive applications of ad-hoc network, these systems still face several challenges and constraints that need more investigation before the widespread commercial deployment of ad-hoc network. The most constraints that may have an effect on ad-hoc network design are as follows: (1) the limited energy and lifetime of the battery, quality of service (QoS),infrastructure-less and autonomous configuration, dynamic network topologies, the mobility of nodes, wireless link reliability, variation in node capabilities, multi-hop routing scalability, multicast support and security threats [4]. Therefore, routing protocol plays a major role in such networks, and there remains ought to consider the on top of constraints of ad-hoc network within the development of latest routing protocols to modify the efficient forwarding of packets over a wireless medium, primarily once the source and destination are non-neighboring nodes. The routing protocol should choose the best route between pairs of source–destination nodes in terms of energy consumption and QoS metrics like available link bandwidth, average end-to-end delay, packet losses and average noise.

Section II discusses about Problem Statement of current research area. Section III provides an overview of related research. Section IV describes about Energy Consumption Model and metrics used in ad-hoc network. Section V discusses about conclusions and emerging trends and future directions.

II. PROBLEM STATEMENT

There are many ways in which protocols are beneficial to the application [5], we use the following metrics:

Node Deployment: The node deployment attribute of key design issues indicates the style of node placement on the sensor network environment.

Energy Consumption: Energy consumption represents the performance of network lifetime.

Data Delivery Model: Data reporting model indicates the time criticality of the data routing.

Fault tolerance: Fault tolerance attribute shows the ability of sensor nodes to retain their functionalities without interruption from single or multiple failures of sensor nodes and perform quick recovery after node changes.

Scalability: Scalability reflects the ability of the network to work well as it grows large.

Data Aggregation: The data aggregation attribute reduces the number of transmission at one time by using functions such as suppression, min, max, and avg.

Quality of Service: Quality of Service represents the metrics required for a sensor node to be fulfilled for maximizing the network performance.

Security: Security attribute is another parameter which is imperative in routing protocol to perform security performance against network attacks.

III. RELATED WORK

Recently, researchers have expended substantial effort in developing wireless network routing protocols based on network architecture and application requirements. However, such research has not considered energy-awareness metrics simultaneously with QoS metrics when developing routing schemes for WSN. Many literature surveys have been conducted on routing protocols with respect to wireless networks. A study by [6] investigated routing protocols proposed for use in ad hoc networks by providing a description of the operation of each protocol and comparing their various characteristics. The authors of [7] discussed certain issues relevant to scalability and energy efficiency of geographically based routing protocols. Multicast-based routing protocols in ad-hoc network and their associated energy efficiency and security issues were examined by [7].

In [8] author reviewed various routing schemes in ad-hoc network that have recently been proposed to enhance throughput when transmitting and receiving packets during active communication. The review also focuses on the design of SIC routing protocol aiming at achieving high overall throughput compared to that of the hop count routing. In addition, the performance evaluation metrics are also discussed.

An investigation of power-aware source routing, similar to the lifetime prediction routing protocols for ad-hoc network was conducted with the goal of maximizing the lifetime of the network. Selected reactive and hybrid routing algorithms were also introduced by [9] together with their operating principles. The routing algorithms proposed for wireless sensor network and mesh networks were introduced and extensively surveyed [10].

Figure 2 illustrates the routing protocol classifications. This classification, in particular, is important due to the different network architectures that are well-suited to various kinds of applications for performing routing tasks. Major classification is based on three aspects: (i) mode of function, (ii) participation styles of nodes, and (iii) network structure. Any routing protocol must consider each aspect in its design phase at least for once.

With the mode of function, the ad-hoc network routing protocol can be designed in three different ways. The first two options are proactive and reactive, whereas another option is a hybrid mode. The hybrid option is considered in this study since some protocols performed a combination of both of

 ISSN: 2454-4248
23 – 27

proactive and reactive modes in their routing mechanism in order to meet the requirements of WSNs application purposed.

According to the participation styles of nodes, a protocol could be direct, flat, and clustering-based. Similarly, according to the underlying network, four types: data-centric, hierarchical, location based, and QoS (Quality of Service) aware routing[11].

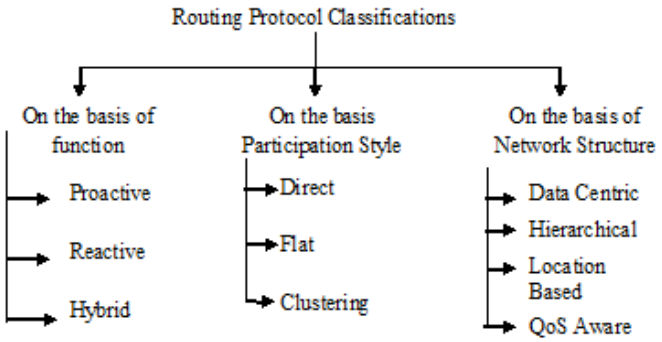

Figure 2: Classification of routing protocol

A. Routing protocols based on functions

Proactive A routing table is generated at each node, so that routing information is kept for every node in the network. Routing information is periodically updated [12].

Reactive No routing table is generated and route discovery is done as needed or on an on-demand basis. The route information is kept for future reference [12].

Hybrid Combines the characteristics of proactive and reactive routing. Furthermore, hybrid routing protocol is powerful in reducing the cost of the network. It first computes all routes and then improves the routes at the time of routing [13].

B. Routing protocols based on participation style of nodes

Direct Allows nodes to send information directly to base station/s[14].

Flat If any node needs to send data, primarily it will find a valid route to the base station and then forward it [15].

Clustering The whole area is divided into a number of small clusters then each cluster will have a cluster head (CH) and only this cluster head will directly communicate with the base station [16].

C. Routing protocols based on network structure

Data-Centric Data-centric protocols are query based and they depend on the naming or tag of the desired data, thus they are responsible for eliminating redundant transmissions.

Hierarchical Used to perform energy-efficient routing where the higher energy nodes can be used to process and send the information while the low-energy nodes are used in sensing to the area of interest[13].

Location-based Requires the location information of the sensor nodes. Generally, location information can be accessed from the GPS (Global Positioning System) signals or received radio signal strength[14].

QoS aware QoS aware routing focuses on several network layer requirements in routing operation such as latency and reliability[15].

D. Non-cluster based routing protocol

The non-cluster based protocols uses flooding mechanism to learn about their neighbors. These protocols do not structure the physical network into virtual groups [16]. Different Non-Cluster based routing protocols are discussed in Table I.

Table I. Non-Cluster Based Routing Protocols

Routing Technique	Merits	Demerits
PARP	It employs transmitter power control. It is multicast routing protocol.	It does not address packet delay properly. Heavy traffic load. High overhead for updating routing table.
SSRP	It is a reactive protocol. The physical network and virtual ring are constructed using distance metric.	It does not always produce shortest path. It does not address packet delay properly.
PCRP	It is a power aware mechanism. It forwards the packet in a stateless Manner.	It creates hidden terminal problem.

E. Cluster based routing protocol

The cluster based protocols virtually divide the nodes into groups using their physical properties. The key idea of these protocols is to exploit the capabilities of actors to reduce the overhead on the sensors [16,17]. Different Cluster based routing protocols are discussed in Table II.

Table II. Cluster Based Routing Protocols

Routing Technique	Merits	Demerits
HEERP	It is an energy efficient Protocol. It performs well in the dense network.	It does not address properly the real time requirements of WSAN
HGCP	It uses virtual grids. Actor acts as a cluster head.	It assumed that both the sensors and actors are static. Delay parameter not discussed properly
LEACH	Dynamic cluster head selection	Fixed number of clusters and random cluster head selection.
HEED	Dynamic cluster head selection	Fixed number of clusters and inefficient processing

 ISSN: 2454-4248
23 – 27

		time.
QARP	It uses packet prioritization scheme.	It assumes that both the sensors and actors are static. Actor nodes are not used properly.

F. Hop Count Routing Algorithm

The Hop Count Routing algorithmic rule will be discovered by using Flooding or Broadcasting.

G. Bandwidth Aware Routing

The bandwidth aware routing algorithmic rule initial finds the one hop neighbors then every of the node acts sort of a supply node. When finding the neighbor sets the node that has lowest bandwidth node is chosen. This method is continual till threshold time expires or till destination is reached. Some of bandwidth aware routing protocol [18-22] are discussed in Table III.

Table III. Comparative analysis of bandwidth aware protocols

Routing Technique	Description
PAC	Passive channel monitoring with low threshold value. Discover fresh routes.
CACP	Three methods are proposed: passive channel monitoring, querying explicitly and use of higher powered transmission. Data flows are unable to get their requested bandwidth.
Q- AODV	Using Periodic HELLO packet dissemination. Update bandwidth using forced HELLO.
B- AODV	Not application as channel is divided in timeslots. Exchange local information of timeslot allocation with its neighbors.

IV. PERFORMANCE EVALUATION METRICS

A. Average communication energy per node

It is the average of total energy spent caused by communication in the network over a particular time period, with respect to a specific data rate. If E_C is the total energy expenditure caused by communication and N is the total number of nodes in the system then E_C/N (i.e., communication energy per node) is the average communication energy [17].

B. Throughput

It is ratio between the actual numbers of packets transmitted by the nodes in the network system to the numbers of successfully delivered packets at the base station. It reflects the percentage of packets loss. A secure routing protocol with higher throughput is desirable [17].

C. *Average of total energy consumed per node*

Energy expenditure in a node is caused by different factors such as transmission of packets, reception of packets, computing, sensing, idle listening etc. This parameter defines the average energy spent by each node in the network system. If E_T is the total energy expenditure in a network system of N nodes then E_T/N (i.e., total energy per node) is the Average of total energy consumed per node. A secure routing protocol with low average of total energy consumed per node is desirable.

D. End-to end delay

The total sum of transferred packet from source to sink node.

E. Overhead

It is the ratio between the RTR packets to the total received packet.

V. CONCLUSION

In this paper we have compared bandwidth aware routing protocols with various unique features that incorporate QoS metrics in route finding. We focused on various techniques for estimating the available bandwidth. A new concept of successive inference cancellation is also discussed by which we can design high throughput routing algorithm for efficient data transmission over the adhoc network. In this paper, we have proposed a set of performance metrics in evaluating network performance. Consequently, further investigation on developing a routing scheme that can extend the network lifetime, reduce energy consumption, bandwidth aware and ensure network connectivity while simultaneously improve the QoS remains in high demand.

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