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A Study on Bandwidth-Aware Routing Protocol based on SIC

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***Abstract*— Wireless Sensor Networks has a greater advantage in today's communication application such as environmental, traffic, military, health monitoring. 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. To achieve these applications it is necessary to have 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 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.**

***Keywords*— ADHOC network, Routing protocols, Throughput, Bandwidth Aware, SIC.**

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].

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 [3]. In an exceedingly such a smart environment, ad-hoc network, Wireless sensor Networks (WSNs) and Wireless Mesh Networks (WMNs) represent key technologies providing many IoT applications and services to users. moreover ad-hoc network have found a range of applications.

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:

i. The limited energy and lifetime of the battery
ii. Quality of service (QoS),
iii. Infrastructure-less and autonomous configuration
iv. Dynamic network topologies
v. The mobility of nodes
vi. Wireless link reliability
vii. Variation in node capabilities
viii. Multi-hop routing scalability
ix. 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 [5]. 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.

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

II. MULTIHOP ROUTING PROTOCOLS IN MANET

Mobile ad hoc networks (MANETs) have received much attention lately because mobile nodes in such networks can communicate with each other without any infrastructure or base stations. Therefore, a MANET can be established quickly anytime and anywhere for use, such as in battle zones, secluded areas, or any other hard to reach places. However, in such networks, how to transmit data is important. Because, the radio is inherently a broadcast medium, traffics carried by wireless links may be interfered with one another [6]. The available bandwidth of a wireless link depends not only on the traffics carried by its neighboring links, but also on how well transmissions on its neighboring links are scheduled.

In multihop wireless networks there are one or additional intermediate nodes on the trail that receive and ahead packet via wireless links [1]. Multihop wireless networks have many benefits: Compared to networks with. In case of dense multihop networks many methods may become accessible which will be wont to increase strength of the network single wireless links, multihop wireless networks will extend the coverage of a network and improve property. Moreover, transmission over multiple "short" links might require less transmission power and energy than over "long" links. Furthermore, they permit advanced information rates ensuing in higher output and additional economical use of the wireless medium. Multihop wireless networks keep away from extensive readying of cables and will be deployed in a very cost efficient methods. Different multihop routing protocols are discussed below:

DSDV: It is a Destination Sequenced Distance Vector protocol, it comes under proactive category. This protocol is based on Bell-Man-Ford routing algorithm. In DSDV protocol each node maintain routing table which contains information of all possible destination node in network, each node entry has specific sequence number, if any new node is joined to network recently then that node has highest sequence number, also when any node left the network then this information is broadcast by transmitting packets to all node in network so that they can update their routing table, so the changes in routing table are extremely dynamic [7].

AODV: It is Ad-hoc on Demand Distance Vector Routing protocol it comes under reactive protocol and based on distance vector algorithm. This algorithm uses different messages to discover and maintain links among nodes, means whenever any node want to communicate or send data packets to other specific node then it first find out all possible routes, it send route request to all neighbor route and all node will reply with specific message to source node. When any node send route request (RREQ) to all other nodes, the sender node will maintain all acknowledged messages from other requested nodes which helps to find route for the destination node as well as it indicate that all nodes are alive. If any other node not giving acknowledgment to the sender's request (request response: RREP) then sender node will remove that link as well as entry of that node from routing table [8].

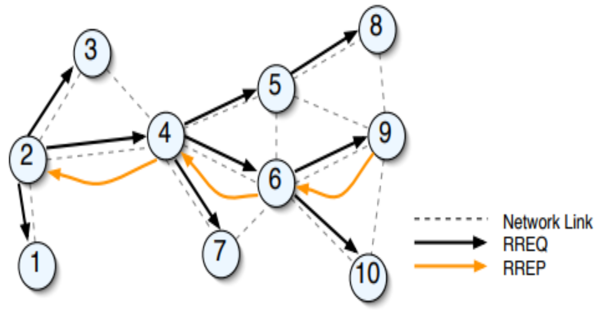

Figure 1: AODV Routing Protocol

DSR: It is Dynamic Source Routing protocol, it comes under reactive protocol. DSR protocol helps to discover desired destination root dynamically among the available roots. In DSR protocol when node sends root request (packet), then this packet stores all paths through which it has travelled to reach to the destination node [9]. This concept reduce the periodic routing of messages which helps to reduce network bandwidth overhead, conserve battery power also avoid large routing updates through Ad-hoc networks.

When node S needs to send a packet to node D, however doesn't understand a route to D, node S initiates a route discovery as follows:

- Source node S floods Route Request (RREQ)
- Each RREQ, has sender's address, destination's address, and a unique Request ID determined by the sender
- Each node appends own identifier when forwarding RREQ
- After receiving the RREQ Destination node D send the reply message i.e. Route Reply (RREP), on the same route through which RREQ had arrived.

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 [6-10] are discussed in Table I.

Table I. 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.

III. ROUTING METRICS

A routing metric may be a unit calculated by a routing algorithm for choosing or rejecting a routing path for transferring data/traffic. A routing metric is calculated by routing algorithms once deciding the best route for causing network traffic. Metrics are assigned to every totally different route offered within the routing table and are calculated victimization many various techniques and ways supported the routing algorithms in use [11-12]. A number of the parameters used for scheming a routing metric are as follows:

- Hop count
- Path responsibility
- Path speed
- Load
- Bandwidth
- Latency
- Maximum transmission unit

IV. SUCCESSIVE INFERENCE CANCELLATION

Successive interference cancellation (SIC) may be a well-known physical layer technique [13]. Briefly, sic is that the ability of a receiver to receive 2 or more signals at the same time (that otherwise cause a collision in today's systems). attack is feasible as a result of the receiver could also be able to decode the stronger signal, deduct it from the combined signal, and extract the weaker one from the residue.

Our key observations could also be summarized as follows:

In the case of distinct receivers (T1→R1 and T2→R2), the gains from sic are marginal.

In the case of common receivers (T1→R1←T2), sic could provide modest MAC layer throughput gains if transmitters are rigorously coordinated with techniques like transmitter pairing and power reduction. However, somewhat counter-intuitively, the throughput gain is maximized once the system is forced to operate below the physical (PHY) layer capability.

We notice that these behaviors hold even below numerous real-world network architectures (e.g., enterprise WLANs, wherever multiple APs are connected via a wired backbone).

$$SIC = \frac{P(tx)d^{-\alpha}(i,j)}{\sum_{k=1}^{N} P(tx)d^{-\alpha}(i,j) + \sigma^2}$$

Where, $P(tx)$ = Transmission Power

$d^{-\alpha}(i,j)$ = Distance between node i and j

σ = Power level of noise

α = Path loss components

Successive interference cancellation (SIC) is a physical layer capability that allows a receiver to decode packets that arrive simultaneously. While the technique is well known in communications literature, emerging software radios are making practical experimentation feasible [14]. This motivates us to study the extent of throughput gains possible with SIC.

In the previous approaches all the possible paths for about the neighbor set levels are discovered by using the process of flooding and forwarding. For each of the possible paths the routing metrics especially end to end delay is computed which is directly proportional to bandwidth [15]. Finally the path which has the lowest number of hops is chosen to send the packets.

The advantages of previous technique are: The route that is used for sending the packets has the low End to End Delay there by reducing the amount of time required for delivery of packets.

The disadvantages of the previous technique are: Complexity is very high because of discovery of huge number of routes and also for each of the routes lot of control packets are wasted. The energy consumed is very high due to fact that the energy required for transmission and Euclidean distance are directly proportional to energy consumed hence as the number of links are high the energy consumed is high.

Researcher in [13] proposed a design of bandwidth-aware routing protocol with SIC, aiming at achieving high overall end-to-end throughput. We develop an SICable condition for a routing protocol to identify beneficial SIC opportunities that improve spatial reuse without impacting transmission quality. To further explore the benefits of SIC, we formulate the problem of SIC-aware path bandwidth computation as a linear program, and design a distributed heuristic algorithm with polynomial complexity. A routing metric capturing the benefit of SIC in terms of bandwidth and network resource is proposed, by which our routing protocol can choose a path satisfying the bandwidth requirement of the current flow and reserving more network resource for the subsequent ones.

Author in [14] developed a distributed routing protocol that exploits the benefit of SIC and takes interference into consideration. The main contributions are as follows. First, we introduce the concept of guard zone to show not all SIC opportunities are beneficial to the overall network throughput, and then define an SICable condition by which SAR can discover the beneficial SIC opportunities. Second, the benefits of SIC that improves the overall end-to-end throughput is captured in terms of reduction in spatial resource consumption and bandwidth efficiency improvement. Finally, an SIC aware routing metric is designed which takes into account the effects of both SIC and interference. Using this metric, our routing protocol can discover the high throughput path with less spatial resource consumption, and therefore enhance the overall network throughput.

In [15] researcher focused on the design of SIC routing protocol aiming at achieving high overall throughput compared to that of the hop count routing. A comparison of hop count routing and SIC routing is developed with respect to various parameters. The introduction of SIC improves the path bandwidth and high throughput.

V. CONCLUSION

In this paper a study on bandwidth aware routing protocols with various unique features that incorporate QoS metrics in route finding is discussed. Various techniques has been focused 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. 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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