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# OPTIMIZING OVERHEAD AND DELAY IN WIRELESS ADHOC NETWORKS USING ADAPTIVE ROUTING

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## ABSTRACT

In this paper, we propose an opportunistic adaptive distributed routing scheme where the use of control overheads and delay is limited. The enormous proliferation of mobile devices and the exploding use of high volume services using a wireless interface introduce issues like overhead and serious delay or latency problems in mobile networks. Usually in forwarding packets from sender to receiver multiple hops are employed when destination is not within immediate reach. An opportunistic adaptive distributed routing for multi hop wireless ad hoc network exploits a reinforcement learning methodology to route even in the absence of network statistics and system model which limits delay and overhead problem. A key aspect of the proposed approach is, it draws on short packet transfer delay of proactive routing protocol and less control overheads of reactive routing protocol. This scheme works considering the nodes that are one hop distance away from this the route query packets overhead and flooding time for retrieving network topology information is lowered. A backup route is intended in case of a node failure to further improve delay performance. The analysis shows the improved performance of delay and control overhead parameters in routing scheme.

**KEYWORDS:** **adaptive, opportunistic, distributed routing, ad hoc network, control overhead, flooding time, proactive routing, reactive routing.**

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# 1. INTRODUCTION

On wireless computer networks, ad-hoc approach is a method for wireless devices to directly communicate by each other. Functioning in ad-hoc mode allocates all wireless devices in range of each other to understand and communicate in peer-to-peer manner deprived of linking central access points (and those built in to broadband wireless routers).Thereby, an ad-hoc network be likely to form a small group of devices all in very close proximity to each other. Performance undertakes as the number of devices develops, and a huge ad-hoc network rapidly gets difficult to manage. Ad hoc networks mark sense when need to build a tiny, all-wireless LAN fastly in addition spend the minimum amount of money on equipment. A wireless ad hoc network is a decentralized type of wireless network. The approach is ad hoc because it does not depend on a pre-existing arrangement such as routers which are present in wired networks or access points in managed (infrastructure) wireless network. In this, each node participates in routing by forwarding data for remaining nodes; here nodes forward data is through dynamically on basis of network connectivity. In adding to the classic routing, the ad hoc network can use flooding for forwarding data. Ad hoc network usually denotes to any set of networks where all the devices have same status on a network and are free to contact with any other ad hoc network in link range. Ad hoc network often refers to an operation of IEEE 802.11 wireless networks. Routing is a process of picking best path in a network. The term routing used to mean forwarding network traffic amongst networks. Routing is performed for various kinds of networks, including telephone network (Circuit switching), electronic data network (Internet) as well as transportation networks. Distributed Routing shows the capability of a system, over which routes are featured by their destination, to adjust the path that route takes through system in response to alteration in conditions. The adaptation is planned to allow as so many routes are possible to continue valid (have destinations that can be taken) in response to change.

***The multi-hop routing***

In this, no default router available every node turns as a router and forwards each one other's packets to enable information allocation between mobile hosts. The next section will outline some of the existing literature designed for MANETs in order to position the work. Section 3 will present the research gaps. Section 4 presents in depth description of how the proposed protocol works. Section 5then presents mathematical analyses on various metrics. Section 6 gives details of the simulation results and the paper is concluded in Section 7.

## 2. LITERATURE REVIEW

The recent advances in wireless sensor networks approach have led to several new protocols specifically intended for ad hoc networks where delay responsiveness is an essential consideration. Most of the importance, has been set to the routing protocols since they force differ depending on application and network construction. In comparison to static sensor networks, there is limited work on MANETS and even less so for routing in communication applications. For this reason, in this section, the existing literature will be reviewed from a more generic MANET point of view and conclusions will be drawn as such. Essentially, in terms of existing protocols, mobile ad-hoc networks (MANETs) are the overlap between WSNs and MWSNs. Generally, WSNs only require data flow one-way from many sources to a single sink. Whereas, MANETs requires that data must be able to flow both ways between any two nodes. This additional functionality often adds overhead, which is necessary in a MANET. On the other hand WSN protocols are intended for static nodes and therefore cannot cope with the fast changing topology of MANETs. So, for the demands of emerging applications in this area, new protocols are needed. Mainly wireless routing protocols are classified based upon the mode of function, participation style of nodes, network structure. Routing protocols are hierarchical and flat while network structure is considered. The hierarchical protocols assign roles to different nodes, where as in flat protocols all nodes perform the same tasks. While considering the mode of function, it is broadly classified into proactive, reactive, hybrid protocols. If participation style of nodes is considered protocols are classified into direct, clustering. The rapidly changing topology can cause proactive protocols to flood the network with topology information so frequently that the amount of data delivered is severely reduced. Alternatively, the topology information may not be distributed often enough and a large number of packets may be lost. In Proactive routing protocol a routing table is generated at each node so that routing information across network is kept for every node and is periodically updated. The main advantage of using proactive routing protocol is that it gets shorter packet transfer delay. In Reactive routing protocol no routing table is generated and route discovery is done as needed or on an On-demand basis of the routing process made between the sender and the receiver. The route information is kept for future reference. The main advantage of using Reactive routing protocol is that it has small control overheads. The hybrid routing protocol is a mixture of proactive routing protocol and reactive routing protocol. Hence it is powerful in reducing cost of network. Hybrid routing protocol first computes all routes and then improves the routes statistics at the time of routing across the network. So, proactive MANET routing protocols, like OLSR (Optimized Link State Routing) [1] are often deemed unsuitable and Reactive protocols suffer from similar effect to proactive protocols, in that the mobility of the network may warrant the discovery of new routes frequently that the network becomes clogged up with control traffic, or the data will be lost by attempting to use an outdated route. However in low traffic scenarios this approach may still be feasible making MANET routing protocols such as DSR (Dynamic Source Routing) [2] possible. However, It is the popular AODV protocol (Ad hoc On-demand Distance Vector), is most commonly used. Even if for highly dynamic scenarios it is unable to react fast enough to the frequent topology changes[3]. An improvement on this is Ad-hoc On-demand Multipath Distance Vector (AOMDV) [4] which introduces a multipath element to the protocol. For MANETs Data Centric Braided Multipath (DCBM) [5] has been proposed. The protocol is query-driven so when the sink requires a certain piece of data a query is broadcast. The queries are flooded through the network in the same way as a route reply in AODV, such that nodes record the ID of the node from which they received the query. This allows each node to forward the data from the response of the query onwards. As it is likely that each node will receive multiple copies of the query the multipath element comes from the nodes storing the IDs of more than one node, similarly to AOMDV. DCBM reduces the overhead associated with route discovery by performing it in conjunction with data queries from the sink. Another protocol, with similarities to AODV is AODV++ [6], which is based on the same route request/reply framework, but the choice of route is made based on link reliability, node energy levels and traffic rates. In this way the protocol attempts to prolong the network lifetime whilst trying to find the quickest, most reliable path to the sink. Alternatively, Geographically Opportunistic Routing (GOR)[7] is a protocol designed for MANETs and splits the network area into grids and nodes use GPS to determine which grid they are in. GOR eliminates the need to distribute topology information as the nodes forward data to a grid that is closer to the sink rather than a node. The sink must remain static at a known location, so that each grid can be given a priority based on its distance from the sink. GOR is opportunistic in the fact that a node will transmit to a specific grid based on the nodes transmission range, if no nodes in the intended grid hear the transmission then the data is forwarded through other nodes in a closer grid. Essentially this is a proactive protocol in which a node may determine a path for its data based on its GPS coordinates and a grid system rather than the distribution of topology information. RRP (Robust cooperative Routing Protocol) [8] assumes a path has already been found and then cooperatively aids the transmission. It does this by enabling nodes that are not on the intended path, to relay overhead transmissions. This means that if a link is broken the packet can still be passed forward, making it able to handle frequent topology changes. OR–RSSI (Opportunistic Routing–Received Signal Strength Indicator) [9] uses an opportunity probability and is based on Extremely Opportunistic Routing (Ex-OR)[10]. Opportunistic protocols are particularly applicable in MWSNs as they can exploit the transient connections that are created and destroyed by the mobile nodes. Angle-based Dynamic Source Routing (ADSR)[11] uses the angle between potential forwarding neighbors and the sink to determine its next hop neighbor. This information is constructed from the sharing of location data and enables the protocol to ensure that packets are always being forwarded towards the sink. The proposed mechanism in[12] allows nodes with data to transmit, to request location information from their neighbors. The paper suggests that disseminating node position information through the use of packet transmission may cause nodes to forward data based on out-of-date information. So, by allowing location information to be retrieved on-demand, nodes will make better choices. Also, the recently proposed protocol MACRO (Mobility Adaptive Cross-layer Routing) [13], is designed specifically for MANETs. It utilizes information such as average speed and RSSI data across multiple layers. Its route discovery method is similar to that of AODV, although it reduces the amount of flooding by restricting the subset of nodes able to forward the requests. Additionally, the most reliable routes are chosen for packets, based on link quality and the mobility of nodes. Overall, in terms of reactive protocols, there is generally an initial delay caused by the discovery of routes. Though in comparison to proactive protocols, this is minimal compared to the much larger delays caused by the flooding of routing tables. The delay caused by flooding topology information is significantly higher in large mobile networks due to the higher quantity of nodes and rate of topology change, which often makes reactive protocols the preferred choice in MANETs. For these reasons simulation results in Section 6 include AODV as a representative of current network deployments. Since AODV is a reactive protocol, results for the popular proactive Adapt OR routing protocol have also been included for completeness.

### *3. RESEARCH GAPS*

The paper provides recent routing techniques for ad hoc networks and offers an algorithm for improving delay and control overheads problem. Furthermore, protocols using contemporary methods such as network flow and packet transfers exist illustrated by using reactive routing protocols and proactive routing protocols in the previous work but the improved network statistics can be obtained by using this methodology.

***The contributions of the paper are***

- Present an overview of the challenges and the requirements to build a secure routing among the nodes in the network.
- Provide taxonomy of different protocols proposed for wireless ad hoc networks and with respect to the employed key features like control overheads and delay and also propose a comparative analysis of these protocols and techniques using algorithms.
- Finally, provide a review of ongoing research initiatives in the field of performance analysis of different protocols in the proposed areas.

### *4. PROPOSED METHODOLOGY*

Here proposed a novel responsive Opportunistic based distributed routing protocol, which can be construed as an addition to the multi-hop Ad Hoc On Demand Distance Vector Routing (AODV) algorithm. An Opportunistic based distributed routing is a form of cooperative transmission (CT) in which a collection of inexpensive simple relays or forwarding nodes operate without any related coordination, but certainly route together in response to energy received from an only source or another Opportunistic based distributed routing. An Opportunistic based distributed routing transmission has the same prototypical as a multi-path signal.

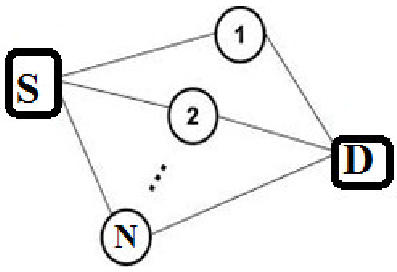


**Figure 1**
***Routing from source to destination***

In contrast, the projected routing protocol avoids the scalability problems like control overheads and delay, because no nodes are separately addressed (from the Source and Destination Nodes) and the complexity of the projected scheme is self-regulating of node density. We reflect reactive routing protocols, such as AODV and DSR, our algorithm involves mainly three phases: (1) Route Request (RREQ) broadcast by Source Route Reply (RREP) Unicast by Destination Node and (3) The Route taken by data transmission (DATA). We examine the problem of opportunistically routing packets in the wireless multi-hop network when zero or erroneous information of transmission success probabilities in addition network topology is available. Using the reinforcement learning framework, here we propose an adaptive opportunistic routing algorithm which reduces the expected average per packet cost for routing the packet from a source node to a destination. The opportunistic algorithm proposed and indirectly depends on a specific probabilistic model of wireless connections and local topology of the network. In practical situation, however, these probabilistic models need to be "learned" and "preserved". Question of estimation error and learning in an opportunistic routing situation has recently received attention. In this paper, by means of a reinforcement learning framework, we propose the distributed Adaptive Opportunistic Routing approach (d-AdaptOR) which lessens the expected average for every packet cost when zero or erroneous information of transmission success possibilities and network topology is presented. The algorithm extends our earlier centralized algorithm to permit for a practical distributed asynchronous operation with low complexity and overhead costs.

## 5. DISCUSSION MATHEMATICAL ANALYSIS

Here, we propose the problem of routing packets from source node o to destination node d in a wireless ad-hoc network consisting of d + 1 nodes denoted by a set fo; 1; 2; _ _ _ ; dg. Time is slotted and given by n_0 (this hypothesis is not technically critical and is merely assumed).The packet indexed by m _ 0 is generated at source node o at time m s permitting to an arbitrary distribution with mean > 0. If an effective transmission from node i to set of nodes S, next routing decision includes 1) retransmission through node i, 2) relaying packet by a node j 2 S, or 3) dropping packet completely. If node j is selected as the relay, then it transmits packet at the next slot, even though other nodes expunge that packet. Here, consider upon a transmission from node i, fixed transmission cost$c_i$> 0 is acquired. The transmission cost can be considered to ideal the amount of energy used for transmission, expected time to transfer a given packet, or hop count when the cost is equivalent to unity. We assume termination event for packet m to be event that packet m is either established by the destination or is released by a relay before reaching its destination. We define termination period to be a random variable once packet m is terminated. We describe upon the termination of a packet at destination (successful delivery of the packet at destination), a fixed and positive reward R is acquired, however if the packet is terminated (dropped) earlier it reaches destination, no reward R is acquired.

***Problem***

The nature of algorithm allows the nodes to make routing decisions happening distributed, asynchronous, and in an adaptive manner.

***Remark***

Difficult of shortest path routing among all source-destination pairs can be effectually decomposed to routing choices where routing from one node to the given specific destination is obtained.

***AODV Protocol Study Algorithm***

Figure 2illustrations a simple mobile self-organizing network structure[14], dotted line denotes the route requests of every node. As in Figure 2 from the source node to destination node d, a total of M paths will occur, for the first i paths, so it is the average packet delay Di, defined by F cost function for routing path selection, which was conveyed as[15]

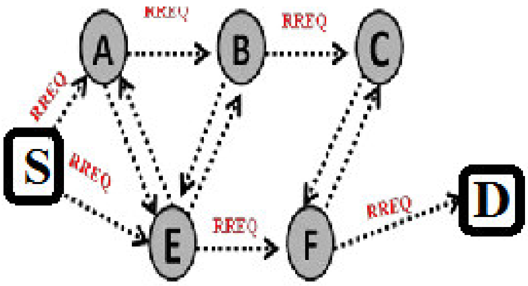


**Figure 2**
***AODV protocol analysis***

$F=\sum_i Di$

In MANETS, a single node queuing delay, transmission delay and processing delay is the key source of delay in routing. For a solo packet, the processing delay and transmission delay is a constant, while the queuing delay is pretentious by the degree of network congestion, altered greatly. The average delay of data packets confirm to the following association:

**D= λ/ μ(μ- λ)**

Where, λ is packet arrival rate, μ is packet transmission rate, then μ ≥ λ.

**Description of d-Adapt OR:**

The operation of d-Adapt OR is described in terms of initialization and stages of transmission, reception and acknowledgment, relay, then adaptive computation as shown in Figure 3. For ease of presentation we adopt a sequential timing for every single of the stages. We note n+ to denote some (small) time afterwards the start of nth slot, (n + 1)-- to denote some (small) time before end of nth slot so n < n+ < (n +1)− < n + 1.

***1) Initialization***

For all initialization of nodes take place by giving a unique number.

***2) Transmission***

Transmission stage happens at time n in which node i transmit if it takes a packet.

***3) Reception and Acknowledgment***

Let $s_n^i$ denote (random) set of nodes that has received the packet transmitted by node i in its reception.

***4) Relay***

Node i transmit a control packet which has information about routing choice at some time firmly between n+ and (n + 1) −. If termination action is selected, all nodes in $s_n^i$ expunges the packet.

Upon choice of routing scheme, counting variable $v_n$ is updated.

***5) Update***

At time (n + 1)−, afterward being done with transmission then relaying, node i updates.

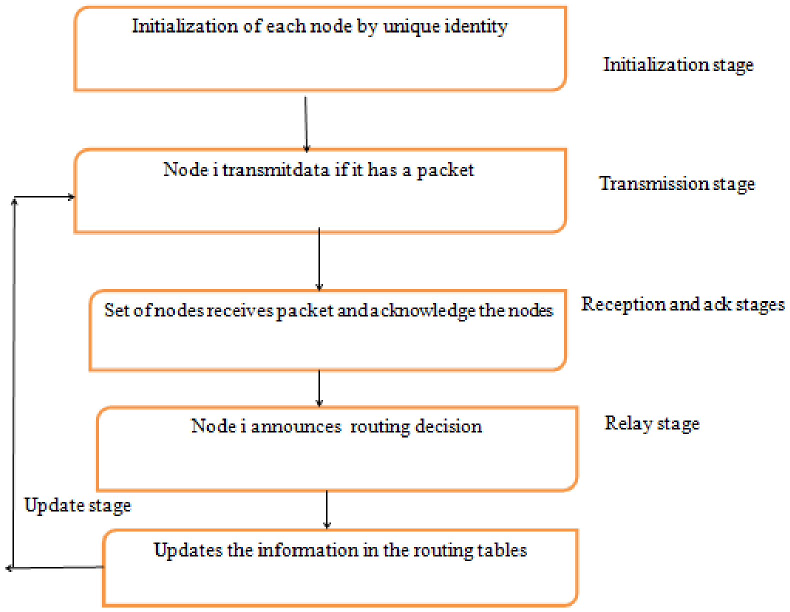


**Figure 3**
***Flow of the algorithm***

## 6. ANALYSIS RESULTS

The proposed model is assumed to truly capture the results among overhead, delay and number of nodes in the network. This model implies an use of routing protocols AODV and adapt OR. Furthermore, the scheme shows the improved performance in its analysis while broadcasting the data in the network. Lastly, identically distributed hypothesis on successful broadcasts imposes a less delay and less overhead on the operation of network and meaningfully restricts the topology changes of the network. In the analysis diagram CRP (combined routing protocol) is a combination of AODV and adaptive routing protocol. The below graphs depicts the control overhead and end to end delay has improved performance when CRP is compared with AODV routing protocol.

**Table 1**
***Depicting values of number of nodes and control overheads***

| s.no | Number of nodes | Control overhead(AODV) | Control overhead(CRP) |
|---|---|---|---|
| 1 | 50 | 0.92 | 0.99 |
| 2 | 100 | 0.98 | 0.85 |
| 3 | 150 | 0.97 | 0.84 |
| 4 | 200 | 0.968 | 0.86 |
| 5 | 250 | 0.96 | 0.81 |
| 6 | 300 | 0.98 | 0.85 |

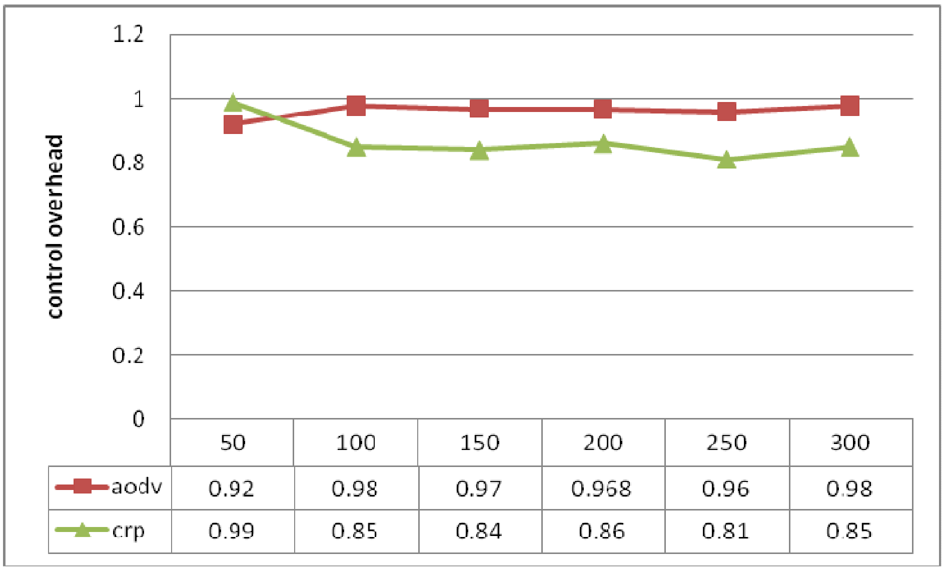


**Figure 4**
***Control overhead Vs Number of nodes***

**Table 2**
***Depicting values of number of nodes and delay***

| s.no | Number of nodes | Delay(AODV) | Delay(CRP) |
|---|---|---|---|
| 1 | 5 | 0.09 | 0.03 |
| 2 | 10 | 0.11 | 0.08 |
| 3 | 15 | 0.31 | 0.13 |
| 4 | 20 | 0.38 | 0.14 |
| 5 | 25 | 0.43 | 0.19 |
| 6 | 30 | 0.67 | 0.23 |

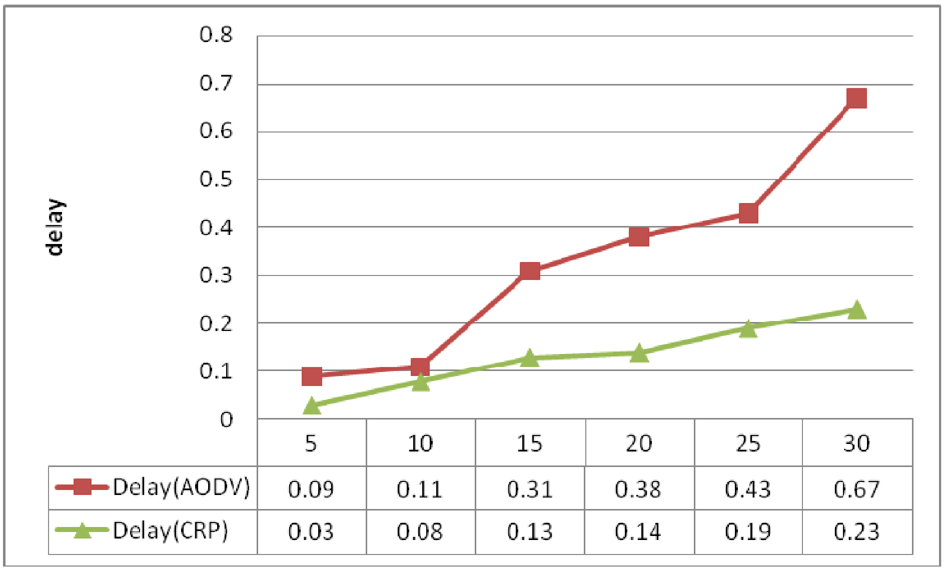


**Figure 5**
***Delay Vs Number of nodes***

## 7. CONCLUSION

The distributed adaptive routing through ad hoc on demand distance routing for multi hop wireless ad-hoc network is shown to be optimum with respect to the expected average per packet delay and control overheads. The suggested routing protocol works on the base of consisting of a group of only that nodes that are single-hop distance away so maintaining routing tables (i.e. control overheads) for nodes is reduced. The performance parameters of the network like computational overheads, flooding time and delay is improved with transmission success probabilities higher than previous methodologies, which results in the reliability of the network.

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