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# ANALYSIS AND EVALUATION OF AD HOC ROUTING PROTOCOLS

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## ABSTRACT

*Ad-hoc networks concept in computer communications means that user's wishes to communicate with each other's by forming a temporary network, without any form whatsoever of central administration. So, each node that will participate in the network will have to act as a host as well as a router therefore, willing to forward packets for other nodes. Therefore, for the purpose of forwarding packets, a routing protocol is needed. New demands on a routing protocol are imposed due to some characteristics that an ad-hoc network has. A very important characteristic is the topology which is dynamic and as a result of node mobility. Nodes can change position quite often, which means that a routing protocol is needed that adapts quickly to topology changes. The routing protocol should try to minimize traffic control, such as periodic update messages. Therefore, the routing protocol should be reactive (on demand) in nature i.e. should only calculate routes after receiving a specific request for route.This dissertation evaluates some of the routing protocols for ad-hoc networks. This evaluation is done by means of looking at the ad-hoc routing protocols, analyzing them and comparing their strengths and weaknesses over one another.*

## I INTRODUCTION

The popularity of Wireless communication between mobile users is increasing more than ever and the world's future in computing is a mobile computing world. This is as a result of advances in laptop computers and wireless data communication devices, such as wireless modems and wireless LANs. This has lead to higher data rates coupled with lower prices, which are the two main reasons for the continued rapid growth of mobile computing. There are two distinct approaches for enabling wireless communication between two hosts. The first approach is to let the existing cellular network infrastructure carry data as well as voice. The major problems include the problem of handoff, which tries to handle the situation when a connection should be smoothly handed over from one base station to another without noticeable delay or packet loss. Another problem is that networks based on the cellular infrastructure are limited to places where there exists such a cellular network infrastructure.The second approach is to form an ad-hoc network among all users wanting to communicate with each other. This means that all users participating in the ad-hoc network must be willing to forward data packets to make sure that the packets are delivered from source to destination. Wireless ad-hoc networks have gained a lot of importance in wireless communications. Wireless communication is established by nodes acting as routers and transferring packets from one to another in ad-hoc networks. Routing in these networks is highly complex due to moving nodes and hence many protocols have been developed. This dissertation concentrate mainly on

routing protocols and their functionality in Ad-hoc networks with a discussion being made in brief. Therefore the essay is of great significance in aiding the selection of which routing protocol is suitable in different cases based on the environmental factor, mobility nature and other factors explained in the dissertation.

## II MATERIAL AND METHODOLOGY

Routing is the process of selecting the best path in a network through which message is sent from sender to receiver. It is performed by many kinds of network such as the telephone network which uses circuit switching, electronic data network (e.g. internet) uses the packet switching technology and other transportation networks [40, 44]. This essay focuses mainly on the packet switching policy.

**Packet Switching:** Packet switching networks route logically addressed packets from their source to their destination through intermediate nodes, basically through some form of hardware devices called routers, bridges gateways and firewalls or switches [17, 22, 40, 43]. Other general-purpose computers can also route and forward packets but may suffer in performance because they not specialized hardware for that purpose. This routing process usually directs forwarding on the basis of routing tables which maintain a record of the routes to various network destinations thereby constructing routing tables which maintain a record of the routes to various network destinations thereby constructing routing tables which are held in the routers memory and is needed very essential for efficient routing. The use of one network path at a time is used on most routing algorithms, but multipath routing techniques enable the use of multiple alternative paths. Broadcasting to all nodes has to be avoided because ad-hoc networks are self-organized in order to avoid flooding at the nodes [39]. Therefore, an alternative route should in case a node failure occurs to serve a backup. One of the major challenges in designing a routing protocol for ad-hoc is to determine reliability because of the dynamic nature of infrastructure.Many routing protocols have been proposed for ad-hoc networks but not a single one of them has good performances in all scenarios with different network sizes, traffic loads and node mobility patterns [31]. Therefore, each protocol is based on different principles and has different characteristics. Therefore, classifying them is necessary. This classification is done usually based on characteristics related to the information which is exploited for routing and roles which nodes may take in the routing process they. They can be classified into three main categories; Proactive, Reactive and Hybrid [24, 26, 28, 31].Proactive protocols (table-driven) attempt to evaluate the routes continuously within the network, so that when a packet needs to be forwarded, the route is already known and can immediately use [28]. This type of protocol is called table-driven because it maintains a list of destinations and their routes by periodically distributing routing tables throughout the network [24]. Example of the Proactive Protocol includes the destination sequence distance vector (DSDU) and the optimized link state (OLSR) routing protocols, FSLR, and TBRF [31].

**Ad-hoc On-Demand Distance Vector:**The Ad-hoc On-Demand Distance Vector (AODV) routing protocol enables multi-hop routing between participating mobile nodes wishing to establish and maintain an ad-hoc network [19]. AODV is based on the distance vector algorithm with the only difference that AODV is reactive as opposed to proactive protocols like DV [42]. AODV [33] only request a route when needed and does not

require nodes to maintain routes to destinations that are not actively used in communications. As long as the end points of a communication connection have valid routes to each other, AODV does not play a role [27].

**Dynamic Source Routing :**Dynamic Source Routing (DSR) also belongs to the class of reactive protocols and allows nodes to the class of reactive protocols and allows nodes to dynamically discover a route across multiple network hops to any destination, Source routing means that each packet in its header carries the complete ordered lists of nodes through which the packet must pass [37]. DSR uses no periodic routing messages (e.g. no router advertisements), thereby reducing network bandwidth overhead, conserving battery power and avoiding large routing updates throughout the ad-hoc network. Instead DSR relies on support from the MAC layer (the MAC layer should inform the routing protocol about link failures). The two basic modes of operation in DSR are route discovery and route maintenance[21, 37].

**Temporary-Ordered Routing Algorithm:** Temporarily Ordered Routing Algorithm (TORA) also is a reactive protocol that is meant for routing data across Wireless Mesh Networks or mobile ad-hoc networks [12, 22].The TORA attempts achieving a very high degree of scalability using a "flat" non-hierarchical routing algorithm [14]. The algorithm attempts to suppress the generation of far-reaching control message propagation [22]. In order to achieve this, TORA builds and maintains a Directed Acyclic Graph (DAG) rooted at the destination. No two nodes may have the same height.Information may flow from nodes with higher heights to nodes with lower heights. Therefore, information can be taught as a fluid that may flow downhill. By maintaining a set of totally-ordered heights at all times, TORA achieves loop-free multipath routing as information cannot flow uphill and so cross back on itself [12].

## III RESULT ANALYSIS AND DISCUSSION

**Comparisons:** The protocols have so far been analyzed theoretically. The table below summarizes and compares the results from these theoretical analyses and shows what the protocols have and do not have, as it can be seen from Table 1, none of the protocols support power conservation or quality of service [8]. All the protocols are distributed, thus none of the protocols is dependent on a central node and can therefore easily reconfigure in the event of changes in topology.

| | **DSDV** | **AODV** | **DSR** | **ZRP** | **TORA** | **CBRP** |
|---|---|---|---|---|---|---|
| Loop-free | Yes | Yes | Yes | Yes | No | Yes |
| Multiple Routes | No | No | Yes | No | Yes | Yes |
| Distributed | Yes | Yes | Yes | Yes | Yes | Yes |
| Reactive | No | Yes | Yes | Partially | Yes | Yes |

| | | | | | | |
|---|---|---|---|---|---|---|
| Unidirectional Link support | No | No | Yes | No | No | Yes |
| QoS Support | No | No | No | No | No | No |
| Multicast | No | Yes | No | No | No | No |
| Security | No | No | No | No | No | No |
| Power conservation | No | No | No | No | No | No |
| Periodic bradcasts | Yes | Yes | No | Yes | Yes | Yes |
| Require reliable or sequenced data | No | No | No | No | Yes | No |

**Table 2: Comparison between ad-hoc routing protocols**

DSDV is the only proactive protocol in this comparison. It is also the protocol that has most in common with traditional wired routing protocol networks. The sequence numbers were added to ensure loop-free routes [8]. DSDV will probably be good enough for networks, which allows the protocol to converge in reasonable time [4]. This however means that the mobility cannot be too high. The authors of DSDV came to the same conclusions and designed AODV [42], which is a reactive version of DSDV [33]. They also added multicast capabilities which will enhance the performance significantly when one node communicates with several nodes. The reactive approach of AODV has many similarities with the reactive approach of DSR [33, 37]. They both have a node discovery mode that uses request messages to find new routes [4]. The difference is that DSR is based on source routing and will learn more routes than AODV [2]. DSR also has the advantage that it supports unidirectional links. DSR has however one major drawback and it is the source route that must be carried in each packet. When QoS is going to be used especially, this can be quite costly.

ZRP and CBRP divide the network into zones/clusters. This approach is probably a very good solution for large networks [16]. Within the zones/clusters they have a more proactive scheme and between the zones/clusters they have a reactive scheme that has many similarities with the operation of AODV and DSR [19]. They have for instance a route discovery phase that sends requests through the network. The difference between ZRP and CBRP is how the network is divided. In ZRP all zones are overlapping and in CBRP clusters can be both overlapping and disjoint [16, 45].None of the presented protocols are adaptive, meaning that the protocols do not take any smart decisions when the traffic load in the network is taken into consideration [1]. As a load selection criterion, the proposed protocols use metrics such as shortest number of hops and quickest response time to a request. This can lead to the situation where all packets are routed through the same node even if there exist better routes where the traffic load is not very large [8].

## IV CONCLUSION

This dissertation presented an exhaustive survey about existing routing protocols, and comparison between the different methods proposed, most of its conclusions pointed to a phenomenon, not a routing protocol can adapt to all environments, whether it is Table-Driven, On-Demand or a mixture of two kinds, are limited by the network characteristics; highlighting their features, differences. Mobile ad-hoc networks consist of a large number of nodes that moves in dynamic infrastructure and operate on batteries. In order to maintain reliability and reduce discovery time the network should be hierarchical. Other than that link quality, alternative routing path and mobility prediction of nodes helps to reduce probability of the failure of links, but it increases in destination rehabilitee.

**Future Research Areas:** Ad-hoc networking is a very hot aspect of computer communications. This means that there is so much research going on and many issues that still remains to be solved. Due to limited time, this dissertation only focused on the theoretical aspect of the routing protocols. However, there are many issues that could be subject to further studies.

**First of all,** there is a need for improved simulations which will include measuring of computing complexity.

**Secondly,** there are many issues related to ad-hoc networks that could also be subject to further studies:

- Security: A very important issue that has to be considered is security because ad-hoc networks are formed without centralized control therefore; they are prime targets for impersonation attacks.
- Addressing of hosts is another important issue. How should hosts in an ad-hoc network be addressed? What happens if an ad-hoc is partitioned into two separate networks or two ad-hoc networks are merged into one new larger ad-hoc network?
- Unicast and Multicast routings should be looked at thoroughly.

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