Theory of Centralization for Routing in Mobile Ad-hoc Network

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ABSTRACT: Routing has been a challenging issue in mobile ad-hoc network. Much effort is under going to propose and develop solutions which can full-fill dynamic routing requirements of an ad-hoc network. In essence, routing protocols of mobile ad-hoc network could be divided into one of six types. Most of the proposed schemes till-to-date fall into one of the two categories i.e. tables driven and on-demand types. Tables driven protocols follow old traditional approach of maintaining routes prior to data transfer and on-demand focuses on the route establishment only when require. There is a seventh or the third type known as on-demand data deliveries which have been introduced with the development of mobile ad-hoc on-demand data delivery protocol (MAODDP). The contribution of this work is to introduce a new family of protocols for mobile ad-hoc network. In addition theory of centralization has also been presented.
KEYWORDS: MAODDP; AODV; DSR; TORA; DSDV; Routing Theory; Routing Protocols; MANET.

Introduction

Mobile ad-hoc network is the collection of two or more mobile nodes establishes network without the need of fixed infra-structure. Mobile ad-hoc network is deployed in applications such as in a disaster recovery and in places where it is not possible otherwise [Bak04]. It is due to the absence of supporting structure which poses additional requirements for mobile ad-hoc network. Routing in mobile ad-hoc network has attracted a great focus with number of different routing protocols proposed as routing solutions for mobile ad-hoc network. Categorically, protocols can be divided into one of six types with two main types' i.e. tables driven and on-demand protocols.

Recently a new type known as on-demand data delivery has been introduced. Mobile ad-hoc on-demand data delivery protocol (MAODDP) has been taken as the first protocols which fall into this category. The key feature of protocol belongs to on-demand data delivery type is the route establishment and data delivery simultaneously at the same time. MAODDP foundation is based on theory of centralization which is described in the later section of this paper. The contribution of this paper is to introduce a new protocol family of mobile ad-hoc network. In addition, an overview of theory of centralization is also presented. In this context, this work has been organized as follows. In section 1, a discussion on the relative benefits of new category with respect to the previously reported schemes is presented and in section 3, conclusions and future work is presented.

1. Discussion

Routing is one of the challenging issues in mobile ad-hoc network. Existing protocols for ad-hoc network can generally be categorized into pro-active and re-active protocols types. It is a well known fact that most of these protocols have certain weaknesses. Some of the main problems include Limitation: Most of the well known protocols in this area are limited to a particular scenario i.e. does not perform well in all environments; Lack of analytical studies: not sufficient work has been conducted to evaluate their performance with respect to other techniques of similar types. Moreover, proposed schemes focus on routing without considering their affects on some other routing relates issues [BMA04].

In the past routing in mobile ad-hoc network is achieved through traditional pro-active approach. An example of such kind is Destination sequence distance routing protocol (DSDV) [WKD04]. DSDV uses distance vector shortest-path routing as underlying routing protocol. It has a high degree of complexity in link failure, detection and additions. It is known that the maximum settling time is difficult to estimate in DSDV. In addition, DSDV does not support multi-path routing.

Fluctuation is one other problem of DSDV. In some simulation studies, DSDV is much more conservative in terms of routing overhead but due to link breakages are not detected quickly more data packets are dropped. Specification of DSDV is silent on security. DSDV assumes all nodes are trust worthy and cooperative. Therefore, if the false sequence has been established the attacker will continuously send out new packets and more hosts will be cheated .

One other dominant class of routing family is reactive type. Ad-hoc on-demand distance vector routing (ADOV); Dynamic source routing (DSR) and Temporary ordered routing algorithm (TORA) are some of the known on-demand routing protocols. Similar to their counter part, on-demand routing does have their own weaknesses.

AODV follows on demand approach uses periodic broadcast to track neighbouring nodes similar to tables driven protocols [PR99]. Such control packets however cause network overhead. In AODV a route has to discover prior to data transfer. This initial search latency could slow down its operations and thus makes it quite unsuitable for interactive applications. In essence, the quality of path is discovered only during setting up the path. This quality of path is monitored by intermediate nodes at the cost of additional latency and overhead.

AODV requires symmetric routes as it cannot utilize routes with asymmetric links. Mobile nodes in AODV maintain routes that are needed. Nodes use this information to reply to route requests. It could result in uncontrolled replies leading to network overhead and unnecessary consumption of available resources.

DSR [JMB01] is not designed to track topology changes occurring at a high rate. DSR is based on source routing requiring considerably greater routing information. In DSR a route is discovered prior to the actual communication. Quality of path is not known prior to route discovery. This quality of path is monitored by intermediate nodes at the expense of additional latency.

Route discovery and maintenance are considered as two main sources of bandwidth consumption [Bak10a]. It could be reduced in DSR using intelligent caching techniques at the expense of memory and CPU resources. The remaining bandwidth consumption is due to source route header in packet. This overhead cannot be reduced by techniques outlined in protocol specification.

Scalability due to source routing is an issue in DSR. Mobile nodes use routing caches to reply to route queries. This results in an uncontrolled replies and repetitive updates in hosts caches. Therefore, as network grows, control packets and message packets also increase in numbers. This could limits DSR performance after some time in an active session.

TORA is one of the largest and complex protocol requires extra memory for routine operations [Bak10b]. Each node maintains a structure describing node’s height and status of all connected links per connection supported by the network. TORA requires each node to be in constant coordination with neighbouring nodes to detect topology changes. Therefore coverage in TORA, requiring high bandwidth and CPU requirements. TORA not only require bi-directional links and a link-level protocol but also depends on correct and in-order transmission of all packets, which is regarded as one of its main weakness.

TORA uses internodal co-ordination similar to count-to-infinity problem in tables driven protocols. In such a case, there is a potential for oscillations to occur when multiple sets of coordinating nodes are concurrently detecting partitions, deleting routes and building new routes based on each other.

ZRP limits the proactive overhead to only the size of the zone. It also limits reactive search overhead to only select border nodes [HP99]. Potential inefficiency may occur when flooding of the RREQ packets goes ZRP can provide a better solution in terms of reducing communication overhead and delay. However, this benefit is subjected to the size and dynamic of a zone. ZRP does not provide an overall optimized shortest path if the destination has to be found through IERP. Moreover with the increase of network size ZRP could create unpredictable large overhead. In ZRP each path to a destination may be suboptimal which means that each node will have higher level topological information. Therefore, it poses a higher memory requirement and an extra burden on the network resources.

Clustering algorithm introduces additional overhead and complexity in the formation and maintenance of clusters [HP99]. The disadvantage of having a cluster head scheme is that the frequent cluster head changes can adversely affect routing protocol performance as nodes are busy with cluster head selection rather than packet relaying. Cluster head table also pose additional requirement to the memory.

CGSR use distance vector shortest-path routing as the underlying routing protocol. It has the certain degree of complexity during link failure and additions. In CGSR cluster heads and gateway nodes have higher computation and communication load than other nodes. The network reliability may also be affected due to single points of failure of these critical nodes. Hence instead of invoking cluster head reselection every time the cluster membership changes clustering algorithm is introduced.

MAODDP can utilize routes with asymmetric links between nodes and do not require symmetric links like in some on-demand protocols. MAODDP does not require update packets. Mobile nodes in MAODDP maintain better status position. Thus, nodes are in more comfortable status to switch into sleep mode. In absence of some known controls packets, MAODDP can offer faster data communication without burdening available resources [BMA02]. In addition, achieving real time communication is more realistic in MAODDP then on-demand routing protocols.

On-demand protocol following source routing requires greater routing information as compared to MAODDP. In such on-demand routing, query packet contains the sequence of all intermediate nodes it has to traverse to the destination. In comparison with protocols flooding route request network wide, MAODDP offer a distinguishing benefit as it deliver data along with route request and does not establish a route before data communication. In some on-demand protocols hosts are required to operate in promiscuous mode resulting in a higher routing and processing overhead. Since it needs to process every packet heard that's not the case with MAODDP.

In one of the on-demand protocol i.e. DSR, there is no explicit mechanism to expire stale routes. Stale routes, if used, may start corrupting other caches. MAODDP follow a more conservative approach and prefers a fresh route when multiple choices are available. It assigned sequence number to each route and a route with most updated sequence number is always selected. At last, MAODDP use hop-counter and information gathered in network operations, thus can track topology changes more quickly then some on-demand protocols.

MAODDP does not broadcast route updates on periodic bases as it is in proactive or tables driven protocols. Such approach considerably reduces the bandwidth overhead and efficiently utilizes network bandwidth. In addition routing table size could be reduced by avoiding the periodic updating. MAODDP is scalable to large networks and addresses the scalability issue effectively. MAODDP provides loop free routing via sequence numbers and broadcast ID. Tables driven protocols do-not normally offer multicast routing, MAODDP support both unicast and multicast routing. At last but not least, MAODDP can save battery consumption better then tables driven protocols.

2. Theory of Centralization

In the light of the above discussion it could be concluded that routing to some extent still a challenging issue in mobile ad-hoc network. It is due to the fact that most of the dominant solutions presented addresses routing without considering their affects on some routing related factors. A theory of centralization thus proposed that:

An effective routing mechanism could be established only if routing is dealt in connection with bandwidth, battery power and security of an ad-hoc network.

Conclusions and Future Work

Routing in mobile ad-hoc network is a challenging issue. Much work has been going on to develop a routing mechanism capable of meeting mobile ad-hoc network requirements. The contribution of this work is to introduce a new routing protocol type for mobile ad-hoc network and theory of centralization for routing in mobile ad-hoc network. We believe presented theory could be used as a base in developing new or modifying existing routing schemes to form a better routing strategy for mobile ad-hoc network. In future we will be looking into various interrelated topics of the presented work. We are committed to share our future finding with the ongoing research in this area.

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