Performance Evaluation and Analysis of Routing Protocols

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ABSTRACT

Mobile ad hoc network is an autonomous system of mobile nodes connected by wireless links. This paper reviews comparison of several different classes of routing protocols. For relatively small networks flat routing protocols may be sufficient. However, in larger networks either hierarchical or geographic routing protocols are needed. There is no single protocol that fits all networks perfectly. The protocols have to be chosen according to network characteristics, such as density, size and the mobility of the nodes. MANET does not require any fixed infrastructure, therefore, it is an attractive option for connecting devices quickly and spontaneous.

Keywords: MANET, NS2, AODV

I. INTRODUCTION

Information technology is rapidly changing from regular desktop computing, where isolated workstations communicate through shared servers in a fixed network, to an environment where a large number of different platforms communicate over multiple network platforms. In this environment the devices adapt and reconfigure themselves individually and collectively, to support the requirements of mobile workers and work teams.A Mobile Ad Hoc Network (MANET) is a set of mobile nodes that perform basic networking functions like packet forwarding, routing, and service discovery without the need of an established infrastructure. Every node performs role of both, a host and a router.

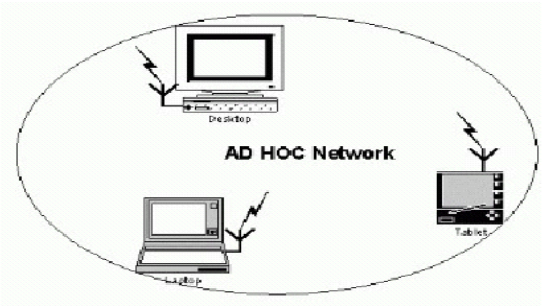

Fig 1: MANET as ad hoc network

The basic criteria for evaluating a service discovery scheme is the effectiveness with which: (1) service clients are able to find a service provider and (2) the service provider will successfully deliver the requested service. Since connections can be broken with nodes moving, the most important factor affecting service delivery success is the qualities of wireless connections along the service path between service provider and requester. Connectivity can be determined according to the relative distance (e.g., Euclidean distance) of the geographical positions of the nodes. For instance, physical proximity of service providers to service seekers has been proposed as a metric for service selection. However, position acquiring is luxury and comes at a price. From current state of the art, one way to obtain (geographical) position is by using GPS. But GPS is an extra hardware and suffers from poor signals in indoor environments. Another way is by measuring relative locations from fixed, position-known base stations. But it requires the coordination of multiple base stations and thus does not fit MANET.

II. REVIEW OF ROUTING PROTOCOL

In this section we review the workings of the AODV and DSDV MANET routing protocols. AODV is characterized as an on-demand (also called reactive) routing protocol. Routes are created as needed at connection establishment and are maintained for the duration of the communication session. During route discovery a node broadcasts a route request (RREQ) message for a given destination address. Nodes that have a route to the destination respond to the RREQ by sending a route reply (RREP) message to the source and record the route back to the source. Nodes that do not have a route to the destination rebroadcast the RREQ message after recording the return path to the source. In the event of link breakage a route error (RERR) message is sent to the list of nodes (referred to as precursors) that rely on the broken link. Upon receipt of a RERR message, the corresponding route is invalidated and a new RREQ may be initiated by the

source to reconstruct the route. The time-to-live (TTL) is used in RREQs for an expanding ring search to control. Successive RREQs use larger TTLs to increase the search for destination node.

III. COMPARISION OF DIFFERENT CLASSES OF ROUTING PROTOCOLS FOR MANETs

Generally routing protocols in MANETs are either based on the link-state (LS) routing algorithm or on the distance-vector (DV) routing-algorithm. Common for both of these algorithms is that they try to find the shortest path from the source node to the destination node. The main difference is that in LS based routing a global network topology is maintained in every node of the network. In DV based routing the nodes only maintain information of and exchange information with their adjacency nodes. Keeping track of many other nodes in a MANET may produce overhead, especially when the network is large. Therefore one of the most important issues in MANET design is to come up with schemes that will contribute to reduce routing overheads.

MANET routing protocols fall into two general categories:

- Proactive routing protocols
- Reactive routing protocols

There is also a new class of routing protocols known as the hybrid routing protocols, which tries to encompass the advantages of both the proactive and reactive routing protocols.

Pro-Active / Table Driven routing Protocols

Proactive MANET protocols are table-driven and will actively determine the layout of the network. Through a regular exchange of network topology packets between the nodes of the network, a complete picture of the network is maintained at every single node. There is hence minimal delay in determining the route to be taken. This is especially important for time-critical traffic (Scientific Research Corporation, 2004).

However, a drawback to a proactive MANET of protocol is that the life span of a link is significantly short. This phenomenon is brought about by the increased mobility of the nodes, which will render the routing information in the table invalid quickly.

When the routing information becomes invalid quickly, there are many short-lived routes that are being determined and not used before they turn void. Hence, another drawback resulting from the increased mobility is the amount of traffic overhead generated when evaluating these unnecessary routes. This is especially aggravated when the network size increases. The fraction of the total control traffic that consists of actual practical data is further decreased.

Lastly, if the nodes transmit infrequently, most of the routing information is deemed redundant. The nodes, however, continue to expend energy by continually updating these unused entries in their routing tables (Scientific Research Corporation, 2004). As mentioned, energy conservation is very important in a MANET system design. Hence, this excessive expenditure of energy is not desired. Thus, proactive MANET protocols work best in networks that have low node mobility or where the nodes transmit data frequently.

Reactive / On Demand Routing Protocols

On-demand routing is a popular routing category for wireless ad hoc routing. It is a relatively new routing philosophy that provides a scalable solution to relatively large network topologies. The design follows the idea that each node tries to reduce routing overhead by only sending routing packets when communication is requested. Common for most on-demand routing protocols are the route discovery phase where packets are flooded into the network in search of an optimal path to the destination node in the network.

There exist numerous on-demand routing protocols, but only two of them is significantly more important. These are Ad Hoc On-Demand Distance Vector Routing (AODV) and Dynamic Source Routing (DSR). These two have been chosen because both have been extensively evaluated in the MANET literature and are being considered by the Internet Engineering Task Force (IETF) MANET Working Group as the leading candidates for standardization.

HYBRID ROUTING PROTOCOL

Since proactive and reactive routing protocols each work best in oppositely different scenarios, there is good reason to develop hybrid routing protocols, which use a mix of both proactive and reactive routing protocols. These hybrid protocols can be used to find a balance between the proactive and reactive protocols.

The basic idea behind hybrid routing protocols is to use proactive routing mechanisms in some areas of the network at certain times and reactive routing for the rest of the network. The proactive operations are restricted to a small domain in order to reduce the control overheads and delays. The reactive routing protocols are used for locating nodes outside this domain, as this is more bandwidth-efficient in a constantly changing network

The most recognized protocol among these is the ZRP. In this protocol, the radius of each node's local routing zone plays an important part in determining the proactive zone. The proactive routing protocol is used to determine the topology within the radius of the node. The reactive routing protocol is then used to locate nodes outside the radius of the node on demand.

The adjustment of the zone radius will allow the protocol to adapt to different MANET environments. A larger radius will favors the proactive routing protocol, optimal for slow-moving nodes or large amounts of traffic (Scientific Research Corporation, 2004). Consequently, a smaller zone radius will favors the reactive protocol, which is optimal for fast-moving nodes or small amounts of traffic.

The WARP, on the other hand, constantly updates all the active routes between the nodes in the network. This is done using routing tables and link-update propagations (De Renesse and Aghvami, 2004). When there are link breakages, the destination may become unreachable. In this scenario, WARP will use reactive protocols to find alternative routes to break the deadlock.

HIERARCHICAL ROUTING PROTOCOLS

As the size of the wireless network increases, the flat routing protocols may produce too much overhead for the MANET. In this case a hierarchical solution may be preferable. CGSR, HSR, ZRP and LANMAR are four hierarchical routing protocols that have different solutions to the organization of the routing of nodes in a MANET.

GEOGRAPHICAL ROUTING PROTOCOLS

There are two approaches to geographic mobile ad hoc networks:

1. Actual geographic coordinates (as obtained through GPS – the Global Positioning System).

2. Reference points in some fixed coordinate system.

An advantage of geographic routing protocols is that they prevent network-wide searches for destinations. Control and data packets can be sent in the general direction of the destination if the recent geographical coordinates are known. This reduces control overhead in the network. A disadvantage, however, is that all nodes must have access to their geographical coordinates all the time to make the geographical routing protocols useful. The routing update must be done Faster than the network mobility rate to make the location-based routing effective. This is because the nodes' locations may change quickly in a MANET.

FLAT ROUTING PROTOCOLS

Flat routing protocols are divided into two classes; Common for both protocol classes is that all nodes participating in routing play an equal role. They have further been classified after their design principles; proactive routing is mostly based on LS (link-state) while on-demand routing is based on DV (distance-vector.

Here we consider AODV as a fundamental protocol:

AODV

Route discovery:
 Route Request Stage—the source node floods the network with a route request control packet (RREQ), and each node (with the exception of destination) rebroadcasts the RREQ the first time it hears.

 Route Reply Stage—upon receiving a RREQ, the destination sends a route reply packet (RREP), which is propagated to the source in the reverse path of the RREQ.

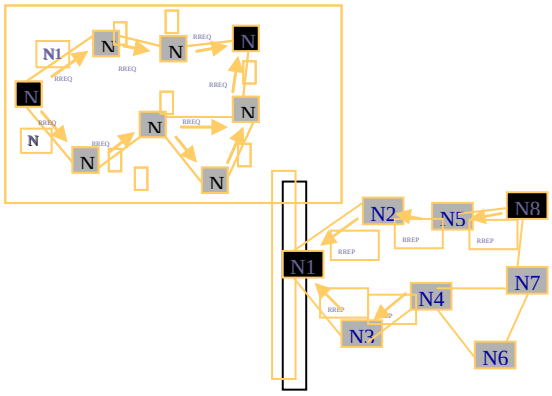

Fig. 2: Route discovery

Route maintenance:
 If an intermediate node is unable to transmit a data packet to the next hop in the path, it sends a route error control packet (RERR) to the source to inform the broken route.

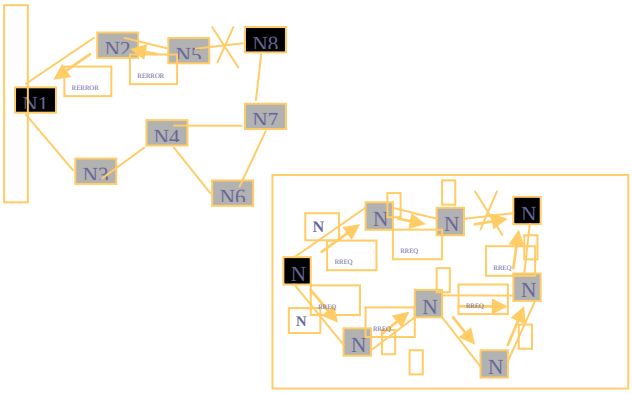

Fig. 3: Route maintenance

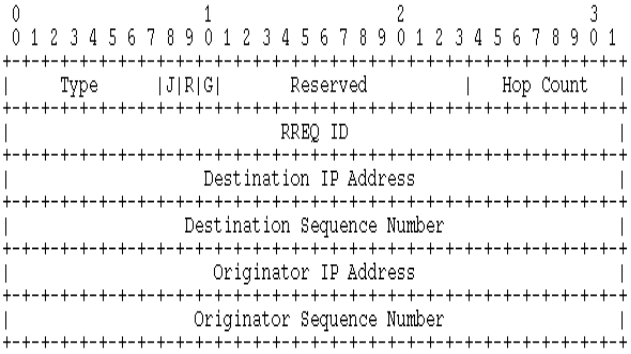

Fig. 4: AODV message format for RREQ

IV. SIMULATION MODEL

In this section we present simulations that have been carried out to compare the performance of different protocols In MANETs. We performed the simulations using the NETWORK SIMULATOR 2.NS2 is a discrete event network simulator. ns is popularly used in the simulation of routing and multicast protocols, among others, and is heavily used in ad-hoc networking research. ns supports an array of popular network protocols, offering simulation results for wired and wireless networks alike. It can be also used as limited-functionality network emulator. It is popular in academia for its extensibility.

NS was built in C++ and provides a simulation interface through OTcl, an object-oriented dialect of Tcl. The user describes a network topology by writing OTcl scripts, and then the main NS program simulates that topology with specified parameters.

Here we take a same topology for all routing protocol & analysis about TR file & we conclude that Table driven is faster as compare on demand. Below shows some results:

RESULTS

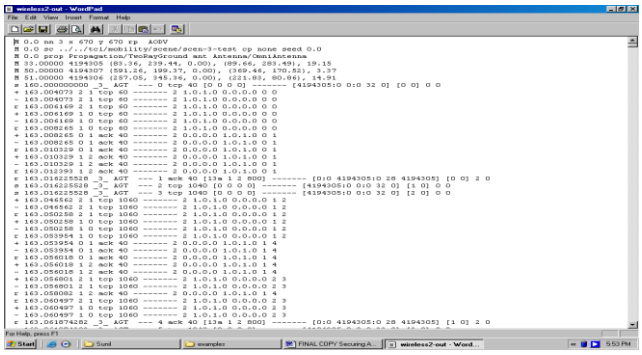

Fig 5: Simple trace file

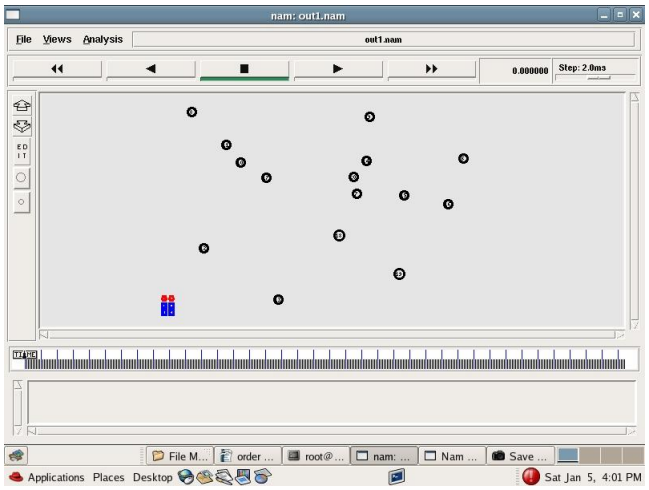

Fig. 6: Topology in NAM

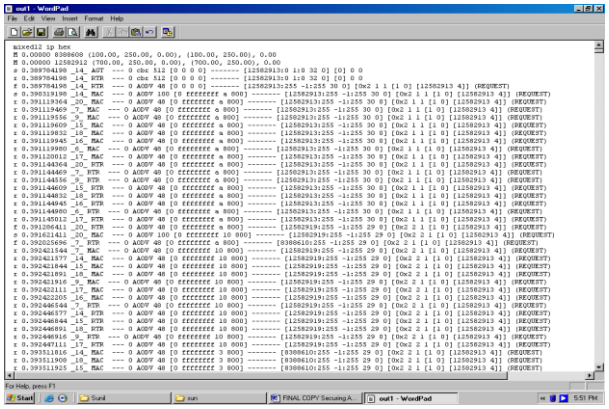

Fig. 7: Discrete trace file

V. CONCLUSION

All the routing protocols mentioned in this essay are either on-demand or proactive. There is a trade-off between sending updates often or just when needed. Sending updates may produce overhead in mobile ad hoc networks because the nodes are moving frequently. When the size of the network is small a flat routing protocol will be sufficient. Then each node keeps track of the other nodes in its routing table. How the nodes discover other nodes and how they send requests for a destination, differs between the routing protocols.

Different MANET applications have different needs, and hence the various MANET routing protocols may be suitable in different areas. The size of the network and the frequency of the change in topology are factors that affect the choice of the protocols. There is no best protocol for all applications. For flat, hierarchical and geographic routing protocols, scalability is a big challenge. There is still ongoing research on mobile ad hoc networks and the research may lead to even better protocols and will probably face new challenges. The current goal is to find an optimal balance between scalable routing and media access control, security, and service management.

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