A Comparative Approach towards Optimized Modeling of Ad-hoc Network Routing Protocols and Performance Analysis over Multiple Simulating Engines

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Abstract— Ad-hoc networks are booming in the field of communications as a growing and interesting area of research due to their infrastructure-less advantage, although such networks being short-ranged. They are widely being researched to get utilized in communication of road-factories (vehicles), disastrous areas (where there is no infrastructure, or has been damaged), air-borne vehicles (aircrafts, commercial planes), etc. Sky being the limit, the horizons of such networks is so broad and promising that they can prove to be a vast success in the ever-emerging field of communications. The idea of getting connected and staying connected, even when there is no prior infrastructure or backbone available (as is the case with ad-hoc networks), poses certain kinds of problems which need to be specifically addressed and eliminated in order to have a healthy, error free, reliable, and as-and-when needed communication between several participating entities readily available. For a packet to successfully be forwarded from source point - A to destination point - B in an ad-hoc network, some sort of path or route must be available in between, two of which being Static Routes and Dynamic Routes [5]. Having said this, the problem of optimizing the above stated types of routes depending on requirement so as to get valid results, and then utilizing these routes in order to model various ad-hoc network routing protocols (proactive/reactive) for mapping over multiple simulating engines to get the requisite connectivity and connection-success-rate (CSR) is the problem statement of this research work being proposed.

Index Terms— ad-hoc networks, CSR, dynamic routes, proactive, reactive, routing protocols, static routes.

1 Introduction

An ad-hoc network is an autonomous system of mobile hosts, with some acting as routers, which are connected as wireless links, and by coalescing these links into some sort of topology, a whole communication network is formed. Having said this, the communication network (essentially being wireless), hosts and routers which act as network entities in a wireless network are mobile can move around rendering the topology of network to be dynamic and unpredictable. Now since, some common conventions are not valid in this kind of dynamic network, traditional routing protocols are not normally used for wired networks and cannot be directly applied to most wireless networks [2].

A basic difference comes with advent of MANETs (Mobile Ad-Hoc Networks) from the traditional cellular networks, and which is that the communication which is carried out with the deployement of base stations as APs (Access Points) relies on the wired backbone and fixed base stations. Whereas the case is totally different in MANETs, in which no such prior infrastructure is present at hand and unpredictibility factor is large due to the fact that movement of nodes is free and the network topology may dynamically change from time to time depend-

TABLE 1
IMPORTANT CHARACTERISTICS OF A MANET

Sr. No.	Characteristic	Description
1	Dynamic Topologies	Nodes are free to move arbitrarily with different speeds; thus, the network topology may change randomly and at unpredictable times.
2	Energy-constrained Operation	Some or all of the nodes in an ad hoc network may rely on batteries or other exhaustible means for their energy. For these nodes, the most important system design optimization criteria may be energy conservation.
3	Limited Bandwidth	Wireless links continue to have significantly lower capacity than infrastructured networks. In addition, the realized throughput of wireless communications – after accounting for the effects of multiple access, fading, noise, and interference conditions, etc., is often much less than a radio's maximum transmission rate.
4	Security threats	Mobile wireless networks are generally more prone to physical security threats than fixed-cable nets. The increased possibility of eavesdropping, spoofing, and minimization of denial-of-service type attacks should be carefully considered.

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ing on the establishment/disconnection of links between communicating nodes.

Also, to throw some light on symmetric and asymmetric links, which are acting as a major the several challenge encountered in a MANET, scalability and robustness attributes are worked out in different arenas of study. Nodes Mobility Pattern is also a breakthrough issue in analysis of MANETs [8]. Some nodes are highly mobile, arbitrarily changing their position in a brisk fashion while others are primarily stationary posing great difficulty in predicting a node's movement and its followed pattern.

2 Ad-hoc Network Routing Protocols – An Overview

A large number of Mobile Ad hoc Network routing protocols have been suggested over the past decade. Design, improvement, and performance comparison of these protocols has been largely worked upon. But very little work has been done in suggesting performance optimization techniques based on these analyses. Various simulators have also been developed and used in the market for requisite study and the lack of consistency in results of these research groups is due to the fact that MANET routing protocol models and application environments themselves are inconsistent and they include profiles of networking and user traffic [1]. No generalized conclusions have been made due to this fact and therefore selection of a specific routing protocol for a particular MANET application becomes vague and unclear at times.

Major limitations that pose to MANET applications usually are bandwidth and power. This tells that in MANET routing protocols, network overhead is one of the biggest issue and research efforts have been made in control and improvement of this overhead. Another important attribute is Node mobility in MANETs. Simulation results have shown that optimization of routing protocols resulted in minimizing this control overhead, topology information maintenance, and shortest path route support after comparison of known routing protocols [10].

3 Manets – A Bigger Picture

Largely speaking, routing protocols that are used in fixed wired networks do establish routing in fixed wireless networks and mobile networks with stationary access points requiring only one-hop routing over a link in a wireless network with fixed access points and many fixed wireless network. Whereas the routing scenario is different in case of mobile ad hoc networks and multihop routing strategy is deployed in some fixed wireless networks as well. Mobility causes routing protocols to change its path for this kind of wireless network in order to maintain path to the participating nodes.

There is a difference between routing in a MANETand routing in taditional infrastructured networks. A number of factors like topology, route(r) slection, request initiation, and specific underlying characteristic that could serve as empirical in finding the path quickly and efficiently. Efficient operation is required for the low resource availability in these networks and this is what motivates this research for optimization of routes in ad hoc networks. Also, severe restrictions on routing protocols are imposed because of highly vibrant nature of these networks, thus motivating the study of protocols which aim at achieving routing stability [5].

To design a routing protocol for ad hoc networks is one of the outstanding areas of research and since it is a major factor in successful connection establishment of a specific network type, all information from a source to destination must be know to the node including the fidelity of neighbors which would overall define a packet route. Increasing the number of nodes increases the routing table entries and network is prone to large overhead. On another perspective, when the nodes are highly mobile, they do effect on overhead capacity of routing protocols and maintenance of periodic updating of routing table entries is pretty much a cumbersome job at hand. And this is where optimization of routing protocols comes into play. Ad hoc routing protocols can be broadly classified as being Proactive (or table-driven) or Reactive (on-demand) [13].

3.1 Proactive Routing Protocols

Proactive routing protocols demand that nodes in a MANET should keep tracking information of routes to all possible destinations so that route is already known and can instantly be used whenever a packet needs to be forwarded, the. In approach adopted by proactive protocols, one of the prime advantages is that there is a minimal delay in route selection n whenever it is required. One of the disadvantages, on the other hand, is that in order to maintain the routing information of whole network, they have to continuously use a significant share of the network capacity thus causing possible overhead.

3.2 Reactive Routing Protocols

Reactive routing protocols deploy another tactic in which route discovery is completely on demand basis i. e. whenever a source needs to communicate data to destination, its only then that route discovery for those specific nodes is initiated.

Less bandwidth and less overhead is required in case of reactive routing protocols as compared to its counterpart (proactive routing protocols). This is so because discovery of route is only undertaken when needed. One drawback that damages the reputation of reactive routing protocols is the delay factor because the time it takes to decide a route from source to destination can be quite much high depending upon node locations and network congestion scenarios and a large time is required for discovering of routes than when the actual communication of data starts.

4 Comparison And Performance Optimization

Wherever there is a contest between competency and usefulness of the protocols defined previously, there is one question that pops up in mind, and that is their relativity. That is, no such protocol has a mark advantage onto the other as till this

part of the research as we may assume, but all this comes with different trade-offs and onsite conditions that prevail in terms of QoS, Capacity, Bandwidth Utilization, Speed, Deliverability, Robustness, etc [3]. In theoretical studies to this research, we have developed a sound base of the working of all four protocols under limelight in this research (DSDV, OLSR, DSR, AODV) of mine with several advantages/disadvantages of one over the other. Then I have developed another perspective after making a sound comparison of these protocols and then deviced the optimization strategies that may lead us to the efficient utilization of one over the other as per the circumstances and available scenario [2]. Performance parameters are the key to establish such working and so here I took some KPIs first and then proceeded with the optimization.

5 Result And Discussion

As it has been established now, in order for an early identification of route from source to desitination, proactive routing protocols (DSDV, OLSR) is used as it keeps track of routes to all possible destinations.

A change in topology of any one member of the network causes scattering of that member from throughout the entire network. Instances include "destination-sequenced distance-vector" (DSDV) routing, "wireless routing protocol" (WRP), "Optimised Link-State Routing" (OLSR) "global state routing" (GSR), and "fisheye state routing" (FSR).

Reactive routing protocols (DSR, AODV), on the other hand, will form the routes on demand basis, i. e. whenever the source desires to flow information to the desitination. In the case when a node A requires sending data packets to multiple destination nodes (B, C, D, …) but the routes to the destination are not known, the process of route detection will be initiated. And as soon as the route is discovered, it will be maintained by a route maintenance procedure until the destination becomes inaccessible or till there is no requirement of route anymore. Instances include "ad hoc on-demand distance vector routing" (AODV), "dynamic source routing" (DSR), and "Cluster Based Routing protocol" (CBRP).

After analysis and simulation portfolios carried out overmentioned protocols, we conclude that Proactive routing protocols have the advantage of fast and reliable communication with minimal delay, but the drawback is that control overhead burdened over the network is too large because routing table need to be periodically updated as soon as a connection makes or breaks between two pariticipating nodes. Reactive routing protocols, on the other hand, have this same advantage over proative routing protocols as they use the inverse strategy, i. e. tracking down route to a destination only when required [11].

Less bandwidth is required in reactive routing protocols compared to proactive protocols. But this scheme comes with a disadvantage which is the consumption of huge amount of time for any route tracing activity to a destination proceeding to the reliable communication. And unnecessary traffic will be created whenever reactive routing protocols relayed route requests, especially when there are applications which require regular route discovery demand.

Having discussed the categorical distribution of Mobile Adhoc Network Routing Protocols and describing the working methodologies and underlying algorithms of four of them under limelight in this research, a thorough comparison and optimization mechanism based on preset KPIs has been discussed. Now to give this research a sound base and concluding based on the hypothesis, simulation study of these four protocols on the selected simulation tools has been carried out and based on this study, concluding remarks have been established in the next section of the usability scenarios of all four protocols.

The methodology adopted was defining certain parameters over the ansim-4.00 network simulator and then changing those parameters logically for comparison purposes of all the four protocols over various scenarios.

6 Conclusion

Although their have been numerous breakthrough efforats in ascertaining the fruitability of one ad hoc network routing protocol over the other, the area of research is still pretty vast to explore. As concluded from the simulation study and behavorial models of 4x routing protocols (2x proactive and 2x reactive) under the criteria of specific KPIs, reacitive routing protocols outclass the proactive routing protocols in overhead optimization and speedy performance in disaster prone areas, whereas proactive routing protocols are more trustworthy in developing ad hoc network infrastructure of a facility or corporate office, where we require a reliable data delivery. A side future work to this research can be to analyse a generic algorithm for a number of routing protocols which can work on a generic platform and workout the KPI threshold parameters related to simulating engines; a low level psuedo machine language type. The research on link lifetime duration, the adaptive interval scheme, and the new mobility model can lead to future research topics.

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