Analysis of Mobility Models in Mobile Ad-hoc Networks

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ABSTRACT

Mobility models in ad-hoc networks uses protocols to discover and setup routes between nodes. Each device in a mobile ad-hoc network is free to move independently in any direction and will therefore change its links to other devices frequently. Mobility model represents the movement of mobile users and how there location, velocity and acceleration changes overtime. Various mobility models are proposed for ad-hoc networks and to facilitate communication within such networks routing protocols are used mainly AODV, DSR, FSR, TORA, DSDV, DYMO etc. Some of the popular mobility models are Random Way Point Model, Random Walk Model and Mobility Vector Model etc. Each model has its own characteristics, working capacity and limitations.

In this paper we present the comparative of different protocols like AODV, DSDV and DSR for mobility models and considered that AODV delivers highest PDF(packet delivery fraction), NRL(Normalized Routing Load) and DSR delivers highest average end-to-end delay.

Keywords:

Ad-hoc network, AODV, DSR, FSR, AODVUU, TORA, DSDV, DYMO, OLSR, mobility models.

1. INTRODUCTION

A mobile adhoc network (MANET) is a self-configuring, self organized and infrastructure less network of mobile devices connected by wireless connection. Ad-hoc networks do not require a pre-existing architecture for communication purposes and do not rely on any type of wired infrastructure, all communication occurs through a wireless median. This network does not have any central control and each node can communicate with other node within the range. It enables to communicate emergency search and rescue operations. This type of network is a collection of two or more mobile nodes that are dynamically interconnected. MANETs are a kind of Wireless adhoc network that usually has a routable networking environment on top of a Link Layer adhoc network. The primary challenge in building a MANET is equipping each device to continuously maintain the information required to properly route traffic. Such networks may operate by themselves or may be connected to the larger Internet. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently Mobility models represent the movement of mobile users, and how their location, velocity and acceleration change over time. Basically mobility models are of two types, I- analytical mobility model and II-simulation mobility model. The behavior or activity of a user's movement can be described using both analytical and simulation models. Such models are frequently used for simulation purposes when new communication or navigation techniques are investigated.

2. VARIOUS MOBILITY MODELS USED IN AD-HOC NETWORKS

The movement of mobile users is represented by mobility models. In mobility modeling activity of user's movement can be described using analytical and simulation models. Analytical models may provide performance parameters and Simulation models can derive valuable solutions for more complex cases. Typical mobility model includes-

- Brownian Model
- Random Waypoint Model
- Random Walk Model
- Random Direction Model
- Random Gauss-Markov Model
- Markovian Model
- Incremental Model,
- Mobility Vector Model
- Reference Point Group Model (RPGM)
- Pursue Model
- Nomadic Community Model
- Column Model
- Fluid Flow Model
- Exponential Correlated Random Model
- Map Based Model
- Manhattan Mobility Model
- Mission Critical Mobility Model
- Obstacle Mobility Model
- Smooth Random Mobility Model
- Post Disaster Mobility Model

3. PROTOCOLS USED IN AD HOC NETWORKS

To facilitate communication within such network, a routing protocol is used to discover and setup routes between nodes. The goal of routing protocol is to have an efficient rout establishment between a pair of nodes, so that messages can be delivered in a timely manner [2]. In mobile ad-hoc network ad-hoc routing protocol is a standard which controls the way to route packets between computing devices decided by the nodes. Ah-hoc networks is able to use many kind of protocols

according to their needs, few common protocols are as following:

3.1 AODV (Ad-Hoc On-Demand Distance Vector)

It is a routing protocol for MANET and other wireless ad-hoc networks. In AODV until a connection is needed the network remains silent. It uses on-demand approach, means when source node needs route to transmit data packets only when a route is established [1] [8] [12] [14] [19].

3.2 DSR (Dynamic Source Routing)

In wireless mesh network DSR protocol is used. DSR uses source routing in which a data packet carries the complete path to be traversed. [1] [8] [10] [14] [19]

3.3 FSR (Fisheye State Routing)

It is an implicit hierarchical routing protocol. FSR uses fisheye technique which is used to reduce the size of information required to represent the graphical data [2].

3.4 AODVUU (Ad-hoc On-demand Distance Vector, from Uppsala University)

It is a Linux implementation of AODV routing protocol and developed at Uppsala University, Sweden. In this type of protocol both users and routers are mobile. It supports IPv6 and multicasting. [2]

3.5 TORA (Temporally-Ordered routing Algorithm)

It is also an on-demand routing protocol. It is developed by The objective of TORA in highly dynamic mobile computing environment is to limit the control message propagation [9] [10] [15] [20].

3.6 DSDV (Destination Sequenced Distance Vector)

It is most common routing algorithm based on distance vector. In this protocol each node maintains a routing table which is periodically updated. it involves sequence numbers originated and updated by the destination, to avoid the looping problem caused by stale routing information [12] [14] [15] [16].

3.7 DYMO (Dynamic MANET On-Demand)

It is a dynamic MANET protocol which uses on-demand technique. The basic operation of DYMO is to discover routes and maintain the routes. It is a reactive, multihop, Unicast routing protocol. It stores minimal routing information and so the control packet is generated when a node receives the data packet and it does not have any valid route information. It is a memory concerned routing protocol. [19]

3.8 OLSR (Optimized Linked State Routing)

It is an IP routing protocol. It is used in mobile ad-hoc network and other wireless ad-hoc networks. It is a proactive linke-state routing protocol that uses hello and topology control (TC) messages to detect and then announce link state information throughout the mobile ad-hoc network. [20]

4. RELATED WORK

Arvind Kumar Shukla et-al presented an analysis on mobility models used in ad- hoc networks. Author compared two ad-hoc routing protocols (AODV and DSR) by using mobility model and change the node density with varying number of sources node. In this work only random way point mobility model was used and it provides detailed performance and analysis on ad-hoc routing protocols. Both protocols use On-Demand route detection idea but inner method for find the route is different. At lower speed DSR performs better than that of higher speed across the mobility models. In a random way point mobility model with CBR traffic sources, AODV does enhanced than DSR when node solidity is low. In high node solidity AODV act is still better in low traffic load but in high traffic load DSR do better [1].

Foez Ahmed et-al investigated the effects of various mobility models on QoS metrics for two prominent proactive and reactive MANET routing protocols – Fisheye State Routing (FSR) protocol and Ad-hoc On-demand Distance Vector, from Uppsala University (AODVUU). Performance is measured by the varying number of traffic sources, number of nodes, host velocity and data sending rate. Author simulated and compared above protocols under Random way point mobility model, Manhattan grid mobility model and Reference point group mobility model. Author found that at dense network FSR is superior to AODVUU, but under Manhattan grid mobility model AODVUU performs better when network load is high enough. AODVUU is more sensitive to the speed of mobile nodes than the proactive routing protocol FSR. FSR can be used in bandwidth and resource critical environment and scalability of AODVUU is limited for high speed network. [2]

In [4] Author provided classification and survey of random-based mobility models in concerning the requirements for tactical scenarios.

Santosh Kumar et-al provided analysis of models which meet the tactical scenario requirement and also provided survey and categorization of the mobility model on account of mobility metrics. Some models strongly satisfy separate tactical requirements and some of models integrated in other models to attain tactical scenario requirements together [5].

In [6] Authors describe the trade-off associated with adding detail to simulation models. They evaluated the effects of detail in five case studies of wireless simulation for protocol design. Ultimately the researcher must judge what level of detail is required for a given question, but authors suggest two approaches. First approach is, when error is not correlated, networking algorithms that are robust to a rage of errors are often stressed in similar ways by random error as by detailed models. Second approach is visualization techniques that can help pinpoint incorrect detail and manage detail overload. This work is in focusing on the relatively unexplored area of fidelity of wireless simulations.

Stefano Basangi et-al introduced a new routing protocol for ad-hoc networks. This protocol introduced using a novel mechanism for the dissemination of location information. It minimizes the amount of bandwidth and transmission power used to maintain routing tables without penalizing the accuracy of the routing tables. DREAM protocol provides loop-free routes, and is robust in providing multiple routes to a given destination [7].

Geetha Jayakumar et-al compared the performance of two prominent on-demand routing protocols for mobile ad hoc networks i.e. DSR and AODV in terms of packet delivery ratio, normalized routing load, normalized MAC load, average end to end delay by varying the number of sources, speed and pause time. Authors found DSR and AODV share similar on-demand behavior, the differences in the protocol mechanisms can lead to significant performance differentials. For lower loads DSR is more effective while AODV is more effective for higher loads [8].

Author R. Asokan et-al proposed a new energy and delay aware protocol called energy and delay aware TORA (EDTORA). It is based on TORA protocol. EDTORA satisfies the energy and delay QoS requirements. Simulation results shows that the proposed protocol has a higher performance than TORA in terms of network lifetime, packet delivery ratio and end-to-end delay [9].

Rakesh Kumar Jha et-al present and examine analytical simulation result for the routing protocols DSR and TORA network performance. Authors conclude that proxy environment is suitable for TORA routing because the network will maintain the same behavior after proxy enabled too but DSR routing is highly affected by proxy [10].

In [11] a mobility measure for MANET is proposed that is flexible and consistent, flexible because one can customize the definition of mobility using remoteness function, and consistent because it has a linear relationship with the rate at which links are established or broken for a wide range of network scenarios. Authors proposed canonical mobility measure for MANETs. The consistency was demonstrated by consistent linear relationship between the mobility measure and the link change rate for various simulation scenarios.

Sunil Kumar et-al focused on designing a simulative study and investigation of mobility models performance with the use of PDF (packet delivery fraction), average end to end delay, and throughput routing protocols. Authors considered Manhattan and Freeway mobility models. Authors made comparison on three parameters PDR, Throughput, Average end to end delay. They found Manhattan mobility model is performed better as compare to freeway mobility model on given parameters [12].

Ming Zhao et-al analyzed topology dynamics based on the smooth model. Authors provided a relative movement trajectory model, in which the relative velocity of two mobile nodes changes during their link connection. They developed a distance transition probability matrix P, so they can predict the future link status based on the present distance between two neighboring nodes and their relative speed [13].

Mohammad Rafiq et-al focused on the energy consumption issue of the routing protocols with three routing protocols AODS, DSR and DSDV in terms of average remaining energy, average consumed energy, network life time, system life time and energy consumption per successful data delivery. By doing many simulations authors used NS-2 simulator. By using simulation results DSDV gives better performance in wide range [14].

Arvind Kumar Shukla et-al presented analysis routing performance of AODV, DSR (reactive), DSDV and TORA (proactive) routing protocols with respect to mobility models RPGM, CMM,RWP with PDF (packet delivery fraction), average end to end delay and through put. Their result shows that a reactive is much better than proactive in the manner of PDR, end to end delay and throughput. The delay of DSR is less and in the TORA is worst, throughput is high in case of AODV, In DSR delay is greater than AODV and TORA. TORA is very poor and not reliable for the ad-hoc network [15].

CP Agarwal et-al presented performance of DSDV protocol using NS-2 simulator with network load, packet delivery, fraction and end-to-end delay. In this they used four different mobility models Random waypoint, Reference Point Group Mobility, Gauss Markov & Manhattan mobility model having varying network load & speed. Simulation experiments results suggested that in the considered simulation scenario at increasing network load and speed of nodes, selecting DSDV with RPGM mobility model would be best in order to have higher delivery of packets with lowest delay [16].

A. Subramani et-al analyzed mobility management schemes and discussed. Mobility management models in ad-hoc networks are classified and illustrated based on entity and group based mobility model. Traffic pattern can be generated by using AnSim simulator, it provides a good platform to trace out node movement by changing the pause time and speed of node [17].

In [18] authors presented the simulation result in order to choose the best routing protocol to give the highest performance when implement the routing protocol in the target mobile grid application. Three routing protocols are used for simulation comparing i.e. DSDV, DSR and AODV. DSR have a dramatic decrease in performance when mobility is high, the AODV and DSDV are perform very well when mobility in high.

Parma Nand et-al examined on demand routing protocols AODV, DSR and DYMO based on IEEE 802.11. Characteristics summary of these routing protocols is presented. Performance is analyzed and compared on performance measuring metrics throughput, jitter, packet delivery ratio, end-to-end delay and error reply packets and dropped packets due to non availability of routes by varying CBR data traffic load using QualNet 5.0.2 network simulator. It is found that the packet deliver is better in case of AODV with increased traffic load and mobility [19].

Ginni Tonk et-al. have compared the DSDV, DSR and AODV protocols using NS2 simulator, and random way mobility model in terms of packet delivery fraction, normalized routing load and average end-to-end delay. Authors found that AODV delivered highest PDF and NRL; DSR delivered highest average end-to-end delay [22].

5. DISCUSSION / FINDINGS

Ginni Tonk et-al. have compared the DSDV, DSR and AODV protocols using NS2 simulator with respect to packet delivery fraction (PDF), normalized routing load and average end-to-end delay. Authors used random way point mobility model and traffic source was continuous bit rate (CBR). Packet size was 512 bytes, simulation time 200 seconds, area was 800 m x 800 m. Authors used number of nodes 10,20,30,40,50, used pause time was 0,20,40,60,80 and maximum speed was 10,20,30,40,50. Results found by authors are as following:

5.1 Packet Delivery Fraction (PDF)

- DSR protocols have highest PDF if number of nodes were between 10 and 20.
- PDF was decreasing for AODV, DSR and DSDV if number of nodes were between 20 and 30.

- AODV delivers highest PDF if number of nodes were increased up to 50.
- The values of PDF for AODV, DSR and DSDV were increased when pause time was varied from 0 to 20.
- Overall AODV delivers highest PDF and DSDV delivers lowest PDF.

5.2 Normalized Routing Load (NRL)

- If number of nodes were 10 then DSR and AODV had approximately same NRL, if number of nodes were increased upto 30 then AODV had the highest NRL, if number of nodes were between 30 and 40 the NRL remained constant for AODV and DSDV, NRL decreased for DSR.
- NRL for AODV and DSR decreased when pause time was varied from 0 to 20 and it increased upto 80, but NRL of AODV was highest.
- When pause time was varied upto 60 the NRL increased for both AODV and DSR.
- If maximum speed was between 10 and 20, the NRL remain constant for all.
- If maximum speed was between 20 and 50, the NRL was increased for AODV and DSR and it was still remain constant for DSDV.
- Overall AODV delivers highest NRL due to its nature on-demand protocol.

5.3 Average End-to-End Delay

- Average end-to-end delay was highest for DSR when the number of nodes was between 10 and 20, but it was decreased for AODV and DSR and it was remain constant for DSDV.
- When the number of nodes was increased the value of average end-to-end delay for DSR was highest and was lowest for DSDV.
- DSR has highest average end-to-end delay when the pause time was 0, when it was increased to 20 DSR decreased and AODV, DSDV remained same.
- Overall DSR has the highest average end-to-end delay due to caching mechanism.

6. CONCLUSION

Mobility model in ad-hoc networks uses protocols to discover and setup routes between nodes. Various types of mobility models are available like Random Waypoint Model, Random Walk Model, Mobility Vector Model, Column Model and Map Based Model. Each model has its own characteristics, working capacity and limitations. According to the need of ad-hoc network architecture user can use any model out of them. In mobility model of ad-hoc network, it is necessary to use routing protocol because a routing protocol facilitates communication within the ad-hoc network. Many routing protocols are available for mobility models in ad-hoc network like AODV, DSDV, DSR and TORA. Each protocol has a different technology, nature, working capacity and performance. Many protocols are discussed, presented and compared by authors.

In comparison of the AODV, DSR and DSDV using NS-2 simulator in terms of packet delivery fraction (PDF), normalized routing load (NRL) and average end-to-end delay by varying number of nodes, maximum speed and pause time. On the basis of comparison and analysis of network simulation results it is found that when number of nodes, pause time and maximum speed are varied, packet delivery fraction (PDF) and normalized routing load (NRL) are highest in AODV due to its nature of on-demand, but average end-to-end delay is highest in DSR due to its caching mechanism.

In all cases like, varying of number of nodes, pause time and maximum speed, AODV delivers highest PDF and NRL and DSR delivers highest end-to-end delay. It is difficult to conclude that which one is best protocol in all respects.

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