"AN ANALYSIS ON MOBILE AD-HOC NETWORKS FOR THE EXISTING PROTOCOLS AND CHALLENGES"

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Abstract

Mobile ad-hoc network is a collection of nodes that is connected through a wireless medium making rapidly changing topologies. Mobile means moving and ad-hoc means temporary without any fixed infrastructure. Mobile ad-hoc network (MANET) represent complex distributed systems that contain wireless mobile nodes that can easily and dynamically in an arbitrary manner using radio waves. The infrastructure less and the dynamic nature of these networks demands new set of networking plans to be implemented in order to provide efficient end to end communication. This paper focus on study of mobile ad hoc networks (MANET), issues and challenges that are compulsory by mobile ad-hoc networks (MANET).

Key words: Wireless ad-hoc networks, mobile ad-hoc sensor network, routing protocol MANET, security.

Introduction

The mobile wireless network is the infrastructure less mobile network, commonly known as a Mobile ad-hoc network (MANET). Infrastructure less networks have no fixed routers; all nodes are capable of movement and can be connected dynamically in an arbitrary manner. Nodes of these networks function as routers which discover and maintain routes to other nodes in the network. Example applications of ad-hoc networks are emergency search-and-rescue operations, meetings or conventions in which persons wish to quickly share information, and data acquisition operations in inhospitable terrains.

A Mobile Ad Hoc NET work (MANET) is an autonomous system of mobile hosts (MHs) (Also serving as routers) connected by wireless links and the union of which forms a communication network modeled in the form of an arbitrary communication graph. In a MANET, no infrastructure exists and the network topology may dynamically change in an unpredictable manner since nodes are free to move. The mode of operation in ad hoc network is peer – to – peer multi – hop mobile wireless networks where information packets are transmitted in a store – and – forward manner from the source to an arbitrary destination. [1]

In MANET routing goal is to find the optimal path by also taking into consideration communication overhead, latency and power by using most of the available hosts to reach the destination in order to reduce failure in transmission. However, a rapid discovery of alternate route in respect to frequent change in structure of the network involving continuous process of disappearing and regeneration of hosts should not affect the uniformity and optimality of routing packets between the nodes. The overall routing protocol types responsible for transmission of packets between different mobile hosts in ad-hoc network falls into three broad categories (as in Fig. 1)

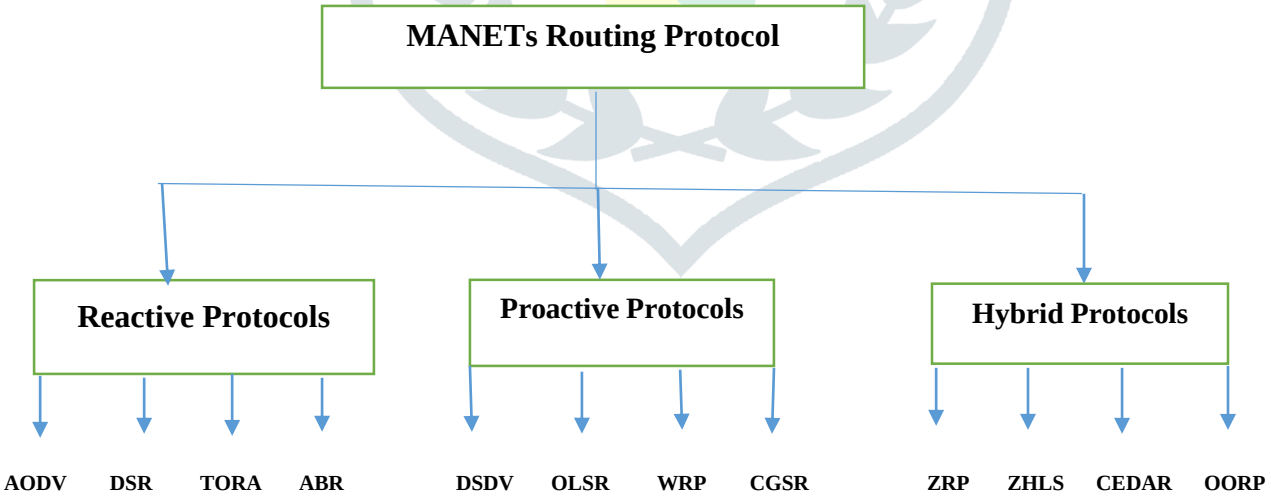

Figure 1. MANET Routing Categories and Protocols

In mobile ad-hoc networks, topology is highly dynamic and random. In addition, the distribution of nodes, and, eventually, their capability of self-organizing play an important role. The main characteristics can be summarized as follows:

- The topology is highly dynamic and frequent changes in the topology may be hard to predict.
- Mobile ad-hoc networks are based on wireless links, which will continue to have a Significantly lower capacity than their wired counterparts.
- Physical security is limited due to the wireless transmission.
- Mobile ad-hoc networks are affected by higher loss rates, and can present higher delays and jitter than fixed networks due to the wireless transmission.
- Mobile ad-hoc network nodes rely on batteries or other exhaustible means for their energy. [2]

1. Mobile Ad-Hoc Networks

A mobile ad hoc network (MANET) is a continuously self-configuring, infrastructure-less network of mobile devices connected wirelessly. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. “A collection of wireless mobile hosts forming a temporary network without the aid of any centralized administration or standard support services.” Ad-hoc network topology is dynamic-nodes enter and leave the network continuously. No centralized control or fixed infrastructure to support network configuration or reconfiguration.

The special features of Mobile Ad Hoc Network (MANET) bring this technology great opportunity together with severe challenges [6]. All the nodes or devises responsible to organize themselves dynamically the communication between the each other and to provide the necessary network functionality in the absence of fixed infrastructure or we can call it ventral Administration. It implies that maintenance, routing and management, etc. have to be done between all the nodes. This case Called Peer level Multi Hopping and that is the main building block for Ad Hoc Network. In the end, conclude that the Ad Hoc Nodes or devices are difficult and more complex than other wireless networks. Therefore, Ad Hoc Networks form sort of clusters to the effective implementation of such a complex

process. In the following figure 2 will shows some nodes forming ad hoc networks, and there are some nodes more randomly in different direction and different speeds.

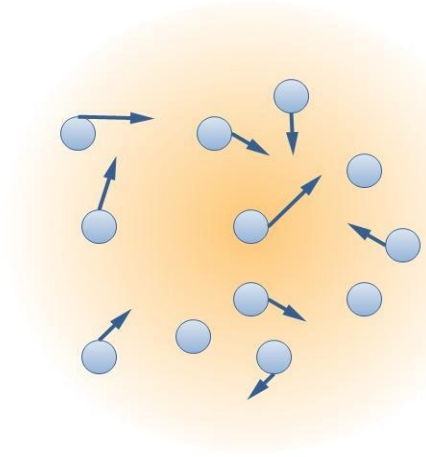

Fig 2. Ad Hoc Network: Nodes mover randomly in different direction and different speeds.

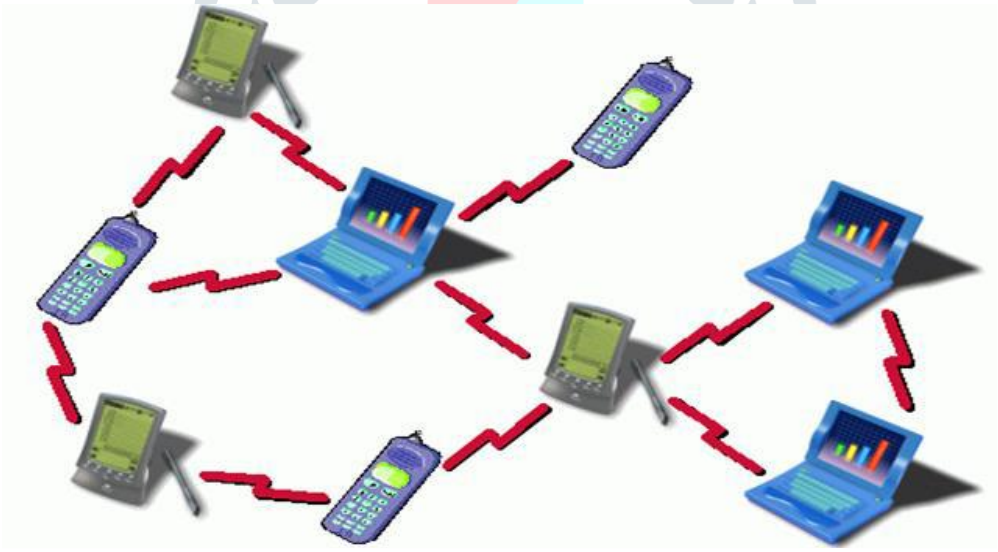

Fig 3-A mobile ad hoc network diagram

1. Evolution of MANETs

- In 1970, Norman Abramson and his fellow researchers at the University of Hawaii invented ALOHA net.
- In 1972, early ad hoc networking applications can be traced back to DARPA Packet Radio Network (PR Net) project [3], which was primarily inspired by the efficiency of the packet switching technology.
- In 1980, Survivable Radio Networks (SURAN) were developed by DARPA to address the main issues in PRNet, in the areas of network scalability, security, processing capability and energy management.
- During 1983, with the emergence of Internet Engineering Task Force (IETF) formed the mobile ad hoc networking group.
- In 1994, to leverage the global information infrastructure into the mobile wireless environment. Department of Defence (DOD) initiated DARPA Global Mobile (GloMo) Information Systems program, which aimed to support Ethernet – type multimedia connectivity anytime, anywhere among wireless devices.
- In 1995, the emergence of Bluetooth by Ericson came into existence.

II. Simulation Environment and Parameters

The research is carried out using discrete event simulation software known as OPNET (Optimized Network Engineering Tool) Modeler version 14.5. It is one of the most widely used commercial simulators based on Microsoft Windows platform and incorporates more MANET routing parameter as compared to other commercial simulator available. It not only supports MANET routing but also provides a parallel kernel to support the increase in stability and mobility in the network. [13] Claims that OPNET's intensive analyzing feature provides best environment for comparing and coordinating the output obtained. The simulation focused on the performance of routing protocols with increased in scalability and mobility. Therefore, two simulation scenarios consisting of 30 nodes initially and doubling amount nodes i.e. to 60 is considered. The nodes were randomly placed within

certain gap from each other in 800 x 800 m and 1500 x 1500 m campus environment for 30 and 60 nodes respectively. The constant File Transfer Protocol (FTP) and video conferencing traffic was generated in the network explicitly i.e. user defined via Application and Profile Configuration. The transmitters and receivers parameter were configured with defining RX Group in the network. Every node in the network was configured to execute AODV, DSR, TORA and OLSR respectively. The simulation time was set to 600s and used Karn's Algorithm to calculate the Transmission Control Protocol (TCP) parameters in the network. In addition to that all the nodes were configured with defined path trajectories for mobility in space within certain time interval. The simulation parameter configured in this research work is influenced from the related work produced on the same field by different researchers namely [1] [3] [8] [9] [10].

III. Routing Protocols

Routing protocols between any pair of nodes within an ad hoc network can be difficult because the nodes can move randomly and can also join or leave the network. This means that an optimal route at a certain time may not work seconds later. Discussed below are three categories that existing ad-hoc network routing protocols: Table Driven Protocols, On Demand Protocols Hybrid Protocols.

1) Table Driven Routing Protocols-Table Driven Routing Protocols, also known as Proactive Protocols, work out routes in the background independent of traffic demands. Each node uses routing information to store the location information of other nodes in the network and this information is then used to move data among different nodes in the network. This type of protocol is slow to converge and may be horizontal to routing loops. These protocols keep a constant overview of the network and this can be a disadvantage as they may react to change in the network topology even if no traffic is affected by the topology modification which could create unnecessary overhead. Even in a network with little data traffic, Table Driven Protocols will use limited resources such as power and link bandwidth therefore they might not be considered an effective routing solution for Ad-hoc Networks. Example-Fisheye State Routing (FSR).

2) On Demand Routing Protocols-On Demand Routing Protocols, also known as Re-active Protocols, establish routes between nodes only when they are required to route data packets. There is no updating of every possible route in the network instead it focuses on routes that are being used or being set up. When a route is required by a source node to a destination for which it does not have route information, it starts a route discovery process which goes from one node to the other until it arrives at the destination or a node in-between has a route to the destination.

3) Hybrid Routing Protocols-Hybrid Routing Protocols combine Table Based Routing Protocols with On Demand Routing Protocols. They use distance-vectors for more precise metrics to establish the best paths to destination networks, and report routing information only when there is a change in the topology of the network. Each node in the network has its own routing zone, the size of which is defined by a zone radius, which is defined by a metric such as the number of hops. Each node keeps a record of routing information for its own zone. Zone Routing Protocol (ZRP) is an example of a Hybrid routing protocol.

VI. Security Issues in AD HOC Network

1) Susceptible to Channels- messages can be eavesdropped and bogus messages can be injected into the network without the difficulty of having physical access to network components which violent the security issue.

2) Lack of Infrastructure-Ad hoc networks are considered to operate independently of any fixed infrastructure.

VII. Security Requirements for AD HOC Network

1) Confidentiality-Ensures certain information is never disclosed to unauthorized users.

2) Integrity- Message received at the receiver side must be original.

3) Authentication:-Only the authorized user can access the data.

4) Non-impersonation-No one can act to be another authorized member to learn any useful information.

5) Attacks using fabrication:-Attackers created the false route to access the information. This type of attacks is hard to identify.

A. Wireless Parameters

The Wireless LAN parameters were common to all of the four routing protocols as shown in table 1. In addition, one more wireless LAN scenario was created with RTS set to 256 as configured in the manual provided by [11] in order to minimize the chances of collision in the topology assigning RTS/CTS. This was also used to overcome the hidden node problem [11] and provide an efficient operation of MANETs. The same wireless LAN parameters were configured with change in RTS threshold value from none to 256 for second scenario in both 30 and 60 nodes topology.

Wireless LAN MAC Address	Auto Assigned
BSS Identifier	Auto Assigned
Physical Characteristics	Direct Sequence
Data Rate (bps)	11 Mbps
Channel Settings	Auto Assigned
Transmit Power	0.030
RTS Threshold	None
Packet-Reception Threshold	-95
Short Retry Limit	7

Table 1. wireless lan parameters

B. Traffic Flow Parameters

Traffic was generated in the network explicitly by configuring user defined application and profile definition.

I) Application Configuration

A heavier application traffic flow in the topology was generated which each node will be processing from the respective application server in the network. The application traffic generated was as, FTP_Application: High Load and Video Conferencing: High Resolution Video. The traffic generation parameter used for

FTP Application Parameters	
Attribute Value	Attribute Value
Command Mix (Get/Total)	0%
Inter-Request Time (seconds)	Constant (3600)
File Size (bytes)	Constant (15000000)
Symbolic Server Name	FTP Server
Type of Service	Best Effort (0)
RSVP Parameters	None
Back-End Custom Application	Not Used

Table 2. FTP Application Parameters

FTP_Application are the same as in the manual provided shown in table 2, also in addition to that to allow more traffic flow in the network video application was also configured with default values available in OPNET for higher resolution video.

ii) Profile Configuration

The profile configuration for each application was defined as, Operation Mode: Serial (Ordered) and Start Time: 55 Seconds. In addition, the FTP application start time was set to constant 5 seconds of time period as similar to those configured in the manual provided by [11] and the video application start time was set at constant 75 seconds. The constant mode of application traffic was selected so as to generate Constant Bit Rate (CBR) traffic flow in the network.

C. Routing Protocol Parameters

The configuration parameter for AODV was setup as in the work of [12] except Time-To -Live (TTL) was set to default configuration as set by OPNET Modeler 14.5. The gratuitous reply was enabled for AODV as it helps in reducing the time for route discovery shown in table 3. Also, the "hello" interval time was increased in AODV parameter from the default value to decrease the congestion in the topology.

AODV Parameters	
Route Request Retry	5
Route Request Rate Limits (pkts/sec)	10
Gratuitous Route Reply Flag	Enabled
Active Route Timeout (seconds)	30
Hello Interval (seconds)	Uniform (10, 10.1)
Allowed Hello Loss	10
Timeout Buffer	2

Table 3. AODV Parameters

D. RX Configuration Parameter

All the RX configuration in the network was set to default except for the node refresh time was set to every 10 seconds periodic interval.

Willingness	Willingness Always
Hello Interval (seconds)	2.0
TC Interval (seconds)	5.0
Neighbour Hold Time (seconds)	6.0
Topology Hold Time (seconds)	15.0
Duplicate Message Hold Time (seconds)	30.0
Addressing Mode	IPv4

Table 4. OLSR Parameters

III. Results and Analysis

The work attempts to compare the protocols in two scenarios i.e. with RTS 0 and 256 respectively for all performance metrics considered.

A. Wireless LAN Delay

Fig. 4 shows that the overall delay in the network, AODV has the highest LAN delay marked at the scale of 28 and 25 seconds for 0 and 256 RTS value respectively. This is because AODV does not keep routing information as other on-demand protocols, instead it uses of Destination sequence number together with different identifiers for routing between the nodes in topology. The route configured by the AODV have short lifespan, therefore periodic update has to be completed which compels route expiry. In addition, the re-initialization of route discovery at certain intervals, results in higher delay to be observed. Furthermore, link failure detection is not quick enough, which results in sending the packets through the failed nodes.

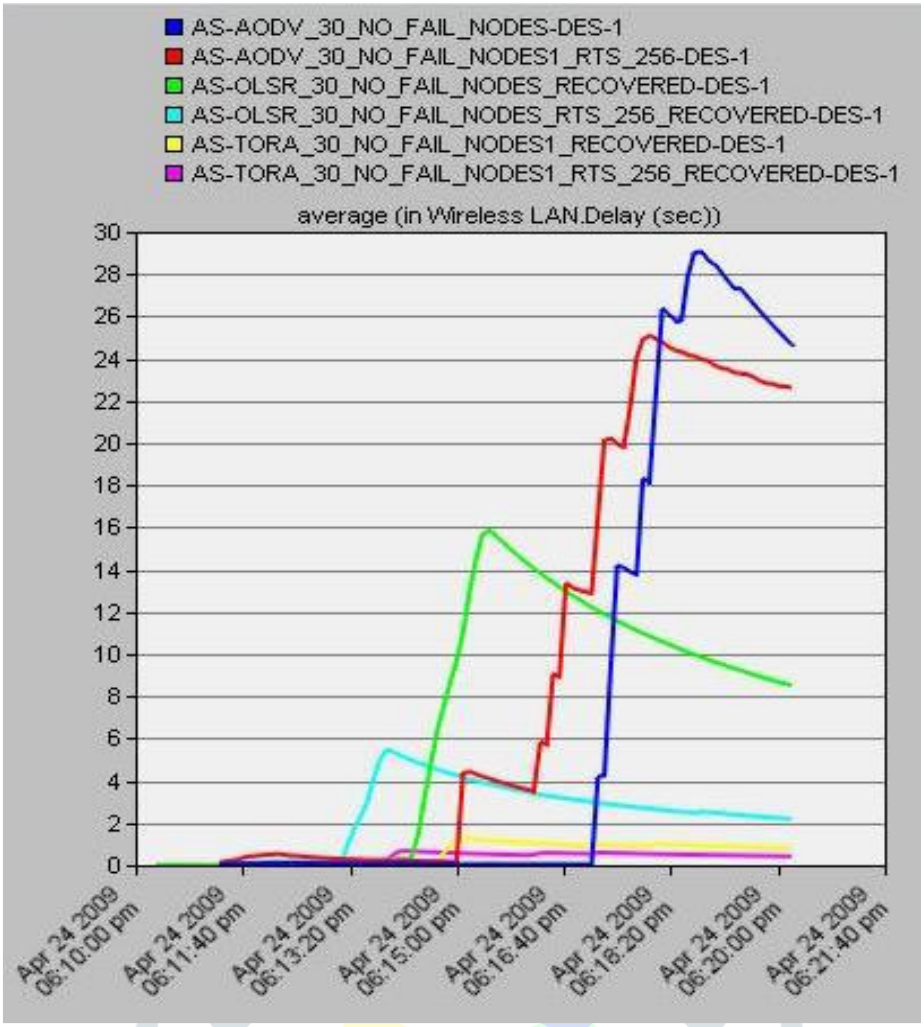

Figure 4. Average in wireless LAN delay (seconds)

B. Routing (Network) Load

Fig. 5 shows the increase in network load for OLSR. For OLSR the routing load takes the peak at initial stage of the simulation with the drastic rise and drops down slowly as the simulation progresses. This is simply because of the constant mobility of the node; there is a frequent change in the link state and this result in the change in MPR node due to random mobility. This is in turn results in periodic broadcast of 'hello' message and Topology Control (TC) messages in order to discover neighborhood nodes. In addition, OLSR is a link state protocol which uses a table driven approach. Therefore, it generates more communication overhead and takes more maintenance time which adds to the overall load in the network. AODV on the other hand has higher network load due to the fewer routing information packets kept in its cache. Therefore, the frequent transmission of RREQ and

RREP messages results in generation of higher communication overhead. This uses the bandwidth available and increases the routing load within the network. On the other hand, TORA limits the communication overhead to the node area in order to increase the bandwidth utilization. In addition, due to the link reverse algorithm employed within TORA, link failures are localized to certain area of the topology which in return improves the performance of the network. [14]

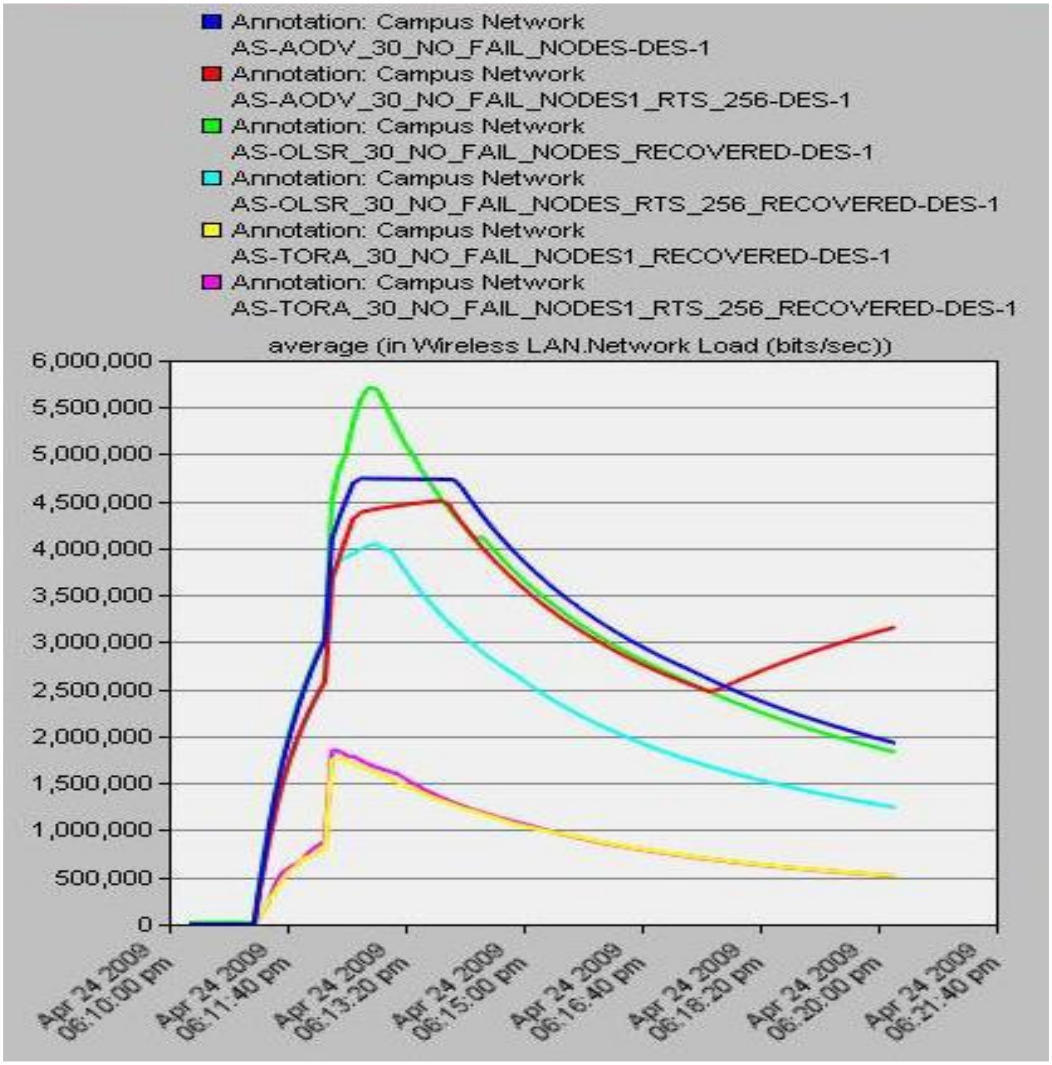

Figure 5. Average in wireless network load (bits/sec).

Conclusion

In this paper, we presented on extensive survey about the mobile Ad-hoc network (MANET). Ad-hoc networking is at the centre of evolution towards the 4th generation wireless technology. Ad-hoc networks are seen as a key in the evolution of wireless networks. There are several applications for mobile ad-hoc networks that will require being part of the internet, mobile ad-hoc networks are also proposed for different application models. In this paper, performance of AODV has analyzed using OPNET modeler 14.5. The protocols were tested using the same parameters with high CBR traffic flow and random mobility. Result showed that, AODV and OLSR experienced higher packet delay and network load compared to TORA. When segment delay is considered both OLSR and AODV performed very reliable and established quick connection between nodes without any further delay. AODV showed better efficiency to deal with high congestion and its scaled better by successfully delivering packets over heavily trafficked network compared to OLSR and TORA.

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