Brunel University

School of Engineering & Design

Wireless Data Communications Systems

Ad-Hoc Wireless Network Comparison

A comparison between the DSR and AODV Routing Protocols

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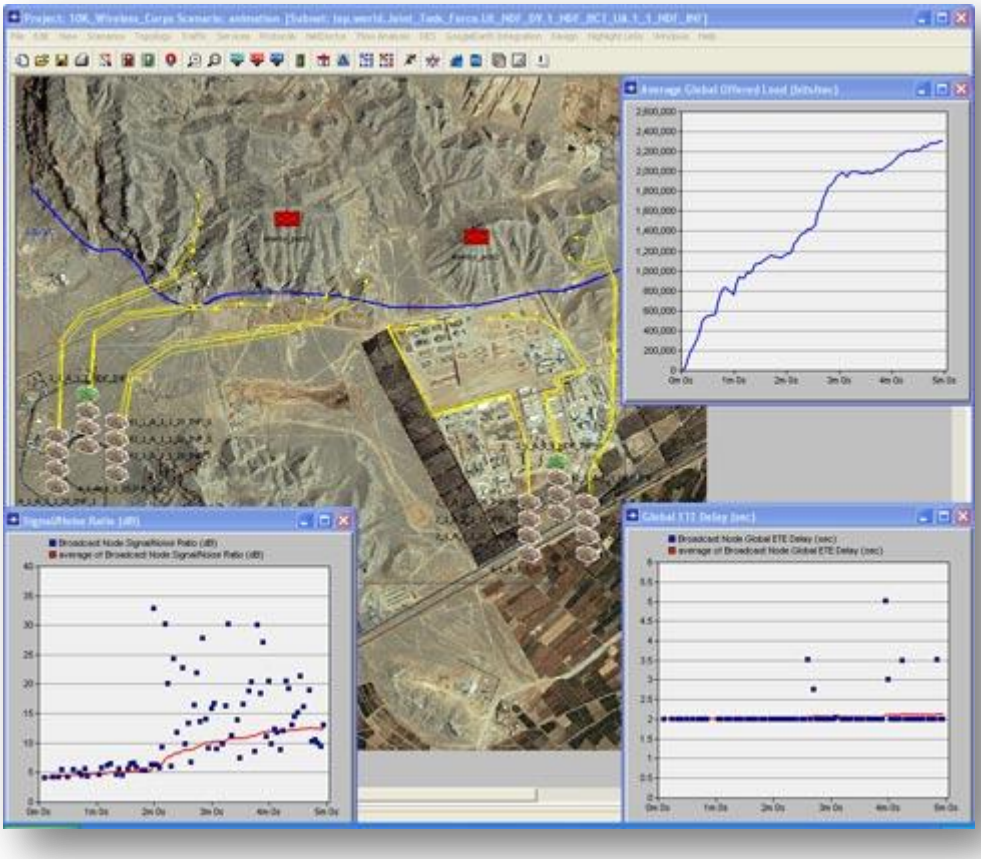


Page of Contents

Introduction

Opnet is a widely being accepted as the frontrunner in simulation based tools in most universities and industry. It is therefore a very useful tool to acquire and become familiar with. This assignment is designed with this in mind, it will help you have a better understanding of how a wireless network is designed and implemented towards a real life scenario.

Your task is to design a small and large wireless network using particular wireless network mode (Ad hoc) using (DSR, ADODV) Routing protocols, which will be compared and analysed with each other. This model is presenting a small office environment that is using a dedicated server.

Aims and Objectives

- Compare DSR and AODV routing protocols in OPNET
- Build a MANET network connected to a server via a wireless router
- Evaluate and analyse network performance
- Familiarise yourself with Opnet

Background

Ad-hoc Routing Protocol's

Ad-hoc routing is the method nodes agree on routing data between each other in a mobile ad-hoc network (MANET). There are a few main routing philosophies:

Reactive

Reactive routing is what **DSR** and **AODV** protocol's use. They plan the path for their packets "as and when" it need's to. Updates to the routes are performed when needed and in the process of route discovery. The disadvantage of this general approach is the risk of full flooding which is when nodes after receiving a hit message, and then flood the network with Route Request Packets.

Proactive

This routing methodology is used by the **OLSR** protocol and requires fresh tables of destination routes by the transfer of existing tables through the network via nodes. This needs a decent infrastructure to manage the dataflow of tables between nodes and reliable node to node communication.

Reactive and Proactive

This approach is a hybrid approach of combining both benefits of reactive and proactive routing. The routing initiates using the Proactive method of pre planned routes. Extra demand is then handled by reactive flooding. This methodology is only suitable for some situations where traffic demand and the number of nodes can be determined before hand.

DSR (Dynamic Source Routing)

DSR works by forming a route on demand when needed and uses *source routing* instead of hop by hop routing. When using source routing, it requires the discovery of each device between the source and destination of the route. This path via nodes is then cached and used to route packets. Each routed packet will have the address of each device it will pass through and can sometimes have large overhead.

Advantages

- No Hello Packages

Disadvantages

- High overhead
- Stale Route Cache information
- Higher Connection Delays
- Performance Degrades with increasing mobility

AODV (Ad-hoc On Demand Distance Vector)

This is an on demand routing protocol for wireless ad hoc mobile networks that uses Hop By Hop routing. It works by constructing routes between nodes *on demand* by source nodes, and are kept until they are not needed. There is only one main route to the destination unlike DSR. Requests for routes have a time to live which stop's flooding of route requests, and there is a time limit of double the TTL before it can be re-requested.

Advantages

- Uses sequence numbers on route updates to find the latest route to destination
- Small Connection Setup Delay
- Fast for existing links
- Higher Capacity then DSR

Disadvantages

- Inconsistent routes if nodes have stale entries
- High traffic establishing route

Table 18-2 MANET Routing Protocols

Characteristic	DSR	AODV	OLSR	TORA
Routing Philosophy	Reactive	Reactive	Proactive	Both proactive and reactive
Type of Routing	Source routing	Hop-by-hop routing	Hop-by-hop routing	Hop-by-hop routing
Frequency of Updates	As needed	As needed	Periodically	Based on mode of operation
Worst case	Full flooding	Full flooding	Pure link state	Full flooding
Multiple routes	Yes	No	No	No

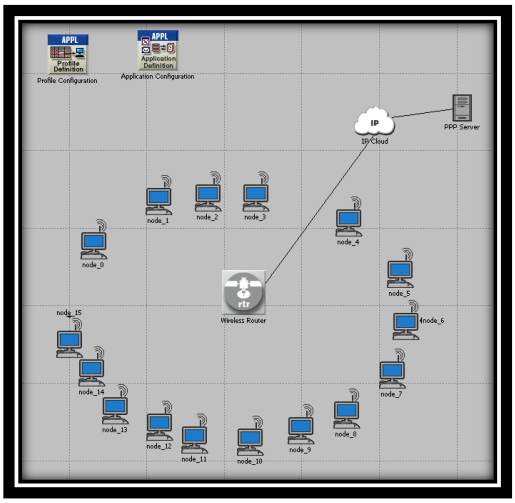
End of Table 18-2

Modelling

I propose to model the two routing protocols in Opnet Version 12. A standard scenario will be made first containing

- Sixteen Manet Workstations (AD-Hoc Routing Set to DSR or AODV depending on scenario)
- One Manet Wireless Ethernet Gateway (To connect Manet to IP Network)
- One PPP Server to Host the Applications
- 1 IP Cloud to Simulate a Wan
- The Workstation will connect wirelessly to the Manet Gateway at 2 - 11mb
- The Wireless Network will have the BSS Identifier of 0
- The Gateway will communicate over the IP Cloud to the PPP Server via a PPP DS1 Line
- The scenario will take place in an Office of size 100m x 100m
- Each Node will be in between 5-10 meters of each other to simulate an office environment and 20 meters away from the gateway

This will then be duplicated exactly for each routing protocol via the duplicate scenario function



A Print screen my scenario in Opnet

Applications

The application configuration used by each node will be as follows

- Mail High Load
- FTP High Load
- Video Conferencing (High Quality)

Profile

The Profile Configuration will be as follows

- Operation mode : Serial Random (This is to simulate real life usage)
- Start Time : 500 Seconds

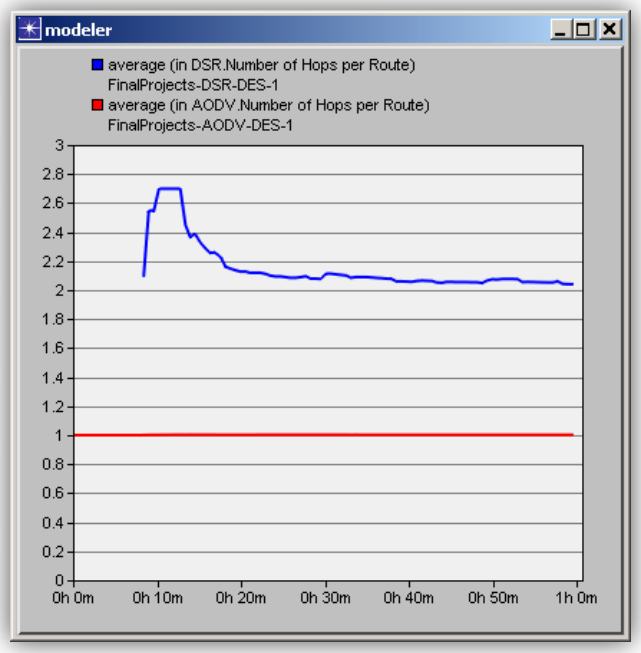
Simulation

The following statistics will be collected from each Scenario over a period of one hour

- Wireless Lan Throughput
- Delay
- Number of Hops
- Route Discovery Time

Results

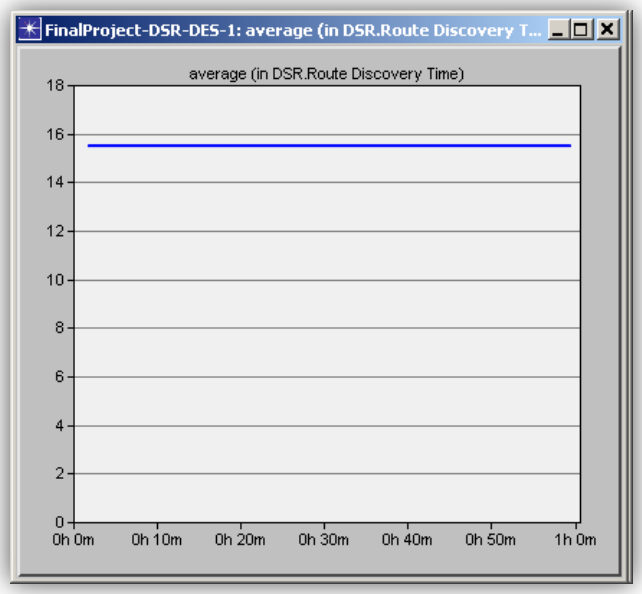
Number of Hops



As shown in the graph to the right the AODV Routing protocol produces a steady one hop per route. However DSR fluctuates between 2 and 2.8. This is due to the method of AODV offering one main route to the destination and DSR offering multiple routes.

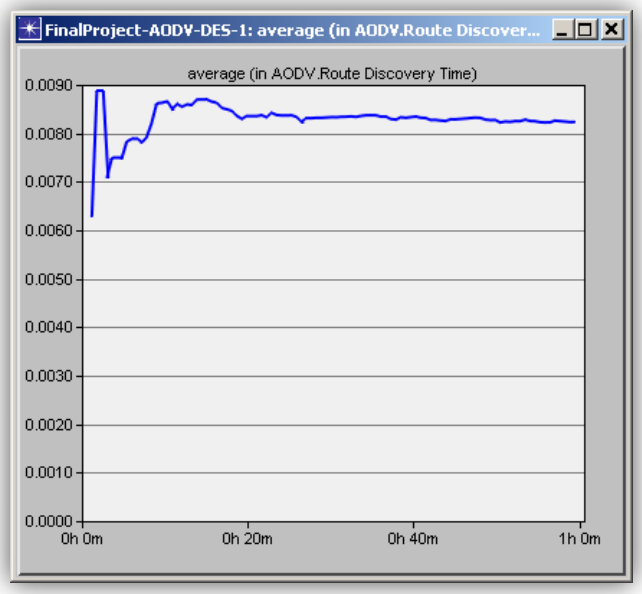
Route Discovery Time

Due to the wide variance in scales, I split up the graphs instead of overlaying them



DSR

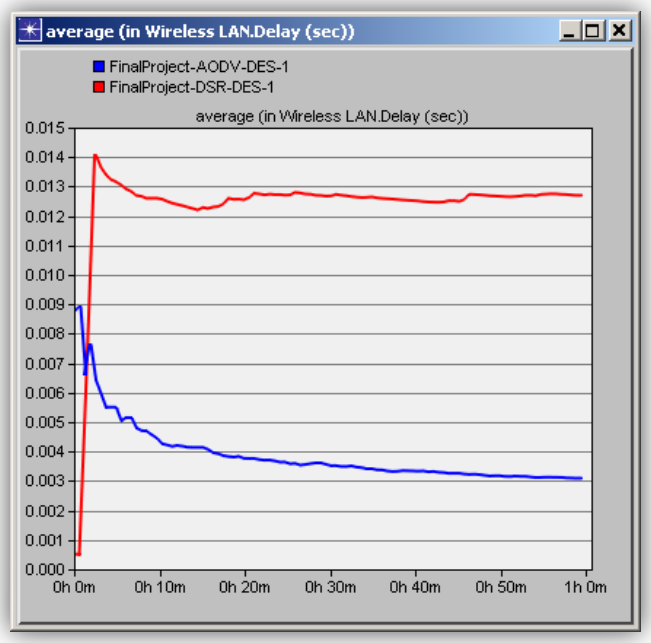
The route discovery time is constant around the mark 15.7. It is constant as it already has the route marked out are cached (Hence for the delay at the start) for each journey across the network. This is quite high due to the reactive routing protocol



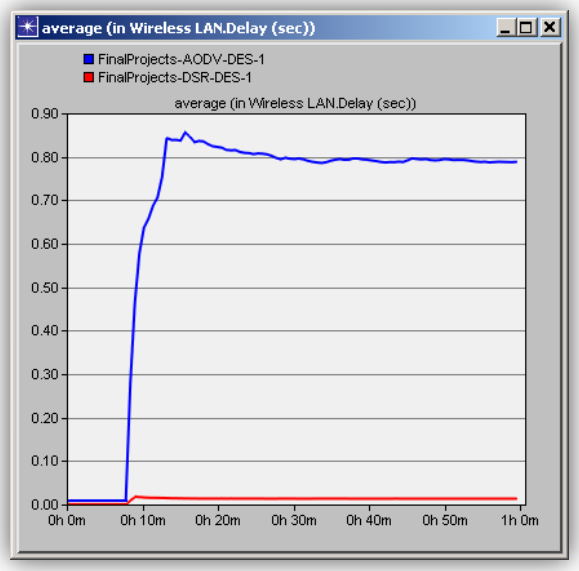
AODV

Compared with DSR the route discovery time is minimal and varying. However it shows that AODV is a faster protocol at finding the route due to using one route instead of multiple

Delay

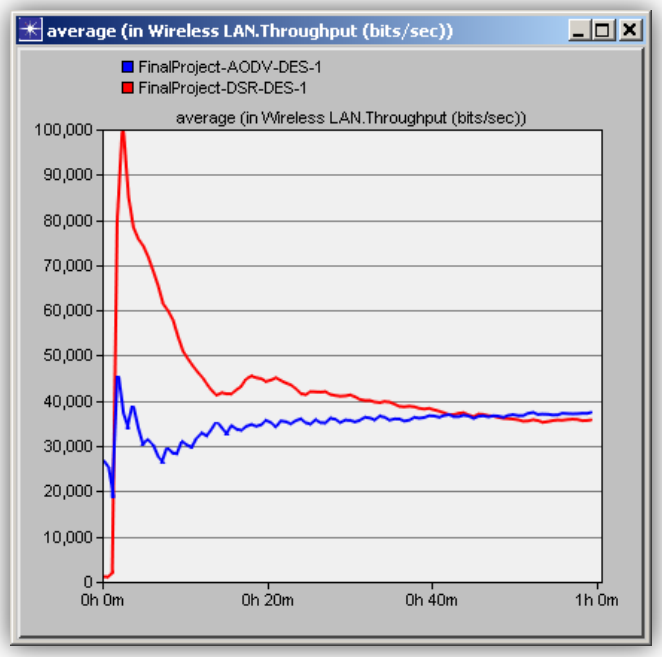


This shows AODV's ability to handle speed's of 11mb on a networks. DSR has a higher delay due to a higher overall overhead due to the increase in its route request



I then changed the data rate to 2mb , and AODV seemed to have a much higher delay.

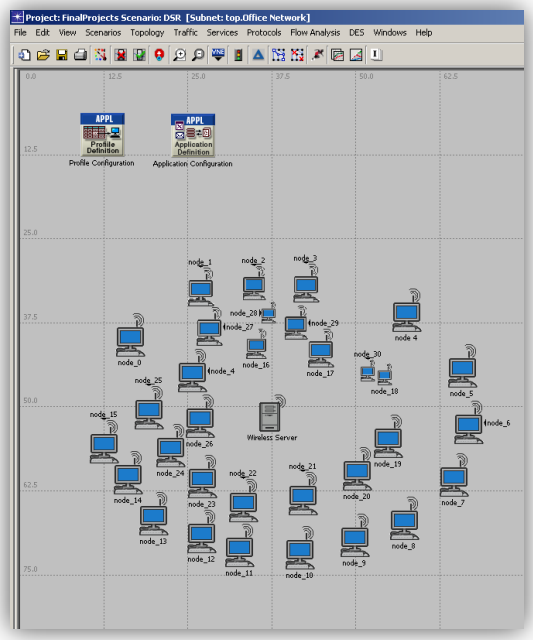
Wireless Throughput

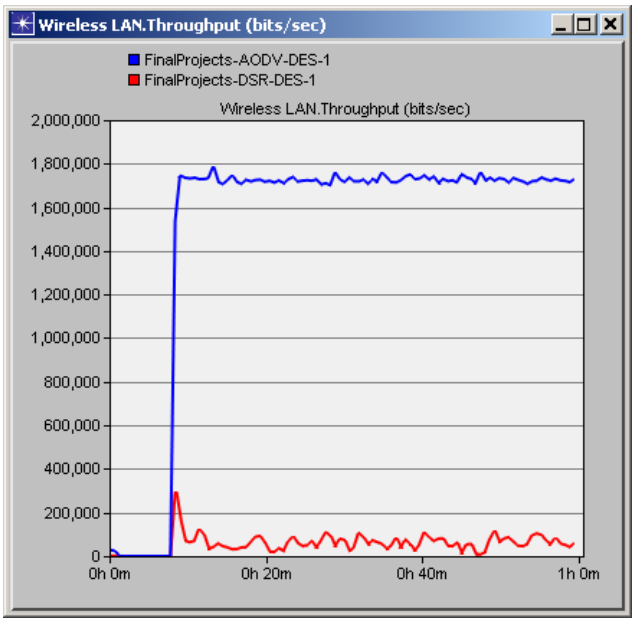


DSR seemed to have a peak throughput at the start. This could have been down to the amount of route requests at the start (A small Network flood). However at the 8m mark both protocol's had the same average throughput

Doubling the amount of Nodes

To test each scenario under pressure I thought I would double the node count. Due to the simulation run-time doubling I reduced the time of simulation to 20mins in DSR. Due to the third problem listed in the Title “Problems That Occurred”, I changed the Manet Gateway to a wireless Server with exactly the same settings as the PPP Server. Results might vary in Delay and No of Hops due data not flowing through an IP Cloud and Router, so these will be ignored



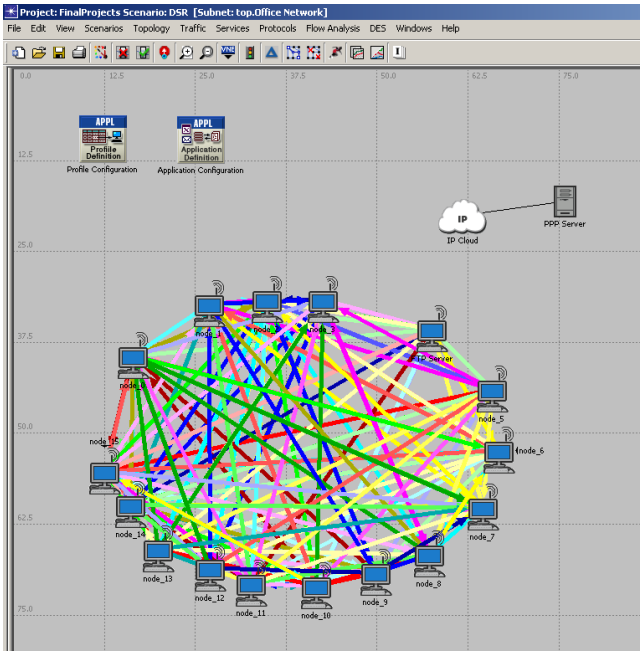


Doubling the number of nodes showed AODV with much more data throughput then DSR. This show’s AODV can handle nodal increase better then DSR

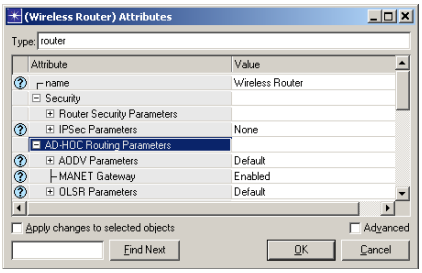
Problems That Occurred

During the modelling I had several problems that I have documented:

- During the setup of the main scenario I verified the links before simulation; however the line between the wireless router and the IP cloud came up with an error. After several attempts of rejoining the link I found it was the router I had chosen (Wireless Ethernet Router), which did not have the facility to connect to an IP Network. The replacement MAN ET gateway solved this and this is the only way to connect a Manet to IP Network in Opnet
- Once I ran the first simulation, it was clear there was no load getting through to the PPP server hence no general traffic on the network. After diagnoses through old lab sheets, I resolved the issue by selecting “All” from the attribute “Supported Services” on the PPP Server.



The wireless router chosen to connect the IP network with the MANET (Wireless MANET Gateway) did not support DSR routing , Only AODV.

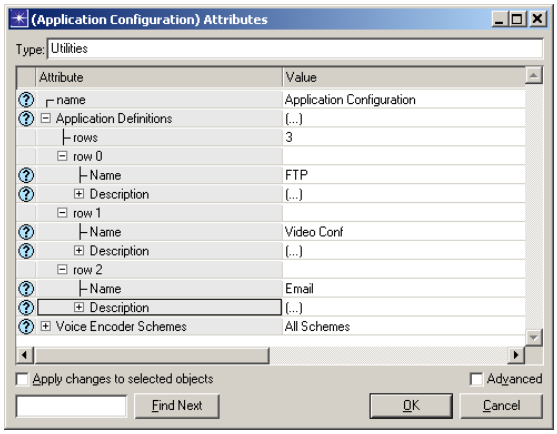


This was the only router that could connect a IP cloud in a MANET. For the DSR Scenario I listed the routes used by each node so show the hopes and network activity.

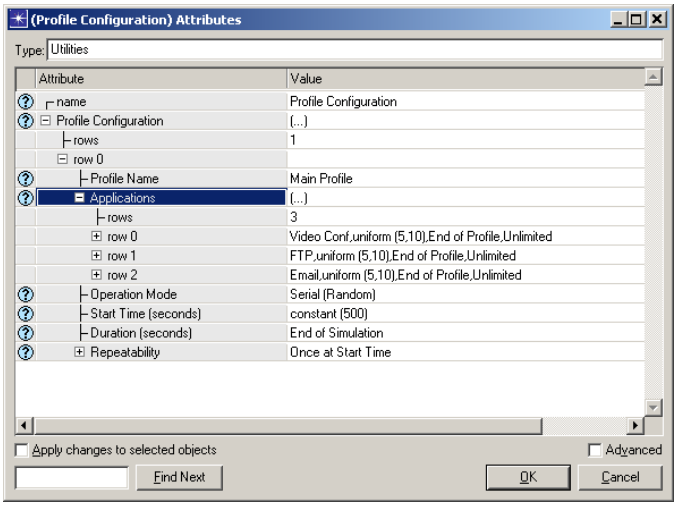
Questions

1) **What is the difference between the Application and Profile Configurations?**

   The Application Configuration in Opnet defines the Applications used in a specific project. For example in this project we where given the Application Types : Mail , Ftp and Video Conferencing. We can define the usage of these applications between low, medium and high. These can then be linked to a profile of a user



The Profile Configuration lets us define the profile of user's using our system. For example we could have a normal network user who has light HTTP and VOIP usage and we can model the network with this user by the creation of a profile with the above usage demographics. If we wanted to stress test the model we would create a profile for an advanced user who is likely to user high HTTP , Video Conferencing , FTP and model with both user's to make sure the network can cope with both.



2) Why did you assign a common BSS identifier? And what did you assign?

A BSS identifier (Basic Service Set Identifier) is a unique identifier for a particular Ad-Hoc BSS 802.11 Wireless LAN. For communication between each of the nodes and the router there needs to be a common BSS Identifier. For this I choose the Value “0” as the identifier needed to be numerical unlike an SSID.

3) Explain the role of the three interfaces? i.e. Router , Internet_Cloud, Server?

The role of the router is to act as a wireless access point for the wireless nodes, and route traffic to and From the PPP Server , via a PPP_DS1 through the internet. There would have been multiple virtual Routers in the IP Cloud.

The role of the internet cloud is to represent and simulate data flowing over a WAN. The data flows through virtual random number of router’s, and this cannot be edited. It is typically used to model sites through the internet.

The role of the server is the host all of the application’s that the application’s use e.g. FTP Server, Web Server or database Server. It does this over a PPP_DS1 link via an IP Network hence the use of a Point to Point Server.

4) From your results which protocol gives you the best throughput, less delay and less number of hops, with the shortest route discovery time? Why?

My results prove that AODV gives the largest throughput and lower amount of hops. However delay depends on the amount of traffic and user’s (DSR performs between on a normal data rate of 2mb). This is down to their individual methods of data delivery , DSR has multiple routes but AODV one has one, Throughput is the headers and data combined so this could be a benefit of bandwidth provided or a negative factor of congestion. AODV has a much shorter route discovery time which could be down to the initial flooding of route requests.

5) **From your simulation results, what is the best-case scenario for both protocols?**
From my results in this instance it shows AODV is the strongest candidate when experiencing an increase in nodes and bandwidth. However DSR is still a strong candidate for high throughput Ad-Hoc network s with an average amount of nodes.

6) **What is meant by on-demand routing protocol?**
On –Demand routing is the ability to route data when needed from it's peer's. This cerate's routes on demand that are kept open until need then closed. This is a totally different approach to most routing protocols which keep routing tables of peer's around them leaving or joining the network.

Conclusion

To conclude after the investigation of the DSR and AODV routing protocols I have found the following

- What Ad-Hoc Network's are the routing Methodologies used by each major protocol
- In modelling Reactive Protocols , Network full flooding did occur slightly but not enough to effect major delays or congestion
- How to create , modify and benchmark a MANET Network and Compare Scenarios

DSR seems to be much better suited to smaller highload networks as it does not need to flood the network with table updates requests in table driven protocols such as AODV. As the number of nodes increase AODV can handle the increase in nodes arriving and leaving with its structured table approach as long as the overall bandwidth can cope with the other head of table sharing. DSR has also got to store the whole route in the header, so when a network increases in nodes, this extra overhead goes up exponentially.

I found this project very useful for getting to know and use Opnet , I diagnosed problems using the User guide and published internet journals (*Referenced below*). I feel this will aid my dissertation topic on comparing two wireless technologies's and give me the background knowledge to model each one and extract correct data.

References

MANET, Operation Manual (2007, January). Opnet.

Rodolfo Oliveira, L. B. (2006). Departamento de Engenharia Electrotécnica - Universidade Nova de Lisboa,Portugal. *Flooding Techniques for Resource Discovery on High Mobility MANETS* .