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Comparing Performance of AODV, DSR, DSDV, ZRP with Black Hole Attack and without Attack through Use of NS2 Simulator

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Abstract

MANET is a collection of wireless mobile hosts forming a temporary network without the aid of any centralized administration. Security has become a primary concern in order to provide protected communication between mobile nodes in a hostile environment. Unlike the wired networks, the unique characteristics of MANET pose a number of non-trivial challenges to security design. In MANETs, routing protocols are necessary to find specific paths between the source and the destination. MANET routing protocols are categorized into three types named as proactive, reactive, hybrid. To Provide Connectivity, Wireless MANETs take the help of multi-hop peer to peer routing. The MANETs topology change with time. MANETs have applications in several military and civilian areas. Ad-hoc Networking allows movable devices to make communication without any centralized infrastructure. Due to the unavailability of centralized infrastructure, routing and security are the two kinds of problems created by the random motion of devices. This paper contains comparison related to five different types of routing protocols named as AODV, DSDV, DSR and ZRP. In MANET, these protocols are used for active routing under the several scenarios which plays a complex role in places where wired networks neither present nor economical to play. My objective was to implement four routing protocols named above by using NS2 and compared their performances under different Parameters and metrics by using Attack and without attack.

Keywords: - MANETs, DSR, DSDV, ZRP, AODV, NS2, Routing Protocols, Black Hole Attack, AODV-BH, DSDV-BH, DSR-BH, ZRP-BH.

I. Introduction

A MANET uses multiple hops routing that have uses in several domains like military, civilian and computing areas. The MANETs topology continuously manipulate with time. The traditional routing protocols are not superior for MANETs due to this fresh challenge faced by protocols of routing. Not all the protocols can handle change in topology as well as the proved assumptions used by these protocols. Mobile Ad-hoc network can be divided into Table Driven, on demand, hybrid (ZRP), hierarchical, geographical due to several techniques of routing. A mobile ad-hoc network is a union of mobile nodes forming an ad-hoc network without centralized infrastructure. These networks did well in environment without any infrastructure and deploy an infrastructure is not very cost effective. The Famous/known IEEE 802.11 WIFI protocol is capable of giving ad-hoc network facilities at low match, when no infrastructure is available. They do not data route across the network but the nodes are limited to send and receive data. Mobile ad-hoc networks are possibly link to a large network such as internet. These networks show same performances in all places. MANET is famous because of broad area of present wireless services providing pervasive computing at low cost. The main objective of such type of network is to give quick process of communication arrangement and computing. The Behavior of protocols of routing in this changing world topology environment is important. DSDV, DSR, ZRP, OLSR, AODV are some of the protocols of routing have been suggested on the last two decades. This changing environment and framework not only provides big dare to improve the role of ad-hoc network routing protocols. Nodes differing speed leads to failure of link. Congestion leads by size of networks and load of traffic. Limited range of transmission, power and high frequency also causes reasonable impacts over scalability of networks. We have been use wireless cellular systems since 1980. It has been manipulated to 1^{st}, 2^{nd} and 3^{rd} generations. These systems operate by way of an access point. With the support of these access points, wireless users can be interconnected with wireless system when they move from one position to another position. The versatility of wireless systems is bounded by the existence of a constant supporting coordinate. In the absence of fixed infrastructure, technology cannot operate effortlessly. Smooth and quick categorization of wireless networks will be familiar by the forthcoming generation wireless systems. This rapid network classification is unimaginable due to present structure of existing wireless systems. Latest upgrading and improvement like Bluetooth popularized a fresh combo of wireless systems that is also known as MANETs. This is also known as short line networks. MANETS is a sovereign system of mobile nodes affiliated by wireless links, every nodes works as a router for the remaining nodes in the networks otherwise nodes works as an end system. Electronically, wireless network is an upgraded fresh automaton that will permit users to connect to information and services without regard of their geographic locations. Infra-structured network and infrastructure-less networks are the two categories of wireless networks. Infra-structured networks are those networks where fixed and wired gateways exist. In this network, mobile communicate with a bridge in its communication radius.

Handoff is the procedure in which mobile node interact with fresh base station if it goes out of range with previous base station. In this network, the base stations are

finite. A MANET is a union of nodes that are wireless which communicate/interact by forwarding packets to permit them to collaborate with foreign domain of explicit wireless transmission.

Mobile adhoc wireless network is a set of self sufficient mobile nodes that can interact to each other with the help of radio waves. The mobile nodes can connect explicitly to those nodes that are within radio-range of each other. While the other nodes wants the help of in-between nodes to route their packets. These networks are fully disseminated and act at any area without the service of any structure. This feature turns the network highly strong.

In order to interact, nodes P and Q needs to find the route with the help of R nominal area to every nodes radio devices for receiving such as transceiver. Nodes P and Q are neither in explicit transmission area of other. So P takes the help of R to send a information to Q. In this A behaves as In-between node.

II. Routing Protocols

MANETs are multi-hop ad-hoc wireless networks in which structure of the networks manipulates vigorously due to the motion of nodes. Nodes in these networks make use of the similar random access in wireless channel, collaborating in a friendly manner to involving themselves in forwarding the network nodes that only behave as hosts but also behave as routers that shift data from one node to other node. Like as wireless networks, MANET also does not have infrastructure support. There is a requirement of a routing procedure when the node of a destination outside the range of a source node. There is a need of routing procedures to get a path, so as to send the packets accurately between the transmitters of a destination.

A. AODV

Reactive routing protocol/ source initiated routing protocol/ reactive gateway discovery is called by Adhoc on demand vector routing protocol. This is due to AODV only finds the way to the destination when source desires to send data. Route discovery mechanism of AODV depends upon route request, route reply and route fault message. In AODV, when there is a desire to discover path, source node sends so many RREQ messages to all nearby immediate nodes. The serial number of destination is contained by this RREQ message. The sequence number of destination is contained by this RREQ message. This sequence number guides in assuring route effectiveness availability and protect from loop in routing. For sending node, a node having highest sequence number is preferred first. Neighboring node review the destination ID after collecting RREQ message. RREQ message is reciprocated to requested node if the path is found. The path that follows RREP message send data packet neighboring nodes forwarding the RREQ message to their nearby neighbors, if the path is not found. RREQ message is send to source node if the link break occurs. The format of RREQ is

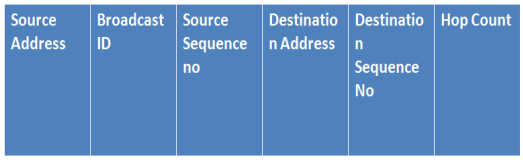

Figure 1: - Format of RREQ

The < Sender Address/ Source Address, Distributed ID/Broadcast ID> recognize a RREQ

B. DSR

It depends on bellman ford algorithm. Few extreme / extensive modifications have been done in bellman ford algorithm so that it is well suited for environment and suffer with CI (count to infinity) problem. Sequence number used by DSDV to compare between stale/old and new routes and escape from CI problem. Modifications are transmitted due to manipulation in topology which causes overhead. Table driven and time are two category of update. A complete dump and incremental manipulation are the two categories of updating that are used to overcome the drawback. In complete dump, whole routing table is sent to neighbors as far as full topology change. In incremental manipulation, modification in the route is set. It I depend on classical bellman ford algorithm designed for MANET. Each node maintains a number of all destinations and list of hops to every destination. To reduce network jam/traffic created by route update, DSDV uses incremental manipulation or complete dump. The settling time delays the broadcast of route updates. The avoidance of routing loops and CI problem is one of the improvements in a mobile network of routers, whether the source node needed the information or not. Routing information can be always available with this improvement when there is a link addition/removal occurs, i.e. manipulation occurs. The format of DSDV is

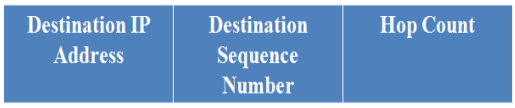

Figure 2: - Format of DSDV

C. DSDV

The routing protocols designed basically for used in multiple hops adhoc wireless networks. DSR make the network self learned with any consolidated infrastructure. DSR appears under reactive routing access that raises route discovery and route maintenance process. It uses the source routing means source needs to know the full hop sequence to the destination. The main loss is that every packet has to carry the overhead. Finding a route is high priced in case of time, energy and high frequency. Advantage is that it avoids routing loops due to determination of complete route by a

single node. Another advantage is that avoidance of the need for update routing information in the in-between node due to all the needed routing information. It establishes the way with less delay. It easily repaired the broken link in active/ working routes. Sequence numbers are used for loop free activity and trace accuracy of information. Only carry trace file of next order hop for a single path rather than complete path. To footprint neighbors, continuous HELLO messages are used. It removes the requirement to continuously traffic the network with update message like in an AODV. The in-between node makes use of information of route cache efficiently to overcome the control overhead. Path distance is directly proportional to the overhead routing.

D. ZRP

ZRP is outline to direct the problem related with proactive and reactive routing. Extreme bandwidth usage due to flooding of update packets and high delay in request of route discovery are two major problems of proactive and reactive routing protocol. ZRP arise/occur with the idea of zones. Route maintenance is smoother and less no of routing updates due to limited zone. Border node performs the task of reactive routing when the node is external to the zone can communicate. Hence ZRP gathers the characteristics of both proactive and reactive protocol. MAC level functions intra zone routing protocol, broadcast routing protocol are the four components contained by the ZRP structure/architecture. When the nodes are inside/within the zone, proactive routing is used. When the nodes are outside the zone, reactive routing is neighbor finding and function of maintenance is done by MAC level. When nodes is in connected or loses area, a acknowledgement of freshly coming neighbor is sent to IARP. Packets routed by an IARP protocol within a defined zone. IARP holds information in the routing table about all the nodes. If the nodes are outside the zone, IERP protocols help to search best path. Accurate routes are maintained by the IERP outside the zone. If the routes in its table are not present in IERP, then it transmits query to BRP that restricts traffic/flood within network. It sends route query request to nodes lie in border which transmit and receive packets only.

III. NS2 Simulator

NS2 is a disconnected event simulator directed at networking research. It gives generous means for TCP routing and Multicast protocols by wired and wireless Networks. Imitation results can be shown as graphical interpretation by xgraph. The flavor used is ubuntu 12.04 in platform of linux operating system. NS2 deciphers OTCL scripts illustrated by user. A user explained several elements of system of connections in OTCL like scheduler objects. These simulators are reproduced with the NS2. The broad understanding of NS2 in research and thesis sector is due to free dissemination and open source. It is appropriate for distinguishing several protocols, jam and builds fresh protocols. It is a union of C++ and otcl. Object oriented imitator is also known as ns2 because it uses c++. Otcl works as an interpreter. On one hand, constituent imitations of protocols need a system programming language which can usefully packet header. The time it takes to deal with is less and run time speed is

more important for the tasks. C++ is quick to learn but change slowly. In NS2 two languages are used one of two is tcl which is the front end language removes the disadvantage of C++. It changes quickly but slow to run. Second of two is called backend language written in C++. DSDV, DSR, ZRP, OLSR and AODV programming are done in tcl program. When it is compiled, a trace and a nam file are generated, which gives information about the motion pattern of nodes, sum of hops among nodes and type of linking. A scenario file is originated which describe mobile nodes destination along with their speed. Cbr file s also generated illustrates the connection arrangement, topography and packets type that are useful to obtain the trace file and nam files used by the imitator to reproduce the network.

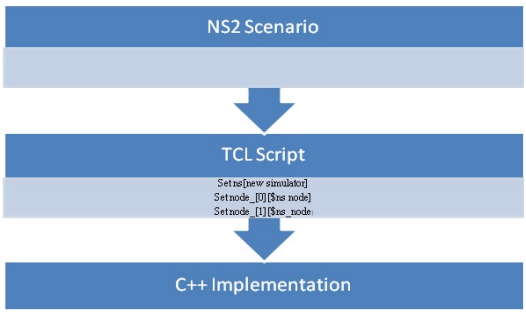

Figure 3: - Basic steps of NS2

A. **Use of NS2**

It is used in TCP, routing in adhoc networks like DSDV, DSR, ZRP, AODV and the remaining protocols too, MAC like TDMA, multiple casting protocols, used in satellite like spacecraft protocols.

B. **Installation of NS2**

After running all these commands bestowed in the figure below, then next step is to run make and make depend command when it is required. The motive was to implement DSDV, DSR, ZRP, OLSR and AODV for nodes sending cbr file with irregular speed. Scenario and cbr files are generated at first and using protocol imitation done which output the nam and trace file for DSDV, DSR, OLSR, ZRP and AODV protocol of routing. Scenario file helps to hoard the starting place of the nodes and motion of nodes at distinct times and their speed. Since it will be tough to mutually give start position, motion of the nodes and then speed for each motion at distinct times.

Figure 4: - Installation Process

C. **Architecture of NS2**

In TCL basic architecture, first TCL imitation script is written in tcl file and its expansion is.tcl then it is operate by NS2 shell executable command which involves both C++ and tcl language. The connection within two languages is provided through tclcl associating. Shell originates two outputs one of two is NAM which hoard the output as activity. Second of two outputs is Trace file which hoards the output as easily studied? Advanced architecture differ from basic architecture of NS2 because in advance architecture, c++ imitation objects is exchanged with c++, OTCL simulation objects is regained with otcl interpreter and NAM and Trace file is replaced with simulation results.

D. **Metrics of Routing Protocol**

a. PDR**: -** It is also known as packet delivery ratio which is defined as division of packets of data arrived at receiver to the originated/total packets of data. It only computes the sum of packets reached in the destination.

b. Delay: - The subtraction of arrived data packet time to the originated data packet time through sender. This is also called as latency. The application that is used in Delay that is sensitive is voice. It is inversely proportional to behavior of protocols.

c. NRL: - The sum of control message of routing is divided to the sum of arrived messages at the destination.

d. Throughput: - The sum of messages arrives at receiver is followed by size of packet multiplied by 8 is divided to the total time of simulation. Mathematical calculations can be used to determine throughput.

e. Packet Sent: - The sums of packets assigned to the destination.

f. Packet Receiving Count: - The sum of packets reached in the destination.

E. Dissimilarity between C++ and OTCL

The dissimilarity between C++ and otcl is shown in below table: -

Table 1: - Dissimilarity between C++ and O-TCL

S.No	C++	O-TCL
1	Speedy to operate	Lazy to operate
2	Lazy to code	Speedy to code
3	Lazy to manipulate	Speedy to manipulate

F. Performance parameters:-

The several parameters used in DSDV, DSR, ZRP, OLSR and AODV are given below: -

Parameters	Value
Operating System	Ubuntu 12.04
NS2	2.35
Routing Protocol	AODV,DSDV,DSR,ZRP
Channel Type	Wireless Channel
Radio Propogation Model	Two wayround
Network interface Type	Wireless Physical
Mac Type	802.11
Queue/Drop Tail	Priority Queue
Antenna	Omni Antenna
Max Packet in NIT	50
No of mobile nodes	30
X dimension of topography	1000
Y dimension of topography	1000
Simulation time	"./comm"
Initial energy	1000
Transmission Power	0.025
Range	3.65262e-10
Frequency	914e+6
Agent	UDP
Application	CBR
Packet Size	512
Maximum Packets	1000
Speed	3, 5, 7

Figure 5: - Performance Parameters

IV. Literature Review

Lakshmikanth *et al.* distinguished the behavior determination of Ad hoc Protocols of routing DSDV, DSR and AODV. The Behavior metrices of two parameters: - PDR and AED for better effort of traffic. The NRL helps in put into action the effectiveness of the routing protocol. In other side, organized load of MAC is a computation of the efficient use of the wireless medium for data Jam. Graph is obtained after portioning the 41 schemes into 4 areas. Distinct outcomes are shown by all procedures. The behavior of routing protocols is mainly changed by the sum of nodes. Maximum speed affects PDR but not NRL and AED. Transmission power is directly proportional to range of transmission but due to increase in range of transmission,

interference within the nodes increases and increase in PDR. Due to on demand nature of both AODV and DSR, it is best than DSDV. Also AODV and DSR use less power and handling rate of packet is more. The behavior of DSR is fine at all rate of mobility and speed of movement. Mobility rate and speed movement of DSR is similar to AODV that fulfill the objective of overcoming overhead routing. Mobility rate of AODV is costly than DSR. At final, AODV and DSR behavior is good than DSDV at high power transmission and routing load of AODV is raised too. [1]

Tomar *et al.* suggested an algorithm to remove flooding drawback from the network and reduce the sum of packets in the network which overcomes the overhead packet routing. Instead of mobility rate, AODV and DSR behave well and send 95% of data packets but DSDV is unable to converge if the mobility rate drops is dropped by both overhead of AODV and DSR routing protocol. The behavior of DSDV is fine at fewer rates of mobility and less speed of movement. Increase in immovability decreases the performance or behavior. The behavior of DSR is fine at all rates of mobility and at all speed of movement. But it needs bytes of high overhead routing and sends and receives packets of several overhead routing. Throughput and delivery rate improves the network in this paper. [2]

Kalia *et al.* determined the behavior of adhoc protocols of routings likely DSDV, DSR and AODV. End to end delay is directly proportional to nodes density and inversely proportional to pause time. Better end to end delay and throughput behavior is provided by AODV. During the route discovery phase, sum of packets are dropped by the AODV. DSR has a tiny higher PDR than AODV. It is a modification of DSR and DSDV. DSR is appropriate for that network with balanced rate of mobility and having low overhead that changes it appropriate for small bandwidth as well small power network. Those nodes having heavy population are appropriate for DSDV. The main advantage is its best support for multicasting and multiple routes. [3]

Khan *et al.* distinguished the behavior of 3 routing protocols named as DSDV, DSR and AODV depend on changing sum of nodes in the ad hoc wireless network. DSR behaves well in terms of PDR, if the sum of nodes is directly proportional to load otherwise behavior will degrades. DSDV behave better with maximum sum of nodes than in distinguishing with the remaining 2 protocols. The static behavior produced by AODV. For the AED, the behavior of DSR and AODV are completely uniform. The behavior of DSDV is declining because of increase in the total number of nodes. Because of the motion of nodes, the load of routing tables exchange converts to high and the frequency change also rose. Routing overhead of DSR and routing overhead of AODV is completely same in performance. It shows that the behavior of the DSR and AODV is better than DSDV. [4]

Dalal *et al.* distinguished the AODV and DSR Behavior; AODV even though is an On-Demand protocol of routing and also keep up routing tables. It has characteristics of on demand and table driven protocol of routing both. To harbor to route discovery more than DSR, only one access per pair is used. It does not take the help of tables of routing but has several routes per pair. Full hop to hop route has been considered by the sender or source node so that it catches the full application of routing. It has to harbor to route discovery lower than AODV because there are

several substitute of routes existed. AODV has low end to end delay and more average throughput than DSR. Hence the behavior of AODV is better. [5]

Vijaya *et al.* determined DSDV, DSR and AODV, study the behavior and categorized by load, size, ratio of delivery and end-to-end delay. They studied that DSDV has bad throughput because of deal with mobility. DSDV is good for small loads with less number of nodes. AODV is superior at max loads. DSR pursue the huge amount of traffic is transmitted by AODV and then by DSDV. It transmits the routing traffic only in the occurrence of data that has ready to transmit is the main reason of acquiring low overhead. This removes the desire to transmit unwanted routing traffic. Due to much route reply to a single request, AODV has high routing overhead as compared to DSR. This in turn eliminates the need to send unnecessary routing traffic. AODV and DSR use distinct mechanism for route discovery but with same table driven method. AODV originates maximum overhead than DSR. But DSDV produces same overhead always hence it is constant because of proactive nature. High rate of mobility causes repeated failures in DSDV and overhead participated in modifying all the nodes of network with fresh routing information as distinguished with DSR and AODV in which routes are built and it is needed. [6]

Mahmoud *et al.* distinguish the behavior among 2 routing algorithms named as DSDV protocol and AODV protocol. In case of AODV, speed and nodes is inversely proportional to throughput. AODV uses inundation for route discovery. But in case of DSDV, throughput is inversely proportional to nodes and speed too. It produces more traffic as compared to its analogue AODV. The main reason is that DSDV continuously produces traffic of routing as anti to AODV which is not afflicted by speed as DSDV. DSDV is chosen due to simple nature over other techniques which are complex without give up their behavior. [7]

V. Related Work

A comparison will be organized to search which routing protocol is adequate in terms of security issues, PDR, delay, NRL, Packet sent, throughput, Packet received.

This paper contains issues related to four different types of routing protocols named as AODV, DSDV, DSR, and ZRP. First we installed OS ubuntu by virtual box. The package used in our thesis is NS2 because it contains all AODV, DSDV, DSR protocols. As per our objective, we have to compare the performance of DSDV, DSR, ZRP, and AODV. But ZRP is not under ns2.35, so for ZRP, we need to integrate both separately with NS2 and make the patch file of them. Now we will have to design a network as per required for all- AODV, DSR, DSDV, ZRP. For analysis of Performance we can opt any script like Shell, Perl, Awk and so on. After getting performance of multiple protocols we can do next step. For checking performance we will have to apply an attack so we are going to apply black hole attack on all routing protocol named as AODV-BH, DSDV-BH, DSR-BH, ZRP-BH and then we will check the performance. BH is black-hole. Make, make depend, sudo make install are the commands used to run all protocols. The performance metrices that we consider for comparing performances are named as throughput, PDR, NRL, end to end delay, loss of packet, routing overhead. This is done by using AWK script. This analysis is

done by way of Graph and AWK script file. We Enter the values comes through AWK script file is entered in EXCEL sheet and make a chart by way of the entries as represented in figure given below

A. Analysis of comparison between AODV and AODV-BH (AODV with Black hole):

From the below table and graph we analyzed that AODV is better in delay than AODV-BH attack. AODV is superior in PDR, NRL and throughput than AODV-BH. The Receiving packet count values of AODV table is less than receiving packet count values of AODV-BH table. The sum of packets lost values in AODV table is less than AODV-BH table.

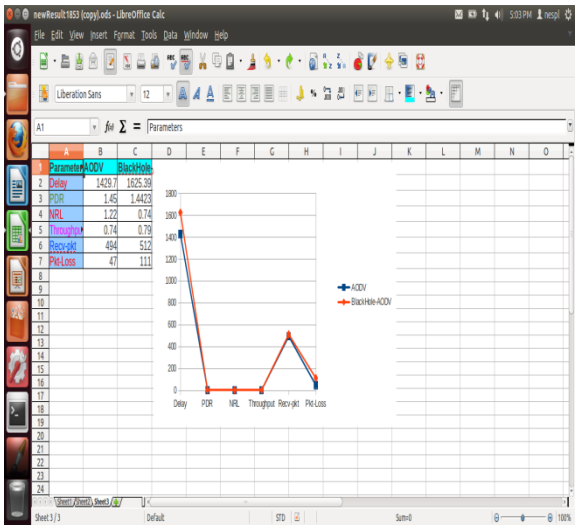

Figure 6: - Comparative Analysis between AODV and AODV-BH

B. Analysis of comparison between DSDV and DSDV-BH (DSDV with Black hole):

The graph and Table of DSDV with Black Hole Attack and Without Attack is shown below: -

From the below table and graph we analyzed that DSDV is very much better in delay than DSDV-BH attack. DSDV is superior in PDR and throughput than DSDV-BH. The Receiving packet count values of DSDV table is inferior than receiving packet count values of DSDV-BH table. The sum of packets lost values in DSDV table is inferior to DSDV-BH table. The NRL (Normalized Routing Load) of DSDV is superior to DSDV-BH.

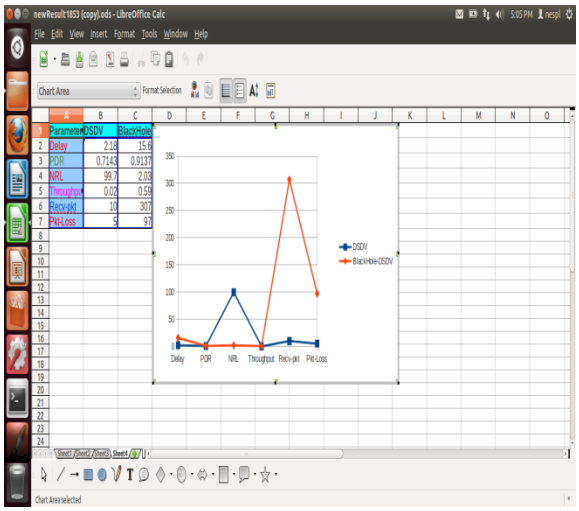

Figure 7: - Comparative Analysis between DSDV and DSDV-BH

C. Analysis of comparison between DSR and DSR-BH (DSR with Black hole):

The graph and Table of DSR with Black Hole Attack and Without Attack is shown below: -

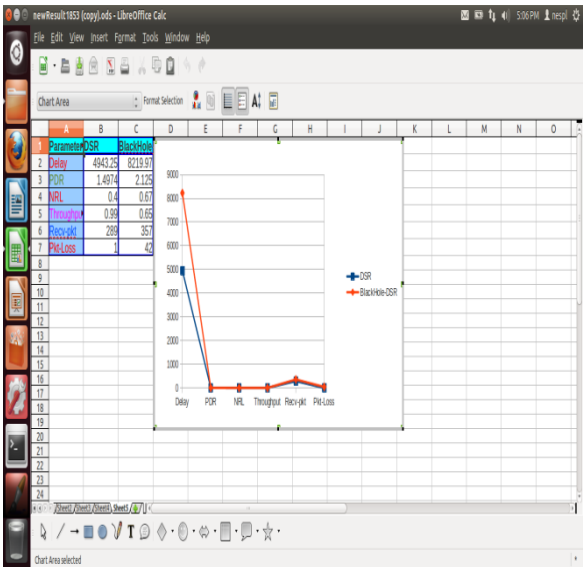

Figure 8: - Comparative Analysis between DSR and DSR-BH

From the above table and graph we analyzed that the values of delay, NRL and packet lost in DSR table is very lower than DSR-BH table that means DSR is superior in delay, NRL and Packet lost than DSR-BH Attack. The values of PDR in DSR table are very less than DSR-BH table hence DSR is inferior in PDR than DSR-BH. The throughput in DSR is extremely higher than DSR-BH.

D. Analysis of comparison between ZRP and ZRP-BH (ZRP with Black hole):

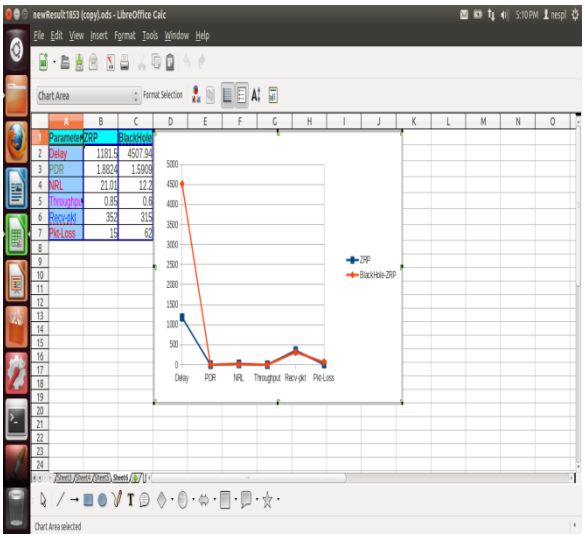

Figure 9: - Comparative Analysis between ZRP and ZRP-BH

From the above table and graph we analyzed that ZRP is superior in delay, PDR, Receiving Packet Count, Throughput and Packet lost than ZRP-BH attack. The values of NRL in ZRP table is extremely higher than ZRP-BH table hence ZRP is inferior in NRL than ZRP-BH.

E. Performance without Attack: -

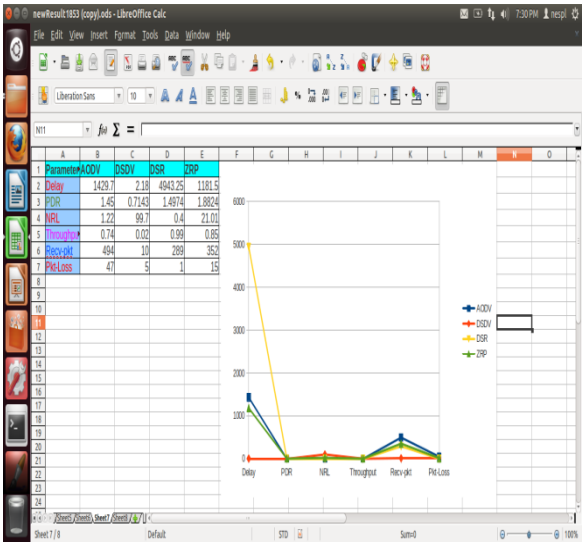

Figure 10: - Comparative performance of AODV, DSDV, DSR and ZRP without Attack

From the above table and graph we analyzed that the value of delay in DSR table is higher than all values of delay in the remaining tables of protocols. DSDV is superior in delay without Black hole attack due to less value of delay in its own table. ZRP is superior in PDR but DSDV is inferior in PDR due to less value of PDR in its own table. The value of NRL is extremely high in DSDV table and less in DSR table. The value of Throughput is extremely high in DSR table and less in DSDV table. The value of receiving packet count is extremely high in AODV and less in DSDV table.

F. Performance with Black Hole Attack

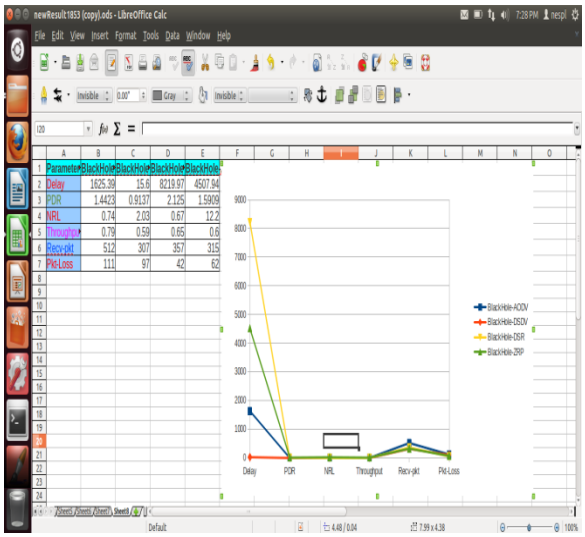

Figure 11: - Comparative performance of AODV, DSDV, DSR and ZRP with Black Hole Attack

From the above table and graph represented in the figure, we analyzed that the DSR-BH is inferior in delay due to extreme high values of delay in its own table and superior in packet loss due to less packet loss value in DSR-BH table. DSDV-BH is superior in Delay. The values of Receiving Packet Count are high in AODV-BH table. The values of through put are high in DSR-BH table. The values of NRL are high in ZRP table. DSR-BH is superior in PDR.

VI. Conclusion

The paper concludes that DSDV is superior in delay than all protocols it means that it DSDV has good DSR and DSR-BH is superior in PDR than all protocols but DSR-BH is superior in PDR than DSR. Throughput and NRL is superior in DSDV. The value of receiving packet count is more in AODV table and AODV-BH table but the values of receiving packet count in AODV-BH table is more than values of receiving packet count in AODV table. The values of packet loss in DSR and DSR-BH are lesser than all protocols tables. But DSR-BH has more packet loss than DSR. The values of throughput are high in AODV and AODV-BH table, but throughput in

AODV-BH is superior in AODV. ZRP is superior in delay, PDR, Receiving Packet Count, Throughput and Packet lost than ZRP-BH attack. The NRL value in ZRP table is more than ZRP-BH table hence ZRP is inferior in NRL than ZRP-BH.

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