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Modified IDS-AODV for Prevention of Black Hole Attacks in MANIT

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ABSTRACT
Mobile ad hoc network is a self-configuring and decentralizing network which is proficient to structure network dynamically. Due to its dynamic behavior and lack of central authority security becomes the challenging task for this network. In this most of the nodes can get compromised from various types of threats such as worm hole, black hole and denial of service. Black hole attack is a serious threat which inject false route over the network by broadcasting itself as a shortest route. In this work, we use the light-weight versions of symmetric encryption protocols PRESENT and HIGHT because the goal is to provide better security by minimizing the number of computations used for encryption so as to reduce the energy consumption. The simulation of our proposed mechanism is performed in NS-2.34 network simulator and the analysis of proposed mechanism is done using performance measuring metrics like PDR, Throughput, Routing load and End-to End delay. The experimental results of our work outperforms than the other ones.
Keywords: Ad hoc network, Black hole, PDR, Cipher, Network Simulator

INTRODUCTION

A MANET is a gathering of portable hubs that arrange themselves into a system with no predefined framework or brought together operation administration. MANET is an IP based system comprising of various remote and versatile machine hubs connected with radio. In MANET, hubs inside of the radio reach speak with one another specifically by means of remote connections, while hubs out of the radio extent require a moderate hub to forward their messages.[11] All the hubs in system take an interest in system administration undertaking. Thus organize administration is done in conveyed way. Every hub in the system works both as switch and host. As all hubs are portable so this progressions topology of the system powerfully, that acquires more difficulties security of Ad hoc system. MANET does not require any settled foundation, for example, base stations; in this manner, it is an alluring systems administration choice for interfacing cell phones rapidly and suddenly. Element system topology, fluctuating connection data transfer capacity, multi-jump steering, self-association, self-versatile and self-configurable make it an appealing choice for expansive zone of systems administration, especially in military strategic, individual range, moment gatherings and hazardous situation systems.

Distinctive attributes of MANETs incorporate self-sufficient terminal, quick arrangement, dynamic topology, fluctuating data transmission, asset limitations, absence of altered foundation, self-association, disseminated operation and absence of physical security. There are five noteworthy security objectives that keep up a dependable and secure impromptu system environment. They are classification, trustworthiness, accessibility, confirmation and non-denial. Assaults in MANETs can be ordered into two fundamental classifications: latent assaults and dynamic assaults. Distinctive sorts of detached assaults are: listening stealthily, area revelation and movement investigation. Dynamic assaults incorporate lack of sleep, warmhole assault, blackhole assault, sinkhole, greyhole, hurrying assault, Sybil assault and DDoS assault. The point of this paper is to recognize blackhole hub utilizing figure security instrument and hindering the dark gap hubs. The test investigation of our work is done on system test system NS-2.34 utilizing distinctive execution measuring parameter like bundle conveyance proportion (PDR), throughput, directing load and end to end delay. The construction modeling of portable specially appointed system is appeared in fig. 1

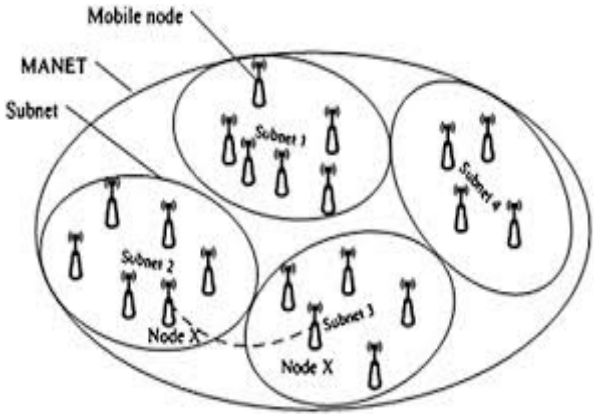

Fig.1 Mobile ad hoc network Architecture

The remaining section of the paper is presented in this manner: Section II presented the literature study of formerly work done for detection of black hole attack and Section 3 gives overview of the black hole attack in AODV and in next section describes the proposed methodology for black hole detection. The experimental result and its analysis is described in section V and section last not least concluded our paper.

RELATED WORK

Security is the most imperative issues in versatile impromptu system and awesome degree of work has been done for location and evacuation of dark opening in system in which a portion of the techniques is clarified underneath:

Yadav et al. [5] proposed a system in view of fluffy rationale to affirm a hub is tainted by dark opening assault or not. The given examination shows the clarification of bundle misfortune if there should be an occurrence of blackhole assault over the system. Firstly the blackhole hub is distinguished utilizing fluffy tenet. The fluffy tenet is actualized on reaction time of hub declaration. Rather than exchanging information on this hub, it will be going on from neighboring hubs: it will simply handle the transmission that is coordinated to it just. **Vanitha et al**. [6] proposed a probabilistic trouble making discovery strategy which is very fortunate to guarantee the safe DTN steering and also the foundation of the trust, among DTN hubs. A zone (directing zone) of a hub is utilized to gather the hub data inside of the extent. In this convention, it can't accomplish the bundle conveyance proportion, execution and information misfortune rate. This paper is giving the clarification nearby dark opening assault which depends on fluffy guideline. Fluffy principle is utilized to find out the contaminated hub and additionally convey the answer for lessen information misfortune over system. Fluffy justification scopes between the quality as {0, 1}. Geographic coordinating is a champion amongst the most suitable controlling frameworks in remote versatile Ad hoc arrange predominantly because of its adaptability. Multi Input Multi Output strategy used to send information as often as possible in steering convention. Examination and recreation results exhibit the adequacy and effectiveness of the drop hub investigation, high bundle conveyance proportion, throughput and postponement. **Kaur et al.** [7] proposed a strategy to plan an instrument of blackhole recognition in view of fake neural systems (ANNs). Utilizing a mimicked MANET environment, ANNs displaying for recognizing the dark gap assault is explored and it is demonstrated that model can distinguish hubs under blackhole assault adequately. Sakuna et al. [8] utilized that source hub will telecast RREQ to different hubs till a destination hub or hub which have a course to target answers RREP back to source. The getting hub will relegate an a good representative for the following bounce hub or who sent RREP. At the point when a hub in the way sends one bundle, one credit is withhold from the following bounce hub. When a destination hub gets information bundle, it will send Credit Acknowledge (C-ACK) and it will back to a source hub. A hub inside a path back will enlarge credit of the following jump by 2 to assign a higher trust level of the following bounce. Then again, credit will be diminished if a hub can't enthrall C-ACK. The hub will be untrusted and imprint as a boycott, as a credit achieves zero. **Narang et al.** [9] proposed fluffy based methodology which utilized these two variables to take care of the issue. Clear conclusion taking into account equivocal boisterous or missing data. In the first place we characterize the N number of hubs and set source and destination hub and rehash step un till current hub equivalent to destination hub with utilizing neighbor hubs and keep record of every neighbor hub. Calculation is on need high need hub will tune in correspondence. Need profess by resulting step 1) bundle misfortune is low and information rate is high set high need 2) parcel misfortune is medium and information rate is extraordinary set medium need 3) Packet misfortune and information rate both low set low need. **Patro et al**. [10] proposed a security evaluate to dark gap assault on AODV based MANETs. It is one of the dynamic DOS in which pernicious hub mirrors a destination hub by sending a manufactured RREP to the source hub. They concentrated on the dark opening assault by the presence of single malicious hub in the system and its answer

proposed by diverse creators. Survey of proposed arrangements recommended that the execution of the steering convention is influenced as far as extra overheads, end-to-end postponement and parcel conveyance proportion. **Howarthet al** [11] proposed a study of MANET interruption recognition and counteractive action approaches for system layer assaults. This empowers an insurance system to gain as a matter of fact and utilize the current information of assaults to gather and identify new meddlesome exercises. Assurance instrument needs to sufficiently strong to secure them and not bring new vulnerabilities into the framework. Singh et al. [12] proposed a method in which telecast synchronization (BS) and relative separation (RD) method of clock synchronization is used to thwart the black hole nodes. In this internal and external clock node evaluate with the threshold clock if both the clock time is greater than the threshold then it is initiate that the node is malevolent. This method can simply detect and thwart the block-hole node. ***Wahane et al. [13]*** proposed the modification of Ad Hoc on Demand Distance Vector Routing Protocol. The proposed work suggests two new concepts, Maintenance of Data Routing Information Table and cross checking of a node. A security protocol has been proposed that can be utilized to identify multiple blackhole nodes in a MANET and thereby identify a secure routing path from a source node to a destination node avoiding the blackhole nodes.

BLACK HOLE ATTACK IN MANET

Mobile ad hoc networks use conveyed directing conventions, if malignant hub vicinity in the system then it will interfere with the system. MANETS are defenseless against different sorts of assaults. In view of distinctive qualities the assault on portable impromptu system is delegated aloof and dynamic assaults. One of the dynamic assaults is Black gap assault. A dark gap is a hub that has a few qualities like that it generally reacts with a Route Reply (RREP) message to each RREQ, despite the fact that it doesn't have any course to the destination hub. In systems administration, dark gaps allude to puts in the system where entering or leaving activity is quietly tossed, without overhauling the source that the information did not achieve its arranged beneficiary. [2] In dark gap assault a pernicious hub can be identifies the dynamic course and notes the destination address or can be sends a course answer parcel (RREP). In Black opening assault Hop tally esteem is set to lowermost qualities and the succession number is set to the highest worth. Malevolent hub send RREP to the following hub which is has a place with the dynamic course. This can likewise be send straightforwardly information to source hub if course is accessible. The RREP got by the following hub to the noxious hub will spread through the set up opposite course to the information of source hub. The crisp data got in the Route Reply and it will permit the source hub to keep educated to its steering table. New course chose by source hub for picking information. The malevolent hub will drop now all the information to which it have a place in the course. [3] There are two sorts of dark opening assault in system. 1) Single Black gap assault 2) Collaborative Black gap assault. [4] In single dark opening assault, all system movement is diverted to single dark gap hub which is pernicious hub and drops every one of the parcels. A solitary dark opening assault is effortlessly happened in the versatile impromptu systems. In shared dark gap assault, there are numerous vindictive hubs cooperate to divert ordinary directing data to them and produce that course as indicated by them.

Security Goals

In giving a protected systems administration environment some or the majority of the accompanying administration may be required.

1. **Authentication:** This administration confirms the character of hub or a client, and to have the capacity to counteract mimic. In wired systems and base based remote systems, it is conceivable to execute a focal power at a point, for example, a switch, base station, or get to point. Be that as it may, there is no focal power in MANET, and it is a great deal more hard to verify an element. Confirmation can be furnishing utilizing encryption alongside cryptographic hash capacity, computerized mark and endorsements.
2. **Confidentiality**: Keep the data sent disjointed to unapproved clients or hubs. MANET utilizes an open medium, so generally all hubs inside of the immediate transmission reach can get the information. One approach to keep data classified is to encode the information, and another procedure is to utilize directional recieving wires. It likewise guarantees that the transmitted information must be gotten to by the proposed collectors.
3**. Integrity:** Guarantee that the information has been not adjusted amid transmission. The respectability administration can be given utilizing cryptography hash capacity alongside some type of encryption. At the point when managing system security the honesty administration is regularly given verifiably by the confirmation administration.
4**. Availability:** Guarantee that the expected system security administrations recorded above are accessible to the planned gatherings when required. The accessibility is ordinarily continue by redundancy, physical protection and other non-cryptographic means, e.g. use of robust protocol.
5. Non-repudiation:

Guarantee that gatherings can demonstrate the transmission or gathering of data by another gathering, i.e. a gathering can't erroneously deny having gotten or sent certain information. By creating a mark for the message, the element can't later deny the message. In broad daylight key cryptography, a hub A signs the message

utilizing its private key. Every single other hub can confirm the marked message by utilizing An's open key, and A can't deny that its mark is joined to the message.

PROPOSED WORK

In this proposed work provides security to the entire network. The main goal of proposed protocol is to secure the packets losses and suspicious behavior of the unauthorized node that is being detected by the IDS nodes by implementing the proficient security approach. Thus, it helps to avoid any type of black hole attack as well as some suspicious activities from disordered movements ,the services provided by the wireless network and also prolongs the durability of nodes.

The black hole attack is a major issue to destroy network activity, and huge packet losses. As the mobile nodes are deployed in crucial environmental conditions, they keep on sensing the data and information frequently. Whenever mobile node does not process the sensed information itself but it transmits it to the sink node via intermediate nodes in entire network.

Here in the proposed approach every node will carry key "KE" with the useful information in the encrypted form, the encryption process will be done by the our proposed scheme where XOR logical operation is done to encrypt the information, after that the receiver end same information is decrypted by using XOR reverse process. The main goal is using this type of operation is that, it provide security to the network and reduces overheads of the packets, and it is very light process and less time taking and it is also energy efficient. Here key "KE" is dynamic and if value changes frequently so if attacker equipped data/node cannot easily traced the value of the KE and thereby getting the access of the information. When the packets reaches to the destination node then the inverse XOR process will be done to revert encrypted information to the its original form.

The XOR process is done like:

suppose we have initial message = 15 and key value is 10, then the process will be done as follows:

encryptMsg (initial message) = initial message XOR KE
15 XOR 10
(1111) ^ (1010)

encryptedMsg = 5 (0101), here encrypted message become 5, now it will be proceed by the intermediate nodes, and when receiver destination node get catch the encrypted message then the inverse XOR description will be done as follows:

decryptedMsg(encryptedMsg) = encrypted message XOR KE
= 5 XOR 10
= (0101) XOR (1010)
= 15 (got original message)

so, by this process the receiver will get original information, in the proposed scheme the KE value is dynamic, and will change every time.

Proposed Algorithm

The key KE is generated using random number generator (RNG) that is designed using system time. The sensed information is encrypted by 'KE' using simple XOR operation. The XOR operation has been chosen to be used as encryption operation because it is computationally very light, but it is not itself secure enough to prevent the attacks, thus the key 'KE' is made dynamic by changing its value periodically to reduce the chances of various attacks like blackhole attack.

The algorithm used for encrypting the sensed information at source node is:

```
DATA  = 454545;
ENCRYPT-by-ONEKEY (KE)
 {
        DATA = DATA^ KE;
}
DECRYPT_BY_ONEKEY(KE)
{
        DATA = DATA^ KE;
}
DYNAMIC_ONEKEY _ALGORITHM()
{
        FOR (; ;)    //INFINITE LOOP
        {
                RANDOM RAND = NEW RANDOM(130486);
                INT K = RAND.NEXTINT(545454);
                ENCRYPT_ BY_ONEKEY();
                DECRYPT_ BY_ONEKEY();
        }
```



```
}
```

FOLLOWING ALGORITHM WILL BE USED IN THE INTERMIDIATE NODE

```
DATA  =454545;
ENCRYPT_ BY_ONEKEY(KE)
{
        DATA = DATA^ KE;
}
DECRYPT_BY_ONEKEY()
{
        DATA = DATA^ KE;
}
DYNAMIC_ONEKEY _ALGORITHM()
{
        WHILE(1)
        {
                RANDOM RAND1 = NEW RANDOM(130486);
                INT K = RAND.NEXTINT(99999999);
                DECRYPT-by-ONEKEY();
                RANDOM RAND2 = NEW RANDOM(130486);
                INT KK = RAND.NEXTINT(545454);
                ENCRYPT_ BY_ONEKEY();
        }
}
```

In the sink node, the decryption of message of source node algorithm is used to decipher the data. The proposed method provides better security to the network in the both cases, when the node left unattended and when the information is transmitted from source node to the sink node and receiver node. Here firstly the algorithm changes the value of encrypted message periodically, so as to safeguard it from the different type of attackers, after that the description and re-encryption process are repeated at intermediate nodes till the whole information reaches to the sink/receiver node.

EXPERIMENTAL RESULT & ANALYSIS

Simulation is a fundamental tool in the development of MANET protocols, because the difficulty to deploy and debug them in real networks. The simulation eases the analyzing and the verification of the protocols, mainly in large-scale systems. It suggests bendable testing with dissimilar topologies, mobility patterns, and numerous physical and link-layer protocols. Nevertheless, a simulation cannot offer indication in real-world scenarios, owing to conventions and simplifications that it makes. Consequently, the results obtained from the simulations should be evaluated appropriately. The well-known simulators are used for MANET simulations: NS-2.34, GloMoSim and OPNET. We selected NS-2.34, because firstly it is very dynamic and also scalable simulator that is designed particularly to large wireless networks. It supports hundreds of nodes, using parallel and distributed environment.

Simulation Environment

The NS-2.34 Network Simulator [12] is an open-source object-oriented discrete-event simulator for network research. The simulator is written in C++, with an OTcl (Object Tool Command Language) interpreter used as the command interface. The C++ part constitutes the core of the simulator, where detailed protocol implementation and the simulation engine are located.

We modeled network traffic using Constant Bit Rate (CBR) sources. A CBR traffic source provides a constant stream of packets throughout the whole simulation, thus further stressing the routing task. In each experiment, half the nodes in the network are CBR sources, and each source transmits 64-byte packets at a rate of 4 per second. We experimented with higher sending rates, packet sizes and number of sources. We omit those results, as they show similar trends, with the predictably higher effect of network congestion.

Table 5.1 Simulation Setup

Simulation used	NS-2.34
Topology area	1000 X 1000
No. of Mobile Nodes	50
Simulation Time	250
Speed	45 m/sec
Packets	CBR
Black hole	1, 2, 3
Protocol	AODV, Black hole AODV, IDSAODV

Result Analysis

The results of simulation are given in the Figures. The performance of the network is analyzed in terms of four metrics such as packet delivery ratio, throughput, routing load and end to end delay.

The simulation performance for packet delivery ratio of black hole node and our work is done and it is observed that the PDR of our proposed work is about 78% after varying the simulation time. The simulation result of PDR is shown in table 5.2 and the comparison is shown through graph 5.1

Table 5.2 Simulation result of PDR

PDR Performance				
Time	B0	B1	B2	Proposed
1	0	0	0	27
20	99.712	56.559	21.351	81.512
40	98.679	55.237	19.289	84.655
60	99.375	53.629	18.313	85.213
80	94.107	52.906	17.789	84.795
100	90.095	51.846	17.427	84.145
120	86.999	51.418	17.244	83.778
140	85.59	51.618	17.107	83.312
160	82.817	51.733	17.616	83.213
180	80.964	51.768	17.993	83.203

Average PDR Performance			
B0	B1	B2	Proposed
81.8338	47.6714	16.4129	78.0826

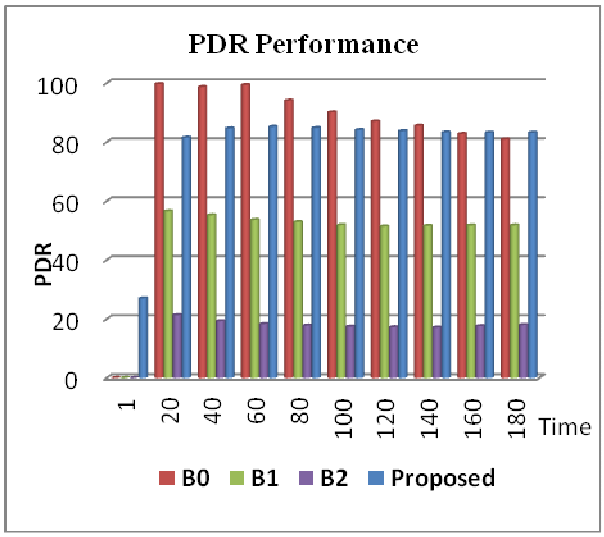

Fig 5.1 Analysis for PDR of proposed work

Table 5.3 Simulation result of Throughput

Throughput Performance				
Time	B0	B1	B2	Proposed
1	2	8	2	4
20	70.008	61.476	4.925	94.45
40	74.872	51.3076	4.688	94.45
60	81.379	42.397	4.604	94.45
80	83.135	39.269	4.59	94.45
100	84.996	39.864	4.562	94.45
120	87.773	39.236	4.559	94.45
140	91.431	38.65	4.572	99.535
160	94.456	36.81	4.556	93.038
180	94.033	34.049	4.567	88.003

Average Throughput Performance			
B0	B1	B2	Proposed
76.4083	39.10586	4.3623	85.1276

The analysis & performance for throughput of black hole node and proposed work is perform and it is observed that the throughput of our proposed work is about 85% by varying the simulation time. The simulation result of throughput is shown in table 5.3 and the comparison is shown through graph 5.2.

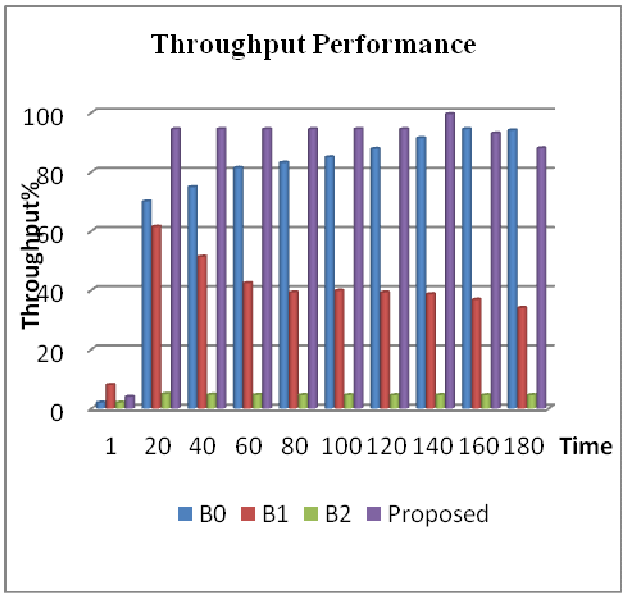

Fig 5.2 Analysis for Throughput of proposed work

Table 5.4 Simulation result of Routing Load

Routing Load Performance				
Time	B0	B1	B2	Proposed
1	0	0	0	0
20	3.2	21.4	3.9	2.2
40	5.9	34.2	4.8	3.2
60	10	45.7	9.9	3.9
80	13	45.8	14.6	5
100	15.2	46	16.7	5.6
120	16.4	46.1	19	6.3
140	16.6	46.2	21.6	6.5
160	17	46.6	24	7.1
180	17.8	47	25.9	7.2

Average Routing Load Performance			
B0	B1	B2	Proposed
11.51	37.9	14.04	4.7

The analysis & performance for routing load of black hole node and proposed work is perform and it is observed that the network routing load of our proposed work is about 4.7% by varying the simulation time which means that our method reduces the network load than other one. The simulation result of routing load is shown in table 5.4 and the comparison is shown through graph 5.3.

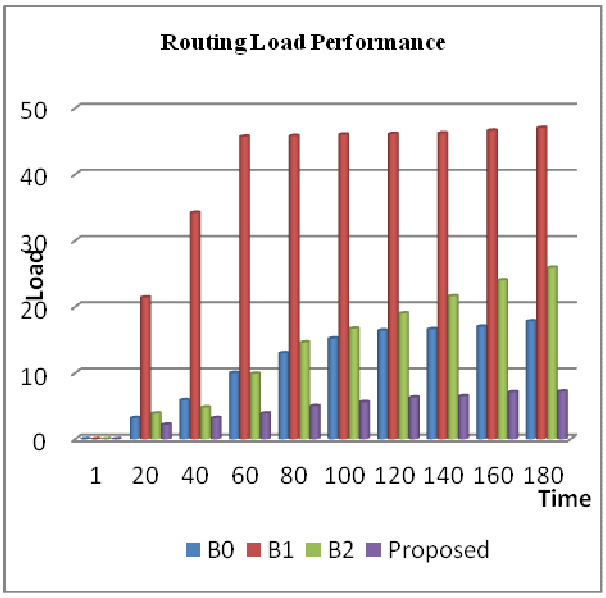

Fig 5.3 Analysis for Routing Load of proposed work

The analysis & performance for end to end delay of black hole node and proposed work is perform and it is observed that the delay of our proposed work is about 2.7% by varying the simulation time which means that our method reduces the end to end delay than other one. The simulation result of routing load is shown in table 5.5 and the comparison is shown through graph 5.4

Table 5.5 Simulation result of Routing Load

End to End Delay Performance				
Time	B0	B1	B2	Proposed
1	1.38	178.6	83.32	1.38
20	2.34	164.72	272.81	3.6
40	2.16	164.72	248.02	3
60	2.6	99.33	252.93	2.76
80	2.75	164.72	269.84	2.85
100	2.65	124.36	286.16	2.3
120	2.55	117.3	263.1	3.04
140	2.85	124.36	299.51	2.37
160	3.04	99.33	286.83	2.52
180	2.87	178.6	272.91	3

Average End to End Delay Performance			
B0	B1	B2	Proposed
2.519	141.604	253.543	2.682

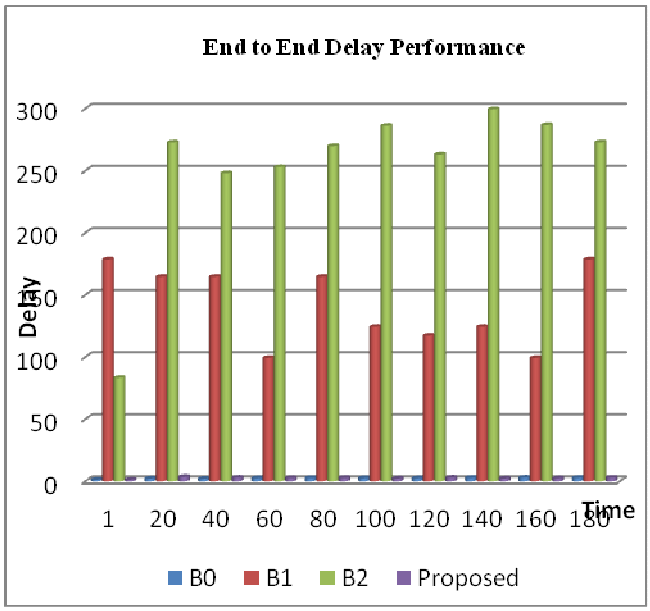

Fig 5.4 Analysis for End to End delay of proposed work

CONCLUSION

Security is the key challenge in wireless ad hoc network because of its dynamic behavior to form the network. Black hole attack is one of the more vulnerable threats which inject false route over the network. To combat such serious problem, a lot of techniques has been proposed or implemented but they are not much effective to detect the black hole nodes. In this thesis, we use the light-weight versions of symmetric encryption protocols PRESENT and HIGHT to provide better security by minimizing the number of computations used for encryption so as to reduce the energy consumption. This uses a key 'KE' with which the sensed information is encrypted using simple logical invertible operation(s) such as XOR instead of using simple logical operations and decryption is made at the receiver end using decrypting algorithm. This proposed approach enthusiastically enhances the PDR and throughput of the network but it continually need observation due to which the end to end delay increase and traffic load on the network also increases. In future work, develop an algorithm which can efficiently reduces the overhead and must be able to detect the affected node accurately due to this the CPU time increases which enhances the performance of the network.

REFERENCE

[1]. Ramanpreet Kaur, Anantdeep Kaur, "Blackhole Detection In Manets Using Artificial Neural Network " International Journal For Technological Research In Engineering Volume 1, Issue 9, May-2014, ISSN (Online): 2347 – 4718.

[2]. Chander Diwaker, Sunita Choudhary " Detection Of Blackhole Attack In Dsr Based Manet" *International Journal of Software & Web Sciences* 4(2), March-May, 2013, pp. 130-133.

[3]. Sushil Kumar Chamoli, Santosh Kumar, Deepak Singh Rana "Performance of AODV against Black Hole Attacks in Mobile ad-hoc Networks" *Computer Technology & Applications*, Vol 3 (4), 1395-1399 IJCTA July-August 2012.

[4]. Ravinder Kaur, Jyoti Kalra "A Review Paper on Detection and Prevention of Black hole in MANET" *International Journal of Advanced Research in Computer Science & Software Engineering* Volume 4, Issue 6, June 2014.

[5]. Yadav Poonam, Kumar Naveen, Gill R.K., "A Fuzzy Based Approach to Detect Black Hole Attack" in International Journal of Soft Computing And Engineering (IJSCE), ISSN: 2231-2306, Volume-2, Issue-3, July 2012.

[6]. S. Karthika, N. Vanitha, "Secure Routing Protocol in Delay Tolerant Networks Using Fuzzy Logic Algorithm", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 4, Issue 5, May 2015, ISSN (Print) : 2320 – 3765.

[7]. Ramanpree tKaur and Anantdeep Kaur "BLACKHOLE DETECTION IN MANETS USING ARTIFICIAL NEURAL NETWORKS", International Journal For Technological Research In Engineering Volume 1, Issue 9, May-2014 ISSN (Online): 2347 – 4718.

[8]. Watchara Saetang and Sakuna Charoenpanyasak, "CAODV Free Blackhole Attack in Ad Hoc Networks", 2012 International Conference on Computer Networks and Communication Systems (CNCS 2012).
[9]. Sonal, KiranNarang "Black Hole Attack Detection using Fuzzy Logic" 2013 International Journal Of Science and Research (IJSR), ISSN: 2319-7064.
[10]. Subash Chandra Mandhata, Dr. Surya Narayan Patro, "A Counter Measure to Black hole Attack on AODV Based Mobile Ad hoc Networks", International Journal of Computer & Communication Technology(IJCCT), Vol.2, Issue 6, 2011.
[11]. Adnan Nadeem and Michael P. Howarth, "A Survey of MANET Intrusion Detection & Prevention Approaches for Network Layer Attacks", IEEE Communication Surveys & Tutorials, accepted for publication, 2013.
[12]. Harsh Pratap Singh, Rashmi Singh, "A mechanism for discovery and prevention of cooperative black hole attack in mobile ad hoc network using AODV protocol", International Conference on Electronics and Communication Systems (ICECS) 2014 , Page(s):1 - 8 Print, ISBN:978-1-4799-2321-2.
[13]. G. Wahane, A. Kanthe, s"Techniques for detection of cooperative Black hole Attack in MANET" in IOSR-JCE, 2014.
[14]. http://www.isi.edu/nsam/ns.