A NOVEL ALGORITHM FOR TCP TIMEOUT CALCULATION OVER WIRELESS AD HOC NETWORKS

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ABSTRACT

*To accommodate real-time multimedia applications that achieve Quality of Service (**QOS**) requirements in a wireless ad-hoc network, a **QOS** control mechanisms is needed. Correspondence over such networks must consider other aspects in regard to network properties; that the time it takes to send a message and reach its destination faces different variables from one message to the other in a short time. Therefore, the equation of calculating the time required to resend the message must be able to contain the worst case and acknowledges different features for the network. The objective of this paper is to improve retransmission time calculation adaptability when occurring using Transmission Control Protocol **(TCP)** over wireless Ad hoc networks. Hence, it aims to obtain more accurate time to ensure retransmission time occurring in accordance to the network environment variables efficiently.*

KEYWORDS

TCP Computation Enhancement, Wireless networks, wireless Ad-hoc networks, Mobility, QOS for routing, smart routing.

1.INTRODUCTION

Wireless ad-hoc networks do not require any fixed equipment or infrastructures such as routers, switches, access points, base stations, or cables. Nodes are connected with each other through radio signals to organize a network and transmit data from one node to another**.** Therefore wireless ad hoc networks are considered as promising technology to establish a means of communication where installation of network equipment and cables is not allowed due to some difficulties, For instance high cost. For example, historic landmark, festival site, or when conventional communication infrastructures are destroyed due to catastrophic disasters like earthquake. In such situations, wireless ad-hoc networks are expected to accommodate real-time multimedia flow for remote Monitoring, video conferencing, and Voice over IP (VoIP) communications. Congestion may occur at one node or which generally affects QOS by routing.

Several papers on QOS routing have been proposed for wireless ad-hoc networks**.** QOS - Ad hoc on-demand Distance Vectors (AODV) **[4]** is a per node available bandwidth estimation protocol based on AODV. It estimates the available bandwidth using the number of packets exchanged between nodes. On the other hand, Several Studies on retransmission adaptability have been proposed to wireless ad-hoc networks and TCP timeout adaptively over wireless mobile ad hoc networks **[2] [5]** to enhance retransmission's timeout and reduce congestion which affects on the

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overall throughput of the network. To our knowledge, there has been no work addressing the problem of controlling time retransmission time in order to achieve performance gain in the context of real-time multimedia applications over mobile wireless ad hoc networks.

This paper proposes a new approach which ensures occurrence of retransmission in more adaptive scenarios in case of congestion in one node or more, consistent with application QOS requirements in a wireless ad hoc network. This paper focuses on new algorithm that has been built and tested in the NS-2 simulation environment, where sequence has been applied in number of nodes and movement speed through multiple test cases to ensure the stability of the low percentage of delays with the increasing number of nodes. Thus, we are talking about the stability of performance to coincide with unstable network.

The remainder of this paper is organized as follow. Problem statement is described in Section II. Section III includes the literature review. Section IV presents a novel algorithm for TCP timeout calculation over ad hoc networks. Simulation set up is described in section V. Proposed equations are displayed in Section VI. Finally, conclusions and future work are included in Section VII.

2. PROBLEM STATEMENT

Recent years have seen rapid progress and evolution in the context of communication technology and wireless networks. This was a result of the continuous development of accuracy in the technology of Integrated Circuit (IC) industry. In addition, it provided a qualitative improvement, which led to the acquisition of mobile devices with ultrafine sizes and lower costs have made successes of a multifaceted in terms of the quality of performance in the services and applications that provide user **[1]**.

The evolution in wireless revolution governed by the quality of the applications and services required, which is used by the studies and research related in wireless networks recently cares in the quality of messaging and ideal transmission channels. The following are challenges faced by wireless networks **[2]**:

- Limited capacity of transmission's frequencies Bandwidth (BW), where the wireless network is characterized by lower capacity range of messaging and data rates offered unlike the wired network which is characterized by a larger transmission capacity **[3]**.

- long times to track Round Trip Time (**RTT**) , which tend wireless networks to own delay, due to high relatively loss of packets more than wired networks . So, a renewed tracks offering concept of mobility for the user to move free with enjoyment of the services without interrupting the network **[4]**.

- Energy consumption such as mobile computers, mobile devices and PDA, that managed by cell power / battery. Therefore, there is need to reduce power consumption through producing batteries less consumption **[5]**, or smart routing algorithms.

The majority of the above factors impose themselves on applications and network services, especially real world applications; for instance, video conferencing, that require to ensure a sequential flow and order of packets to achieve the reliability and quality of the delivery to the end users. Instant wireless environment is affected by several factors **[6]** including:

- Geographic locations. Variation in the flow of transmission over sight line of sight, which is known as the Line of Sight (*LOS) /*Non Line of Sight (*NLOS*)
- High Latencies.
- Disconnect temporary connection.
- High degree of delay to deliver packages.

The low performance for TCP influenced by the properties of the wireless network that imposes itself, which led to the research and investigation in recent years to make the TCP more adaptive wireless work **[7] [8].**

Wireless networks are classified into two categories: namely: infrastructure networks and mobile wireless networks. The most important characteristic of the second type from the rest of the other networks is the amount of communications managed between nodes mobile in the absence of standalone router, as it relates to nodes with each other. Mobile wireless network mechanism of action is crystallized through temporary telecommunications and short-term with a plurality of hops, each node acting as a guide to push the data packets and routed to hold other **[9]**.

The basic idea of the decrease of the performance and quality of the TCP on the wireless network is the inability to detect the position of the packet loss, which causes the loss attributable to a variety of reasons not limited to network congestion, but for other things, including:

- Link Breakage disconnection, Handoff, Fading **[10].**
- Delay Ability (wireless mobile networks, for example, talking about the fullness of the queue for a specified size and thus a drop of the packages).
- High error rate in the deciding one.

With respect to these causes for the loss of packets is generating reactions as a reduction of inappropriate window transmission and reduce the period of the beginning of the transmission and activation of control mechanisms in congestion reduces the productivity of the transport protocol **[11]**. The causes of low productivity during the occurrence of transmission by using TCP in a private mobile network illustrated as follows **[7]**:

- Effect of re- calculating the route to the source: by virtue of mobile nodes may change tracks, and re-build new tracks that require being more obvious, that the process of discovery of the new route takes time at length what makes TCP sender subject to a waiting period longer, until the discovery of the new route.

- Effect of the division of the network: This problem occurs When stationed sender in part of the network and recipient ensconce him into another part of the network. Packet cannot reach to destination directly, sender still in a waiting period (Timeout) and by virtue of the non-arrival notification access within the estimated round trip time (ERTT) of the flight path and go back. Sender resends the package lost several times with doubling in (timers); we talk about inflation in timeout.

- Effect of window congestion in mobile ad hoc networks (MANET): congestion window indicate the percentage of accepted data for a particular party and by virtue of that, the roads changed much capacitive given two ways will fluctuate as well.

Increasing or decreasing the number of mobile nodes over the path between the transmitter and receiver with different speeds will renew the change in the values of the time of the flight path default such as Sample Round Trip Time (**SRTT**); thus affected the values to guess the time of the flight path (**ERTT**) in a manner sudden increases so led ultimately to possible inflation processes and the value of the retransmission Timeout. Irregular variations for guess the round-trip time and the possible delay caused by Retransmission Timeout (**RTO**) lowers the efficiency of the TCP and hence the low quality of the service provided. That requires TCP to be more in recognition of the properties of the network with the calculated values for retransmission. Therefore, we talk about reducing effects by the changes to the values of renewable time in virtual flight path. RTO lowers the efficiency of the TCP and hence the low quality of the service provided.

Estimating times of renewable tracks the most important factor in the performance of the transmission appears through the TCP, especially when dealing with change in the movement of the node between the sender and the receiver. This will cause a sudden increase values to guess the time of the flight path and thus increasing the value of timeout **[12]**.

Temporary disconnection lead to wide difference on time values over virtual paths, in regards to packets and approval its arrival. The big difference is known incremental sudden delay and thus a "Spurious TCP Timeout" occurs, which reduce productivity and performance of the TCP **[13]**.

This study aims to improve the calculation of time retransmission by the sender who uses the TCP, which take the sender until the completion of the receiving instant, acknowledgment (ACK) from the destination, and adapt to what can occur in this period under the conditions imposed by the mobile network.

3. LITERATURE REVIEW

There are many previous studies regarding the adaptability of transmission protocol on wireless networks in general. The studies focused specifically on operations to calculate values and guess retransmission waiting time and the extent of vulnerability to the vagaries of flight paths, with indirect talk about the nature of the problem, which circulated the current study. The paper in **[16]** Presented algorithm EIFEL which made the TCP more durable on the wireless network, through the removal of uncertainty for the re-messaging and being able to reduce the Spurious Timeout & Spurious Fast Retransmission. Fahmy, et. Al. **[9]** suggested improving the performance of the TCP packet loss in wireless scenarios, where showed that the collapse or loss of packets is not due to congestion. However, it does not intersect with the proposed study in this paper in terms of the impact of renewable infrastructure for the wireless network in terms of the movement of mobile nodes on the performance of the TCP. Another study presented in **[13]** investigated the subject of TCP Timeout on the wireless network and studied add additional delay is added regularly to increase the contrast time flight path. This study has shown that the additional delay added to the time of the flight path will increase the productivity of the TCP and reduce Spurious Timeout formed as a result of the high variability of the values of the time of the flight path Default. The big challenge faced by this study is that when the value of the guess is too long Timeout lead to Underutilizing Network and when the value is very small guessing there will be inflation in the retransmission. Kesselman and mansour **[17]** proposed that the value of the retransmission ideal time depends on the RTT & TCP windows size. It also touched upon the completion of the study to the time that the retransmission increases the productivity of the TCP, noting that the time of retransmission is affected by the difference quotient of the flight path and go back higher the value of the TCP windows size increases the value of the time of retransmission. The paper also talked about the sense of Premature RTO occurrence send back fast and early to coincide with the lack of an actual loss for the package, any package that comes to be the status of the delay notice arrives late; Mini occurrence of resending unjustified. Costa **[19]** suggested so-called *FREEZ-TCP* To alert the sender about the loss of signal expected in transmission range to avoid the loss of packets and increasing the rate of delay their arrival, sends a notice to the sender to freeze timers Instant (timers) to receive further notice acknowledges the return signal strength Instant. Then, TCP sender proceeds into transmission.

The most important studies that provided a solution through the presence of the equations is provided by Jacobson study **[14].** The equations proposed provided optimal solutions in a manner calculated wait time on wired networks to its stability with relatively lower rates of loss of packets as the loss of packets on the wired network leads to congestion on the network. Theses equations show the following:

- When data segments transmission began sequentially by the sender depending on **TCP**, records the start time of the actual transmission to send the segment. When receiving the notice of arrival **(ACK)** of that segment, the time of its receipt is also recorded. The difference between those times called (**SRTT),** time that represent for send the packet and receive delivery notification; that is,

SRTT = current time where the segment ACK received – Previous time where the segment was sent to distance

- TCP calculates the estimated value of the time of route between the weighted average of the value of time and track previously estimated the value of the flight path according to the new equations **[15]**

$$ERTT = a * \mathrm{ERTT} + (1 - \mathrm{a}) * \mathrm{SRTT} \qquad (1)$$

where, ‘a’ is a constant value ranging between [0.8 – 0.9],
ERTT is the estimated round trip time

$$Timeout = 2 * ERTT \qquad (2)$$

Timeout is calculated as a function of the value of **ERTT** multiplied by the number (2), which represents the process of Backoff. This process is trying to keep the network stable in the event of a sudden burden on the network leads to the probability of loss of firmness **[15].**

$$Difference = SRTT - ERTT \qquad (3)$$

$$ERTT = \mathrm{ERTT} + (\delta * Difference) \qquad (4)$$

$$Deviation = \mathrm{Deviation} + \delta\ (\ |\mathrm{Diff}\,| - \mathrm{Deviation}\ ) \qquad (5)$$

Where, | | represent the absolute value

$$Timeout = \mu * \mathrm{ERTT} + \emptyset * \mathrm{Deviation} \qquad (6)$$

Where, Deviation be between SRTT and ERTT, $\phi = 4$ ideal value of inflation, $\mu = 1$, $\delta = 1/8$ factor value Influenced with movement.

Equation (6) illustrates that if the difference is large, the deviation coefficient is dominant at the expense of timeout. On the other hand, if the difference is small, then timeout approaches **ERTT**. However, Jacobson algorithm applied to the mobile wireless network suffers from several challenges for not adopting wireless scenarios taking into account the work in terms of the high rates of loss of packets and mobility node then is repeated time values estimated route (Estimated) between two mobile nodes difficult process. In addition, a deviation value for the time of route from time to time leads the issue of the movement of nodes at different speeds. Also, application of Equations (3-6) on the mobile wireless environment showed that the Timeout values are increasing sharply due to the movement of nodes at different speeds either be oncoming traffic from each decade, or vice versa.

The study in **[12]** refers to the direct reasons that leads to low effectiveness of Jacobson's equations in the wireless environment through two scenarios relate to the movement of the decade:

- Timeout will increase if two nodes moved away from each other, comparing to delay with receive duplicated notifications.
- If two nodes closer to each other, timeout is supposed to decrease, but actually it increases comparing to delay with receive duplicated notifications.

More recent study in this area is the study in **[18].** This study presented several proposals to amend the equation calculating the Timeout in the equations developed by Jacobson [14] to become more suitable for mobile wireless networks taking into account the mobility of the node and speed. Pointing out that the values of the times of route varies from time to time largely because of the volatility in the node and speeds different. The study presented several proposals to amend the Timeout calculation in Equation (6). The results obtained from Jacobson equation applied in **[18].** The deferments are decreasing between *SRTT* and *ERTT*, when number of hops is lower and nodes speed is slow. The deferments are increasing between *SRTT* and *ERTT*, when number of hops increases and nodes speed is fast.

The original form to the Jacobson equation is: $Timeout = \mu * \text{ERTT} + \emptyset * \text{Deviation}$

So, we can summarize the results of Jacobson equation within wireless environment depending on increasing and decreasing in the number of hops:

- When nodes movements near each other quickly, the number of hops will decrease and thus SRRT reach to lowest level. After that each of **ERTT** and the impact of deviations also reduced. So, **ERTT** will be the major factor through timeout computation with no difference between **SRTT** and **ERTT** paths.
- Increasing the speed of the nodes makes the number of nodes that form the path of communication is changing rapidly, thus increasing potential node makes changes at the time of the flight path the default happen faster.
- In Jacobson's Equation, Deviation value hits in the factor **(Φ = 4)** to enlarge the values Timeout toward super value and therefore there is a big difference between the values of the **SRTT** times and **RTO**.

Halasa in **[18]** has begun with the following modification on equation (6), so its amendment produced the following equation:

$$Timeout = \mu * \text{ERTT} + ((\emptyset * \text{Deviation})/\text{n}) \qquad (7)$$

Results can be summarized as follows:

- Talked about the worst case ($\Phi *$ deviation) in terms of exception hit that value with the number of hops, just Sufficiency in dividing by the number of nodes.
- With increase of the speed of movement and increase the number of nodes, increasing changes in the estimated times for sending what makes the expression Deviation dominant element in calculating the period Timeout.

Kajioka, et. Al. **[20]**, proposed a QOS-aware routing mechanism for real-time applications. By embedding bandwidth information in control messages of OLSRv2, a source node establishes the logical path with the maximum available bandwidth. It confirmed that proposal could achieve almost the same packet delivery ratio, the end-to-end delay, and the delay jitter as QOLSR in general topology. But this study did not address the impact of the movement of nodes on the accounts of TCP protocol regarding the time of re-transmission for packets and adaptive computations that relating to this dilemma. Lee et. al., **[21]**, explains how the network coding **(NC)** is useful in the wireless network and evaluated various aspects of the performance of NC at wireless ad hoc network. It found the impact each of (characteristic of MAC protocol, additive power consumption by NC protocol and network conditions inappropriate for NC) on performance evaluation. Therefore, the practical gain of NC is lower than the theoretical gain. Also, this investigation does not refer to the TCP adaptability in regard to RTO and the effects of mobility on overall network throughput.

4. A NOVEL ALGORITHM FOR TCP TIMEOUT CALCULATION OVER AD HOC NETWORKS

The Transmission Control Protocol is a messaging Transfer Protocol to enable the reliability for guaranteed delivery of data packets to their goals according to its harmonized multi-tasking structure, together towards the optimization of its performance. On the other hand it uses the Transmission Control Protocol timers' retransmission (Retransmission Timers) as one of the mechanisms of the main supports reliability to deliver data. It is the process of retransmission based on the calculated value of the retransmission time (Retransmission Timeout), which spent by the sender to re-send the missing package if elapsed time is estimated to reach the notice received the package sent by the sender to the node. This value is calculated as a function of the average time of the virtual transmission path, which represents the elapsed time between sending data segment of the sender and the receipt of notice of delivery section node dispatcher. When directly sender used for Transmission Control Protocol sent to the first data packet after the adoption of a session contact with the receiving party through a mechanism called "Three Way Hand Shake", then the time of the virtual transmission path time is calculated from the estimated transmission path. Its value at the first package posted equal to the virtual transmission time. That is, ERTT = SRTT (But it will vary later while sending the following packages due to different placement of the node any movement) and then the value of the retransmission time will be calculated even if the elapsed time is estimated to receive delivery of the package sent notice. Then it a period of retransmission (Timeout) starts, which were calculated in advance to re-send the package, lost successively until the receipt of the notice delivered means that the sender shall remain for a period of time until the retransmission received notice of the arrival of the package lost **[16].**

Methodology of the current study focused on the need for accuracy in regard to RTO computation through making the processes of accounts more adaptive. Then, if these values are calculated in inaccurate approach, it may lead to re-send the wrong information for lost packages.

The method of calculating the time of retransmission by Jacobson Karl's equations has proven to give good results on the network stable by virtue of the low rate of loss of firmness. The main reason for the loss of packets on the wired network is congestion on the network **[13].** Therefore, the present study was to consider the factor of congestion can be included in the calculation of the equation of time retransmission used in the Transmission Control Protocol and study its behaviour over wireless networks for the mobile as if they contain the retransmission period of time the value of the congestion at the path of an actor is not stable between the sender and the future of the network.

Current study processes can be crystallized into the following functional steps:

1. Apply the proposed algorithm using *TCL* language via *NS2* simulator and ongoing to start with last formulation obtained by [**18**]; namely Equation (7) in this paper. This includes timeout equation that consists of a factor for the number of nodes **n.** It should be mentioned that the number of nodes used in the current study is 10.
   - Analysis the behavior of Equation (7) via **15** nodes. That is expanding the number of nodes to measure the overall throughput of this equation by increasing the number of nodes. Thus, justifications are made for the amendment to the equation to bring a new vision to the equation.
   - Formulate the equations through present study that included the inclusion of the change in the value of the congestion coupled with the number of nodes as the first vision is included for the calculation of the equation of time retransmission within the present study **(15)** node.
   - After that, an optimal formulation is applied, with nodes increasing from **20 – 30** nodes. Therefore, an ideal situation is applied to maintain a better level of delay on the network.

2. Make adjustments to the equation presented in **[18]**, which include the inclusion of the change in the congestion value at the node **(Cwnd)** coupled with the change in the number of nodes **n** according to random velocities within the equation of calculating the value of retransmission time.

3. Applying the modified equations within the increasing number of nodes between **20-30** nodes to reach to the optimal case, with stable in the delay level.

5. SET UP AND CONFIGURE THE PROPERTIES OF THE MOBILE WIRELESS NETWORK SIMULATION (PREPROCESSING)

The process of creating the network's properties within the simulation is crystallized at the following steps:

First step

Configure each channel of transmission across the network and any coverage pattern which is multiple destinations deployment on the network.

- Create a standard of physical specifications which is the participatory use of participatory usage of transmission medium by end users including network frequency with (2.4 - 5 **GHz**) with the transfer rate of data across a network's nodes of (2 **Mbps**) and throughput of (0.9 **MB**).
- Next would be, configure a data link layer on the network and the type of sensor for wireless messaging in each node.

- Create communication interface wireless that consists of **PHY** protocol to connect between data link layer & physical layer as a communication protocol between these two layers through network. That's because of its basic and direct role in running entities a peer to peer among users of mobile network.
- Define a variable for the number of nodes that needs to be applied in the simulation.
- Define the size of the queue for packets at each node (what has a relationship with the flow management and scroll in the nodes).
- Prepare the protocol that manages following processes (flow, scroll and dropping) for packets and it in each of the nodes.

This means that we are talking about Queuing management methodology used in network, which consists of Drop-tail protocol whose methodology is to achieve priority to push and scroll packets on **(FIFO)** queue principle within incoming packets from different nodes either to pass it to another node or to drop it. Then, packets from the queue that exceeds the size of the queue for each node are dropped.

After that, define variable for routing protocols for mobile wireless network. Then define simulation time in the study.

Finally, define 64 **kbps** transmission rate, we talk about the bandwidth of frequencies transmission through the network.

Second step

Consist of configuring the nodes by assigning all the properties of the network that had been prepared in *First step* to the nodes, starting from linking the number of nodes defined in the *First step* to a channel network.

Then, the nodes in the network are positioned by selecting the initial sites for nodes that are defined in the *First step* before starting the implementation of the Network Simulation.

Finally, implementation of random movement of nodes is requested when simulation is applied at different speeds of the nodes.

Third step

- Consist of configuring *sink* Agent & *TCP* Agent who manages the transmission control between two selected nodes as receiver and transmitter.
- Following this, achieving the linking of *TCP* Agent with the node selected as a source of transmission to manage and control messaging sent from source.
- As well as achieving the linking of the *Sink* protocol Agent with nodes selected as a destination for sending to control and manages instant Messaging with the recipient.
- Then comes the actual linking between messaging management protocols for both source and Destination.
- Following this, defining and configuring communication and interaction management for intermediate nodes that represent path between specific source and specific target.
- And then, implementing the actual communication and interaction management by creating Constant Bit rate Application that is linked with *TCP* Agent as the application that runs the adjustment of traffic to queue the packets in the path from the source node, Through several criteria like determining the size of the packet which is 2321 **Byte** also like determining the data transfer speed rate through the path between source and target which is 600 **Kbps**.

The following is the preprocessing steps mentioned above, which represents the Characteristics to the environment of an Ad hoc network during the study.

1. **Step One**

Set channel-type Wireless Channel

Set Propagation –Model Two Ray ground

Set Mac-type IEEE 802.11

Set Link-Layer-type LL

Set Antenna-model Omni Antenna

Set Network-Interface-Type Phy/wireless

Set No. Of Mobile Nodes n

Set Max-packet-In-Ifq 10000

Set Interface-Queue-type Drop tail/Priority Queue

Set Routing-Protocol Var(rp),
where Var(rp) is a variable Selected by the user. (Aodv, Dsdv , Dsr ….)

Set Simulation Time 150 Second

Set Mac-Data-Rate 2 MB/s

Set Mac-Bandwidth-Rate 64 Kb/s

2. **Step Two**

Set Nodes-Configuration as defined in **Step 1**

Set Initial position For the Nodes, Defined Previously

Start Mobile-Nodes Motion randomly

3. **Step Three**

Set Tcp Agent, for the sender

Set Tcp Sink, for the receiver

Figure 1. Preprocessing steps

6. PROPOSED EQUATIONS

$$Timeout = ERTT + n * \frac{Deviation}{\Phi * Cwnd} \quad (8)$$

Where, ***ERTT*** is the estimated round trip time, ***Cwnd*** is changes the value of the congestion with the change of the number of nodes obtained by TCP agent, ***n*** is number of nodes, ***Deviation*** **is** the deviation between **SRTT** and **ERTT,** $\boldsymbol{\Phi = 4}$ is Ideal value of inflation*,* used by Jacobson/ Karels [22].

The application of equation's algorithm (8) as shown in the **Figure 2**, the following result has been obtained from simulation as shown in **Figure 3**.

Algorithm

Procedure Plot ( )
Set SRTT = 0; initial value.
Set ERTT = 0; initial value.
Set Deviation = 0; initial value.
Set δ = 1/8
Set μ = 1
Set Φ = 4
Get SRTT from TCP agent
Set ERTT = SRTT
Set Time = 0.01 ms
LOOP
i: 0.01 : 150
Get SRTT from TCP agent.
Get Cwnd from TCP agent.
Set $Difference = SRTT - ERTT$
Set $ERTT = ERTT + (\boldsymbol{\delta} * Difference)$
Set $Deviation = Deviation + \boldsymbol{\delta} * (|Difference| - Deviation)$
Set $Timeout = ERTT + n * \frac{Deviatin}{\Phi * Cwnd}$
Commit file F0 = RTT
Commit file F1 = Timeout
Set $Time = Time + 0.01$
End LOOP
Execute X Graph For Files **F0 , F1**
Execute

Figure 2. The algorithm for the first modification.

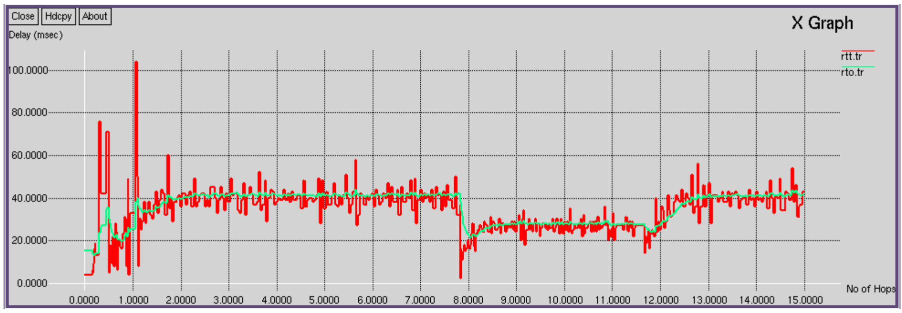

Figure 3. Applying first modification using AODV via 15 nodes.

$$Timeout = ERTT + \phi * \frac{Deviation}{n*Cwnd} \qquad (9)$$

where, ***ERTT*** is the estimated round trip time, ***Cwnd*** is changes the value of the congestion with the change of the number of nodes Obtained by TCP agent, ***n*** is number of nodes, ***Deviation*** **is** The deviation between **SRTT** and **ERTT,** $\boldsymbol{\Phi = 4}$ is Ideal value of inflation**,** used by Jacobson/ Karels.

Applying equation (9) to the algorithm in **Figure 2**, with change in the equation, the following result has been obtained using simulation as shown in **Figure 4**.

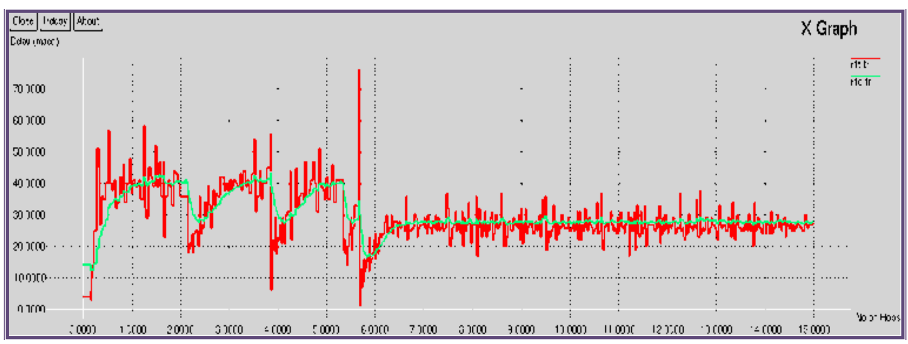

Figure 4. Applying second modification using AODV via 15 nodes.

$$Timeout = ERTT + \frac{Deviation}{(n*Cwnd)} \qquad (10)$$

Where, ***ERTT*** is Estimated round trip time, ***Cwnd*** is Changes the value of the congestion with the change of the number of nodes Obtained by TCP agent , ***n*** is number of nodes, ***Deviation*** **is** The deviation between **SRTT** and **ERTT,** $\boldsymbol{\Phi = 4}$ is ideal value of inflation**,** used by Jacobson/ Karels.

In the application of equation's algorithm (10) using **Figure 2**, with change in the equation, the following result has been obtained using simulation as shown in **Figure 5**.

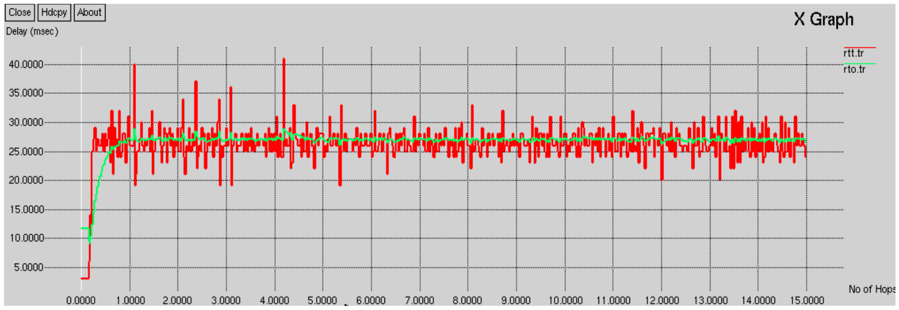

Figure 5. Applying third modification using AODV via 15 nodes.

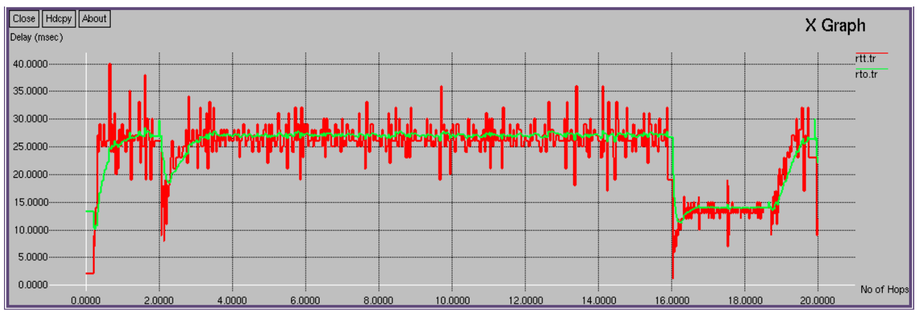

Figure 6. Applying third modification using AODV via 20 nodes.

$$Timeout = ERTT + \frac{Deviation}{\lambda} \quad (11)$$

where, ***ERTT*** is Estimated round trip time, ***Deviation*** **is** The deviation between **SRTT** and **ERTT** , $\lambda = \Phi * Cwnd * n$, ***Cwnd*** is Changes the value of the congestion with the change of the number of nodes obtained by TCP agent, ***n*** is number of nodes, $\boldsymbol{\Phi = 4}$ is Ideal value of inflation**,** used by Jacobson/ Karels.

In the application of equation's algorithm (11) using **Figure 2**, with change in the equation, the following result has been obtained using simulation as shown in **Figure 7**.

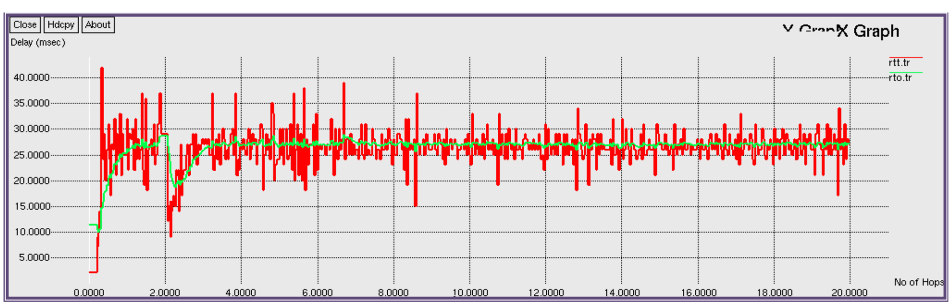

Figure 7. Applying fourth modification using AODV via 20 nodes.

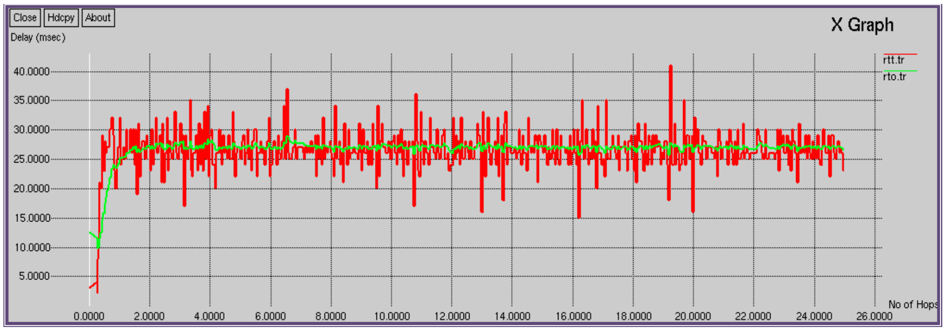

Figure 8. Applying fourth modification using AODV via 25 nodes.

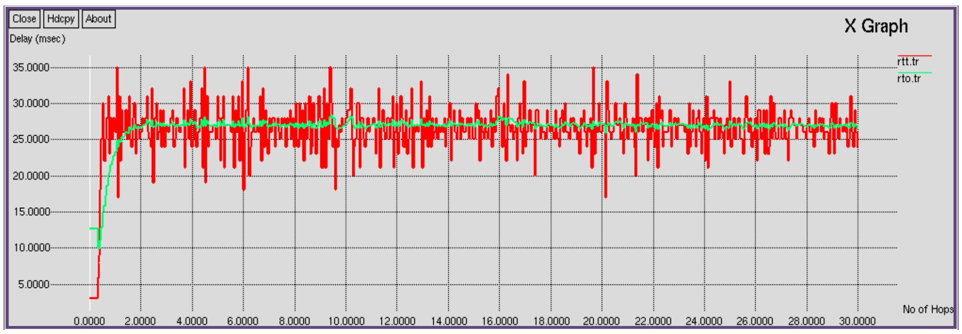

Figure 9. Applying fourth modification using AODV via 30 nodes.

A comparison of the retransmission timeout (RTO) using the original equation in [18] AND the modified proposed equation in this paper is shown in Table 1.

Table 1. Comparison between the results using original and proposed (modified) equations

Method	Number of Nodes	RTO in msec
Original equation in [18] Equation (11)	10	38.5584
Modified equation Equation (12)	15	26.3908
Modified equation Equation (15)	30	26.6854

Hence, the retransmission timeout has maintained a relatively good level with doubling the number of nodes from 15 to 30 nodes. That is, the difference in the rate of RTO during incrementing the number of nodes is 0.2946 msec. Therefore, RTO is not affected by increasing the number of nodes, thus preserving a low level of delay in the network.

7. CONCLUSIONS AND FUTURE VISIONS

The paper presented an algorithm to improve the retransmission time over ad hoc networks. The algorithm is a modification to the formula developed by [**18**]. Several experiments were performed taking different number of nodes. A comparison was made between the formula in **[18]** and the proposed modification. The results obtained shows that the proposed method outperformed the one in **[18].** The retransmission time was about the same when we went from 10 to 30 nodes using the proposed algorithm.

We suggest that different studies should be considered to introduce new mechanisms that achieve smart and more effective routing, with taking into account the mobility Characteristics.

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