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Proposal and Evaluation Method to Reduce Loops to Congestion Avoidance in Ad Hoc Networks

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Abstract:

Congestion is the most important problem for private networks, one of this problem is the formation of routing rings when an error occurs in the operation of the routing algorithm between a set of nodes and the path to a particular destination is a loop that leads to cut the connection.

In the present research we try to limit the formation of guidance rings and avoid congestion by proposing and evaluating the LLD and LMR methods to reduce the Interim loops. The foundation has been given a rationale for the loop prevention performance, and each methods was simulated using the program Qualnet 4.5 for simulation ad hoc network.

Keywords:

Ad Hoc , Congestion Avoidance , LLD , LMR , proactive protocol

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INTRODUCTION

Ad hoc networks consist of several devices or nodes that are wirelessly connected without an access point or a wireless router. They are based on direct connection between the wireless network of the card installed on each device to transfer data between them and the application of routing protocols to ensure that messages reach the desired destination[1].

The congestion in ad hoc networks are a major problem that leads to cut the connection, one of the most important reasons for the cut of this connect is the formation of path loops that prevent data to access to the desired destination

In this research, we try to obtain high reliability for secure communications by changing the dynamic parameters of the private wireless network through proposing and evaluating a technique to reduce the formation of temporary guidance rings in a scheme to control the proactive routing protocol by suggest two methods LLD and LMR [2].

Previous studies

A number of congestion control schemes have been proposed for traditional ad hoc networks

A study [3] provided a brief survey of several congestion control algorithms used in MANET, as well as a simple congestion control algorithm for mobility models such as the MANET random walk model and designing an effective technique to monitor and reduce network congestion.

In [4] congestion control measures were studied in detail which are considered insufficient and do not reduce the loss of the beam to a large level. It has been suggested metric RFR (resource free ratio) that works on the three important parameters for discovering a congestion-free path and load balancing on the network.

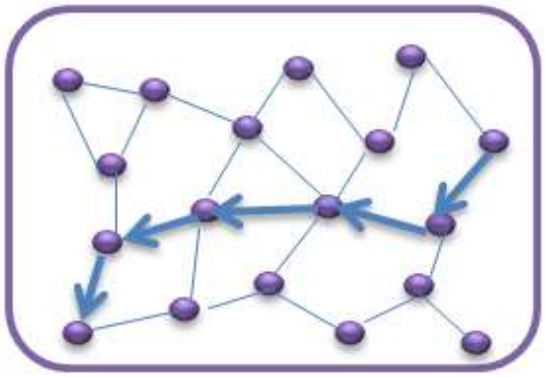
In a study [5], the TCP sender can regulate congestion window size (CWND) by dynamically adjusting window size according to ACK or by indicating packet losses when they occur, and a proposed effective, reliable mechanism to avoid congestion has been created to enhance TCP performance in networks with latency Big bandwidth. Includes a facility to send multiple streams over the same connection with a new technology to dynamically estimate the number of flows available, via network simulation.

Study [6] provides free traffic congestion (CFR) in Ad hoc networks, by computing the average node queue length. While using the average queue length, the nodes congestion state is divided into three zones (safe zone, likely to be congested zone and congested zone). CFR uses non-congested neighbors and initiates a path detection mechanism to discover a road without congestion between the source and the destination. The evaluation was performed between CFR and AODV using the Ns-2 simulator. The results were that CFR improved packet delivery, reduced end-to-end delays, and control packs.

Protocol proactive

It is Routing protocols used in ad hoc networks to send data from source to destination through multiple nodes. This type of network is used in disaster, space or military zones. In this type of routing protocol, a routing table is created in advance based on control packets transmitted regularly by all the nodes in the network and all the network nodes are flooded ,the shorter paths are saved between each pair of nodes, although some paths are never used. Then, the routing table that contains the nodes and the input that the data packet must follow is constructed to reach the Selected target [7].

These tables are also updated regularly to maintain updated routing information from each node to each other node.



Figure(1) Exchange information in an Ad hoc network

In the figure (1) ad hoc network in which the topology is understood and the calculation of the shortest path and then the exchange of information.

Routing by changing the dynamic scale

The dynamic scale is:

(1) Expected Transmission Count (ETX)

It is a simple Scale and fitter to path of network and that supports reliable and high-capacity connections. and it is The number of transmissions required to deliver a packet over a wireless link successfully. ETX is defined from the path as an ETX sum of each link along the way. ETX is measured in a real network link by:

$$ETX = 1 / (Df * Dr) \quad \ldots\ldots(1)$$

Where Df is the forward delivery ratio

Dr is the ratio of reverse delivery.

Df and Dr are measured by broadcasting test packets to dedicated to a fixed-size link for each. [8]

(2) Expected Transmission Time (ETT)

It is an extension of ETX which takes into account packet size and link bandwidth. ETT is expected time to successfully transmit a packet at the Media access control (MAC) layer and is defined for a single connect as**:**

ETT = ETX *S/B …..(2) where:

S denotes the average size of packet

B denotes current link bandwidth.

ETT path metric is obtained by adding up all the ETT values of individual links in the path[9].

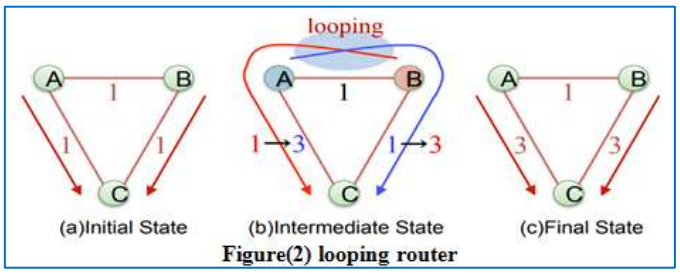
Quantify the quality of radio link to select good quality route , Normally, select the route with the smallest metric sum by shortest route calculation , In a situation where the link quality dynamically changes, it is always possible to select good route.

Routing loop problem

Depending on the metric propagation delay, old metric values are used on some nodes, Path loops occur because the routing tables of each node lack consistency.

Loops cause congestion and communication disconnection, which significantly impairs the reliability of communication , In order to realize stable communication, it is important to prevent loops[10]

In figure (2) the loops are shown based on the latency of the metric propagation, and the use of the old measurement values in some nodes.



Figure(2) looping router

The first suggested method

Loop free Link Duration (LLD)

The method of change a scale LLD is a Period connect without loops, where the shortest path is calculated using measures that are low enough to maintain stable connections and ensure that there is no problem in the routing loop. Thus, the transition formula of the scale is in the elapsed time t of the link1 [11]

$\delta^t(1) = ab^t + c$ …..(3)

See Figure (3) showing the LLD path and the traditional path between the nodes and Figure (4) which shows The more communication it has, the more stable the link

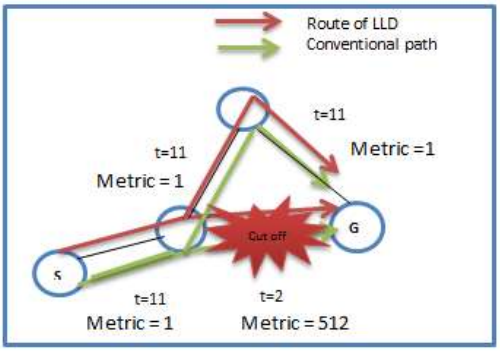


Figure (3) The LLD path and the conventional path between nodes

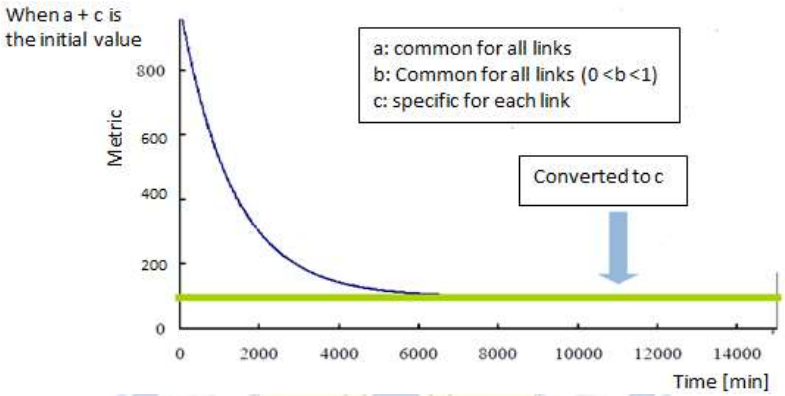


Figure (4) The longer the connection is made the more stable the link

LLD routing protocol

LLD extends proactive routing systems by introducing dynamic metrics. Based on the assumption that long-term bonds are more stable in probability, each link is constantly reduced over time by an initial value. Once the link remains constant, it becomes scale smaller .

In the LLD routing protocol, link metrics are updated periodically and their timing is almost synchronized in the network. With synchronization, we can reduce all correlation to metric values with the same ratio, which ensures the freedom of loops as long as they do not become a link. However, they can not only guarantee loop freedom when an unstable link appears, but it also requires additional messages for synchronization. As a way to reduce routing loops in ad hoc wireless networks, thus the scale change rate to the time of all links should be constant at any time when the ad link is created and metrics updated every time that time passes and recalculates the routing table [12].

Synchronization message

Broadcast synchronization messages at regular intervals. Node which received the synchronization message recalculates the metric and the routing table, and no need to periodically advertise metrics, overhead low

(1) The node notices at the synchronization time

(2) I noticed the node

and Broadcast synchronization message is

(3) Time is synchronized, t is updated, Metric recalculation is done [13].

In the theoretical analysis of the LLD guidance protocol , The connection interruption should not occur and the synchronization will not collapse. At this time, there appears to be a higher limit of the t-synchronization interval, which can ensure that no loop occurs. An algorithm is also displayed to calculate the value of the upper limit.

Network Simulation Program QualNet

A simulation program Ad hoc network that offers a comprehensive set of tools with all components for network modeling and tools for planning, testing and training "simulates" the behavior of real network connections in addition to accurately predicting network performance for a variety of application requirements, and faster than real time [14].

The simulation Is a cost-effective way to develop, deploy, and manage network-centric network systems over their entire lifecycle. Users can evaluate the network's

core behavior and test combinations of network features that are likely to work.

Our network simulation software tool provides a comprehensive environment for designing protocols, creating and moving network scenarios, and analyzing their performance.

In our search, a simulation evaluation is performed using Qualnet version 4.5

• LLD preferentially utilizes stable routes and improves quality

- Evaluate the performance in a network including stable routes

- Route between fixed nodes stably connect

• Create a scenario where fixed nodes and mobile nodes are mixed[15].So there is a fixed and moving nodes Communication occurs randomly between the mobile nodes, and the following is an explanation of the simulation field as in Figure (5).

The field of simulation 1200 m × 1200 m

Fixed node: 30

• nodes to be transferred: 30

Movement model: Random Waypoint (RWP) model, 5 km / h

It is a model Synthetic Commonly used for mobility, in Ad Hoc networks. Is a prototype describing the pattern of motion of an independent nodes in simple terms.

• Distance between fixed nodes 200 m Link communication Bandwidth 2 Mbps

Communication distance of node 250 m.

Random communication occurred between mobile nodes and Communication by User Datagram Protocol (UDP) that is an alternative communications protocol to Transmission Control Protocol (TCP) used primarily for establishing connections It is a fast because it does not waste time in the process of broadcast or correcting mistakes.

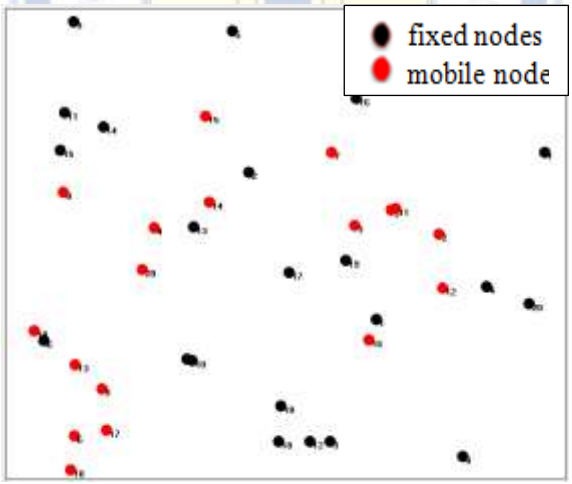


Figure (5) Simulation field (LLD)

Packet transmission rate 10 kbps

- a = 1000 ،b = 0.9 ،c = 1
- Simulation time 60 minutes
- Time synchronization interval 1 minute
- Evaluated on an average of 4 trials

Simulation Result

The packet access rate was compared by change in number of connections , LLD achieved higher access than the current HOP which is part of the signal journey from source to receiver (a hop is a portion of a signal's journey from source to receiver) [16].

When the number of connections increases, the interference of the radio waves increases, so the link is broken , The frequency of the difference between LLD and HOP access rates decreased, see Figure (6).

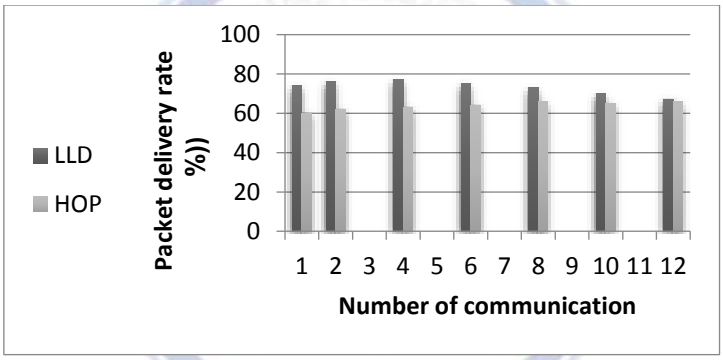


Figure (6) Simulation result (LLD)

The second suggested method

Loop-free Metric Range (LMR)

We propose a mechanism called ring-free metric range (LMR) by limiting the range of metric values to change.

LMR applies to a large portion of the current metrics including ETX, ETT, MIC, etc. without having to load any message. The theoretical results show LMR guarantees that the message will not be lost. LMR is also in practical scenarios where message loss may occur. Through simulations and actual assessments, LMR works effectively as a measure of dynamic metrics to reduce routing loops and improve network performance through real simulations and assessment. The steps followed in this method are to determine the value range of the newer scale of the previous value using

the r > 1 parameter, and to prevent / reduce the loops by slowing the metric fluctuations and thus apply to the current measurement method, so that they contain a wide range of applications, see Figure (7).

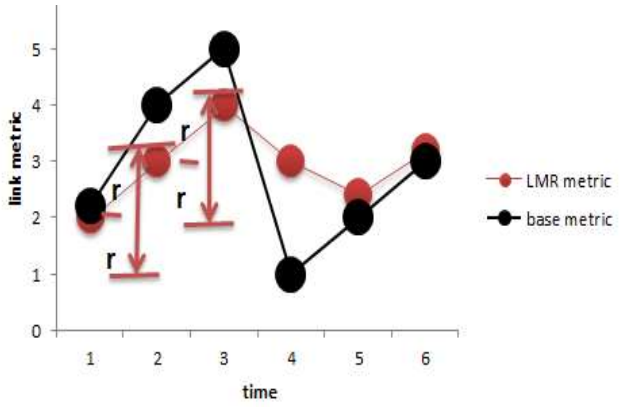


Figure (7) LMR metric

Theoretical resuits (LMR)

Theorem: Suppose there is no loss of link disconnection and control messages.

When considering a certain loop, the upper limit of the expansion coefficient r that can guarantee that the loop does not occur is given by the following expression:

$$h \leq K^{1/w} \quad \text{where} \quad K = \frac{\sum dist(n_{k\to d})}{\sum metrics\ in\ loop} \ldots . (4)$$

Where w = network diameter based on hop count

The minimum value of K gives the value of r without any ring

To find the value r in practical terms as follows:

• In the case of grid diameter w = 10, the minimum value of the scale Mmin = 1, where the maximum value is Mmax = 5, the r value that can guarantee loop free is r = 1.002, it is too small for practical use, however, according to the theoretical result, If r is relatively large, the smaller the size, the less likely the loop will be.

Simulation experiments were performed to measure the effect of ring reduction with the value of r.

The Simulation of LMR method

The LMR method was simulated using the Qualnet 4.5 software as follows, see figure (8):

- The 1300 × 1300 field, 30 fixed knots arranged in a grid, 300 meters between each node and the bandwidth link is 2 Mbps and the connection occurs on each diagonal line

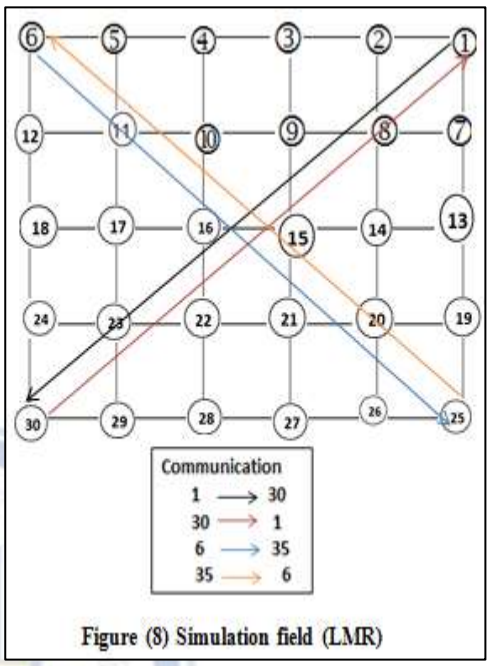


Figure (8) Simulation field (LMR)

- CBR communication: 20 kbps to 80 kbps

Constant bit rate (CBR) is a term used in telecommunications, relating to the quality of service. Compare with variable bitrate[17].

-FTP communication (File Transfer Protocol): is a standard Internet protocol for transmitting files between computers on the Internet over TCP/IP connections[18].

The FTP protocol relies on the client / server method, in which the file server uploads and downloads files on directories, provided that the specified domain has a special identification (ID) and a password.

Where the size of one package is 512 bytes and a connection for 5 minutes in the following manner:

– ETX、ETX+LMR 1.01～1.50

- Number of duplicates 30

- Use the average value for experiment results

Simulation result : Communication rate variation

Relationship between loop packet count and total throughput

Discussion and Future Tasks

Both LLD and LMR have the effect of reducing loops. The result was a simulation experiment with the effect of reducing rings and avoiding congestion. And with increased load of communication, congestion occurs, which causes link breaks will not arise.

A loop is created when path is changed by separating link. loops cannot be handled in the manner suggested. And Combined with congestion control method that can prevent the separation of the link even at high load.

Conflict of interests.

There are non-conflicts of interest.

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