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Reliability Analysis of Network Connectivity on Wireless Ad Hoc Networks

Pranati Mishra[1] and Ananya Das[2]
[1]Asst. Professor , Department of Computer Science and Engineering, Odisha University of Technology and Engineering, Bhubaneswar, India.
Email: pranatimishracse@cet.edu.in.
[2]Department of Computer Science and Engineering, Odisha University of Technology and Engineering,Bhubaneswar,India.
Email: dasananya1011@gmail.com

***Abstract*—Reliability on wireless ad hoc networks will offer a fault-tolerant network and identify faults that occur at various levels. The key task of the sensor is to monitor the area by gathering data and transmitting it to the destination node. Sensors failed as a result of their low cost and low energy capacity. Reliability requirements and disadvantages depend on the resources used by the wireless network. The paper addresses the issue of wireless ad hoc and sensor network reliability using a node and link failure model. The number of neighboring nodes, rate of the packet success, type of device , and the size of the packet are all factors that go into calculating node reliability. The reliability of a link among any node pair is estimated by taking into consideration the distance between nodes and the ratio of signal to noise .This method is projected to evaluate and calculate the reliability of wireless ad hoc networks, taking into consideration numerous routes from starting and destination nodes. Analyzed and discussed are the effects of various factors on reliability analysis of node and link.**

***Index Terms*— Reliability analysis of Node and Link, Signal to noise ratio.**

I. INTRODUCTION

Ad-Hoc is not centralized. That network is referred to as "Ad Hoc" because it does not depend on existing configuration such as routers in Wired Networks or access points in managed (infrastructure) Wireless Networks. Instead, each node carry out in routing by forwarding data to another nodes, and network connectivity determines that nodes are used to forward data on a dynamic basis. There are two categories of wireless networks: infrastructure-based networks and infrastructure-less networks. A network with fixed and wide gateways makes up an infrastructure-based network. A wireless ad hoc network is one that is impulsively formed when devices interact and communicate with each other. In Latin, the word “Ad Hoc” means “for this,” signifying that it was spontaneous or improvised. As opposed to wireless LANs, where a base station or access point is used, direct communication between the devices occurs. By using the routing algorithm to find the path and communicating with other devices along the way, each device participates in the routing process.
A Wireless Sensor Network contains of base stations and a huge number of small, self-contained, low-power devices known as sensor nodes. In order to collect, process, and deliver data to users, WSN naturally consists of a huge number of small, spatially dispersed, battery-operated embedded devices. It also has restricted computing and processing abilities. Be WSN is a wireless network composed of base stations and several nodes (wireless

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sensors). Also, even though the devices and links are functioning correctly, due to ineffective sensor placement, insufficient coverage, and connectivity, the target or sink node may occasionally go undetected. Sensors are in direct interaction with their surroundings. Faults were presented for measurement of sensor while handling, sensing or detecting the data to the sink. Therefore, incorrect sensor data must be identified and filtered out for enhance data integrity and recognition reliability, while faultless sensor data must be aggregated and delivered. Even when an object or event is reliably detected, a communication link of poor quality leads to an error. The reliability of the network can be increased by using an appropriate routing protocol.

A. Application Of Wireless Network

Military Applications
Military sensing networks are proposed to discover and collect data on enemy movements, explosions, and other occurrences.

Event Detection Application
In the initial situation of the sensor, this application occurs to determine and encounter an action or event; for examples, see volcanic eruption, avalanches and landslides, blizzards and snowstorms, earthquakes, forest fires, and so on.

Environment Applications
Tracking animal and insect activities and migration, monitoring habitats, detecting floods, detecting forest fires, and monitoring civil and environmental engineering are some examples of this applications.

Personal Area Networks And Bluetooth
A personal area network (PAN) is intended to be a highly confined network that is made up of a few network nodes that are directly related to a single person. These nodes could be stowed in a handbag or fastened to the wearer's belt. These gadgets may be or may not be connected at to the wide area Internet, However, they will almost certainly need to communicate with one another.

II. LITERATURE SURVEY

In this paper I reviewed reliability on Wireless ad hoc Network on the basis of :
1. Impact of Inter Node Distance on Link Reliability
2. Impact of signal noise ratio on Link Reliability

In this research, they reviewed wireless sensor networks, routing strategies, hierarchical architecture, and a brief overview of energy-harvesting wireless sensor networks to satisfy application requirements and scale challenges, protocols should be created with the goal of keeping sensors active for extended periods of time. MATLAB was used to simulate the two protocols MODLEACH and MIEEPB. A comparison showed that MIEEPB outperformed MODLEACH. The biggest issue that WSNs are dealing with is energy. sensors reduced of energy are unable to perform their function until the energy source is restored. A potential approach for many wireless sensor applications is the use of ambient energy to power wireless sensors[1].
The simulations' findings showed that when a greedy attack is launched against the network, energy consumption will actually increase and node transmission performance will decrease. The evaluation has proved the nongreen behavior induced by such an attack, as the latter has a negative effect on the network's lifetime and energy efficiency. This research explored the potential for and methods for detecting the appearance of greedy behavior based on the analysis of some transmission parameters. Two solutions that demonstrate their partial efficiency in respect to the network load are proposed and simulated in this research as counter measures and to reduce the impact of such non-green behavior. More specifically, the waiting technique appears to be more suited to handle greedy behavior as well as a network overload in the case of a false suspicion[2].
In this paper, several models and implementations of various energy-efficiency protocols for wireless sensor networks were discussed. This research examined the heterogenous LEACH protocol and improved the protocol's performance for various parameters. In that paper, the suggested models was applied on an n-node network, and the performance was estimated and demonstrated using the obtained results. It is done to analyze the heterogeneous LEACH simulation network .The duration of a stable phase and its unstable period also affect performance. Heterogeneous LEACH Protocol's Network Lifetime for €_ft1=1 is significantly more stable. It indicates that energy consumption almost stays constant until the first node dies and after that it starts to decline. SEP cluster head of advance node are more likely to become cluster head than standard node. In comparison to heterogeneous LEACH, the SEP's stability period has decreased, and it has also improved[3].

A reliable routing metric for Wireless Sensor Network that is energy balanced was proposed by Jian ZHU, Hai ZHAO, and Juqiang XU in 2009[4]. This work first advances an optimization model for the lifetime of Wireless Sensor Network. Then the lack of expected transmission (ETX) based routing metric is resolved with the help of optimization model. Lastly, an energy composed routing metric is advanced. This metric balances the network's load, prolongs the network's life, and ensures reliable communication.
In a large-scale wireless sensor network, the reliable routing protocol (RRP) was presented in this research Jianlin, koichi Ishibashi 2014[5]. Multiple bidirectional routes are found by RRP between sensors and sink nodes. Sink node starts route creation with an imaginary node as destination in order to ensure that the entire routing topology has been built up. By sending data packets over a path with lighter workload, load balancing is accomplished. It can be made to be lightweight routing-optimized.
An Efficient Delay Aware Routing Protocol (EDARP) was proposed by Ghufran Ullah and Abdul Hanan in 2014[6]. It improves the quality-of-service parameters to fulfil the end-to-end delay and needs for real-time WSN applications in terms of reliability. The comparison of EDARP with other protocols reveals that it performs better in terms of reliability and end-to-end delay. This protocol is appropriate for fewer hops.
Dr. B. Paramasivan and Bejoy. B. J represented transport protocol for WSN in 2012[7]. Clusters are created to reduce energy loss. A node may update its neighbor list in response to forward data and any modifications in the local topology. Whenever a node detects a change in the neighbors on its list. It is capable of suddenly re-advertise all of its data. As a result, it offers reliable transport in condition of mobility.
Juan Wang, Yuping Zhou, and Zhenjie Huang proposed a global deterministic linear propagation verification protocol 2014[8]. (GDL). The WSN node clone attack is addressed by this protocol. The node's location information is transmitted and stored in both the horizontal and vertical directions.

III. PROPOSED METHOD

Structured graph G(N) with nodes N, where ri has the reliability of each node, can be used to explain a wireless network.Two nodes i and j can be connected though a two-
method wireless link, which is denoted by the expressions :
l_{ij}, i, j=1, …., M and i ≠ j.
A link's presence is binary and is described as follows:

$$l_{ij} = \{ \textit{If a link presences between two nodes i and j, the value is 1, otherwise it is 0.} \} \quad (1)$$

The below expectations have prepared as per [15]:

a. The root and destination nodes are recognized.
b. similar type of nodes
c. Each nodes and each pair of nodes between the range of wireless communication within that limit of wireless transmission are measured to be connected.
d. The anyway point mobility model explains how the host moves.
e. Rayleigh random variables are the fading factors for various links.

A. Reliability Analysis Of Node

As long as a node can forward the packets it collects, it is said to be reliable. The number of neighbors nodes, rate of the packet success , type of device , and size of the packet are helped to calculate the node reliability. Any node pair's link state is binary, and its dependability is calculated by taking into account the space among nodes and the signal to noise ratio (SNR). This approach is recommended to evaluate and determine the reliability of Wireless Ad Hoc networks, taking into consideration various paths between the source and sink nodes.
The following variables have an impact on the node's reliability
1.The node's capacity and type (α)
2. The number of neighbor nodes and its distances
3. Size of the packet (β)
4. Rate of the packet success (γ)

$$r = 2(e^{2\alpha(g_{i-\beta})}+1)^{-1} \times \gamma \quad (2)$$

where g_i is the number of neighbor nodes of node i.

B. Analyzed Reliability of Link

A wireless network's link reliability (P_{IJ}) is determined by the probability that the signal will be correctly received at the acceptor's end and is mainly influenced by the below variables:

1. Power of transmit
2. The inter distance among interconnecting nodes(d)
3.The Signal to Noise Ratio (snr) Consequently $P_{I,J}$ can be described as

$$P_{ij} = e^{\left(-d^k / snr\right)} \qquad (3)$$

In this scenario, k is the propagation power loss exponent.

C. Analysis Of Reliability

The possibility that each two network nodes will have a functional route interconnecting them can be used to analyze the reliability of a Wireless Ad Hoc network. In a Wireless Ad Hoc network, a multi-hop route can be used to determine the path through which statistics are transmitted from a root node (s) to a sink node (t).

i.e.: $Path = \langle s, b_1, b_2 b_3 \ldots b_i \ldots t \rangle$

Where

bi= Intermediary network node

b= no. oh nodes

$$R = \pi_{i-1}^{h} \; r_i p_{ij}$$

$$= \pi_{i=1}^{h} \; 2(e^{2\alpha\left(g_{i-\beta}\right)} + 1)^{-1} \times \gamma \times e^{\left(-d^{k} \; (i,i+1) / snr(i,i+1)\right)} \qquad (4)$$

where signal to noise ratio snr(i,i+1) between nodes i and i+1 and d(i,i+1) is the space between nodes i and i+1. Equation 4 analyze the Wireless Ad hoc Network reliability when there presents a single route between source and termination.

IV. Result and Discussions

A. Link Reliability Is Affected By Inter Node Distance

Figure1 examines the values of link reliability in relation to various factors for example inter node spaces, number of neighbors nodes, and the behavior of link and node reliability under various conditions.

The reliability analysis of link drops uniformly with regard to inter node distances due to decreasing. This is caused by the f distances increase, attenuation also increases, resulting in bad signal reception at the acceptor end. In addition, the result of the propagation power loss exponent (k) on reliability is fluctuating from 2 to 4. When the reliability of link value is decreased, value of component is increased.

B. Link Reliability Is Affected By Signal-Noise-Ratio

Plotting link reliability values versus signal noise ratio values from 1 to 6 for various specific parameters of the propagation power loss exponent(k). In figure 2, link reliability increases when the value of signal noise ratio incr eases since it rises strength of the signal.

In Figure1 and 2 the following parameters are used which are $s = 1, t = 4, k = 2, \alpha = 1.0, \beta = 10, \Upsilon = 0.5$, $snr = 10$.

C. Node Reliability Is Affected By Neighbor Nodes

In figure3, the various reliability analysis of node values are computed and shown against the number of neighbor nodes from 2 to 14 . This figure shows high reliability analysis of node values for up to 8 neighbor nodes. When the reliability is 0.9, the neighbor node is situated on 9. Calculated reliability is 0.5 for neighbor node 10. The estimated reliability is 0.1 for neighbor node 11. The reliability analysis of the nodes is nearly 0 when the number of nodes ranges to 13. As a result, each node can acclimate a maximum of 10 neighbor nodes. This reliability behavior with respect to no. neighbor node is caused by the fact that increase neighbors result increases packets arriving.

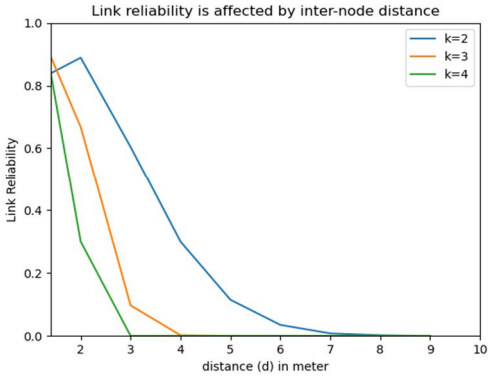

Figure 1

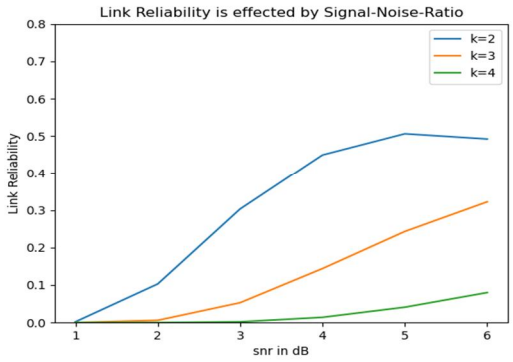

Figure 2

The receiver node will be overloaded when the volume of packets and rate of the packet reach at a node reach their higher value as related to the receiving rate. As a outcome congestion will happen and the nodes' packet loss rate will grow. Then it will lead to the node's unreliability.

In Figure 3 and 4 the following parameters are used which are $s = 1, t = 4, k = 2, \alpha = 1.0, \beta = 10, \Upsilon = 0.5$, $snr = 10$.

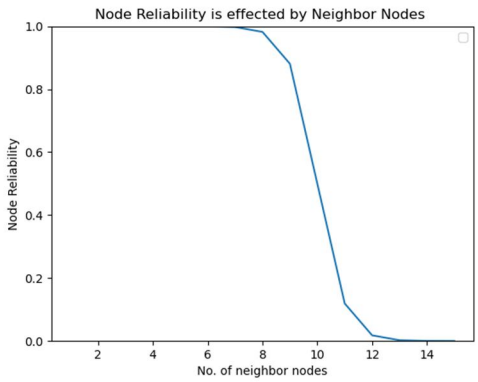

Figure 3

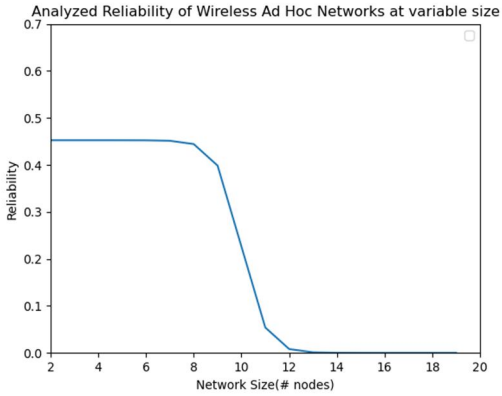

Figure 4

D. Reliability Analysis Of Wireless Ad hoc Networks At Variable Size

In Figure4, the reliability is plotted against network size. This numerous paths occur between source and destination nodes. The value of reliability begins dropping when the size of network is 10 number of nodes. The reliability falls to 0 when size of network scopes to 14.

V. Conclusion

This paper analyzes the reliability of the node and link of Wireless Ad Hoc Networks. The evaluation of reliability of node depends on a various factors, such as the number of neighbor nodes, the type and capability of the node, the rate of packet success, and the volume of the data packet. The inter-node spaces and signal to noise ratio (SNR) are utilized to estimate the link reliability. This method proposes to estimate the reliability of Wireless Ad Hoc Networks. It has been discussed how various parameters affect both link and node reliability. This method evaluates reliability of wireless Ad hoc network at variable size.

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