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Utilizing A Dynamic Source Routing Protocol (EIGRP) Approach Can Enhance Energy Efficiency in Wireless Sensor Networks.

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Abstract

An infrastructure-free wireless network called a Wireless Sensor Network (WSN) is set up ad hoc using a large number of wireless sensors to monitor environmental, physical, and system conditions. The data transfer from the sensor nodes caused the collision, and the extra data transmission by the sensor nodes is the reason for the excessive traffic at the SINK node. The Medium Access Control (MAC) mechanism in a WSN controls a crucial portion of resource utilization. An established MAC protocol was started to use the single channel of the WSN for data transfer. The deployment of wireless sensor nodes is problematic in severe environments because abrupt changes in a node's status and a link's quality can cause extreme conditions to alter. Since sensor nodes have a finite amount of energy, extending the life of a network is crucial. As a dynamic routing system to address issues, the Enhanced Interior Gateway Routing Protocol (EIGRP), a sophisticated distance-vector routing protocol, was created. EIGRP is used on a computer network to automate routing decisions and setup. EIGRP reduces the amount of data that needs to be transmitted and the strain on the router by just providing incremental updates. This study will discuss the use of EIGRP to increase energy efficiency.

Keywords*: (EIGRP) Enhanced Interior Gateway Routing Protocol -Energy efficiency- (MAC) Medium Access Control -SINK-(WSN) Wireless Sensor Network.*

Introduction:

Wireless sensor networks are described as self-configured, infrastructure-less wireless networks that monitor physical or environmental parameters such as pressure, temperature, motion, sound, vibration, or pollutants. The data or information collected by these networks is then directly transmitted to a sink, also known as the primary location where the data is frequently observed and analyzed. Radio transmissions are used to facilitate communication between the sensory nodes. An interface that appears to be between users and the network is a base station or sink. By inserting some queries and obtaining answers from the sink, it can retrieve some of the necessary data from the network. Many thousands of sensor nodes are often found in a wireless sensor network. The wireless sensor nodes have radio transceivers, processing, sensing capabilities and power components.

The following are typical WSN energy-wasting behaviors: According to Sahoo et al. (2014), idle listening is the practice of a node listening to an idle channel to potentially receive traffic. Collisions occur when a node gets several packets at once, causing the surplus packets to be retransmitted and wasting energy (Tao et al., 2012). Over-emitting is the unexpected transmission of data by a node. When a node accepts data that is meant for another node, it is referred to as over-hearing (Zahra and Shima, 2012; Hossam and Ahmad, 2020). The majority of the energy minimization models in use today concentrate on data transfer and reception while ignoring other factors that may be important for energy reduction. Heinzelman et al. (2000) and Heinzelman et al. (2002) concentrated on the cost of power consumption modeling.

To reduce the energy consumption of retransmission, the approach took into account a middle node between the transmitting and receiving ends. According to Junaid et al. (2014), it is crucial to take energy supply and consumption into account simultaneously while designing an energy-efficient algorithm. For WSNs to save energy, a solid conservation plan that looks at energy sources, energy usage processes, and energy waste activities is necessary.

An enhanced distance vector routing protocol is called EIGRP (Enhanced Interior Gateway Routing Protocol). This protocol is an advancement on an earlier, now deprecated Cisco protocol known as IGRP. Along with many other helpful features, EIGRP enables load balancing, route summarization, incremental updates, classless routing, and VLSM. Since EIGRP is a Cisco proprietary protocol, every router in a network running it needs to be a Cisco router.

Before sharing routing data, EIGRP-enabled routers need to establish a neighboring relationship. 224.0.0.10 is the multicast IP that EIGRP routers use to dynamically discover neighbors.

Three tables are used by each EIGRP router to hold routing and topology data:

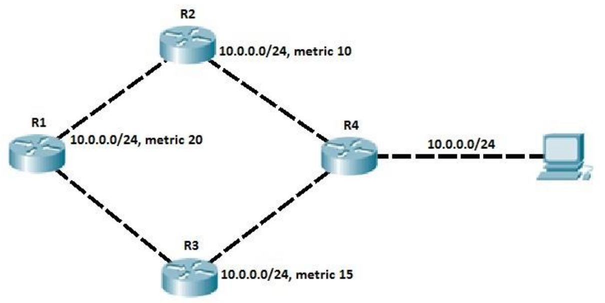
Information about EIGRP neighbors is stored in the neighbor table.

Topology table: contains routing knowledge gleaned from nearby routers.

The optimal routes are stored in a routing table.

The idea of autonomous systems is used by EIGRP. A group of routers with EIGRP enabled that aim to become neighbors is known as an autonomous system. For routers to become neighbors, each router inside an autonomous system needs to be set with the same autonomous system number.

Two more terms that are frequently used in the context of EIGRP are feasible successor and successor. The route with the best measure for arriving at a destination is called a successor. The routing table has a record of that route. A viable alternative that may be employed right away if the successor route is unsuccessful is a backup route that leads to the same location. The topology table contains these fallback paths. One requirement must be satisfied for a route to be selected as a viable successor: the neighbor's advertised distance (AD) for the route must be smaller than the feasible distance (FD) of the successor.



Objective of the study:

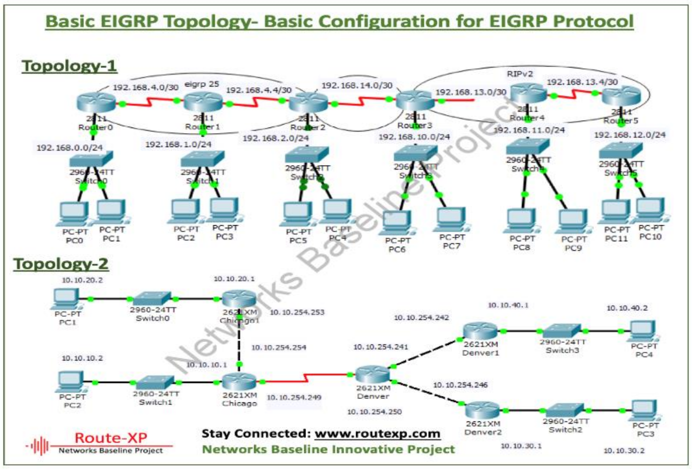
- To increase the energy efficiency by using EIGRP.
- By using EIGRP reduce the amount of data transmission.

Literature review:

- Leila Abbad in 2022 The article presents a technique called weighted Markov-clustering-based routing (WMCL-BCRP), which is an improvement on Markov-clustering-based routing. It is based on selecting cluster heads and sensors in a way that increases the lifetime of networks with a non-uniform distribution of sensors. The two primary factors that determine its adaptive cluster-head selection are distribution density and sensor residual energy. Sparse regions are maintained for the longest duration possible in the network by differentiating between low and high abundance (density) regions, while intra-cluster energy consumption is minimised by avoiding duplicate data transmissions in dense regions.In 2022, Arif Hossan, Pallab K Choudhury proposed DE-SEP is a proactive routing protocol, which considers both the nodes' position and energy during the CH selection process by imposing a limit on the total number of CHs to prolong the network lifetime, throughput and stability period for heterogeneous WSN.
- Rakesh Kumar Lenka, Manjur Kolhar, Hitesh Mohapatra, Fadi Al Turjman, and Chadi Altrjman examined the CRPSH protocol in 2022 and made sure all potential routes were found before using them. Static networks are suitable for this strategy. The path connecting the hub and CH is necessary for the clustering method used by CRPSH. The hub is in charge of determining the best path and controlling each sensor device's energy usage inside the network. Peer discovery, cluster creation, data transfer, and re-clustering and rerouting are its four stages.
- In 2022, a proposal called the Enhanced Energy Conservation Routing Protocol (EECRP), with five levels of heterogeneity, was made by Shashank Barthwal, Sumit Pundir, Mohammad Wazid, and D.P. Singh. The number of clusters used per round at the minimum side, the average energy of sensor nodes, and the residual energy are used to elect CH. Simulation results demonstrate that EECRP performs significantly better than SEP, TSEP, and BEENISH. Compared to SEP, TSEP, and BEENISH, it can be observed that EECRP improves network stability by 65.18%, 40.36%, and 30.88%. Similarly, EECRP increases throughput by 66.68, 69.13, and 49.16%.
- To lower energy consumption and determine the distances between cluster heads, a new Delay Constrained Energy-efficient Multi-hop Routing Algorithm (DCEMRA) has been proposed in 2019. It incorporates two distinct methods, namely computational and delay constrained reliable routing algorithms. Reliability, packet delivery ratio, network longevity, and energy conservation are all enhanced. In 2018, it was demonstrated that a new Quorum time-slot adaptive condensing (QTSAC)-based media access control protocol may accomplish the goals of decreased latency and effective energy use for WSNs. Network latency can be reduced while network performance can be enhanced by the QTS condensing to the period and the nodes using their residual energy in the periphery. Consequently, the execution of a suggested methodology.

Proposed system:

The proposed protocol is explained in full below, along with an algorithm and diagram.



EIGRP Routing procedure:

The diffusing update method (DUAL) is used by the distance vector and link state routing protocol EIGRP to increase protocol efficiency and reduce calculation mistakes while figuring out the optimum path to a remote network. Five metrics are used by EIGRP to calculate the path's value: MTU, bandwidth, load, latency, and dependability. EIGRP communicates with neighbouring routers using five distinct messages. The Hello, Update, Query, Reply, and Acknowledgment messages are sent by EIGRP.

```
Router1# show ip eigrp topology 10.0.0.1[13] 255.255.255.255
IP-EIGRP topology entry for 10.0.0.1/32
State is Passive, Query origin flag is 1, 1 Successor(s), FD is 40640000
Routing Descriptor Blocks:
10.0.0.1 (Serial0/0/0), from 10.0.0.1, Send flag is 0x0
Composite metric is (40640000/128256), Route is Internal
Vector metric:
Minimum bandwidth is 64 Kbit
Total delay is 25000 microseconds
Reliability is 255/255
Load is 197/255
Minimum MTU is 576
Hop count is 2
```

Routing Metric:

Five parameters, or "K values," are used to compute the composite routing metric: K1 through K5. These are used to compute the composite metric as multipliers or modifiers. K1 and bandwidth, etc. are not the same.When a router is first configured with EIGRP, it only takes into account the minimum bandwidth and total delay by default. However, an administrator can enable or disable all K values to take into account the other Vector metrics.

These are incorporated in a weighted calculation to provide a single overall metric that is used to compare routes:

$$\left[\left(K_1 \cdot \text{Bandwidth}_E + \frac{K_2 \cdot \text{Bandwidth}_E}{256 - \text{Load}} + K_3 \cdot \text{Delay}_E\right) \cdot \frac{K_5}{K_4 + \text{Reliability}}\right] \cdot 256$$

Where the various constants (K1 through K5) can be set by the user to produce varying behaviours. An important and unintuitive fact is that if K5 is set to zero, the term $\frac{K_5}{K_4+\text{Reliability}}$

The default is for K1 and K3 to be set to 1, and the rest to zero, effectively reducing the above formula to $(\text{Bandwidth}_E + \text{Delay}_E)$

In an EIGRP system, it goes without saying that all routers need to have these constants set to the same value in order to prevent permanent routing loops. Until these values are the same on these Cisco routers, they will not construct an EIGRP adjacency and will complain about a K-value mismatch. The customisable static interface bandwidth on Cisco routers is measured in kilobits per second; changing this option only impacts metric computation, not the real line capacity. The result obtained by dividing the interface bandwidth statement value by 107 kbit/s, or 10 Gbit/s, is utilised in the weighted calculation. Tens of microseconds are used to express the changeable static parameter known as the interface delay. EIGRP does not scale this value into the weighted formula; it takes it straight. Nonetheless, the interface latency is shown in microseconds via a number of show commands. As a result, before utilising a delay value in microseconds in the weighted calculation, it must first be divided by 10.

$$\mathrm{Bandwidth}_E = 10^7 / \text{Value of the } \textit{bandwidth} \text{ interface command}$$

$$\mathrm{Delay}_E = \text{Value of the } \textit{delay} \text{ interface command}$$

Feasibility Condition:

In an EIGRP-routed network, the feasibility requirement is a sufficient condition for loop freedom. It is employed in the process of choosing viable successors who will always travel a path free of loops to their objectives. The concept can be expressed in an incredibly straightforward way: if a neighbor router for a destination advertises a distance that is strictly less than our feasible distance, then this neighbor is on a loop-free route to accomplish this goal.

Diffusing Update Algorithm:

The Diffusing Update Algorithm (DUAL) is the EIGRP's central nervous system. It is an algorithm that finds a path to the target that avoids loops by tracking every route that a neighbor advertises. The Diffusing Update Algorithm DUAL uses three tables to determine the optimal path. These table names are own routing table, neighbor routing table, and topology table. The neighboring routers share information through the EIGRP protocol, which maintains all three tables.

All immediately related routers' information is stored in the neighbor table. Every table contains the addresses of nearby routers and network interface data. A greeting packet is broadcast and received to see how the neighboring router is doing. It was determined by the hello packet reply whether or not the neighbor router was operational. The router assumes it is dead if the hello packet reply is not received within the predetermined period.

The topology table, which contains metrics information for every route in the network, comes next. The neighboring routers gathered this data. The best path and alternate path information are retained by the feasible successor and the successor. So in case of failure of a successor, the feasible successor is selected with some other terms like reported distance and feasible distance.

Results:

Scenario designed:

Consider a network with the following topology:

Three routers: Router A, B, and C form a triangle topology.

Each router is connected to the other two routers forming full connectivity.

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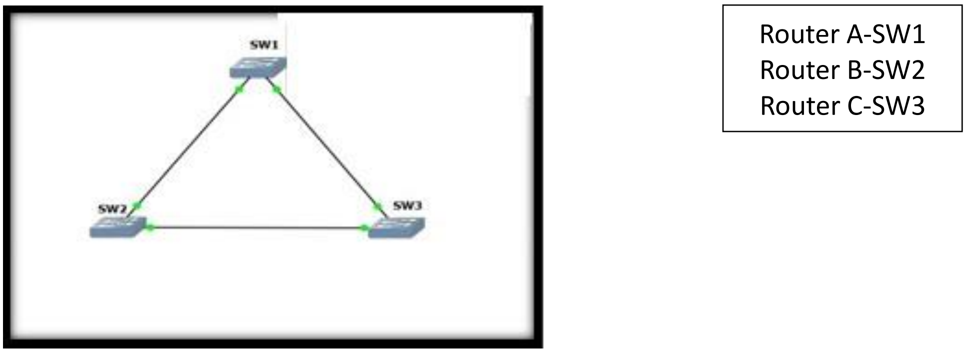


Performance Metrics:

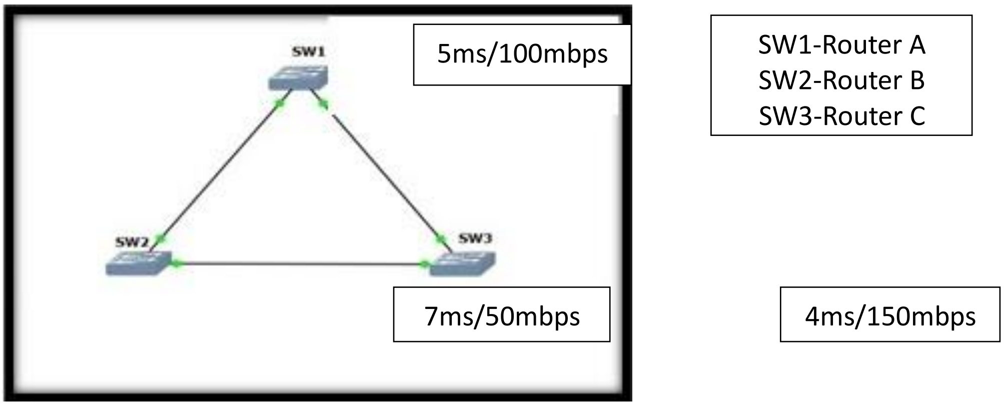
For each link between routers, we will consider latency and bandwidth:

- Router A<->Router B: Latency :5ms, Bandwidth:100 Mbps
- Router A<->Router C: Latency :7ms, Bandwidth:50 Mbps
- Router B<->Router C: Latency :4ms, Bandwidth:150 Mbps

EIGRP Configuration:

All routers are running EIGRP with an autonomous system number 100.They are exchanging routing information.

Performance Diagram:



Conclusion:

EIGRP sends update packets across a network without using the TCP or UDP protocols. Routing protocols assist routers in creating and maintaining their routing tables. The router is informed about the networks linked to each interface using routing protocols. Data packets are not carried or pushed by routing protocols in any way. Every modification to the network necessitates updating the routing tables on every router. The routing protocols are responsible for doing this work. The routers choose the optimal way for data packets to leave with the assistance of routing protocols.

The use of the DUAL algorithm facilitates a quick and easy convergence of the EIGRP. The cost of the path to a distant destination network can be calculated with the use of a copy of the routing table. The optimal route for sending data to a distant destination network is now known to the router. Assuming that the optimal path now fails, the router will instantly search the topology table for a viable replacement. Thus, they automatically determine the simplest way to decrease energy consumption by utilizing the DUAL algorithm in EIGRP. The foundation of EIGRP is the DUAL algorithm. To reduce energy consumption, we might switch from EIGRP to another dynamic or static protocol in the future.

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