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# ENERGY-EFFICIENT HIERARCHICAL ROUTING WITH CLUSTERING

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## ABSTRACT

Vehicular Ad Hoc Networks (VANETs) provide a vehicle-to-roadside infrastructure communication platform and, consequently, is an essential element of intelligent transport and safety appsDespite these advancements, problems like huge routing above, energy loss, loss of packets due to mobility, and duplicate communication broadcast persist in similar networks.

To address similar problems in this design, an Energy-Effective Hierarchical Routing with Clustering( E2HRC) system is handed. On this system the bumps are partitioned into clusters and a cluster head is originally chosen stoutly with regard to residual energy. The cluster head position is aimlessly varying similar that a single knot did n't get too drained. This is because the cluster head receives information that has been collected by the members and transmits it to a superior head or straight to the base station. This makes the communication contents more unique, saves energy, and improves the stability of packet delivery.

These parameters were taken into account and used to measure the scheme performance through the NS2 criteria of outturn and outflow. The answer to this question is that E2HRC is better than the heritage routing tables and it also provides a scalable model that can handle the changes in VANET.

## 1. INTRODUCTION

The project focuses on addressing the disadvantage of energy usage, dependability and size of wireless communication systems i.e. sensor and vehicular ad hoc networks. The traditional routing schemes have been beset by redundant overhead, successive retransmissions and lopsided power consumption, leading to a reduced network performance and reduced lifetime. In bid to close these extent, this work proposes and analyses an Enhanced Energy-Efficient Hierarchical Routing with Clustering (E2HRC) protocol.

Under this strategy, the network nodes are formed in regular clusters and each cluster has a designated cluster head. The hierarchical work avoids redundancy of messages, lowers overheads of control and offers equal energy distribution to all parts of the network. The system evades chances of premature node failure and maintains connectivity in highly dynamic environments through dynamic cluster head rotation as well as optimal routing decision-making.

The simulation platform used to implement the project is the NS2 platform and different performance parameters such as Packet-Delivery-Ratio (PDR), Throughput, Routing Overhead, Packet Loss and Energy Consumption have been measured. The simulation findings indicate that E2HRC highly improves the delivery of packets with reduced energy consumption relative to the conventional routing protocols. The proposed scheme is also hard to both node mobility and topology change that are prevalent in vehicles and cities.

The output of this project has shown application of hierarchical clustering-based router tools to be useful in real-life applications in the brilliant communication systems, good cities and large-scale sensor networks. Having both energy efficiency and efficient data dissemination, E2HRC belongs to sustainable and scalable communication paradigms of future networks.

## 2. LITERATURE SURVEY

Energy-efficient routing and clustering protocols of wireless-sensor-networks (WSNs) and vehicular ad hoc networks (VANETs) have been studied. Clustering was introduced by protocols like LEACH, which made less communication overhead, but had the drawback of random selection of cluster head. HEED improved cluster formation by residual-energy considerations, however, it was scaled poorly in large networks. AODV and DSR offer good mobility support within VANETs but are connected with specific routing overhead due to a high amount of route discovery and maintenance processes. Recent research is on hierarchical clustering and adaptive routing to maximize energy use and enhance data delivery. Such findings highlight the need of an improved scheme like E2HRC to establish eco-friendly communication.

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## 3. METHODOLOGY

The energy-efficient hierarchical clustering routing approach proposed here, Enhanced Energy-Efficient Hierarchical Routing with Clustering (E2HRC), is build on a hierarchical clustering strategy that improves the energy utilization and the data delivery reliability in wireless and vehicular networks. The approach works by first clustering nodes in the network based on clusters, each with a cluster head. Cluster heads are dynamically elected based on residual energy and network conditions as follows to achieve fair workload allocation.

When selected, the cluster-head has two main jobs:

1. **Data Aggregation -** This combines and consolidates data from its underlying nodes to minimize redundancy and transmission costs.
2. **Efficient Forwarding -** It transmits the aggregated information to the higher level nodes, or even to the main station through which the information is delivered reliably.

To avoid the early exhaustion of critical nodes, the heads of clusters are rotationally changed, and energy consumption is distributed among all nodes. This dynamic scheme increases network lifetime without destabilizing communication.

Finally, the efficiency of the approach is evaluated using the NS2 simulator and performance is calculated in terms of key metrics such as Packet-Delivery-Ratio, Routing Over_head, Throughput, Packet Loss and Energy Consumption. Comparison with other protocols (LEACH, HEED, AODV, DSR) confirms the superiority of the introduced method in terms of scalability, efficiency and reliability.

**Software Environment**

Operating System: Ubuntu 14.04/16.04, Fedora (NS2 recommended).
Simulation Tool: NS2 (Network Simulator 2.35+).
Scripting Language: Tcl (used to characterize simulation cases)
Visualization Tools: XGraph and NAM (Network Animator) for the analysis of simulation results.
Optional Tools: Python or GNUPlot for additional processing and plotting of data.

## 4. RESULT AND DISCUSSION

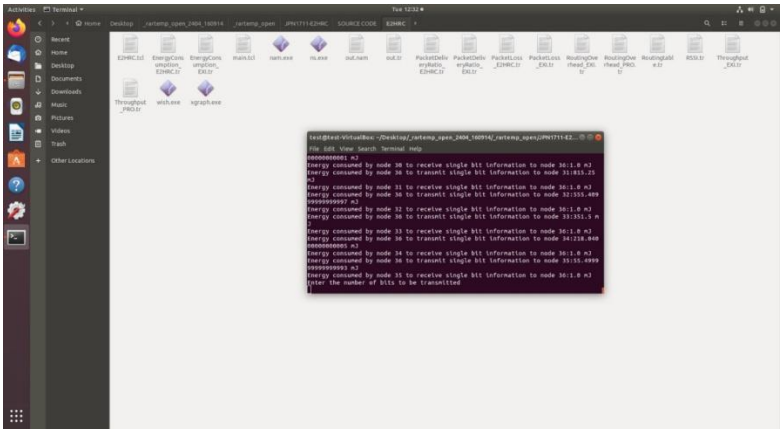

**Figure 1:** Execution output window in Ubuntu

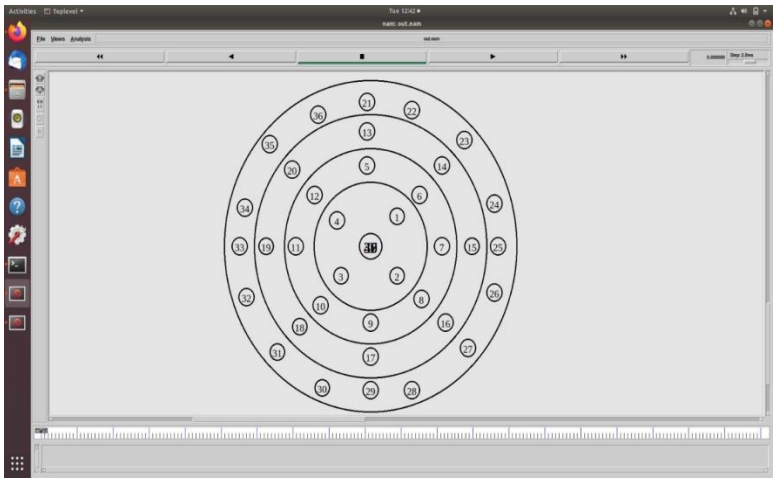

**Figure 2:** Node arrangement shown in Network Animator

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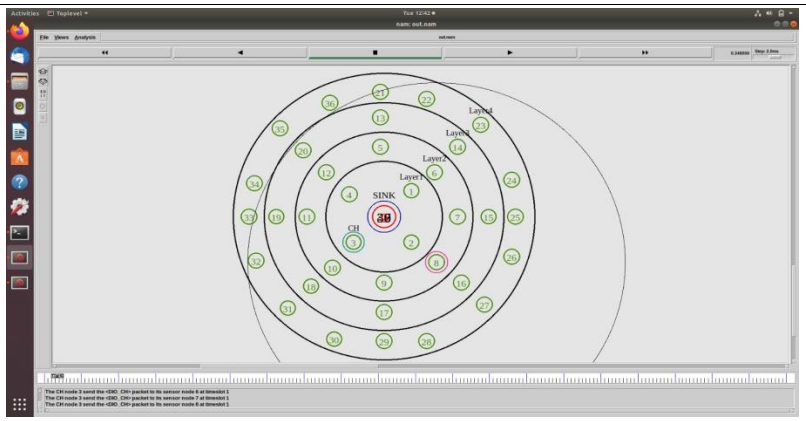


**Figure 3:** Layered network topology with sink and cluster head in NAM


**Figure 4:** Communication links among layered nodes in NAM

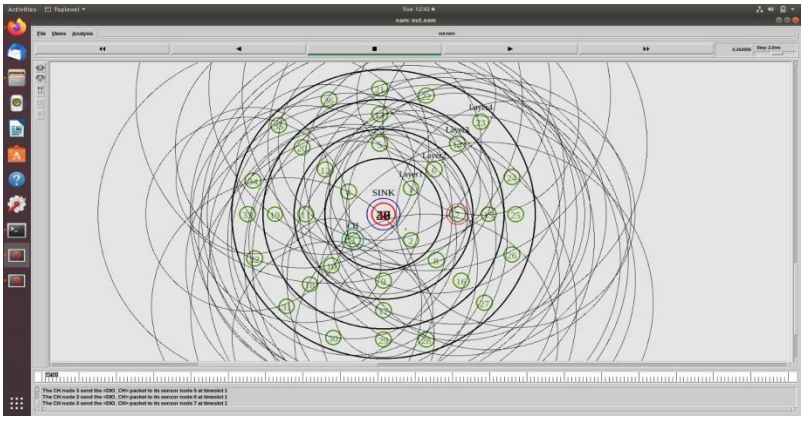


**Figure 5:** Network topology with sink, cluster head, and node interactions

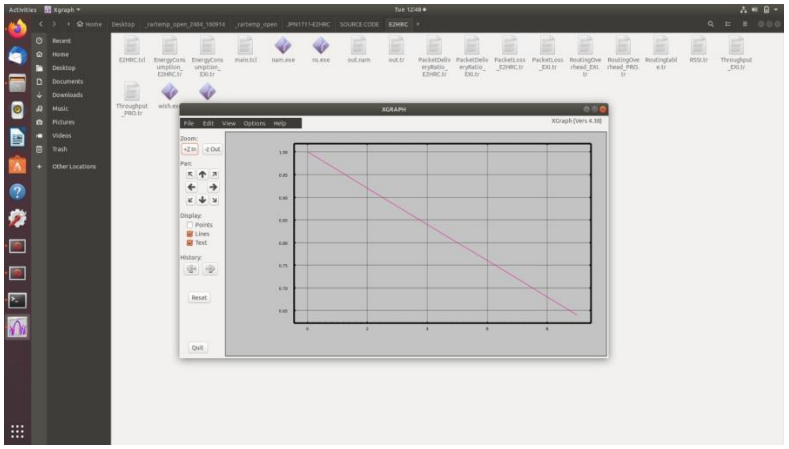


**Figure 6:** PacketLoss EXI graph

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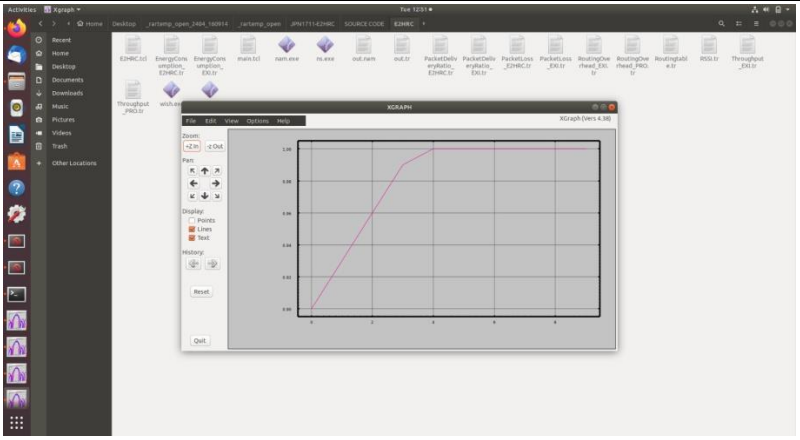

**Figure 7:** PacketDeliveryRatio graph

## 5. CONCLUSION

Testing and evaluation of the E2HRC protocol routing in the NS2 system showed that the system is running smoothly and provides constant values for various parameters of performance. The simulation as to create outputs in terms of energy-consumption, packet- delivery-ratio, packet loss, routing overhead, RSSI and through-put, which are good parameters in determining routing efficiency of wireless networks.

The results proved that E2HRC not only obtains advantages in the aspects of throughput and energy consumption as compared to state-of-the-art practices but also exact position as a valid routing solution. Minor issues that occurred during running was fixed with proper environment setup and dependency installation, the result repeatability was ensured.

In summary, the project reached objectives for accurately modeling network behavior and giving meaningful insight into protocol performance. Its future work can be done in generalizing the simulation to larger network environments, mixed types of traffic, and more complicated mobility models to improve the evaluation and practical applicability of the protocol further.

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