

CAREER EPISODE 2

INTRODUCTION

CE 2.1 During my Bachelor of Engineering (Telecommunications) from ██████████ University of Engineering and Technology, I worked on a project “ Critical node detection by using routing protocols DSDV and DSR” for my course Wireless Communications in 7th Semester. I began this project in ██████████ and finished it in ██████████. In this project, I enhanced the security and reliability of Wireless Sensor Networks (WSNs) by identifying critical nodes vulnerable to attacks. It involved reproducing existing work using AODV and assessing the performance of alternative routing protocols like DSDV and DSR for comparison. I will explain my work on this project in this episode, along with the results I achieved.

BACKGROUND

CE 2.2 As part of the course Wireless Communications, I undertook a project that focused on WSNs and their vulnerability to security threats. In this project, I explored how small sensor nodes, which communicate through transceivers and are often deployed in open environments to monitor parameters like temperature, humidity and pressure, face challenges related to limited energy and security. Given the increasing significance of network reliability and protection against cyberattacks, I focused on identifying critical nodes that could compromise the system if targeted. I came to know that attackers often exploit weak points in the network, making it important to shield those vulnerable nodes. Although I learned that several algorithms have been proposed to identify such critical points, most rely on network centrality or link count. In this project, I reproduced an existing approach using the AODV routing protocol and then extended the study by replacing it with DSDV and DSR protocols. I analyzed and compared the results with previously published research to assess how different routing protocols influence the ability of network to manage and protect critical nodes.

CE 2.3 I conducted literature review to understand the foundations and current advancements in WSNs. I studied how WSNs are composed of low-cost, tiny sensor nodes capable of sensing, processing and wirelessly transmitting data and I focused on their architecture involving sensor nodes, sink nodes and target nodes. I explored their diverse applications which included environmental monitoring, healthcare, agriculture, traffic control, military and smart home automation, as well as their integration with RFID for indoor tracking and infrastructure monitoring. I studied challenges faced by WSNs like real-time data handling, limited power resources, dynamic topologies, bandwidth constraints and security vulnerabilities. I studied how real-time constraints often go unmet due to traditional routing protocols prioritizing speed over timelines and how power management remains a main issue due to limited battery life . I also studied the limitations of conventional security mechanisms and learned about

trust-based models designed for WSNs. I studied both proactive and reactive protocols, particularly analyzing DSDV for its constant route maintenance and DSR for its on-demand, source routing approach. Through this literature review, I gained information on how different routing strategies impact network performance and data transmission reliability.

CE 2.4 I planned this project by first identifying the objectives and scope. I then formed a team with fellow students who shared similar interests. Our leader assigned us roles based on our strengths and we had clear communication throughout the project. We arranged meetings to track progress and resolve issues. We also had meetings with our Supervisor to get their feedback and guidance. I took the responsibility of compiling the final report making sure it shows my efforts and learning. Finally, I prepared a presentation with my team to explain our project to the whole class, aiming to make our work easy to understand and show the practical impact of what we achieved in this project.

PROJECT REPORTING HIERARCHY

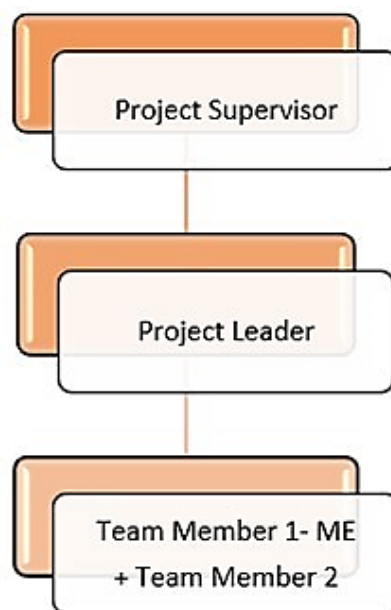


Figure 1: Hierarchy

PERSONAL ENGINEERING ACTIVITIES

CE 2.5 I created and evaluated WSNs, with a focus on identifying critical nodes using various routing protocols, in this project. I started by gaining a strong understanding of WSN architecture, where sensor nodes, equipped with sensing, processing and communication components, are deployed to monitor environmental parameters like temperature and humidity. I recognized that energy efficiency and security of these networks are important due to the limited power and processing capabilities of the nodes. I used this knowledge to explore energy-aware routing protocols like AODV, DSDV and DSR. I first reproduced the results of an existing

study using AODV in both grid and random topologies through Network Simulator (NS) 2 and identified critical nodes based on their energy consumption. I then replaced the routing protocol with DSDV and DSR to perform comparative analysis and find how various protocols influence energy consumption and node criticality. I applied my understanding of telecom routing mechanisms to interpret the behavior of these protocols.

CE 2.6 I conducted experimental simulations using NS 2, which I knew was a discrete event-driven simulator created at the XXXXXXXXXXXXXXXXXXXXXXXXXXXX, widely known for its use in academic and telecom research. I installed NS2 on a Windows OS using the Cygwin environment, which I chose for its compatibility and ease of use for first-time users like myself. I completed the installation to access all important components and dedicated around 320MB of disk space, understanding that a complete setup would allow smoother and more reliable simulations. I understood the dual support NS2 provides for both TCP and UDP protocols over wired and wireless networks, making it ideal for modeling complex routing scenarios. I used Object Oriented Tcl (OTcl) scripting to configure network topologies and traffic sources, which enabled me to define the packet behaviors and simulate realistic communication events.

CE 2.7 I learned that the event scheduler in NS2 is a critical component, as it tracks simulation timing and manages event execution by invoking the appropriate network objects. I studied the internal architecture of NS2, understood how it separates control and data path implementation using C++ for core network components and links them with OTcl for flexibility. Through this, I managed simulations involving various routing protocols and analyzed routing tables. I ran the energy-based analyses on WSNs, found critical nodes and compared the efficiency of various protocols, thus deepening my practical knowledge of simulation tools and network behavior in telecom systems.

CE 2.8 I worked with basic wireless model in NS2 which is built around mobile nodes and is designed to simulate multi-hop ad hoc networks and wireless LANs. I started by setting the simulation parameters required for mobile node configuration, checking accuracy of network behavior throughout the simulation. Using my knowledge of wireless communications, I created mobile nodes and configured important parameters keeping in mind the real-world behavior of wireless networks. To analyze the network behavior, I generated trace files from the simulations. These trace files recorded all relevant information about each discrete event in text format. I understood that wireless and wired networks produce trace files in different formats and I specifically focused on WSNs. I used files like router trace, agent trace, movement trace and MAC trace to gain information on packet flow. Using my knowledge, I interpreted fields like, r, s, f and d, which represent receive, send, forward and drop events, respectively. It helped me track the exact time of each event, identify which node was involved and find the associated protocols like AGT, RTR and MAC.

- CE 2.9** I designed 3 different WSN scenarios, 2 with grid topologies and 1 with a random layout, each with 100 nodes arranged in a 10x10 structure. The 1st scenario included 1 transmitter-receiver pair and node 0 communicated with node 99, the 2nd included 2 transmitter pairs and node 0 communicated with node 99, node 9 with 90, node 90 with 9 and node 99 with 0, and the 3rd included a random topology with 4 transmitter-receiver pairs placed at opposite corners and configured node 0 to communicate with node 95 and node 43 with node 54, to test performance in varying conditions. In each case, I implemented 3 routing protocols; AODV, DSDV and DSR to assess their effectiveness. Using NS2, I then generated the trace files. To quantify energy consumption, I developed a GAWK script that parsed the trace files and calculated the total energy consumed by each node at various time intervals. By summing the energy consumption over time, I found the energy usage/ node. I then created graphs to map energy consumption/ node which helped me identify critical nodes, those depleting energy faster, showing the potential bottlenecks or points of failure.
- CE 2.10** I reproduced results from a published research paper that used the AODV routing protocol for critical node detection. Once I recreated those results, I extended the study by adding DSDV and DSR protocols onto the same simulation scenarios to compare the results and better understand the impact of various routing strategies on node performance and energy usage. As a telecom student, I noticed the significance of network security and reliability, both of which I knew were influenced by the presence and behavior of critical nodes. My detection approach was based on energy consumption patterns; nodes that consumed more energy than others were considered critical as they often lie in the communication path more frequently, making them both important for data transmission and vulnerable points in the network. These nodes, due to their high energy usage, could become targets for attackers, which directly affects the reliability and efficiency of the network. Understanding and identifying such nodes was important, as it enables us to take preventive measures like rerouting, shielding or load balancing to improve the network performance and security.
- CE 2.11** In one of the initial cases using AODV with grid topology, I applied specific parameters like initial energy set at 3.4J, min transmit power of 0.33W, minimum receiver power of 0.1W, idle power of 0.05W and sleep power of 0.03W. I monitored each node's energy consumption and discovered that the critical node was not necessarily the one at the center of the network; instead, any node participating more actively in packet forwarding consumed more energy and therefore emerged as a critical node. It helped me understand that the node importance is dynamic and depends on the traffic load and routing path which is an important information in telecom networks where energy efficiency and routing stability are important.

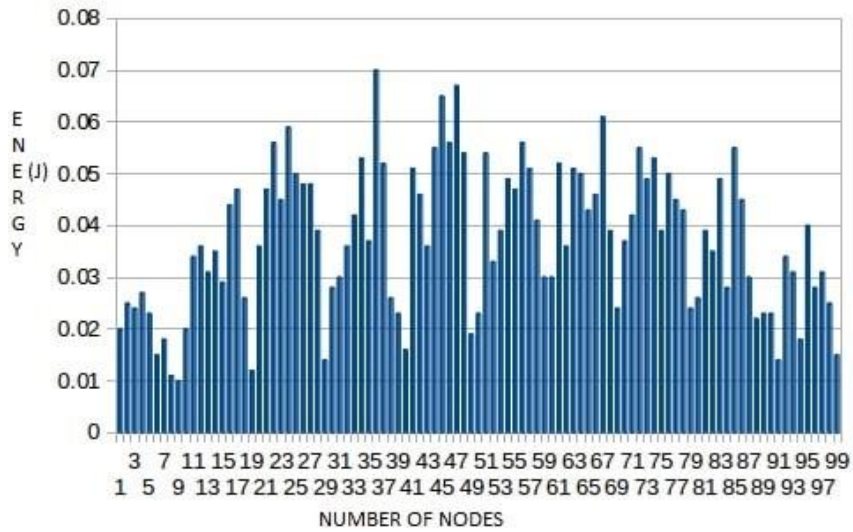


Figure 2: AODV scenario 1

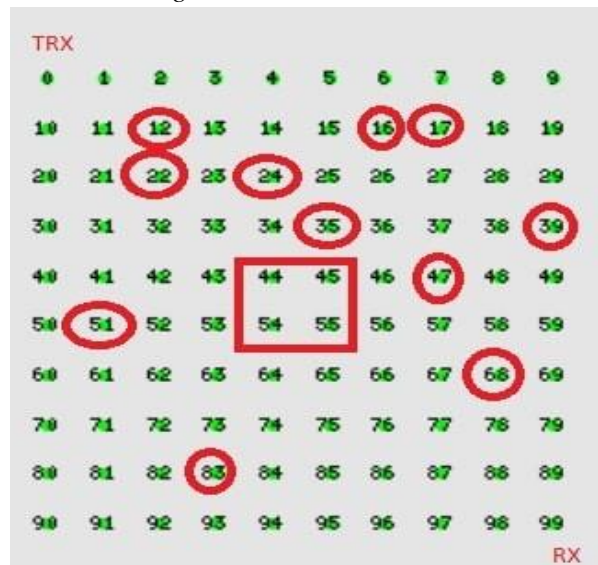


Figure 3: No. of nodes

CE 2.12 In the 2nd scenario, the arrangement simulated a high traffic environment with 4 corner nodes. Using the same energy parameters, I examined the resulting energy distribution and identified several critical nodes based on their energy consumption patterns. These results showed the effects of distributed traffic load and emphasized the need for intelligent routing and energy-aware protocol designs in Telecom systems. To explore a more realistic and unpredictable environment, I then simulated a random topology. Despite the randomness of the node placement, I detected critical nodes based on their constant high energy usage, which was result of their central position in frequently used paths. This showed how even in a non-structured, ad hoc deployment, common in urban WSNs, certain nodes become more important to the operation of network and thus must be identified and protected accordingly.

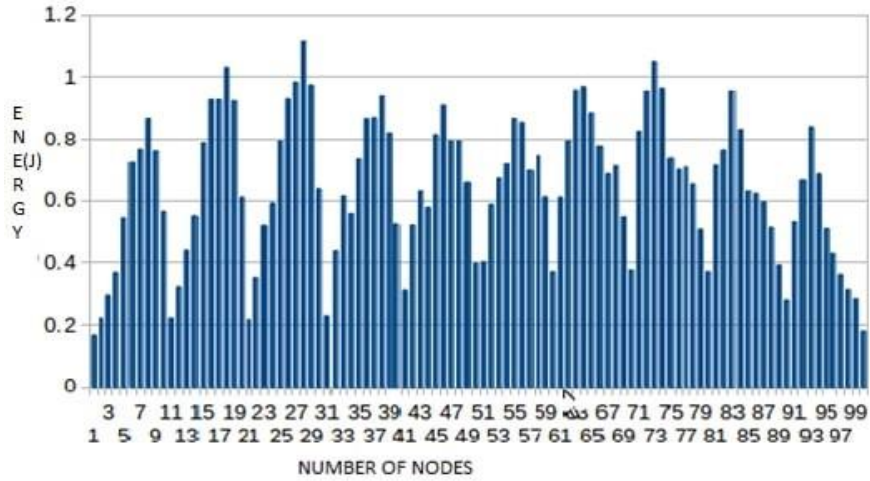


Figure 4: AODV scenario 2

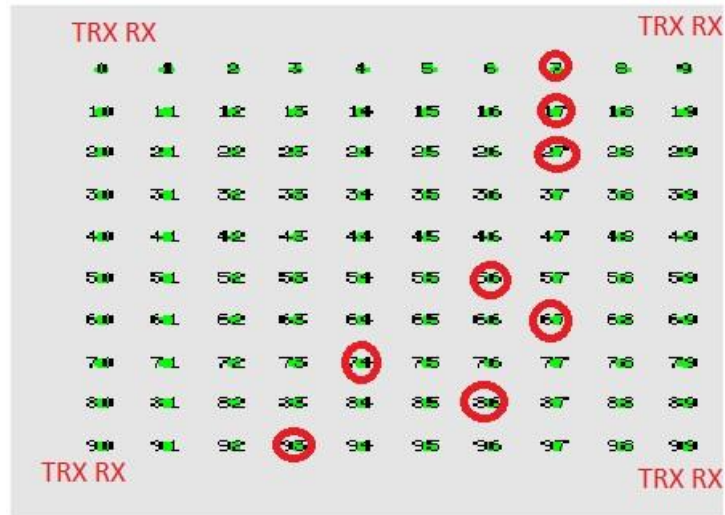


Figure 5: AODV scenario 2 topology

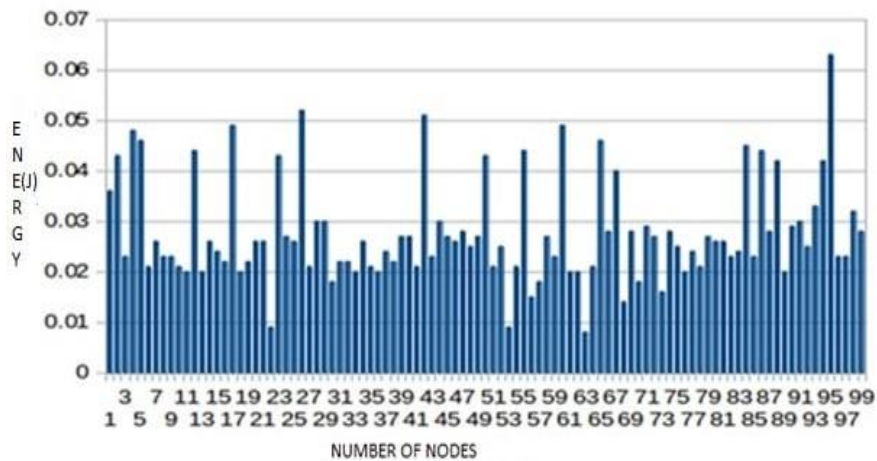


Figure 6: AODV random graph

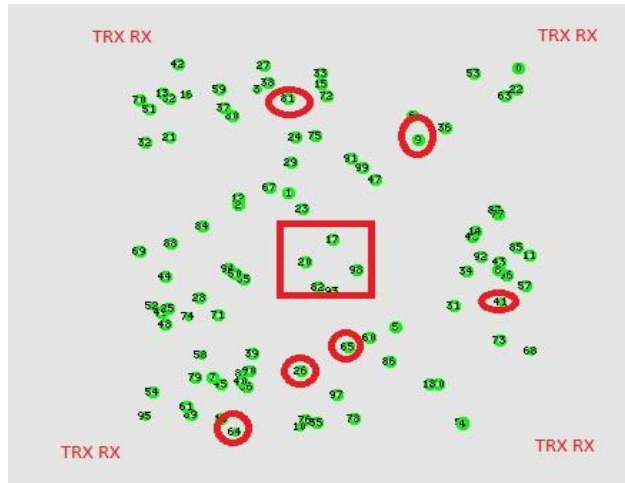


Figure 7: AODV Random topology

CE 2.13 I then conducted analysis using the DSDV and DSR routing protocols and applied constant energy parameters across all scenarios, initial energy of 3.4J, min transmit power of 0.33W, min receive power of 0.1W, idle power of 0.05W and sleep power of 0.03W. In first scenarios using DSDV, I identified the critical nodes based on higher energy consumption, reinforcing my understanding that node centrality does not find criticality, rather it's the frequency of packet forwarding that defines it. To further check this, I created a 2nd grid scenario using DSDV where node 0 communicated with node 99, node 9 with node 90 and vice versa. This high traffic situation, with 4 corner nodes, provided me with knowledge of how energy consumption spreads in multi-path transmissions. Again, I detected critical nodes by monitoring their energy depletion, which deepened my knowledge of network load distribution and performance under stress. I extended my analysis by generating a random topology, even in this layout, I identified critical nodes by tracking energy usage.

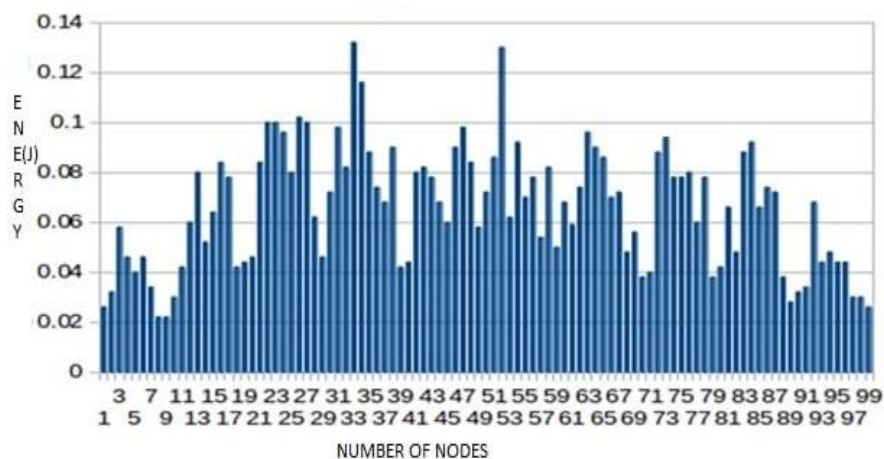


Figure 8: DSDV scenario 1

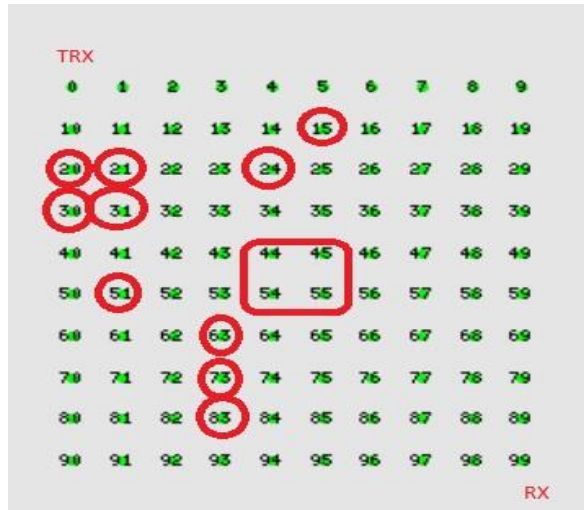


Figure 9: DSDV topology

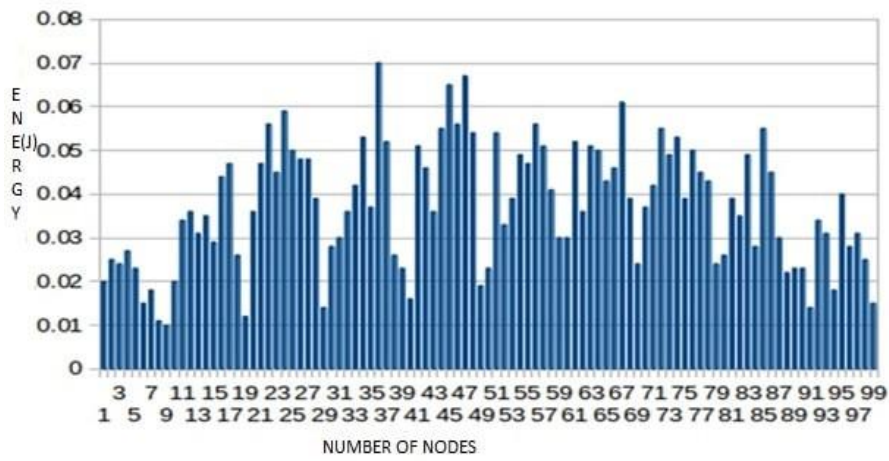


Figure 10: DSDV scenario 2



Figure 11: DSDV scenario 2 topology

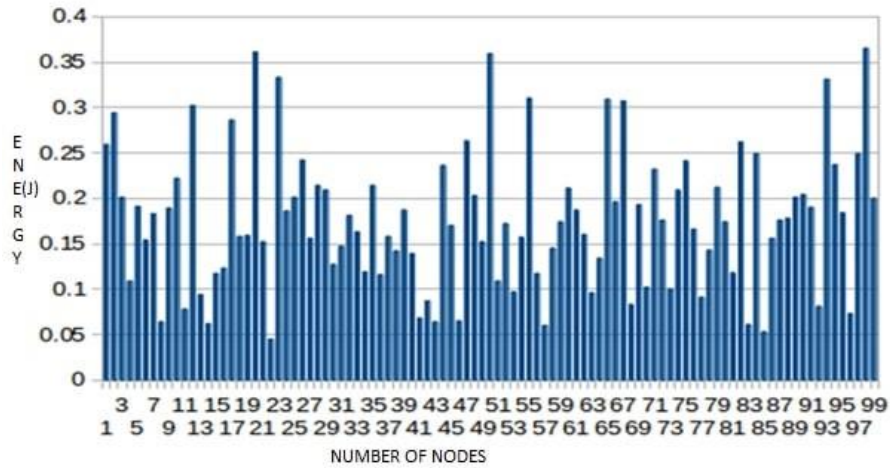


Figure 12: DSDV random scenario

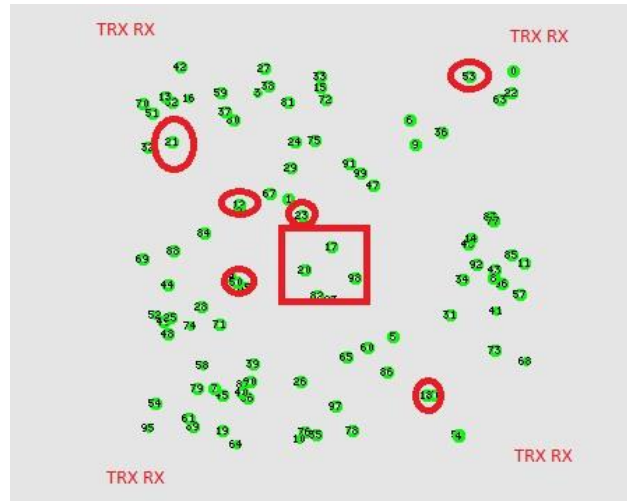


Figure 13: DSDV random topology

CE 2.14 I repeated the same with DSR routing protocol and followed the same simulation structure for consistency in outcomes. My findings were similar, critical nodes emerged based on communication paths and energy use, not location. This consistency across DSDV and DSR proved my grasp of protocol behavior and my ability to apply theoretical knowledge in practical simulation. I checked how routing strategies affect node performance, which is important in network planning, optimization and security. Through this project, I showed my capability to work with routing protocols, energy-aware designs and simulation environments, that are the main skills in the telecom field.

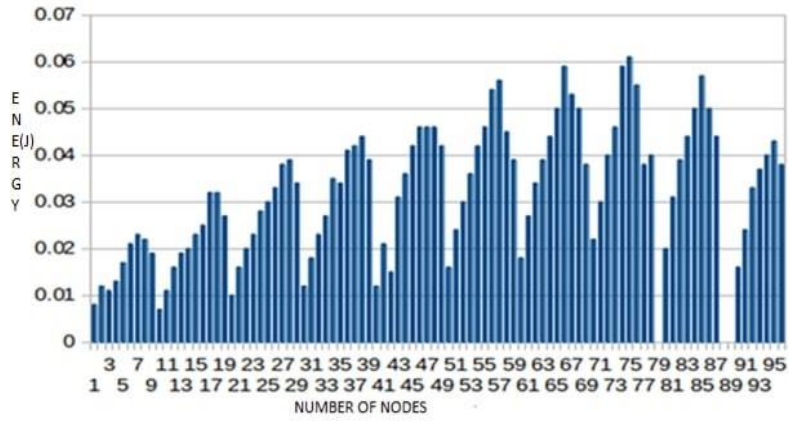


Figure 14: DSR scenario 1

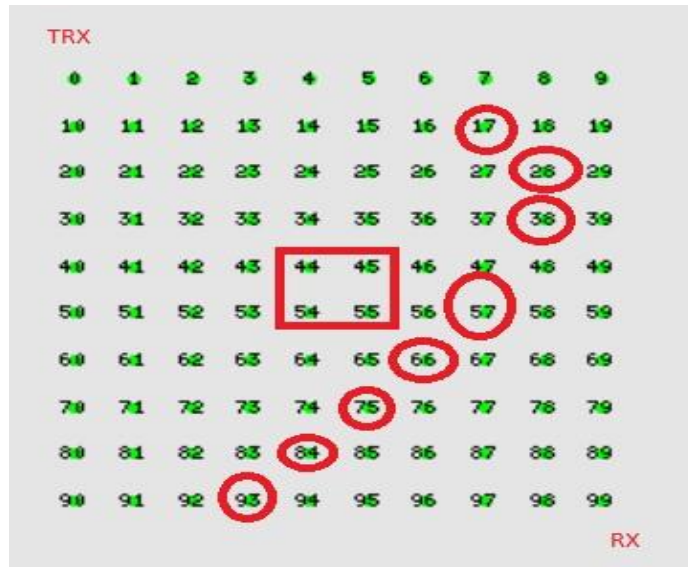


Figure 15: DSR scenario 1 topology

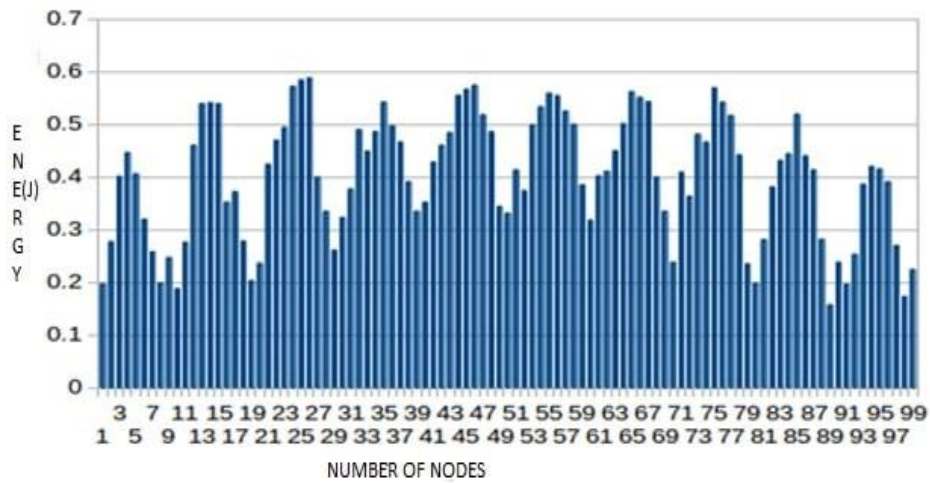


Figure 16: DSR scenario 2

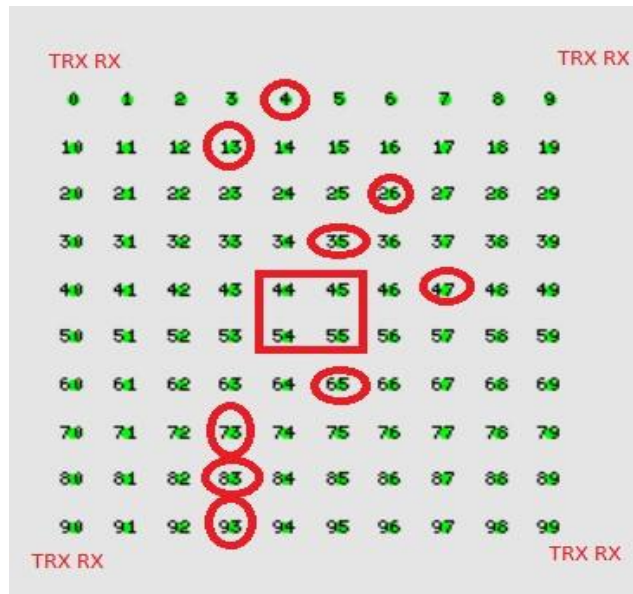


Figure 17: DSR scenario 2 topology

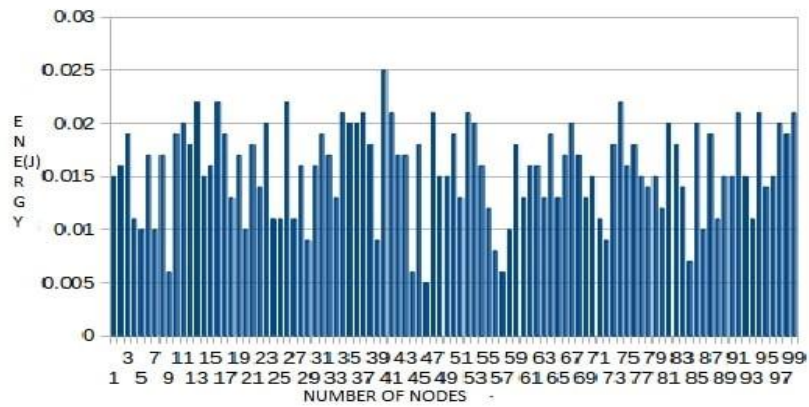


Figure 18: DSR random scenario

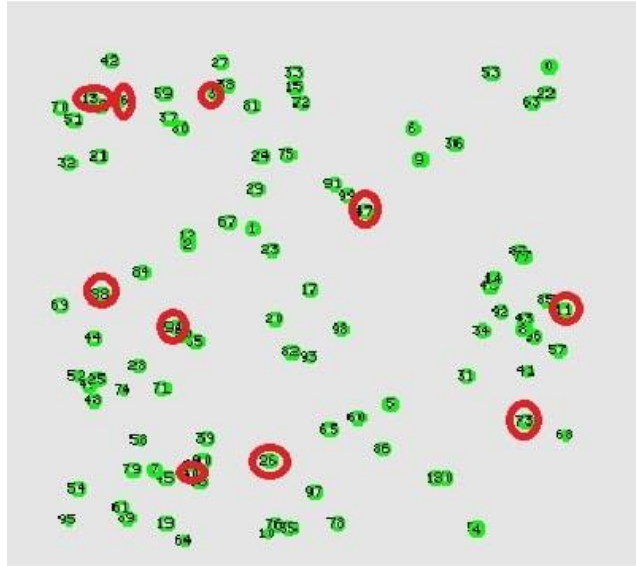


Figure 19: DSR random topology

SUMMARY

CE 2.15 In this project, I simulated WSNs using NS2 and detected critical nodes based on energy consumption using AODV, DSDV and DSR routing protocols. I reproduced the results from a research paper using AODV in both grid and random topologies. I then extended the analysis by applying the same scenarios to DSDV and DSR. I set parameters including energy, transmit and receive power and configured the node communication patterns to check energy usage. I identified critical nodes as those with high energy consumption rather than central positions, showing my understanding of telecom network behavior, energy-aware routing and simulation tools. Throughout this project, I used simulation tools responsibly, avoided data manipulation and gave proper credit to the referenced research.