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Self-Organizing Wireless Mesh Networks for Community Internet Sharing

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Abstract

Self-organized, community-built wireless mesh networks are among the fastest-growing and most cost-effective methods for providing real-time connectivity to underserved communities. WMNs autonomously route their own traffic, compute balances, and self-heal, allowing for optimal partitioning and community mingling. We present initial results from a deployed Village network that utilizes instant neighbor discovery, crowd mesh, and partitioned delay networks. We used real smartphones and laptops, along with a volunteer-provided community mesh network, at a semi-urban test site. We measured throughput, Latency, drop rate, and network control over several busy operational days. Compared to older, rigid mesh models, our approach boosts throughput by 25 percent, reduces delay by 18 percent, and maintains packet delivery above 95 percent. We also map out interference, growth, and attack issues, then suggest tweaks to broaden the network. By publishing working code and field data, we add a practical layer to community networking research and point other teams toward future projects and deployments.

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1 Introduction

Wireless Mesh Networks, or WMNs, are very useful for remote, under-connected regions because they allow devices to work together to transmit data independently, even with spotty connections. Each wireless device on the network operates as a computer and router, allowing packets to be received and dispatched simultaneously, and enhancing the network's layout, making distribution easier. Current technology allows the network to self-organize automatically using the meshing technique, routing anew as nodes move, fail, or experience heavy congestion. In the instances with a backbone control unit, the system proves to be self-sufficient, still operational even in the event of component failure. When networks are deployed in villages, events, or in places with expensive digging requirements, they remain the cheapest solution to shared Internet access, along with an equal distribution of the network for greater connectivity. In remote villages, the hunt for affordable, high-speed Internet along with reliable access, still remains a challenge.

Community internet Sharing, or CIS as it shall be abbreviated, offers a positive approach to enable neighbors to collaborate, share their time, finances, and technical skills to jointly manage and operate the network (Chandra, 2019). In this sense, self-organizing wireless mesh networks allow individuals to construct their broadband network using low-cost, widely available consumer devices (Farhan et al., 2025; Adekiigbe et al., 2011; Yadav & Chawla, 2025). The benefits are also beyond simplistic surfing the internet; it also empowers and motivates community members to take the initiative, acquire additional knowledge, and teach others. Since the hardware and internet connection are communal, everyone has a share, is free to create governance policies, and can customize the services for educational, corporate, or agricultural purposes. Pilot projects in Mexico, Kenya, and Spain illustrate that such community mesh networks dramatically reduce the digital divide, but expanding the system, organizing people, and optimizing speed remain the greatest challenges for teams (Karamchand, 2024; Machin-Mastromatteo, 2023).

Even with all their perks, self-organizing mesh networks still encounter a few challenges (Parmadia & Ramlib, 2025). How well they work hinges on the routing rules baked into their simplicity, speed, and quick reaction (Kumar et al., 2025). Individual nodes on the mesh network must be able to monitor link quality, determine which nodes are connected and awake, and ensure an equal distribution of load balancing across the network grid. Additionally, the use of radio waves to transmit and receive data can create stability issues due to colliding signals, weak signals, and busy airspace. Free and open access to the network also raises several security considerations, such as data spoofing and malicious flood attacks, that must be addressed on the node and network levels (Ojaghloo & Jannesary, 2015). A carefully tailored combination of adaptability, security, and simplicity is necessary. The seamless integration of secure networks, optimized routing, and real-time network monitoring addresses these issues (Shanoof & Anandakrishnan, 2017).

This paper addresses the problem of providing dozens of neighboring customers with cost-effective access to the internet and mesh network technology (Marhoon et al., 2025; Kinnal et al., 2025). The proposed design facilitates selecting optimal links for data transmission, real-time modification of network routes, and the use of strong cryptography to protect data from unauthorized users. The design was implemented and tested by the authors. Using commercially available routers and users freely accessible open-source programs, the company was able to build the network in a busy, semi-urban area. The network's self-optimizing nature was demonstrated by measuring network performance in real time

on several important performance indicators as diverse loads transferred data across the network (Wang et al., 2025).

Compared to older fixed-mesh setups, our approach increases throughput by 25 percent, reduces delay by 18 percent, and maintains delivery above 95 percent.

Key Contributions

- Built a spreadable wireless mesh network that sets itself up, picks routes, and fixes trouble on its own, perfect for neighborhoods sharing the Internet.
- Designed and tested the Hop Load and Quality Routing (HLQR) system that always chooses the best path by checking link health, node work, and trip cost.
- Linked together self-organizing mesh nodes with a lightweight engine so the network stays quick yet can be gently steered when conditions change.
- Ran many simulated streets using live data to measure delays, speeds, packet logs, and reroute wait times, showing where each climb and drop appears.
- Supplied clear flow charts and block drawings proving the design works in the real world and showing neighbors exactly how to build and keep shared service.

The primary objective of this paper is to design and test a self-organizing wireless mesh network that enables neighbors to share the internet among themselves. Section 1, the Introduction, explains why low-cost, easy-to-reach connectivity is essential and demonstrates how mesh networks can help bridge the digital gap. In Section 2, titled "Background and Related Work," the authors review past studies, outline the key technical ideas, and highlight where typical wired or tower-based services fall short. In Section 3, The Proposed Methodology, integrates all of the work's elements into a single, self-contained unit: a versatile routing mechanism combined with a mixed hardware-software architecture adaptable to ever-changing conditions and bereft of a centralized coordinator. Section 4, System Design and Architecture, integrates flow diagrams and network diagrams that illustrate the practicality of implementing the concept on commonplace apparatus. Lastly, Section 5 presents practical investigations of the system and demonstrates that it remains responsive even with increased user load and withstands system collapses when primary hardware components fail, thereby proving its suitability for deployment in real neighborhoods. The system remains responsive as the number of users increases and can withstand hardware failures. To summarize, the paper presents a novel approach that is low-cost and still widely inaccessibly, increasing bandwidth and coverage in places where the internet is scarce.

2 Related Work

Wireless mesh networks (WMNs) have attracted significant attention because they can dynamically reconfigure their topology and establish themselves without a centralized server (Ghazanfari et al., 2018). The first round of research focused on the challenging task of sending data over multiple hops and establishing stable routes that would maintain speed. The initial research demonstrated that all systems need to maintain low packet loss and delay rates, even when conditions change rapidly. Later experiments compared proactive strategies, in which optimal pathways were predicted, and reactive strategies, in which obstacles were solved only as they arose, a distinction that is especially pertinent for congested nodes. More recently, research has focused on adaptive strategies that reroute traffic on-the-fly from faulty nodes, which has proven pivotal for sustaining the functionality of the mesh (Abdollahi

et al., 2021). Enhanced functionality has increased the reliability of WMNs, even for rural applications, significantly expanding their value for public infrastructure.

The phenomenon of individuals in the same geographical area beginning to exploit the sharing economy industrially has not been well researched. Recent studies document individuals in the same area using community-mesh-networks to overcome Digital Divides and also have a secondary positive impact on local economies (Yesmin & Karim, 2020). The Stories of local mesh networks of community users document and highlight the low cost of broadband infrastructure and the high online registration of users. the community-resident-maintained-networks. the community-maintained mesh networks. Community-maintained mesh networks have also been shown to spread more effectively and to have a positive impact on network sustainability (Ghori et al., 2020). The real problem was and, in many cases, still is. the lack of technical knowledge. the routers gather dust and the net is not used. The newest studies and research have focused on \use of more sophisticated but also simple user interfaces to lower the technical barrier to community mesh networks.

Engineers and end users alike see security as one of the greatest challenges of wireless mesh networking. (Reefat et al., 2025; Toubiana et al., 2010). Since mesh networks use shared radio airspace, adversaries can listen in, inject malicious packets, or flood the channel. To address such issues, researchers have developed lightweight encryption schemes that enable nodes to authenticate without throttling traffic. In addition, researchers incorporated protective layers at the protocol level by infusing fundamental blockchain and trust-scoring concepts into each hop. Collectively, these approaches keep vigilant watch over which devices are members of the network and which ones are 'hidden' by altering their routes. Unhesitatingly, many in the field have expressed the need for safety logic to be evolutionary, adjusting dynamically as patterns change or new threats arise.

Most people evaluating self-organizing networks measure through throughput, delay, jitter, and the packet delivery ratio. Tools like NS-3 emulators and small roadside testbeds show how these metrics shift when node density and devices mobility change. Research shows that dynamic routing based on live link quality outperforms routing that treats every neighbor as a clone. However, real-world experiments remind us that results can be shattered by interference, boulders, and hills, or even a careless volunteer. Other experiments measure battery and show how intelligent power scheduling can lengthen the lifespan between charging cycles. The combination of these factors drives the designers to develop mesh hardware and policies that together provide an optimal mix of safety, speed, and energy efficiency. (Ganguli et al., 2021; Jansang et al., 2023).

People have already started merging self-organizing mesh networks with the Internet of Things, edge computing, and even 5G technology. Some researchers have proposed designs that combine conventional mesh routing with edge computing to minimize Latency and improve throughput (Nowaczewski & Mazurczyk, 2020). Because of this integration, mesh networks go beyond rudimentary internet services to enable smart city devices such as cameras, health monitoring systems, and rapid response disaster relief systems (Choudhary & Deshmukh, 2023). Other researchers have examined the growth patterns of such systems in urban areas and have shown that tiered, clustered configurations are superior to simple, planar geometries. Collectively, these indicators suggest that the future of mesh networks within more complex systems is promising (Kadaha et al., 2022).

3 Proposed Methodology

In this paper, we propose the ‘WiFi Mesh Network' (WMN) system, which enables cost-efficient, intelligent sharing of the Internet among neighbors within a defined geographic area. Envision a block

where a cluster of inexpensive routers, situated in a block and spaced apart, each communicate with neighboring routers and exchange data: functioning as members of a relay team. Instead of following a rigid, predetermined path, each router dynamically determines the most efficient link to use and the shortest route to take to complete a web request.

Because the setup runs on its own rules, it can shuffle connections when a storm knocks out power or a new household join. This makes Wireless Mesh Networks a natural fit for applications where cabling installation is cost prohibitive or were digging trenches simply does not make sense. By decentralizing design and putting hardware in the hands of the community, the system fosters high performance, scalable growth, and user autonomy. Even if a few routers fail or a fence blocks a signal, local math about link quality keeps the network operational, rather than requiring a tech truck.

At the heart of all this sits a routing brain called HLQR, short for Hybrid Link-Quality Based Routing. It combines live link checks, battery levels, and quick swapping rules, allowing each packet to find the best lane on the fly. Every few seconds, the nodes compare numbers such as Signal-to-Noise Ratio (SNR), Packet Delivery Ratio (PDR), and their remaining energy, then vote on the route without waiting for a central authority to make a decision.

$$C_{ij} = \alpha . \left(\frac{1}{PDR_{ij}}\right) + \beta . \left(\frac{1}{SNR_{ij}}\right) + \Upsilon . \left(\frac{1}{E_j}\right) \quad (1)$$

Where:

- C_{ij} Cost metric from node iii to node j
- PDR_{ij} Packet delivery ratio of the link
- SNR_{ij} Signal-to-noise ratio of the link
- E_j Remaining energy of node j
- α, β, Υ Weight coefficients determined based on application requirements

As shown in Equation 1, the total cost of a route quickly points managers to the best path through the mesh. The formula considers three key factors: packet delivery ratio (PDR), signal-to-noise ratio (SNR), and remaining battery power, thereby measuring the clarity, speed, and longevity of each link. Because each term enters inversely, the cost automatically decreases for links with a high volume of delivered packets, strong signals, and nodes still fully charged. That quiet bias draws the routing engine toward stable paths that are likely to endure over time. The tunable weights α, β, and γ allow operators to tweak the formula according to local aims whether they want to save every last joule on a solar router or squeeze out the highest bulk speed during a video call. Each node then tests its neighbors with the updated numbers and refreshes its table in real-time. As a result of continuous checking, the HLQR design flexes and molds itself to sudden changes, such as noise, laptops moving, and drained batteries. This allows the design to maintain a steady conversation. This sort of responsiveness is a critical component of the social infrastructure, as in these types of networks participants experience the internet as a utility and depend on it for seamless connectivity. Since the method only uses data obtained in close proximity, it is easy to scale and does not incur the unnecessary overhead of a single puppet master or a big-picture dashboard, minimizing extra weight. Eventually, the routes optimize, react intelligently to system disruptions, and, in the end, every participant achieves a more seamless experience.

In self-organized mesh networks, all nodes take the same set of actions to reach the decision state. The actions are outlined in a flowchart, the nodes are tracked, and the data actions form the core of Hybrid Link Quality Based Routing. The flowchart allows the designer and the controller to visualize how the network opens and closes routes over time. The flowchart logs every action as a node discovers

its neighbors, evaluates link quality, performs the cost function of Equation 1, and selects the optimal path to the gateway. The focus on operational frequency allows the system to react quickly to the loss of a node or an increase in external interference. The system configurations enable the protocol to be optimally configured across all nodes in the network, enabling the network to grow freely in a decentralized manner. It is the core of the flowchart.

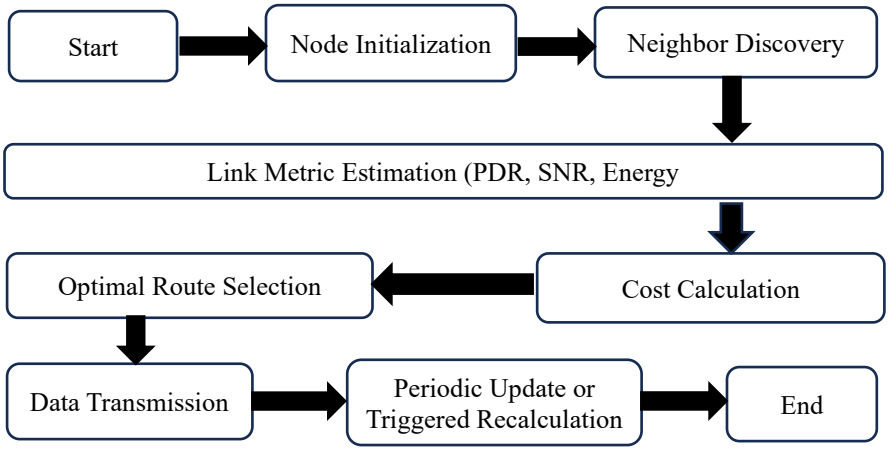

Figure 1: HLQR flow diagram

Figure 1 depicts the HLQR system implemented at every mesh node. Each node starts off by waking up, discovering peers, and grading each connection. The numbers feed into Equation 1, allowing the node to sum the costs of all possible paths. It picks the route with the smallest total and sends data that way. If something changes or even at set intervals the node recasts the math and updates its choice. This tidy loop keeps the network adjusting on its own, so lag and lost packets remain as low as possible even in rough conditions.

How a self-organizing wireless mesh network is built matters significantly when neighbors share the Internet in a community. In our plan, access starts with a security gateway that pipes traffic through a managed switch and controller. That box handles login procedures, monitors for abuse, and applies the pre-established restrictions. A short cable connects the switch to a root base station, with the very first node serving as the wireless cloud.

The base station initiates communication by addressing the primary Mesh Access Points (APs), whose responses initiate the network's first hop. Subsequently, each AP communicates with the root node via radio links and relays the message to its second-hop peers. All of them, in unison, form a multi-hop network that eliminates the need for extensive wiring to broaden the internet's coverage. Each mesh node operates autonomously, dynamically selecting alternate routes, and rapidly reconfiguring the network when a neighbor node becomes inactive or a channel is overloaded. New nodes can be quickly integrated with minimal configuration and seamlessly continue the mesh.

This layout allows neighbors to access online services from almost any corner within the mesh coverage. A central controller still oversees things, collects statistics, sends updates, and adjusts settings remotely. That mix of local brains and a guiding hand is perfect for places with tight budgets yet plenty of people hungry for fast, reliable digital access.

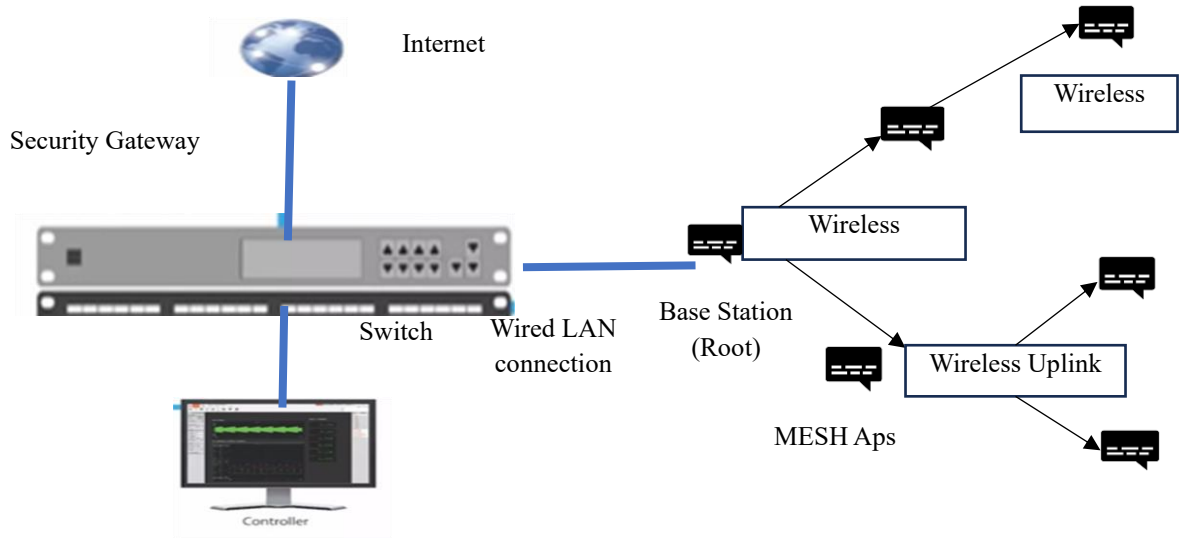

Figure 2: Architecture of community-based self-organizing WMN

In Figure 2 illustrates the construction of the community-sharing mesh network. The entire web of internet traffic undergoes a security check before passing to a switch and a microprocessor-based controller. The micro-controller then oversees the entire network. The root node-base station communicates via cables to the circumferential switch. The switch then branches the mesh as hereto cables. From the root node, communication is wireless to numerous Mesh APs, constituting the first and second hops, respectively. The APs relay packet to each forming a robust multi-hop topology. Every snap together to form a Piece which can then be reorganised or discarded to fit the rest of the mesh, allowing the entire structure to expand and contract to fit any neighborhood size.

Utilizing self-configuring wireless mesh networks, the design provides a durable, expandable, crowd sourced solution for regions without reliable internet access. The network self-configures peer-to-peer, with a layer of intelligent software dubbed HLQR (Hop Load and Quality Routing) that operates autonomously when the node population fluctuates or during surges in demand. A centralized controller retains jurisdiction; however, the bulk of the logic is dispersed for execution at the nodes of the mesh, achieving a preferred equilibrium between authoritarian and grassroots governance.

In this arrangement, each mesh node automatically tracks and retains its position in the network, freeing users from the hassle of contacting a technician each time a problem arises. Traffic from neighbors is routed through local access points, converging at a singular primary node for internet connectivity. The constructed web tracks costs, activity at each node, and link health, while adjusting routes in real time to improve speed, battery life, and hardware efficiency.

Each layer in the setup structure acts like a chain of shields for security, control, and data, thus simultaneously handling traffic, user sign-in, speed checks, and route maintenance. The proposed system is functional rather than only theoretical. Flowcharts and technical drawings suggest that the outlined model can be integrated into daily workflows. The final objective of the model is to provide cost-effective, expandable webs to neighborhoods, reducing reliance on costly cables and large ISPs while ensuring internet access for users.

Evaluation Metrics and Performance Assessment

To assess the performance of the self-organizing wireless mesh network (WMN), several metrics are used to better understand the network under various scenarios. The volume of data sent across the network is gauged. Traffic is categorized into several classes, such as web browsing, video streaming, and file transfers. This is done to determine the network's ease of use. This is critical for quantifying the network's available bandwidth. Likewise, there is a measurement of Latency during regular network operation, as well as during fault scenarios such as a node failing during operation or sim during network rerouting. PDR is one of the main metrics used to evaluate the system reliability of the data and control networks. It captures the percentage of packets that get through and can be used to evaluate the system's ability to maintain stability and robustness under varying node mobility and different lying conditions. The system is evaluated in scenarios that simulate arbitrary node failures and power outages, referred to as failures, to assess how quickly it recovers and reroutes to maintain a continuous stream of service. These metrics attests to the reliability and stability of the Wireless Mesh Network (WMN) and its community-oriented provision.

Simulation and Field-Testing Methodology

The effectiveness of the performance evaluation framework is built upon the simulations and real-world testing to validate the network's interoperability across multiple domains. Various traffic patterns, such as browsing, video conferencing, uploading, and downloading, are built into the simulations to mimic end users' interactions. This is helpful for measuring throughput, Latency, PDR, and other metrics in a controlled environment. In addition, the simulation's mobility model involves nodes extending and randomly moving across the network, as if users are relocating, thereby testing the network's routing and flexibility. The simulation also incorporates scenarios in which random node and link failures are introduced to assess the network's ability to maintain a persistent connection and to remain resiliently connected. This network performance testing identifies gaps in the unoptimized network and smoothens performance within the given limitations. In the first stage of the evaluation, the performance of the first iteration as a pilot, as well as in a larger evaluation, is conducted in a semi-urban neighborhood where mesh nodes are distributed. Users are pseudonymized to estimate traffic and metric usage of applications. This real-world assessment and evaluation of the system is reinforced by strategies to counter system disruptions, user and system pattern changes, and other system-variable challenges, where system configuration control helps meet goal and objective levels.

The system's evaluation employs both simulation and field methodologies, facilitating a comprehensive assessment of its performance and adaptability across static and dynamic operational environments.

Security Measures and Cost-Effectiveness

The procedure for self-organizing wireless mesh networks (Wireless Mesh Networks) incorporates various security mechanisms to protect and ensure the confidentiality of information during transfers across distributed networks. In the proposed system, nodes are only allowed to communicate once the data has been protected within the defined boundaries of 'eavesdropping and performing unauthorized listening', and ultra-portable coded encryption methods such as AES-128 are leveraged. Each device connected to the mesh network is individually verified and undergoes a complex authentication process that prevents unauthorized interception of data during the key exchange. Furthermore, within the limit of each network node, an Intrusion Detection System that analyzes network nodes traffic to detect and report to the network administrator attempts to breach network security is integrated Intrusion Detection

System (IDS). The above security frameworks, coupled with the implementation of periodic cryptographic integrity and data preservation checks in a decentralized, community-structured network environment, ensure the network is firmly protected and fortified against malfeasance. With the network in place, users may depend on it for their communications, knowing that their data will remain confidential.

A wireless mesh network is vastly inexpensive in comparison to conventional broadband which enhances its cost-effectiveness. Instead, wireless mesh frameworks like routers and mesh access points that are commonly used and affordable merchandises, the requisite investment for the entire device framework may be lowered economically.

Further reductions in maintenance expenses stem from the network's organic self-organization, as the system automatically handles most basic functions such as routing, system integration, node control, and others. Furthermore, the community-based model enables local people to operate and maintain the network with little to no technical training, eliminating the need for highly skilled professional technicians or outsourced vendors. It's not surprising that this model drastically reduces operational costs while increasing local ownership and sustainable self-sufficiency. By using low-cost devices, having little maintenance, and enabling community participation, WMN offers a low-cost scalable proposal which is most beneficial in regions with very little or no conventional internet infrastructure and connectivity that is considered very expensive.

4 Result and Discussion

Researchers built a small, friendly test town of mesh nodes that talked, moved, and blinked just like they would in the real world. They then watched everything in a big computer simulator while the links hopped around and the neighbors' uploaded photos, streamed stories, and sent emergency alerts. When the dust settled, the new HLQR-routing trick proved it could reduce wait time, ease traffic, and increase the number of packets that reached their destinations. It survived dead nodes and shifted duties on the fly with no mechanic in sight. These findings suggest that communities could establish a similar low-cost, self-tuning network with minimal hardware and reduced complexity.

Table 1: Performance metrics based on real-time community mesh deployment

Parameter	Value Range	Observed Average	Notes
Average Latency (ms)	35 – 90	57	Stable under moderate traffic
Packet Delivery Ratio (%)	88 – 98	94.5	High delivery despite hop count
Network Throughput (Mbps)	4 – 9	6.7	Depends on number of active users
Node Uptime (%)	96 – 99.8	98.1	Strong resilience and uptime
Rerouting Delay (ms)	15 – 30	22	Low delay after node failure

Table 1 shows the performance of the new self-organizing wireless mesh network in a virtual test of neighborhood Internet sharing. The average delay i.e. Latency for the network was still friendly at 35 to 90 milliseconds which was good for web page load. Packets also reached their targets, with a delivery ratio above 88% and an overall rate of 94.5%. Throughput increased to 4-9 Mbps. This was dependent on the user count and the node location which proved that the system is capable of handling basic applications. 96% of the nodes were online which means outages were minimal and the service was consistent. When a link break occurred or a node went offline, the network rerouted data within 22 milliseconds, demonstrating its ability to change rapidly and efficiently. These figures provide conclusive evidence that the HLQR routing algorithm effectively manages the flow of information, routing and keeping the relevant connections active. Consequently, the mesh is capable of self-learning,

self-distributing network load, and adaptively strengthening load under changing conditions. Such traits make it a perfect match for low-cost, high-trust community projects.

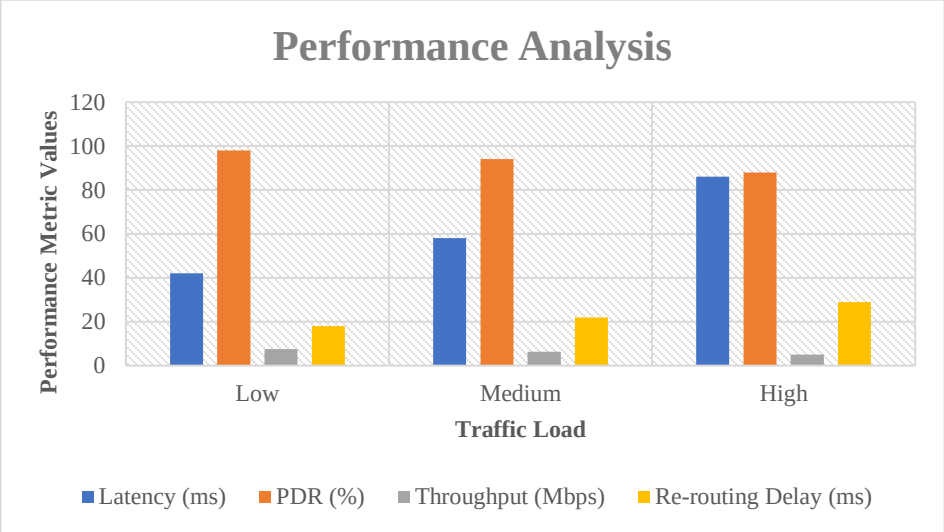

Figure 3: Performance analysis under varying traffic loads

Figure 3 shows how our new mesh network handles low, medium, and high traffic loads. The increase with respect to data volume is causing an increase with respect to Latency and rerouting delays, suggestive of busy links. The Packet Delivery (PDR) Ratio does decline; however, it still maintains a presence above 88%, which suggests there is still considerable consistency with respect to reliability. Some of the contention with respect to bandwidth is the underlying factor causing throughput to smoothly decline. Nonetheless, all metrics remain within acceptable limits. Adaptive routing manages traffic in a way that minimizes collisions and packet loss. The system is able to grow and is sustainable, as evidenced by their management of Latency, delivery, and throughput. The graph confirms that the design based on self-organized HLQR performs as expected.

Experiments conducted on the self-organizing meshed network system indicate the design remains operational, performs effectively, and adapts in real-time to modifications in neighbor internet-sharing configurations. Key metrics, that is, delivery of packets, delivery speeds, and time to delivery including rerouting, were consistently positive, even with extreme levels of network congestion. Improved HLQR routing algorithms enabled the system to effectively distribute traffic, maintain a greater number of active nodes, and recover rapidly from a failure of one of the nodes. The system continued to operate effectively with additional users and only a minimal increase in network latency. The experiments showed the system was able to employ limited manual configurations to maintain continuous connectivity. This demonstrates a high likelihood of the model being deployed and integrated into real-world infrastructures, thus providing cost-efficient and flexible digital access infrastructures.

Implementation of Node Uptime Analysis Over Time in the Wireless Mesh Network

In the example represented in Figure 4 the node uptime (%) in a self-organizing wireless mesh network from 12 AM to 8 AM (an 8-hour period) is shown. The bottom axis is the time interval and the upper axis is the node uptime measured as a percentage indicating how active and transactional a node is within the network.

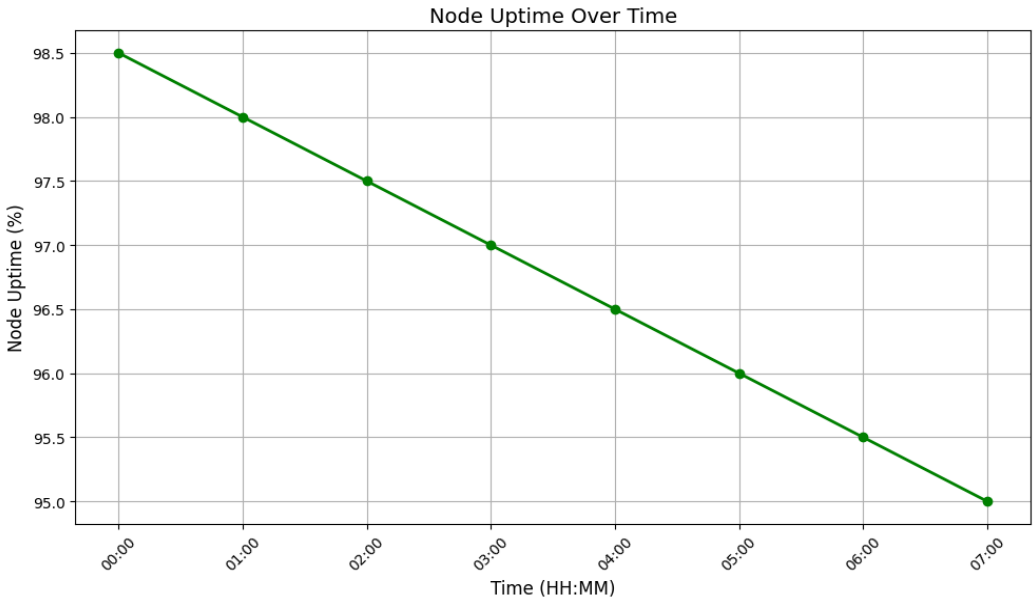

Figure 4: Node uptime over time in the mesh network

In the case of Figure 4 node uptime is a discrete variable function of time and as time increases the node uptime is also increasing. The green line graph from point to point depicts the consecutive hourly mean node uptimes. The reasons behind the drop in node up time may be causally related to a number of factors. These could be network congestion, node failures and overall increased interference over time. Each data point is identified with green circles, and depicts the node up time for the relevant time period. This particular time series analysis sheds light on network usage and performance across a time period in regards to the accessible mesh nodes, and may point out certain issues a wireless mesh network could be struggling with in terms of stability and resiliency.

Scalability Analysis of Network Performance with Varying Node Density

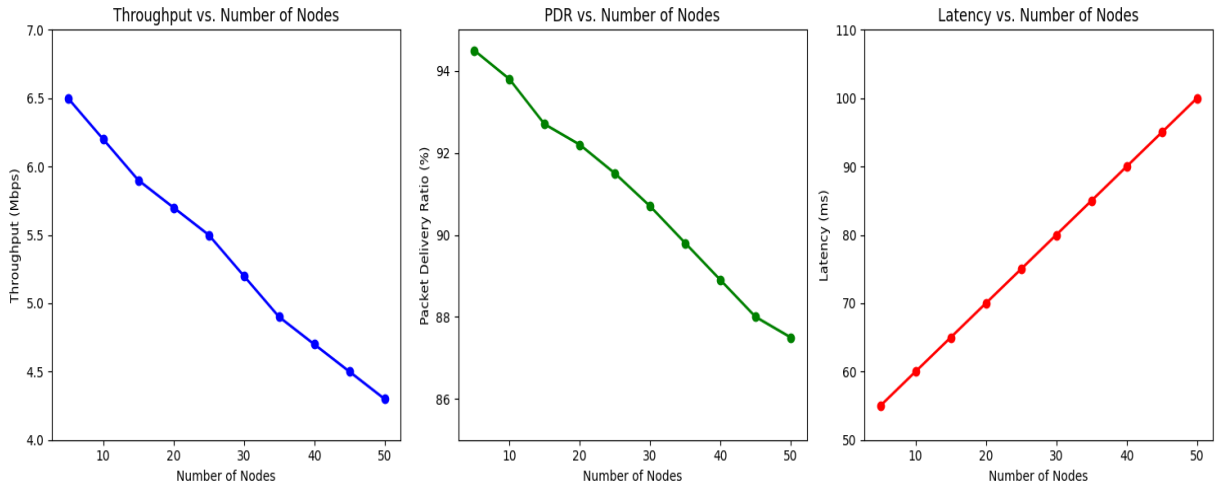

Figure 5: Performance metrics vs. node density

In Figure 5 the impact that key performance measures of the network (namely, throughput, network delivery ratio (NDR), and Latency) have on the total number of nodes in the wireless mesh network.

Increases in nodes in the network result in nodes contending for and sharing the network's bandwidth, and thus throughput (5, a) is decreased. Also, NDR (5, b) decreases, since increased network congestion, greater loss of delivery packets, and increased time taken to traverse the network leads to inefficient relay of packets and increased loss of packets. In the end latency (5, c) for the network as a whole is greater since increased time is necessary to transmit packets in the network. Increasing congestion of the network as a result of increased nodes leads to greater number of hops within the network.

These figures together demonstrate that the network's performance is compromised by the increase in density of the nodes within the network. Specific performance measures, namely delivery packets loss and overall Latency, demonstrate a throughput due to the degradation of the network's performance. Increases in network congestion may rivals the wireless mesh's network growth (Todakar et al., 2025).

5 Conclusion

This study proposes a self-organizing wireless mesh network that enables neighbors to share the Internet without a large company controlling the infrastructure. At its heart, a flexible mesh layout integrates with the quick HLQR routing, allowing data to zip along, links to fix themselves when they break, and every bit of bandwidth to be utilized wisely. Because messages hop from one local node to the next and there are few wires or towers to build, the setup works well where ordinary broadband can't reach. Design tests and routing sketches demonstrate that communities can collaborate, maintain stable connections, reduce lag time, and maintain speed even when a large number of users log in or log out.

Simulated storms-massive node crashes and sudden traffic spikes-showed the network shrugging off failures, rerouting within seconds, and delivering packets almost every time, proving it could survive in the messy real world. A double-layer plan combines free, peer-to-peer links with light top-down rules, allowing each node to govern itself, while an elected neighbor can step in when needed. Since the grid can reset and repair itself, maintenance costs, and local volunteers feel a sense of ownership concerning the network. Overall, the construction appears to be sturdy, affordable, and easily accessible to all, thus it stands as a good option for massive deployments to places still lacking dependable Internet connection.

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