Setting Up a MANET with Raspberry Pi

Tomasz Grabowski (H00422753), Jamie Lewis (H00345371), Dr. Idris Al-skloul Ibrahim

***Abstract*—This study presents a practical implementation of a Mobile Ad-Hoc Network (MANET) using Raspberry Pi (Zero 2W/4/5) devices and the BATMAN-ADV routing protocol. The goal was to demonstrate that functional mesh networks can be built without specialized hardware or deep technical expertise. By configuring Raspberry Pi nodes in IBSS mode with Layer 2 BATMAN-ADV routing, we created a self-configuring, multi-hop network. The setup validated key MANET properties such as autonomous formation, dynamic routing, and resilience to node failures. Testing included neighbor discovery, routing analysis, connectivity checks, and multi-hop communication, achieving 100% packet delivery and latencies between 6.8–7.8ms. This accessible approach supports broader adoption of mesh networking in areas like emergency response, IoT, and low-infrastructure environments, and lays groundwork for future research in optimization, security, and real-world deployment.**

I. Introduction and Motivation

Mobile Ad-Hoc Networks (MANETs) represent a critical networking paradigm for scenarios where traditional infrastructure is unavailable, damaged, or impractical. Despite their importance in emergency communications, disaster response, and remote deployments, practical MANET implementation often appears complex and requires specialized knowledge. This work addresses the accessibility barrier by demonstrating that functional mesh networks can be created using readily available consumer hardware, open-source tools and straightforward configuration procedures.

The primary motivation stems from the need to democratize mesh networking technology. By proving that effective MANETs can be established with minimal technical barriers, we aim to encourage broader adoption among researchers, educators, and practitioners who may have previously considered such implementations beyond their reach, or lack of awareness of it.

II. Experimental Methodology

Our approach utilized multiple Raspberry Pi 4/5 devices running Ubuntu 22.04 Server, configured through standard terminal commands without requiring specialized software or complex automation tools. The methodology emphasized simplicity and reproducibility:

Hardware Setup: Standard Raspberry Pi devices with built-in Wi-Fi capabilities, connected via Ethernet for initial configuration and monitoring.

Software Configuration: Sequential terminal-based setup involving wireless interface reconfiguration to IBSS mode, BATMAN-ADV kernel module loading, and IP address assignment. Key commands included:

```
# Configure wireless interface for ad-hoc mode
sudo ip link set wlan0 down
sudo iw dev wlan0 set type ibss
sudo ip link set wlan0 up
sudo iw dev wlan0 ibss join "RASPI-MANET" 2412

# Enable BATMAN-ADV routing
sudo modprobe batman-adv
sudo batctl if add wlan0
sudo ip link set bat0 up
sudo ip addr add 172.0.10.X/24 dev bat0
```

Testing Scenarios: Limited but comprehensive evaluation focusing on fundamental MANET capabilities rather than exhaustive performance analysis. Tests included neighbour discovery verification, routing table examination, connectivity testing, and multi-hop path validation.

III. Results and Analysis

The experiment successfully confirmed MANET viability with consumer-grade equipment. Key findings include:

Network Formation: All nodes successfully discovered neighbours with `batctl n` showing consistent connectivity (last-seen times ¡ 1 second). The BATMAN-ADV protocol automatically established routing tables and communication link.

Connectivity Performance: Ping tests demonstrated 100% packet delivery with average round-trip times of 6.8-7.8ms between nodes, indicating reliable communication suitable for practical applications.

Multi-hop Routing: Traceroute analysis confirmed successful multi-hop communication, with packets correctly traversing intermediate nodes when direct connections were unavailable, validating the mesh network's core functionality.

Configuration Accessibility: The entire setup process required only standard Linux networking commands available on any modern distribution, confirming that specialized tools or extensive networking expertise are not prerequisites for basic MANET implementation.

IV. Conclusions and Impact

This work demonstrates that functional MANETs can be implemented using accessible hardware and straightforward procedures, removing traditional barriers to mesh networking adoption. The successful validation of key MANET principles—autonomous formation, dynamic routing, and multi-hop communication—using consumer devices has significant implications for research and practical deployment.

The accessibility focus aims to promote wider interest in mesh networking technologies among academic researchers, industry practitioners, and educational institutions. By proving that effective networks can be established without specialized equipment or deep networking expertise, this work encourages exploration of MANET applications in emergency communications, IoT deployments, and infrastructure-limited environments.

Future research directions include performance optimization under varying conditions, security implementation for production deployments, and scalability analysis for larger network topologies. The foundation established here provides a stepping stone for more advanced research while maintaining the core principle of accessibility that makes mesh networking technology available to a broader community.