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AIRLINK: A DECENTRALIZED, SELF-HEALING MESH NETWORKING FRAMEWORK FOR RESILIENT MOBILE COMMUNICATION

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ABSTRACT

In an increasingly connected world, the fragility of centralized communication infrastructures remains a critical vulnerability. Natural disasters, infrastructure failures, and censorship often render traditional cellular and internet-based messaging systems inoperative. This research presents AirLink, a novel decentralized mesh networking application built on the Flutter framework, designed to provide resilient, peer-to-peer communication without reliance on centralized servers or backhaul connectivity. AirLink leverages heterogeneous radio interfaces, including Bluetooth Low Energy (BLE) and Wi-Fi Direct, to form a dynamic, self-healing mesh topology. Unlike traditional mobile ad-hoc networks (MANETs), AirLink introduces an Adaptive Intelligence (AI) Layer that optimizes discovery frequencies based on battery health and motion telemetry. Furthermore, the system implements a Gossip-based Reputation Framework to mitigate the impact of malicious or unreliable nodes, ensuring high-integrity routing in trustless environments. The technical architecture utilizes a modified Dijkstra's algorithm for multi-hop routing, combined with a robust Store-and-Forward mechanism that handles intermittent connectivity. Our evaluations demonstrate that AirLink achieves significant improvements in mesh stability and message delivery rates compared to standard flooding-based protocols, while maintaining a sustainable battery profile for long-term emergency deployments.

KEYWORDS: *Mesh Networking, Decentralized Systems, Gossip Protocols, P2P Communication, Mobile Resilience, Trust & Reputation, Store-and-Forward*

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