

UNITYNODE: A Blockchain-Enabled TVWS-Based Self-Sustaining Network for Resilient Rural Connectivity

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Abstract

Rural communities in many developing countries continue to face limited and unreliable internet access because traditional communication infrastructure such as fiber optics and cellular towers is expensive to deploy, difficult to maintain, and vulnerable to harsh weather conditions. This paper presents UnityNode, a decentralized and sustainable communication framework designed to provide affordable and resilient rural connectivity using Blockchain-based Soft SIM technology, TV White Space (TVWS) communication, wireless mesh networking, and AI-driven renewable energy management. The proposed system removes dependence on physical SIM cards through decentralized digital identity and biometric authentication, while TVWS technology enables long-range and weather-resistant communication in remote environments. Wireless mesh networking supports autonomous data routing between nodes, improving network reliability even during infrastructure failures. In addition, AI-based traffic and energy optimization enhances the efficient use of hybrid solar and wind power systems, ensuring continuous operation in areas with unstable electricity supply. Simulation and prototype evaluations demonstrate that UnityNode improves communication resilience, reduces infrastructure dependency, and provides a scalable, energy-efficient solution for sustainable rural connectivity.

Keywords

Blockchain, Mesh Network, Rural Connectivity, Soft SIM, Decentralized Identity.