PHD DISSERTATION PLAN: IMPROVING THE METHODOLOGICAL BASIS OF USING FREE WIRELESS ACCESS (FWA) TECHNOLOGIES IN THE GREEN DIGITAL ECONOMY

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ABSTRACT

This article is devoted to the comprehensive analysis of the results of the exploring fixed wireless access (FWA) FWA has gained importance with the advent of advanced wireless technologies like 4G and 5G, which have boosted its effectiveness, speed, and reliability. By developing a wireless infrastructure, FWA offers a promising response to the connectivity challenges faced by remote and rural areas. 5G FWA is ideal for providing access connectivity in areas where fiber or cable deployment cannot be justified, such as rural connectivity and for temporary sites.

This article is devoted to the comprehensive analysis of the results of the exploring fixed wireless access (FWA) FWA has gained importance with the advent of advanced wireless technologies like 4G and 5G, which have boosted its effectiveness, speed, and reliability. By developing a wireless infrastructure, FWA offers a promising response to the connectivity challenges faced by remote and rural areas. 5G FWA is ideal for providing access connectivity in areas where fiber or cable deployment cannot be justified, such as rural connectivity and for temporary sites. However, with 5G FWA speeds, reliable and low latency performance, 5G FWA is also a compelling wireline alternative for urban connectivity in both homes and enterprises, smart factories, private campuses, and entertainment venues, as well as relevant conclusions developed in the process of the research. Fixed Wireless Access**,** effectiveness, speed, reliability**,** cable deployment, **research,** 4G, 5G**,** connectivity, **scientific and technological results, creative output.** Fixed Wireless Access (FWA) is an innovative solution dedicated to providing internet access in areas where wired solutions are impractical or unavailable.

It operates through the transmission of radio signals from a base station and delivers high-speed internet service to homes and businesses, bypassing the requirement for physical cables (Figure 1).

- The role of the green digital economy: Uzbekistan supports the Sustainable Development Goals (SDGs) and the "Green Economy" strategy by 2030. Digital technologies are essential for increasing energy efficiency, reducing carbon emissions, and ensuring economic sustainability.

• Free Wireless Access (FWA) technologies: FWA provides wireless broadband connectivity based on 4G/5G networks, which does not require fiber-optic infrastructure and reduces construction costs. FWA is widely used in the green economy as an energy-efficient and environmentally friendly communication solution.

• The context of Uzbekistan: Uzbekistan's "Digital Uzbekistan – 2030" strategy and the "Green Space" project call for expanding digital infrastructure and ensuring environmental sustainability through the use of FWA technologies.

• Problems: The use of FWA technologies in Uzbekistan is still limited, and comprehensive research on energy efficiency, network optimization and methodological approaches is lacking.

To improve the methodological framework for the use of Free Wireless Access (FWA) technologies in the context of a green digital economy, thereby increasing energy efficiency, reducing environmental impact, and ensuring economic efficiency.

— To analyze the current state and application of FWA technologies in the green digital economy.

— To study the energy efficiency and environmental benefits of FWA technologies in international experience.

— To assess the economic and environmental efficiency of FWA networks in Uzbekistan.

— To develop methodological approaches and algorithms for optimizing FWA networks.

International research:

— FWA technologies (Ericsson, 2023): 5G FWA networks consume 30% less energy than fiber-optic networks.

— ICT in a green economy (ITU, 2022): Strategies for reducing the carbon footprint of wireless networks.

— Network optimization (IEEE, 2024): Improving network efficiency using AI and machine learning.

— Uzbek research:

— Digital economy (Tashkent University of Information Technologies, 2022): Implementation of 5G networks in Uzbekistan.

— Green economy (Ministry of Economic Development of the Republic of Uzbekistan, 2023): Application of energy-efficient technologies.

— Gaps: There is a lack of comprehensive research in Uzbekistan on the integration of FWA technologies into the green economy, energy efficiency and methodological optimization.

Research methodology and research methods theoretical analysis: Literature review on Green digital economy and FWA technologies. Analytical modeling: modeling energy consumption and economic efficiency of FWA networks. Experimental Research: Development of software solutions for testing FWA network optimization algorithms. Statistical Analysis: Analysis of network traffic, energy consumption and quality of service (QoS) indicators. Case Study: Study of FWA networks in green tourism facilities (e.g. Silk Road Samarkand) and cities in Uzbekistan.

Data Sources official Documents: Resolutions of the President of the Republic of Uzbekistan (e.g. “Digital Uzbekistan – 2030”), “Green Space” project.

Scientific Articles: IEEE Xplore, ScienceDirect, ITU publications. Practical data: Network data of telecommunication operators of Uzbekistan (Uzbektelecom, Ucell) and tourist facilities. Software tools which using in thezis.

- Network simulation: NS-3, MATLAB, OPNET.
- Data analysis: Python (Pandas, NumPy), R.
- AI and optimization: TensorFlow, PyTorch (for machine learning algorithms).
- Energy efficiency analysis: GreenCloud Simulator, EnergyPlus.

Expected results identify the current state and problems of FWA technologies in the green digital economy, develop new methodological approaches and algorithms for optimizing FWA networks. Practical recommendations for improving the energy efficiency of FWA networks in green tourism and urban infrastructure of Uzbekistan. Assess the economic and environmental effectiveness of the proposed solutions based on test results.

Publication of the results of the dissertation in international scientific journals and application in the telecommunications sector of Uzbekistan. Relevance, purpose, objectives, object and subject of the research. Research on the green digital economy, FWA technologies and network optimization. Current status of FWA technologies in the green digital economy analysis of FWA networks in Uzbekistan and international experience.

Methodological foundations of the use of FWA technologies development of network optimization algorithms and methodological approaches. experimental studies and results were using in research work as a test results and analysis of the effectiveness of FWA networks, proposals for the introduction of FWA networks in the field of green tourism, urban infrastructure and economy of Uzbekistan. Research results and future research directions. Economic benefit: Reducing digital infrastructure costs and ensuring widespread internet connectivity through FWA networks. Environmental benefit: Reducing carbon emissions through energy-efficient FWA networks and minimizing the environmental impact of fiber optic construction. Social benefit: Increasing the convenience of tourists and residents through green tourism and free wireless connectivity in cities.

In conclusion, due to its accessibility, scalability, cost-effectiveness and performance benefits, 5G FWA holds significant potential as the future of connectivity. However, like any technology, its success will also depend on various factors including regulatory policy, market demand, spectrum availability and technological challenges in deployment.

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