Brief information about the project

Name of the project	AP19674715 "Routing of wireless mesh networks based on box-covering algorithms"
Relevance	Due to the rapid advancement of advanced technologies in the telecommunications industry, the development of Wireless Mesh Networks (WMNs) with optimal coverage areas has become a significant research topic. In recent years, these networks have been implemented around the globe with great success, as they possess the properties of self-organization, self-configuration, and self-adaptation. WMNs are characterized by reliable, stable internet connections and high network mobility due to the complete coverage of their topology. Thanks to these benefits, WMNs are utilized in a variety of applications, including broadband home networks, corporate networks, education, healthcare, industrial automation, defense, and rescue missions. Additionally, WMNs equipped with unmanned aerial vehicles (UAVs) are used during natural disaster response to provide wireless coverage for rescue workers and victims.WMNs are mainly used in IoT devices, such as 'Smart Homes' and 'Smart Cities', because they effectively cover the area, creating a cellular and decentralized network.
Purpose	The purpose of this project is to enhance the efficiency of cluster routing in wireless mesh networks (WMNs) by addressing the following challenges: optimal placement of mesh router nodes, effective network partitioning into clusters with even node distribution, and development of a successful routing algorithm for cluster networks.
Objectives	1. MRP Algorithm: 1.1 Development of an Improved Genetic Algorithm (IGA) Based on Fractal Analysis for MRP 1.2 Comparative Analysis of Coverage and Connectivity of MRP Algorithms' Network 1.3 Building an "IGA Mesh" Network Using Field-Programmable Gate Array (FPGA) 2. Clustering Algorithm: 2.1 Clustering of "IGA Mesh" Using Boundary-Clustering (BC) Algorithms 2.2 Comparative Analysis of Node Distribution Uniformity in Cluster and Modularity of BC Algorithms 2.3 Implementation of Selected BC Clustering Algorithm Based on FPGA 3. Routing Algorithm: 3.1 Development of Routing Algorithm for Cluster "IGA Mesh" 3.2 Comparative Analysis of Average Bandwidth and Packet Latency for Mesh Networks 3.3 Experimental Implementation of Cluster Routing Algorithm Based on FPGA
Expected and achieved results	Expected Results: 1. We will obtain a model fractal 'mesh' network, providing maximum connectivity and coverage. 2. We will improve the coverage and connectivity characteristics of our WMN network using the IGA algorithm compared to existing algorithms. 3. We will build an experimental WMN, designed using the IGA

	algorithm and implemented using FPGA. 4. We will create a cluster 'IGA-mesh' network. 5. We will identify the clustering algorithm that has the most uniform node distribution in the cluster and the highest modularity indicator. 6. We will transform the clustering algorithm using FPGA devices. 7. In the developed routing algorithm, we will use Dijkstra's algorithm to calculate the shortest path between clusters and nodes. 8. We assume that the clustered 'IGA-mesh' network will have the best average bandwidth and lowest average packet latency compared to other algorithms.9. The final product will be a mesh network with improved average bandwidth and packet latency, which meets modern standards.An improved genetic algorithm (IGA) has been developed to obtain a fractal mesh network with maximum connectivity and coverage. The IGA algorithm uses an entropy-based fitness function to determine the coverage and connectivity of the wireless mesh network (WMN) network. Compared to other MRP algorithms, the IGA algorithm provides the best coverage and connectivity results. A real experimental WMN was built at Al-Farabi Kazakh National University using the IGA and an FPGA (field-programmable gate array) based on Raspberry Pi4. The FPGA has a built-in Wi-Fi module, and protocols such as OLSR (Optimized Link State Routing), Batman, and Ygdrassil are used. The results of each protocol's throughput are obtained.The scientific novelty of this project is the development of a new Multi-Radio Relay Protocol (MRP) algorithm that takes into account the fractal nature of the network. This algorithm will help to reduce the average packet reception and transmission delays and increase the overall throughput of Broadcasts in Clustered Wireless Mesh Networks (BCR-WMNs). The algorithm is based on the use of BC clustering algorithms to optimize the performance of BCR.
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List of publications with links to them	- 1.Turlykozhayeva D. et al. Routing Algorithm for Software Defined Network Based on Boxcovering Algorithm //2023 10th International Conference on Wireless Networks and Mobile Communications (WINCOM). – IEEE, 2023. – C. 1-5.
Patents	-