

The study proposes and simulates several solutions for deploying telecommunications services in low-population-density areas of Ha Giang province.

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Abstract: This thesis proposes and simulates technical solutions for deploying telecommunication services in low-population-density areas of Ha Giang province, Vietnam. The challenging mountainous terrain and sparse settlement patterns result in high deployment costs and limited service accessibility for traditional infrastructure. The study first analyzes the specific geographical, demographic, and socio-economic characteristics of Ha Giang to identify key constraints. Subsequently, several viable solutions are proposed, including the use of low-power wide-area network (LPWAN) technologies, TV white space spectrum, and satellite backhauling, alongside optimized small-cell and relay station placement. A simulation framework is developed to model coverage, capacity, and cost-efficiency for each proposed solution under local conditions. The simulation results are compared against conventional cellular deployment to evaluate performance metrics such as signal coverage, data throughput, and capital expenditure. The findings indicate that a hybrid architecture combining LPWAN for IoT services and TV white space for broadband access offers the most effective balance between coverage and economic feasibility. This research provides a practical reference for operators and policymakers aiming to bridge the digital divide in remote, low-density regions.

Keywords: telecommunications, low-density population, service deployment, simulation