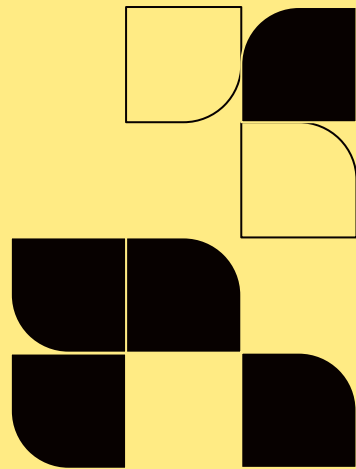January 26, 2025

Network Simulation for School Connectivity in Niger

# Background on Educational Challenges in Niger

Educational Challenges

- Over 99% of schools in Niger lack internet connectivity.

- Only 11% of the population has access to the internet, severely limiting educational resources.

- High dropout rates in rural areas are exacerbated by a lack of digital learning opportunities.

Importance of Digital Connectivity

- Digital connectivity is vital for enhancing educational access and quality in Niger.

- Access to online resources can improve learning outcomes and teacher effectiveness.

- Bridging the digital divide is essential for preparing students for the global economy.

Problem Statement
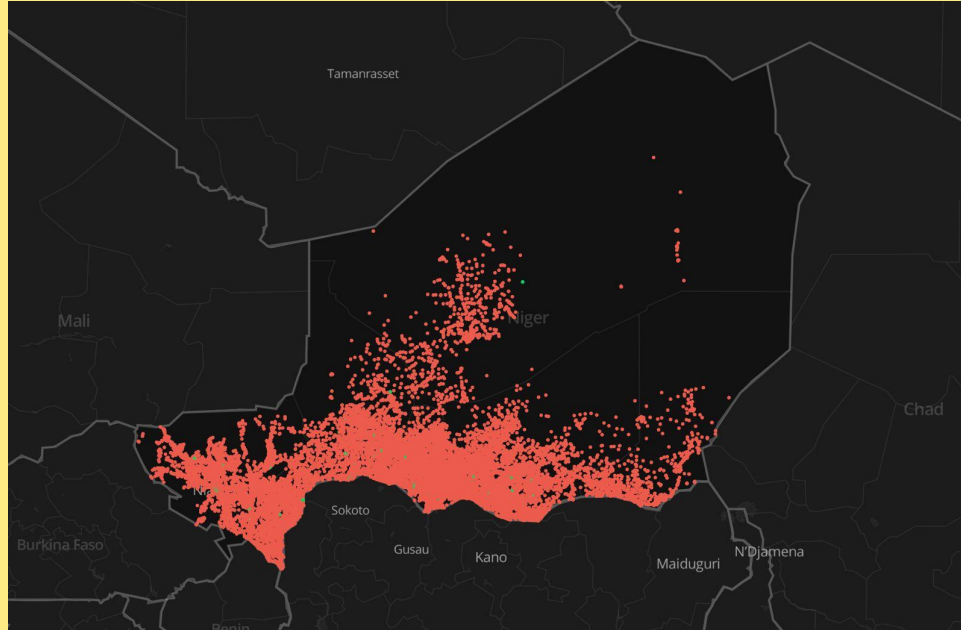
Project Objectives

01 **Enhance Educational Access**

Increase access to digital resources and educational materials through reliable internet connectivity for schools.

02 **Utilize 10 Central Hubs**

Establish a network of 10 strategically placed central hubs to maximize coverage and connectivity efficiency.

03 **Optimize Network Layout**

Design an efficient network layout that minimizes latency and maximizes bandwidth for all connected schools.

Problem Statement

Geographic Constraints

Niger's vast and diverse terrain poses significant challenges for network deployment, as remote areas are difficult to access and may lack existing roads or infrastructure.

High Deployment Costs

The financial burden of laying down network infrastructure is substantial, with costs associated with materials, labor, and maintenance escalating in rural and isolated regions.

Lack of Existing Infrastructure

Many schools in Niger operate without basic connectivity, making it challenging to implement new technologies or systems that rely on internet access for educational enhancement.

Proposed Solution Overview

Hub-and-Spoke Topology

The proposed network utilizes a hub-and-spoke topology, enabling efficient data routing from central hubs to individual schools.

Ten Central Hubs

The design incorporates 10 strategically located central hubs that serve as the primary connection points for surrounding schools.

School Connections

Each school is connected to its nearest hub via high-speed cables, ensuring reliable internet access for educational resources.

Inter-Hub Connectivity

Hubs are interconnected to provide redundancy, enhancing network reliability and ensuring continuous global access.

Simulation Details

Simulation Tools and Methods

- Python scipy, matplotlib and Giga's dataset on schools

- Currently under review - utilizing various cable types: Ethernet for local connections, fiber optics for long-distance links.

Hub Locations and Metrics

- Ten central hubs strategically placed to minimize latency.

- Metrics measured include throughput, latency, and packet loss during simulations.

- Simulation runs conducted under different load conditions to evaluate performance.

Network Topology Diagram
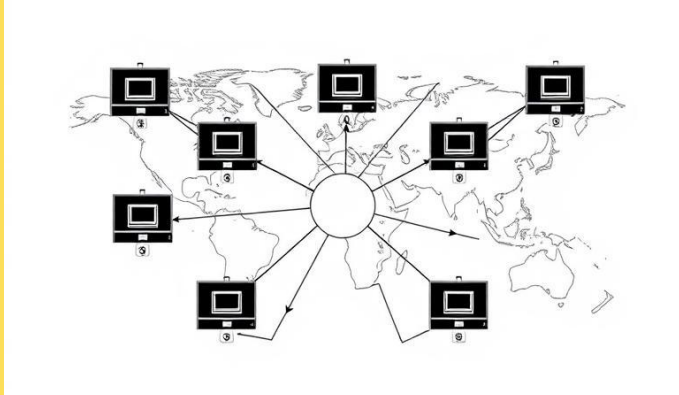

Network Layout Overview

The diagram illustrates the positions of 10 central hubs and their connections to surrounding schools, demonstrating the hub-and-spoke topology for effective connectivity.
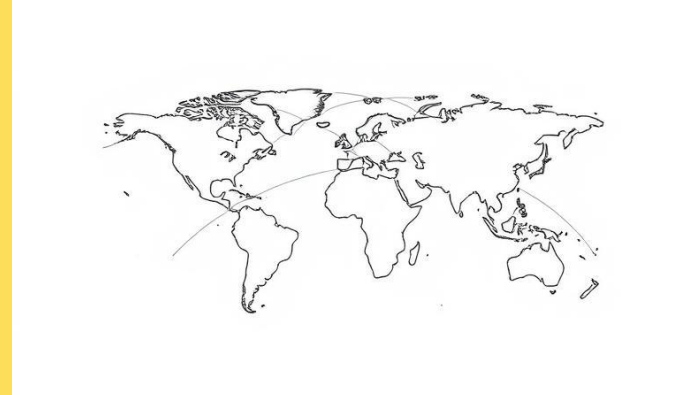
Connectivity and Redundancy

Connections between hubs ensure redundancy, providing multiple paths for data transmission, enhancing network reliability and global access.

Key Metrics and Simulation Results
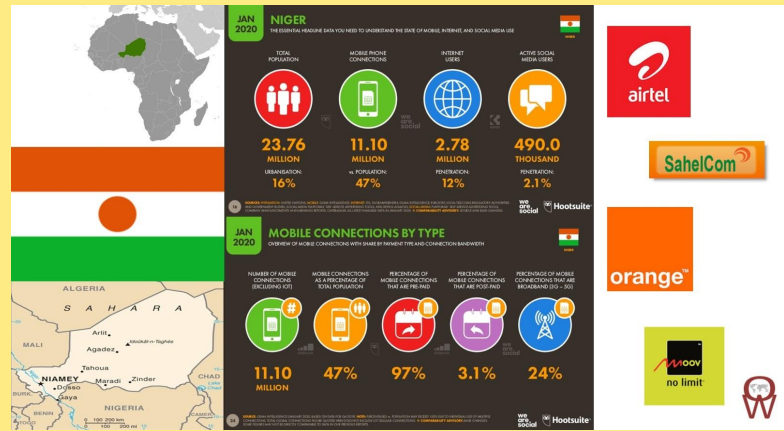
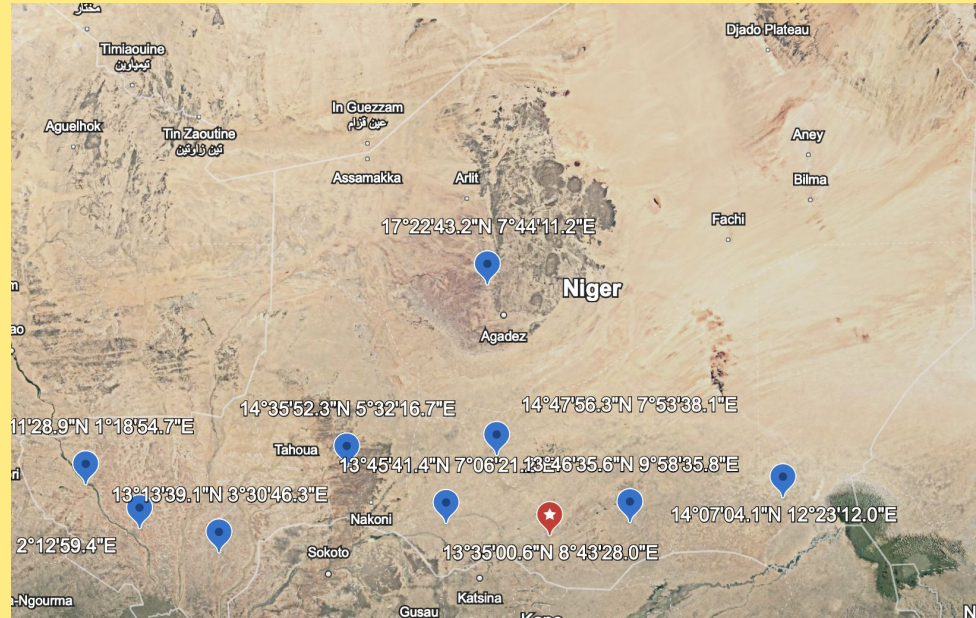
20 ms	Average Latency
75%	Bandwidth Utilization
8	Scalability Score
99.9%	Redundancy Performance

Optimal hub locations have been identified through simulation.

Cost and Feasibility

Estimated Infrastructure Costs

- Initial setup cost for 10 central hubs estimated at $500,000.

- Monthly operational costs, including maintenance, projected at $10,000.

- Costs for high quality cabling and equipment per school roughly $2,500, totaling $5,000,000 for 19,000 schools.

- Initial plan is to set up 1 central hub and connect all the schools corresponding to the hub there

  - Cost around 50,000 + 500,000 = 550,000 USD

Network Scalability and Funding Sources

- Potential to scale by adding more hubs as demand grows.

- Funding options include government grants, NGO partnerships, and private investments.

- Crowdfunding campaigns can also support initial costs and community involvement.

Impact and Benefits

01

Bridging the Digital Divide

The network will provide essential internet access to underserved schools in Niger, reducing educational disparities and ensuring all students have opportunities to learn.

02

Improving Access to Resources

Students and teachers will gain access to a wealth of online educational resources, enhancing learning experiences and facilitating better academic outcomes.

03

Fostering Global Connectivity

The initiative will connect Nigerien students with global peers, promoting cultural exchange and collaboration, and preparing them for a globalized workforce.

Future Plans

Wireless Solutions

Implementing wireless technology to connect remote schools where cabling is impractical, enhancing accessibility and reducing deployment costs.

Adding More Hubs

Establishing additional central hubs to improve network coverage and performance, ensuring more schools can benefit from connectivity.

Partnerships for Growth

Collaborating with NGOs and telecom providers to secure funding, technical expertise, and infrastructure support for sustainable network expansion.

Thank you