

UNIVERSITY OF GREENWICH
FACULTY OF ENGINEERING AND SCIENCE
SCHOOL OF COMPUTING AND MATHEMATICAL SCIENCES

COMP1682 Final Year Project Proposal

**How a hybrid mesh–satellite system manages handoffs and
maintain a stable connection in rural or disaster relief
areas?**

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DECLARATION OF AI USE

Please complete this part when you have used AI during the process of undertaking this assignment to acknowledge the ways in which you have used it.

I have used AI while undertaking my assignment in the following ways:

- To develop research questions on the topic – NO
- To create an outline of the topic – NO
- To explain concepts – YES
- To support my use of language – NO
- To summarise the following articles/resources: – NO
 - 1.
 - 2.
 - 3.
 - 4.
 - 5.
 - 6.
- In other ways, as described below: – YES
 - Create an ordered bibliography to track papers that have been read.

SYNOPSIS

The ability to setup networks in a rural or disaster areas has never been an efficient process, from getting equipment setup, to calculating the best areas to have access points and ensuring that all nodes have stable connections are just some of the difficulties that have to be overcome in order to set up a reliable network in these difficult environments. (Tirmizi, et al., 2022)

A mesh network offers a unique approach to these challenges; a mesh network can group all the available nodes together into a Wide Area Network (WAN). This offers the benefit that in the event one of one nodes on the network fails, it doesn't take the whole chain down, nodes can find other paths instead, greatly improving network resilience. (Karamchand, 2024)

In rural areas, the delivery of a stable and high-quality network connection remains a persistent struggle. Joining and ensuring a fast communication channel with remote communities helps ensure that people who live in remote regions are well connected with the rest of the world and keep them up to date with vital information. (Borgianni, et al., 2024)

(Swathi, et al., 2024) Suggests that algorithmic approaches are favoured, this is because an algorithm running on a testbed would be able to choose the preferred method of connection Nevertheless, Inter-Mesh link scheduling algorithms need to be investigated more.

(Elbehiry, et al., 2025) Investigates using the Bellman-Ford algorithms over something like the Dijkstra algorithm as the end-to-end time is dramatically decreased along with its dynamic nature making it able to find the shortest path while minimising costs. However, the journal also suggests further research is needed since other methods may be more efficient or better suited.

The overall success of this product will be a nodes ability to switch seamlessly between connections to the internet without any effect on the user's end experience. Success will be measured by proving that switching is quicker than remaining on any one network as connection becomes interrupted.

Keywords: Handoff Management, Hybrid routing, Mesh Networks, LEO Satellites.

1. AIM AND OBJECTIVES

1.1 Aim

This project aims to design, simulate, and evaluate a novel handoff management protocol for a hybrid terrestrial mesh and LEO satellite network to improve connection stability and availability in rural and disaster relief environments.

1.2 Objectives

1.2.1 Literature Review and Project Design

- 1.2.1.1 Conduct a comprehensive and critical review of existing research papers on mesh networking, LEO satellites, SDN handoff protocols and algorithms. [10 days].
- 1.2.1.2 Organise and summarise the key academic papers that contain the relevant research to; mesh networking, LEO satellites and SDN handoff protocols. [5]
- 1.2.1.3 Design the core functions and the algorithm that the protocol will use, based on metrics of latency and potential packets lost. [10]
- 1.2.1.4 This will deliver Chapter 2, the Literature review and a System Design specification.

1.2.2 Product build and Testing

- 1.2.2.1 Building of the product source code will begin to produce the working software that the handoff will run on a hardware testbed of raspberry pi's. [30]
- 1.2.2.2 Testing of the software will occur during the build along with the hardware required to make this work, this includes Raspberry Pis that will act as the nodes on the network where the software will run. [10]
- 1.2.2.3 A complete and working source code will be delivered for the handoff protocol.

1.2.3 Project Evaluation and final report

- 1.2.3.1 The final report will be completed, and an evaluation of the project will be conducted, measuring the packets lost and the latency. Proving the protocol can seamlessly switch between networks and reflecting the research and work undertaken. [25]
- 1.2.3.2 Delivered will be a Working product that can successfully switch between networks, greatly improving the connectivity along with the Final report displaying all the research and findings of the project.

2. BACKGROUND RESEARCH AND PROJECT RATIONALE

As (Karamchand, 2024) says, Mesh networking is an essential part of supporting services in rural areas. A mesh network is a network, consisting of interconnected nodes that can route data dynamically. This offers a robust and flexible method of networking. (Karamchand, 2024) Mesh Networks are vital in their ability to provide a stable connection across a network, this is due to their inherent nature of having as many nodes as possible, giving them redundancy. This redundancy is essentially a self-healing capability, where if one pathway goes down for whatever reason, the network can still maintain its connection to the rest of the network. (Tarhouni, et al., 2025) Using a hybrid network to achieve the best possible connection is a step forward in, reliability and stability of rural and off grid networks. (Ben Salem, et al., 2023) This can be provided by satellites in low earth orbit, the local mesh network can be routed via the satellites and use them as another method of redundancy, switching from traditional ground cabling to satellite where needed. (Tirmizi, et al., 2022)

The algorithm this project will provide, aims to be a software defined network (SDN) that is able to algorithmically switch networks between the terrestrial network and LEO satellites. (Westphal, et al., 2023) explains how SDN's are an emerging domain, along with the use of satellite networking. The use of an algorithm to support the network switching is therefore a necessity to maintain a reliable and stable network, as supported in (Zhou, et al., 2023) using a form of handover utility in order to manage the decision making process of switching to a connection with the maximum capacity, stability and overall reliability.

AI is a breaking technology that is being tested in methods like the proposed project, (Turkmanovic, et al., 2025) Suggests that the AI framework can enable an optimal session switching leading to a benefit in optimised resource usages. Machine learning using deep neural networks are attempting to tackle this problem to make the handoff method more dynamic and allow for a more efficient switch mechanism. (Fontanesi, et al., 2025)

Key challenges within the research, these are problems that would be required to overcome to sell the viability of the project. (Ben Salem, et al., 2023) showed that hybrid terrestrial/LEO systems can significantly improve the coverage in rural areas. These however can be costly, as they require a lot of infrastructure to build the mesh network as well as have the facilities to receive network signals from LEO. Satellite downlink connectivity also has shown coverage can sometimes be a logistics challenge, so companies are actively working to have a large coverage to provide the most connected and resilient network coverage which is improved with increasing the coverage area. (Lee, et al., 2025)

This project will use an experimental design method, following an algorithmic and potential machine learning driven approach that has been researched in the literature. (Fontanesi, et al., 2025) (Turkmanovic, et al., 2025) In similar approaches, research have used methods such as complex maths to create models to manage the handoff algorithms. (Han, et al., 2024) Others have created bespoke programmes to handle the management.

3. METHODOLOGY AND TECHNICAL APPROACH

This project will be attempting to create an algorithmic approach which will be run on a central system, in this case a laptop will be used running the algorithm and will use a handover utility function formula to make the best choice of balancing between the terrestrial network and the LEO network. The network will be meshed all linking to each other and linking back to the central system. While the network is running, the connections will be sending information back to the central system consisting of the packets lost and the delay experienced. This data is what will be measured to evaluate the success. The code will be written in python and will connect with the nodes used, for the proof of concept, these will be testing nodes consisting of a raspberry pi and simulated bandwidth delays emulating a LEO satellite as using a satellite such as Starlink is not feasible for this project, a simulated node is of close comparison to its true to life counterpart.

To emulate the realistic network behaviour, Linux based network tools such as 'tc' will be used to simulate varying connection qualities. This tool will allow for manipulation in the traffic control settings and add the expected delays that would exist when using LEO connections. Data will be collected via Wireshark, this is so that packet delay, loss and switching response time can be effectively measured.

4. EVALUATION PLAN

The overall success of the product will be judged by the networks ability to seamlessly switch between, terrestrial and satellite when it is deemed beneficial and having little to no effect on the end users experience. The level of success will be measured by the quality of the connection being provenly better than it would have been having remained on either the terrestrial connection or the satellite connection. In addition, the quality of connection will be determined by multiple of factors. Packet loss will provide a clear metric of how stable the connection is, many dropped packets along an excessive number of hops will provide clear evidence that the current connection is poor, or that the network switching algorithm is not efficient. Latency will also be measured, this is a primary metric of the algorithm to determine what the best method of connection is, whether it be over the terrestrial network or the LEO satellite network as having a higher level of latency means regardless of the stability of the network, network speeds are still subpar.

Further evaluation can be undertaken by running an existing algorithm on the same test bed, this will further provide evidence to the benefits or drawbacks of the proposed solution. A pre-existing algorithm may not have a better efficiency comparatively.

5. LSEPI CONSIDERATIONS

This project involves no human participants or personal data, meaning GDPR or consent does not apply to this project. All evaluations will be conducted in a closed network using simulated traffic rather than live user data. Complying with the UK Data Protection Act (2018) and Computer Misuse Act (1990) to avoid unauthorised access or data misuse.

6. RISK ASSESSMENT

The potential risks for this project include, time constraints, hardware constraints technical risks and scope risks. Time constraints of this project can occur due to the nature of building an algorithm from the ground up within the allotted time. This can be mitigated by ensuring that the basics of the software are operating within the time limit to provide a proof-of-concept idea. Furthermore, hardware constraints can be an issue as the project also requires certain hardware to provide an evaluation of the project, this constraint can be avoided using different hardware. To prove the concept, it is unnecessary that all required hardware is used, simulated hardware or time delays can be added to provide a true to life simulation. The technical risks occur as the project grows, it may become unmanageable, remaining within the scope is important as to further abide by the expected timeline. Finally, the scope risks also link to technical risks as too broad of a scope can balloon the timeline and make the project difficult to complete, remaining within the planned scope and on the expected timeline along with routine meeting with the project supervisor to de-scope some non-essential features, if development falls behind is the expected way to mitigate risks on this project.

7. PROJECT PLAN AND TIMELINE

This project will be broken into 3 key parts, consisting of: Part 1 Literature Review and Project Design, Part 2 Product build and Testing and Part 3 Project Evaluation and final report. Beginning in January 2026, running through to April 2026.

TASK	Duration (Days)	START	END
Literature Review and Project Design			
Literature Review	10	12/01/2026	22/01/2026
Organise and Summarise Key papers	5	23/01/2026	28/01/2026
Choose and Design Core functions	10	29/01/2026	08/02/2026
Product Build and Test			
Building of source code	30	09/02/2026	11/03/2026
Testing software on testbed	10	12/03/2026	22/03/2026
Evaluation			
Final Report	25	23/03/2026	17/04/2026

8. REFERENCES

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