IT4010 – Research Project - 2024

Topic Assessment Form

Project ID: **24-25J-049**

1. Topic (12 words max)

Disaster-Resilient Telecommunication Infrastructure: A Systematic Approach

2. Research group the project belongs to

Computing Infrastructure (CI)

3. Research area the project belongs to

Computer Networks (CN)

4. If a continuation of a previous project:

Project ID	
Year	

5. Brief description of the research problem including references (200 – 500 words max) – references not included in word count.

Natural disasters such as earthquakes, hurricanes, floods, and wildfires can cause significant disruption to telecommunication infrastructure, rendering traditional communication networks, including mobile and internet services, inoperative. This breakdown in communication can severely hamper disaster response efforts, leaving affected populations without critical information and instructions needed for their safety and well-being. The core research problem addressed in this project is the vulnerability of terrestrial telecommunication networks during disasters and the subsequent need for a reliable alternative communication system. Specifically, the project aims to explore and develop a satellite-based communication system that can function independently of terrestrial infrastructure, ensuring continuous information dissemination to individuals in disaster-stricken areas.

Traditional communication networks rely heavily on physical infrastructure such as cell towers, cables, and power supplies, all of which are susceptible to damage during natural disasters. When these systems fail, emergency responders and affected communities face significant challenges in coordinating relief efforts, conducting rescues, and distributing vital information. This communication breakdown can lead to delays in emergency response, increased casualties, and greater overall chaos in the aftermath of a disaster. Satellite communication offers a robust solution to this problem due to its inherent resilience and extensive coverage. Unlike terrestrial networks, satellite systems are not dependent on local infrastructure and can provide reliable communication links even in the most remote and disaster-affected regions. By integrating satellite communication with mobile phones, a seamless and effective communication network can be established to bridge the gap left by damaged terrestrial systems. [1]

The proposed solution involves utilizing satellites to send messages directly to mobile phones in disaster-affected areas. This system would include ground stations that receive satellite signals and relay them to mobile devices, ensuring that critical information, such as emergency alerts, safety instructions, and updates, reaches the impacted population. This approach leverages the wide coverage and reliability of satellite technology along with the ubiquity of mobile phones to enhance communication capabilities during disasters. [2] Additionally, the project includes GPS technology to track and count individuals within disaster zones, providing valuable data for emergency response teams. This function will help in understanding the scale of the impact and planning effective rescue operations. Moreover, incorporating radio frequency (RF) technologies will ensure robust local communication, especially in areas where satellite or cellular signals might be weak. [3]

References

[1] "Wikipedia," [Online]. Available: https://en.wikipedia.org/wiki/Communications_satellite.

[2] "Geeksforgeeks," [Online]. Available: https://www.geeksforgeeks.org/introduction-of-mobile-ad-hoc-network-manet/.

[3] "Stackexchange," [Online]. Available: https://electronics.stackexchange.com/questions/187681/can-a-radio-transmitter-somehow-detect-the-number-of-receivers-in-its-area.

6. Brief description of the nature of the solution including a conceptual diagram (250 words max)

In the context of disaster management, utilizing satellite technology for communication and data dissemination is crucial. During natural disasters, when traditional communication infrastructure like mobile networks are disrupted, satellite communication can provide a reliable means to reach affected populations. By integrating satellite communication with mobile phones, a robust communication system can be established to send messages to individuals in disaster-stricken areas.

The proposed solution involves several key components:

Satellite Communication: Satellites orbiting the Earth establish communication links with ground stations. These satellites are capable of sending and receiving signals even in remote and disaster-affected regions, ensuring continuous communication.

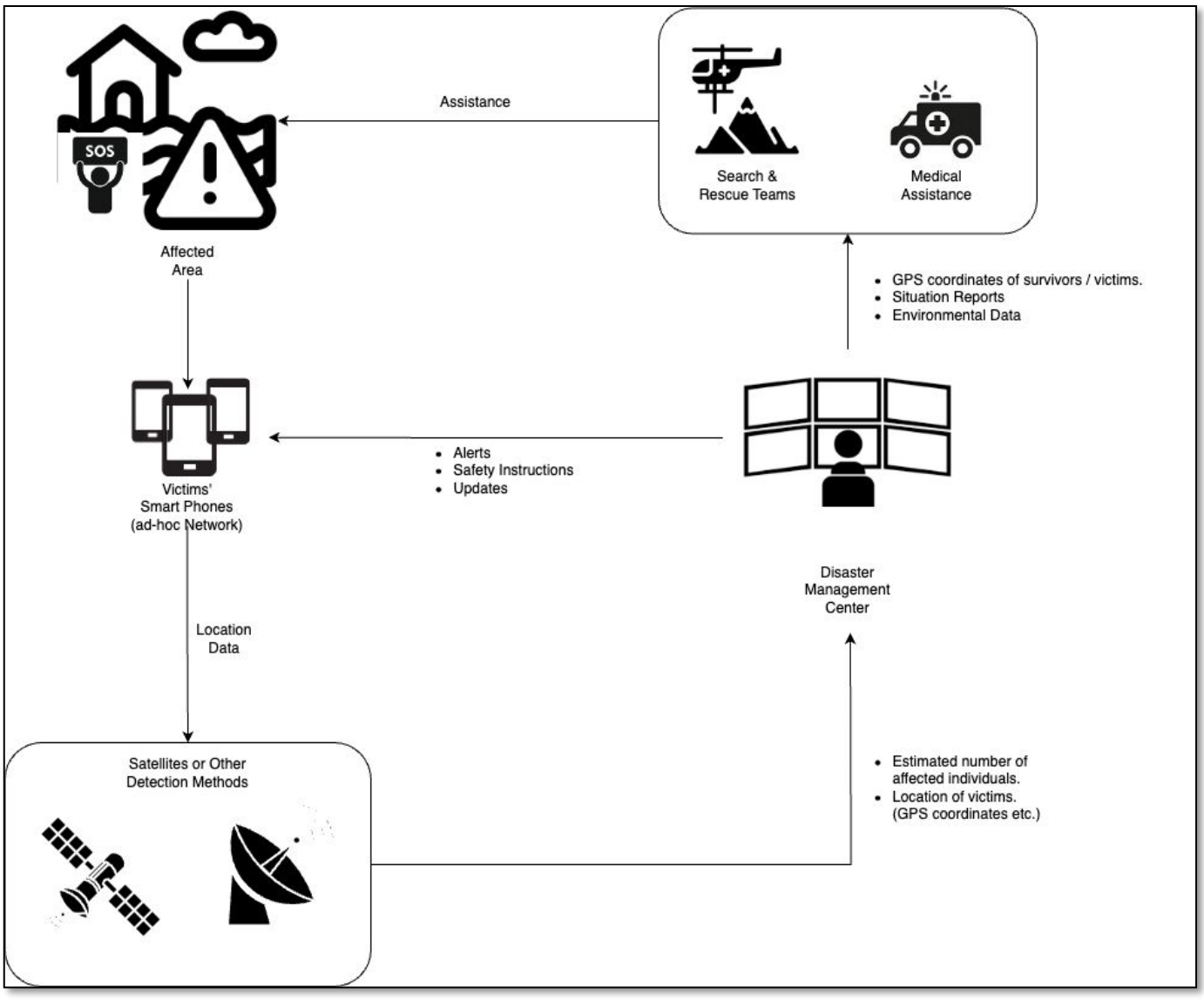
RF Communication Devices: RF technologies, such as two-way radios and emergency beacons, enhance local communication capabilities, particularly in areas where satellite or cellular signals might be weak. These devices use specific radio frequencies to facilitate short-range communication among rescue teams and affected individuals, ensuring that critical information can still be exchanged even in the most challenging conditions.

Ground Stations: Ground stations receive signals from satellites and relay them to mobile phones and other communication devices in the disaster zone. They act as intermediaries, ensuring that messages are transmitted efficiently and accurately.

Mobile Phones: Mobile phones in disaster-affected areas receive these satellite signals, providing critical information, emergency alerts, safety instructions, and updates to individuals. This setup ensures that even when terrestrial communication networks are down, satellite technology can bridge the communication gap and deliver essential messages.

Additionally, the solution integrates GPS Technology and RF Communication Devices to enhance its effectiveness. GPS technology tracks and counts individuals within the disaster zone, providing valuable data for emergency response teams to understand the scale of the impact and plan effective rescue operations. RF technologies, such as two-way radios and emergency beacons, enhance local communication capabilities, particularly in areas where satellite or cellular signals might be weak. This multi-faceted approach ensures robust and reliable communication, aiding efficient emergency responses and ultimately saving lives.

Conceptual diagram



7. Brief description of specialized domain expertise, knowledge, and data requirements (300 words max)

Satellite Communication: Expertise in satellite technologies is crucial for ensuring reliable transmission of SOS messages during network outages. This includes knowledge of satellite communication protocols, signal processing, and satellite network management. Specialists in this area must understand how to configure and maintain satellite links to ensure they remain operational during and after a disaster. Moreover, the integration of satellite systems with ground stations and mobile devices requires advanced technical skills to maintain continuous communication.

Radio Frequency (RF) Technologies: Incorporating RF technologies such as two-way radios and emergency beacons enhances the communication capabilities of the disaster recovery plan. Proficiency in RF communication involves understanding frequency bands, signal propagation, and RF hardware integration. Specialists must ensure reliable short-range communication among rescue teams and affected individuals, even in areas where satellite or cellular signals are weak. Expertise in configuring and deploying RF networks is critical for maintaining robust local communication during emergencies.

GPS Technology: Accurate tracking and counting of individuals in disaster zones necessitate proficiency in GPS systems. This includes understanding how GPS data is collected, processed, and interpreted. Experts in this field should be familiar with the integration of GPS technology into mobile devices and other communication tools, ensuring precise location tracking even in challenging environments. Additionally, knowledge of real-time data analytics is essential to provide timely information for emergency response teams.

Network Security: Securing communication channels is paramount to prevent unauthorised access and data breaches. Professionals in network security must implement robust encryption methods, secure data transmission protocols, and conduct regular security audits. This ensures that all communications, including SOS messages, GPS data, and RF transmissions, are protected against potential cyber threats. Developing secure, resilient systems that can withstand various forms of attacks is critical in maintaining the integrity and confidentiality of sensitive information during disasters.

- **Satellite Access Credentials and Protocols**: Secure access to satellite networks and understanding the communication protocols for transmitting SOS messages.
- **GPS Data**: Real-time tracking data to accurately count and locate individuals in disaster-affected areas.
- **Historical Data on Disasters**: Information on past disaster impacts and communication network failures to validate and test the proposed system.
- **RF Communication Data**: Configuration details and usage logs of RF communication devices to ensure seamless integration and operation.
- **User Data (Anonymized)**: To comply with data protection regulations, user data must be anonymized, ensuring privacy while still providing valuable information for resource allocation and emergency response.

8. Objectives and Novelty

Main Objective: Develop a disaster-resilient telecommunication infrastructure to ensure continuous communication and data dissemination during natural disasters.			
Member Name	Sub Objective	Tasks	Novelty
Bandara H.K.K.T IT21176074	**Ad-Hoc Network Creation** Establish an ad-hoc network to facilitate emergency communication in disaster-affected areas.	Design and implement a dynamic ad-hoc network architecture. Reintegrate the network with existing mobile devices for seamless communication. IOT base station for the ad hoc network	Dynamic ad-hoc network architecture that self-configures and reconfigures in real-time for robust communication without traditional infrastructure.
Widanage W.T.N IT21377426	**SOS Messaging via Ad-Hoc Network** Enable the transmission of SOS messages through the established ad-hoc network.	Develop a protocol for sending and receiving SOS messages within the network. Ensure low latency and high reliability in message delivery.	Development of a dedicated SOS messaging protocol tailored for ad-hoc networks to ensure low-latency and high-reliability message delivery.

S.M.T.S Senaratna IT21337512	**Data Collection and Aggregation** Gather and aggregate data on the number of people in the disaster-affected area using GPS and RF technologies.	Implement systems to collect GPS and RF data from smartphones and other devices. Aggregate and filter the data to estimate the number of affected individuals.	Combining GPS and RF technologies to enhance accuracy and reliability in estimating the number of people in disaster zones.
Muhandiramge M.D.A.D IT21383434	**Data Analysis and Reporting** Analyze aggregated data to provide real-time insights on the number of people in the disaster-affected area.	Develop algorithms for analyzing GPS and RF data to identify population density and movement patterns. Create visualization tools and reporting systems for emergency response teams.	Use of advanced data analytics and machine learning algorithms to provide real-time insights and visualizations for effective emergency response.

9. Supervisor checklist

a) Does the chosen research topic possess a comprehensive scope suitable for a final-year project?

Yes	✓	No	

b) Does the proposed topic exhibit novelty?

Yes	✓	No	

c) Do you believe they have the capability to successfully execute the proposed project?

Yes	✓	No	

d) Do the proposed sub-objectives reflect the students' areas of specialization?

Yes	✓	No	

e) Supervisor's Evaluation and Recommendation for the Research topic:

Components need further clarifications and defining. But acceptable for the time.

10. Supervisor details

	Title	First Name	Last Name	Signature
Supervisor	Ms.	Dimithi	Panditharage	Dimithi Panditharage 24/6
Co-Supervisor				
External Supervisor				
Summary of external supervisor's (if any) experience and expertise				

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Topic Assessment Form

<u>This part is to be filled by the Topic Screening Panel members.</u>

Acceptable: Mark/Select as necessary

Topic Assessment Accepted	
Topic Assessment Accepted with minor changes (should be followed up by the supervisor)*	
Topic Assessment to be Resubmitted with major changes*	
Topic Assessment Rejected. Topic must be changed	

* Detailed comments given below

Comments

The Review Panel Details

Member's Name	Signature

*__Important__:

1. According to the comments given by the panel, make the necessary modifications and get the approval by the **Supervisor** or the **Same Panel**.
2. If the project topic is rejected, identify a new topic, and follow the same procedure until the topic is approved by the assessment panel.