

Thread: Using Offline Mesh Networks to Strengthen Community Communication During Disasters — A Conceptual Case Study

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ABSTRACT

Natural disasters can damage not only homes, roads and public infrastructure but also communication systems. Mobile towers, electricity networks and internet services may stop working exactly when people need them most. This creates a serious communication gap between affected families, local communities, volunteers and emergency responders.

This case study examines **Thread**, a proposed mobile application designed to create an offline communication network during disasters. Instead of depending completely on mobile towers or internet connectivity, Thread proposes using Bluetooth and Wi-Fi Direct to connect nearby smartphones. Messages could then move from one phone to another through a mesh network. The concept focuses particularly on the first hours and days after a disaster, when communities may have to depend on their own resources before organised assistance reaches them. Thread proposes four main functions: emergency alerts, SOS support, sharing of essential supplies and post-disaster recovery coordination.

The case also examines the possible business model for Thread. The application would remain free for community users while government agencies, humanitarian organisations and impact funders could support its development and operation.

The study finds that offline communication technology has the potential to strengthen community-level disaster preparedness. However, technological reliability, user adoption, device compatibility, privacy, battery use and institutional partnerships would have to be tested carefully before large-scale implementation.

Keywords: Disaster Management, Mesh Networks, Emergency Communication, Social Enterprise, Bluetooth, Community Resilience, Technology, Disaster Preparedness

INTRODUCTION

Communication becomes extremely important during a natural disaster. People need to know whether family members are safe, where shelters are located, whether roads are open, where medical assistance is available and which areas should be avoided.

Unfortunately, disasters can damage the same communication infrastructure people normally depend upon.

Mobile towers may lose electricity or suffer physical damage. Internet services may become unavailable. Networks can also become overloaded because thousands of people try to communicate at the same time.

This creates an important question:

Can communities continue communicating even when conventional communication infrastructure fails?

Thread was developed as a possible answer to this problem.

Thread is a proposed mobile application that would allow smartphones located near each other to communicate directly using technologies such as Bluetooth and Wi-Fi Direct. Instead of every phone communicating through a cell tower, phones could communicate with one another and form a temporary local network.

The basic idea is simple: **the phones already carried by community members could become part of the emergency communication infrastructure.**

The purpose of this case study is to examine:

- The communication problem that occurs during disasters.
- How Thread attempts to solve this problem.
- How the proposed technology could work.
- The possible users and markets for the application.
- The business and revenue model.
- The challenges involved in implementing such a system.
- The future possibilities for community-based disaster communication.

Thread should currently be understood as a proposed disaster-technology venture rather than as a proven large-scale emergency network. Therefore, this paper evaluates both its potential and the practical questions that would need to be answered through testing and implementation.

METHODOLOGY

This paper uses a **qualitative case-study approach** to examine the concept, feasibility and potential business model of Thread, a proposed offline communication platform for disaster situations.

The study began with the development of the Thread concept as part of the author's HCBC project. The original project examined the problem of communication failure during natural disasters and explored whether smartphones could be used to create a temporary local communication network when internet services or mobile towers are unavailable.

The research for this case study is based mainly on **secondary research**. Information on disasters, displacement and disaster preparedness was reviewed from organisations including the **World Meteorological Organization (WMO), United Nations Office for Disaster Risk Reduction (UNDRR), Internal Displacement Monitoring Centre (IDMC), EM-DAT, Munich Re and the National Disaster Risk Reduction and Management Centre of Mauritius**. These sources were used to understand the scale of disaster-related risks and the importance of resilient communication systems. WMO, for example, reported that the number of recorded weather-, climate- and water-related disasters increased fivefold over a 50-year period, while IDMC recorded 26.4 million new disaster displacements during 2023.

Academic and technical literature on **device-to-device communication, Bluetooth Low Energy and mobile networks for disaster response** was also reviewed to examine whether the underlying idea behind Thread is technically possible. Previous research has demonstrated the potential for smartphones to communicate directly through technologies such as Bluetooth and Wi-Fi without relying completely on cellular infrastructure.

The case study analyses five main areas: the disaster communication problem, Thread's proposed solution, technical feasibility, possible target markets, and the proposed social-enterprise business model.

This is a **conceptual case study rather than an experimental study**. No large-scale prototype deployment, user survey, interview or live disaster test has yet been conducted. Therefore, the financial estimates, network performance targets and market projections discussed in the paper should be treated as **proposed assumptions rather than proven outcomes**. Future research should involve controlled disaster drills and pilot testing to measure message delivery, battery consumption, network range, user adoption and reliability.

CASE STUDY

I. The Problem: Communication Failure During Disasters

Natural disasters frequently create a chain of problems.

A cyclone may damage electricity lines. Without electricity, mobile towers may stop functioning. Flooding may damage roads and prevent rescue teams from immediately reaching affected communities. Internet services may also become unavailable.

Yet during these same hours, communication becomes more important than ever.

People may need to answer basic questions such as:

- Is my family safe?
- Where can I find drinking water?
- Which hospital is functioning?
- Is the main road flooded?
- Does someone nearby need medical help?
- Where is the nearest shelter?
- Who has food or medicine available?

The Thread concept focuses particularly on the first approximately **72 hours following a serious disaster**.

This period is important because large emergency organisations cannot always reach every affected community immediately. The original Thread presentation argues that communities may have to coordinate amongst themselves while waiting for outside assistance.

A useful example considered while developing the concept was the flooding in **Derna, Libya, in September 2023**. Severe flooding following the failure of dams caused enormous destruction.

The case highlights an important weakness in disaster response: people may still have functioning smartphones even when the communication network those phones normally depend upon is unavailable.

This distinction became central to the Thread idea.

A smartphone itself does not necessarily stop functioning because a cell tower stops functioning. Most modern smartphones already contain technologies allowing them to communicate directly with nearby devices.

This raises the possibility of creating a communication system that does not depend entirely on central infrastructure.

II. The Existing Gap in Disaster Communication

Several communication systems already exist for emergencies.

Governments operate emergency-alert systems. Rescue organisations use specialised radio networks. Satellite phones can function where mobile infrastructure is unavailable. Humanitarian organisations also operate sophisticated disaster-response systems.

However, each approach has certain limitations.

Government Alert Systems

Government emergency systems are useful for sending warnings to large populations.

However, many systems depend upon mobile or communication infrastructure.

They are also mainly designed for **one-way communication**.

A government can warn residents that a cyclone is approaching, for example, but residents may still need ways to communicate with each other after the cyclone.

Satellite Phones

Satellite phones can operate independently of normal mobile towers.

However, they are relatively expensive and are generally used by emergency services, governments, journalists or specialised organisations.

It would not be practical to provide a satellite phone to every household.

Emergency Radios

Radio systems are extremely valuable during disaster response.

However, specialised radio equipment may require trained operators and may not be available to ordinary residents.

Humanitarian Organisations

Organisations such as national disaster agencies, the Red Cross and other NGOs play an important role.

However, in a major disaster, responders may require time to physically reach affected locations. Thread therefore focuses on a different problem.

It asks:

What can ordinary community members use to communicate with one another before conventional infrastructure or organised response systems become fully available?

The proposed answer is the smartphone that many people already own.

III. The Thread Concept

Thread is designed as an **offline community emergency network**.

The application would connect nearby phones using Bluetooth and Wi-Fi Direct rather than depending entirely upon internet access or mobile towers.

The system would operate as a **mesh network**.

In a normal mobile network:

Phone → Cell Tower → Network → Another Phone

In a mesh network:

Phone → Nearby Phone → Another Phone → Another Phone

Each participating device can potentially help carry information farther through the network.

Imagine four people standing at different points along a road.

Person A may be too far away to directly communicate with Person D.

However:

- Person A can reach Person B.
- Person B can reach Person C.
- Person C can reach Person D.

A message could therefore travel from A to B, B to C and finally C to D.

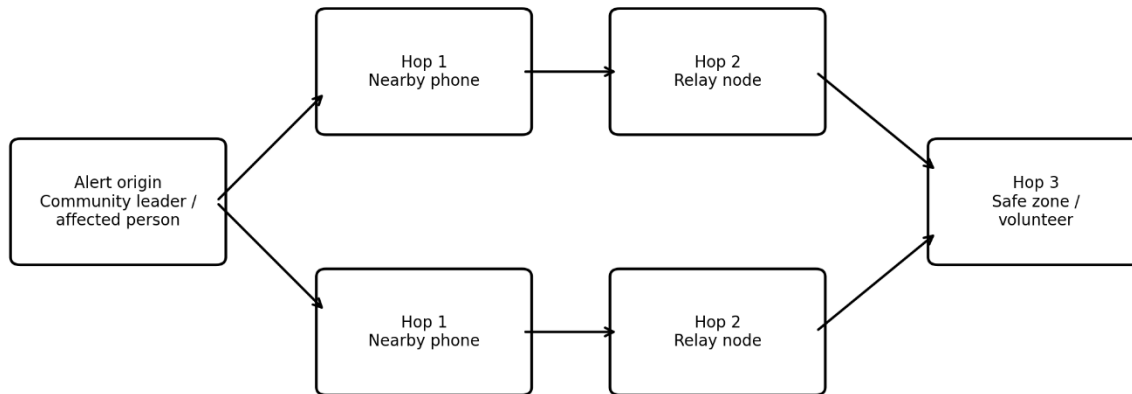
The original Thread model describes this as a **multi-hop relay system**, where devices act as communication points for one another.

The more participating phones located within an area, the stronger the potential network could become.

This creates an interesting reversal of traditional infrastructure.

Normally a community depends upon a communication network.

Under the Thread model, **the community itself becomes part of the network**.



Messages move phone-to-phone; each relay can extend the network beyond one device's direct range.

Figure 1. Simplified Peer-to-Peer Mesh Communication Model Used by Thread

IV. How Thread Would Work

The proposed system can be divided into three main stages.

Stage 1: Alert

An emergency alert could be started by an authorised community leader, an affected person or potentially an integrated emergency sensor.

The alert would then move between participating devices.

Instead of requiring an internet server to immediately distribute the message, nearby devices could pass the message onward.

Stage 2: Network Formation

Phones running Thread in the affected area could connect with other nearby participating phones.

As more devices join, the application could create a local communication network.

Users could potentially communicate their status, such as:

- Safe
- Help needed
- Medical emergency
- Supplies needed
- Supplies available

Stage 3: Community Coordination

Once communication is established, users could use the system to coordinate assistance.

For example:

A family requiring drinking water could post a request.

Another household located nearby might report that it has additional bottled water.

A volunteer could then help connect the two.

Similarly, someone requiring medical assistance could send an SOS message that nearby volunteers or responders could see.

The concept is therefore not intended only to send emergency warnings.

Its broader purpose is to allow **two-way community coordination during periods of infrastructure failure**.

V. Four Main Functions of Thread

The proposed application contains four major modules.

1. Alert Beacon

The Alert Beacon would allow emergency information to be shared across the local network.

Alerts could potentially be divided according to severity, such as:

- Watch
- Warning
- Emergency

The objective would be to allow residents to understand the seriousness of a situation quickly.

For example, during flooding, residents in a particular neighbourhood could receive information that water levels are rising or that a particular route should be avoided.

2. SOS Finder

SOS Finder would allow individuals requiring urgent help to send a distress signal.

Where available, the signal could include the person's last-known location.

Users could identify their situation through simple categories such as:

- Safe
- Help needed
- Critical

This simplicity is important.

During an emergency, people may be frightened, injured or operating a phone with limited battery power. They should not need to complete complicated forms.

A simple SOS system could help nearby volunteers identify who requires assistance.

3. Supply Share

Disasters can create temporary shortages of essential items.

At the same time, supplies may already exist within the local community.

One household might have extra drinking water.

Another might have medicine.

A restaurant or school may have food.

A nearby resident may need those exact resources.

Supply Share would attempt to connect available resources with nearby needs.

Possible categories could include:

- Water
- Food
- Medicine
- Baby supplies
- First-aid materials
- Temporary shelter

Instead of assuming every resource must immediately come from outside the community, the system encourages **local resource sharing during the initial emergency period**.

4. Recovery Hub

Communication remains important after the immediate danger has passed.

The Recovery Hub could therefore help communities share information about:

- Damaged roads.
- Functioning hospitals.
- Available shelters.
- Damaged buildings.
- Volunteer requirements.
- NGO support.
- Recovery activities.

The original proposal therefore sees Thread not only as an emergency-alert platform but as a tool supporting the movement from immediate response toward recovery.

VI. Technical Feasibility

The technologies behind mesh communication already exist. Previous research has also examined device-to-device smartphone communication for disaster response, including the use of Bluetooth, Wi-Fi and low-energy networks when normal communication infrastructure is unavailable (Han & Han, 2018; Hossain et al., 2020; Longo et al., 2025).

Bluetooth allows nearby electronic devices to communicate over short distances.

Bluetooth Low Energy, or BLE, has been designed partly to reduce energy consumption.

Wi-Fi Direct allows compatible devices to communicate directly without necessarily requiring a traditional Wi-Fi router.

However, building a reliable emergency system using these technologies would still involve major technical challenges.

Range

Bluetooth communication has limited range.

Thread therefore proposes using multiple devices as relay points.

A message could travel beyond the direct range of one phone by moving through several phones.

The effectiveness of this approach would depend strongly on **device density**.

A crowded urban neighbourhood may contain hundreds of phones close together.

A sparsely populated rural area may contain very few.

Consequently, Thread may work differently depending on geography and population density.

Battery Consumption

Battery life becomes extremely important during disasters because electricity may be unavailable.

If an application continuously searches for nearby devices, it could consume battery power.

The Thread concept therefore proposes low-power background scanning and stronger network activity only when required.

This would need to be tested on different phone models under realistic conditions.

Network Size

A small network involving ten phones is very different from one involving hundreds or thousands.

As the number of users increases, the system must prevent unnecessary duplication of messages and network congestion.

The proposal suggests dividing larger communities into smaller clusters with selected relay devices.

However, this is one of the areas where real-world trials would be essential.

Device Compatibility

Different smartphones use different operating systems and hardware.

An emergency communication platform must therefore consider:

- Android compatibility.
- iOS compatibility.
- Older smartphones.
- Low-cost smartphones.
- Different Bluetooth versions.
- Different battery capacities.

Technical compatibility cannot simply be assumed.

It requires repeated testing.

VII. Why Mauritius Could Be a Useful Pilot Market

The Thread proposal identifies **Mauritius** as an initial target market.

There are several reasons for this.

Mauritius is exposed to natural hazards including tropical cyclones and flooding.

At the same time, it has relatively high smartphone usage and an organised national disaster-management structure.

This combination makes it useful for testing the concept.

Thread could potentially be introduced through community disaster-preparedness programmes before an actual emergency occurs.

This is important because users should ideally install and understand the application **before a disaster happens**.

Trying to convince thousands of people to download a new application after communication infrastructure has already failed would be extremely difficult.

A pilot programme could therefore involve:

1. Selecting a community.
2. Encouraging residents and volunteers to install Thread.

3. Conducting simulated emergency drills.
4. Testing message delivery.
5. Measuring battery use.
6. Testing the network at different population densities.
7. Collecting user feedback.
8. Identifying technical failures.
9. Improving the application.
10. Repeating the test.

The presentation proposes partnerships with disaster-management organisations and community-response teams as part of this process.

This type of gradual testing would be far more useful than attempting immediate large-scale international expansion.

VIII. Other Potential Markets

If the concept were successfully tested, Thread could potentially be relevant in several disaster-prone regions.

The presentation identifies three additional markets.

Philippines

The Philippines experiences frequent typhoons and contains thousands of islands.

Disasters can affect communication and transportation across geographically separated communities.

An offline community network could therefore have possible applications.

Indonesia

Indonesia faces earthquakes, volcanic activity, floods and other natural hazards.

Its large population also creates opportunities and challenges for community-scale disaster technology.

Haiti and the Caribbean

Haiti and several Caribbean countries face hurricane and earthquake risks.

Communication infrastructure may also be vulnerable in some areas.

The presence of international and local humanitarian organisations could create opportunities for partnerships.

However, expansion into each country would require independent research.

A solution that works in Mauritius may not automatically work in Indonesia or Haiti.

Languages, phone ownership, government systems, geography, disaster types and community behaviour vary significantly.

Thread would therefore need a **localisation strategy** rather than simply copying one model across every country.

Market	Risk context in deck	Why Thread may be relevant
Mauritius	Tropical cyclones and floods	\$110M average losses; NDRRMC; smartphone penetration >85%
Philippines	Frequent typhoons; island geography	7,000+ islands; smartphone penetration >85%
Indonesia	Earthquakes and volcanic hazards	270M population
Haiti & Caribbean	Hurricane corridor	Limited existing infrastructure; humanitarian organisation presence

Table 1. Proposed Target Markets for Thread

IX. Business Model

One of the central decisions behind Thread is that the basic application should remain **free for community users**.

Charging individual users could reduce adoption, particularly in vulnerable communities.

However, software development, security testing, field deployment and technical maintenance all require funding.

The proposed business model therefore places the financial responsibility mainly on institutions rather than individual residents.

Three possible revenue sources are identified.

Business-to-Government Licensing

Government disaster-management agencies could pay annual licensing or service fees for additional tools such as:

- Emergency dashboards.
- Community monitoring.
- Deployment tools.
- Analytics.
- Training systems.
- Disaster-drill support.

The community application could remain free while institutions pay for management services.

NGO Partnerships

Humanitarian organisations could use Thread as a coordination tool.

Possible partners could include national Red Cross organisations, international humanitarian networks and local NGOs.

Institutional versions could include features designed specifically for field teams.

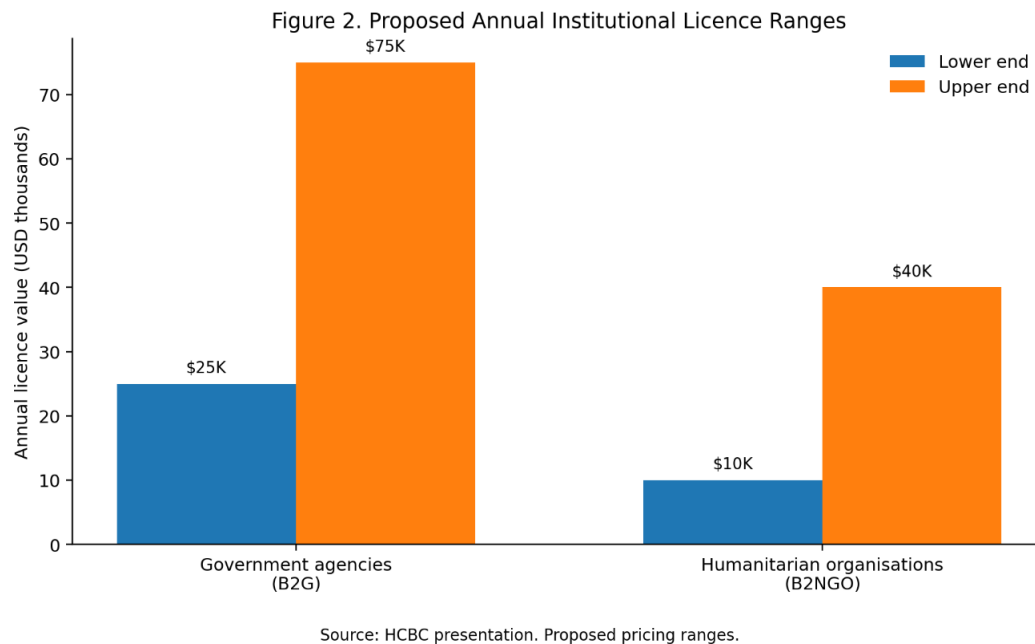


Figure 2. Proposed Annual Institutional Licensing Model for Thread

Grants and Impact Funding

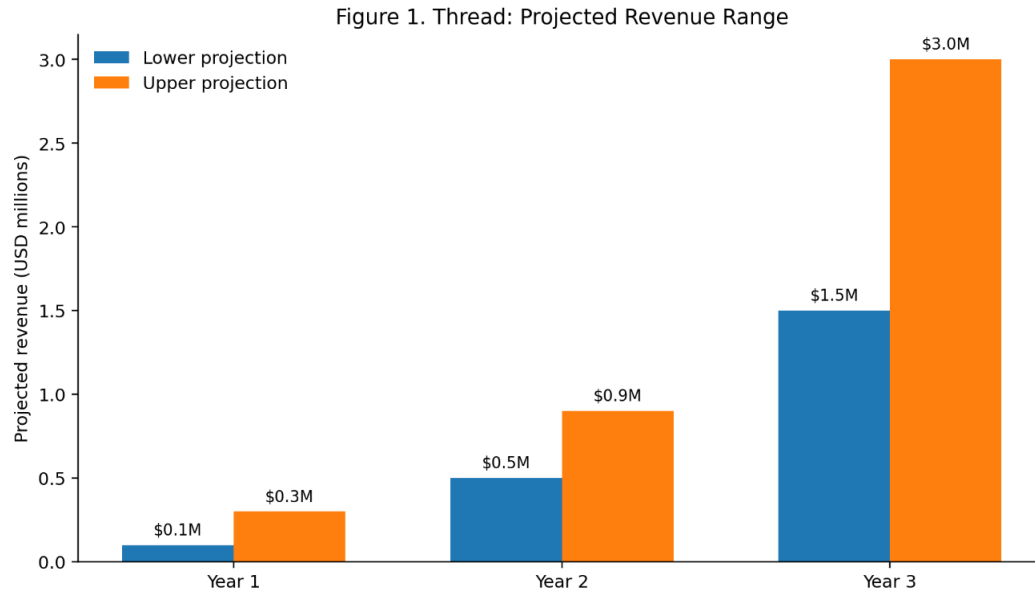
Because disaster resilience is connected to climate adaptation and humanitarian development, Thread could potentially apply for grants or social-impact funding.

This could be particularly useful during early development when commercial revenue remains limited.

The deck proposes annual institutional licensing while keeping the service free for vulnerable users.

For a social-impact technology company, this approach has an important advantage:

The people who need the service most would not necessarily be the people paying for it.



Source: HCBC presentation. Figures are projections, not actual revenue.

Figure 3. Projected Revenue Range for Thread During the First Three Years

X. The Challenge of User Adoption

One of Thread's biggest challenges may not be technology.

It may be adoption.

A mesh network becomes useful only when enough people are using it.

If only three people in a large neighbourhood have Thread installed, the network may provide little benefit.

This creates what is known as a **network effect**.

Every additional user can potentially increase the usefulness of the system.

However, this also produces a difficult starting problem:

Why would people download a disaster application when there is currently no disaster?

Thread's proposed strategy therefore focuses on pre-disaster adoption.

Possible approaches include:

- Including Thread in community disaster drills.
- Working with schools.
- Partnering with local governments.
- Training community leaders.
- Including emergency checklists in the application.

- Providing family emergency-planning tools.
- Working with community centres.
- Encouraging households to invite neighbours.

The presentation suggests that Thread should remain largely invisible during normal life but stay available when an emergency occurs.

This strategy is important because disaster technology has to be prepared **before it is needed**.

XI. Privacy and Trust

Any emergency application handling personal information must take privacy seriously.

Users might share:

- Their location.
- Medical needs.
- Whether they are safe.
- Whether their home is occupied.
- What supplies they possess.
- Information about family members.

In normal circumstances this information is sensitive.

During a disaster it can become even more sensitive.

Thread therefore proposes keeping communication primarily on devices rather than relying completely upon central servers.

The concept also proposes encryption and a privacy-focused system.

However, several questions would need careful research.

For example:

- Who is allowed to issue emergency alerts?
- How can false alerts be prevented?
- Can someone pretend to be a rescue worker?
- How long should location information remain visible?
- Should medical information automatically disappear after an emergency?
- How can misinformation be controlled?
- What happens if a user's phone is stolen?

Trust would therefore be just as important as technology.

XII. Competition and Differentiation

Thread would not be the first project to explore direct device-to-device communication. Previous academic research has examined how smartphones can communicate with one another during disasters when normal cellular or internet infrastructure is unavailable.

Studies by **Han and Han (2018)**, **Hossain et al. (2020)**, and **Longo et al. (2025)** have explored the use of device-to-device communication, Bluetooth, Wi-Fi and low-energy networks for disaster and post-disaster situations. These studies provide stronger evidence that smartphones could potentially support decentralised communication when conventional networks are disrupted.

Applications such as **Briar** also demonstrate that peer-to-peer communication between nearby devices is technically possible. However, Thread's proposed differentiation is its specific focus on **community-level disaster response and coordination**, rather than general messaging. Instead of being mainly a communication application, Thread proposes tools designed around emergency needs:

- Emergency alerts
- SOS requests
- Resource and supply sharing
- Volunteer coordination
- Recovery information

The central question is therefore not simply:

Can smartphones communicate without conventional internet access?

A more important question is:

Can this technology be organised into a simple and reliable system that ordinary communities can actually use during a disaster?

That is what future pilot testing would need to establish.

XIII. Important Challenges and Limitations

Although the concept offers potential, several limitations must be recognised.

1. Technology Must Be Tested

Theoretical communication range does not guarantee reliable real-world performance.

Walls, buildings, weather conditions, device types and network congestion could affect performance.

2. User Density Matters

Mesh networks generally become more useful when enough devices are located close together. This could make performance significantly different between dense cities and rural areas.

3. Battery Life Is Critical

Users may need their phones for several days without reliable electricity. Even relatively low battery consumption may become important.

4. People Must Install the Application Beforehand

A disaster application has limited value if nobody has installed it before the communication network fails.

This makes government and community partnerships essential.

5. Emergency Information Must Be Reliable

False warnings or incorrect information could create panic. Strong verification systems would therefore be required.

6. Accessibility

The application should work for different groups, including:

- Older people.
- People with disabilities.
- Users with limited digital literacy.
- Users speaking different languages.
- People using low-cost devices.

7. Government Approval

Emergency communication can involve regulatory and security concerns.

Thread would therefore need to work with authorities rather than positioning itself as a replacement for official disaster-response systems.

These limitations do not necessarily mean the concept cannot work.

Instead, they identify what needs to be tested before claiming large-scale effectiveness.

XIV. Future Development

The Thread concept includes several possible future developments.

Artificial Intelligence

Future versions could potentially use on-device artificial intelligence to help sort emergency requests.

For example, requests involving severe injuries could be prioritised above less urgent requests.

However, any automated emergency classification system would require careful testing because incorrect decisions could have serious consequences.

Sensor Integration

The network could eventually connect to:

- Flood sensors.
- Weather stations.
- Seismic sensors.
- Community warning systems.

An automatic alert could then move through the local mesh network.

Multilingual Communication

Natural disasters often affect communities speaking different languages.

Offline translation could therefore help residents, volunteers and international responders communicate more effectively.

Preparedness Tools

Thread could become useful even when there is no active disaster.

Features could include:

- Emergency checklists.
- Family emergency plans.
- Shelter locations.
- Disaster drills.
- Emergency contacts.
- Preparedness education.

This could help solve the user-adoption problem by giving people reasons to keep the application installed.

The longer-term vision in the presentation includes expansion through the Indian Ocean region, Southeast Asia and the Caribbean.

DISCUSSION

Thread represents an interesting example of how entrepreneurship can begin with a social problem rather than simply a commercial opportunity.

The problem is not that smartphones disappear during disasters.

The problem is that smartphones normally depend upon central infrastructure.

Thread attempts to reconsider that relationship.

Instead of asking how quickly a damaged tower can be restored, it asks whether communication can temporarily continue **without the tower**.

This is an example of designing around a system's weakest point.

At the same time, the project demonstrates an important lesson about innovation.

Having an interesting idea is not enough.

A disaster technology company must prove that its product works under difficult conditions.

The most important next stage for Thread would therefore not simply be adding more features.

It would be **testing the basic idea**.

A useful pilot could measure:

- Percentage of messages successfully delivered.
- Average delivery time.
- Maximum useful distance.
- Number of participating devices.
- Battery consumption.
- Performance inside buildings.
- Performance outdoors.
- Performance when some phones leave the network.
- Ease of use.
- Number of false or duplicate messages.
- User understanding during simulated emergencies.

These results would allow the concept to move from a business proposal toward an evidence-based disaster-response solution.

A successful pilot could also help governments and humanitarian organisations decide whether technology provides practical value.

CONCLUSION

Natural disasters demonstrate how dependent modern society has become on communication infrastructure.

When mobile towers or internet services fail, communities can become isolated at exactly the moment communication becomes most important.

Thread proposes a different approach.

Instead of depending completely upon external infrastructure, it attempts to turn nearby smartphones into a temporary local communication network.

Through emergency alerts, SOS messages, supply sharing and recovery coordination, Thread aims to help communities communicate during the period between the beginning of a disaster and the arrival or restoration of formal response systems.

The concept also proposes a social-enterprise model in which the service remains free for ordinary users while governments, humanitarian organisations and impact funders support the system.

However, Thread is still a concept that requires practical validation.

Technical performance, battery consumption, device compatibility, privacy, user adoption and government integration all need to be examined through controlled pilots and real-world disaster drills.

The value of the idea therefore lies not in claiming that it has already solved disaster communication, but in asking an important question:

If millions of people already carry communication devices in their pockets, can those devices help communities remain connected even when the normal network disappears?

Thread proposes that they can.

The next step is to test how effectively that idea can work in the real world.

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About the Author

Aadhya Mohan is a student researcher and aspiring entrepreneur with an interest in using technology to solve social and community-based problems. She is the founder and creator of the concept **Thread**, an offline emergency communication platform designed to help communities remain connected when conventional mobile and internet networks are disrupted during disasters.

She developed Thread as part of her HCBC project, exploring the intersection of **technology, disaster preparedness, community resilience and social entrepreneurship**. Through this case study, Aadhy examines not only the potential of smartphone-based mesh communication but also the practical challenges involved in turning an idea into a scalable social-impact solution. Her work reflects an interest in understanding how existing technologies can be redesigned and applied to real-world problems, particularly in communities where access to infrastructure may become limited during emergencies.