



## Post-Disaster Resilient Communication through Infrastructure-Free Networks

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**Abstract.** Traditional communication systems are often disrupted during disasters, leaving communities disconnected and interrupting the exchange of essential information. In these circumstances, a reliable communication approach is critical for coordinating relief and recovery activities. This work presents a Resilient Communication Model (RCM), an infrastructure-free solution designed to enhance post-disaster communication. The model relies on dynamic, self-organizing links between nearby devices, allowing victims and rescuers to communicate effectively. Due to its lightweight and flexible design, the system is particularly well-suited for basic devices, which are more likely to remain functional in crisis conditions. Simulation studies and comparative evaluations with other algorithms demonstrate that the model minimizes packet loss ratios (PLR), delay, and enhances communication stability, packet delivery ratio (PDR) and throughput during network disruptions. Practical experiments across diverse scenarios further confirm the model's feasibility and resilience. Overall, the findings demonstrate that the model can reliably function as a fallback communication system when standard networks are unavailable.

**Keywords:** *PLR; post-disaster communication; RCM; resilience; victim.*

### 1 Introduction

Natural and artificial disasters such as earthquakes, floods, hurricanes, and terrorist attacks frequently cause widespread damage to communication infrastructure, disconnecting impacted populations and impairing emergency services. In such critical moments, a dependable communication system is essential for coordinating rescue efforts, distributing information, and ultimately saving lives [1]. Traditional communication technologies, such as cellular networks and Internet services, are frequently rendered inoperable during catastrophes due to infrastructure damage, power outages, or network congestion [2]. As a result, affected populations are often left without access to critical information, and rescuers encounter substantial obstacles in coordinating rescue and relief activities. This communication gap can cause longer response times, ineffective resource allocation, and increased risk to human life [3, 4].

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Consequently, there is an urgent need for robust, infrastructure-independent communication systems that continue to exchange messages under extreme conditions [5]. Infrastructure-free models, such as mobile ad hoc networks (MANETs) and device-to-device (D2D) communication frameworks, have emerged as possible options to bridge this gap and improve catastrophe resilience [6].

This article describes an infrastructure-less communication model that takes advantage of these devices' widespread availability (low-end handheld communication devices like laptops, mobile phones, etc.) to set up a robust communication network that can safely and effectively transmit text data.

In the aftermath of a disaster, effective communication is vital for coordinating relief operations, giving critical information to impacted populations, and maintaining individual safety and well-being. RCM is an infrastructure-less communication model that is applicable in disaster-prone situations and helps improve communication resilience. In a communication model, resilience refers to the system's ability to maintain or quickly restore communication services in the face of disruptions. Even in challenging circumstances, a resilient communication model can reroute data, adjust dynamically, and provide minimal service continuity and dependability. The following is a summary of this research work's main contributions:

1. A resilient post-disaster communication model is proposed to ensure reliable information exchange when conventional communication infrastructure becomes unavailable or intermittent.
2. The proposed RCM introduces a neighbor-driven communication paradigm for post-disaster contexts. The RCM eliminates persistent route maintenance and instead establishes communication dynamically based on real-time neighbor availability, in contrast to conventional MANET protocols like AODV, DSDV, and OLSR, which rely on route discovery, routing tables, or periodic control updates.
3. Furthermore, the proposed model is specifically optimized for infrastructure-less and resource-constrained environments, enabling deployment on low-end devices such as ESP8266 modules, which makes the system practically viable in real-world disaster situations where high-performance infrastructure is unavailable.
4. In addition, the suggested approach unifies decentralized rescuer coordination, adaptive message distribution, and dynamic neighbor detection into a single integrated framework, ensuring continuous and resilient communication under highly dynamic and disrupted network conditions.
5. Simulation and real-world testing with ESP8266 devices were used to validate the model.

6. The suggested approach differs from current alternatives due to its minimal implementation costs and practical validation.

Simulation and a comparative analysis with existing algorithms evaluate this model's effectiveness. PLR, delay, PDR and throughput are simulation parameters to evaluate the model's efficacy. The proposed RCM was also implemented in different real-life scenarios to test its feasibility and validate its practical feasibility, adaptability, and performance under infrastructure-less conditions.

## 2 Related Work

Bangladesh's geographic location makes it particularly vulnerable to natural disasters. Recent catastrophic events have underscored the country's susceptibility to severe weather and climate-related risks. In May 2024, cyclone Remal struck the southern coastal districts with wind gusts exceeding 120 km/h, forcing over 800,000 people to evacuate and causing extensive damage to homes and infrastructure [7]. Subsequently, in June 2024, monsoon-caused flash floods and landslides struck the Sylhet and Cox's Bazar districts, with over 773 landslides documented in refugee camps alone, killing at least ten people and uprooting thousands more [8]. Additional flash floods in eastern Bangladesh in August 2024, made worse by upstream dam releases and intense rains, affected over 5.8 million people, displaced over 500,000, and killed 71 people nationwide [9]. In addition to highlighting the nation's geographic and climatic difficulties, these recurring disasters highlight the urgent need for robust, infrastructure-less communication models to ensure coordination and information flow in times of crisis. Low-end gadgets like walkie-talkies, solar radios, and manual chargers have shown remarkable resilience and adaptability in these conditions. Researchers underlined how important it is to include these devices in emergency response plans [10].

According to Mohan, *et al.* [11], low-end devices can support high-end ones, creating a more robust and decentralized emergency communication network. Much research has focused on aerial communication platforms as alternatives to terrestrial networks in emergencies. Okada, *et al.* [12] offer a thorough analysis of aerial wireless relay networks, including systems based on balloons and UAVs, designed to support emergency communication during large-scale disasters. The authors provide an optimization framework in which UAVs dynamically modify their positions to service IoT devices on the ground. This lowers the transmission power needed from these devices and prolongs their battery life [13]. In all stages of disaster management—prevention, response, recovery, and mitigation—the authors emphasize the value of prompt information sharing, coordinated response systems, and locally flexible tactics [14]. Digital platforms are becoming more

and more important in disaster response plans in addition to physical infrastructure. Wendling, *et al.* [15] examined how social media might be used to communicate risks and crises, highlighting the advantages of real-time information sharing and public participation in times of crises. Ahmed, *et al.* [16] introduced radios with distributed sensor networks and Internet of Things capabilities, emphasizing automated notifications and real-time disaster monitoring. In order to improve rescue coordination among individuals without a centralized infrastructure, Kim, *et al.* [17] investigated smartphone applications with mesh networking capabilities.

**Table 1** Comparison of communication models for emergency response.

Ref.	Network Paradigm	Communication Tech.	Device Type	Main Focus
Sood, <i>et al.</i> [10]	Hybrid	Radios and walkie-talkies	Low- & High-end	Emergency response
Mohan, <i>et al.</i> [11]	Decentralized Hybrid	Walkie-talkies, solar-powered radios	Low & High-end	Improving emergency
Okada, <i>et al.</i> [12]	Broadcast communication	Solar-powered radios	Low-end	Early warning response
Damon P. Coppola [14]	Community-based	Community mechanism	Low- & high-end	Disaster management
Wendling [15]	Community-driven	Radio frequencies	Low-end	Emergency preparedness and communication
Lee, <i>et al.</i> [16]	Distributed sensor network	IoT-enabled radios	High-end	Real-time alerts
Kim, <i>et al.</i> [17]	Peer-to-peer	Smartphone apps	Low-end	Rescue coordination
Proposed model	Hybrid	Radio frequencies	Low-end	Emergency response

A comparative analysis of several communication models in post-disaster scenarios is shown in Table 1. Important factors such network paradigm, used communication technology, infrastructure dependence are assessed in this comparison. The table also highlights the strengths and limitations of each approach in addressing the unique challenges posed by disaster environments. In addition, when data dissemination is required in an emergency, most communication models use high-end (made with high-end components, cutting-edge technologies, and exceptional performance to meet the needs of demanding users) and low-end (designed with the bare minimum of features to appeal to users who are budget-conscious and want basic functionality) devices to establish these kinds of communications.

### 3 Working Methodology

An RCM, an infrastructure-less communication model, is proposed to facilitate efficient communication among victims and rescuers in post-disaster situations [18]. This study evaluates the efficacy of the RCM. This model employs decentralized communication mechanisms, which can lead to unpredictable connection establishment and disconnection due to the dynamic nature of node mobility, variable signal strength, and the lack of centralized control. The frequent joining and leaving of nodes result in constant changes to the network topology, making it challenging to maintain stable communication paths. As a result, route discovery often needs to be repeated and existing routes may break unexpectedly. Therefore, routing protocols in ad hoc networks must be robust, adaptive, and able to handle real-time changes to ensure reliable data transmission. The establishment and disconnection of links between nodes can be effectively represented using graph theory. In this framework, a network is described as a graph  $G(V, E)$ , where  $V$  is the set of nodes (vertices) and  $E$  is the set of direct communication links (edges) between them. Here,  $(u, v)$  is a specific edge between two nodes (or vertices)  $u$  and  $v$ ;  $\{(u, v)\}$  is the set containing only that single edge;  $\setminus$  is the set subtraction or removal; and  $E'$  is the set of edges after the removal. Connection establishment in ad hoc networks involves creating a communication path between nodes that can join or leave the network dynamically, without depending on fixed infrastructure like routers or access points. A connection between two nodes is established when they can communicate directly. This ability to communicate is typically influenced by factors such as transmission range and the presence of any obstructions.

$$u, v \in V \quad (1)$$

where  $V$  means the set of nodes. Mathematically, this is represented by adding an edge  $(u, v)$  to the set  $E$ , where  $E'$  denotes the updated set of edges after the connection is established.

$$E' = E \cup \{(u, v)\} \quad (2)$$

Conversely, a disconnection according to Equation 3, occurs when an existing link between two nodes is removed, which is often caused by node mobility (e.g., moving out of range), possibly due to mobility, interference, or poor signal quality.

$$E' = E \setminus \{(u, v)\} \quad (3)$$

#### 3.1 Resilient Communication Model (RCM)

The proposed RCM was designed to operate effectively in post-disaster scenarios where network infrastructure is damaged and connections between nodes are either interrupted or highly sporadic. In these situations, maintaining consistent

communication is challenging due to frequent disconnections, the movement of nodes, and variability in link availability. The goal of RCMs is to ensure reliable data delivery and routing by dynamically adapting to these disruptions, thereby providing a resilient communication framework that does not rely on traditional infrastructure. The proposed RCM is divided into three phases: Neighbor Discovery, Dissemination of Urgent Messages, and Intercommunication among Rescuers. A few variables are used to initialize the algorithm,  $Z$  = number of clients,  $M_e$  = emergency message,  $S$  = server,  $M_d$  = connection details,  $E_i$  = connection establishment,  $S_r$  = rescuer server,  $R_i$  = rescuer, and  $R_o$  = other rescuers.

### 3.1.1 Neighbor Discovery

The suggested algorithm starts with neighbor discovery. Because it allows nodes to interact effectively and consistently, neighbor discovery is essential for data distribution, particularly in ad hoc networks. Knowing which devices are within communication range is necessary for data transmission. The foundation of the network is formed via neighbor discovery, which assists each node in identifying its close neighbors. Each device in the vicinity receives the details of the broadcast connection requirement,  $M_d$ . This connection information is essential for victims to be connected to the proposed communications system. Without this information, victims would be unable to establish a connection and disseminate the emergency required assistant messages to rescuers. Without accurate and timely connection details, nodes in such type of networks would struggle to encounter neighbors, construct a communication path, or ensure communication. According to Eq. (4),  $V$  is the set of all nearby communication devices carried by victims. After receiving the broadcast message  $M_d$ , nodes get connected with the proposed communication system. Identifying an encountered neighbor ( $N_c$ ) involves detecting a node that has recently entered the communication range, even if the connection is transient or intermittent. Eq. (5) defines the set of clients that establish a connection with the system by obtaining  $M_d$ .

$$V = \{v_1, v_2, \dots, v_n\} \quad (4)$$

$$N_c = v_i \in V: v_i \text{ satisfies } M_d \quad (5)$$

If  $|N_c| > 0$ , the node has successfully discovered nearby devices within its communication range. In this case, the node can proceed to establish communication and allowing data transmission. That means the system proceeds to communication setup  $C_s$ . If no neighbors are found, the node cannot initiate communication, because there are no reachable nodes nearby. In this case, the node retries neighbor discovery.

$$C_s = \begin{cases} 1, & \text{if } |N_c| > 0 \\ 0, & \text{if } |N_c| = 0 \end{cases} \quad (6)$$

Communication links  $E_i$  are formed between the node and each member of  $N_c$ . The  $M_d$  encountered nodes can directly be connected with the system. No pre-defined setup or configuration is needed to connect with the system. Once the connection is established, victims will be able to send emergency assistance messages to rescuers.

### 3.1.2 Dissemination of urgent messages

If  $E_i = \text{TRUE}$ , the node is ready to transmit data. Once the connection has been established, the nodes are ready to transmit the data. The main purpose of this proposed communication system is to establish a connection and transmit emergency help assistance messages (like rescue requests, medical assistance, etc.) from victims to rescuers. The emergency message  $M_e$  is forwarded to the server,  $S$ , when a victim connected to the system using the procedures discussed above. Immediately, the connected victims disseminate  $M_e$  to  $S$ . According to the system,  $S$  acts as a relay, collecting messages from victims and routing them to rescuers. Eq. (7) represents the way of this transmission:

$$V \xrightarrow{M_e} S \quad (7)$$

The set of rescuers, denoted by  $\mathbb{R}$ , can be defined using the following equation; this representation allows us to formally identify all individuals assigned to perform rescue operations within the system:

$$\mathbb{R} = \{ R_i, \dots, R_o \} \quad (8)$$

Simultaneously, the message is forwarded to the rescuers to ensure a swift response. This communication minimizes delays and enables rescuers to prepare or mobilize immediately. Such synchronization is crucial for effective coordination during emergency situations. Eq. (9) represents this propagation of collected messages  $M_e$  to rescuers  $\mathbb{R}$ .

$$V R_i \in \mathbb{R}: S \xrightarrow{M_e} \mathbb{R} \quad (9)$$

### 3.1.3 Intercommunication among rescuers

According to the RCM, each node periodically reevaluates who is nearby. This helps in dynamically adjusting communication links, node mobility, and adapting to changing connectivity. Rescuers  $R_i$  and other rescuers  $R_o$  exchange messages about the rescued victims and other related information, such as their medical condition, identity, etc. The exchange of messages among rescuers  $R_i \leftrightarrow R_o$  is essential for the success of any rescue operation. Clear communication ensures

the safety of both victims and rescuers by sharing critical information about hazards or changes in the environment. It also helps avoid duplication of efforts by preventing multiple teams from attending to the same victim unnecessarily, thereby saving valuable time and energy. Furthermore, exchanging messages allows rescuers to prioritize victims based on the urgency of their needs, ensuring that those requiring immediate medical attention receive it promptly.

Algorithm: RCM

Initialization:  $N_c$  represents the number of clients,  $M_e$  denotes the emergency message,  $S$  refers to the server,  $M_d$  indicates the connection details,  $E_i$  stands for connection establishment,  $S_r$  represents the rescuer server,  $R_i$  denotes the rescuers, and  $R_o$  refers to other rescuers.

Step 1: Neighbor Discovery

Broadcast connection request  $M_d$   
 Identify available clients  $N_c$  satisfies  $M_d$   
 If ( $N_c > 0$ ) then  
   Establish connection  $E_i \rightarrow N_c$   
    $N_c = N_c + 1$   
 Else  
   Repeat Step 1

Step 2: Disseminate urgent messages

Set  $E_i \rightarrow \text{True}$   
 Forward emergency message  $M_e \rightarrow S$   
 Propagate  $M_e$ , from  $S \rightarrow S_r$

Step 3: Intercommunication among rescuers

Repeat Step 1  
 Exchange messages between rescuers,  $R_i \leftrightarrow R_o$

Algorithm 1 describes the communication procedure for the entire proposed system. This method is separated into three phases: (i) Neighbor Discovery, (ii) Disseminate Urgent Messages and (iii) Rescuer Intercommunication. To find neighboring nodes, the system broadcasts connection data ( $M_d$ ) during the Neighbor Discovery phase. Active clients ( $N_c$ ) are nodes that meet the necessary connection requirements. The system repeats the discovery procedure until at least one neighboring node is found, i.e., if  $N_c > 0$ , in which case a connection establishing process ( $E_i$ ) is started. Once a link is made ( $E_i = \text{true}$ ), the system permits communication and the sending of emergency messages ( $M_e$ ) during the Emergency Message Dissemination phase. To guarantee prompt delivery to responders, these messages are sent to the server ( $S$ ), which serves as a relay and spreads the information to the rescuer server ( $S_r$ ).

Through recurrent neighbor discovery, the system updates the list of active nodes continually during the Rescuer Intercommunication phase. In order to efficiently coordinate rescue operations, rescuers share information ( $R_i \leftrightarrow R_o$ ), such as victim status and situational updates.

In summary, the proposed method dynamically adapts to network variations and ensures reliable communication in highly dynamic, infrastructure-less post-disaster environments.

#### 4 Result

This section presents and analyzes the results obtained from a simulation and experimental evaluation of the proposed RCM. The performance of the RCM was assessed based on key network parameters, including PLR, delay, PDR, and throughput. This simulation was conducted using ns-3 [18]. The output of the suggested communication model's routing strategy was compared to that of three other separate algorithms, respectively AODV [20], DSDV [21] and OLSR [22].

The ratio of data packets lost during transmission to the total number of packets transmitted by the source is known as PLR and is represented by a percentage. The overall time it takes for a data packet to get from a network's source node to its destination node is known as the delay (also known as end-to-end delay). A crucial performance indicator used in wireless networks to assess the dependability and effectiveness of data transfer is the packet delivery ratio, or PDR. Its definition is the proportion of data packets that are successfully received to all packets sent by the source. The actual amount of data that is successfully delivered over the network is reflected in throughput.

**Table 2** Comparative analysis of algorithms for establishing communication.

Algorithm	Strategies	Mobility
AODV	Routes are discovered. Handles high mobility on demand basis. RREQ and RREP are used to discover routes. Routes are maintained in a dynamic manner.	Handles high mobility
DSDV	Route is discovered. Struggles with high mobility in a periodic manner. Periodic updates are provided for route maintenance.	Struggles with high mobility
OLSR	Route is discovered. Handles moderate mobility in a periodic manner with mobility MPR optimization. Constant updates with MPR are provided on route maintenance.	Handles moderate mobility
RCM	Two different approaches, V2R and R2R, make up this communication approach that work dynamically.	Handles high mobility

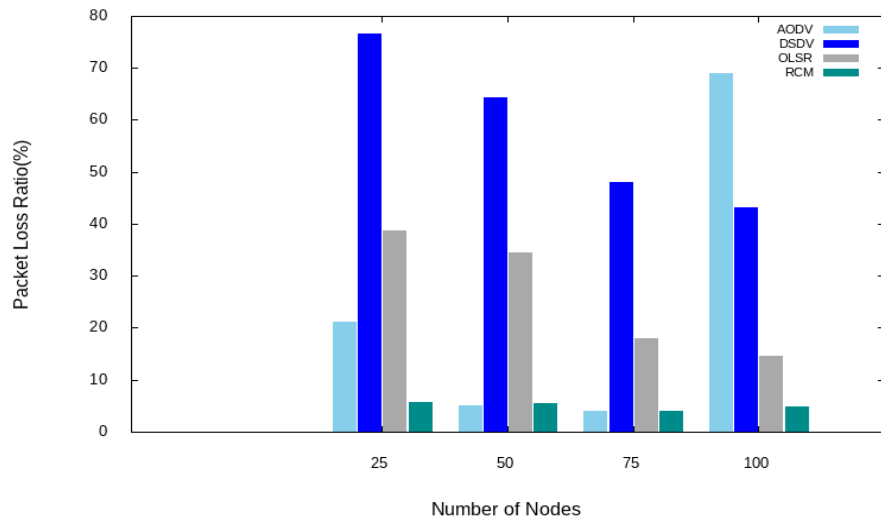
The effectiveness of data delivery was examined by comparing the bit rates of transmission and reception. Delay should be kept low while PDR and throughput should be kept high for optimal network performance.

**Table 3** Simulation configuration for performance evaluation.

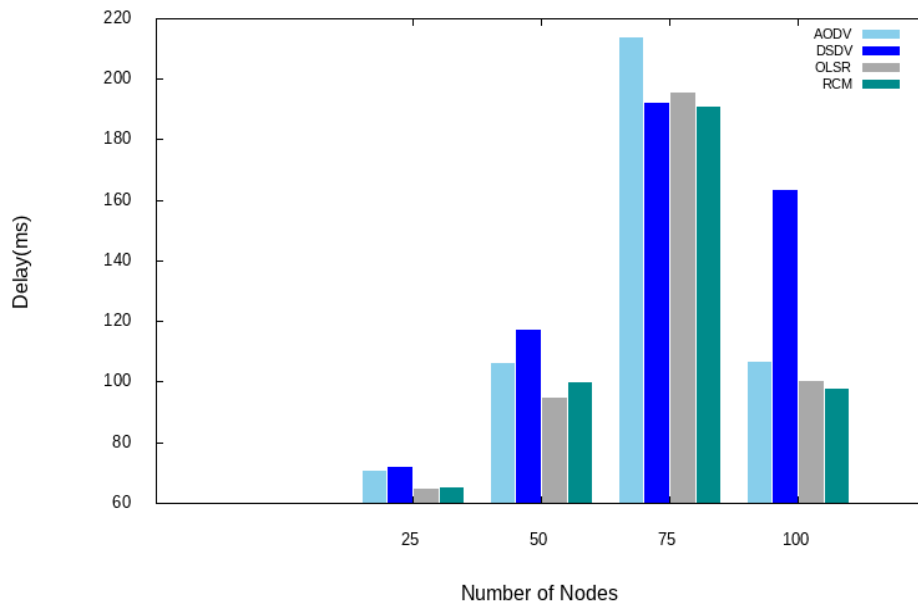
Parameters	Values
Algorithms	AODV, DSDV, OLSR, RCM
Mobility Models	Random waypoint
Node Speed	20 m/s
Pause Time	0s
Number of Nodes	1-10
Maximum Packets	100
Packet Size	2048 bytes
Interval	5s
Position allocator & Random rectangle	X [-50, 50] Y [-50, 50]
Traffic Type	UDP (connectionless communication)
Application Traffic	Constant bit rate (CBR)
Simulation Time	200s

For designing the simulation environment scenarios were considered with respectively 25, 50, 75, and 100 nodes. Table 3 represents the details of the simulation configuration for the performance evaluation. Each simulation scenario was run five times under various situations to guarantee dependability, and the average of the outcomes was taken into account. Because our previous study showed that the Random Waypoint mobility model performs better than other mobility models under comparable post-disaster network conditions, it was used in this simulation setting [23].

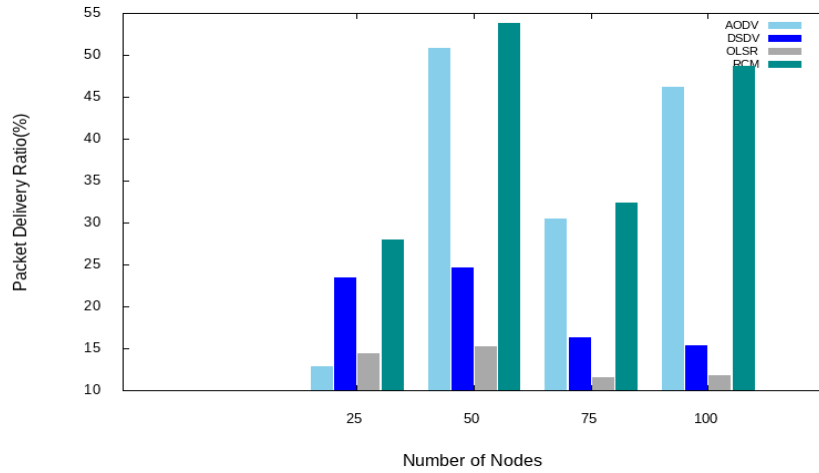
Figure 1 provides a comparison, focusing on the PLR. The proposed RCM shows a lower PLR, indicating a superior performance level, and suggests that it can effectively manage high levels of node mobility. While AODV manages to maintain a lower overall PLR compared to OLSR and DSDV, it experiences a sharp increase in PLR when the network reaches 100 nodes. This increase can be attributed to rising node collisions and network congestion. As the number of nodes increases, the routing protocol may find it difficult to maintain accurate routes, particularly in high mobility scenarios, which can result in a higher rate of dropped packets. Overall, the analysis indicates that DSDV is the least effective routing strategy, as it struggles to manage node mobility in such dynamic environments.



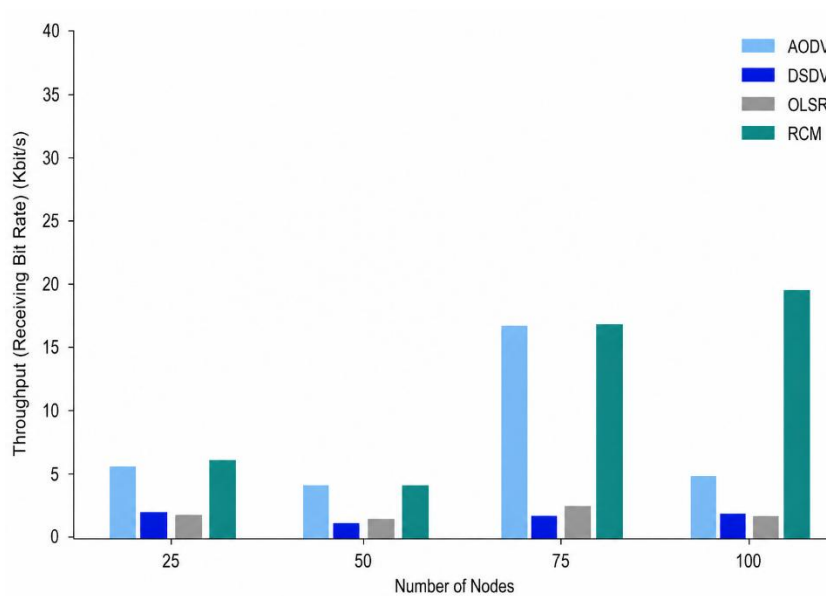
**Figure 1** Comparison based on PLR.



**Figure 2** Comparison based on delay.



**Figure 3** Comparison based on PDR.



**Figure 4** Throughput comparison based on receiving bit rate.

A comparison of the methods based on delay is shown in Figure 2. Among all the algorithms tested, the RCM consistently demonstrated the best performance, offering the lowest delay in every scenario. In contrast, both AODV and OLSR tended to cause significant delays. The inherent characteristics of these two

algorithms inhibit their effectiveness in the various simulated conditions. According to the simulation results, DSDV performs the worst. This is attributed to the highly dynamic environment characterized by nodes with high mobility, which poses particular challenges for DSDV in maintaining efficiency.

The performance of various methods compared with the suggested approach for the packet delivery ratio (PDR) parameter is shown in Figure 3. Across all node densities, the RCM continuously maintained a high PDR, reaching a peak for 50 nodes and remaining robust at 100 nodes. At moderate densities (50–75 nodes), AODV worked well but at large densities it decreased more precipitously than the RCM. In dynamic or extensive post-disaster settings, DSDV and OLSR continuously performed poorly, demonstrating a lack of adaptation.

The performance of the suggested model was further assessed using throughput, which is defined as the receiving bit rate at the destination nodes, in addition to PLR, delay, and PDR. Figure 4 represents a comparison on throughput based on receiving bit rate measured in kbits/s. The findings show that, in comparison to other protocols, the RCM maintains a higher receiving bit rate, exhibiting enhanced network resilience and data transmission efficiency in dynamic circumstances.

The simulation results compare RCM, AODV, OLSR, and DSDV in terms of PLR, delay, and PDR under varying node densities. Even under extremely dynamic and crowded network settings, the RCM consistently performed better than the other approaches, exhibiting the lowest PLR, the lowest delay, and the highest PDR. AODV, on the other hand, operated very well at lower to medium node densities, but as network size increases, congestion and node collisions caused a dramatic rise in PLR and delay. In most cases, OLSR and DSDV performed rather poorly, with DSDV being the least successful, especially in highly mobile environments where it becomes challenging to maintain precise routing. These findings show that in dynamic and high-density network environments, the RCM offers the most reliable and effective communication performance.

#### **4.1.1 Real-World Implementation**

The proposed model was implemented and tested in the real world to see how it works. Implementing a proposed model in the actual world is required to validate its effectiveness, identify practical problems, and guarantee that theoretical benefits become tangible results. These implementations demonstrated the system's resilience to changing device capabilities, ambient factors, and user behaviors frequently seen in disaster-affected locations. The ESP8266 microcontroller module, which is inexpensive and low-power, was used to

implement the system [24]. The success of real-world testing demonstrates the model's technological viability and conformity to the operational reality of field-level catastrophe response.

Table 4 displays the results of several experiments on the proposed communication systems implemented in both open space and laboratory rooms. The experimental data shows how obstructions, ambient factors, and antenna presence impact the communication range. The range was much greater in open-field situations with no obstructions; the longest documented distance when an antenna was utilized was 291 feet. Parking lots and garden areas, which are semi-open spaces, performed moderately well. The success of real-world testing demonstrates the model's technological viability and conformity to the operational reality of field-level catastrophe response. The ESP8266 modules were set up using default transmission power and standard Wi-Fi transmission settings. To guarantee uniformity throughout all trials, fixed-size data packets were sent at regular intervals. In order to measure the communication range, the distance between sending and receiving nodes was progressively increased until a stable connection could no longer be maintained. The effective range was defined as the farthest distance at which dependable communication could be maintained. These results highlight the impact of environmental conditions on wireless communication performance and show that the suggested solution is practically feasible.

**Table 4** Overview of experiments and observations.

Experiments	Number of Victims	Distance Cover	Status	Place	Antenna
1	1-10	272 ft	Without obstacles	Open field	No
2	1-10	291 ft	Without obstacles	Open field	Yes
3	1-10	83 ft	With obstacles (trees)	Forest edge	No
4	1-10	101 ft	With obstacles (trees)	Forest edge	Yes
5	1-10	40 ft	Without obstacles	Closed-door room	No
6	1-10	55 ft	Without obstacles	Closed-door room	Yes
7	1-10	34 ft	With obstacles	Closed-door lab room	No
8	1-10	150 ft	Without obstacles	Parking lot	No
9	1-10	162 ft	With obstacles (vehicle)	Parking lot	Yes
10	1-10	112 ft	Partial obstacles (bush)	Garden area	No

## 5 Conclusion

This study presents an infrastructure-less Resilient Communication Model (RCM) designed to maintain effective communication during post-disaster scenarios. The proposed model demonstrates that dynamic, self-organizing networks among proximate devices can facilitate real-time information exchange between victims and rescuers, even when conventional communication infrastructure fails. Its lightweight and adaptive design ensures compatibility with low-end devices, which are more likely to remain operational in emergency conditions. The simulation results indicate that the RCM reduced both the packet loss and delay while also improving the packet delivery ratio (PDR) and throughput. Furthermore, real-world experiments validated the model's feasibility, robustness, and practical applicability across diverse situations. Overall, the findings highlight the proposed RCM as a viable and scalable alternative for post-disaster communication, offering critical support for timely relief operations and improved coordination among responders. Future considerations will involve conducting larger-scale experiments and improving the system's scalability.

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