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DEPARTMENT OF ADSE

CSE434P-Computer Networks PROJECT REPORT

**B. Tech - Computer Science and Engineering
(AIML)**

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Abstract

Natural disasters frequently damage conventional communication infrastructure, disrupting coordination between victims and rescue teams. This project presents a simulation of an Emergency Communication Network using a drone-based mesh architecture. The system is implemented in two layers:

1. Cisco Packet Tracer simulation demonstrating dynamic routing and network redundancy using OSPF.
2. Python-based distributed simulation implementing priority-based message transmission using priority queues.

The system ensures self-healing communication, multi-hop forwarding, and prioritization of life-critical emergency messages. This project integrates networking principles and distributed systems concepts to model disaster-resilient communication.

Background

During disasters, communication systems such as cellular towers may fail. Drone-based networks provide temporary communication infrastructure where mobile nodes form a mesh network to relay emergency messages. This project simulates such a system at:

- Network Layer (Cisco Packet Tracer)
- Application Layer (Python Distributed System)

Problem Statement

The project addresses:

- Maintaining communication when infrastructure fails.
- Dynamically rerouting traffic if a node fails.
- Prioritizing emergency messages.
- Simulating distributed multi-hop communication.

Objectives

- Design a drone mesh topology.
- Implement OSPF dynamic routing.
- Add redundant backup links.
- Simulate priority-based message transmission.
- Demonstrate self-healing network behaviour.

Cisco Packet Tracer Implementation

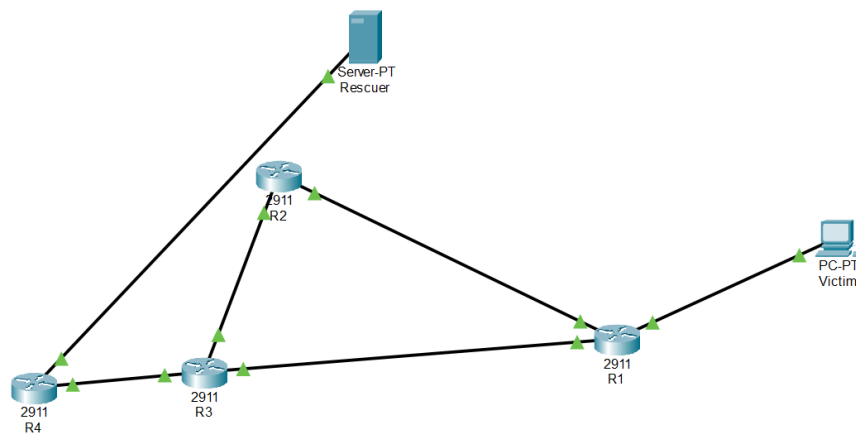
Network Topology

The drone nodes are represented by routers connected in a mesh topology with a backup link.

Topology:

PC → R1 → R2 → R3 → R4 → Server

Backup Link: R1 ↔ R3



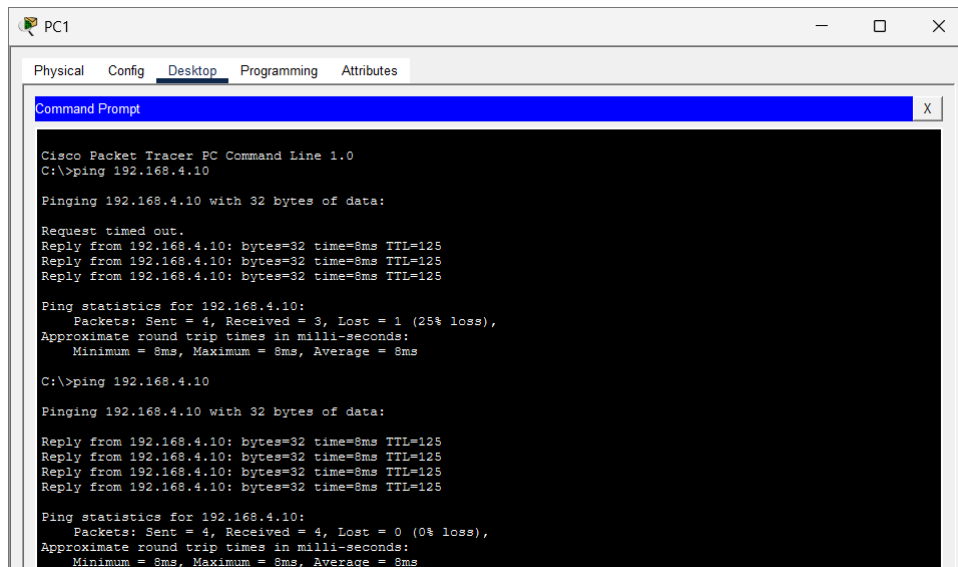
IP Addressing and OSPF Configuration

Each router interface is assigned a unique subnet. OSPF routing protocol is enabled on all routers to allow automatic path discovery and rerouting.

Dynamic Routing and Self-Healing

When Router R2 is shut down, OSPF recalculates the shortest path and reroutes traffic via the backup link. This demonstrates:

- Fault tolerance
- Redundancy
- Self-healing communication



The screenshot shows a Cisco Packet Tracer PC Command Line window for PC1. The window has tabs for Physical, Config, Desktop, Programming, and Attributes. The Desktop tab is active, showing a Command Prompt window. The Command Prompt displays the output of a ping command to 192.168.4.10. The first ping attempt shows a 25% loss (1 packet lost) with a round trip time of 8ms. The second ping attempt shows 0% loss (0 packets lost) with a round trip time of 8ms.

```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 192.168.4.10

Pinging 192.168.4.10 with 32 bytes of data:

Request timed out.
Reply from 192.168.4.10: bytes=32 time=8ms TTL=125
Reply from 192.168.4.10: bytes=32 time=8ms TTL=125
Reply from 192.168.4.10: bytes=32 time=8ms TTL=125

Ping statistics for 192.168.4.10:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 8ms, Maximum = 8ms, Average = 8ms

C:\>ping 192.168.4.10

Pinging 192.168.4.10 with 32 bytes of data:

Reply from 192.168.4.10: bytes=32 time=8ms TTL=125
Reply from 192.168.4.10: bytes=32 time=8ms TTL=125
Reply from 192.168.4.10: bytes=32 time=8ms TTL=125
Reply from 192.168.4.10: bytes=32 time=8ms TTL=125

Ping statistics for 192.168.4.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 8ms, Maximum = 8ms, Average = 8ms
```

Quality of Service (QoS)

QoS policies were configured using:

- Access Control Lists (ACL)
- Class Maps
- Policy Maps
- Service Policies

Traffic classes:

- HIGH – Medical emergency
- MEDIUM – Urgent assistance
- LOW – Default traffic

Due to limitations of Cisco Packet Tracer, full real-time queue scheduling under congestion cannot be visually demonstrated.

Python Distributed Mesh Simulation

System Architecture

The Python-based system consists of:

- sender_client.py – Victim device simulator
- node.py – Drone mesh node
- base_station.py – Rescue control center

Messages are forwarded dynamically between nodes until reaching the base station.

```
abel@Abels-MacBook-Air skylink-rescue-network % python3 sender_client.py
=====
                EMERGENCY COMMUNICATION SYSTEM
                Victim Device Simulator
=====

[CONFIG] First Node: 127.0.0.1:5001

This simulator allows you to send emergency messages
through the drone mesh network to the base station.

-----
Enter Emergency Message Details:
-----

Your Name: Annmarie
Your Location: Bangalore
Emergency Message: Test Message

Select Priority Level:
  1. HIGH   - Life-threatening emergency
  2. MEDIUM - Urgent but not critical
  3. LOW    - Information or non-urgent

Enter choice (1/2/3): 1

=====
MESSAGE PREVIEW:
=====
Sender Name : Annmarie
Location    : Bangalore
Message     : Test Message
Priority     : HIGH
Timestamp   : 2026-02-14 00:38:20
=====

Send this message? (y/n): y

[INFO] Connecting to first node at 127.0.0.1:5001...
[SUCCESS] Message sent successfully!
[INFO] Message ID: 894c8679-ca81-441a-b2b6-572a2ed8d7ae

[SUCCESS] Your emergency message has been transmitted!
[INFO] The message will be relayed through drone nodes
[INFO] to reach the base station.

Send another message? (y/n): █
```

Priority Queue Implementation

Each drone node maintains a priority queue:

- HIGH → Priority value 1
- MEDIUM → Priority value 2
- LOW → Priority value 3

Messages are processed based on priority before forwarding.

```
[abel@Abels-MacBook-Air skylink-rescue-network % python3 node1.py
[00:37:54] [INFO] Message forwarding thread started

=====
                        DRONE NODE - MESH NETWORK
=====
[00:37:54] [INFO] Node listening on port 5001
[00:37:54] [INFO] Neighbors configured: 1
    Neighbor 1: 172.20.10.2:5002
=====
[00:37:54] [SUCCESS] Node is ready to receive and forward messages!
=====

[00:38:27] [INFO] Message received from 127.0.0.1:64466

=====
NEW MESSAGE RECEIVED:
=====
Message ID   : 894c8679-ca81-441a-b2b6-572a2ed8d7ae
Sender      : Annmarie
Location    : Bangalore
Message     : Test Message
Priority     : HIGH
Timestamp   : 2026-02-14 00:38:20
=====

[00:38:27] [SUCCESS] Message queued with priority: HIGH (value: 1)
[00:38:27] [INFO] Queue size: 1
[00:38:27] [INFO] Processing message (Priority: HIGH, ID: 894c8679...)
[00:38:27] [INFO] Simulating transmission delay (1s)...
[00:38:28] [INFO] Attempting to forward to 172.20.10.2:5002...
[00:38:28] [SUCCESS] Forwarded to 172.20.10.2:5002
█
```

Dynamic Forwarding

Each node maintains a neighbour list and attempts to forward messages to the next available node. If a node fails, alternate forwarding can occur.

```
[abel@Abels-MacBook-Air skylink-rescue-network % python3 node2.py
[00:37:53] [INFO] Message forwarding thread started

=====
                        DRONE NODE - MESH NETWORK
=====
[00:37:53] [INFO] Node listening on port 5002
[00:37:53] [INFO] Neighbors configured: 1
    Neighbor 1: 172.20.10.3:5000
=====
[00:37:53] [SUCCESS] Node is ready to receive and forward messages!
=====

[00:38:28] [INFO] Message received from 172.20.10.2:64467

=====
NEW MESSAGE RECEIVED:
=====
Message ID   : 894c8679-ca81-441a-b2b6-572a2ed8d7ae
Sender      : Annmarie
Location    : Bangalore
Message     : Test Message
Priority     : HIGH
Timestamp   : 2026-02-14 00:38:20
=====

[00:38:28] [SUCCESS] Message queued with priority: HIGH (value: 1)
[00:38:28] [INFO] Queue size: 1
[00:38:28] [INFO] Processing message (Priority: HIGH, ID: 894c8679...)
[00:38:28] [INFO] Simulating transmission delay (1s)...
[00:38:29] [INFO] Attempting to forward to 172.20.10.3:5000...
[00:38:29] [SUCCESS] Forwarded to 172.20.10.3:5000
█
```


Base Station Processing

The base station:

- Receives messages
- Displays structured output
- Stores data in messages.json
- Tracks priority statistics

```
Windows PowerShell
EMERGENCY COMMUNICATION NETWORK - BASE STATION
Rescue Control Center

[00:38:52] [SUCCESS] Base station listening on port 5000
[00:38:52] [INFO] Messages will be saved to: messages.json

Waiting for emergency messages from drone network...

[00:38:58] [INFO] Message received from drone node at 172.20.10.2:64468

MESSAGE #1
+-----+-----+
| Field | Value |
+-----+-----+
| Message ID | 894c8679-ca81-441a-b2b6-572a2ed8d7ae |
| Sender Name | Annmarie |
| Location | Bangalore |
| Priority | HIGH 🚨 |
| Timestamp | 2026-02-14 00:38:20 |
+-----+-----+
MESSAGE CONTENT
+-----+
| Test Message |
+-----+

[00:38:58] [SUCCESS] Message saved to messages.json

STATISTICS:
+-----+
| Total Messages Received: | 6 |
| HIGH Priority: | 3 |
| MEDIUM Priority: | 2 |
| LOW Priority: | 1 |
+-----+

[00:38:58] [SUCCESS] Message #1 processed successfully
```

Results

The system successfully demonstrated:

- Multi-hop communication
- Dynamic routing with automatic rerouting
- Redundant backup path activation
- Priority-based message processing
- Successful end-to-end transmission

Cisco Packet Tracer validated routing and redundancy behavior.

Python simulation validated priority scheduling and distributed forwarding logic.

Conclusion

The project successfully models a drone-based emergency communication network at both networking and application layers.

Key achievements:

- Dynamic OSPF routing
- Redundant topology design
- Priority-based emergency transmission
- Self-healing network behavior
- Distributed system simulation

The integration of Cisco routing concepts and Python distributed systems creates a comprehensive disaster-resilient communication model.

Future Scope

- Real wireless mesh implementation
- Cloud-based monitoring dashboard
- AI-based route optimization
- Integration with IoT distress sensors
- SDN-based centralized control
- Real drone hardware deployment