Search & Rescue Swarm Drone
Mesh Communications Architecture
(Aligned System Specification)

This document defines the communications architecture for the 150 g class Search & Rescue swarm drone system. It is aligned with:

• Electronics Stack (STM32H7 / STM32N6 / STM32WL separation)
• Swarm Perception Architecture (Camera + LiDAR processing on STM32N6)

The purpose of this document is to provide a clear specification for both human engineers and large language models implementing simulation or firmware.

1. Mission Concept

System: 1–12 cooperative indoor swarm drones

Mission example:
• Enter unknown building
• Map interior collaboratively
• Detect people and hazards (e.g., IED-like objects)
• Share map and detections across swarm
• Relay mission-critical data back to base

The swarm must function even when individual drones lose direct base contact.

2. Processor & Radio Responsibilities

STM32H7:
• Flight control
• Navigation and failsafe
• Interface to 900 MHz control radio

STM32N6:
• Camera + LiDAR perception
• Object detection
• Semantic map updates
• Structured detection packet generation

STM32WL:
• 900 MHz sub-GHz mesh networking
• Store-and-forward packet relay

900 MHz long-range radio:

• Pilot command
• Telemetry
• Emergency override

3. Radio Architecture (Phase 1)

First development phase uses only:
• 900 MHz XBee-class mesh radio

Purpose:
• Building penetration
• Multi-hop backbone
• Low-bandwidth reliable relay

Future phase (not included yet):
• 2.4 GHz short-range burst radio for high-speed local exchange

4. Mesh Philosophy

Distributed store-and-forward mesh.

Each drone:
• Acts as sensor platform
• Acts as relay node
• Stores undelivered data locally
• Forwards packets when routes become available

No central dependency required for mapping continuity.

5. Realistic Radio Constraints (Simulator Model)

Effective usable throughput: ~100 kbps
Per-hop latency: 20–80 ms
Packet loss: 1–15%
Max payload size: ~200 bytes

System must:
• Fragment larger data
• Prioritize critical messages
• Avoid flooding

6. Data Types Transmitted

Structured data only (no video streaming).

1. Drone pose updates (50–80 bytes)

2. Map deltas (100–800 bytes)
3. Object detections (100–500 bytes)
4. Compressed LiDAR keyframes (1–5 KB, fragmented)

Detection packet includes:
• Object type
• Confidence
• Position estimate

7. Priority Model

Highest Priority:
• Mission commands
• Hazard detections

Medium Priority:
• Map updates

Lower Priority:
• LiDAR keyframes
• Noncritical diagnostics

Mesh layer must implement a priority queue.

8. Failure Model

Assume:
• Link drops
• Packet loss
• Temporary drone isolation

Behavior:
• Continue mapping locally
• Store data
• Relay once reconnected

Progress must continue under partial connectivity.

9. Integration with Perception Architecture

Perception (STM32N6) generates compact detection and map packets.
STM32H7 handles flight stability and passes packets to STM32WL.
Mesh propagates detections hop-by-hop.

Hazard detections are immediately elevated in priority.

All drones maintain partial global map redundancy.