SWARM DRONE CHALLENGE
2026

Technical Report – Finals Submission

Team

Mach Mind

Collective intelligence at Mach speed

2026 June

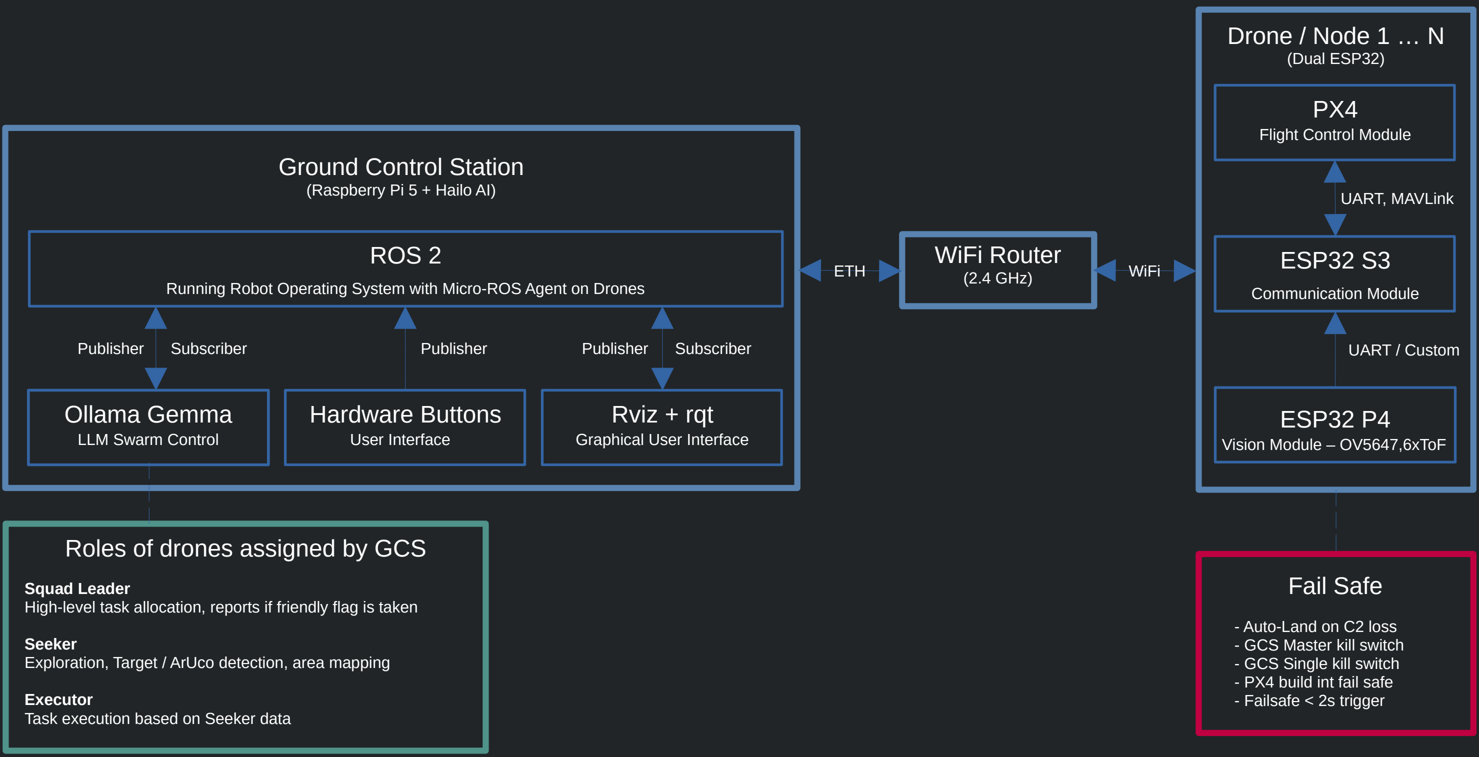
MBDA X brigk AIR

Mach Mind
Collective intelligence at Mach speed

Team
Mindaugas Jonauskis
Hauke Renk

Contact
info@machmind.dev
http://machmind.dev

1. System Architecture Overview – Version 2.0



System Summary

Mission	Autonomous multi-drone swarm for capture the flag scenario, GPS-denied indoor arena
Architecture	Ground Control Station handles tasks allocation, while drones maintain local autonomy.
System Config	5 drones (1 Squad Leader, 2 Seekers, 2 Executors) and a Ground Control Station
Design Philosophy	Off-the-shelf hardware, open-source software stack - cost-effective, reproducible, scalable.

Team
Mindaugas Jonauskis
Hauke Renk

Contact
info@machmind.dev
http://machmind.dev

2. Drone / Node

Platform

Airframe	Custom GEP-CT30
Flight controller	MicoAir NxtPX4v2
Props	T3x1.5x3, prop guard
ESC	4 in 1 33A Bluejay
Battery	LiHV 1100mAh 4S1P
Motors	2450KV

Swarm Stack (V2.0)

Vision Module – ESP32 P4
ArUco detec. 3FPS, pose and dist estimation
Obstacle detection, 6x ToF
new for finals

Comms Module – ESP32 S3
Data link to GCS, WiFi - micro-ROS
Data link to FC, UART - MAVLink
Data link to Vision Module, UART

Sensors

MicoAir MTF-01
Optical flow + LiDAR
Primary indoor nav

6x VL53L1X ToF
210° horizontal + up
obstacle detection

OV5647, MIPI-CSI, adjustable M12 focus
ArUco detection, QVGA, up to 12 meters
upgraded for finals

Qualifying → Finals: What has changed?

Vision Comp.	Obstacle detect.	ArUco detec.	MCU	PCB
Offboard (GCS)	4x ToF	up to 3 - 4 m	1x S3	COTS
↓	↓	↓	↓	↓
Onboard (Drone)	6x ToF	up to 8 m	1x S3 + 1x P4	Custom PCB

Figure 2. Swarm Stack comparison Qualifying V1.0 vs Finals V2.0

Mach Mind
Collective intelligence at Mach speed

Team
Mindaugas Jonauskis
Hauke Renk

Contact
info@machmind.dev
http://machmind.dev

3. Ground Control Station (GCS)

Hardware

Compute	Raspberry Pi 5
AI Accelerator	Hailo AI HAT+ (Not used)
OS	Ubuntu 24.04 LTS Server
Monitor	15.6-inch Full HD IPS
Router	Flint (GL-AX1800)

Software

ROS2	Jazzy — all node communication
micro-ROS agent	Bridge ROS2 ↔ ESP32 S3
GUI	RViz + custom rqt panel
Swarm Node	Ollama Gemma
Button Node	Physical buttons → ROS2 publisher

GUI — **GCS – Control Station**
Launches ROS2, uROS, RViz, rqt, troubleshooting

Buttons — **GCS – Button**
Physical buttons publishing state over ROS2

FLASH — **IDE – Flash**
Firmware flashing for ESP32 inside Docker

SWARM — **GCS – Swarm Ollama**
Launches Ollama services over ROS2

STREAM — **IDE – Stream View**
Camera and ToF data live stream over USB

VISION — **GCS – Vision**
GCS ArUco detection via OpenCV (not used)

Figure 3. Desktop launchers and their function

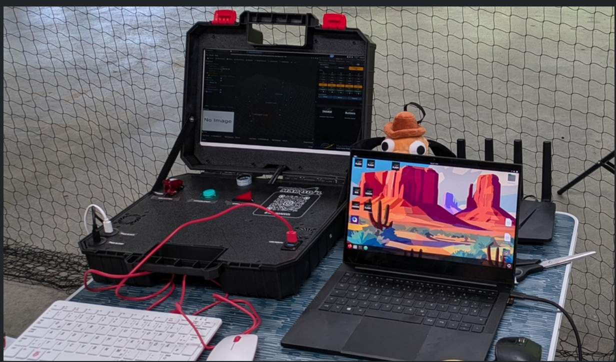


Figure 4. GCS for flight testing

Figure 5. GCS being assembled on a tools box

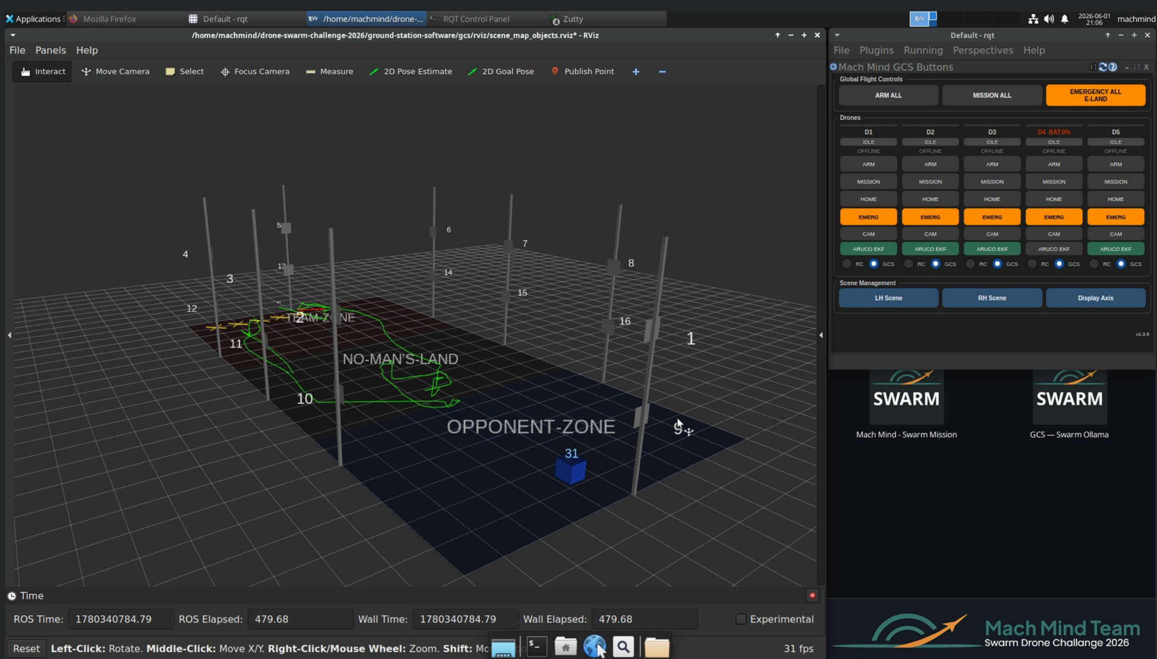


Figure 6. Real-time ArUco ID 31 target localisation and path tracking in RViz

MBDA X brigk AIR

Mach Mind
Collective intelligence at Mach speed

Team
Mindaugas Jonauskis
Hauke Renk

Contact
info@machmind.dev
http://machmind.dev

4. Swarming

4.1 ROS Communication messaging for Swarm control

GCS (Publisher) → Drone (Subscriber)

Topic (main)	Purpose
/gcs/drone_N/command	Arm, takeoff, land, mission, emer.
/gcs/drone_N/control	Waypoint
/gcs/drone_N/config	Runtime config (e.g. role)
/gcs/system/team_color	Team colour, defines starting point

Drone (Publisher) → GCS (Subscriber)

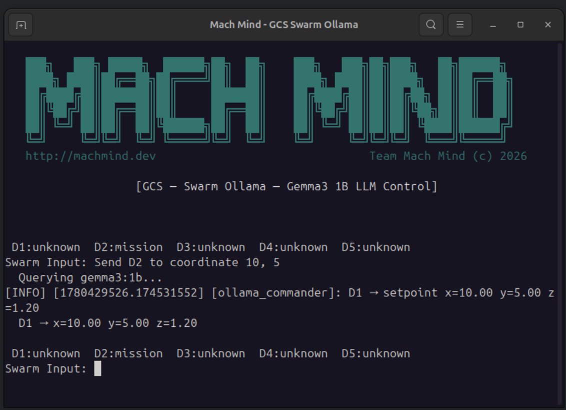
Topic (main)	Purpose
/drone_N/state	Flight state
/drone_N/role	Accepted role
/drone_N/vision_pose	Estimated position
/drone_N/box_detected	ID and position of box

Note: Only critical topics are shown, N – denotes drone ID.

4.2. Swarm Data

Swarm Size	5 drones — finals config (2 drones at qualifying)
Coordination	Centralized GCS task allocation, drones maintain local autonomy
LLM control	Ollama Gemma 3 on Pi5 (CPU) via natural language ruleset → JSON → ROS2 commands
Inter-drone comms	All traffic routed through GCS
Autonomy level	Drones: local stabilize + collision avoidance. GCS: high-level task allocation

4.3. Swarm Control via LLM (DEMO)



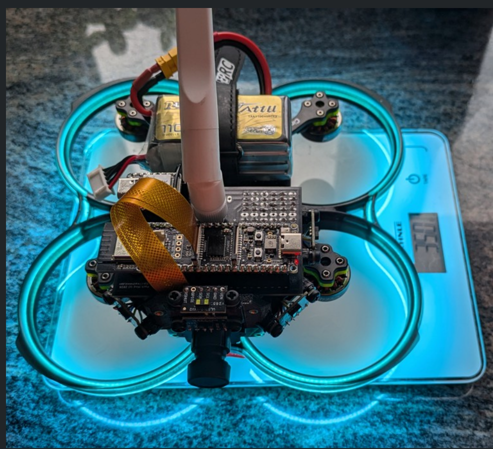


Figure 7. Sample of control input to LLM and drone with props removed.

5. Source Code and Drawings:

https://github.com/machmind-dev/drone-swarm-challenge-2026

```
drone-swarm-challenge-2026/
├── drone-firmware/                      # All drone onboard firmware (v1.0 and v2.0)
│   ├── v1.0/                            # SDC 2026 Qualifying – single ESP32-S3
│   └── v2.0/                            # SDC 2026 Finals – dual ESP32-P4 + ESP32-S3
│       ├── drone-vision-esp32p4/        # Navigation: ArUco, ToF, UART TX
│       ├── drone-comms-esp32s3/         # Communication: MAVLink, micro-ROS
│       └── shared/                      # Binary UART protocol header
├── ground-station-software/             # ROS2 ground control station, swarm algorithms & vision
├── hardware/                            # Mechanical and electrical design files
├── launchers/                           # Platform-specific launch scripts
│   ├── ubuntu-gnome-pc/                 # x86_64 Ubuntu GNOME (development GCS)
│   └── ubuntu-xfce-pi5/                 # ARM64 Raspberry Pi 5 (field GCS)
└── docs/                                # Documentation and media
```

MBDA X brigk AIR