

## INTRODUCTION

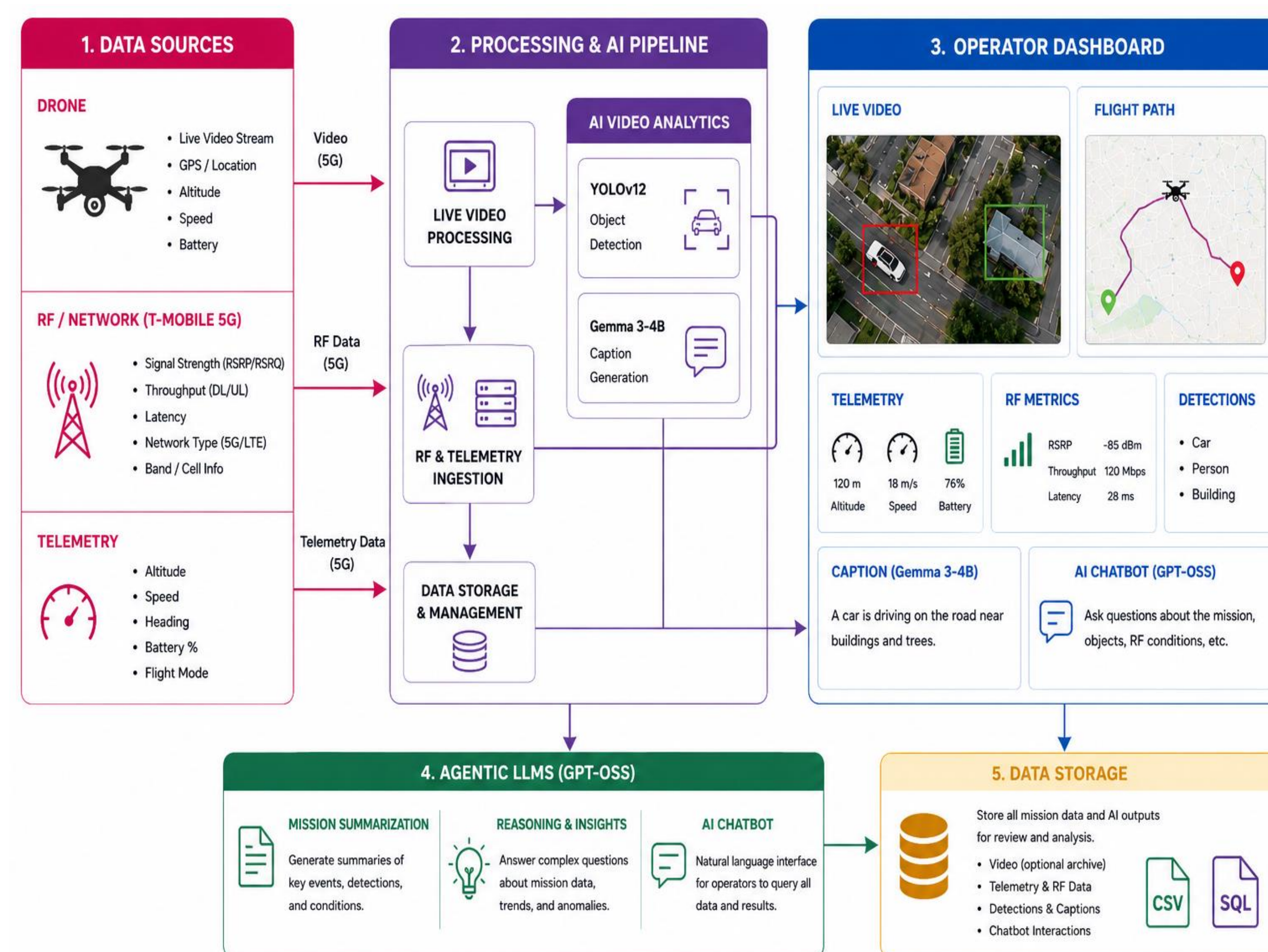
### 5G Drone Monitoring System

- Real-time drone video, telemetry, RF data
- 5G connection to edge platform
- AI object detection, captions, summaries
- Live operator dashboard
- GPS path, RF metrics, detected objects
- Improved situational awareness for testing, emergencies, inspections

## OBJECTIVES

- ✓ Build real-time drone monitoring system
- ✓ Combine video, telemetry, RF/network data
- ✓ YOLOv12 for object detection
- ✓ Gemma 3-4B for video captions
- ✓ GPT-OSS for summaries, reasoning, chatbot
- ✓ Operator dashboard with flight path, telemetry, RF metrics
- ✓ Show detected objects, captions, chatbot responses
- ✓ Connect drone surroundings with network conditions
- ✓ Improve operator situational awareness

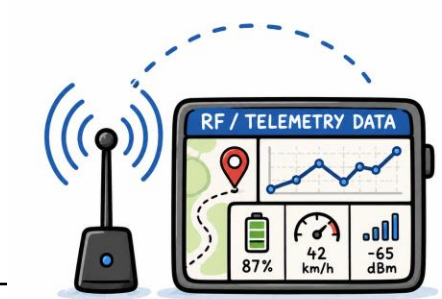
## SYSTEM ARCHITECTURE



## REQUIREMENTS

### RF / Telemetry Data

- Gather live RF metrics and drone telemetry data from the mobile/drone setup.
- Synchronize GPS, altitude, speed, battery, signal strength, latency, and network type using timestamps.



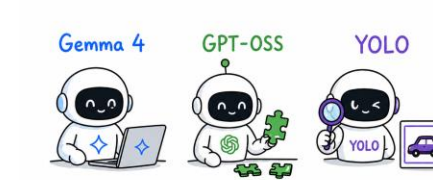
### Operator Dashboard

- Display live telemetry, flight path, RF history, detected objects, and captions in one operator view.
- Store mission data and AI outputs in CSV/SQL format for later review and analysis.



### Agentic LLMs

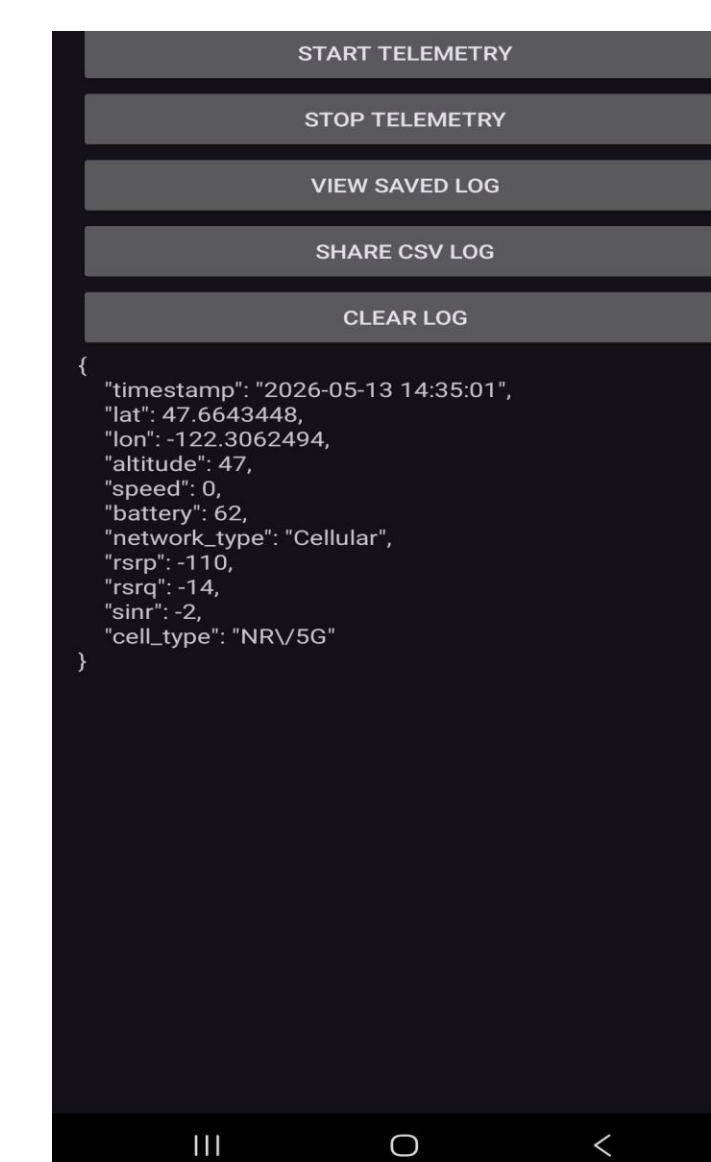
- Process live drone video with YOLOv12 for object detection and Gemma 3-4B for caption generation.
- Use GPT-OSS to support mission summarization, reasoning, and AI chatbot responses



## IMPLEMENTATION

### Live RF / Telemetry App

- Android app for live RF + telemetry collection
- CSV log export
- RF: SINR, RSRP, RSRQ
- Telemetry: GPS, battery, speed, network type



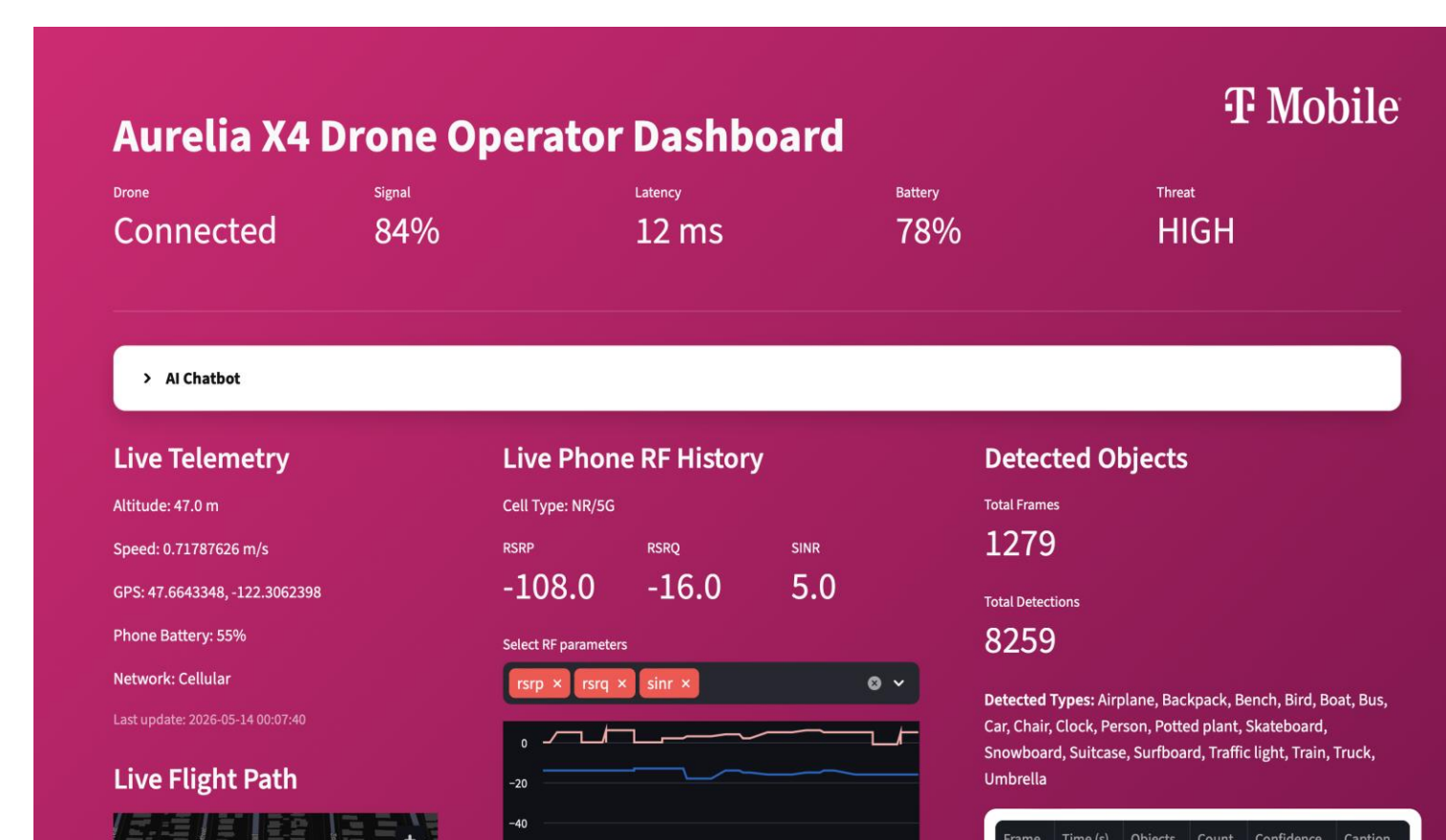
Android app interface showing live RF and telemetry collection, CSV log controls, and real-time JSON data being sent to the backend.

### Agentic LLM Pipeline

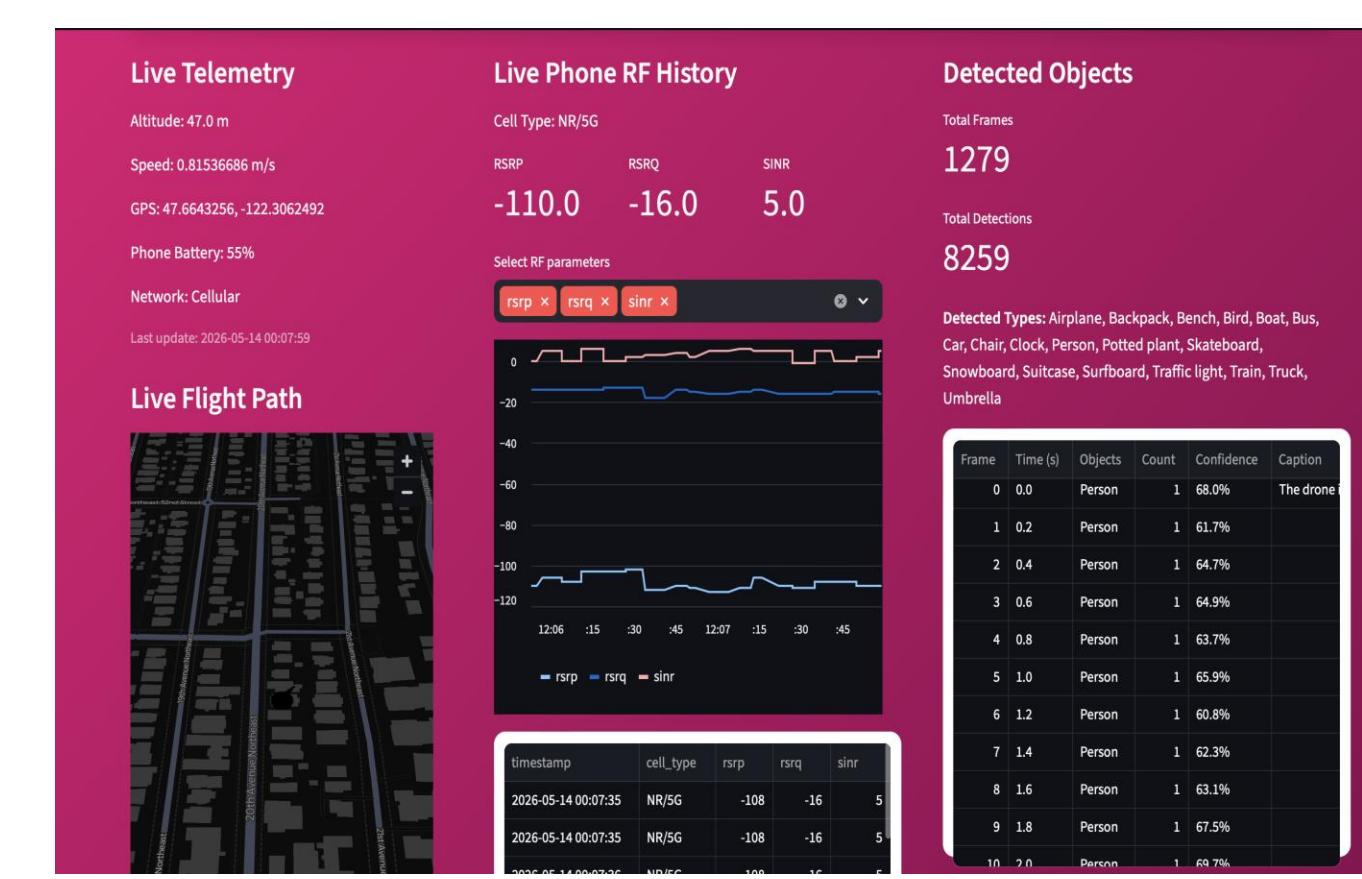
- YOLOv12: real-time object detection
- Gemma 3-4B: video captions + scene descriptions
- GPT-OSS-20B: summaries, Q&A, reasoning, chatbot

### Operator Dashboard

- Streamlit dashboard + FastAPI backend
- Live telemetry, RF data, flight path, AI outputs
- Shows GPS, speed, battery, network type
- Tracks SINR, RSRP, RSRQ for monitoring



The Streamlit-based dashboard provides a live operator view of drone telemetry, RF signal history, flight path, detected objects, and AI chatbot access in one place.

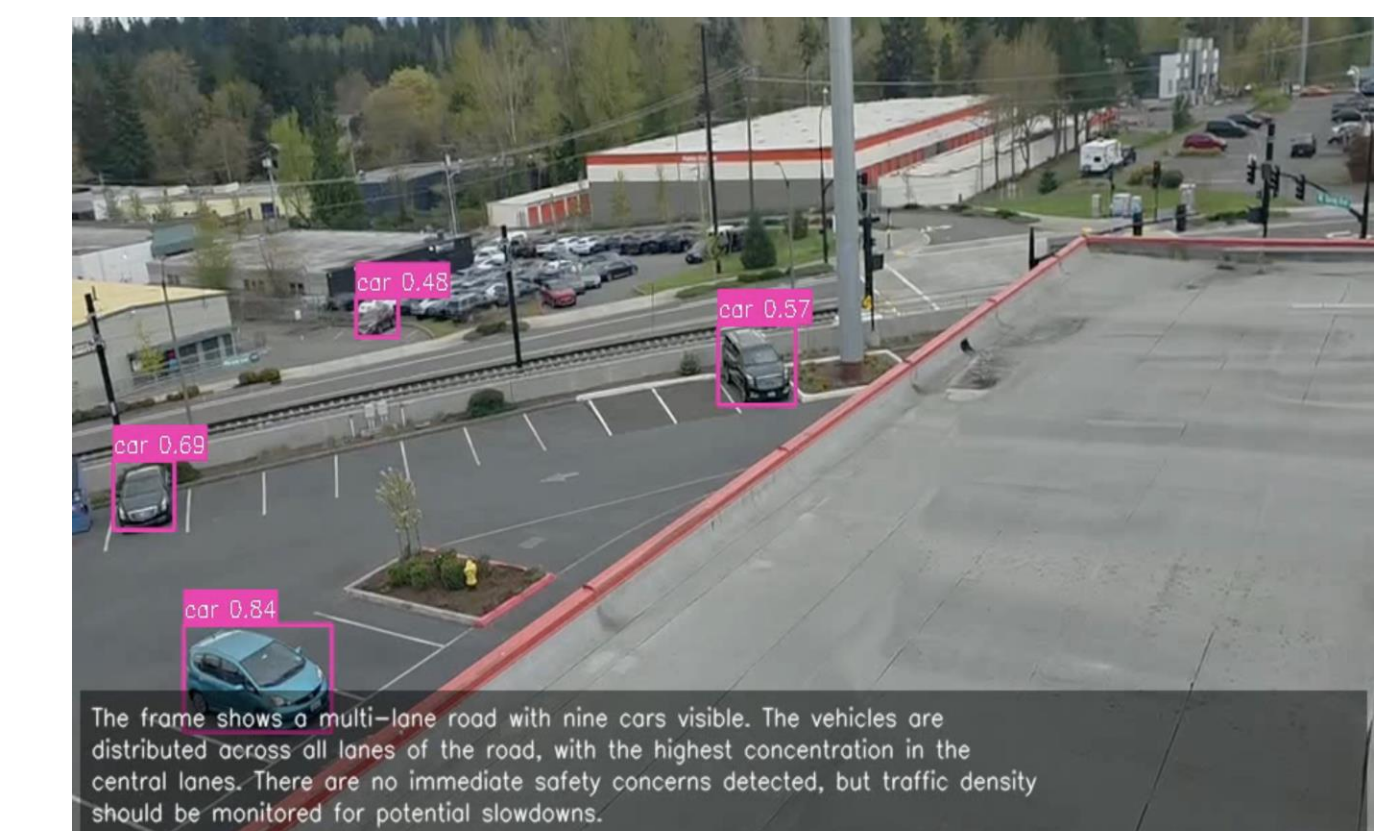


The Streamlit-based dashboard consists of three columns showing live telemetry and flight path, RF signal history, and AI-detected objects for real-time drone mission monitoring.

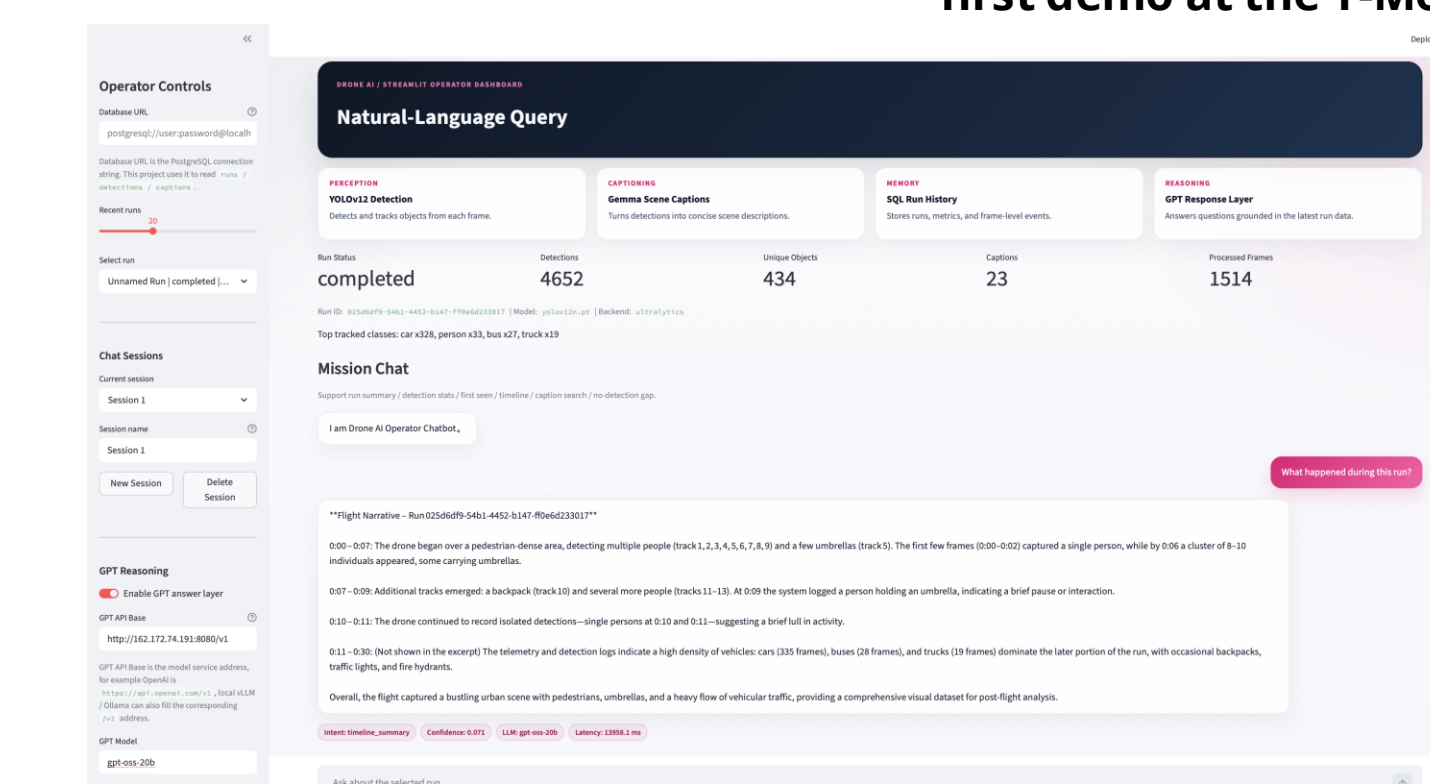
## RESULTS



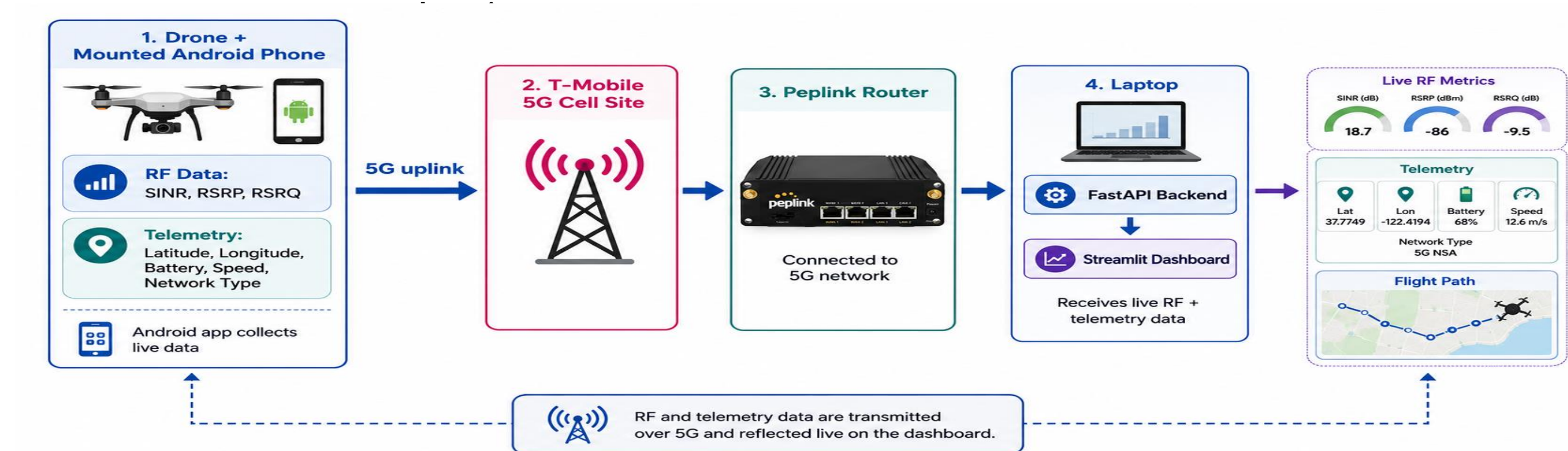
Object detection and video captioning results from our first demo at the T-Mobile Innovation Hub.



AI object detection and video captioning results from our first demo at the T-Mobile Innovation Hub.



Streamlit-based AI chatbot page for asking mission-related questions about telemetry, RF data, detections.



## FUTURE WORK

- Improve detection/captioning with stronger multimodal AI
- Add anomaly detection, alerts, and mission summaries
- Use Edge UPF and GH200 to reduce latency
- Support robots, autonomous vehicles, and IoT cameras
- Add LiDAR, thermal, and environmental sensors Expand to Jetson, Raspberry Pi, and mobile edge devices

## CONCLUSION & CONTRIBUTIONS

- Developed a real-time 5G drone AI system integrating live video, RF telemetry, object detection, captioning, and mission reasoning into a unified operator dashboard.
- Demonstrated how edge AI, multimodal LLMs, and 5G connectivity can improve real-time situational awareness and scalable autonomous monitoring applications.