Identifying Drone Components

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@ NFSU, Delhi
9 Sept'25

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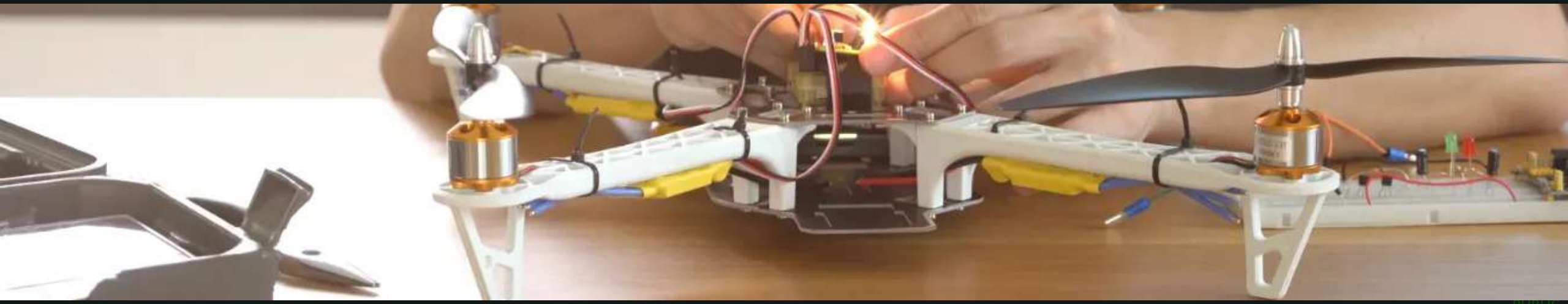
Goals of this presentation -

- Getting basic understanding of Drone architecture
- Drone Sensors
- Real world usage and application of drones in Military
- Case Study
- Future Trends
- Conclusion

Introduction to Drones

Drones—also known as **UAVs**—are aircraft without onboard pilots. They range from **palm-sized quadcopters** to large **military platforms.**

Military roles include ISR (**Intelligence, Surveillance, Reconnaissance),** precision strike, electronic warfare, and logistics.

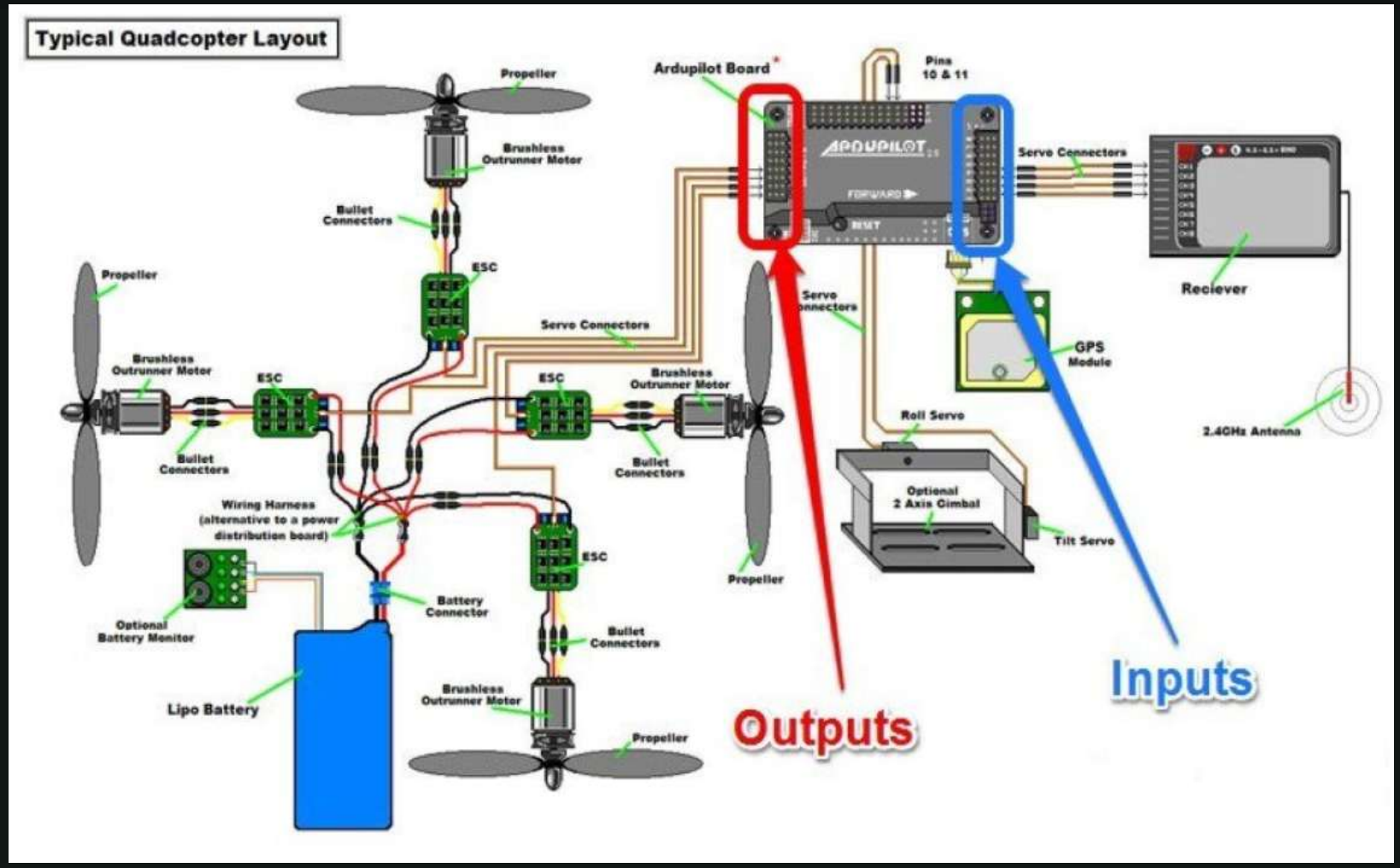


Drone Anatomy Overview

Typical components: airframe, motors, propellers, ESCs, flight controller, GPS, IMU/compass/barometer, battery/power, payloads, and communications.

Each module contributes to stability, navigation accuracy, endurance, and mission performance.

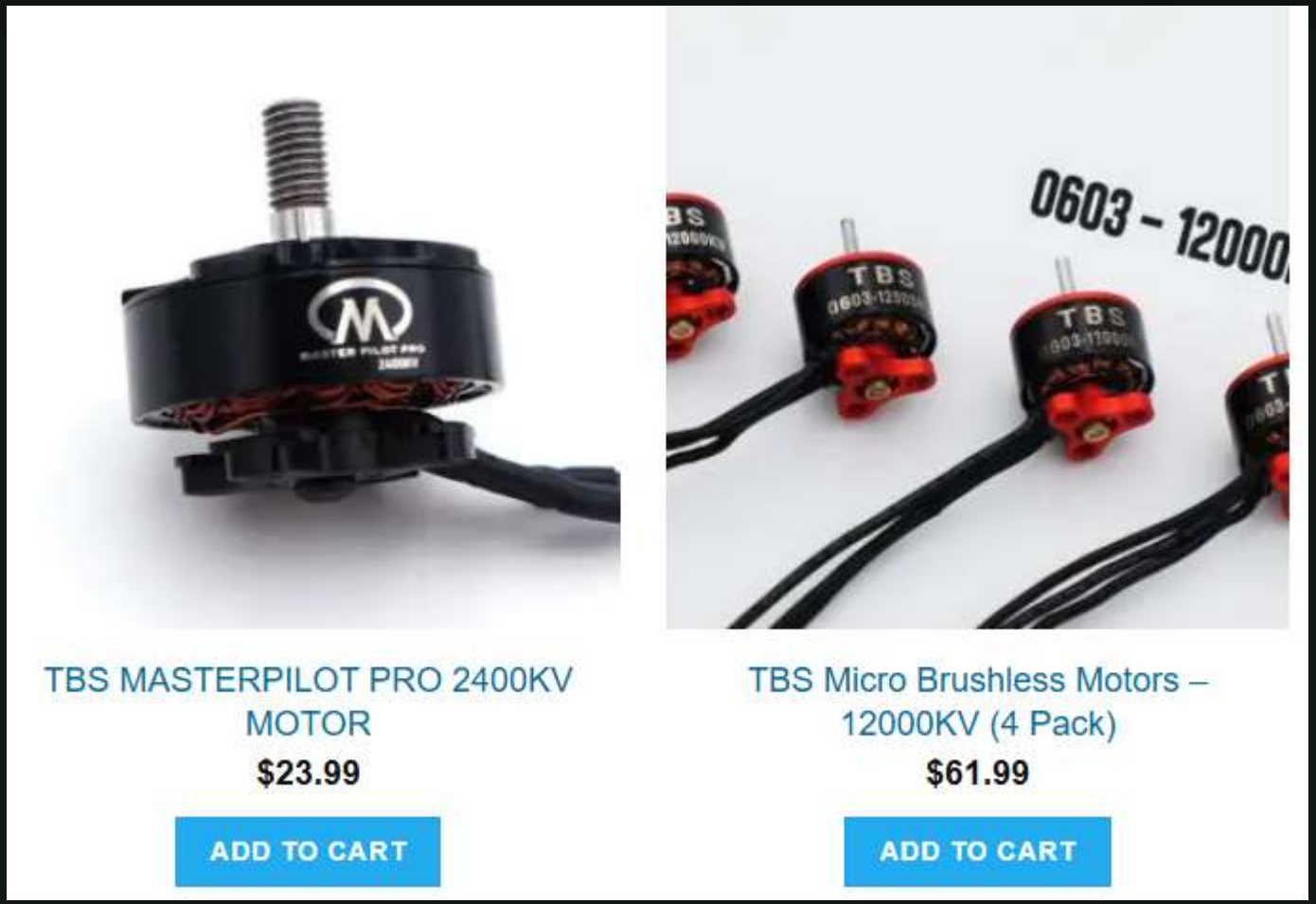
Drone Anatomy Overview



Motors & Propellers

Brushless motors deliver efficient thrust; propeller size/pitch affects lift and noise.

Proper motor–prop matching is key to efficiency, agility, and payload capacity.



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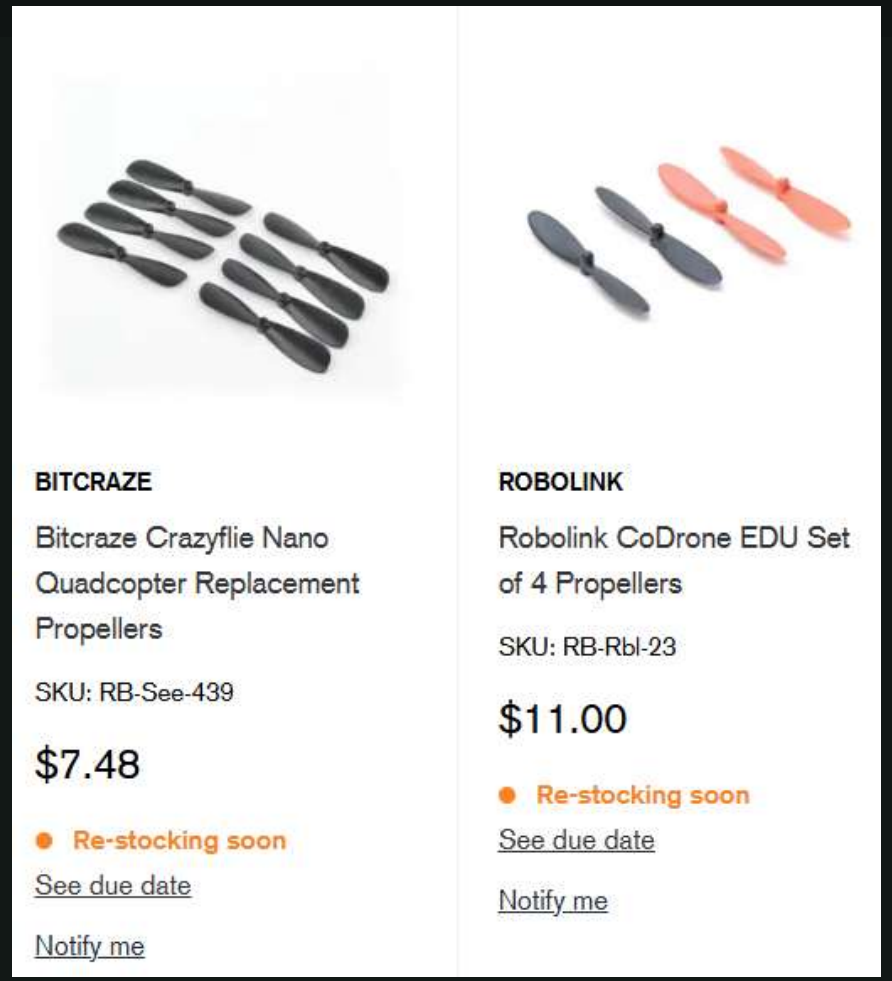


Flight Controller (FCU)

The FCU is the drone's 'brain', reading sensors and stabilizing the craft in real time.

It translates pilot or mission commands into precise responses for actuators and power systems.

Other components of great relevance to the control of the drone, such as the compass, gyroscope and sensors, are usually located on this board.

Flight Controller (FCU)

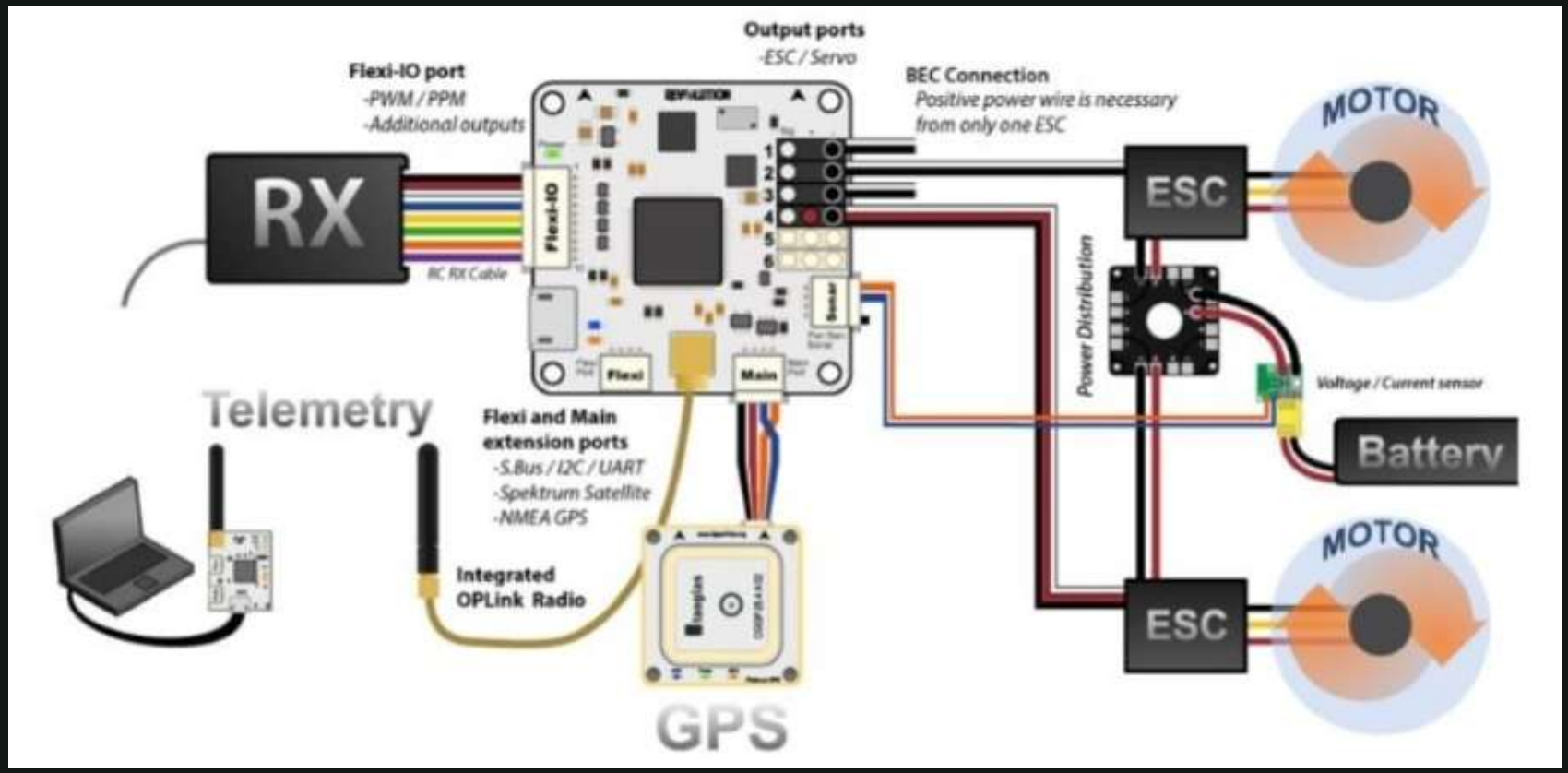
Stability and Safety: Counteract environmental factors for smooth, reliable operation.

Precision Execution: Enable tasks requiring high accuracy, such as filming or inspections.

Ease of Use: Simplify operation through features like auto-hover and return-to-home.

Autonomy: Support advanced applications with GPS, AI, and algorithms.

Versatility: Adapt to diverse environments and use cases.



Battery & Power Systems

Small drones use LiPo batteries; larger UAVs may use fuel engines for endurance.

Power management protects cells, balances loads, and maximizes mission time.

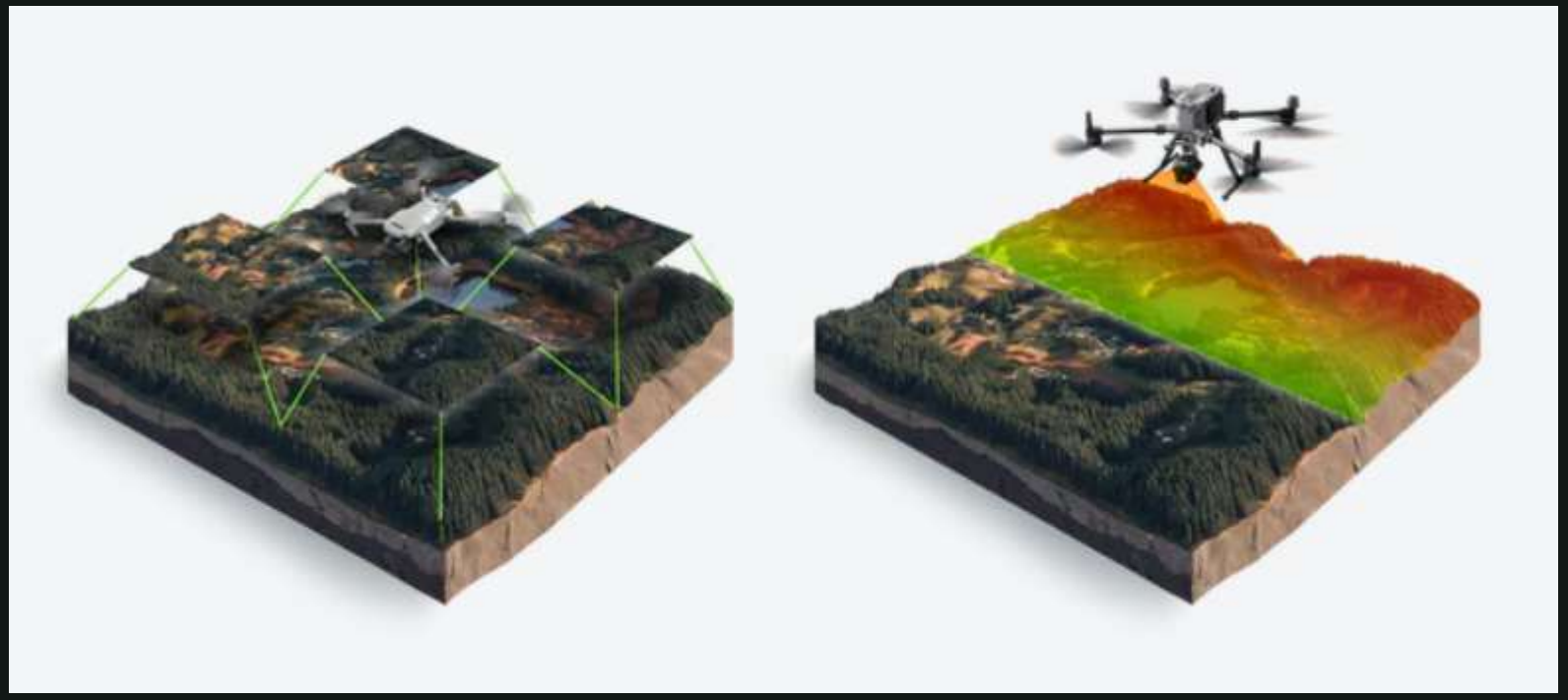
Cameras & Sensors

EO/IR cameras, thermal imagers, LiDAR, and SAR radar provide all-weather ISR.

Sensor fusion improves detection, tracking, and target identification.

Cameras & Sensors

Cameras & LiDAR vs Photogrammetry

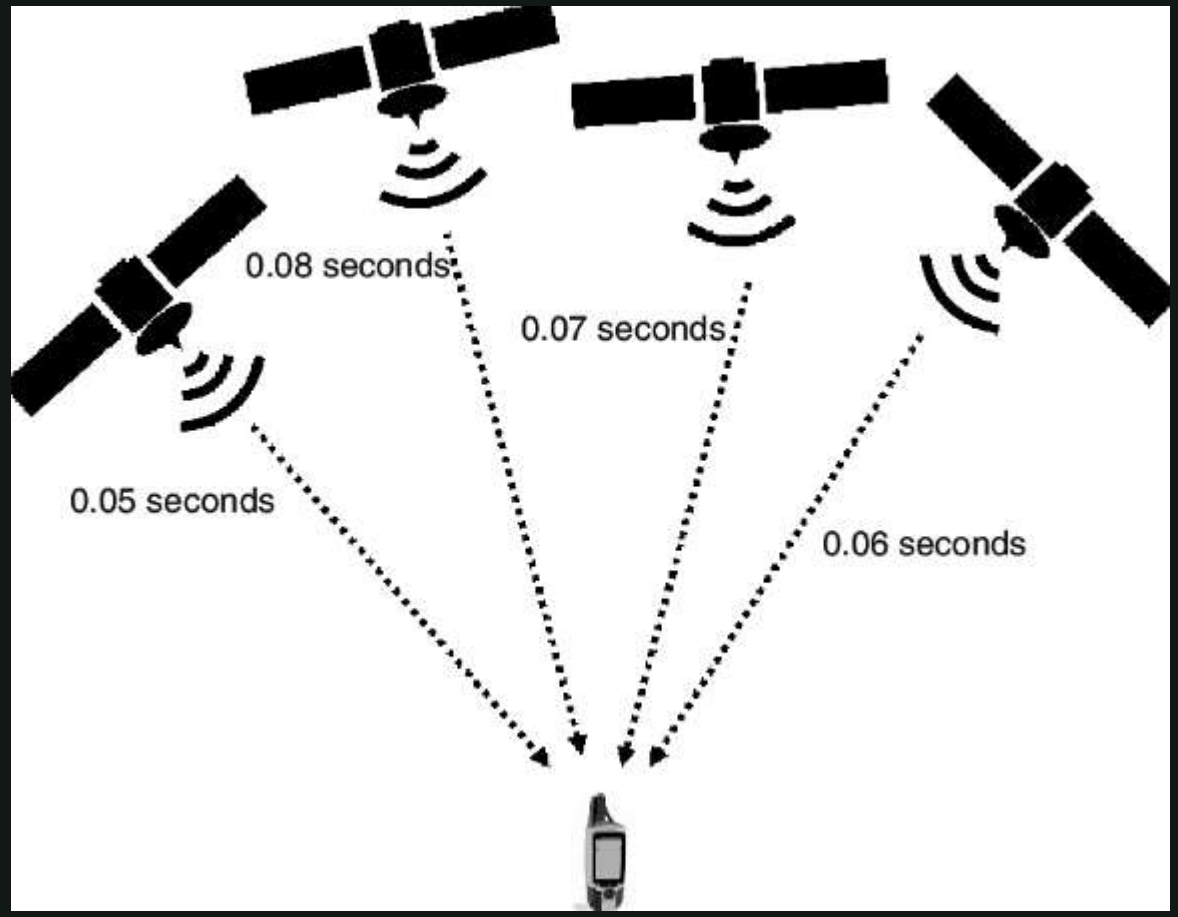


Example - DJI Zenmuse L2 , GeoCue TrueView 1

GPS Module

GPS provides absolute positioning for navigation, waypoints, and return-to-home.

Military drones use robust receivers with anti-jam techniques and multi-constellation support.



IMU (Inertial Measurement Unit)

Combines gyroscopes and accelerometers (often magnetometer) for attitude and motion estimation.

High-grade IMUs enable operation even in GPS-degraded or denied environments.

IMU (Inertial Measurement Unit)

1. Flight Stability
2. Autonomous Navigation
3. Precision
4. Safety
5. Responsiveness

Compass & Barometer

Compass provides heading for navigation and yaw stabilization.

Barometers measure air pressure to hold altitude precisely during hover and cruise.

Electronic Speed Controllers (ESCs)

ESCs control motor RPM and provide smooth throttle response.

Reliability and cooling are vital; failure can cause loss of stability.

Communication Systems

Line-of-sight radio, satellite links, and secure datalinks connect UAVs to ground control.

Beyond-line-of-sight control enables long-range operations and remote split ops.

Payloads & Armaments

ISR payloads include gimballed EO/IR turrets; combat payloads include precision munitions.

Modularity allows quick reconfiguration for surveillance, strike, or EW roles.

More sensors …

https://www.flyeye.io/drone-technology-sensors-cameras/

Case Study: MQ-9 Reaper

MALE UAV with long endurance; integrates EO/IR, radar, and precision munitions.

Used for persistent ISR and strike missions; notable for modular payload flexibility.

Case Study: Bayraktar TB2

Cost-effective UAV used in multiple conflicts; carries smart munitions and EO/IR payloads.

Exemplifies how smaller platforms can deliver asymmetric battlefield effects.

Case Study: IAI Heron

Long-endurance platform for border surveillance and maritime patrol.

Carries diverse ISR payloads and SATCOM for extended reach.

Case Study: Black Hornet Nano

Pocket-size reconnaissance drone used at squad level for urban and indoor scouting.

Provides real-time situational awareness with minimal signature.

Failsafes & Redundancy

Return-to-home on link loss/low battery; dual IMUs or redundant power to prevent failures.

Geo-fencing, self-checks, and safe landing routines mitigate risk.

Drone Software & GCS

Mission planning software defines waypoints, geofences, and payload actions.

Telemetry dashboards display health, link status, and sensor feeds for operators.

Electronic Warfare & Countermeasures

Anti-jam GPS, frequency hopping, and hardened datalinks resist EW threats.

Counter-UAS systems use RF, radar, and directed energy to detect and defeat drones.

Safety & Airspace Compliance

No-fly zones, altitude limits, and line-of-sight requirements vary by country/mission.

Military ops coordinate with air traffic control and deconfliction procedures.

Future Trends

- AI-assisted autonomy, teaming with crewed aircraft, and swarm tactics are advancing.
- Higher-density energy storage and low-signature designs will expand capability.

Conclusion

Understanding each component helps diagnose issues, plan missions, and improve safety.

Modern UAVs blend hardware, software, and doctrine to achieve precise effects.

References and more reading resources -

- Umiles
- Fierce Electronics
- Flyeye.io
- Advexure
- myfpvstore.com
- robotshop.com

Thank You

Questions?

Slides are available here -