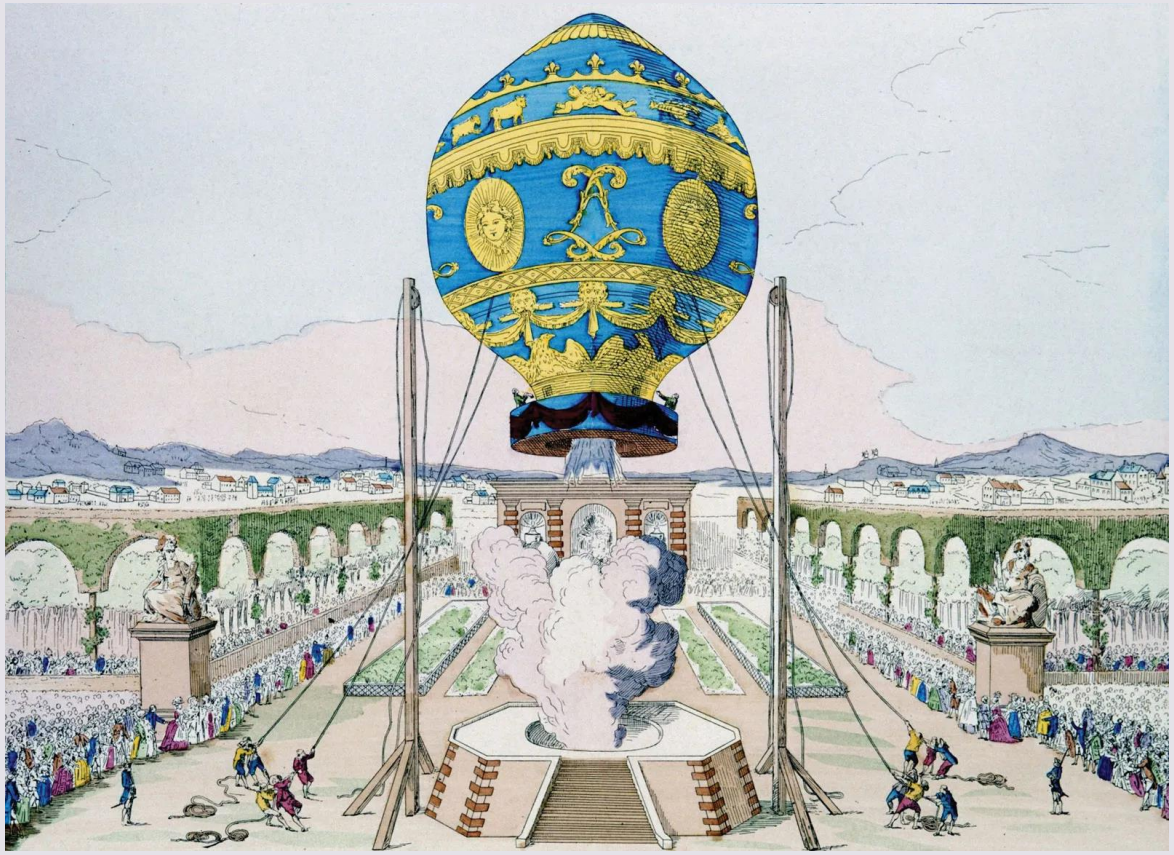
UNMANNED AERIAL VEHICLE (UAV)

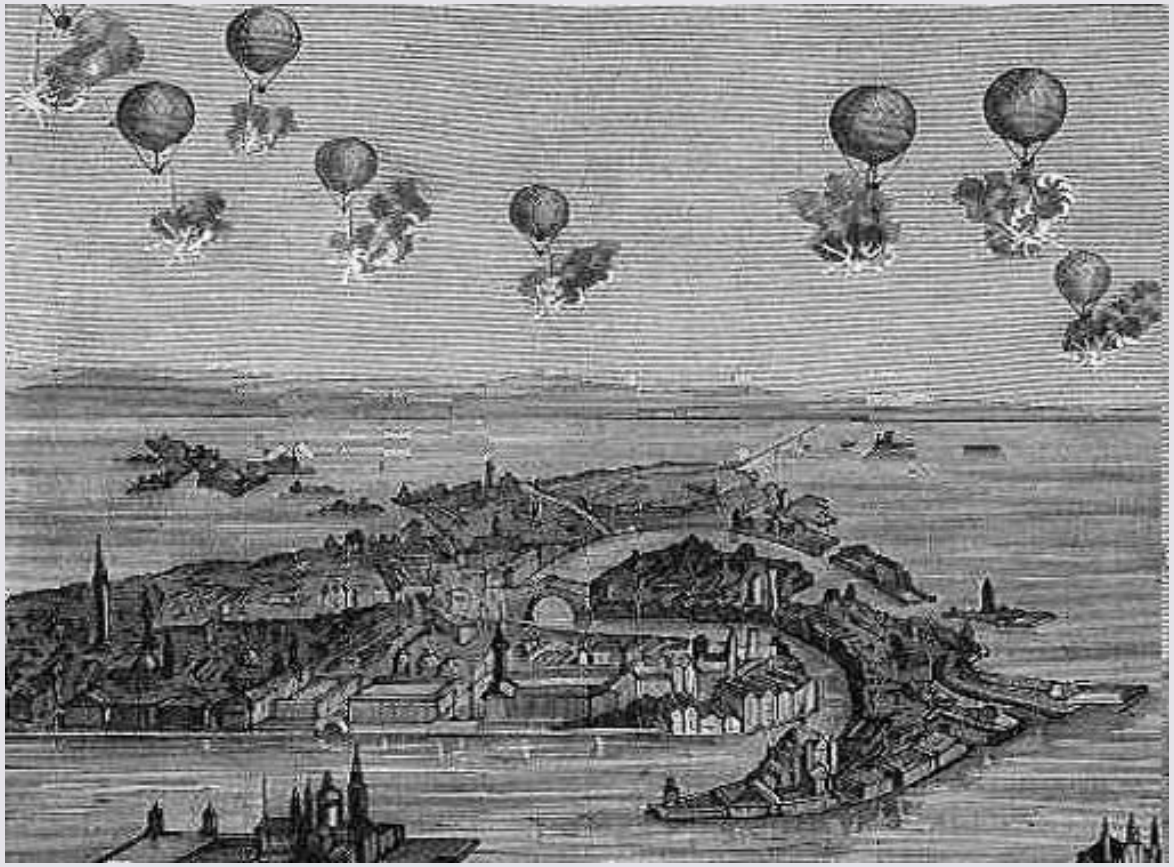
HISTORY OF THE ROBOT

1783 – The First UAV



From a technical standpoint, these crafts were the first aircraft to not require a human pilot. Joseph-Michel and Jacques-Etienne Montgolfier hosted the first public demonstration of an unmanned aircraft, a hot air balloon in Annonay, France.

1849 – The First Military Use of UAVs



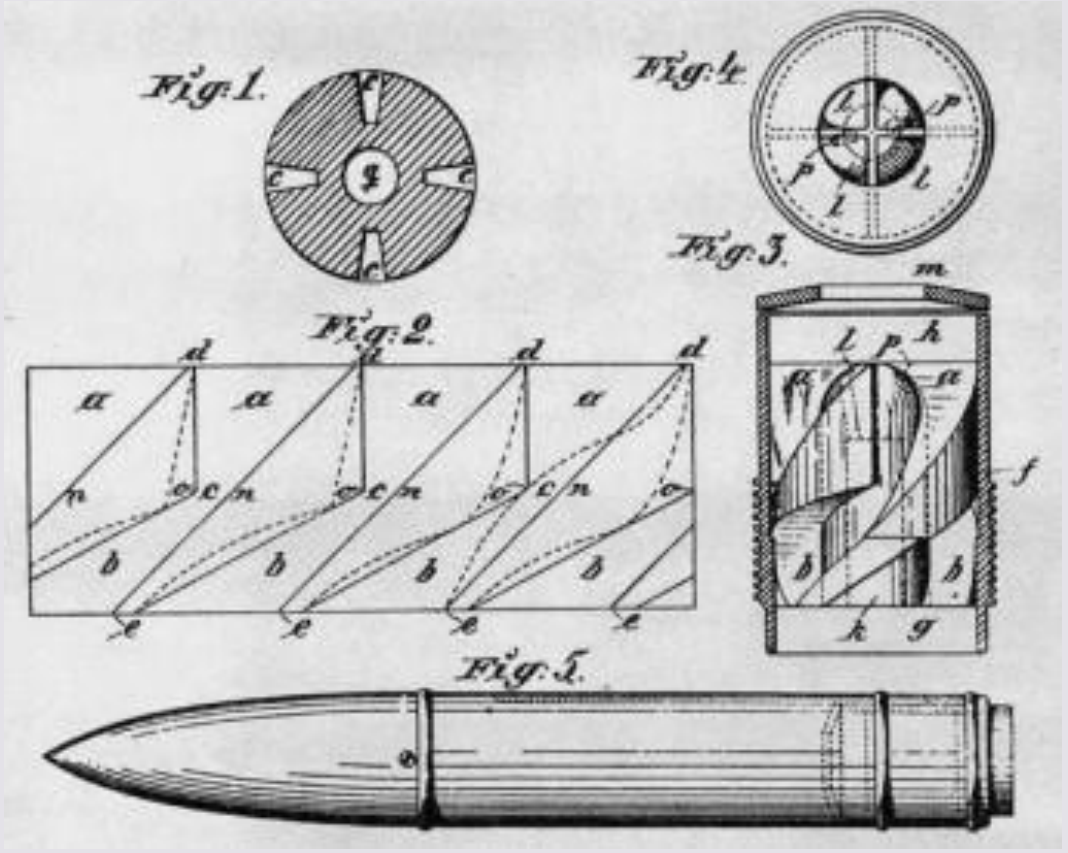
Austrian artillery lieutenant Franz von Uchatius invents the balloon bomb. Field Marshall von Radetsky used the balloons to attack Venice, but they were mostly ineffective.

HISTORY OF THE ROBOT

1858 – First Aerial Photograph

Gasper Felix Tournachon takes the first aerial photograph from a hot-air balloon in Paris, France. Unfortunately, the photograph has been lost in history.

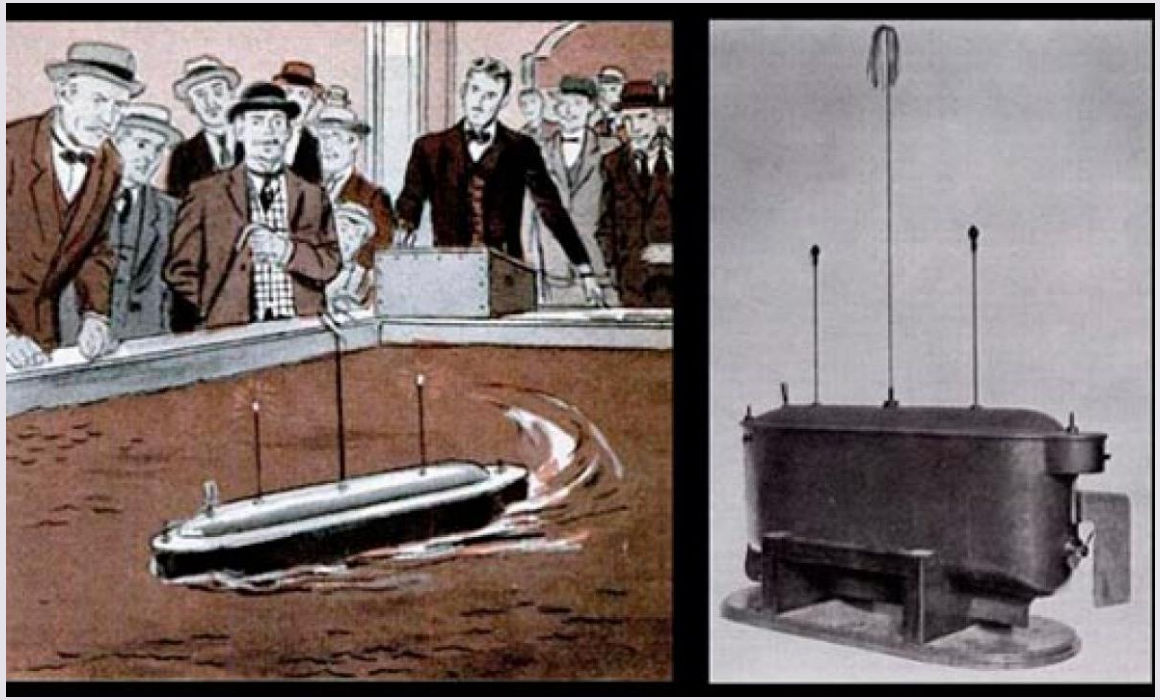
1896 – First Camera on a UAV



Alfred Nobel, famous for the invention of dynamite, launches a rocket with a camera on it. Nobel's experiment marks the first-time cameras were placed on an unmanned system.

HISTORY OF THE ROBOT

1898 – The First Radio-Controlled Craft



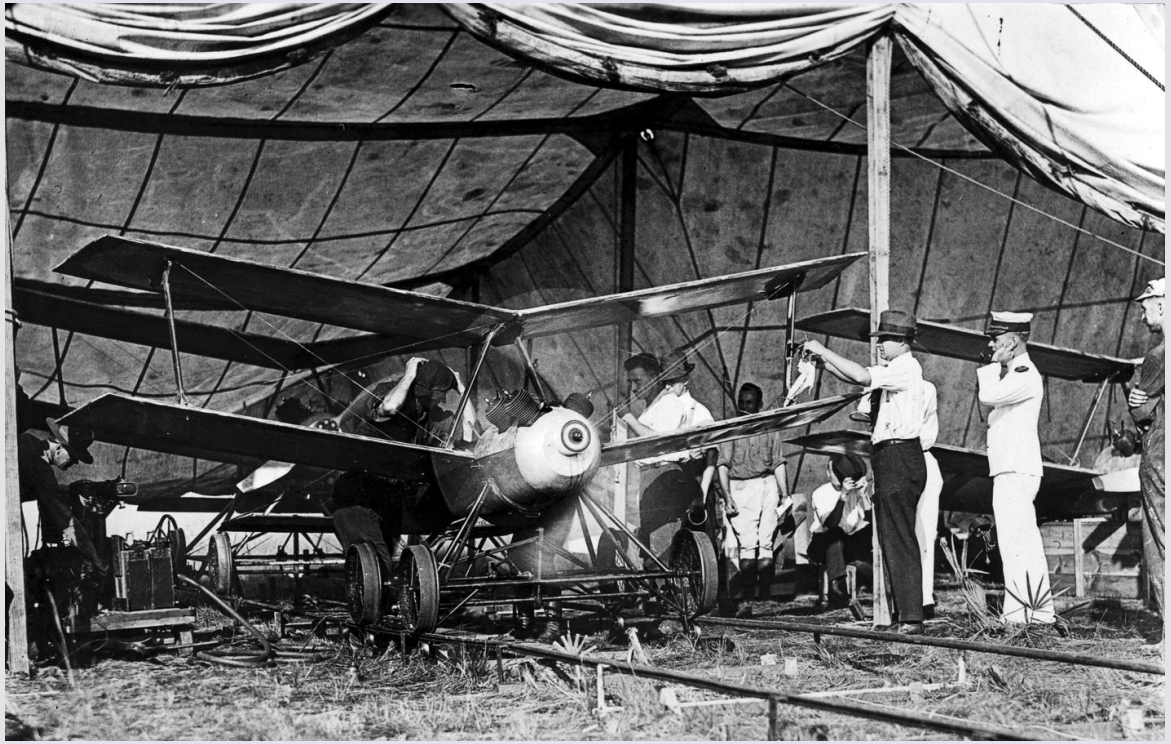
Nikola Tesla displays his radio-controlled boat for a crowd in Madison Square Garden. The craft could respond to directional signals sent to it by Tesla and could also flash its lights. It was a compelling demonstration of what would evolve into radio-controlled aircraft.

1915 – British Use of Aerial Reconnaissance Photos

During the Battle of Neuve Chapelle, British forces used aerial photography to build a map of the German front. The photographs were layout on top of one another and are one of the earliest examples of an orthomosaic.

HISTORY OF THE ROBOT

1917 – First UAV Torpedo the Kettering Bug



Charles Kettering invented the unmanned Kettering Aerial Torpedo, nicknamed the “Bug” in Ohio. The Bug used a system of pre-set internal pneumatic and electrical controls to stabilize the aircraft. When the Bug reached a pre-determined distance, the engine would stop, wings would detach, and the Bug would fall from the sky. It carried 180 pounds of explosives.

1935 – The First Modern Drone is Developed

When the Royal Air Force’s commenced in 1918, the UK needed effective methods for training pilots. Target practice was typically accomplished by towing gliders behind crewed aircraft. However, that method failed to provide a realistic simulation for engaging enemy fighters in live combat. In response, the De Havilland DH.82B Queen Bee aircraft was used a low-cost radio-controlled drone developed for aerial target practice. It is considered by many to be the first modern drone.

HISTORY OF THE ROBOT

1936 – US Drone Program Begins

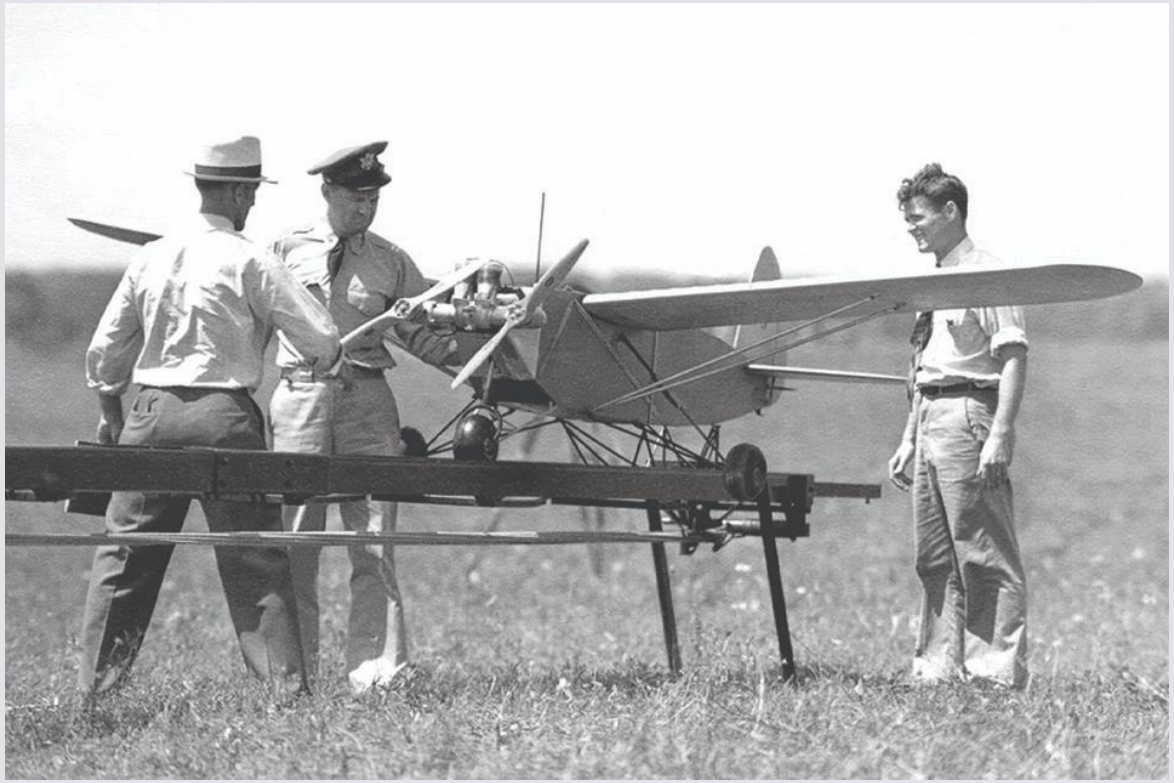
U.S. Admiral William Harrison Standley witnessed a test flight of the Queen Bee in 1936. After returning to the U.S., he placed Lieutenant Commander Delmar Fahrney in charge of developing a program similar to the UK's. It is believed that Fahrney first used the term "drone" for the U.S. platform as a tip of the hat to the UK's Queen Bee.

1937 – U.S. Navy Develops a Radio-Controlled UAV Torpedo

The first radio-controlled UAV was the Curtiss N2C-2. The N2C-2 received its commands from an operator located in a crewed aircraft that flew alongside the Curtiss. While this limited the UAV's effectiveness, it was a significant step in the development of radio-controlled UAV technology.

HISTORY OF THE ROBOT

1941 – Actor Reginald Denny invents the Radio Plane



The Radio Plane was a radio-controlled target plane. After forming his company, Denny produced target drones for the military and was responsible for numerous drone technology innovations. By the time the Northrop Corporation bought the company in 1952, Denny's company had produced almost 70,000 target drones for the US Army.

1943 – The Beginnings of First-Person View (FPV) Flight

Boeing and the U.S. Airforce developed the BQ-7, which operated on a crude FPV system. Old bombers were effectively stripped of non-essential equipment and loaded with explosives. A human pilot would fly the aircraft towards the designated target. Once the target was in view, the autopilot was engaged, and the pilot bailed out of the plane. The BQ-7 would then fly to the target on its own. The BQ-7 was virtually ineffective in war, and the pilots that bailed out had a high rate of death or capture.

HISTORY OF THE ROBOT

1973 – Israel Develops UAVs for Surveillance and Scouting

The Mastiff and the IAA Scout series of UAVs represented a leap in the capabilities of drones. Military commanders were able to increase their situational awareness with these platforms significantly.

1986 – The RQ2 Pioneer Drone is Developed

The U.S. and Israel jointly develop what will become one of the most successful UAV platforms to date. The system was an upgraded IAI Scout drone and featured significant payload improvements. During the Gulf War, some Iraqi forces even surrendered to a Pioneer UAV.

HISTORY OF THE ROBOT

1991 – UAVs Fly 24/7 During the Gulf War

For the first time in a major conflict, at least one drone was airborne from the conflict's start until its conclusion.

1996 – The Predator Drone is Developed

With the help of UAV giants like Abraham Karem, the U.S. develops the Predator drone. This platform brought weaponized drones to the battlefield like never before. Probably more than any other UAV, the Predator created the public image of drones striking targets around the world.

HISTORY OF THE ROBOT

2006 – UAVs Permitted in US Civilian Airspace for the First Time

Following the devastation caused by Hurricane Katrina, the FAA allowed UAVs to fly in civilian airspace for search & rescue and disaster relief operations. Predator drones with thermal cameras were able to detect the heat signatures of humans from up to 10,000 feet away. Around this time, the consumer drone industry began to really take shape. While DJI had yet to become the marketplace giant it is today, companies like Parrot, DJI, 3DR, and many others were looking to take military UAV technology and repurpose it. The potential for industrial and consumer UAV markets was more than enough for many businesses to invest in the technology.

2010 – Parrot Controls a Drone with a Smartphone

At CES, French drone manufacturer Parrot unveiled its AR Drone. The UAV was a small quadcopter fit for consumer use. An app on a smartphone was all the pilot needed to operate the drone safely.

HISTORY OF THE ROBOT

2013 – DJI Produces the First Phantom Drone

While the company was founded in 2006, the iconic Phantom series was not released until 2013. This drone began the modern camera-equipped drone craze. Within just a few years, DJI would hold a commanding position in the consumer drone market, with almost 80% of consumer drones in operation manufactured by DJI or one of their subsidiaries.

2013 – Major Companies Look to Start Drone Delivery

FedEx, UPS, Amazon, Google, Uber, and countless other delivery companies recognize drone benefits as a delivery platform. Testing of various UAV concepts and work with regulatory agencies around the world begins.

HISTORY OF THE ROBOT

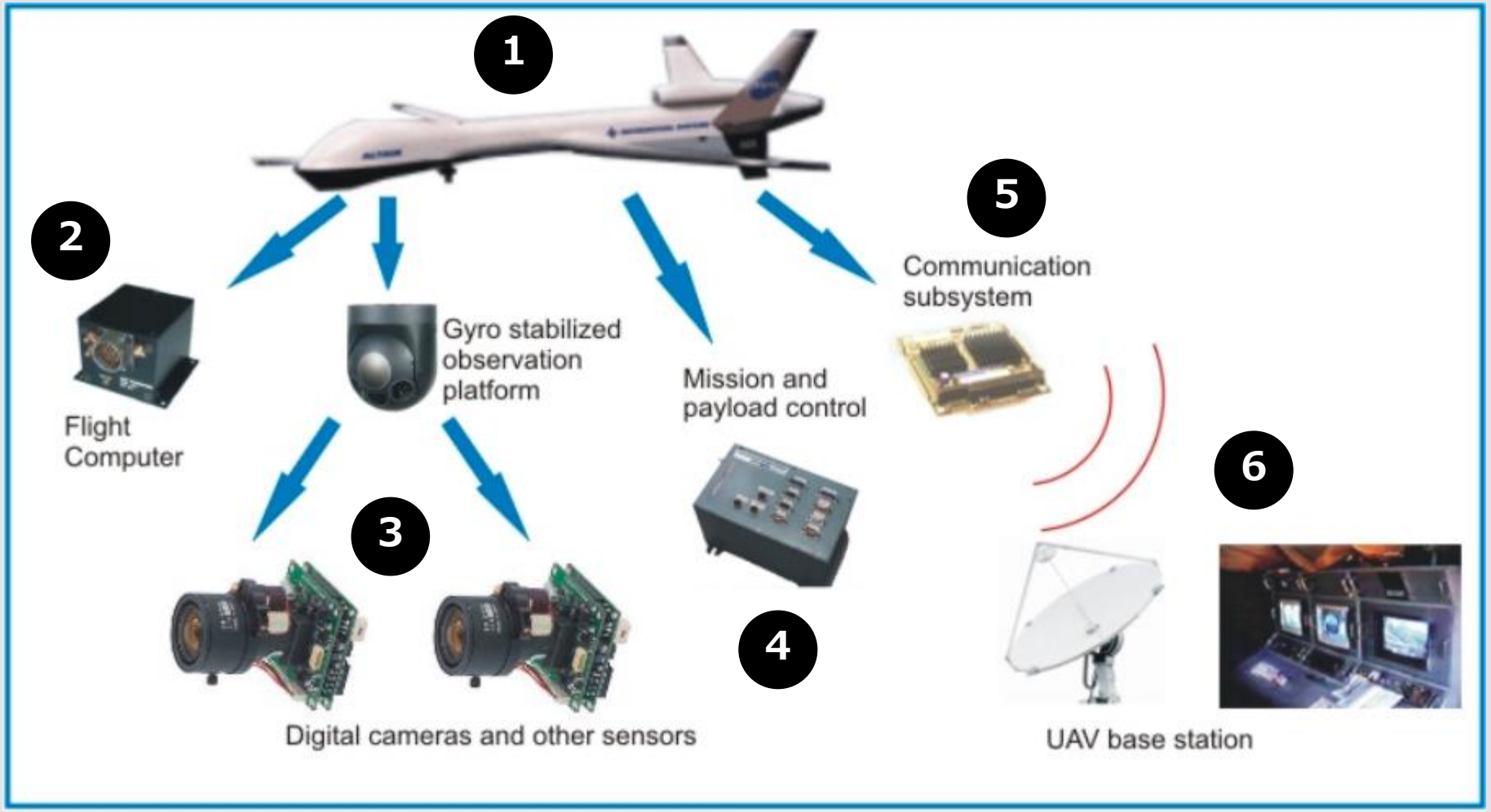
2014 – Use of Drones Rapidly Grows in Industry and with Consumers

Since 2014, UAVs have continued to expand in capabilities and use cases. As more industries explore how drones can make their work safer and more cost effective, growth is expected to rapidly surge in the coming years. By 2030, the entire UAV market is set to be worth $92 billion.

2020 – Pandemic Alleviation

From quarantine & social distancing enforcement to mass disinfection and medical supply delivery assistance, drones have been a staple during the coronavirus outbreak. Now, more than ever before, regulations are being adjusted to provide fast-track authorizations for promising use-cases. It’s impossible to predict the long-term impact of these developments, but one thing is certain: the pandemic has helped countries around the world imagine the potential that drones hold for society.

COMPLETE SYSTEM ARCHITECTURE



An UAV is a complex system composed of six main sub modules that work coordinately to obtain a highly valuable observation platform.

1. UAV Airframe
2. Flight Computer
3. Payload
4. Mission/Payload Controller
5. Communication Infrastructure
6. Base Station

COMPLETE SYSTEM ARCHITECTURE

1. UAV Airframe

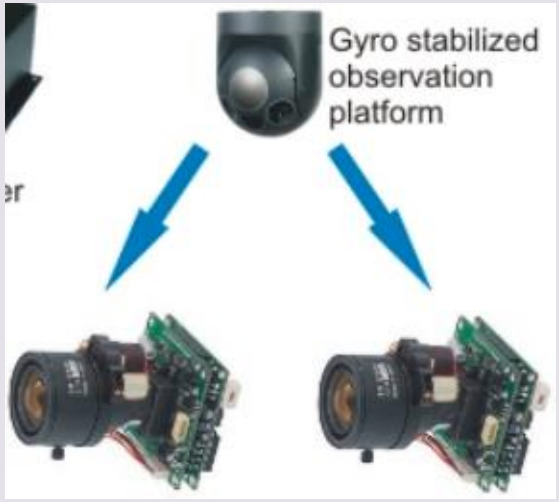
A simple, lightweight, aerodynamically efficient and stable platform with limited space for avionics, and obviously no space for a pilot.

2. Flight Computer

The heart of the UAV. A computer system designed to collect aerodynamic information through a set of sensors (accelerometer, gyros, magnetometers, pressure sensors, GPS, etc.), in order to automatically direct the flight of an airplane along its flight-plan via several control surfaces present in the airframe.

COMPLETE SYSTEM ARCHITECTURE

3. Payload



A set of sensors composed of TV cameras, infrared sensors, thermal sensors, etc. to gather information that can be partially processed on-board or transmitted to a base station for further analysis.

4. Flight Computer

A computer system onboard the UAV that has to control the operation of the sensors included in the payload. This operation should be performed according to the development of the flight-plan as well as the actual mission assigned to the UAV.

COMPLETE SYSTEM ARCHITECTURE

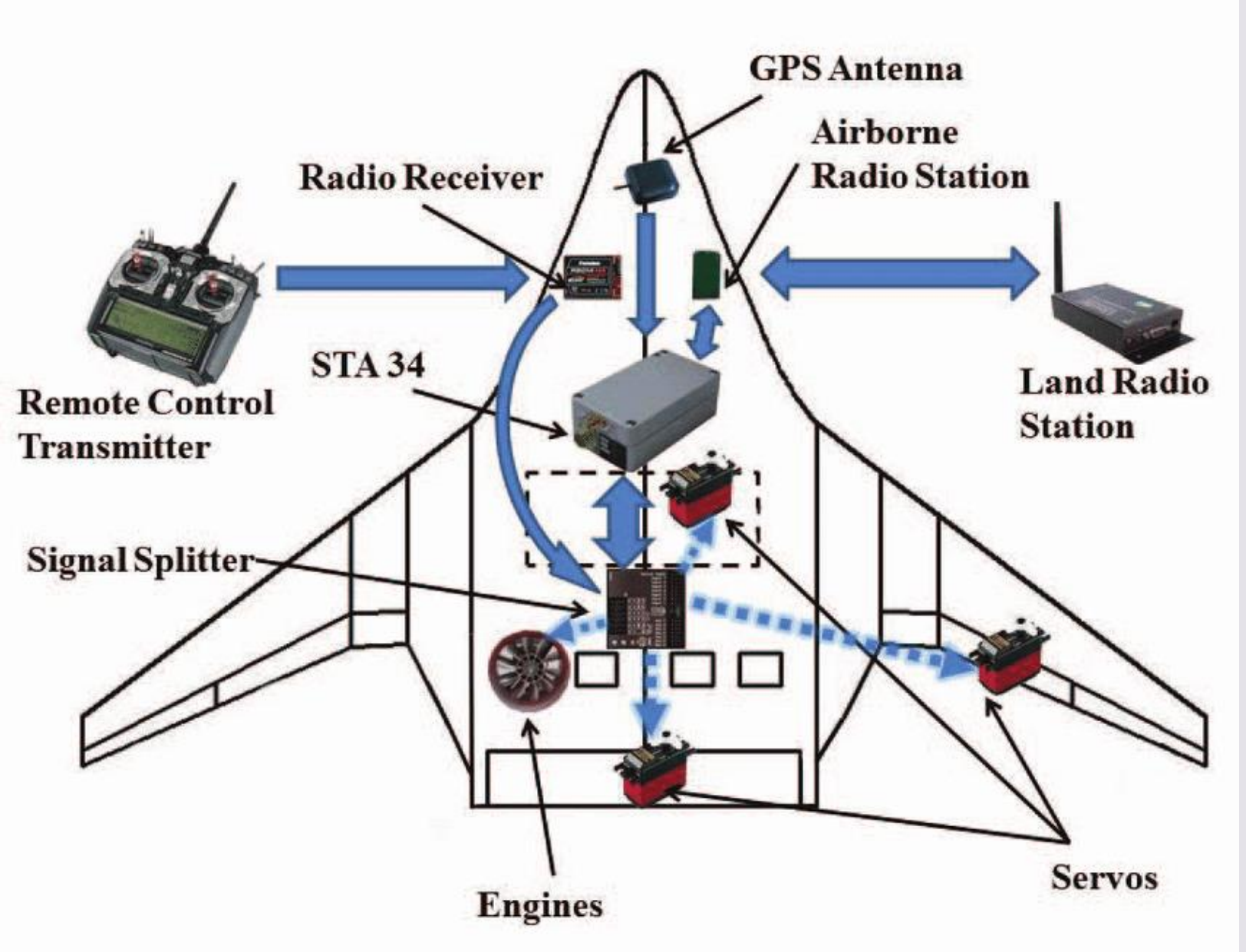
5. Communication Infrastructure

A mixture of communication mechanisms (radio modems, satcomm, microwave links, etc.) that should guarantee the continuous link between the UAV and the base station.

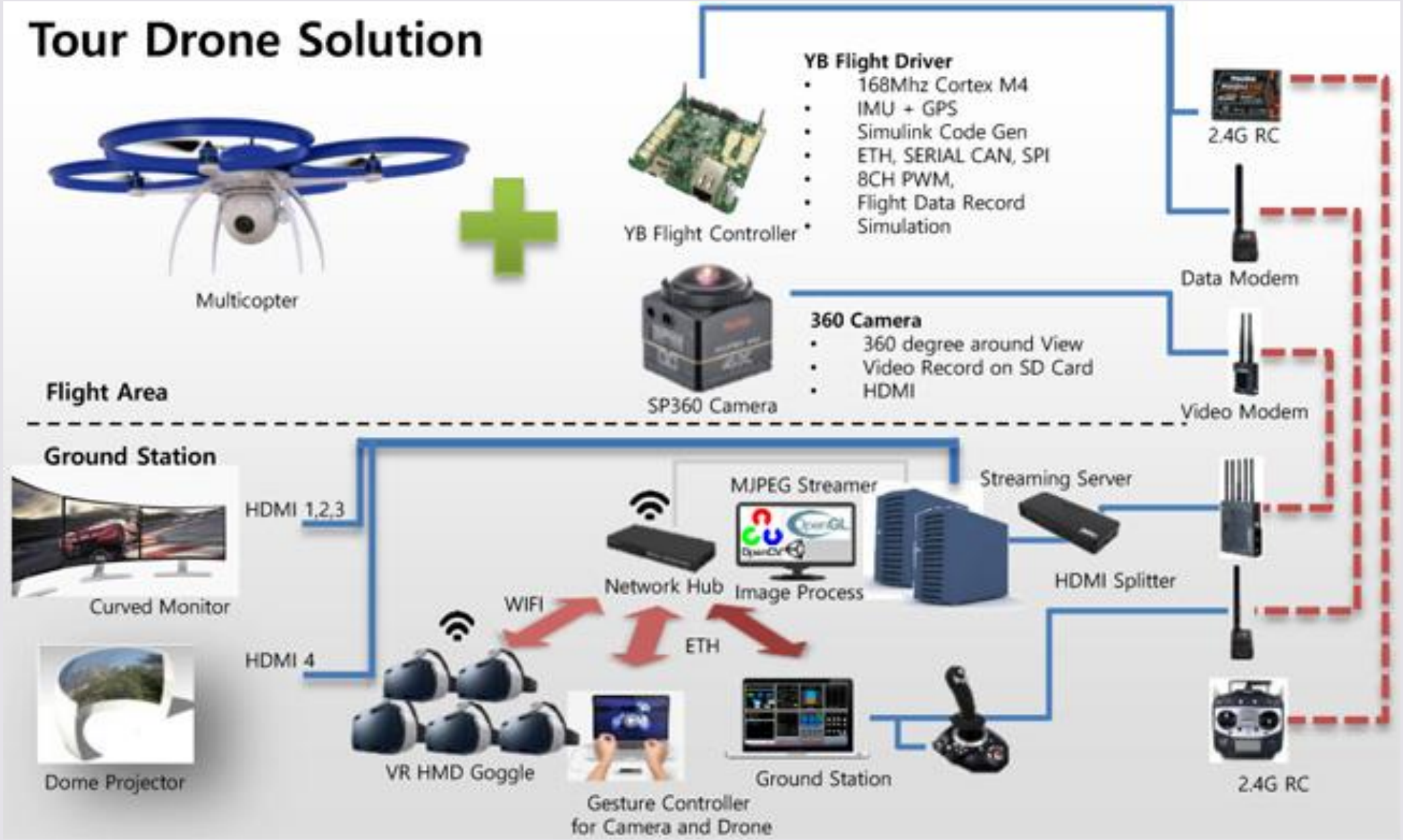
6. Base Station

A computer system on the ground designed to monitor the mission development and eventually operate the UAV and its payload.

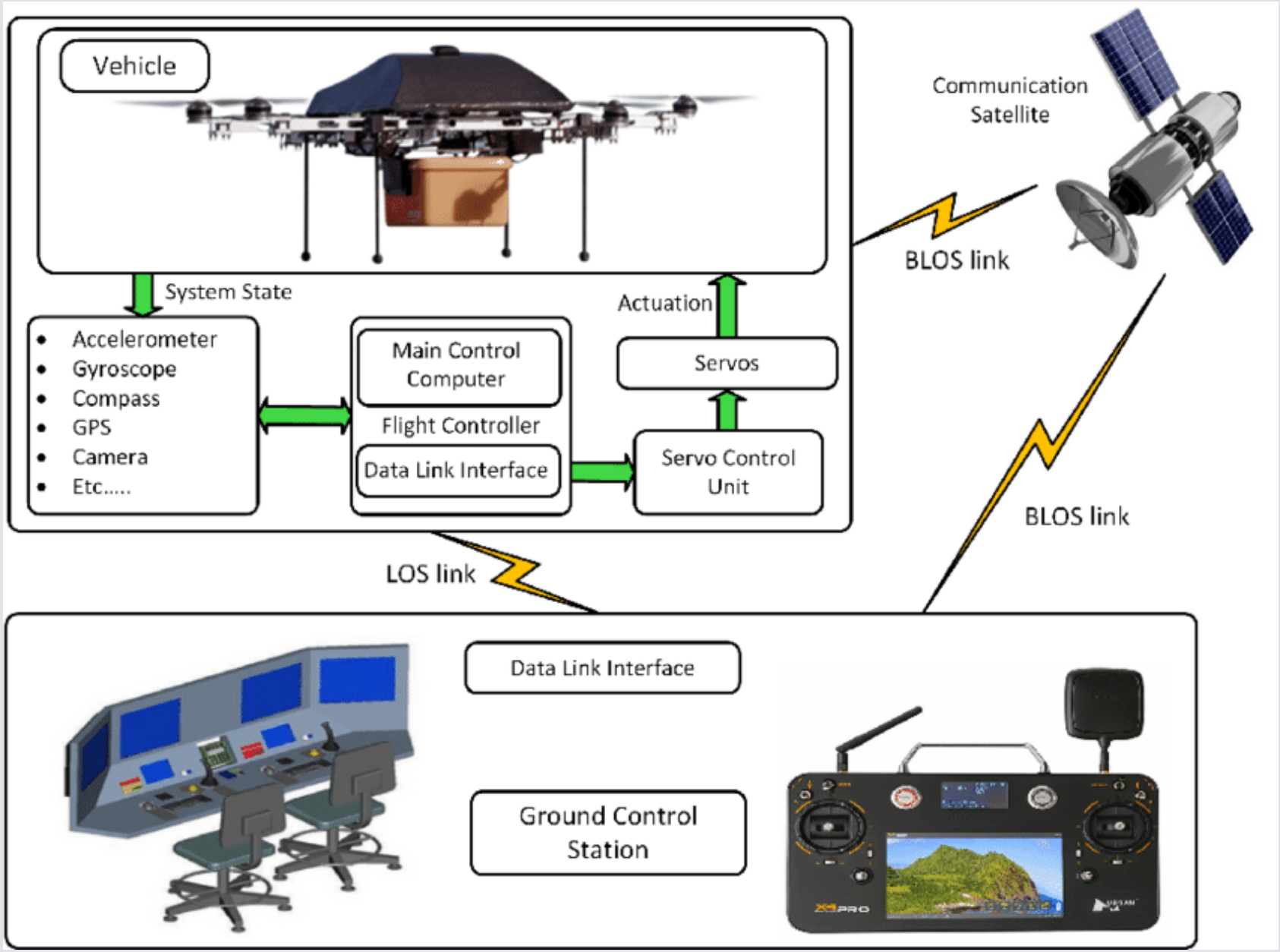
COMPLETE SYSTEM ARCHITECTURE



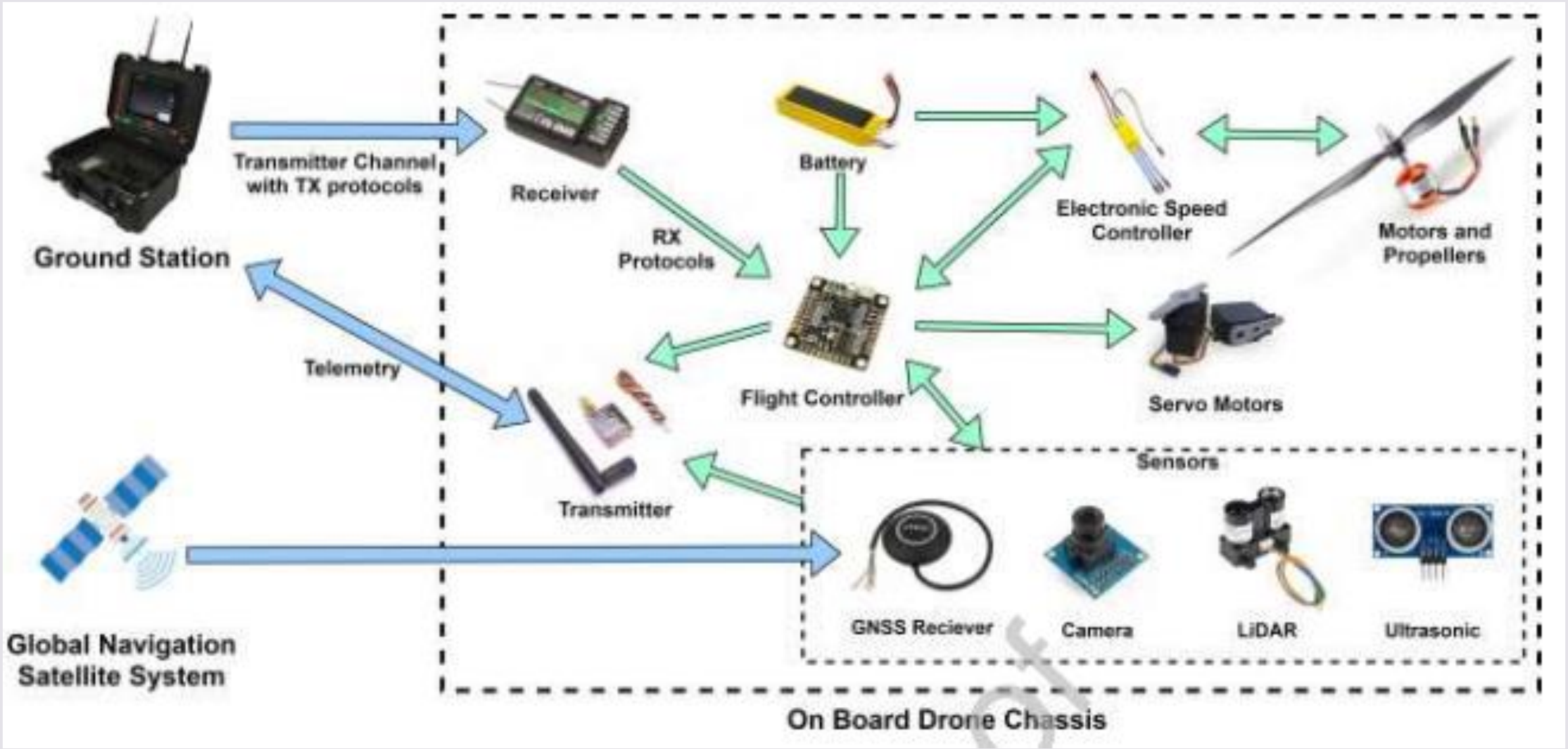
COMPLETE SYSTEM ARCHITECTURE



COMPLETE SYSTEM ARCHITECTURE

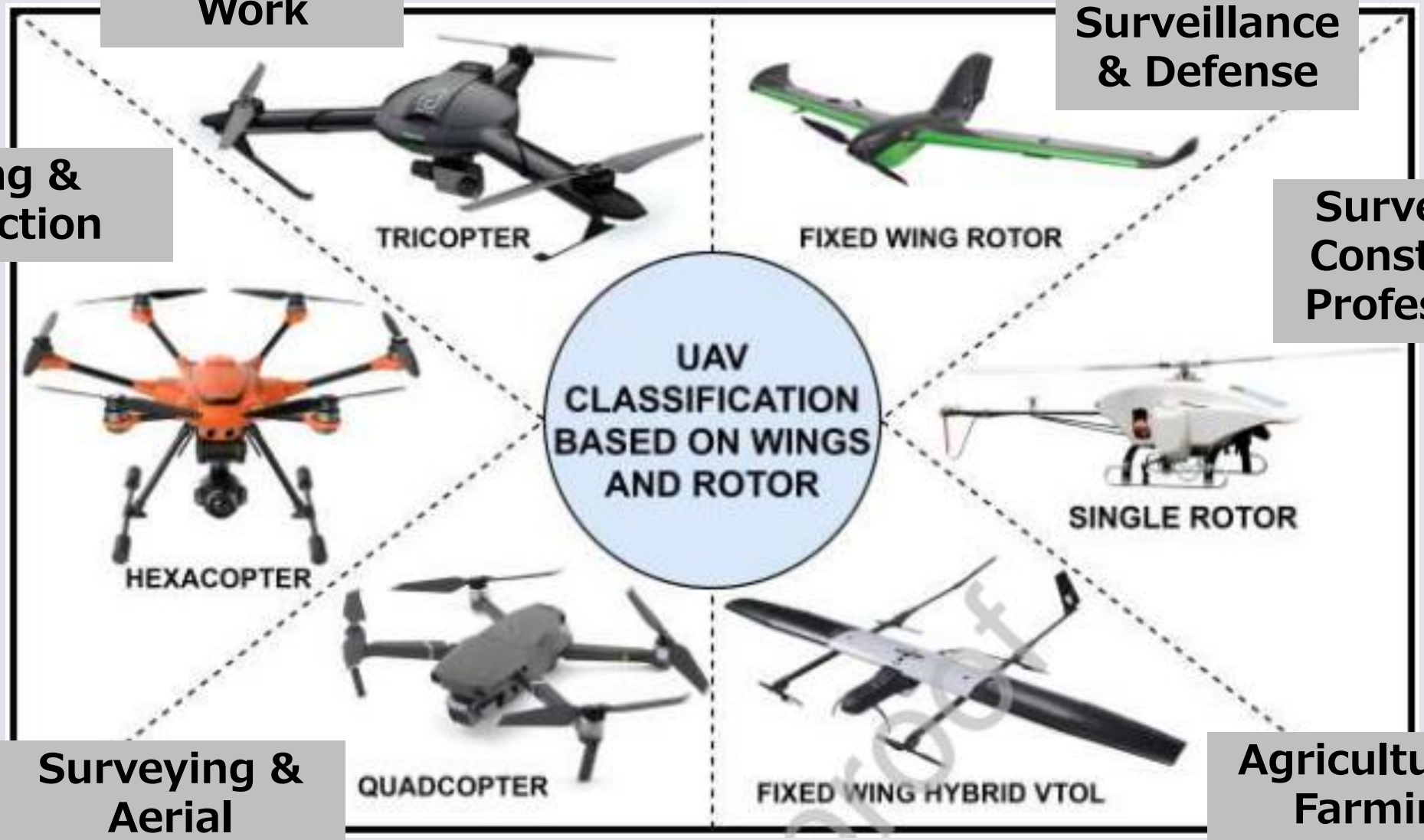


COMPLETE SYSTEM ARCHITECTURE



ROBOTICS HARDWARE COMPONENTS

1. ROBOT BODY DESIGN VS. TASKS



Warehouse Work

Mapping, Surveillance & Defense

Mapping & Construction

Surveyors & Construction Professionals

Surveying & Aerial Photography

Agriculture & Farming

1. ROBOT BODY DESIGN VS. TASKS

JUPITER TRICOPTER

Jupiter tricopter offers heavy lift, easy-to-deploy, and stability for industrial users. The app caters to businesses in security, mining, warehouse work, public safety, surveillance, and several other applications. Jupiter is reliant on FlightWave's open-source payload integration.

FIXED WING ROTOR

Fixed-wing UAVs can usually carry heavier payloads for longer distances and flight times than VTOL (Vertical Take-off and Landing) UAVs, while using less power. This makes them well-suited for long distance missions, such as mapping, surveillance and defense, where long endurance can be an important factor. They may also be better equipped to survive technical failure in the air, as many designs incorporate natural gliding capabilities in the event of loss of propulsion.

1. ROBOT BODY DESIGN VS. TASKS

SINGLE ROTOR

Single rotor drones are used for surveyors and construction professionals who want to lift heavier payloads of up to 40kgs because the single rotor is more efficient in the lift and uses less battery or fuel life as it flies. They can also fly faster than multi-rotors.

FIXED WING HYBRID VTOL

VTOL fixed-wing drones can provide highly efficient coverage and data collection for large farms, allowing farmers to quickly gain insights into crop health and other indicators and thus reducing costs of pesticides and fertilizer. A thermal camera payload will help detect well-watered field regions as well as dryer patches.

1. ROBOT BODY DESIGN VS. TASKS

QUADCOPTER

Quadcopters are typically simpler in construction and cheaper and easier to fly than unmanned helicopter drones, making them an ideal choice for certain applications such as surveying and aerial photography. They can also be used for drone deliveries and have already been used to provide medical supplies in both remote and urban areas.

LEICA AIBOT HEXACOPTER

Leica Aibot, the complete UAV solution for surveying, mapping and construction enables fast and flexible data collection. An easy workflow integrated into the Leica Geosystems ecosystem guides you through your project lifecycle, providing you quick access to critical information to perform your day-to-day work.

1. ROBOT BODY DESIGN VS. TASKS

TABLE I: Classification of UAV based on Altitude and Range

Type of UAV	Altitude	Range
Hand Held	<600 m	<2 km
Close	<1500 m	<10 km
NATO	<3000 m	<50 km
Tactical	<5500 m	<160 km
Medium Altitude Long Range	<9100 m	<200 km
High Altitude Long Range	>9100 m	NA
Hypersonic	<15200 m	>200 km

1. ROBOT BODY DESIGN VS. TASKS

Type	Pros	Cons	Typical Use
Fixed Wing	Longer flight times at faster speed giving more area coverage	Takeoff and recovery needs large space and no VTOL or hover	Pipeline and Power line inspection, Aerial mapping
Multi-rotor	Easy to use even in confined areas, support VTOL and hover, giving good camera control	Short flight times and small payload capacity	Video inspection and Aerial photography
Single Rotor	Longer flight times with VTOL and hover support, higher payload capability	More dangerous, harder to fly, more training needed, expensive	Aerial LIDAR scanning
Fixed-Wing Hybrid VTOL	VTOL and longer flight times	Not perfect at either forward flight or hovering	Delivery through UAVs

2. ACTUATORS/LOCOMOTIONS

Rotary Actuators

Rotary actuators will either provide a limited angular stroke, or be capable of continuous rotation, which is useful for electro-optical targeting and other positioning and scanning systems on UAVs.

Flight Control Actuation Systems

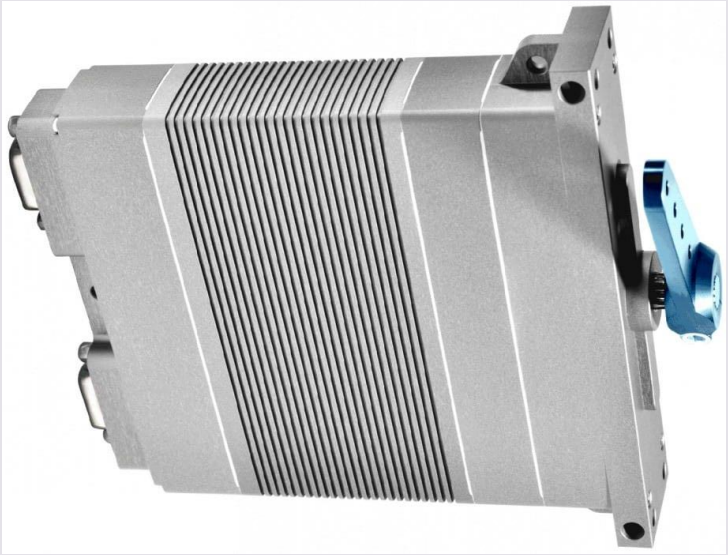
Actuators are also commonly used to move flight and attitude control surfaces on UAVs, such as the elevator, ailerons, flaps and nose wheel. Other unmanned aircraft applications include opening and closing the throttle valve on combustion engines, as well as doors and hatches. Actuators can be combined with an electromagnetic clutch which can be manually engaged or disengaged. Such a system can be found in Optionally Piloted Vehicles (OPVs), allowing the pilot to switch between unmanned and manned flight modes.

2. ACTUATORS/LOCOMOTIONS

DA 20-TS Throttle Actuator

The DA 20-TS throttle servo is a fully programmable, compact fly-by-wire actuator for direct installation on the throttle valve shaft of a combustion engine. It is IP-67 rated, immune to shock and vibration and designed for use at high temperatures. The RS-485 digital serial command interface can be used to monitor the shaft position as well as diagnostic information such as the supply voltage, the current consumption, and the temperature of the electronics.

DA 26-D Duplex Redundant Actuator



The DA 26-D is designed for applications where reliability is of the utmost importance. Its two-channel redundant design means that it can continue to operate even after one channel has failed. A three-channel position sensor is incorporated, as well as several diagnostic sensors that provide continuous information on current consumption, supply voltage levels and temperature readings. Data can be read out via the integrated serial RS-485 interface.

3. NAVIGATION SYSTEM & CONTROLLER

A typical UAV Navigation (UAVN) Flight Control System (FCS) consists of:

	Component	Provided By
Onboard Elements	▪ Autopilot	▪ UAV Navigation: ▪ VECTOR
	▪ Datalink	▪ UAV Navigation: ▪ TELEM07 ▪ External supplier: RS-232/ETH capable

	▪ Peripherals	▪ UAV Navigation:
		  ▪ External Magnetometer (MG01)
		  ▪ Target Drone Peripheral (TGTIO02)
		  ▪ Dual GNSS Compass (DGC01).
		  ▪ Flight Data Recorder (FDR01)
		▪ External supplier: to see integrated peripherals list go to Knowledge Base article 'Supported Peripherals'.

On Ground Elements	▪ GCS Hardware: Modem	▪ UAV Navigation: ▪ Modem with external datalink (GCS03-NR)
	▪ Datalink	▪ UAV Navigation: ▪ TELEM07 ▪ External supplier:RS-232/ETH capable
	▪ GCS Hardware: Joystick	▪ UAV Navigation: ▪ JY02
	▪ GCS Software	▪ UAV Navigation: ▪ Visionair

3. NAVIGATION SYSTEM & CONTROLLER

ONBOARD ELEMENTS: Autopilot
VECTOR-600

The VECTOR-600 is a fully integrated autopilot for use in advanced aerial target and UAV platforms where ultimate performance is required. It is suitable for all types of platform, including fixed and rotary wing UAVs; it is also suitable as the base for a flight control system of an Optionally Piloted Vehicle (OPV) or conversion of a manned aircraft into a UAV. Other than servos, batteries and an external datalink (radio transceiver), the VECTOR-600 is the only onboard system required to control a UAV and its payload.

ON GROUND ELEMENTS: GCS Hardware Modem
GCS03-NR

When putting together a system based on a UAV Navigation (UAVN) autopilot (AP), Ground Control Station (GCS) units must be included. The GCS is the hardware interface used to handle communications with the AP (via either an internal or external datalink) and to communicate with the PC running Visionair. It is always recommended as far as possible to use Ethernet instead of serial port to interface GCS and PC. The GCS also serves as the connection point in the system for the Joystick (if MANUAL mode is required at any point during operation).

3. NAVIGATION SYSTEM & CONTROLLER

ONBOARD & ON GROUND ELEMENTS: Datalink
TELEM07

The TELEM07 is a radio datalink compatible with all UAV Navigation (UAVN) autopilots (AP). The TELEM07 is supplied in a rugged, impact-resistant metal case and comes with the following accessories: System Mating connector (female) BINDER 77 3406 0000 50006-0200, SMA bulkhead connector, SMA to SMA coax cable, 1/2 Telemetry Radio antenna (for GCS use) or 1/4 Telemetry Radio antenna (for UAV use).

ON GROUND ELEMENTS: GCS Hardware: Joystick
JY02

Where manual control of a UAV is required, UAV Navigation (UAVN) offers the JY02, a radio-control style joystick, for use with its system. The JY02 connects via a cable to any of the Ground Control Station (GCS) units offered by UAVN: GCS03, GCS03-NR. The JY02 does not require batteries as it draws power from the GCS to which it is connected.

3. NAVIGATION SYSTEM & CONTROLLER

4. DATA COLLECTION

LANDPOINT

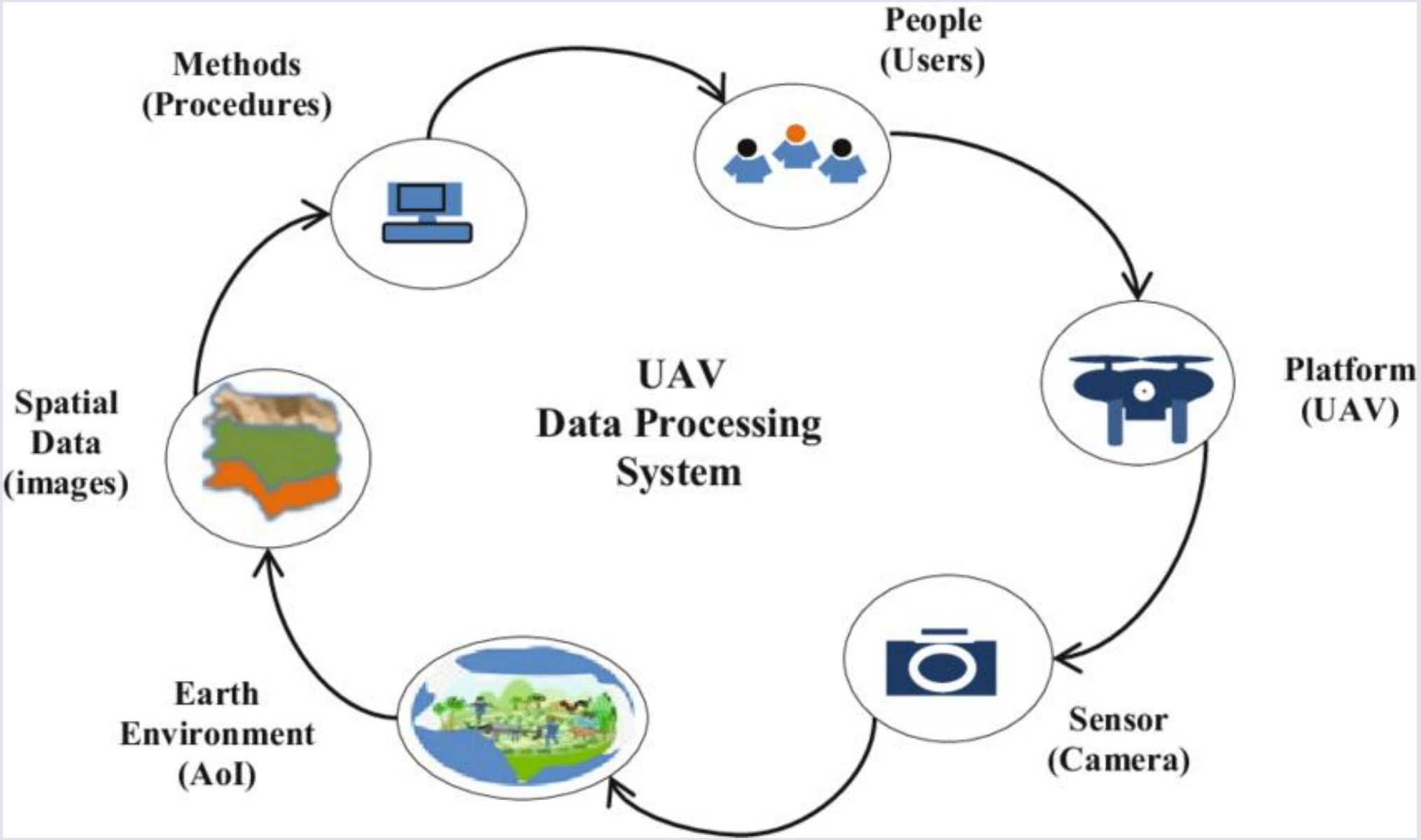
Landpoint is a complete end-to-end drone data collection provider. We collect, analyze, and distribute aerial data quickly and more cost effectively than ever before. At 1cm / pixel resolution, our drone surveying deliverables lead the industry in precision. Turn-around time can be as short as a few hours. Whether the project is a 100-mile pipeline inspection, mining volume calculation, or a vegetation / crop diagnosis our team can quickly and safely provide a UAV LiDAR survey at a never-before-seen price-point.

4. DATA COLLECTION

LANDPOINT

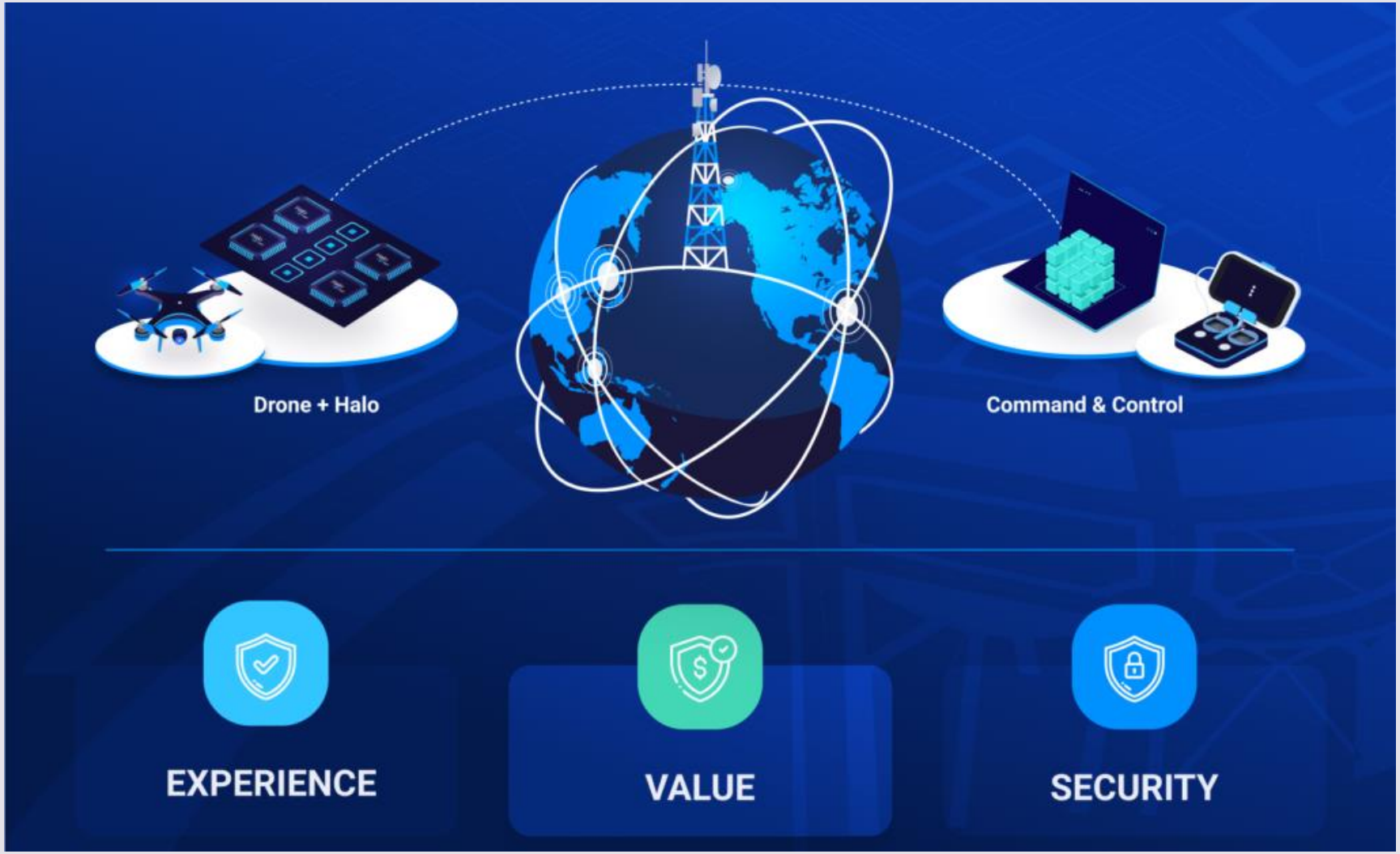
How it works:

4. DATA COLLECTION



5. DATA TRANSMISSION

Elsight is a leading developer of state-of-the-art drone connectivity solutions that provide seamless, always-on secure data transmission in challenging environments.



5. DATA TRANSMISSION

elsight

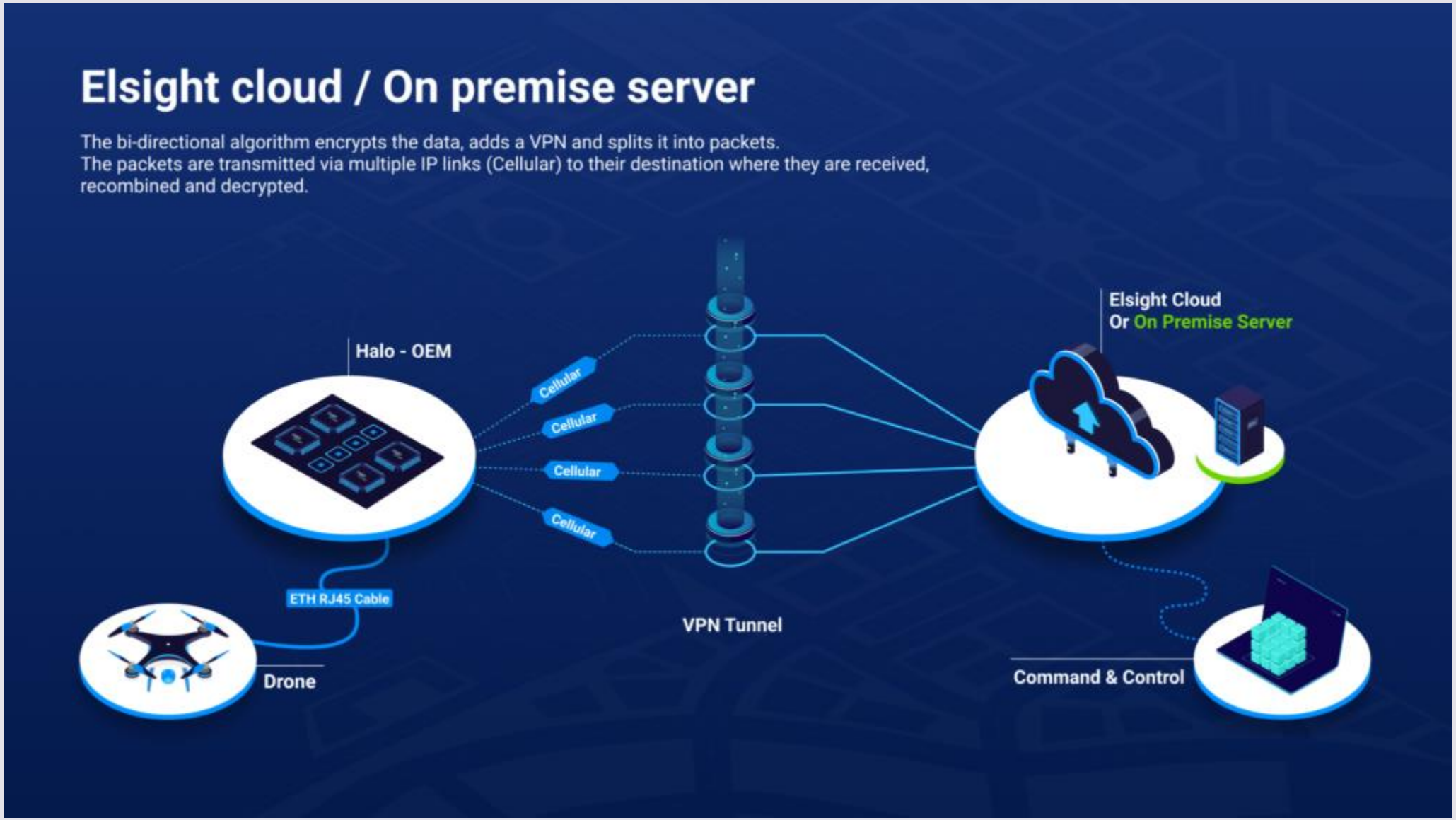
Halo OEM drone communication module

The secure wireless data transmission technology has been proven with over 4000 hours of operations (aerial and ground) across a broad range of applications, supporting hundreds of drones and unmanned systems, and is FCC and CE compliant and certified. Halo has been selected as the solution of choice by a variety of industrial robotics companies, first responder organisations, and government and military entities.

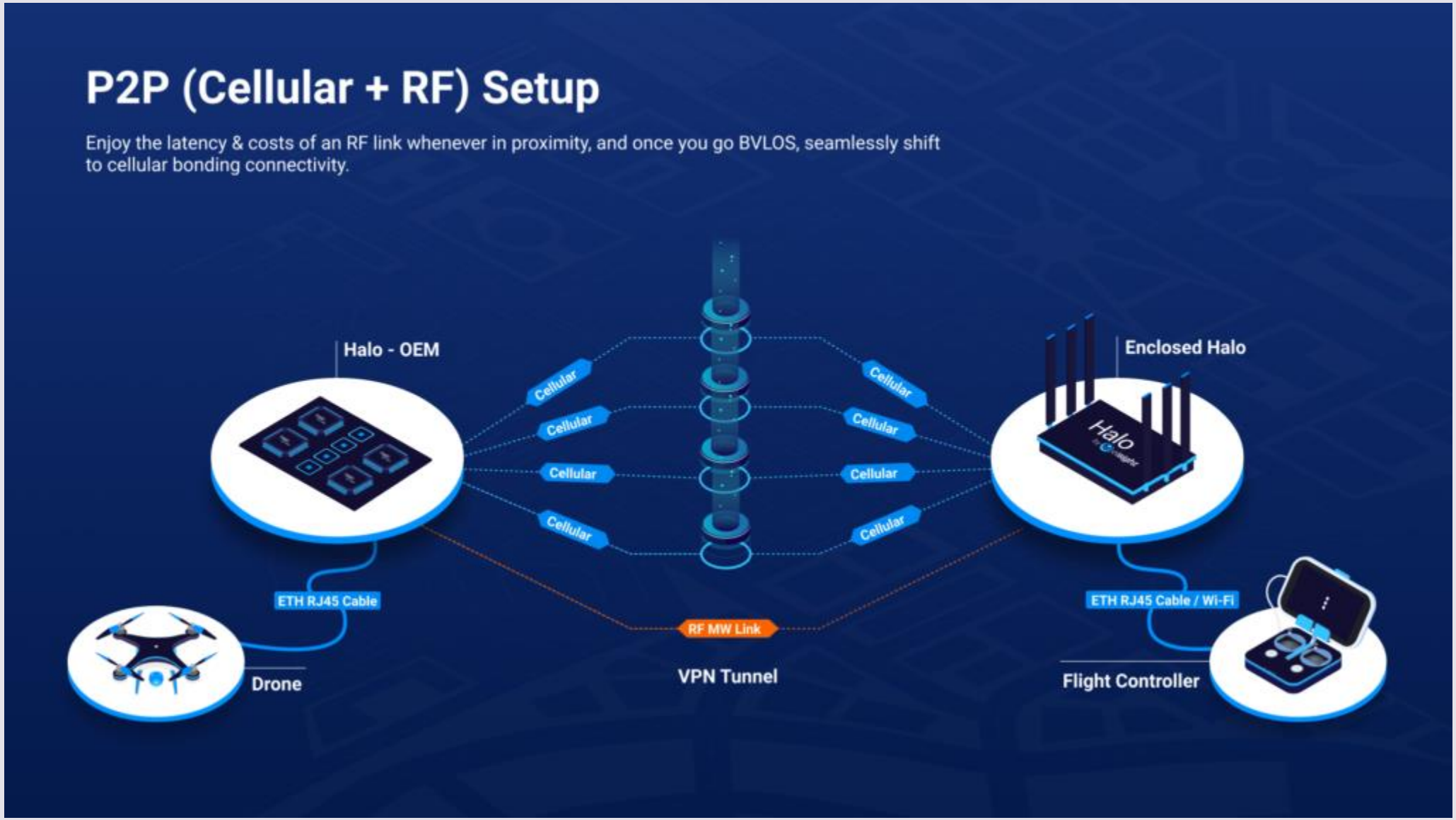
Stand-alone UAV Communications System

Halo provides reliable connectivity in dynamic conditions for even the smallest drones and robots. The highly compact system has been designed with an extremely low power consumption and heat index, and allows you to save space and weight, fly further, and undertake challenging missions beyond the line of sight while maintaining secure communications.

5. DATA TRANSMISSION



5. DATA TRANSMISSION



5. DATA TRANSMISSION

elsight

6. POWER SYSTEM MANAGEMENT

GREPOW
RECHARGEABLE BATTERY

GREPOW Rechargeable Battery

GREPOW's UAV Drone Battery are widely use in Agricultural, e-VTOL, Industrial Patrol, Forest Fire Fighting, Construction Monitoring, Cargo Transport, Aerial Photography, Surveying and Mapping. Exclusive Customized battery for DIY Manned Drone. Tattu standard batteries that are a part of the general series have a high capacity, high discharge rate, great compatibility, and reliable power for UAV, RC, VTOL, Quadcopter, Multirotor, Hexacopter, etc.

6. POWER SYSTEM MANAGEMENT

INTELLIGENT ENERGY Hydrogen Fuel Cells

Intelligent Energy's Fuel Cell Power Modules (FCPMs) for UAVs provide clean, efficient DC power from only hydrogen and ambient air, with zero emissions. With a higher energy-to-mass ratio than traditional battery systems, hydrogen fuel cells can provide commercial UAVs with over three times the flight endurance, allowing you to maximize productivity, minimize downtime and achieve more in a single drone flight.

LIST OF UAV COMPANIES

(SERVICE/MANUFACTURER/COMPONENTS) LOCALLY

aerodyne

Aerodyne is a DT3 (drone technology, data technology & digital transformation) enterprise solutions provider, leading the global tech curve in the use of drone data and AI-powered analytics to resolve complex industrial challenges, enabling organisations to rapidly scale, digitally transform, operate optimally and increase productivity.

LIST OF UAV COMPANIES

(SERVICE/MANUFACTURER/COMPONENTS) LOCALLY

Poladrone

We're accelerating the path to the drone revolution. Founded by a team of engineers, Poladrone is an all-in-one drone solutions provider for enterprises looking to modernize and streamline their operations workflow. Our mission is to help companies overcome difficult tasks through innovative and cost-efficient drone technology strategies. More than just toys for the enthusiast, we believe drones are the workhorses of the future.

LIST OF UAV COMPANIES

(SERVICE/MANUFACTURER/COMPONENTS) LOCALLY

DEFTECH

DRB-HICOM Defence Technologies Sdn Bhd

DEFTECH Unmanned Systems has supported customers by offering a wide range of UAV products and services with the necessary tools, expertise and certification from the relevant authorities to simplify the surveillance and monitoring the need of the customers. Going forward, we will continue toward a better future through advanced technologies and services.