



## SELECTING THE RIGHT TECHNOLOGY FOR UAVs

Unmanned Aerial Vehicles (UAVs), or drones, are being put to use in a huge variety of fields due to advances in the technology involved. There's no question that it's an expanding sector, and advances in onboard technology are enabling an even wider range of applications.

## Introduction

The global commercial drone market is predicted to exceed US\$8.5bn by 2027<sup>1</sup>. Additionally, the “special purpose” drones segment of the UAV market is projected to grow from nearly US\$9.5bn in 2021 to over US\$20.5bn in 2026, at a CAGR of 17.1%, proving the need for customised and adaptable solutions. Demand from the armed forces remains strong, with the military drone market being valued at over US\$11bn in 2021 and expected to reach over US\$26bn by the end of 2028, growing at a CAGR of 12.8%<sup>2</sup>.

However, as we saw in 2020, unpredictable events such as shortages of raw materials and components or availability of skilled labour can affect the output of UAVs and some manufacturers have seen demand outstrip supply.

So, **what are the most important factors when designing a UAV?** This article looks at the latest developments and what’s available to engineers seeking to optimise surveillance, remote monitoring and even delivery technology. We should also remember that UAVs are in fact a two-part system – the vehicle itself and the control centre on the ground.

## UAV Communications

**Datalink Communication** refers to digital communications between air and ground systems, or air to air, referred to as **swarming** between two or more drones. In the case of UAVs, controllers could have a single unit to manage, or several drones, and the uninterrupted transmission of large data loads over hundreds of miles may be required. The best choice for a communication device will bring together data, video, and voice functionalities in real-time. One leading solution is **Wave Relay®**, an encrypted advanced **Mobile Ad hoc Network (MANET)** developed by [Persistent Systems](#) and supplied by Steatite as the UK’s only authorised distributor of Wave Relay® technology.

An unmanned aerial vehicle equipped with Wave Relay® as its primary datalink will provide unparalleled throughput at range. The maximum throughput supported by Wave Relay® is over 100Mbps, whilst the range between two nodes when using the Wave Relay® tracking antenna can exceed 200km.

Based on the Wave Relay® network, Steatite provides the [MPU5](#) and [Embedded Module](#) - the most advanced, most scalable and efficient MANET smart radio in the world. Designed into a number of current UAV systems, these devices replace separate, specialised equipment, reducing size, weight, power and cost, enabling increased flight time and releasing valuable payload to embed other sensors. Each system installed with an Embedded Module extends the Wave Relay® MANET, allowing users to access services such as video or data on any node, from anywhere.



Fig.1 [MPU5 Radio](#)

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1. <https://www.prnewswire.com/news-releases/global-commercial-drone-market-expected-to-exceed-8-5-billion-by-2027--301234242.html>  
2. <https://www.fortunebusinessinsights.com/military-drone-market-102181>

Furthermore, using the built-in Android system in the MPU5 or Embedded Module enables the direct installation of applications onto the radio, **transforming a single Smart Radio into a pilot system**, able to fly or drive multiple unmanned systems. An entire fleet of UAVs can now operate, communicate and swarm on a common network.



Fig.2 [Auto-Tracking Antenna System](#)

Delivering high bandwidth connectivity at long ranges, our [Auto-Tracking Antenna System](#) is a deployable unit that works in concert with the MPU5 radio, keeping **constant communication from air to ground**. It has the ability to self-calibrate before operation, eliminating the risk of human error and improving tracked precision, providing higher accuracy than ever before. It's a **fully portable solution**, breaking into several parts and needing only 15 minutes to assemble.

## Onboard computing

As drones are tasked with more and more complex assignments, compute capability is becoming increasingly important, but onboard components need to be **compact, lightweight and power efficient**. Materials used in construction must also be strong enough to **withstand pressure from the high altitudes** at which military drones are flown. COM Express or SMARC modules with a custom carrier board are ideal as these fall within most weight and power requirements and can be specifically designed for the required task.

Steatite offers a range of industrial grade [COM Express](#) and [SMARC](#) computer modules. Based on the latest CPUs and supporting x86 and ARM processors, components are selected for **long-term availability** and reliability with **High Performance Computing (HPC)** and **wide temperature options** available.

For larger vehicles, our military grade [VITA 75](#) Convection Cooled embedded system for SONAR and image processing applications offers a powerful Intel® Xeon® processor, 16GB DDR4 soldered memory and support for Windows® and Linux operating systems.

To make UAVs even smarter, AI-ready [NVIDIA Jetson](#) systems can be used. Using the power of deep learning algorithms to understand and react to the world around them, Jetson platforms support **visual situational awareness and autonomy** onboard drones. Industrial grade [Xavier carrier boards](#) bring powerful processing to control computers while some [Nano](#) and [TX2](#) carrier boards are compact enough to be included in the UAVs onboard devices.

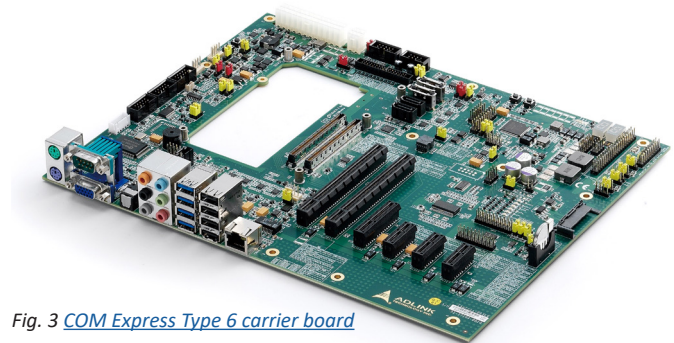


Fig. 3 [COM Express Type 6 carrier board](#)



Fig.4 [VersaSync master clock and network time server from Orolia](#)

GNSS signal interference can impact the timing synchronisation of embedded sensors, therefore data collection on the navigation computer could be compromised. By using an **atomic clock** as holdover oscillator, sensor data will be synchronised even in **GNSS-denied environment**, by using products such as Orolia's [VersaSync](#).



## Ground Control

The **Ground Control Station (GCS)** is also likely to be moved regularly as the UAV will cover different terrain. So, this may also need to be rugged and portable, although weight restrictions are less important for this part of the system. Again, a fully customised computer will ensure optimum functionality without having unnecessary features taking up valuable space and power. Some GCSs, however, may be static, such as a military command centre, and here, the ability to **maintain real-time communication** with the vehicle over hundreds of miles will be the top priority.

The Universal Command & Control Terminal ([CRiB](#)) developed by Steatite is an all-in-one battle management system (BMS) complete with **Unmanned Systems control capability, voice/data communication, and full motion video (FMV)**. Playing an integral part of any MANET, the CRiB provides an instant viewing terminal for full motion video (FMV), situational awareness and other sensor data, all from one convenient HQ management platform.

The CRiB combines with a compatible tracking antenna and MANET Command Environment ([MaCE](#)) software to provide **complete ground to air data communications** for UAV systems. MaCE provides a flexible docking interface combining multiple video feeds into a single customisable panel, and the CRiB itself demonstrates how our expertise in computers, communications and power comes together to produce unique and innovative products.



Fig. 5 [Universal Command & Control Terminal \(CRiB\)](#)

## Powering a UAV

Selecting the most suitable power system for a specific UAV is complex, with many considerations to take into account such as **capacity, voltage, physical size, weight and rate of discharge**. Depending on the purpose of the UAV, other factors may need to be considered such as tolerance to **vibration, moisture and dust, as well as extremes of temperature**.

While developers may think that the lightest cell option will be the best, it may in fact be the case that a heavier battery with a higher power-to-weight ratio is optimal, allowing fewer, longer missions which will be more cost-effective than multiple, shorter ones.

**Lithium polymer** (LiPo) cells offer the lightest option and can be used in vehicles where weight is critical, but [Lithium-ion](#) cells are far more robust, will not expand during use and can be designed in different shapes outside prescribed squares and oblongs.

Again, a fast-charging battery pack may seem like the best option but may, as a result, have a shorter cycle life, and, indeed, a limited total life. Developers will need to consider the **whole life cost of cells** over what may appear to be a cheaper choice.

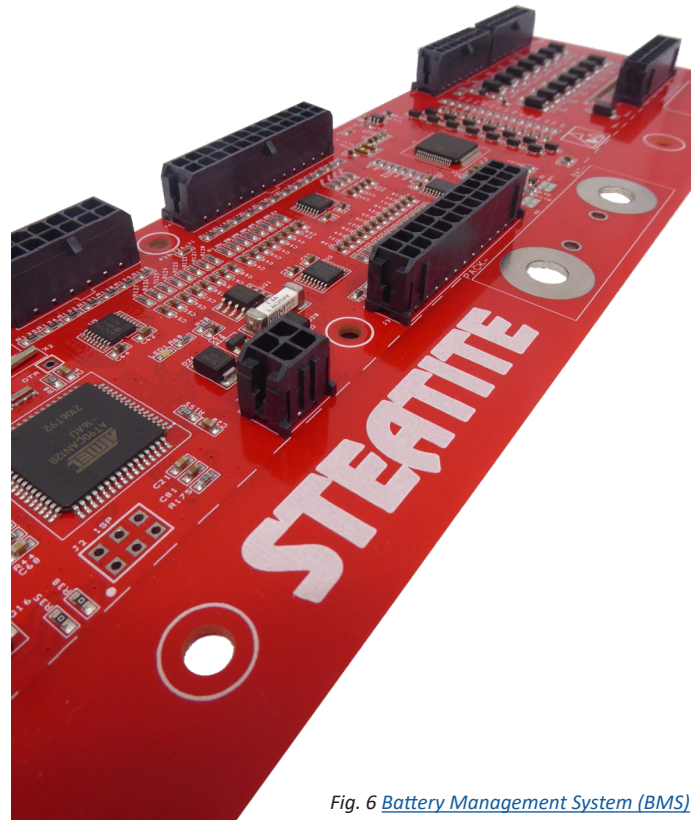


Fig. 6 [Battery Management System \(BMS\)](#)

**Battery Management Systems** ([BMS](#)) can provide a wide range of self-diagnostic information to assist in extending battery life. Data based on capacity, current, discharge, cell temperature, ambient temperature and more is collected and analysed so remediate action can be taken when needed to improve battery performance. Therefore, receiving real-time information on battery management is vital as power failure could result in the loss of data or the UAV itself. In stark contrast to many other battery powered applications, should a fault be detected by the BMS, **the battery pack must not fully shut down immediately**, but rather continue to provide limited power to enable the UAV to attempt to land in a safe location in a controlled manner.

In addition, due to the airborne nature of a drone and therefore in line with all other aircraft within the aerospace industry, there must be potential for **built-in redundancy**. It is often the case that UAVs will also house primary (single use) battery packs for back-up safety functionality.

**Enclosures and connectors** also need to be selected carefully to suit the application requirements. Bespoke enclosures may need to be constructed, requiring innovative design skills at an early stage of the project.

Our wealth of UAV-specific experience means that inhouse battery capabilities include:

- Dedicated fuel gauge engineering
- Firmware development (STMicro STM32 based)
- Hardware design expertise in power circuit design
- Cold temperature operation management
- Small footprint (memory) CAN Bus implementation with PC GUI
- PC based CAN GUI for debug and firmware updates
- High current PCB design
- High power interconnect system design using copper-clad weld tabs
- Vast experience in ruggedised composite material enclosure design

Steatite offers a range of **high capacity custom engineered [battery packs for large UAVs](#)**, designed and built in the UK to the very highest standards. Furthermore, engineers with decades of experience in [designing batteries](#) for a huge range of uses will guide developers through the selection process to ensure the best cells – which may not be the most obvious ones – are chosen for the vehicle.

Li-ion cells must meet the intended nation's testing and safety standards, and must be transported according to international regulations. All Steatite's battery products are designed to meet **international battery safety standards** IEC62133 (Portable) / IEC62619 (Industrial) as applicable, as well as transport regulations (UN38). You can see more about our accreditation on our [website](#).



Fig. 7 [UAV battery pack](#)

Additionally, our engineers can customise heating solutions capable of heating core battery packs from -20°C to +5°C in less than 20 minutes. These mylar-based thermo heaters will ensure batteries are performing at optimum levels for the entire flight duration.



Fig. 8 & 9 [Mylar based thermo foil heaters](#)

## Aerial navigation and steady flight

Getting a UAV in the sky requires careful selection of all the above components; keeping it there requires further technological considerations. As Beyond Visual Line of Sight (BVLOS) trials are now being allowed by more countries, being able to avoid electricity cables, buildings and birds is vital for drones. **Obstacle detection and collision avoidance** uses sensors based on a variety of technologies including [LIDAR](#), [ultrasonic](#), [Time of Flight](#) or a standard [image sensor](#). Simultaneous Localisation and Mapping ([SLAM](#)) technology can be used to process data into 3D maps to check for obstacles as well as precisely monitoring the UAV's location.



Fig. 10 [Sinuous Antenna](#)

While ground control will benefit from technology such as our CRiB and long range antennas, onboard remote navigation requires tech like Steatite's Dual Linear and Dual Circular **polarised sinuous antennas**. With the capability to simultaneously receive signals from the ground or other UAV source of any two orthogonal linear polarisations and simultaneous left and right-handed circular polarisations, the wide beamwidth provided by a sinuous/spiral antenna allows the link to be maintained with the platform in any attitude. Alternatively, the **Multiple Input Multiple Output (MIMO) blade antenna** which provides long range and high throughput can be placed aerodynamically on the body of the UAV.

UAVs must be controllable and operational, even in unpredictable conditions, strong air currents and inclement weather. Sensing technology is therefore needed to enable the UAV to remain airborne. Sensors are comprised of **accelerometers**, to detect linear acceleration, **gyroscopes** to measure angular rate, and **magnetometers**, measuring XYZ magnetic field strength to provide a heading reference. The raw data from these sensors can be processed by an inertial and/or navigation unit to calculate attitude, velocity and position so the UAV can compensate for pitch, roll and yaw and maintain a steady flight path.

Our sister company, [Willow Technologies](#), supplies this core sensing technology, such as Silicon Sensing Systems' [DMU41](#) – a new and versatile IMU containing three inductive and three piezoelectric resonating ring gyroscopes, along with six accelerometers. This compact unit **reduces unit volume, weight and power consumption by more than 40%** compared to earlier models and is ideal for smaller, commercial UAVs that need to spend more time in the air to be profitable.

Also supplied by Willow, the [RM3100](#) from [PNI](#) is a geomagnetic sensor designed to deliver **precise compass headings and magnetic field measurements**.

It's been designed in by one of Willow's specialists to a medium-sized multi-rotor surveillance and special mission drone created for use by UK emergency services. The sensor was selected due to its low power consumption, large dynamic range, high sampling rates, high stability over a wide temperature range, and for being inherently free of offset drift.



Fig. 11 [DMU41 Inertial Measurement Unit \(IMU\)](#)



## An artificial eye in the sky

The demand for UAVs with advanced computer vision is becoming commonplace in security, surveillance, agritech and logistics to name but a few applications. Being able to monitor an area, record image data and make this data available in real-time for a controller or observer is paramount in making quick, accurate, responsive decisions. Whilst size, weight and power are key parameters, each application also imposes different requirements on the optical properties of the camera.

A camera that uses a [rolling shutter CMOS sensor](#) may be smaller and cheaper but a **global shutter** is often preferable for UAV cameras. A global shutter exposes all the pixels on the sensor instantaneously, so every pixel of the final image is captured at the same moment in time, rather than a rolling shutter which captures the image line by line, resulting in image distortion of fast-moving objects or scenes.

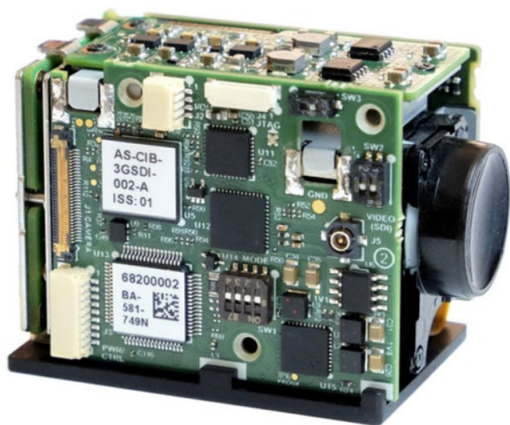


Fig. 12 [Harrier 10x AF-Zoom 3G-SDI Camera](#)

[Autofocus-zoom](#) (AFZ) capability is also a must, so that **focus and field of view can be maintained** throughout the flight. While it is possible to use very small, light mobile phone type cameras which give a good fixed image, AFZ cameras give a better quality image due to the larger optics – in particular the optical zoom, as digital zoom is not optimal for capturing a quality zoomed image.

Miniaturisation of components means that some elements of image processing can be carried out onboard the UAV, minimising the amount of data that needs to be transferred. This requires compact cameras and power-efficient processors. AFZ cameras with closely attached [interface boards](#) and **external adapters offer multiple video transmission, conversion and processing options.**

Technology such as [Harrier cameras](#), [Oriole Cameras](#) and [BlueBird adapters](#) from [Active Silicon](#), the imaging business unit of Steatite, bring all these features together in a range of camera solutions. Harrier AFZ camera modules include units with **10x, 30x, 36x or 40x zoom, 3G-SDI/HD-SDI, USB3, HDMI, IP Ethernet and LVDS** outputs, global and rolling shutters and **2MP, 3MP, 4MP and 4K** resolution. Combined with some of the most compact AFZ cameras in the market, **MIPI CSI-2** options are also imminent meaning there's an ideal camera available for every UAV.

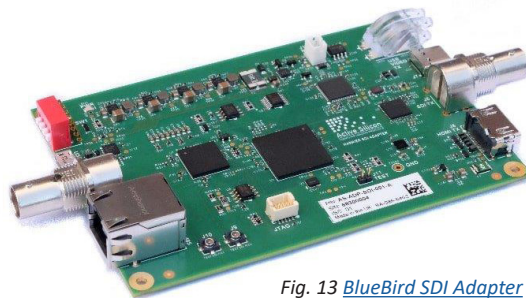


Fig. 13 [BlueBird SDI Adapter](#)

The [BlueBird SDI Adapter](#) is designed for format conversion of 3G-SDI, HD-SDI and HD-VLC video streams and operates as a USB/HDMI/SDI converter, splitter and external frame grabber for streaming video and video capture, bringing increased flexibility to tethered drones.



Fig. 14 [Harrier 10x AF-Zoom Camera](#)

Any one of these cameras can be mounted on a UAV to give **First Person View (FPV)**. The camera transmits a live video feed to the remote controller so, that from any distance, they can see what the UAV “sees” just as if they were on board the vehicle.



Advanced vision technologies are being more widely used in UAVs including [infrared](#) and [hyperspectral](#) imaging. These allow controllers to see enhanced details in dark, cloudy or smoky environments, and collect and analyse data outside of the human visual range, further expanding the operability of the unit.

Cameras need to be mounted in a constant position and Willow Technologies supplies sensing technology including MEMS Gyroscopes and MEMS IMUs, specifically designed to **stabilise platforms for mounting mobile antennas and cameras**. Designed and manufactured by Silicon Sensing, the range includes high-end solutions such as the [CRS39](#) for **optimum bias instability, angle random walk and low noise**.

Alternatively, a tri-axis accelerometer, such as the [Kionix KXTJ3-1057](#) from [Rohm](#), also available from Willow, can be used. Image stabilisation reduces blurring associated with the motion of a camera during exposure. Specifically, it **compensates for pan and tilt** (angular movement, equivalent to yaw and pitch) of a camera or other imaging device.

Of course, all components must be rigorously tested prior to manufacture to be sure they meet the stringent dust, vibration, shock and moisture levels that commercial and military drones are subjected to.

Steatite has extensive in-house testing capabilities across our business units. These include a near-field RF test chamber, semi-anechoic EMC test chamber, battery pack analysis and testing against extreme environmental conditions with our climatic chamber, vibration table, and altitude test chamber.

Read our [Test Facilities & Capabilities brochure](#) to see exactly which standards we can test against.



TECHNOLOGY FOR EXTREME ENVIRONMENTS

## Applications for UAVs

So, what can we do with all this technology? UAVs bring immense scope to a plethora of applications in today's commercial and industrial markets.

UAVs were initially conceived for **military purposes** and this area continues to drive development, especially in the autonomous arena. These range vastly in size and scope, for example, the tiny Black Hornet Nano was put into action in Afghanistan to snoop round corners and give soldiers heightened situational awareness. Measuring approximately 10cm x 2.5cm and weighing just 16g, it uses near-silent motors powered by a rechargeable battery designed to be replaced in the field. Three onboard cameras transmit live video and still HD images. At the other end of the scale is the huge RQ-4 Global Hawk, which measures 40m across, can fly for over 30 hours, reaching altitudes of 18km and surveying over 100,000 sq.km. a day.

Even before the pandemic, delivery companies were using and trialling **airborne deliveries**, particularly in the medical field where drones were bringing vital **pharmaceutical supplies** to rural communities. Local and national lockdowns have since fuelled the delivery sector and unmanned airborne delivery vehicles could become commonplace in the near future. Notably, Royal Mail recently trialled an autonomous delivery drone on the Scilly Isles, using a large, twin-engine drone developed by Windracers Ltd with a payload of 100kg.

Manna are another start-up looking to benefit from the growth in last-mile retail and food delivery with their drone with a payload of 3kg and top speed of 80kph. Such innovations are being further boosted by the current drive for greener delivery channels.

**Agricultural drones** are experiencing some of the largest growth of any UAVs at present. The market in 2021 was worth an estimated US\$4.9bn and is expected to expand by over 19% by 2026<sup>3</sup>. Of particular note is the demand for UAVs equipped with hyperspectral imaging (HSI) capability. This enables farmers to survey vast areas of crops and identify which specific patches need more water, fertiliser or weedkiller, in a trend known as **Precision Agriculture**. UAVs for this purpose require low processing capacity as only a yes/no outcome is required – does the crop need water or not? And it's not just arable farmers employing drones, cattle farmers can also keep watch over their herds using airborne cameras, allowing them to cover a far greater area than could be managed on the ground.

UAVs are also used in **industrial applications**, often to inspect areas which are not accessible or safe for humans to access, such as **nuclear installations**. As well as collecting visual data, UAVs equipped with temperature sensors are used in heating, ventilation and air-conditioning (HVAC) applications to detect heat loss from buildings, and drones with air quality sensors fly along miles of gas pipelines to detect leaks.

Cameras with optical gas imaging, LIDAR and thermal imaging add certainty to gas line inspection in many circumstances. While much of this data can be safely recorded and viewed at a later time, some inspections require real-time data transmission in order to be most effective, such as when an electrical fault has been detected that poses an imminent fire risk. And of course, down time costs money, and **fast identification and resolution of maintenance issues** can help organisations to save thousands of pounds over time.

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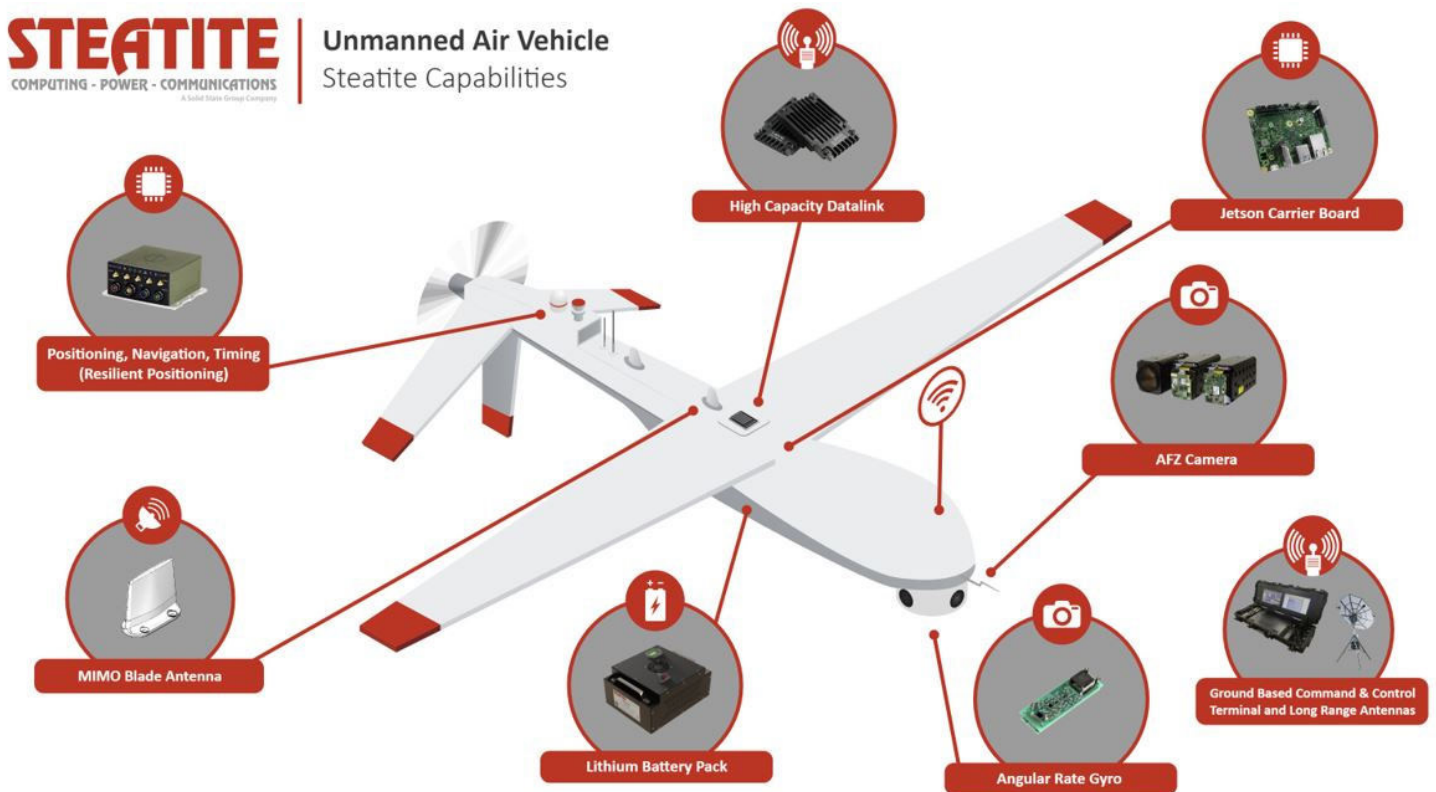
3. <https://www.marketsandmarkets.com/Market-Reports/agricultural-robot-market-173601759.html>

## Building the best UAVs

The use of UAVs and drones is becoming more commonplace across many sectors, and that trajectory is set to continue. Using the best and most suitable technology available for all materials, components and supporting equipment will increase the efficiency and ROI of any vehicle.

Steatite engineers will **guide developers through the selection processes** involved in identifying and securing the prime **computing, communication, power, navigation and imaging solutions** for any application. This means being involved in the project at an early stage as the most obvious choices aren't always the right ones.

[Contact our experts](#) for more information and assistance with your UAV mission, and see what we can bring to the drawing board.







# STEATITE

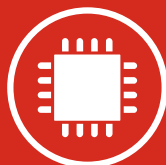
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