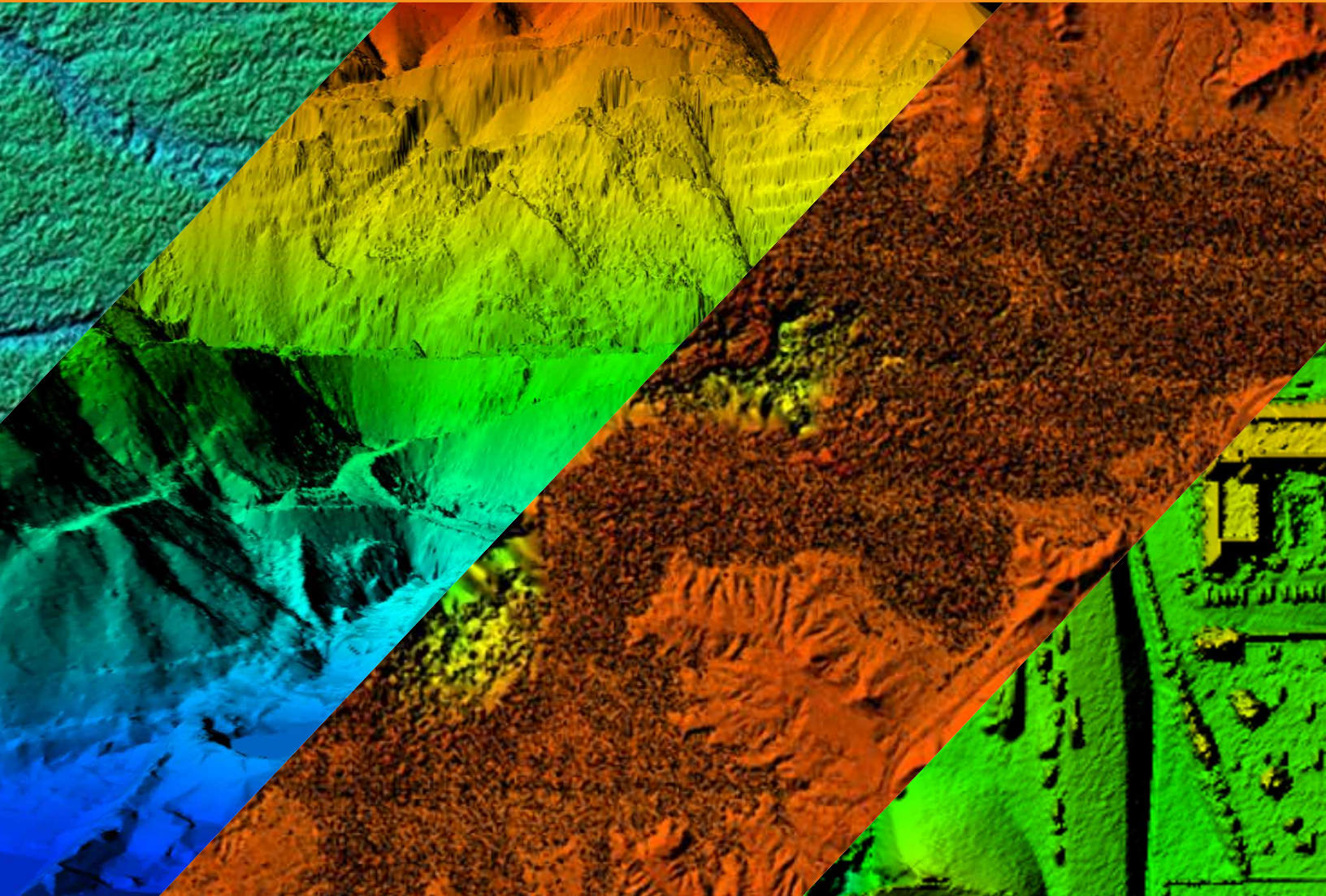


UAS MARKET DIFFERENTIATORS



WHITE PAPER

EXECUTIVE SUMMARY



Commercial and government organizations that want to benefit from the remarkable data being captured by drones for surveying, mapping and engineering applications should be careful in selecting a professional UAS services vendor that is safe, effective and has a great reputation.

There are many UAS operators in the United States that have been put through the paces and developed the capability of providing good quality results. But there are also thousands of companies with little or no professional drone experience. They make big promises but deliver unsatisfactory results.

When choosing a contractor for your next UAS data collection project, we recommend you take the following into consideration.

PROFESSIONAL FLIGHT OPERATIONS

Drone Flight Operations Must be Professional and Safe



There are thousands of companies that claim to be in the business of using drones to collect data for surveying and mapping, but only a few operate with the level of professionalism you would expect from a commercial airline. In an ideal world, each company would have systems in place to ensure their operations are safe, effective and compliant with the law. These systems should address the qualifications of the pilot, suitability of the aircraft and sensor, compliance with local airspace regulations, and assessment of flight hazards.

Unfortunately, federal regulations in the United States currently fall far short of ensuring unmanned aerial systems are operated in the same safe and efficient manner as their manned counterparts. Not only does this pose danger (and possibly liability) for you as the contracting organization, a lack of highly professional flight operation standards jeopardizes the quality of data collected for your geospatial project.

Ask the following questions when assessing the flight operations of prospective drone contractors:

- **What is your plan to collect the data that meets the specifications of my project?**
- **May I review your pilot's log book?**
- **May I review the operations log and maintenance schedule of the drone that will be used?**
- **Have you performed a compliance review of my project area?**
- **What safety precautions does your team take onsite?**

At Juniper Unmanned, we understand that there is no one-size-fits-all approach to collecting quality geospatial data, especially with a drone. That's why we have assembled teams of professionals with expertise in surveying and mapping, as well as infrastructure inspection, asset management and other applications. They work backwards from your application to determine your unique data quality requirements and create a comprehensive airborne acquisition, ground control and data processing plan customized to your needs.

We have four different LiDAR sensors, multispectral, thermal, and optical cameras, along with more than two dozen drones representing six preferred rotor and fixed-wing airframes. Don't know what sensor, airframe or data accuracy your application requires? Don't worry. The Juniper staff will help determine the right platform and sensor integration to best meet your needs.

Additionally, our pilots exceed government mandated training. In addition to FAA ground school certification, Juniper pilots have been trained and tested in the flight operation of each drone in our inventory. A drone should be operated by the trained professional.

Each pilot logs their hours of flight and the hours of operation for each of our drone airframes and data acquisition sensor. Each log includes details of past activities as well as records of completed maintenance. This significantly reduces the chance a hardware malfunction will disrupt your acquisition timetable.

Before every flight, our crews complete a 12-page Compliance Review of FAA-mandated airspace restrictions and limitations in your project area, contacting air traffic control (as needed) and pinpointing hospitals, schools and critical infrastructure that should be avoided. Juniper Unmanned's professional pilots know what to expect when they arrive, but the field crew still completes a Hazard Review onsite to avoid powerlines, populated events or other safety concerns that may impact operations.

To add one final layer of safety, Juniper crews arrive wearing Personal Protective Equipment, replete with reflective vests, steel-toed boots, and hard hats. Our goal is to ensure your data is acquired safely and efficiently, as well as accurately and quickly.

DATA PROCESSING AND MANAGEMENT

Every Drone Data Processing Job Must be Custom to Fit Your Needs

Don't fall for the 'push-button' solution to data processing now being promised by some drone operators. Automated processing tools are sufficient for some applications, but they generally make too many standardized assumptions about data quality that do not apply to engineering- and survey-grade projects.

If your end-use application requires accurate measurements of features or distances, the acquired data must be custom processed. And the same is true if you need your data tied to a local coordinate system.

Related to data processing is the management and archiving of the digital files. The most common unpleasant surprise faced by first-time users of UAS data is the massive volume of the data files. Either you or your drone services company must be ready to handle the data.

Here are some questions to ask relating to data processing and management:

- Does the UAS firm have personnel dedicated to data quality assurance?
- Do the data quality personnel interact with the flight crew?
- Does the UAS firm have the capability to process and archive large data files?
- Does the operator use Standard Operating Procedures that ensure safety, compliance, effectiveness, and repeatability?
- Is the operator properly insured?

Juniper Unmanned has a data processing team dedicated to (you guessed it) processing data. More importantly, team members are experts in a variety of geospatial applications, including surveying and mapping, infrastructure inspection, and asset management – having worked with utilities, transportation agencies, and survey companies.

Ensuring data quality starts with planning and acquisition and ends with the processing. In planning your project, our data experts work backwards from your end use to determine the correct accuracy and precision for the data. (Of course, if you already know your project specifications, that's great!)



From there, our data experts figure out which combination of sensors and airframes – along with the proper level of ground control – will capture the right data to meet and exceed your requirements.

Next, our data experts interact directly with our field crews and pilots to plan the flight paths to acquire the data you need. Once the data is collected, we process it in a workflow customized to generate the end-product you need and want, whether it's a LiDAR point cloud or GIS-ready vector layers, in nearly any popular file format.

We perform the processing in-house using our own proprietary integration of image and LiDAR processing software on computers with massive number-crunching power. And as a part of our service, we store your data (so it can be used again in the future as a reference layer) in the Amazon cloud.

STANDARD OPERATING PROCEDURES & SAFETY MANAGEMENT SYSTEMS

Every Drone Operation Should Have a Documented SOP and SMS



Providing drone operations that are safe, effective, and compliant with the requirements of law requires a lot more planning and preparation than most drone services companies want to admit. Highly professional operators will have a well-documented Standard Operating Procedure (SOP) that outlines the written checklists that the company follows rigorously on each and every flight operation.

The best drone services companies manage safety in a fashion that is very similar to a commercial airline. Beyond verifying the proper function of the airframe and sensor, a UAS mission must include a Safety Management System (SMS) in its SOP. The pilot reviews a written checklist to verify all equipment and systems aboard the aircraft are operating nominally. And, they should conduct an operational hazard review of the site before operations, including the weather conditions, the obstacles on the site, the preparedness of the pilot, and the limitations of the aircraft platform.

Before conducting flight, the drone services company also should ensure they are operating in compliance with the requirements of law. They should document each requirement in the federal regulations and verify their specific method for maintaining compliance. This document should be on-site for all flight operations and should be available for review.

Finally, effective data acquisitions require a carefully planned mission that defines the activities of the sensor, the flying height, and the flight pattern. The flight should be planned in a way to successfully gather the data that meets the customer requirements. It cannot be done without a significant amount of thought and careful planning. The results of drone data acquisitions are frequently substandard due to companies thinking drone operations are completely push-button.

To achieve safe, effective, and compliant operations, here are the right questions to ask:

- May I review your SOP, your checklists, and your operational hazard review?
- Can I have a look at your compliance documentation?
- What is your mission plan and how was it designed to get the right data?

At Juniper, we use a written pre-flight SOP checklist to ensure that our drone, sensor and software are operating according to manufacturer specifications. Beyond the UAS, our SOP spells out what the roles of each team member will be during the planning and execution of the mission, as well as management and processing of collected data. We see the SOP as governing the safety and effectiveness of the data acquisition mission.

Our SMS requires assessment of a number of risks and anticipates local air traffic and control. As with our Hazards Assessment, we identify critical infrastructure and flight limitations before arriving on-scene.

We have also developed a risk assessment checklist for each airframe that must be completed before every flight as part of the SMS. This takes into account altitude, wind, density altitude, and payload constraints that may impact the risk profile of that specific flight with that individual aircraft. The pilot has authority to determine a general level of risk but must seek organizational approval to initiate the flight if certain risk thresholds are exceeded.

Finally, each Juniper pilot must complete an 'I Am Safe' checklist prior to flight to verify they are clearheaded, unimpaired and focused on the mission at hand. (You will read more on this in the next section.)

PILOT TRAINING

Drone Pilot Training Should Exceed Federal Regulations



We touched on the importance of pilot training in the earlier section on Flight Operations, but the topic bears repeating. The bottom line is the FAA requires every drone pilot, often called a remote pilot, to train for and pass a written test relating to the Part 107 Remote Pilot Certificate. It's crucial to stress this test pertains primarily to written rules and airspace regulations but involves no actual in-flight examination by the FAA.

In other words, there is no practical test for a remote pilot to prove he or she knows how to safely launch, operate, maneuver and land any type of drone. This lack of flight-proven competence has a direct impact on the quality and efficiency of data collection – in addition to the safety of everyone involved (including unwary bystanders).

Here are the questions you need to ask to make sure your remote pilot exceeds FAA regulations for drone operations:

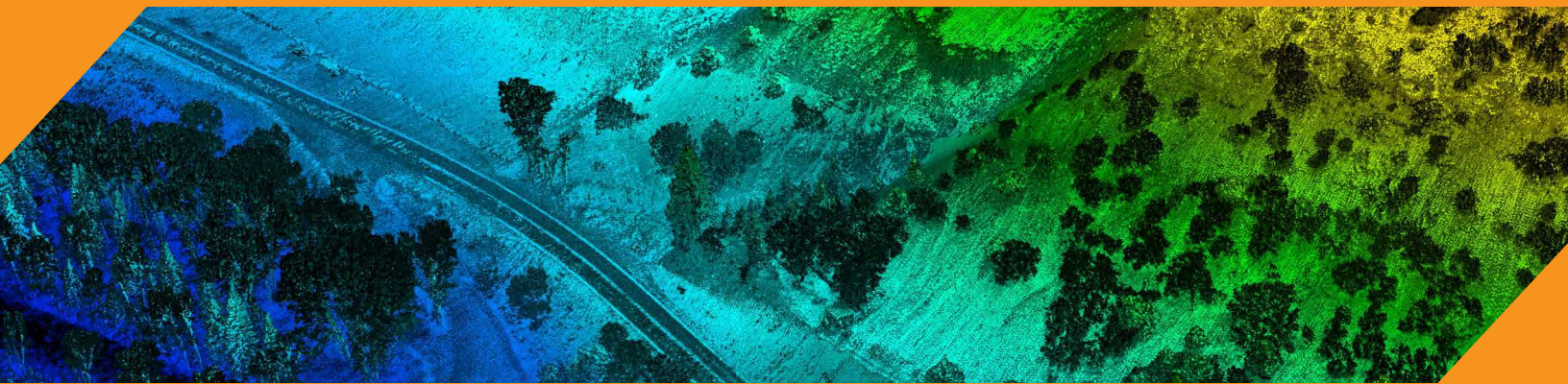
- Has your pilot been trained and tested in the use of each available drone airframe?
- Does your pilot maintain a log book of flight operations?
- Has your pilot received instruction on flight operations of each sensor?

At Juniper, we believe the FAA certification of remote pilots doesn't go far enough. Our pilots receive flight training in the operation of each drone airframe. And they learn directly from the manufacturer how to operate every sensor. We have even hired a Flight Standards Officer to oversee this training and conduct in-flight proficiency demonstrations for our pilots, the results of which are documented in log books for clients to review.

Prior to every project, the Juniper Flight Standards Officer verifies our pilot is certified – and ready – to complete the mission safely, efficiently and effectively with the airframe and sensor selected for that mission. And our pilots attest to the fact they are ready to fly on a given day, in much the same way commercial airline pilots do.

VERIFIED SUPPLY CHAIN

Supply Chain Must be Established and Researched



The two most important pieces of hardware for a provider of UAS mapping services are the airframe and sensor. That's hardly shocking news. And hopefully it's also not a surprise that a serious geospatial data acquisition firm can't purchase their drones and cameras at Best Buy. A drone services company should have a hardware supply chain that is both well established and well researched.

Just like any other product, drone airframes and sensors come in many levels of quality. A point-and-shoot camera, for example, can't be strapped on a hobbyist quadcopter to capture mapping-grade data. Care must be taken to select the airframe and sensor. Specifically, the drone must fly with the stability to acquire accurate and precise data. The same goes for the imaging or laser sensor. For most geospatial applications, the captured data must meet certain relative and absolute accuracy specifications.

In addition, it's important for a drone services company to standardize on specific equipment rather than buy whatever is on sale. This ensures the pilots know their aircraft and sensors and guarantees the data collected in different projects over time will be consistent and comparable.

Here are a few questions to ask about hardware?

- How many different brands of sensors and airframes do you operate?
- Where are these pieces of hardware manufactured?
- Can your drones be flown using third-party control software?

Juniper Unmanned has standardized our operations on each of our airframes and sensors. Prior to selecting these products, we performed exhaustive research to confirm they were capable of acquiring professional-grade geospatial data. We evaluated each airframe's airworthiness testing, manufacturing and engineering processes, as well as the components used in assembling the final product. And for the reasons described above, we use only a couple of select brands, so our pilots can become experts in their use and the collected data will meet client specifications now and in the future.

AIRWORTHINESS INSPECTION AND DOCUMENTATION

Drone Airworthiness is the Operator's Responsibility

Safe operation of drones begins with safe design and manufacturing. Aeronautical and mechanical failures should be a serious concern for everyone involved, from company CEO to drone operator to those nearby data acquisition operations.

To ensure safe design and manufacture, Congress tasked the FAA with the responsibility for certifying all aircraft, a process called airworthiness. For commercial airlines and private airplanes, the FAA maintains a staff of trained professionals to inspect these manned aircraft on specific schedules. On the other hand, the burden for testing unmanned aircraft systems falls directly upon individual operators to ensure their drones are airworthy.

This is problematic for several reasons. First, a drone that has not been deemed airworthy or has not received scheduled maintenance could possibly crash, causing property damage and/or personal injury. As if these potential dangers are not bad enough, legal liability for harm inflicted has not yet been established in the court of law. The operator is certainly liable, but you as the organization contracting the mission may end up in court as well.

Here are some questions to ask to ensure the drones used in your project are airworthy:

- Do you have a periodic process in place to determine the airworthiness of each UAV?
- Do you document these airworthiness reviews?
- Is your drone operator, or someone involved in their data acquisition operations, qualified to determine airworthiness to the satisfaction of the FAA?

At Juniper Unmanned, we believe we are the only professional UAS operator that regularly inspects each of our airframes to assess its airworthiness – using guidelines provided by the manufacturer. We also document each inspection and are happy to show you the records.



And we take our airworthiness certifications an important step further. We inspect every combination of airframe and sensor payload as an integrated system to ensure it is safe to operate in the sky. And we document those results too. Regardless of how recently this system review was performed, our pilots always begin each mission with a pre-flight safety check of the aircraft and sensor.

INSURANCE

Insurance Must Protect All Involved in Drone Operations, Even the Client



Drone operations involve some degree of risk. Drones lose connectivity and fly away. They also have mechanical failures that cause them to crash, and remote pilots sometimes make mistakes that lead to poor quality data. Drone operators can manage those risks with a good set of standards and procedures, but it is also imperative that they carry reasonable coverages of the right type of insurance policies. Most general commercial insurance policies exclude aviation exposures, including those for drone operators, manufacturers, dealers or service providers.

The commercial uses of unmanned aerial systems are still new enough that many laws regulating them are being written right now. As a result, liability for accidents and professional errors and omissions has not been thoroughly tested in the court of law. Currently, there is no solid case law that has determined what a customer's liability is if the UAS operator they hire causes personal or property damage with the drone.

It's imperative for a provider of UAS services to carry comprehensive insurance policies. Here's what you should ask your vendor:

- What are the coverage amounts for personal and property damage in your insurance policy?
- Am I, as your client, covered by your liability policy?
- Do you carry professional errors and omissions coverage?
- What safety precautions does your team take onsite?

We have found many UAS service providers fail to adequately insure themselves. Aviation is a litigious environment. Drone operators may not consider what they are doing to be dangerous but that could leave them exposed to legal action if someone were to be injured on a job site, there was property damage, or the data leads to poor decision-making.

While most commercial operations have some form of insurance including a general liability policy, it is important to note that the most common policies do not cover drones. Insurance coverages for drone operations are unique. Hiring a company without the proper coverages can create unreasonable risk for the operator, as well as the company doing the hiring. Always ask your drone company to provide an insurance certificate, verifying that the coverages include drone operations.