

# Enterprise Drone Inspection: Picking the Right Platform

## Volume 5

High-Precision Telecom Management:  
How to get decision-quality data from your drone program

By Guillaume Delepine, Senior Product Marketing Manager



## AUTHORS



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Guillaume Delepine is a Senior Product Marketing Manager at Skydio, the leading American drone manufacturer and world leader in autonomous flight. In his tenure at the company, he previously led Skydio's efforts to serve first responders as Public Safety lead. Then, as Enterprise Strategy Manager, Guillaume contributed to the fundraising, planning, and hiring process that led to Skydio's recent announcements of a Series D fundraise at a valuation of over \$1 billion USD, expanded roadmap, and growing executive team. Guillaume holds a BA from Princeton University, and took leave of the joint MPP/MBA program at Harvard University to join Skydio.



### **Brian Richman**

**Senior Product Manager at Skydio**

Brian Richman is an Enterprise Product Manager at Skydio with almost 10 years of experience in drones. Brian works on realizing Skydio's vision for automated drone inspection and mapping by enabling levels of safety, precision, and data quality beyond what even the best drone pilots in the world are capable of. Before Skydio, Brian was the product lead for Airware's Mobile business unit, launching a pioneering end-to-end commercial drone configuration and flight software. Brian is also a former R&D team lead for the RQ-23 Tigershark program, with 700+ combined flight hours as a pilot, payload operator, and mission commander.



### **Russell Bondi**

**Image Quality Test Engineer at Skydio**

Russell graduated from University California Santa Cruz with a major in Photography. He spent the majority of his time there working on digital photography from his weekend job at Skydive Hollister. His love for action sport photography and his understanding of subjective review led him to a career at GoPro, where he was the lead Image Quality Test Engineer on the Hero 6 and 7. His role was to uncover all image quality issues and help find the path to a fix. Working closely with ISP Tuning Engineers, as well as Firmware Engineers, to get products out the door in the best shape possible. When Russell is not working, he spends the majority of his time outdoors either surfing, mountain biking, skydiving, or snowboarding.

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## Prologue

The most forward-thinking telecommunications tower operators and carriers have been turning to drones to help rapidly inspect their asset bases. With the growing number of enterprise drone options on the market today, operators face an ever-growing number of choices. Critically, the rise of autonomy offers an entirely new way to compare drones to each other. While the previous generation of manual drones were all equally limited to 2D waypoint or manual flight, autonomous drones can perform inspection missions with entirely different flight paths. These closer, more adaptive flight patterns render the old ways of comparing drones to each other based on rudimentary camera specifications, like the number of megapixels, outdated.

This paper is the fifth volume of Skydio's eBook: Enterprise Drone Inspection: Picking the Right Platform, a collection of white papers that will help enterprise drone operators from various industries make more informed decisions when choosing their enterprise drones. In this installment, we use 3D model examples and rigorous camera benchmarking to help telecom tower operators and managers understand the tradeoffs of various drone systems, and the impact those tradeoffs will have on the datasets their uncrewed aerial vehicles (UAVs) can generate.

We hope that this analysis will help your drone program make its decisions based on the quality of the drone's outputs, so that you know the end product you will be able to generate as you invest in your next drone system.

# Data Quality Requirements for Key Use Cases

Different inspection programs are likely to have different data quality requirements. The true requirements for a dataset come from the consumer of the data—whichever needs to receive an inspection report and either certify approval or take corrective action. To provide context as operators assess the level of quality that will be required to scale their drone inspection programs, we have assembled key requirements from anonymized sets of customers in the various industries that have adopted drones for inspection.

Skydio’s Solutions Engineering team works with drone programs day in and day out to understand and document their requirements and make sure our customers end up with the best possible drone operations. They have been instrumental in helping to document the requirements that are typical for various industries. While this list is not exhaustive, the industries this eBook will focus most on are:

Industry	Typical Use Cases	Asset to Scan	Artifacts to detect	Common Precision Requirement (GSD)
<b>Construction</b>	<p><b>Primary:</b> Progress Assessments</p> <p><b>Additional:</b></p> <ul style="list-style-type: none"> <li>• Inventory management (Volumetrics)</li> <li>• Site Survey</li> </ul>	Construction sites, equipment inspections	Asset damage, misalignment vs. tolerance across subcontractors	Up to 1 cm
<b>Transportation</b>	<p><b>Primary:</b> Bridge Inspection</p> <p><b>Additional:</b></p> <ul style="list-style-type: none"> <li>• Inventory management (Volumetrics)</li> <li>• Road grading &amp; survey</li> </ul>	Bridges, Roads, Railroad Tracks	Cracks and delamination in concrete, bolts, nuts, connection points in weight bearing areas	Sub-millimeter to 5 mm
<b>Utilities</b>	<p><b>Primary:</b> Transmission &amp; distribution inspection</p> <p><b>Additional:</b> Long linear inspection for wildfire risk</p>	Power plants, Transmission Lines, Oil Pipelines	Rust and loose bolts	Up to 0.5 cm (Primarily photos, not models)

Industry	Typical Use Cases	Asset to Scan	Artifacts to detect	Common Precision Requirement (GSD)
<b>Telecom</b>	<b>Primary:</b> Digital Twins for Remote Management	Cell Towers	Labels on antenna arrays, antenna orientation, structure damage	< 2 mm
Focus of this volume				
<b>Insurance</b>	<b>Primary:</b> Roof Inspection	Homes	Hail damage	< 1 mm
<b>First Responder</b>	<b>Primary:</b> Collision scene reconstruction  <b>Additional:</b> Crime/ Arson investigation	Crime or accident scenes	Crumple damage, skid marks, weapons, broken glass	~ 1 mm

In this Volume, we will take a deep look at the technologies and outputs available to telecom drone operators, using both customer experiences and rigorous camera benchmarking to make sure operators in the industry have all the data they need to make the right decisions.

# Meeting the Bar for Telecommunications Inspection

The United States of America have approximately 150,000 cell towers distributed across the nation; each can be up to 450 feet tall and hold large amounts of expensive carrier equipment. These towers need to be inspected for a variety of reasons, from structural integrity assessments, to 5G upgrade compatibility checks, to "Closeout" inspections after an install.

When carriers need to install new equipment on a cell tower, both the tower companies and carriers hire subcontractors to inspect these structures to determine how much equipment can be installed and where it will go on the tower. These inspections use either tower climbs or ground-based cameras and often generate duplicative work and imprecise results. While manual drone photos improve worker safety and data quality, they are unable to navigate safely near the metallic structure and through the electromagnetic interference emitted by the cell tower, resulting in far-off, low resolution imagery.

Creating 3D models of these structures unlocks revolutionary possibilities for streamlined data analysis of virtual asset bases, or digital twins. For the telecom industry, this will mean significantly more accurate tower models, which would create less back and forth in the design phase of the install cycle, more accurate coverage maps, and faster time to install.



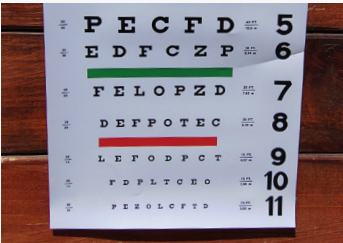
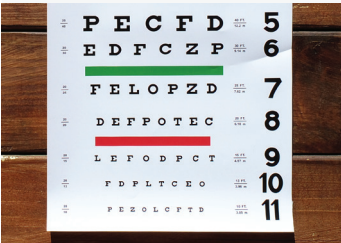

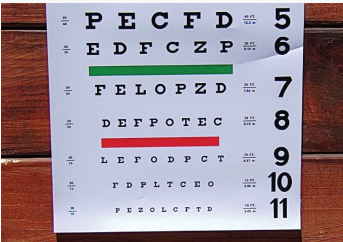
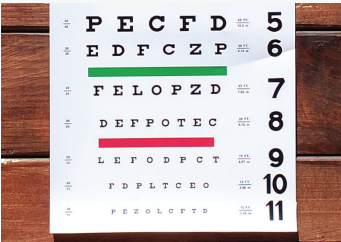
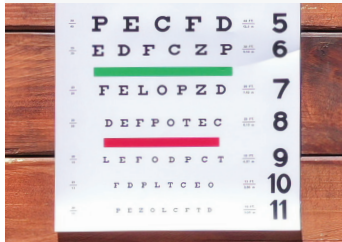
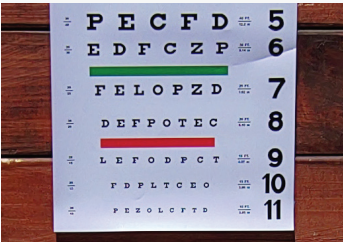
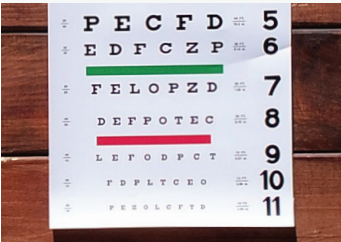
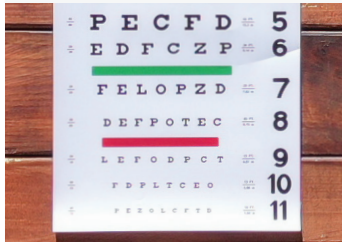
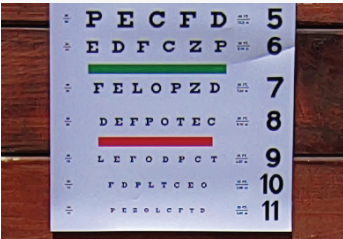

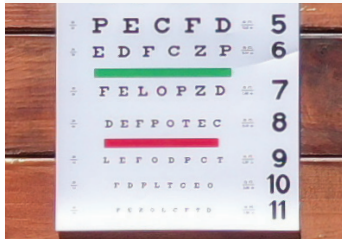
## Key requirements for Remote Asset Management

<b>Resolution</b>	< 2 mm
<b>Photo Quality</b>	Consistent exposure to capture areas backlit by the sun
<b>Photo Location</b>	80%/80% overlap/sidelap. Ideal pattern is consistent orbits at evenly spaced altitudes around the tower
<b>Relative and Absolute Accuracy</b>	Only relative accuracy typically required

### Generating High-Quality Imagery

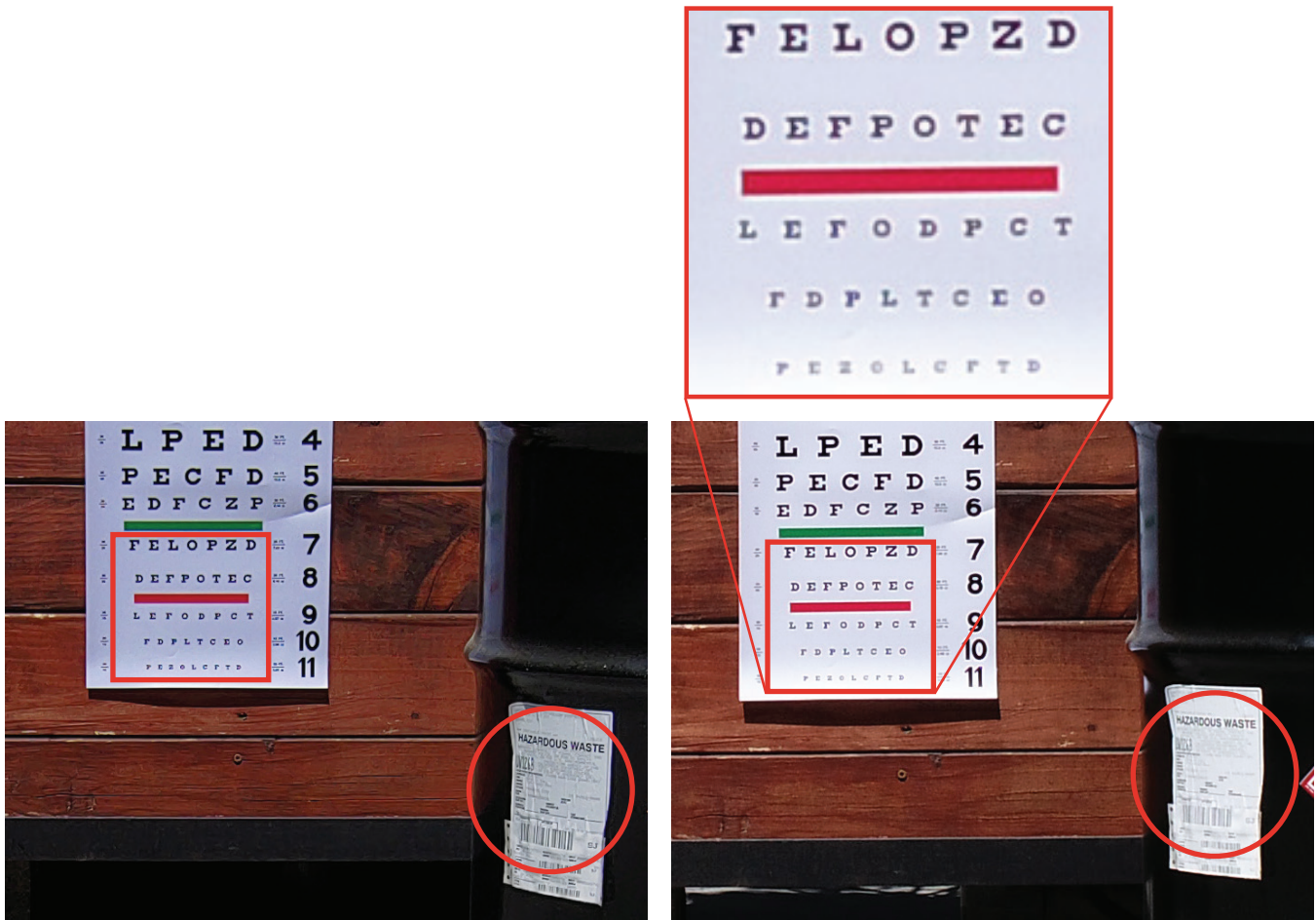
To better illustrate the impact of camera software, we conducted a study comparing the Skydio 2, DJI Phantom 4 Pro V2.0, and DJI Mavic 2 Pro, to understand which camera would generate the best results. Our test subject was an eye chart, which can help inspectors understand what kind of text they might be able to read while examining the antennas attached to a cell tower. We took photos of the chart from various equivalent standoff distances (how far the camera is from the subject) and at various ground sampling distances (how much area on the subject is covered by a single pixel), to see how the various cameras performed. An inspector needing to get precise details would need to zoom into specific features, so here we have zoomed all the photos in to the same field of view to illustrate the cameras' performances at various GSDs.

Here we present a comparison of photos at the same ground sampling distance, and further comparisons by standoff distance are available in Appendix 3.

Camera Performance on Text (Eye Chart)			
Ground Sampling Distance (mm/pixel)	Skydio 2	DJI Phantom 4 Pro V2.0	DJI Mavic 2 Pro
0.25 mm	0.59 meters from subject 	0.92 meters from subject 	1.05 meters from subject 
0.5 mm	1.19 meters from subject 	1.83 meters from subject 	2.10 meters from subject 
0.75 mm	1.78 meters from subject 	2.75 meters from subject 	3.16 meters from subject 
1 mm	2.37 meters from subject 	3.67 meters from subject 	4.21 meters from subject 

This figure compares the camera systems on the Skydio 2, DJI Phantom 4 Pro V2.0, and DJI Mavic 2 Pro drones, at four levels of ground sampling distance (GSD). The distance from the subject that corresponds to the GSD is unique to each camera and indicated in each cell. Photos are cropped to the same frame to enable comparisons of which camera generates fine detail. Note that drones were hand-carried for the study - while Skydio 2's trustworthy obstacle avoidance system enables up close flights, capturing imagery at short standoff distances is risky with DJI drones. Source: Skydio





Skydio 2 photo taken at 0.5mm ground sampling distance

DJI Phantom 4 Pro V2.0 photo taken at 0.5mm ground sampling distance

The comparison above reveals several interesting insights that matter to teams looking to choose the right camera system for their inspection needs. It is important for customers to compare cameras at equivalent GSDs, because this can be controlled for by flying closer or farther away. So we control for GSD such that readers can gain insight on how the quality of the camera tuning will impact the photo outputs available to their teams. Our image quality team notes:

### **Sharpening algorithms make a difference up close.**

Notice the white halo effect around the letters in the photos taken by the Phantom 4 Pro. These negatively impact the readability of fine text, and are a symptom of over-aggressive sharpening algorithms applied to the photos by the drone's camera module.

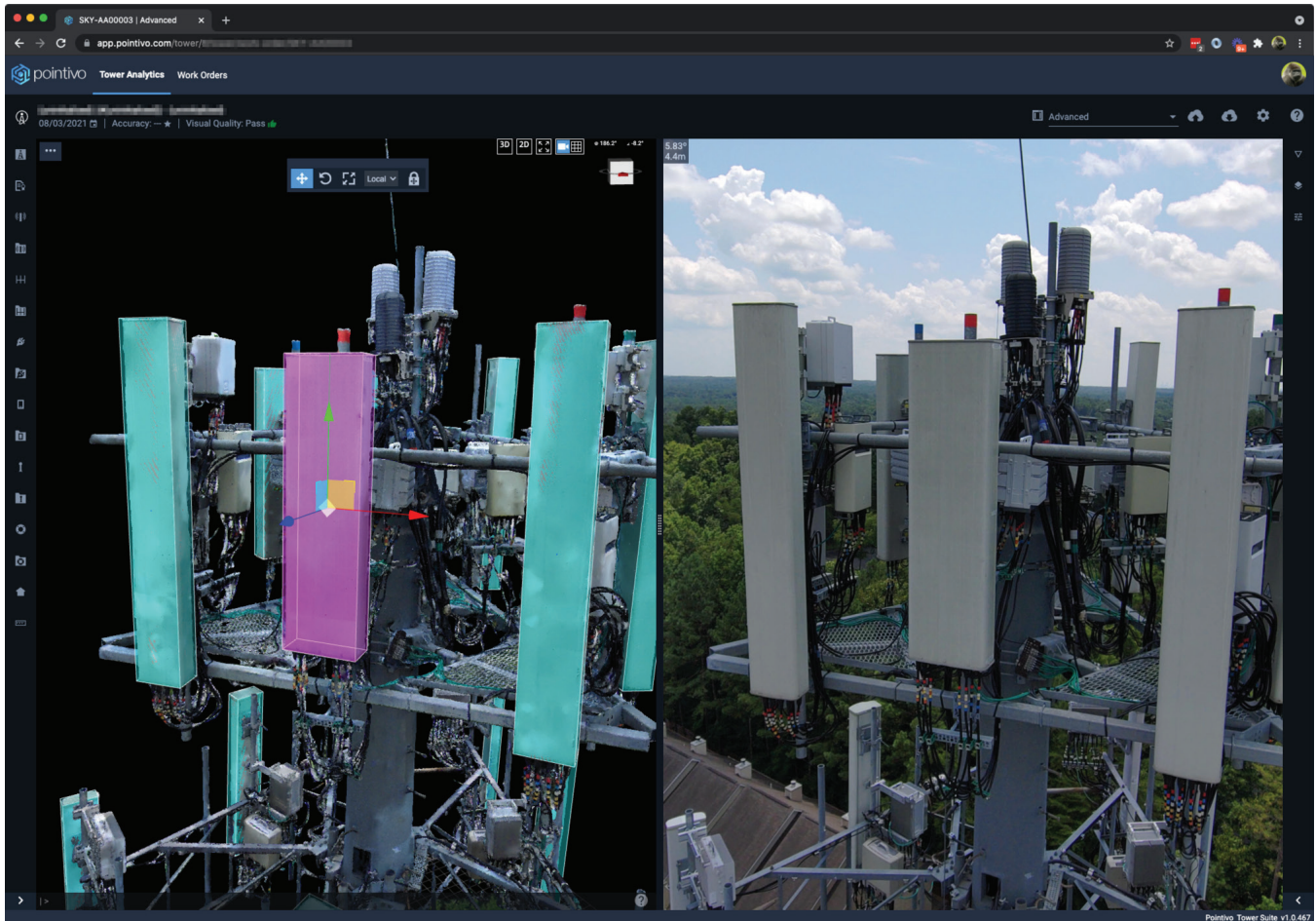
### **Exposure impacts legibility.**

Improperly tuned exposure settings can cause a photograph to lose information, especially near bright whites. The overexposure on the photos from the Phantom 4 Pro is so extreme that it causes the smallest line of text to become nearly illegible. In combination with the oversharpening, the white halos around the letters cause them to fade into illegibility.

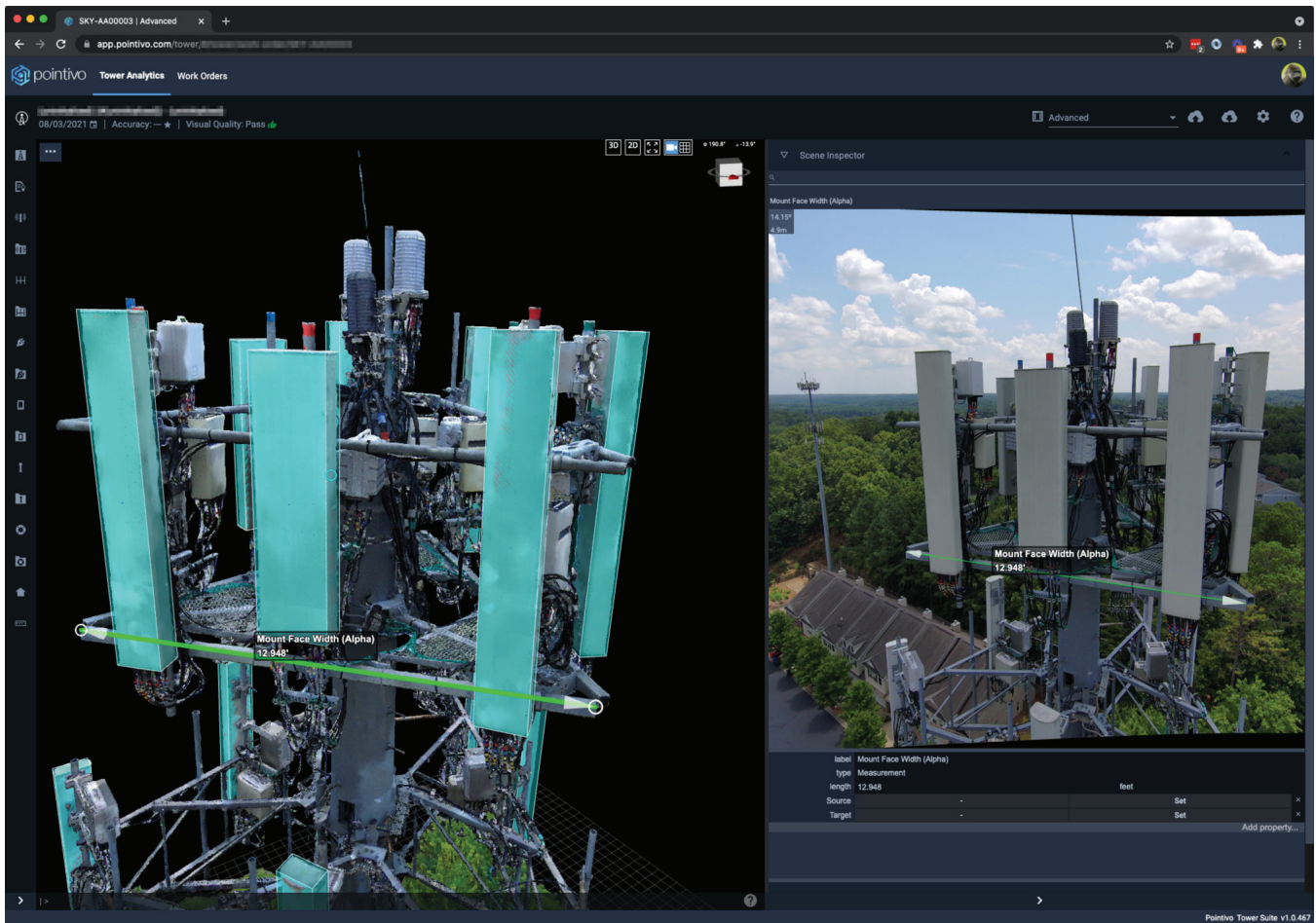
Other than these slight differences, the photos are largely similar. Operators should note that even with a smaller sensor, the Skydio 2 can provide better photos.

## Building Useful 3D Models

The high-quality imagery that Skydio drones can generate with Skydio 3D Scan software can be fed into a complementary photogrammetry engine and developed into 3D models. In these models, analysts can take measurements and perform higher-order analysis that can help improve the eventual inspection report. Skydio 3D Scan data is optimized for generating 3D models with a variety of the leading photogrammetry tools, including DroneDeploy, Bentley ContextCapture, and RealityCapture. In this ebook, we feature Pointivo, a software company that provides a Tower Analytics platform, which can take imagery from Skydio 2 and Skydio X2 and provide a range of higher-order insights. We are excited to share a 3D model that was generated on Pointivo's platform.



Pointivo's Tower Analytics platform has processed tens of thousands of towers using various different drone hardware platforms for capture. However, incorporating scans from a Skydio 2 using 3D Scan optimizes accuracy and richness of both the 3D model and 2D inspection, allowing technicians to perform virtual tower inspections and mount mappings, all while safely on the ground.



Pointivo Tower Analytics supported by Skydio’s autonomous data capture delivers superior dimensional accuracy measuring antennas, ancillary equipment and mount systems to help drive various engineering workflows and deliverables, such as tower mappings, construction drawings and post-construction closeout reports.

## About Pointivo

Pointivo’s analytics platform is built by a world-class team of AI and computer vision software experts pioneering AI-driven 3D analytics technologies for physical asset inspection. We give companies a deeper understanding of their assets to drive revenue, operational efficiencies, and cost reductions. Combining machine learning, computer vision, and advanced analytics, our customers are innovators and rely on our platform and applications to deliver insights that enhance business processes and decisions relating to measurement, damage detection, assessment, inventory management, budgeting, and risk mitigation.

# Skydio Solutions for Inspection

After reading the previous chapters, it is our hope that you feel more equipped to make a decision regarding your selection of drones. As you take this knowledge into the field to evaluate the available technologies, below is a concise summary of the components that make up the Skydio solution for industrial asset inspection. Your Skydio sales and solutions engineering teams can help you determine which options are right for your program and make a plan to implement them.

## Skydio 2

An entry-level drone to introduce autonomy to inspection workflows. Features a 12MP camera, and six 4K color sensors used to support Skydio Autonomy enabling true 360° obstacle avoidance in every situation and up to 23 minutes of flight time. Backpack portable and easy-to-use, Skydio 2 can be provided to any inspector to start taking advantage of aerial data.



Skydio 2

## Skydio X2E

Pairs the breakthrough Skydio Autonomy™ engine with a ruggedized airframe that features a color or optional dual color/thermal sensor, long-range operations, and extended battery life for up to 35 minute flight time. Core autonomy capabilities include **360° Obstacle Avoidance**, **Object and Scene Recognition**, and **Skydio Visual Navigator**.



Skydio X2E

## Skydio Enterprise Controller

Ground control for X2E is enabled via the Skydio Enterprise Controller, which was designed from the ground up for pilots with demanding operating requirements. Ground control software is natively delivered via the Skydio Enterprise App.



Skydio Enterprise Controller

## Skydio Autonomy Enterprise Foundation

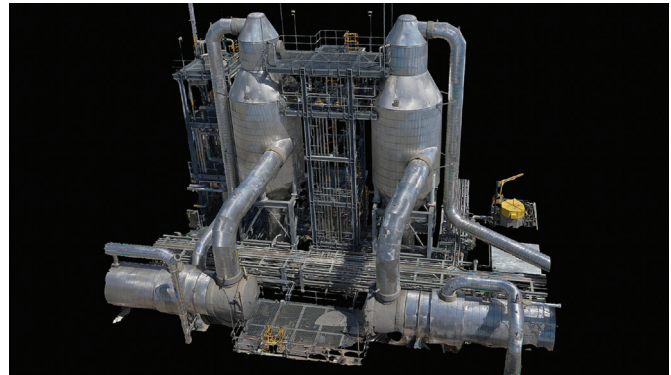
An add-on software package that augments the core autonomy engine. It's designed to assist the pilot through software capabilities that enhance flight control in obstacle-dense environments. Key features of this package include **Close Proximity Obstacle Avoidance**, **Vertical View**, and **Visual Return to Home**.



Skydio Autonomy Enterprise Foundation

## Skydio 3D Scan™

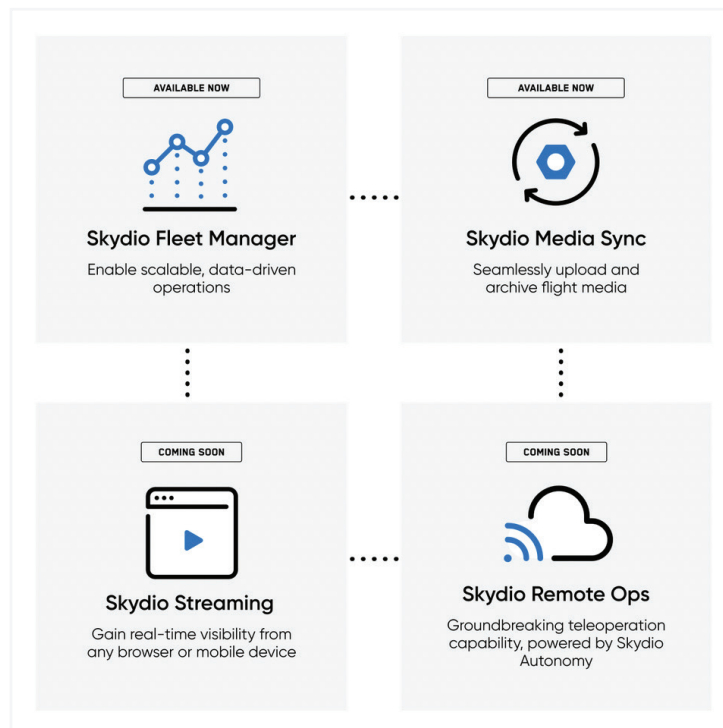
The first-of-its-kind adaptive scanning software built on top of Skydio Autonomy. 3D Scan allows the drone to automate the data capture process needed to generate 3D models with comprehensive coverage and ultra-high resolution, so that crews can perform higher quality scans in less time and with minimal pilot training.



Skydio 3D Scan

## Skydio Cloud

Skydio Cloud serves as a foundation for autonomous connected flight operations as well as API-based integrations with our partner ecosystem. It includes Skydio Fleet Manager and Skydio Media Sync, which help distributed fleets manage their operations and data more effectively than they can with spreadsheets and SD cards. Skydio Streaming and Remote Ops are both coming soon, and allow for real-time monitoring and execution of drone operations through the cloud.



## Skydio Academy

Delivered online, or in-person, in both self-paced and instructor-led configurations, Skydio Academy provides flexible options for your pilots to achieve the **Skydio Professional Operator (SPO)** and **Skydio Expert Operator (SEO)** certifications that can help a program manager manage and track core competencies across a distributed pilot fleet.



### Skydio Professional Operator (SPO)

Certifies **foundational knowledge** about Skydio aircraft, preflight, launch, flight skills, landing, postflight, maintenance, and troubleshooting.



### Skydio Expert Operator (SEO)

(requires Skydio Professional Pilot certification)

Certified **real-life flight skills** to safely and efficiently operate Skydio aircraft and software. As an SEO, you will be ready to take flight with complete confidence.

# Conclusion and Looking Ahead

The data product is the most important output of a drone program, and producing a useful dataset can help a drone program reach scale within a large organization full of consumers of that data. Therefore, we encourage drone operators to work with their downstream colleagues to make sure that the drones they purchase can produce sufficient datasets to meet the precision requirements. The tools in this white paper can help operators look beyond the specifications of the hardware, and instead focus on the outputs the system can generate. Choosing in this way can greatly improve an organization's chance of success.

In the next installment of this eBook, we will be taking yet another deep dive using similar analytic techniques, to help insurance companies select the right drones for the job. Stay tuned for the next volume!



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