

HIGH ACCURACY DRONE MAPPING THROUGH REFERENCE AND WITNESS MEASUREMENTS

InTerra Market Growth

ABSTRACT

This whitepaper examines the rapid growth of the global drone surveying market and the increasing demand for high-accuracy geospatial data. As commercial drone adoption accelerates across construction, infrastructure, and public safety applications, achieving reliable positional accuracy has become critical. The paper explores how reference and witness measurements—captured through the InTerra system of SmarTargets®, Datum™, and Locator™—enable transparent, auditable coordinate generation for professional drone mapping workflows. Industry trends, market forecasts, and practical applications are presented to illustrate how precision geospatial technologies are reshaping modern surveying practices.



Table of Contents

<i>Executive Summary</i>	1
<i>Introduction</i>	2
<i>The Expanding Global Drone Market</i>	2
<i>The InTerra System (Field to Office)</i>	4
Witness Points (Traditionally Known as Ground Control Points)	4
Witness Point Distribution and Placement	5
Datum™ Local Base Station	6
<i>Industries Affected by Drone Mapping & Surveying</i>	6
Surveying and Engineering	6
Building Construction	6
Heavy Construction	7
Scientific Research and Education	7
Public Safety and Emergency Response	7
Transportation Infrastructure	7
Utilities and Energy	8
<i>Drones Transform Traditional Survey Techniques</i>	8
<i>Conclusion</i>	8
References	9
Methodology and Data Sources	9

Executive Summary

The drone industry is entering a period of rapid expansion, driven by technological advancements and increasing adoption across multiple sectors. This white paper examines the growing market for drone surveying services and the increasing demand for reliable, high-accuracy geospatial data.

Key findings highlight that the global drone market is projected to expand from approximately \$73 billion in 2024 to more than \$163 billion by 2030, reflecting strong adoption across commercial, industrial, and defense applications.

Within this broader growth, construction and built-environment applications represent a major opportunity, with the construction drone segment alone expected to grow from approximately \$7.9 billion in 2025 to more than \$15 billion by 2030.

Additionally, mapping and surveying remain the most common drone use case, accounting for roughly 35% of drone operations globally, with the mapping drone segment projected to grow at ~16–17% CAGR through 2030. The increasing use of drones by land surveyors, construction firms, and public safety officials is driving this growth, underscoring the need for precise and efficient data collection methods.

The InTerra system—SmarTargets®, Datum™, and Locator™—provides an integrated framework for producing repeatable and defensible geospatial measurements within drone mapping workflows. This system is particularly beneficial for industries such as Surveying and Engineering, Building Construction, Heavy Construction, Scientific Research and Education, Public Safety and Emergency Response, Transportation Infrastructure, and Utilities and Energy, all of which require reliable and precise data for optimal operations.

By adopting InTerra SmarTarget®, organizations can streamline their data collection processes, reduce costs, and improve overall project outcomes. This white paper provides comprehensive insights into the market trends, industry applications, and future opportunities, positioning InTerra as a leader in the evolving drone surveying landscape.

For more information on how InTerra SmarTarget® can transform your surveying and mapping projects, please contact us at support@interra5d.com or visit our website at www.interra5d.com.

Introduction

The global drone industry is entering a period of rapid expansion, driven by advances in sensor technology, AI-assisted data processing, improved battery systems, and increasing enterprise adoption across sectors such as construction, infrastructure, utilities, and public safety. As drone adoption accelerates across industries, the ability to produce reliable, high-accuracy geospatial data becomes increasingly important. Achieving this level of precision requires a transparent measurement framework that links aerial observations to known coordinate references—an approach implemented in the InTerra system through SmarTargets® acting as the witness, the Datum™ local base station serving as the reference, and Locator™ software providing the processing and verification engine. In professional surveying workflows, maintaining a clear chain of custody and measurement traceability between field observations and coordinate reference systems is essential for ensuring data integrity. By combining witness measurements, local GNSS reference observations, and transparent post-processing, the InTerra system establishes a traceable measurement framework that supports repeatable and defensible geospatial results.

The Expanding Global Drone Market

Unmanned aerial systems have evolved rapidly from niche tools used primarily for aerial photography into widely adopted platforms for industrial data collection. Advances in imaging sensors, autonomous flight systems, and geospatial data processing have significantly expanded the practical applications of drones across industries such as construction, infrastructure management, utilities, mining, agriculture, and public safety.

As these technologies mature, global adoption is accelerating rapidly. Market research estimates that the global drone market will grow from approximately \$73 billion in 2024 to more than \$163 billion by 2030, representing a compound annual growth rate of roughly 14 percent. This growth reflects the increasing value organizations place on high-resolution geospatial data for monitoring assets, improving operational efficiency, and supporting data-driven decision-making.

Within this broader market expansion, mapping and surveying represent one of the fastest-growing segments. Land surveyors and mapping service providers are increasingly adopting drones to collect precise spatial data with greater speed and resolution than traditional methods.¹

Several industries are driving this demand. In agriculture, drone mapping allows farmers to generate accurate field maps that support crop health monitoring, livestock tracking, and more efficient land management. High-resolution mapping enables farmers to better plan planting strategies and monitor field conditions in near real time.

Public safety agencies are also adopting drone mapping technologies to enhance situational awareness. Through aerial mapping and 3D imaging, drones enable officials to

reconstruct accident scenes, assess terrain conditions, and identify optimal routes for emergency response.

Figure 1 shows the projected growth of the global drone market from 2024 – 2030.

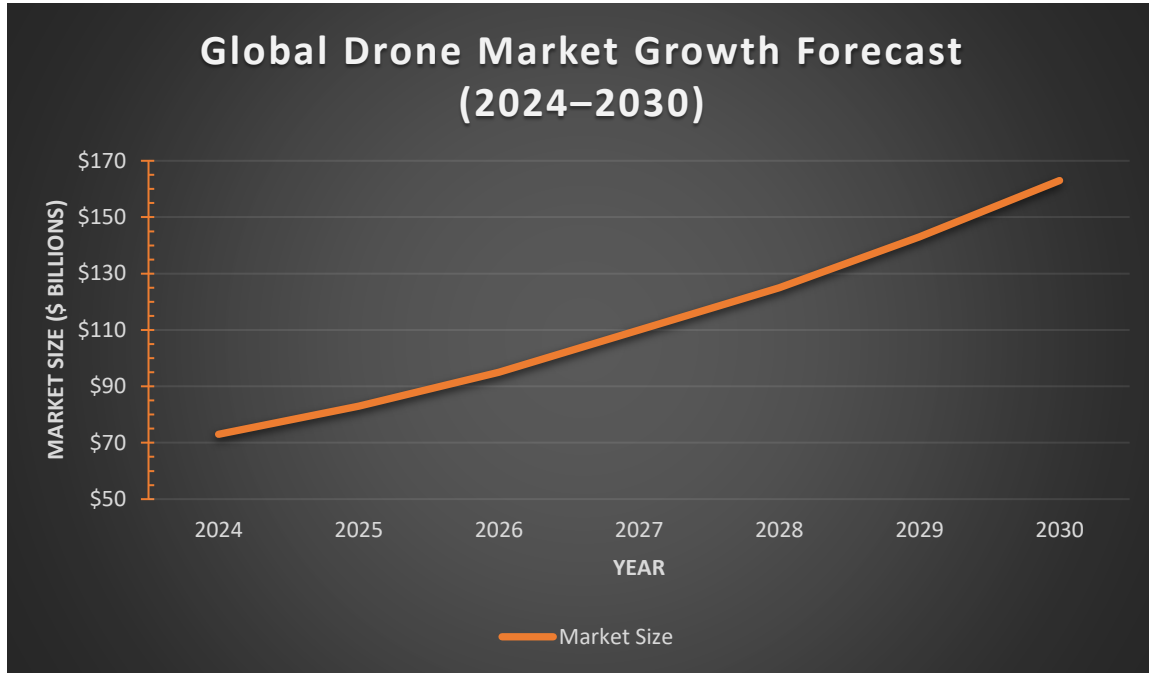


Figure 1. Projected Global Drone Market Growth (2024–2030)

Source: Grand View Research, Drone Market Size, Share & Growth Report

Grand View attributes growth in the mapping and surveying segment to increasing adoption by land surveyors and mapping service providers seeking higher-resolution spatial data.¹

Fact.MR similarly attributes the expansion of drone mapping services to growing demand across sectors such as agriculture, public safety, infrastructure development, and energy.

In the United States, infrastructure development and the reconstruction of aging transportation and utility systems are expected to further accelerate adoption. Drone-generated spatial data allows engineers to evaluate structures, monitor project sites, and make more informed decisions throughout the lifecycle of infrastructure projects.

The oil and gas industry is also contributing to this growth, as drone mapping enables remote monitoring of operational risks while improving communication and safety across project teams.¹

As drone mapping adoption expands across these industries, the need for reliable, repeatable, and defensible geospatial measurements becomes increasingly important.

The InTerra System (Field to Office)

SmarTarget® — The Witness

Smart ground control points that independently record GNSS observations during the drone flight, creating a verifiable, time-synchronized measurement record tied directly to the mapping mission.

Datum™ — The Reference

A rugged, easy-to-deploy local GNSS base station that:

- Establishes a reliable reference near the project site
- Enhances field accuracy and positional precision
- Eliminates reliance on distant infrastructure or network corrections
- Enables simple, repeatable, and error-resistant processing workflows

Locator™ — The Processing and Proof Engine

Locator™ is InTerra's post-processing software for drone surveying and mapping. It transforms raw GNSS observations into explicitly defined, auditable, and repeatable coordinates by combining:

- SmarTargets® as the witness measurements
- Datum™ as the local reference station
- Industry-standard geospatial engines for transparent coordinate transformations

Locator™ is InTerra's powerful post-processing software that uses SmarTargets® as the witness, the Datum™ local base station as the reference, and the PROJ geospatial engine to transform raw GNSS observations into accurate, repeatable, and defensible coordinates.

Witness Points (Traditionally Known as Ground Control Points)

One of the primary benefits of drone mapping and surveying is its ability to produce highly precise geospatial data. Achieving this level of accuracy requires a reliable network of witness points across the mapping site. Traditionally known as Ground Control Points (GCPs), these locations provide known coordinates that allow aerial imagery to be aligned with real-world positions. Properly deployed GCPs significantly improve the positional accuracy of orthomosaics, elevation models, and other mapping outputs.

Pix4D defines Ground Control Points as “points on the ground with known coordinates which the surveyor can precisely pinpoint.”⁴ Simply incorporating witness points into a drone mapping project improves accuracy, but understanding how many to place and where to place them is essential for achieving optimal results. Pix4D recommends using GCPs with high-contrast colors so they stand out from the terrain, placing an appropriate number of points relative to the project area, and spacing them evenly throughout the survey site.⁴

InTerra SmarTarget® is designed to simplify this process while improving field visibility and positioning accuracy. Each SmarTarget includes a high-contrast three-color checkerboard pattern that allows the target to be easily identified in drone imagery. The system includes five rip-stop polyester ground targets measuring 2 ft × 2 ft, constructed with bright orange and black checkerboard patterns that remain highly visible against most terrain conditions.



Having witness targets with dull colors or colors that match the surrounding terrain can affect how easily the points are detected in aerial images. For this reason, surveyors typically use bright materials with checkerboard patterns that create strong contrast in drone photographs. The SmarTarget design addresses this requirement by using durable, high-visibility materials that allow operators to quickly identify control points during post-processing.

In addition to visibility, the number of points used in a project can also affect accuracy. While it might seem intuitive that more control points will always produce better results, this is not necessarily the case. A study conducted by the Nevada Department of Transportation found that placing excessive numbers of GCPs can be unnecessary and may even introduce inefficiencies in the workflow. Pix4D notes that approximately four control points can produce a reasonably accurate survey, with the typical recommended range being five to ten GCPs per site, depending on the size and complexity of the terrain.⁴



The InTerra SmarTarget system includes five GPS-enabled SmarTargets, each equipped with a 12-hour battery and delivered fully charged and ready for field deployment. The kit also includes five braided heavy-duty USB charging and data cables along with a seven-port powered USB hub for convenient charging and data transfer. All components are housed within a custom foam-insert Pelican Vault case, which is crush-proof, dust-proof, and weather-resistant. With integrated locking steel hasps, the case is designed to protect the SmarTargets in demanding field environments.

Witness Point Distribution and Placement

The spacing and distribution of witness points is also a critical factor in producing accurate mapping results. Control points should be placed to cover as much of the project area as possible while avoiding unnecessary clustering or oversaturation of points.

A common best practice is to place witness points near each corner of the project site and one near the center, ensuring that the mapping software has witness points distributed across the entire area. When terrain elevation varies significantly, placing additional control points at the highest and lowest elevations can further improve model accuracy.

By combining properly distributed witness points with GNSS correction data from systems such as the InTerra Datum Local Base Station, drone mapping workflows can achieve highly reliable positional accuracy while maintaining efficient field operations.

Datum™ Local Base Station

While witness points provide distributed measurement observations across the project site, overall positional accuracy can be further improved by incorporating a local GNSS reference station. The InTerra Datum™ Local Base Station records satellite positioning data during drone flights and serves as a reference point for post-processing corrections.

Datum operates as a high-precision GNSS base station, capturing satellite signals simultaneously with the SmarTargets during the drone flight. When processed using the InTerra Locator software platform, these data streams enable post-processed kinematic (PPK) corrections, significantly improving the positional accuracy of the final mapping outputs.

By combining SmarTargets with Datum, surveyors can establish a reliable geospatial reference framework across the project site. This integrated approach allows drone imagery to be aligned with corrected GNSS measurements, producing highly accurate coordinate outputs suitable for engineering, surveying, and infrastructure applications.



Industries Affected by Drone Mapping & Surveying

Surveying and Engineering

The Surveying and Engineering industry plays a crucial role in shaping our built environment by providing accurate measurements and topographic data. With the advent of drones, this industry has experienced a revolution in data collection methods. However, to ensure precise and reliable results, the industry requires reliable reference points for georeferencing. InTerra SmarTarget's advanced system offers a compelling solution, combining rugged design, powerful software, and cost-effectiveness to meet the unique needs of surveying and engineering professionals.

Building Construction

The Building Construction industry plays a pivotal role in constructing residential, commercial, and industrial structures. Accurate topographic mapping is crucial for ensuring precise foundation layout, site grading, and infrastructure planning. Drones have revolutionized the construction industry by providing efficient and cost-effective data collection solutions. InTerra SmarTarget's well-designed

system, featuring rugged hardware and user-friendly Locator™ software, offers an exceptional solution that enhances speed, accuracy, and cost-efficiency compared to traditional survey techniques and Real-Time Kinematic (RTK) systems.

Heavy Construction

The Heavy Construction industry plays a critical role in building infrastructure, developing landscapes, and shaping our cities. Topographic mapping is essential for construction projects as it enables precise planning, design, and execution. Drones have revolutionized the industry by offering a faster, safer, and more cost-effective way to collect data and monitor construction sites. InTerra SmarTarget's robust system, featuring a rugged design and user-friendly Locator™ software, offers a comprehensive solution that enhances speed, accuracy, and cost-efficiency compared to traditional survey techniques and Real-Time Kinematic (RTK) systems.

Scientific Research and Education

The Scientific Research and Education industry plays a vital role in advancing knowledge and understanding of the world around us. Topographic mapping serves as a fundamental tool in various scientific and educational endeavors, enabling researchers, educators, and students to study and analyze landscapes, ecosystems, and geological formations. The advent of drones has revolutionized data collection, offering an unprecedented opportunity to enhance scientific research and educational experiences. InTerra SmarTarget's well-designed system provides an ideal solution, combining ruggedness, user-friendly software, rapid performance, precise accuracy, and cost-effectiveness to meet the unique needs of the Science and Education industry.

Public Safety and Emergency Response

The Public Safety industry plays a vital role in protecting and ensuring the well-being of communities. This industry encompasses organizations responsible for emergency response, disaster management, law enforcement, and infrastructure preparedness. To effectively carry out their responsibilities, public safety agencies require accurate and up-to-date topographic mapping data. Drones have revolutionized the public safety industry by offering efficient and rapid data collection capabilities, enhancing situational awareness, and enabling informed decision-making in critical situations.

Transportation Infrastructure

Transportation Infrastructure plays a pivotal role in connecting people, goods, and services across various modes of travel, including roads, railways, airports, and seaports. Accurate topographic mapping is essential for effective transportation planning, maintenance, and expansion. Drones have revolutionized the industry by providing a faster, more cost-effective, and accurate solution for data collection and analysis. InTerra SmarTarget's witness points (ground control measurements) offer the Transportation industry a reliable, rugged, and user-friendly system that significantly improves speed, accuracy, and cost-efficiency compared to traditional survey techniques and Real-Time Kinematic (RTK) systems.

Utilities and Energy

Utilities and Energy are critical in delivering essential services such as electricity, water, gas, and telecommunications to communities. Accurate topographic mapping is vital for the planning, design, and maintenance of utilities infrastructure. Drones have revolutionized the industry by providing a fast, cost-effective, and precise solution for data collection and analysis. InTerra SmarTarget's innovative system, featuring a rugged design and user-friendly Locator™ software, offers utilities companies an exceptional tool to enhance speed, accuracy, and cost-efficiency compared to traditional survey techniques and Real-Time Kinematic (RTK) systems.

Drones Transform Traditional Survey Techniques

Construction projects demand precise topographic mapping to ensure accurate positioning of building foundations and infrastructure. However, achieving accuracy while maintaining project timelines and budget constraints can be a complex undertaking. Drones have transformed industries by revolutionizing data collection, site analysis, and project management. By leveraging high-resolution aerial imagery, 3D models, and point clouds, professionals can make informed decisions, optimize construction processes, and streamline project execution.

Investing in InTerra's witness-reference measurement framework—SmarTargets®, Datum™, and Locator™—enables professionals to achieve greater efficiency, accuracy, and cost-effectiveness in topographic mapping and construction site analysis. The system's rugged design, powerful Locator™ software, swift data acquisition, and exceptional accuracy make it an invaluable tool for construction professionals. By adopting SmarTarget®, building companies can optimize project execution, minimize errors, reduce costs, and enhance overall project success. The comprehensive benefits and superior performance of InTerra SmarTarget's ground control points provide a compelling business case for revolutionizing mapping and surveying technology.

Conclusion

The InTerra system—SmarTargets®, Datum™, and Locator™—represents a significant advancement in drone surveying workflows by combining witness measurements, local GNSS reference data, and transparent post-processing to produce defensible geospatial coordinates. As the drone industry, and specifically the drone mapping and surveying sector, continues to grow at an impressive rate, the demand for precise and efficient data collection methods will increase across various industries.

Our analysis indicates that sectors such as Surveying & Engineering, Building, Heavy Construction, Science and Education, Public Safety, Transportation, and Utilities stand to benefit significantly from incorporating drone technology witness based control into their operations. By leveraging InTerra SmarTarget®, companies can produce the most accurate maps possible while saving time and effort.

The substantial growth opportunity in the drone mapping market underscores the potential impact of adopting advanced solutions like SmarTarget®. This growth is fueled by the increasing need for precision, efficiency, and safety in data collection and analysis. InTerra is well-positioned to lead this transformation, providing our clients with the tools necessary to enhance their operations and achieve unparalleled success.

By linking witness measurements, local reference data, and transparent post-processing, InTerra's measurement framework makes drone mapping a **repeatable, accurate, and defensible** approach to generating survey-grade geospatial data at scale.

For more information on how InTerra SmarTarget® can revolutionize your surveying and mapping projects, please contact us at support@interra5d.com or visit our website at www.interra5d.com.

References

1. [Grand View Research-Drone Market Size, Share & Growth Report, 2030](#)
2. [The Drone Girl-Mapping Monopoly? Why 35% of Drone Operations Are Surveying](#)
3. [Drone Industry Insights-Global Drone Market Report 2025-2030](#)
4. [Pix4D-Do GCPs equal more accurate drone maps](#)

Methodology and Data Sources

Market size estimates and industry forecasts referenced in this report were compiled from publicly available industry research, including reports from Grand View Research, Drone Industry Insights, and The Business Research Company. These sources provide market estimates for the global drone industry and related vertical segments, including construction and geospatial mapping applications.

Operational use-case data for drone deployments were derived from industry surveys and publicly reported drone operator statistics. These surveys analyze the relative distribution of commercial drone activities across sectors such as mapping and surveying, infrastructure inspection, agriculture, and public safety.

The figures presented in this report represent synthesized estimates intended to illustrate macro-level industry trends rather than precise forecasts. While the sources cited are widely used within the industry and believed to be reliable, actual market growth may vary due to changes in regulatory environments, technology adoption rates, and macroeconomic conditions.

All product descriptions and workflow explanations relating to SmarTarget®, Datum™, and Locator™ are based on internal technical documentation and publicly available product specifications from InTerra Inc.

This whitepaper is intended for civil engineers, surveyors, drone operators, construction managers, and geospatial professionals evaluating high-accuracy drone mapping workflows.

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