

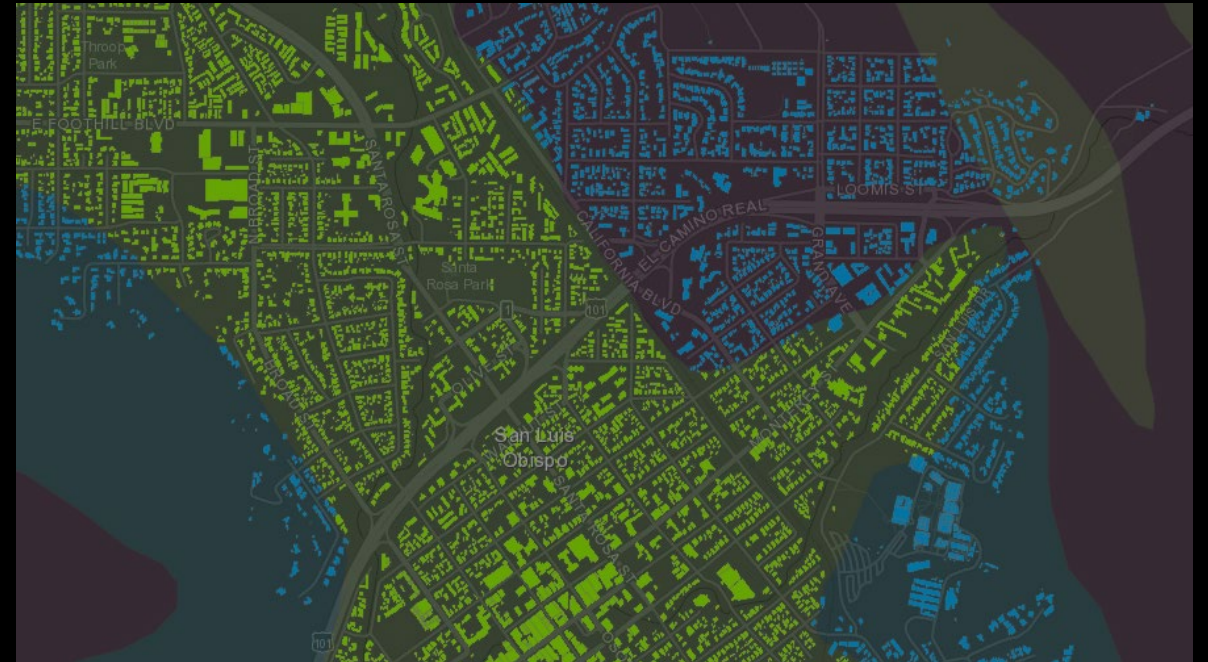


Cardinal
Geospatial

Who We Are



Cardinal is a collaborative team of geospatial professionals with backgrounds in agriculture, UAS & remote-sensing, environmental science, and geology





What is geomatics?

“The science of where” - Esri

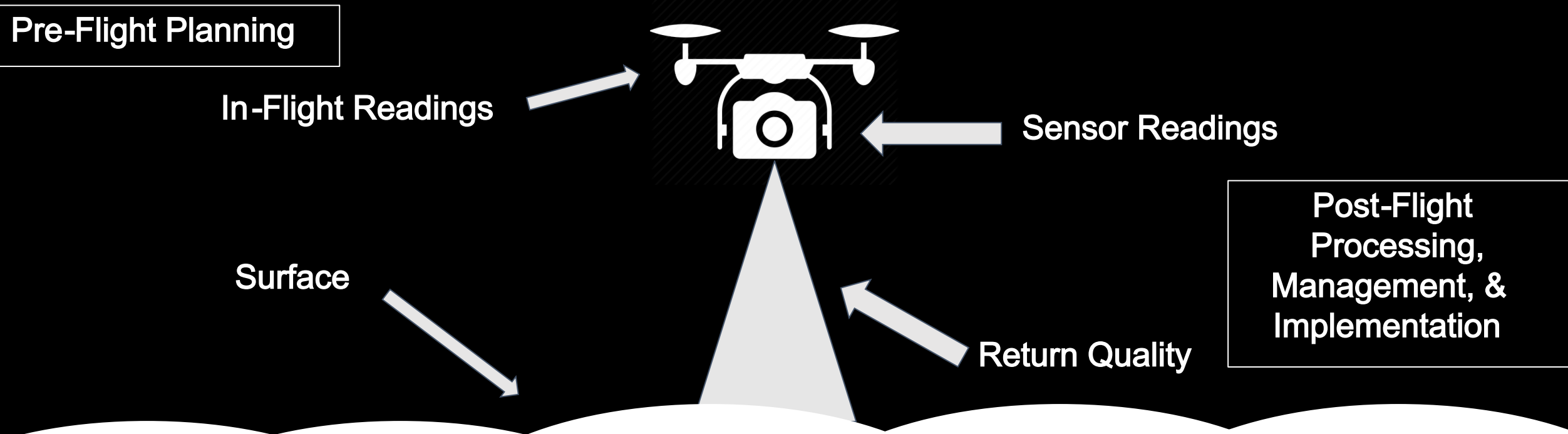
- We collect, process, organize, analyze, and study all forms of spatial data.
- From cartography to photogrammetry to advanced geospatial analytics- spatial data informs some of the biggest industries in the world.





A Dense Data Ecosystem

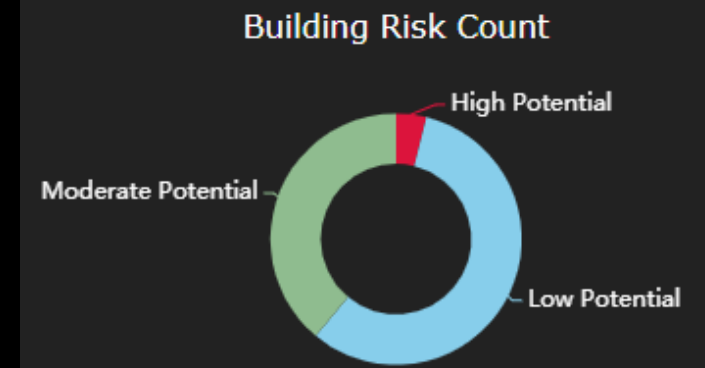
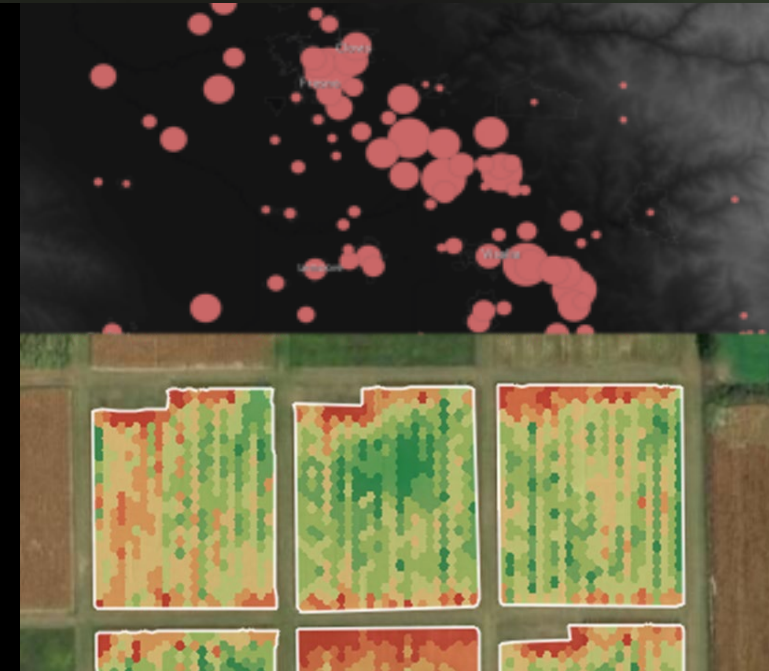
Data saturate the UAS ecosystem. Cardinal is here to simplify how you use them.



What We Bring to the Table



- **Agility** - The problems we solve begin with “where.” Our services range from data management to advanced spatial analytics.
- **Alignment** - Your customers are our customers.
- **Integrity** - We are a data driven team built to support and empower industry leaders.





Types of Customers We Service

We have a wide range of abilities that meet customers where they are.

Software Companies

- Feature Feasibility Research & Recommendations
- Data Collection/Gathering
- Geospatial Workflow Creation

Service Companies

- Data Processing
- Application Creation
- Data Analysis

Research and Education

- Curriculum Development & Training
- Geospatial Problem-Solving
- Geospatial White Papers

Where do our services intersect the drone industry?

Drone Flight Safety Project



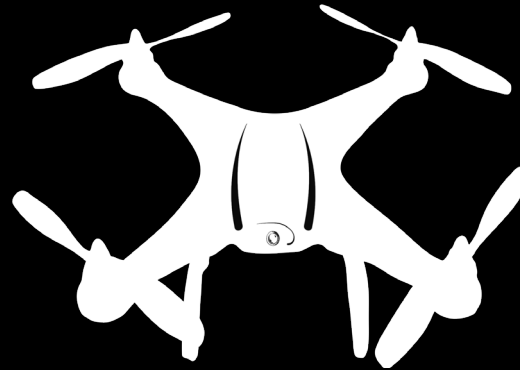
Question: How do inherent errors and their interactions affect positional and altitudinal uncertainty of a sUAS in flight?

Models



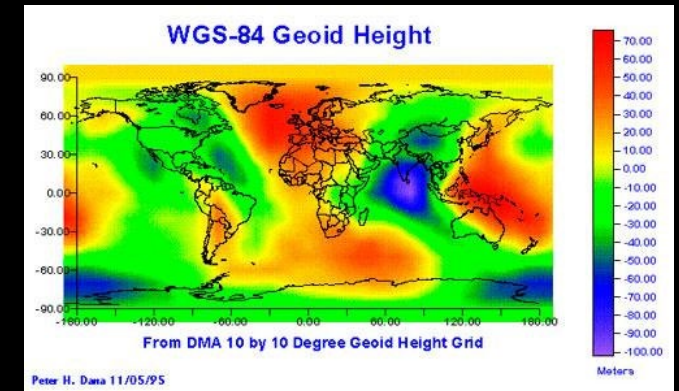
- DEM, DSM, DTM, Other elevation models
- Z-error range provided
- Cell size plays integral role

sUAS



- XY- and Z-error ranges possible
- Ranges not readily available from manufacturers
- Transport Canada guidelines provide generic bounds

Datum



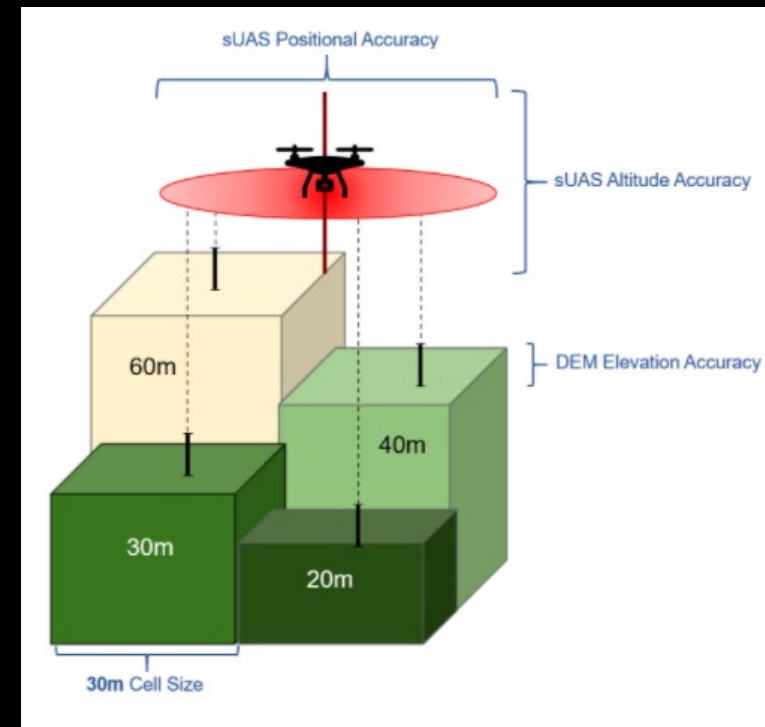
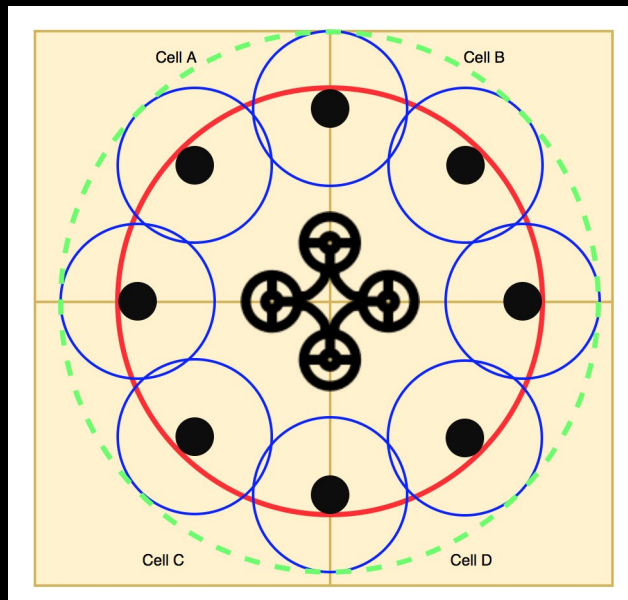
- Reference datum varies
- Gravimetric (MSL) vs. Ellipsoidal vs. Orthometric
- Conversion Errors

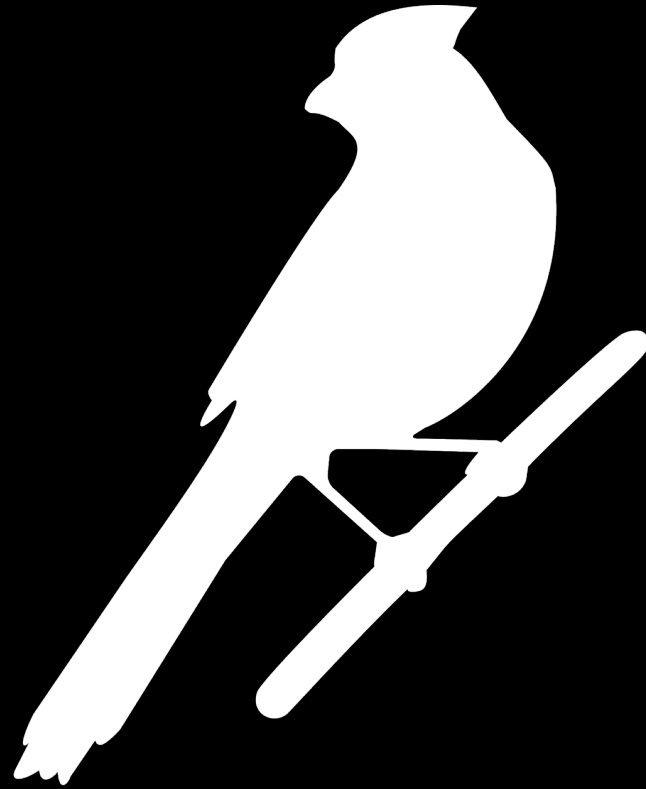
Drone Flight Safety Project (cont.)



Question: How do inherent errors and their interactions affect positional and altitudinal uncertainty of a sUAS in flight?

Interplay of Errors and Total Uncertainty

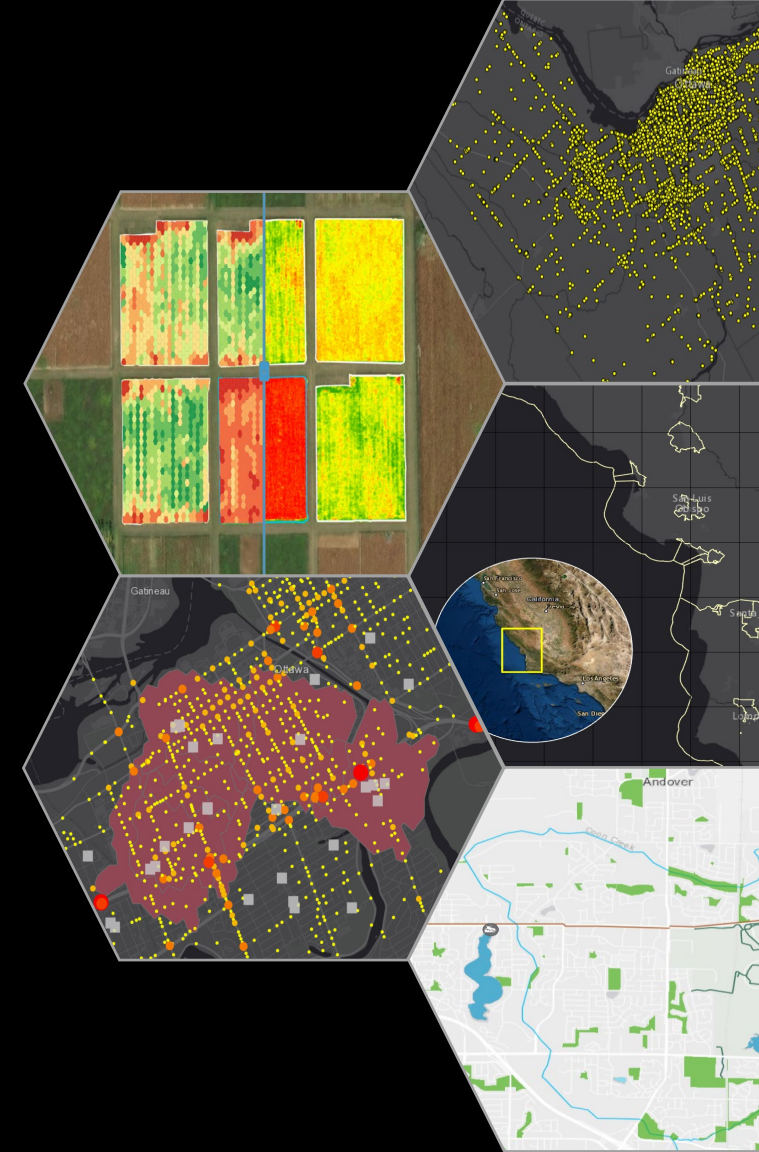
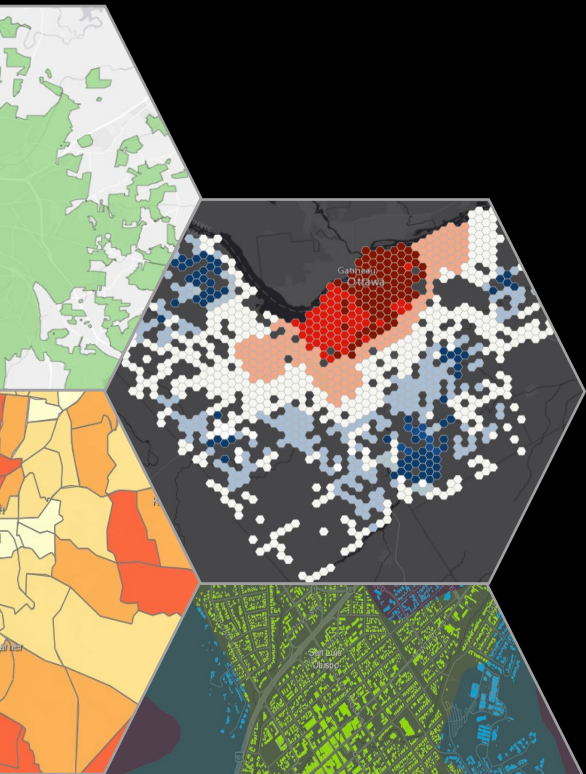




Cardinal Geospatial

If it involves “where” ... we can do that

info@cardinalgeospatial.com



3D Survey Mapping

— — —

Drones (UAV) have
changed the way
we do business!

UAS Safety and Integration Task Force Meeting

May 25, 2021



When drones first appeared on the scene, no one really knew what to do with this new technology.

Just what can it do as a survey tool?

Video, 3D Survey Mapping and Orthomosaic
are the key selling point when considering
adding a drone to your surveying equipment
toolbox.

UAS Safety and Integration Task Force Meeting

Survey Mapping Made Simple - www.cc4w.net

Cooper Aerial Surveys Co. - www.cooperaerial.com

May 25, 2021

3D Mapping from manned aircraft vs 3D Survey Mapping from a drone.

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May 25, 2021

There are two types of aerial mapping. Design level survey mapping and 3D mapping .

3D mapping is done at various levels of accuracy and flying heights mostly with manned aircraft ranging from 1' to 15' contour levels. This type of mapping is generally not used by design engineers to create accurate man-made features. It is used for dirt quantities, layout and alignment design of roads, highways, power lines, etc.

The lowest that manned aircraft can fly is at 1000' AGL which equates to 2.5cm level mapping which is design level mapping but very expensive to acquire.

It is also difficult to fly with the terrain in manned aircraft.

Design level survey mapping is also 3D mapping, however the accuracy is within 0.07' (2 cm) or better. Engineers and Architects can use this mapping to design man made features such as buildings, parking lots, streets and so on that require a higher level of accuracy.

Drones can easily capture imagery for design level survey mapping if done right.

Design level survey mapping is the next level
which takes more than a one button solution.

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May 25, 2021

Having surveying knowledge is the key to getting professional design level survey mapping . You need to understand surveying datums such as State Plane Coordinate System, UTM Coordinate System, Ground vs Grid, Grid Adjustment Factors, Geographic Coordinate System, design constraints, grade breaks, planimetrics, contour generation and breaklines to mention a few.

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May 25, 2021

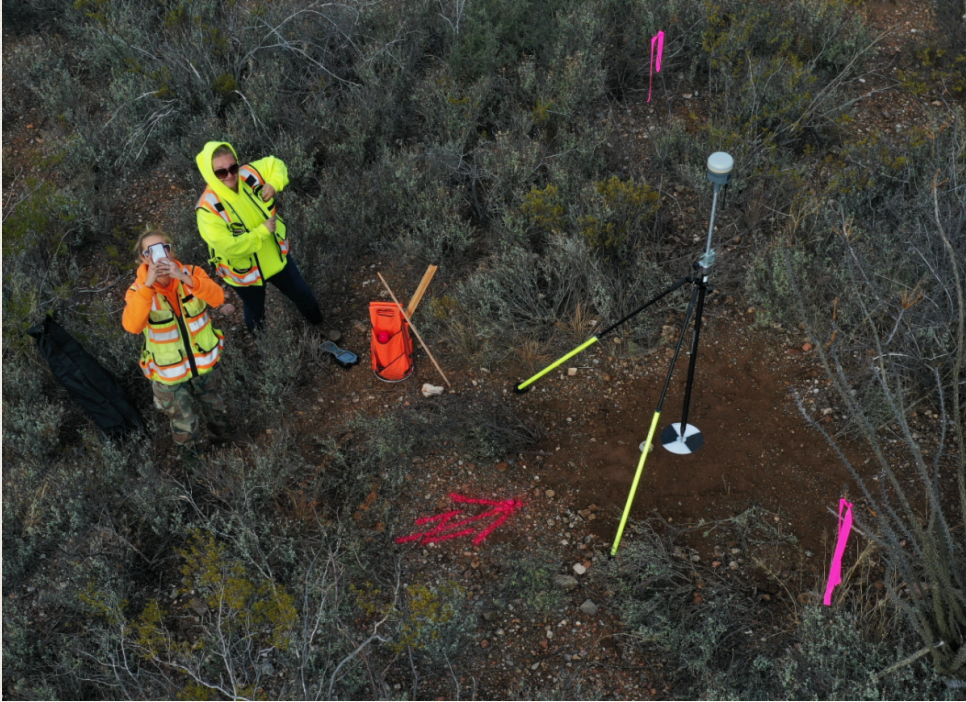
By now, most of us have seen drone company start ups that offer next day service for contours and orthomosaics for almost nothing.

Remember the old saying: ***“You get what you paid for!”***

These companies are utilizing the one-button solution with deliverables that are fully automated.

Spaghetti looking contours are not very professional looking.

You need an operator that knows what they are doing to provide top quality deliverables.



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May 25, 2021

You need a drone with a camera/sensor that will meet the accuracy requirements for the project.

I use a DJI Mavic 2 Pro and Inspire 2 with a X7 camera/16mm lens.

I use the right number of GCPs set in strategic locations using a survey grade GPS to get a solid aerial triangulation solution.

I use Metashape Pro to process the imagery and measure the ASPRS RMSE values. Breaklines are created along grade breaks, man-made features and extracted as a DXF file. A rectified orthomosaic is also created.

The DXF is imported into Civil 3D to create a 3D surface. Planimetrics are added to create a design level survey map for engineers and architects to use for their design.



Here is my survey mapping equipment list:

Surveying knowledge (priceless)

Survey grade GPS equipment (\$20k+)

Mavic 2 Pro (\$2k) or Inspire 2 with X7 camera &
16mm lens (\$8k+)

Mini iPad with Litchi (\$400+)

Metashape Pro for breaklines and orthomosaic
(\$3500)

Civil 3D to build a surface. (\$2400 per year)

Computer (\$3000+)

Total \$37,300+ to get started

This does not include training, office, vehicle,
insurance and all of the other factors it takes to
run a business.

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Cooper Aerial Surveys Co. - www.cooperaerial.com

As you can see it is not cheap to get into design level survey mapping . It has taken me years to build everything I have to provide this type of service. Working with a company such as Cooper Aerial provides the necessary tools and clients to bring it all together.

You don't have to have 46+ years experience in surveying but you do need to work with someone that does have surveying experience. Most states in the US require that design level survey mapping be done by or under the direction of a licensed professional land surveyor.

Anyone can fly a drone. Not everyone can delivery design level survey mapping .

My books on **Survey Mathematics Made Simple** and **Survey Mapping Made Simple** provide the technical aspects to be a professional design level mapper. It is up to you to acquire the necessary experience and knowledge to be the best of the best.

www.cc4w.net

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May 25, 2021

The Secret Sauce

Having topographic survey knowledge.

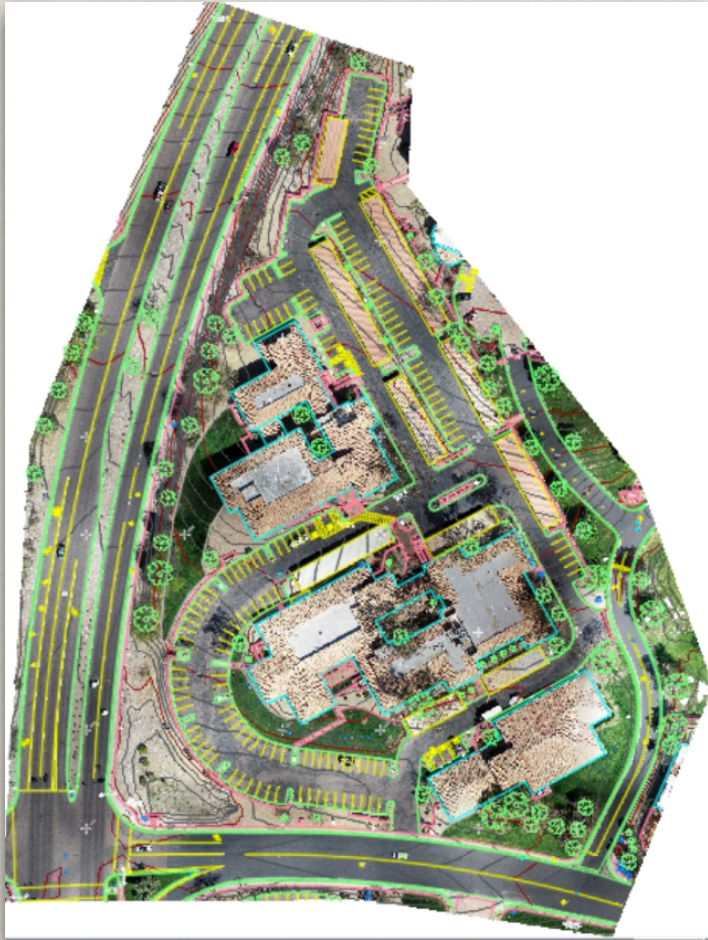
An understanding of Horizontal & Vertical datums.

Choosing the right sensor for the deliverable.

Constraining the imagery to the right number of GCPs in strong locations for good aerial triangulation.

Mastering the processing software.

Creating break-lines at all grade breaks for the strong TIN models.



UAS Safety and Integration Task Force Meeting

Common Questions

What drone platform is the best?
Rolling vs Mechanical Shutter (Urban Myth).

Is RTK drone better?

Are AeroPoints good?

What flight app is the best?

What AGL is the best height?

What about overlap?

What is the best processing software?

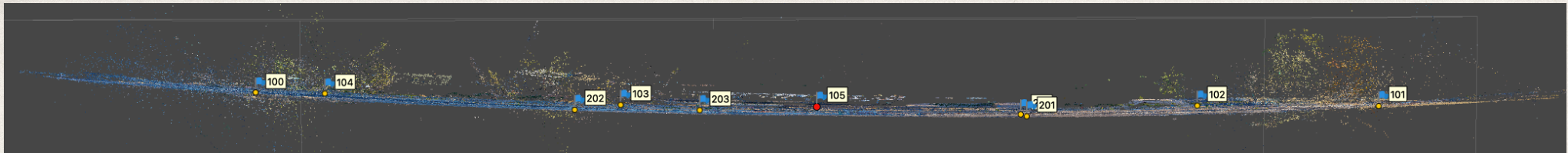
When to use Manned over Remote aircraft?

Why are GCPs needed?

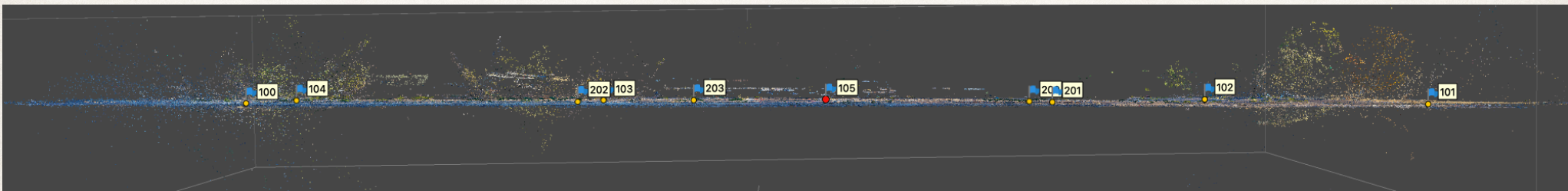
How many GCPs are needed?

Survey Mapping Made Simple - www.cc4w.net

Cooper Aerial Surveys Co. - www.cooperaerial.com



Without GCPs



With GCPs

Markers	East err (ft)	North err (ft)	Alt. err (ft)
100	0.104928	0.925494	2.014873
101	-1.289380	0.734708	-0.211055
102	-1.201044	0.112704	0.860122
103	-0.203916	0.058669	2.845988
104	0.147604	0.291691	2.645332
105	-0.561419	0.427347	2.081539
200	-0.839830	0.288995	1.851606
201	-0.823461	0.673479	1.488539
202	-0.220959	0.644576	2.416085
203	-0.328444	0.220959	2.641889
Total Error			
Control pol...			
Check points	0.709555	0.517840	2.067257

Without GCPs

P4P RTK

Markers	East err (ft)	North err (ft)	Alt. err (ft)
✓ 100	0.010805	0.040106	0.007089
✓ 101	-0.003473	-0.044597	0.005653
✓ 102	-0.027641	0.037580	-0.008043
✓ 103	0.024382	0.012749	0.026521
✓ 104	-0.023259	-0.044562	-0.019816
✓ 105	0.019186	-0.001276	-0.011405
100	0.046427	0.073712	0.161770
101	0.057586	0.095642	0.139323
102	0.051313	0.035975	0.112850
103	0.061069	0.000483	0.072209
Total Error			
Control pol...	0.019985	0.034544	0.015127
Check points	0.054392	0.062999	0.126026

With GCPs

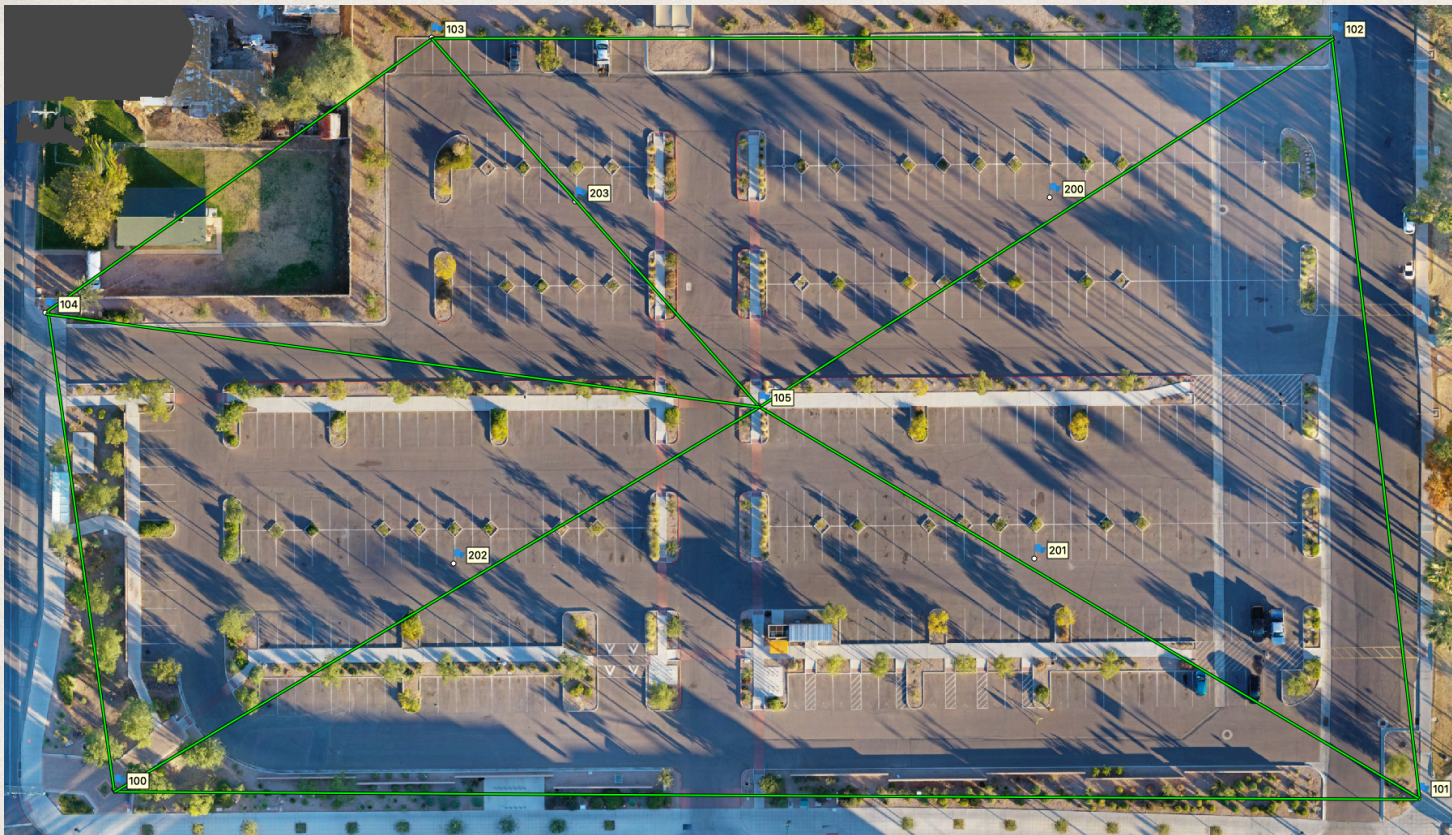
P4P RTK

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UAS Safety and Integration Task Force Meeting

May 25, 2021



GCPs and Check Shots

Markers	East err (ft)	North err (ft)	Alt. err (ft)
✓ 100	0.012888	0.038693	-0.000077
✓ 101	0.000687	-0.044465	0.000374
✓ 102	-0.023050	0.039534	-0.000918
✓ 103	0.030092	0.007865	0.001631
✓ 104	-0.020616	-0.041627	-0.001010
105	0.031456	-0.003065	-0.393288
200	0.054408	0.074732	-0.064651
201	0.064141	0.096310	-0.186889
202	0.056940	0.035118	-0.178788
203	0.068211	-0.000634	-0.166484
Total Error			
Control poi...	0.020142	0.036965	0.000966
Check points	0.056495	0.056751	0.225151

Without Pt 105

Markers	East err (ft)	North err (ft)	Alt. err (ft)
✓ 100	0.010806	0.040106	0.007089
✓ 101	-0.003473	-0.044597	0.005653
✓ 102	-0.027641	0.037580	-0.008043
✓ 103	0.024382	0.012749	0.026522
✓ 104	-0.023259	-0.044562	-0.019816
✓ 105	0.019186	-0.001276	-0.011405
200	0.046427	0.073712	0.161771
201	0.057586	0.095642	0.139323
202	0.051313	0.035975	0.112850
203	0.061069	0.000483	0.072210
Total Error			
Control poi...	0.019985	0.034544	0.015127
Check points	0.054392	0.062999	0.126026

With Pt 105

Survey Mapping Made Simple - www.cc4w.net

Cooper Aerial Surveys Co. - www.cooperaerial.com



IP Access international

- Leading Provider of Mobile & Fixed Satellite Solutions
- Over 20 Years Experience Serving the Industry, with over 900 Public Safety Agencies on our Network
- Operate 1,700+ Sites Daily
- Round the Clock Operations – 24/7/365

[IP Access Tier 1 FirstNet Dealer-5-1.mp4](#)

Customers for different Vertical Markets

Utilities



Emergency Management



Oil & Gas



Mining



Enterprise



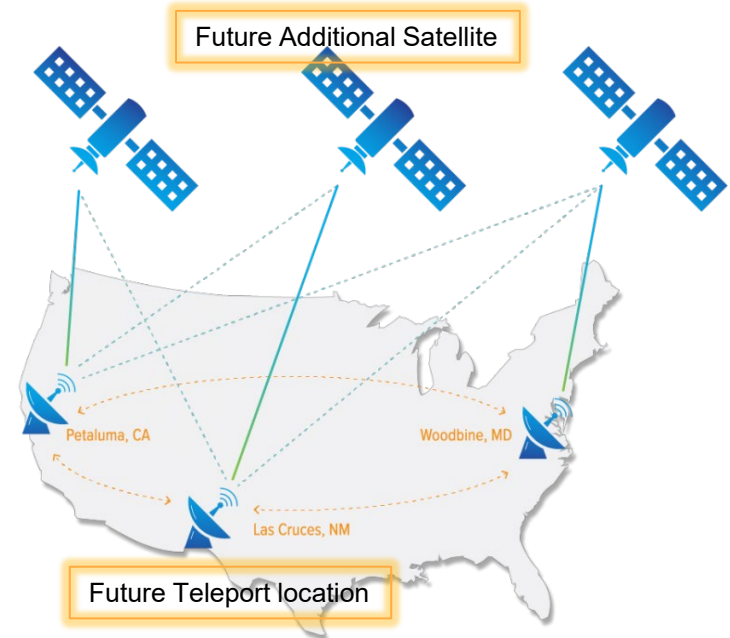
Government





Network and Coverage Advantages

- IPA Select Satellite Network - Designed with Mobility Customers in Mind
- Ability to Provide High Throughput Carriers (20 Mbps Down and 5 Mbps Up)
- Offer Managed Private Networks
- Offer Part-time, Usage Based, Day Rate, and Pooled Plans
- Ramp to Dedicated Bandwidth as Needed Without an Annual Commitment



HYBRID CONNECTIVITY

Delivered in the IP Access FUSION service offerings

No matter where you are or need to be, IP Access will always provide the best possible **connectivity** that is available.

- ✓ The service bill will remain the same regardless of which path the data crosses
- ✓ One contract and one support number covers cellular and satellite connectivity

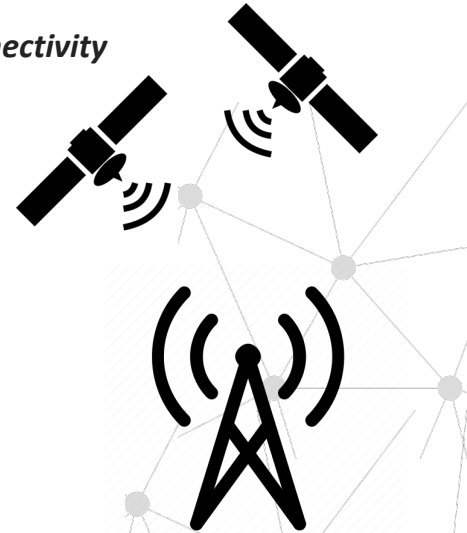
verizon[✓]

T Mobile[™]

FIRSTNET[®]
Built with AT&T

 **AT&T**

IPaccess
international

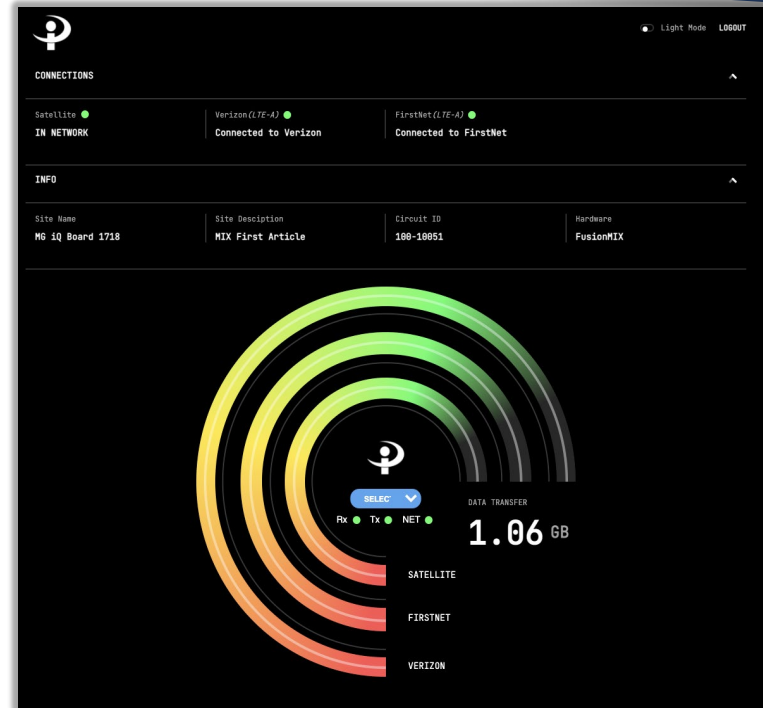


FUSION MIX

SPACE CONSCIOUS 1U RACK MOUNT

IDEAL FOR MOBILE VEHICLES OR BUILDINGS*

- No hardware costs, upgrades or sparring needed.
- Automatically finds and connects to all available networks - including LTE, 4G/5G, & Satellite
- Single bill, regardless of route the data passes
- User interface provides complete network availability of all networks and data transferred
- Fully managed white glove service



FUSION HARRIER

IDEAL FOR RAPID DEPLOYMENT

ALL-IN-ONE INTEGRATION

- FirstNet Ready
- Fully self-contained – no external electronics
- Highly portable, quick deploy system
- Available bandwidth up to 20Mbps X 5Mbps via satellite
- Multiple satellite look angles with no IP reconfiguration
- Integrated Cellular LTE, 4G/5G, and Band 14 connectivity

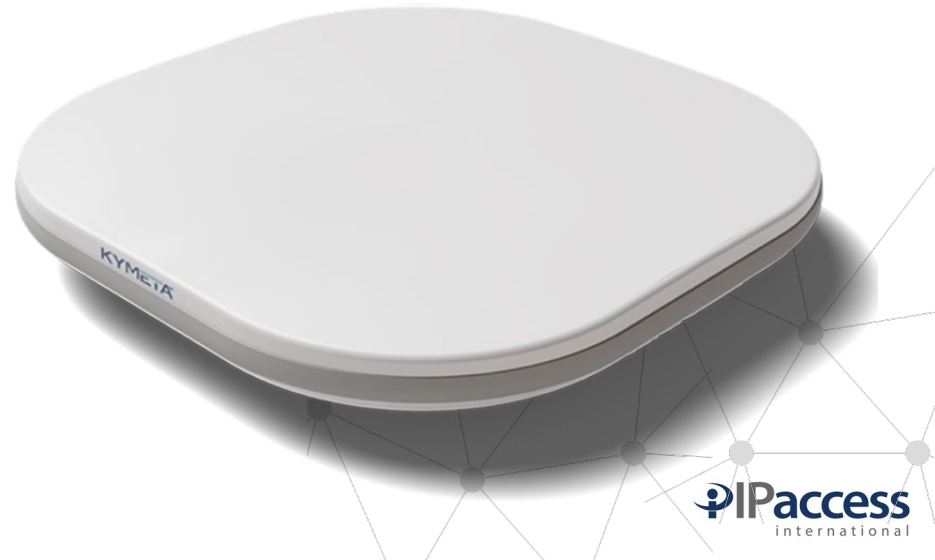


KYMETA™ u8 TERMINAL

COMPLETE ON-THE-GO CONNECTIVITY SOLUTION

MOUNTS EASILY ON VEHICLES TO PROVIDE SEAMLESS HYBRID SAT/CELL CONNECTIVITY

- Connectivity out of the box
- All-inclusive GB packages with monthly rates
- Integrated multi-WAN device, providing seamless communications
- Native DC power input and new accessories simplify vehicle integration
- Field-upgradeable for Ku-band LEO constellations



TOUGHSAT XP & AvL 1258

QUICK ONE BUTTON DEPLOYMENT

DUAL MATRIX ANTENNA CONTROLLER

- Complete Ready-To-Go system
- Includes TS2 controller, iDirect satellite gateway, 6 watt BUC service

1.2M FLY & DRIVE ANTENNA

RELIABLE, ROBUST, AND SIMPLE TO OPERATE

- One-button auto acquisition controller
- AvL Auto-Acquisition Controller with Web Browser GUI



RedPHONE

OPERATES WHEN EVERYTHING ELSE IS OFFLINE

TRUE off-The-grid COMMUNICATIONS

- Agency to Agency voice service over satellite
- Functionality not dependent upon the availability of PSTN or Global Internet
- Web-based directory showing other agencies extension and status
- RedPHONE Standard, Enhanced, and Enhanced DID options available
- Ability to host Agencies servers off-the-grid in our secure teleport data centers

Over 2000 Agency extensions deployed

Name	Extension	State	Online
Caltrans - DI T...	0149	CA	●
Caltrans - DI D...	0325	CA	●
Caltrans - DI T...	0149	CA	●
Caltrans - DI T...	0401	CA	●
Caltrans - DI T...		CA	●
Caltrans - OAK		CA	●
Caltrans - D7		CA	●
Caltrans - D7		CA	●
Caltrans - D7		CA	●
Caltrans - DI		CA	●

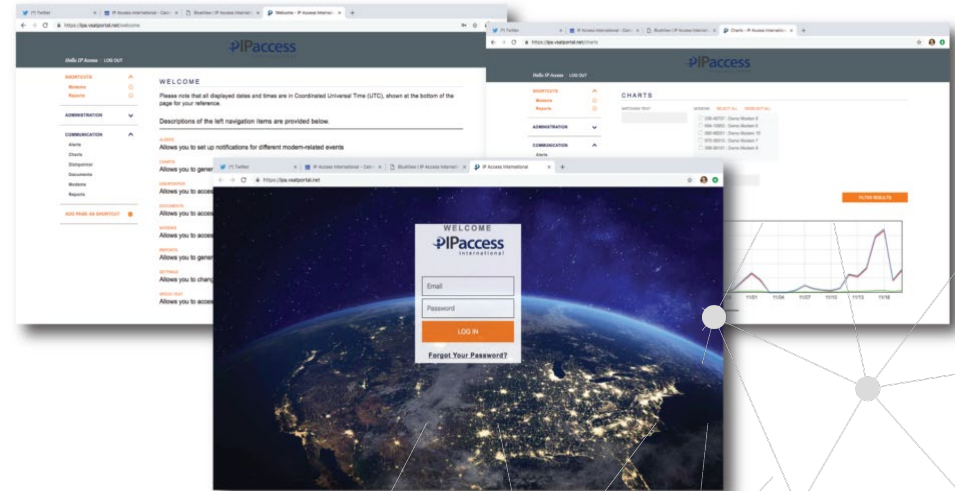


BlueVIEW

PROPRIETARY CUSTOMER PORTAL FROM IP ACCESS

SET NOTIFICATIONS & ALERTS, TRACK LOCATION, RUN REPORTS, BANDWIDTH USAGE

- View near real-time remote usage and status
- Set usage thresholds and email alerts
- Branded URL and page
- IP Address information
- Location mapping
- Order services



Simple yet Customizable Rate Plans

- **EMR** – Emergency Management Specialty Plan
- **EOC** – Emergency Operations Specialty Plan
- **Enterprise Express** – Usage Based Plans
- **Day Rates** – Dedicated 24 Hour Plan
- **Streaming Buckets** – Hourly Plans
- **Pooled Plans** – Shared “pooled” Plan



Fusion Service Plans	GB Allowance	SELECT	Single	Overage/GB
Fusion MIX*				
20M x 5M	20		N/A	
	40		N/A	
	80		N/A	
	100		N/A	
Fusion				
20M x 5M	20		N/A	
	40		N/A	
	80		N/A	
	100		N/A	
Kymeta				
8M x 2M	20		N/A	
	40		N/A	
	80		N/A	
	100		N/A	

Pooled Multi-Carrier Cellular Plans	GB Allowance	Monthly	Overage/GB
AT&T, T-Mobile, Verizon, Firstnet**	10		
	20		
	40		
	80		
100			
Additional SIM			

Enterprise Express	GB Allowance	SELECT	Single Satellite Downgrade	Overages
1GB***	1			MB
1GB Plus***	1			
3GB***	3			
3GB Plus***	3			
9GB	9			GB
9GB Plus	9			
20 GB Plus	20		N/A	
40 GB Plus	40		N/A	
80 GB Plus	80		N/A	
100 GB Plus	100		N/A	

EOC Recovery	Allowance	SELECT	Single Satellite Downgrade	Overages
EOC Recovery	0 Days			/ Day
EOC Recovery Plus				/ Day
Voice Bandwidth Profile (per line)			\$	/ Day
Committed Information Rate				bps / Day

Mobile Responder	Allowance	SELECT	Single Satellite Downgrade	Overages
EMR	10 Days			/ Day
EMR Plus				/ Day
Voice Bandwidth Profile (per line)				/ Day
App Based Committed Information Rate			bps	bps / Day

Pooling Options for Individual Plans

Must be a single customer
Terms on all sites must be co-terminus

Thank you for your time



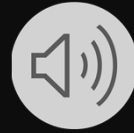
sales@ipinternational.net
WWW.IPINTERNATIONAL.NET

IP ACCESS INTERNATIONAL

Providing Communications To Responders Who Protect And Save Lives

*Providing Communications To First Responders
Who Protect And Save Lives*

DSG NTCOG
5/25/2021



Drone Light Shows

Building the Productive Capacity in North Texas to:

- Earn a Profit
- Produce Skilled Jobs
- Pay Taxes

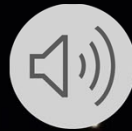
Innovating Simplifying Prototyping



Aerial Light Show System



Flies Longer
Assembles
Faster
Costs Less





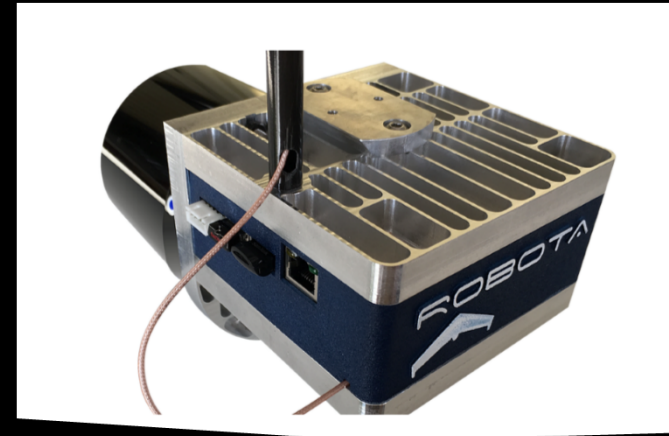
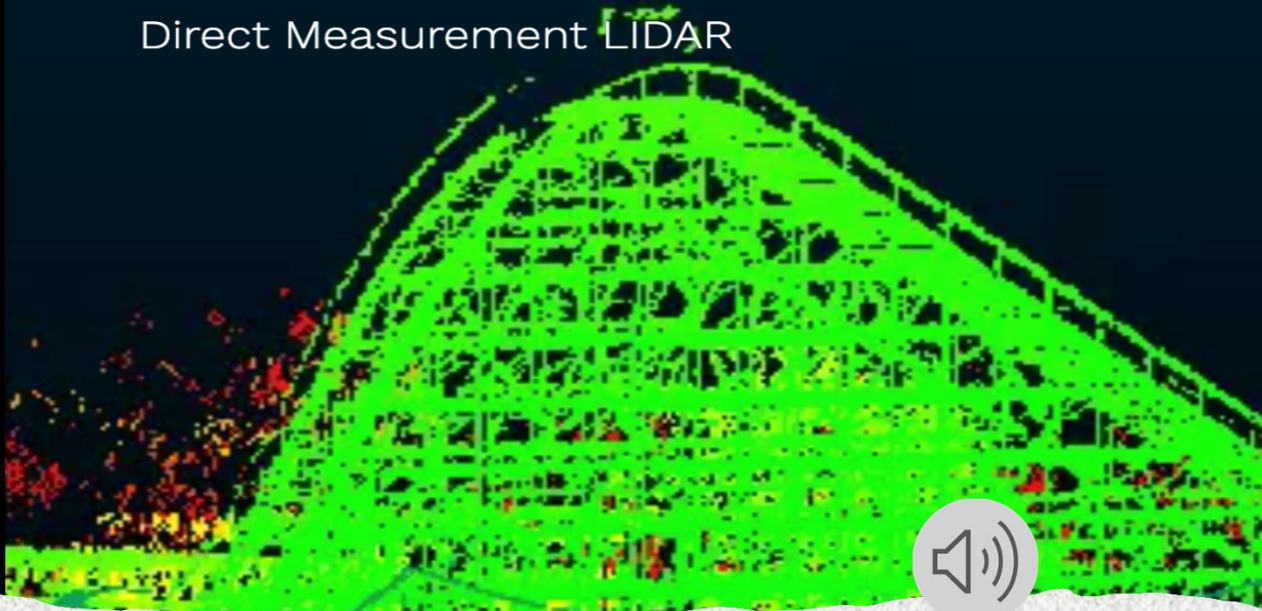
Dallas Executive Airport Hanger 7

Professional Photogrammetric
Mapping



ECLIPSE
2.0^{RTK}_{PPK}

Direct Measurement LIDAR

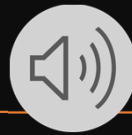


Scan Anywhere

Scan Anything

Six Flags Roller Coaster – Arlington, Tx

Fly Anything Auto Pilot



GNSS Reference Station

Precision measurement accessible with a simple and affordable design.





20 to 25 Skilled People

- | | |
|---------|---------|
| Design | Admin |
| Develop | Market |
| Produce | Sell |
| Support | Perform |



U.S. Fireworks Industry Revenue Figures Breakdown by Industry Segment 1999 – 2020

The U.S. fireworks industry has experienced unprecedented growth during the past decade and a half. Below is a snapshot of industry revenue by industry segment from 1999-2020.

<u>Year</u>	<u>Display Fireworks Revenue</u>	<u>Consumer Fireworks Revenue</u>
2016	\$345 million	\$825 million
2017	\$353 million	\$885 million
2018	\$360 million	\$945 million
2019	\$375 million	\$1 billion
2020	\$ 93 million	\$1.9 billion

A nighttime photograph of the Dallas skyline reflected in water. A large, glowing syringe-shaped drone light show element is positioned in the upper left. The city lights are colorful, with a prominent green tower. A white, torn-paper-like vertical line separates the image from the text on the right.

City of Dallas
Drone Light
Show
100 Days of
Vaccinations



More Drone Shows

Corporate and community
events

How would a drone light show
communicate your idea?



Part 107 FAA Certified Drone Pilot



Support job training for more FAA 107 Certified Pilots with capability to negotiate waivers.

This could be done through NTx's community colleges



Federal Aviation
Administration

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[About FAA](#)

[A-Z Index](#)

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Unmanned Aircraft Systems

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[Getting Started](#)

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Waiver Safety Explanation Guidelines for Part 107 Waiver Applications



Facilitate FAA 107 Waiver
approval process.



Let's get flying...this is our NTx business to lose.

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Legislative Update

Nicholas Allen

North Central Texas Council of Governments

UAS Safety and Integration Task Force Meeting

May 25, 2021

87th Legislative Session

HB 1758 (Krause) - Relating to the operation and use of an unmanned aircraft.

- Senate Intent Calendar for 5/24
- Contains definition of “drone”

SB 149 (Powell) - Relating to the prosecution of the offense of operation of an unmanned aircraft over certain facilities.

- House Calendar for 5/25
- Also adds airports to the list of critical infrastructure

Questions and Comments

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