2025 Fall Conference at Ashore Resort & Beach Club
Ocean City, Maryland
Surveying Technology

September 19, 2025

Paul S. Ewell, Professional Land Surveyor
Nick Alexander, Professional Land Surveyor

WALLACE MONTGOMERY

Paul S. Ewell

- Professional Land Surveyor – MD & PA
- AA Degree in Land Surveying Technology
- Past President of Maryland Society of Surveyors
- 2024 MSS Surveyor of the Year
- MSS Workforce Development Committee Chairman
- Surveying for 39 years

CELEBRATING 50 YEARS 1975 - 2025

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Nick Alexander

- Maryland Professional Land Surveyor
- MSS Young Surveyors Chapter Chairman
- 2024 Inaugural MSS Surveying Technician of the Year
- FAA Part 107 UAS Licensed Drone Pilot

CELEBRATING 50 YEARS 1975 - 2025

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ABSTRACT

SURVEYING TECHNOLOGY

- Geodetic Datums – Brief history and what's coming
- GPS – current applications
- Bathymetric Surveying
- Terrestrial Scanning and Mobile Mapping
- Drone UAS Surveying
- Other tech

- One hour session for 1.0 PDH

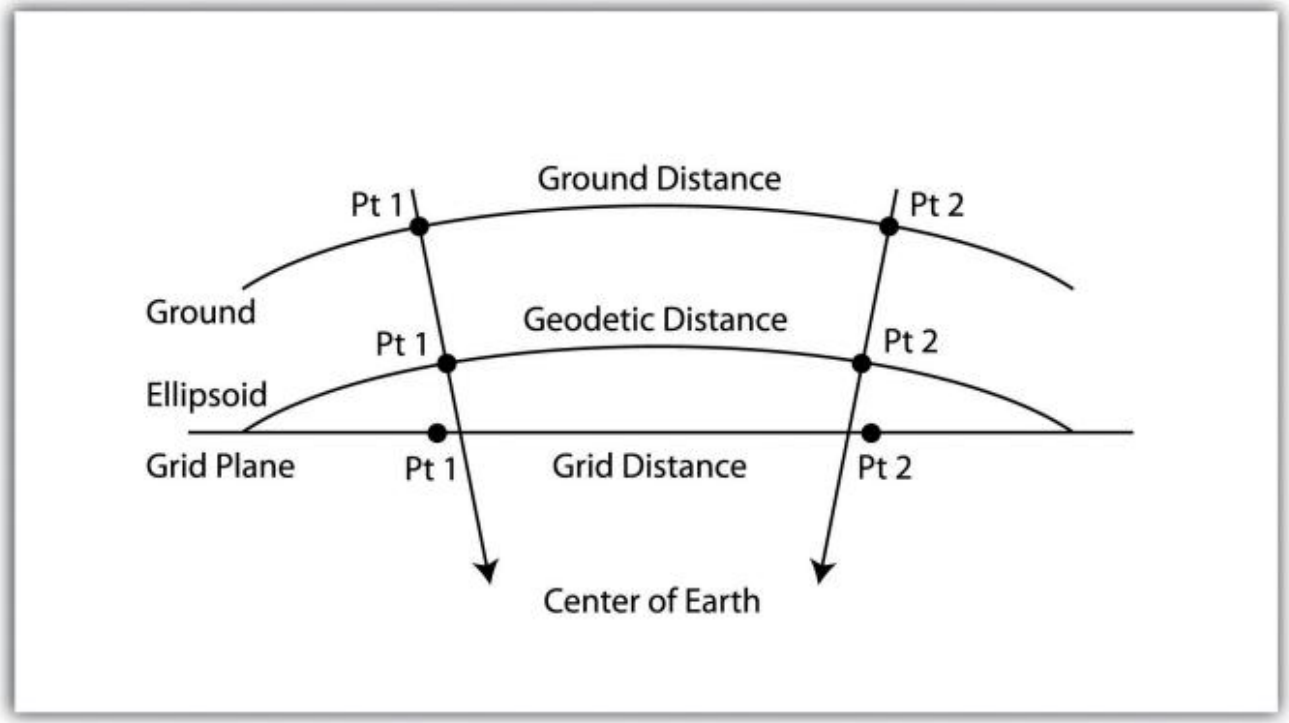
Surveying Technology

GEODETIC DATUM EVOLUTION (Horizontal)

Grid versus Ground (what is state plane and why have it)

Exists to provide a more accurate and practical method for surveying and mapping within specific regions of the United States

- Minimize Distortion
- Better local accuracy
- Simpler Calculations



Surveying Technology

GEODETIC DATUM EVOLUTION (Horizontal)

- NAD 27 (North American Datum of 1927)
  - NAD 27 was based on network of triangulation stations and a Clarke Ellipsoid of 1866.
  - Established from a single reference point at Meades Ranch in Kansas

Surveying Technology

GEODETIC DATUM EVOLUTION (Horizontal)

- NAD 83 (North American Datum of 1983)
  - NAD 83 replaced NAD 27 and offered a more accurate representation of the earths shape.
  - Was released in 1986 with state by state adjustments in the 1990's. Utilized both classical triangulation and newer GPS observations.
  - First iteration was NAD 83 (1991) All classical triangulation adjusted to fit HARN. High Accuracy Reference Network established by state GPS surveys.
  - CORS (Continuously Operating Reference Stations)
  - Next iteration was NAD 83 (2007), All passive control adjusted to fit CORS network positions (67,000+ stations)
  - Current iteration is NAD 83 (2011), All passive control adjusted to fit CORS network positions (80,000+ stations)

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GEODETIC DATUM EVOLUTION (Horizontal)

- Where we're going
  - NATRF2022 (North American Terrestrial Reference Frame)
  - Provides greater accuracies while incorporating modern technologies.
  - More aligned with true "Earth Center".
  - Will rely primarily on GNSS and updated Geoid models from GRAV-D project.
  - Plat Tectonics factor. (new epochs)
  - More defined with positional velocities.

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GEODETIC DATUM EVOLUTION (Vertical)

- NGVD 29 (National Geodetic Vertical Datum of 1929)
  - Also known as Sea Level Datum of 1929.
  - Based on mean sea level observations at 26 tidal stations.
  - Later found to have inaccuracies due to variations in local mean sea levels
- NAVD 88 (North America Vertical Datum of 1988)
  - A more comprehensive adjustment using leveling data, gravity factors and GPS measurements.
  - Aimed to provide a more accurate and consistent vertical refence system.
  - Accounts for variations in gravity and earth distortions.
  - Does not easily account for local vertical velocities.

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GEODETIC DATUM EVOLUTION (Vertical)

- Where we're going
  - NAPGD 2022 (North American-Pacific Geopotential Datum of 2022)
  - Realized by new GEOID 2022
  - GRAV-D Project (**G**ravity for the **R**edefinition of the **A**merican **V**ertical **D**atum)
  - Airbourne Gravity snapshot with absolute gravity tracking.
  - Geoid will be tracked over time to keep datum up to date.

PSA – You CANNOT improve the accuracy of coordinates and elevations by performing datum conversions!

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GNSS APPLICATIONS

- GPS developed by US Military in 1995 using 31 satellites.
- GLONASS developed by Russia in 1995 using 24 satellites.
- Galileo developed by European Union launched in 2016 and has 27 usable satellites.
- BeiDOU developed by China first launched in 2000 and has 35 usable satellites.

- Current Survey equipment is GNSS meaning it uses all the above signals (more signals = better results)

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GPS SATELLITES

- 1978 – Block I satellites started.
- 1989 – Block II satellites started.
- 1995 – Block I fully operational.
- 2000 – Selective availability turned off .
- 2018 – Block III satellites started.
- 2027-2028 – Block III fully operational (maybe)
- 2028-2031 - 0.3 to 1.6 feet real time accuracy

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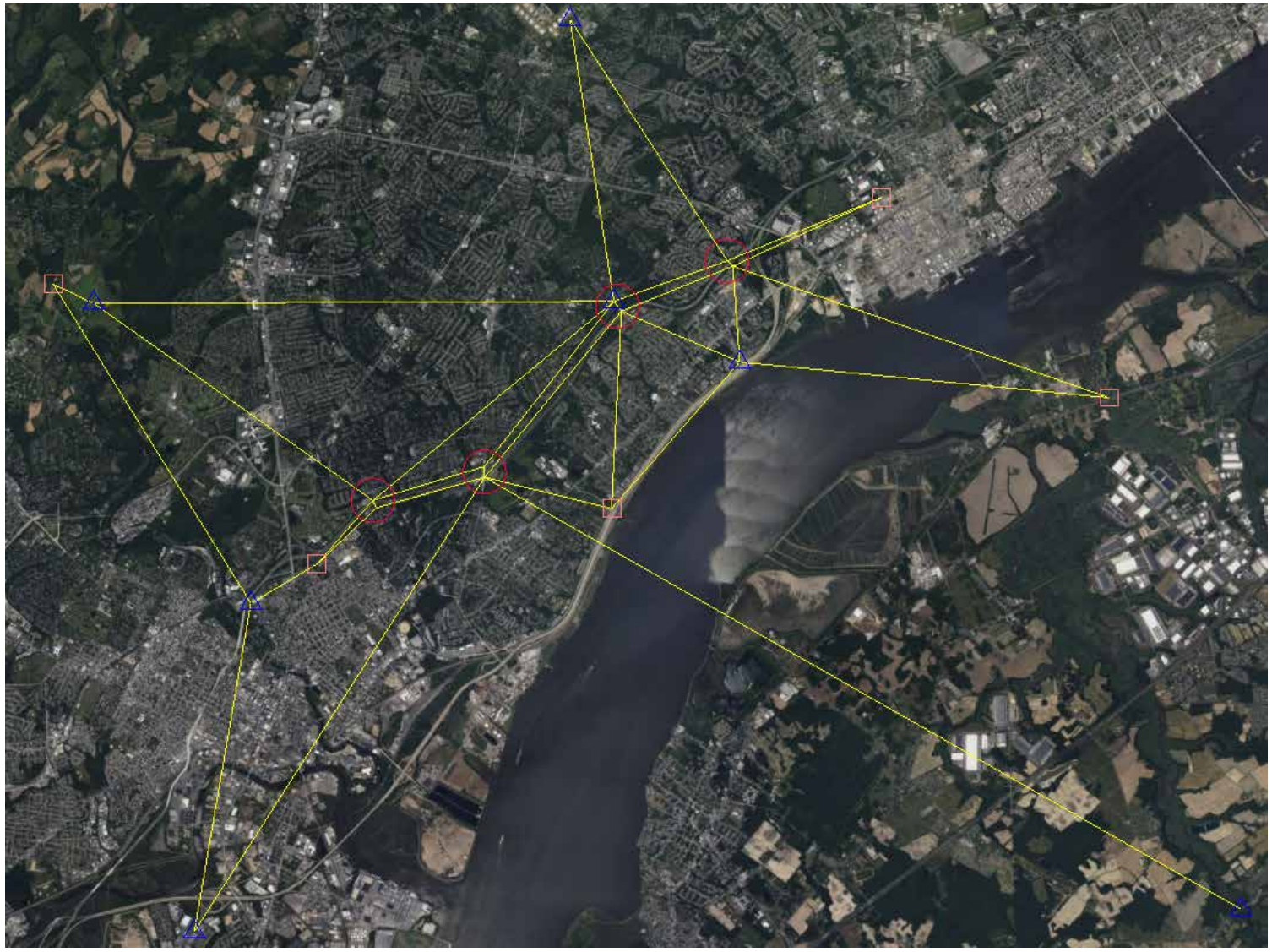
GNSS APPLICATION

- Static Networks
  - Used when greater accuracy is required
  - Excellent for large corridor surveys
  - Rigorous Least Squares Adjustment



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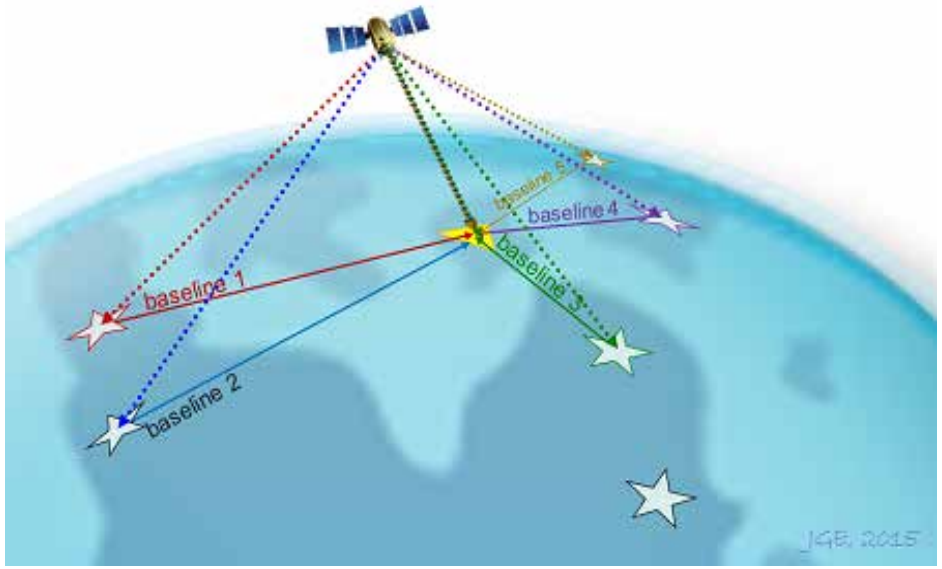
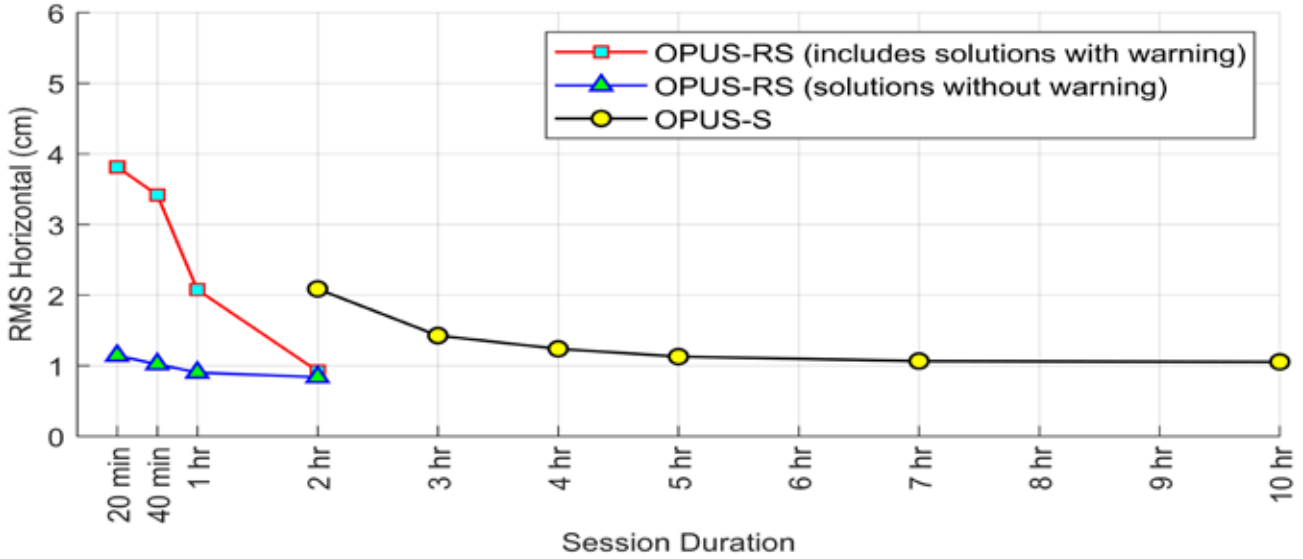
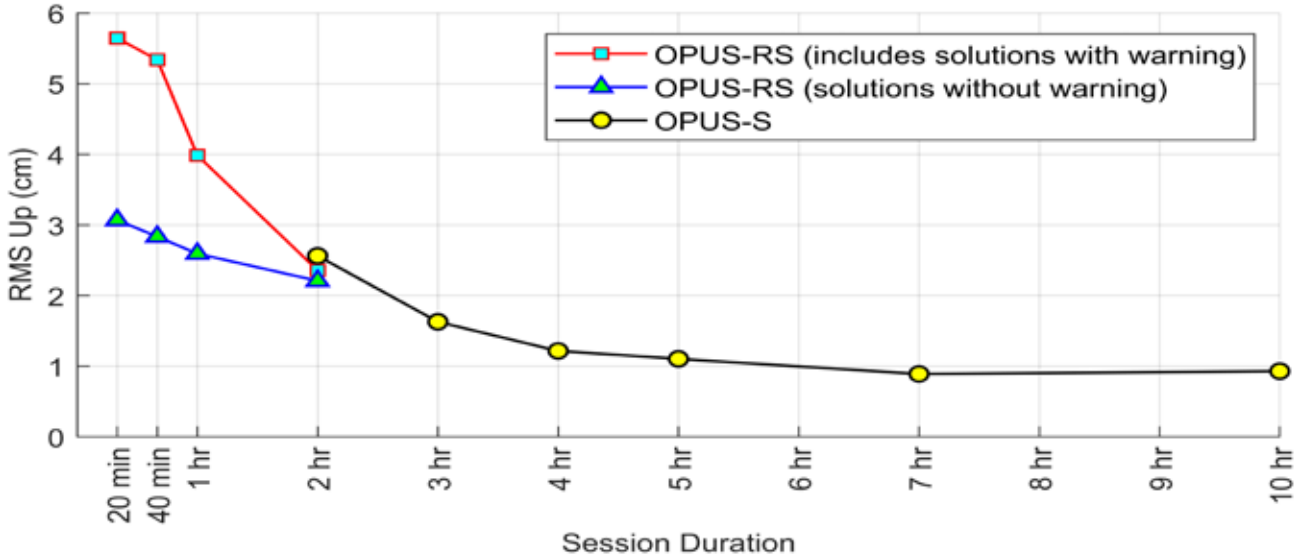
GNSS APPLICATIONS

- OPUS
  - Uses CORS Stations
  - Can be Rapid-Static or Static
  - Varying degrees of accuracy







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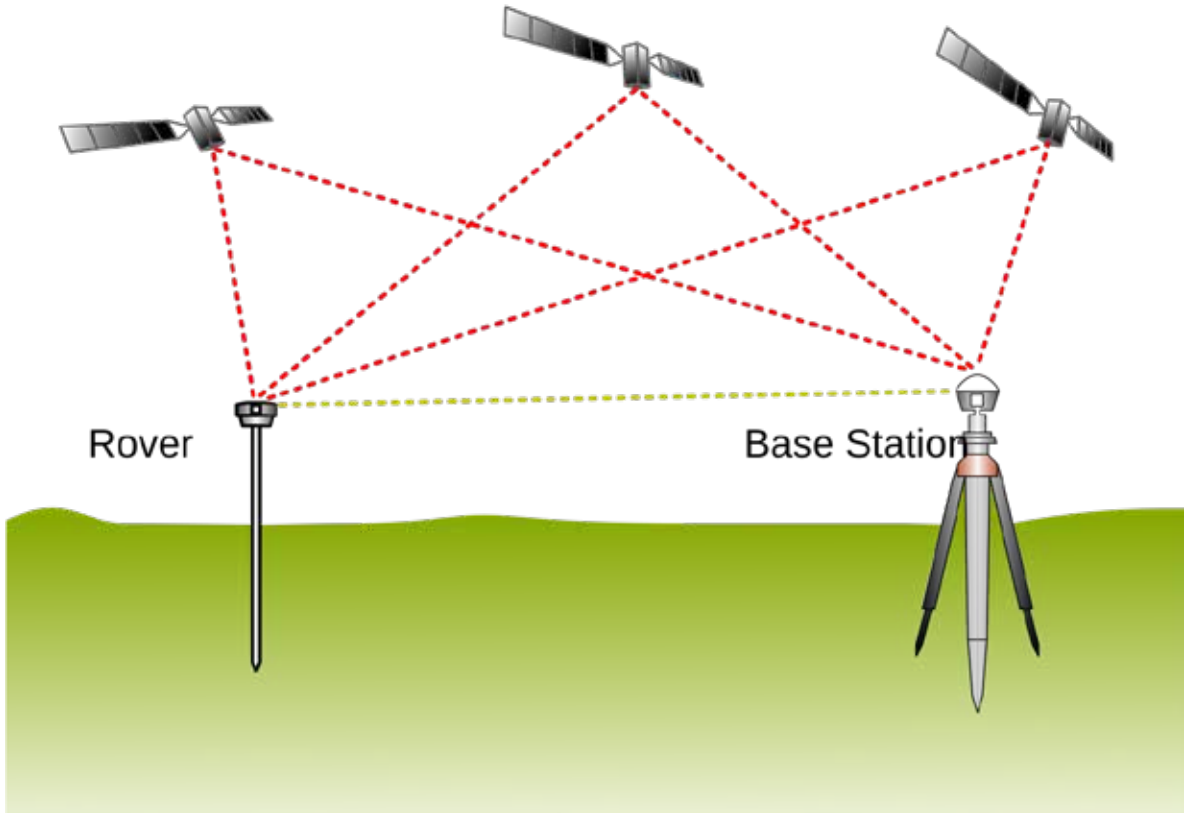
GNSS APPLICATIONS

- Local RTK utilizes real time corrections from on-site known base station to rover unit to establish positions.



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GNSS APPLICATIONS

- RTN and VRS (Real time Networks with Virtual Reference Stations
- A commercial network of know reference stations collecting data
- Computes a VRS that acts as a “local” base station

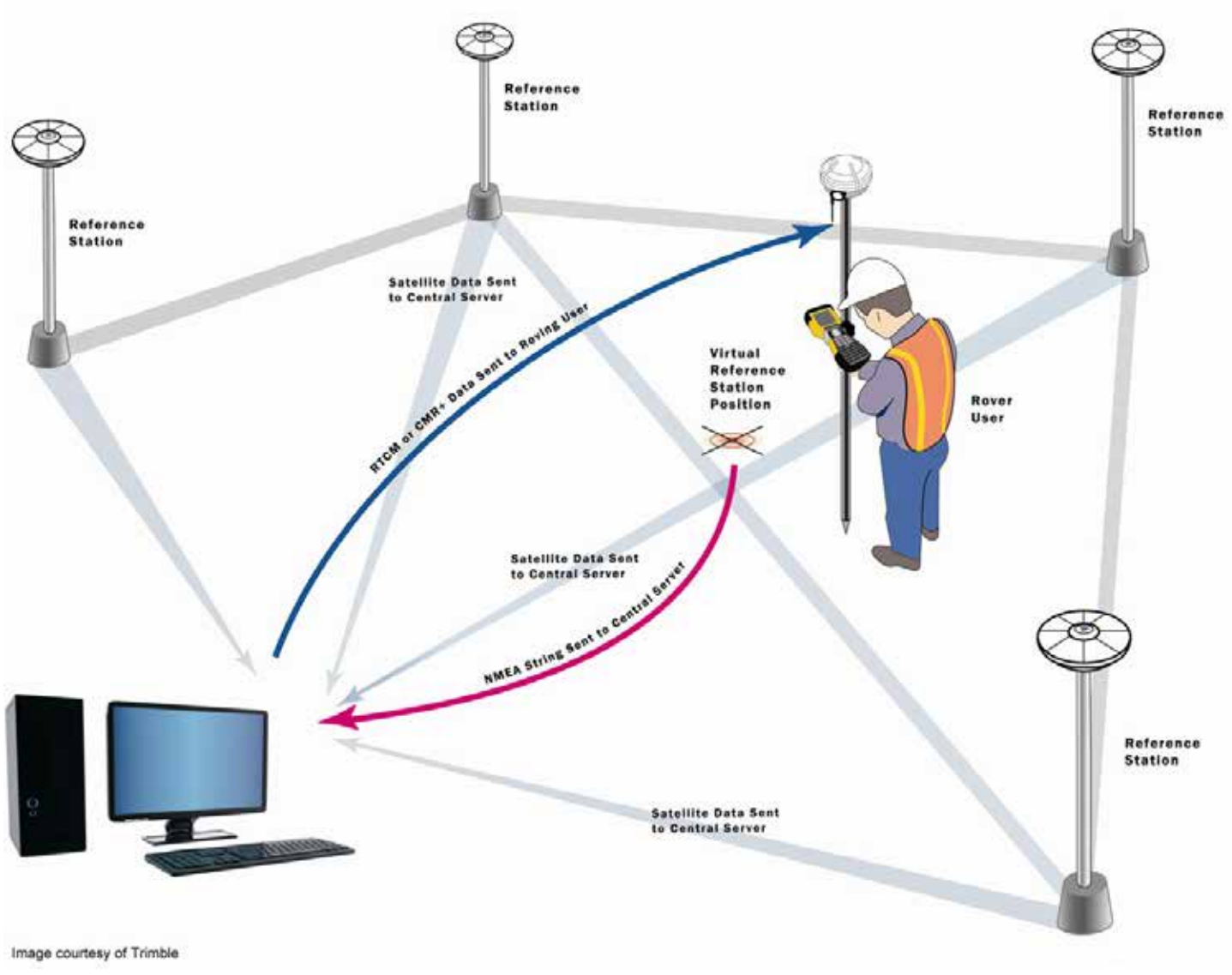

Image courtesy of Trimble

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BATHYMETRIC SURVEYING

- Bathymetric surves measure the depths and shape of underwater terrain, essentially creating a “map of the seafloor, rivers, or lakes”.
- Uses include
  - Navigation safety
  - Engineering & construction
  - Environmental studies
  - Flood modeling & hydrology
  - Archaeology and exploration

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OUR EQUIPMENT

- Seafloor TriDrone

Surveying Technology

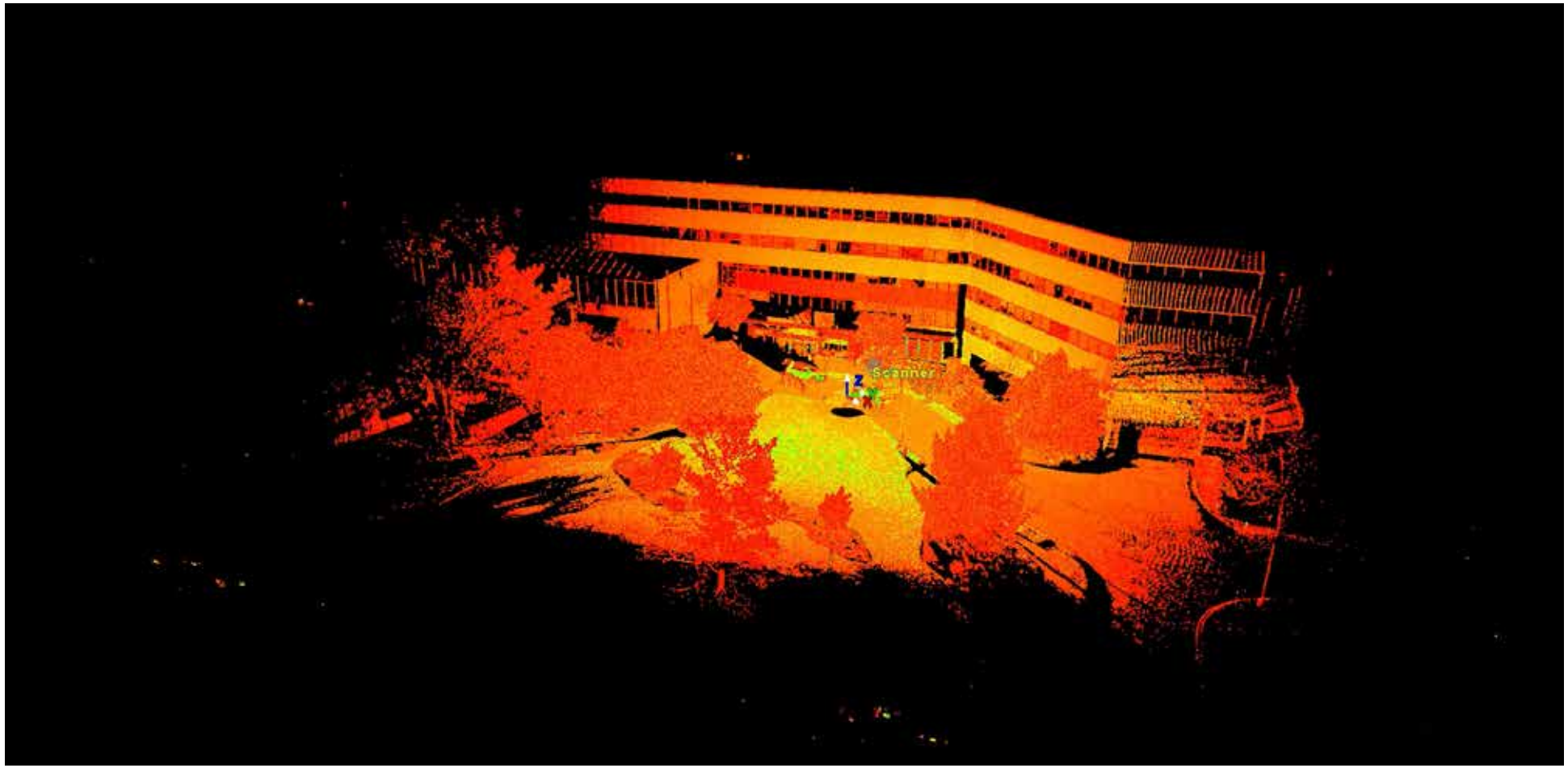
SPECIFICATIONS

- Remote range: Up to 1 km (3280 ft)
- Battery life – 5 hours
- HydroLite – Sonar specifications;
  - Sonar Depth- 0.5m-200m (1.64-656 ft)
  - Depth Accuracy: 1cm/0.1% of depth

Surveying Technology

Surveying Technology

LIDaR – Light Image Detection and Ranging



Surveying Technology

TERRESTRIAL SCANNING

- Most accurate
- Provides the most detail
- Easiest to use
- Great for indoor and outdoor collection
- Safe way to locate high traffic roadway

Surveying Technology

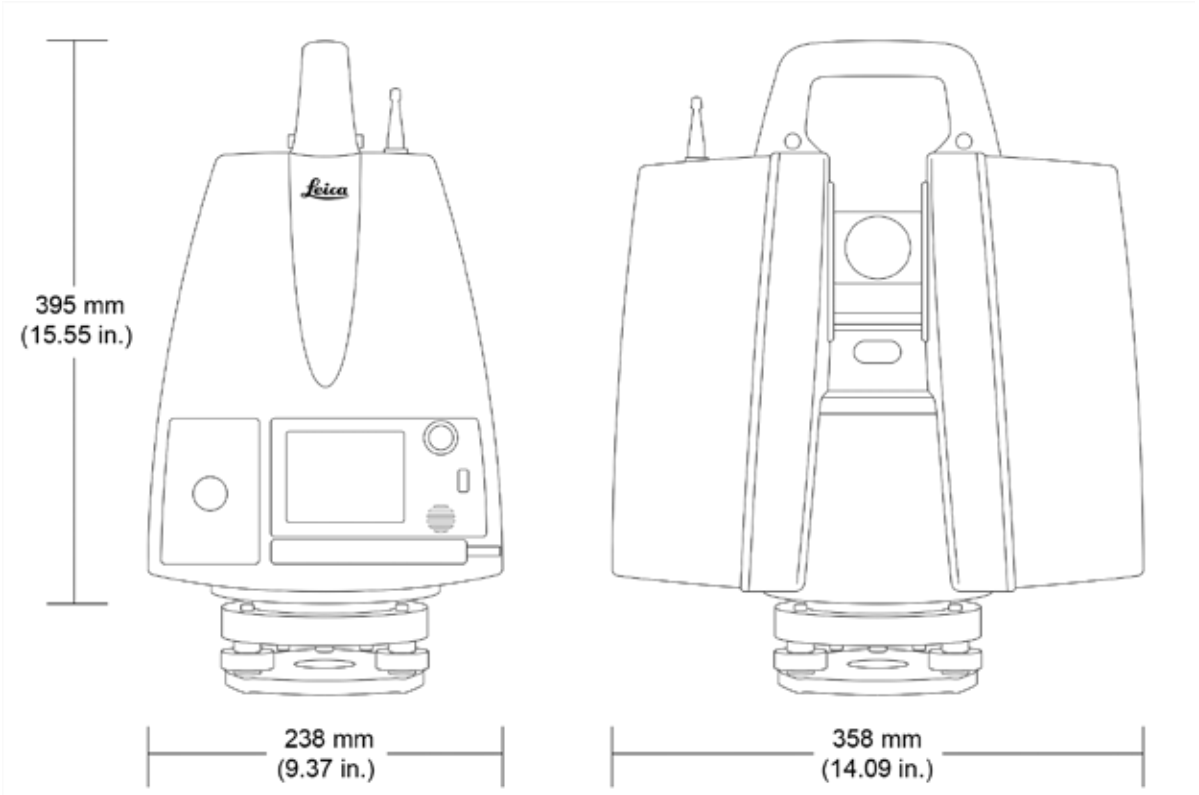
OUR EQUIPMENT

- Leica P40 (Upgraded by Leica for Register 360)
- Leica C10

Surveying Technology

SPECIFICATIONS

- Range 0.4 – 11470 m (1.31 – 37631 ft)
- Speed – Up to 1,000,000 pts/sec
- Accuracies
  - 0.4mm rms at 10m (0.00131 ft at 32.8 ft)
  - 0.5mm rms at 50m (0.00164 ft at 164 ft)



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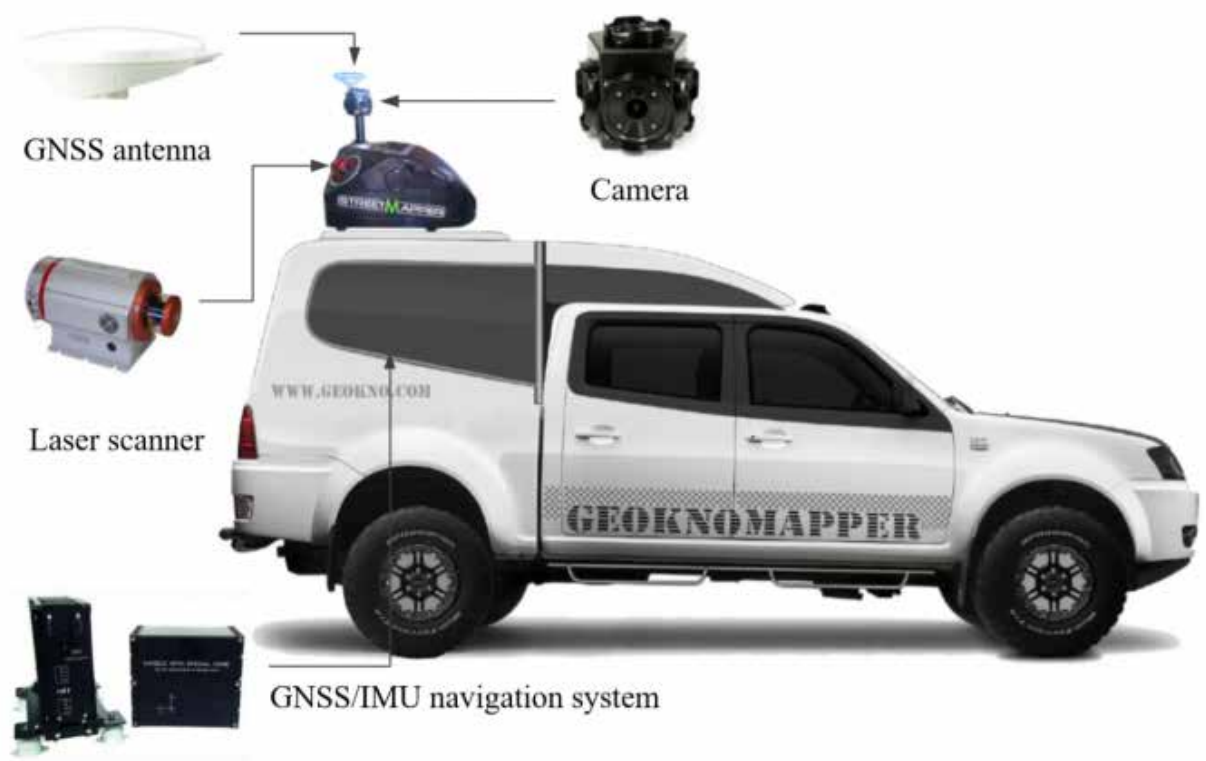
MOBILE MAPPING

- Can collect the most data in the shortest amount of time
- Second most accurate
- GPS real time locationing
- Equipped for tunnels and GPS dead zones



Surveying Technology

OUR EQUIPMENT

- Trimble MX90

Surveying Technology

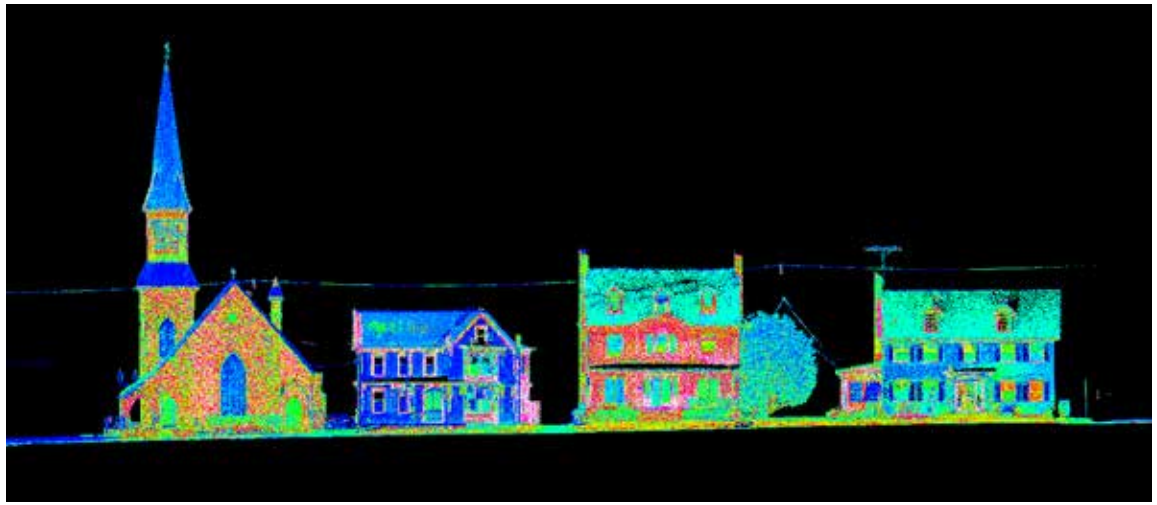
Trimble MX90

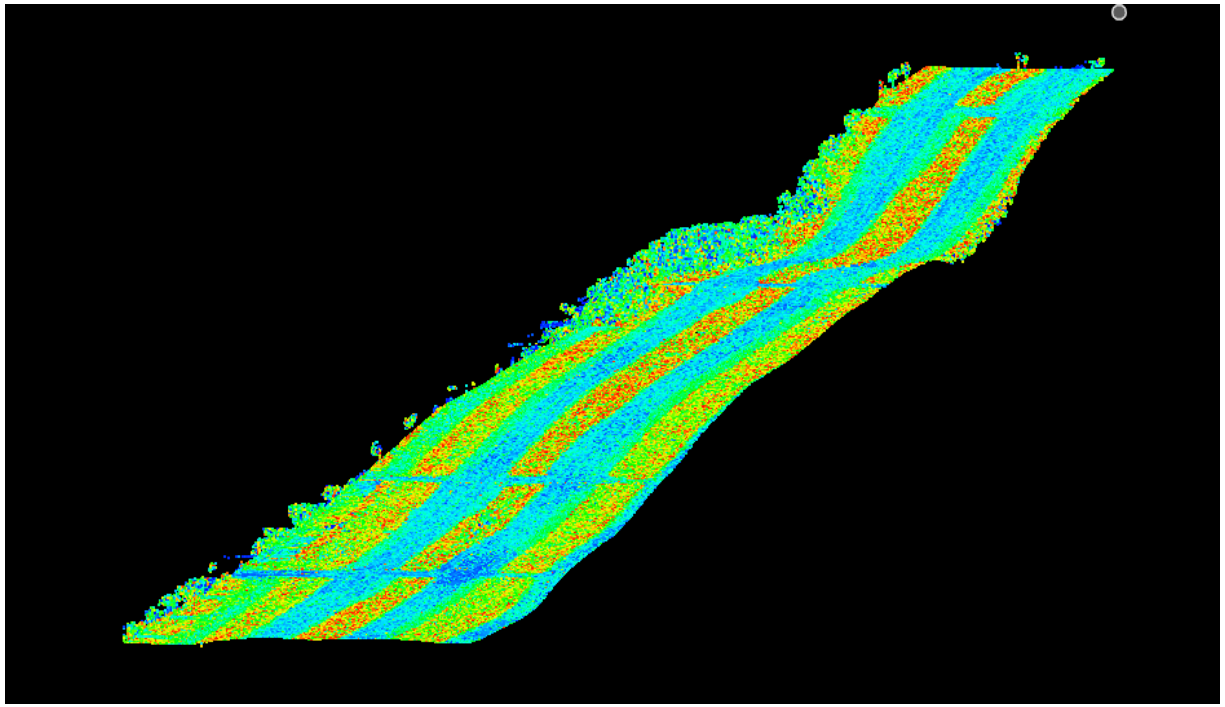
Mobile mapping system

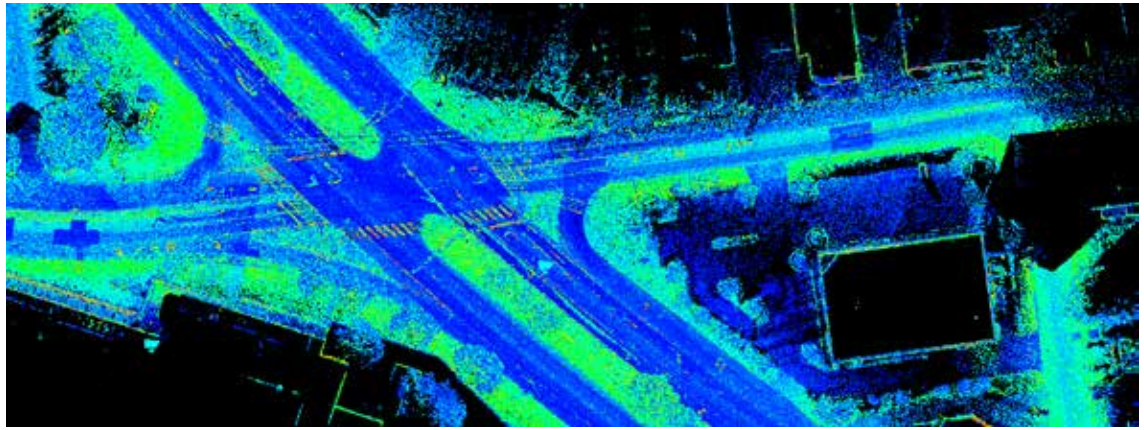
MX90 SYSTEM						
Scan speed	500 scans/sec					
Number of laser scanners	2					
Laser positions	Adjustable in 3 horizontal and 3 vertical positions					
MX90 LASER SCANNER						
Laser class	1, eye-safe					
EFFECTIVE MEASUREMENT RATE[1]	300 kHz	500 kHz	1000 kHz	1250 kHz	1500 kHz	1800 kHz
Maximum range target reflectivity > 80%[2]	475 m	370 m	235 m			
Maximum range target reflectivity > 10%[2]	170 m	130 m	85 m			
Maximum number of targets per pulse	up to 15	up to 15	up to 9	up to 7	up to 5	up to 4
Minimum range	1 m @ PRR ≥ 1 MHz, 1.2 m @ PRR < 1 MHz					
Accuracy[3]/precision[4]	5 mm/3 mm					
Field of view	360° "full circle"					

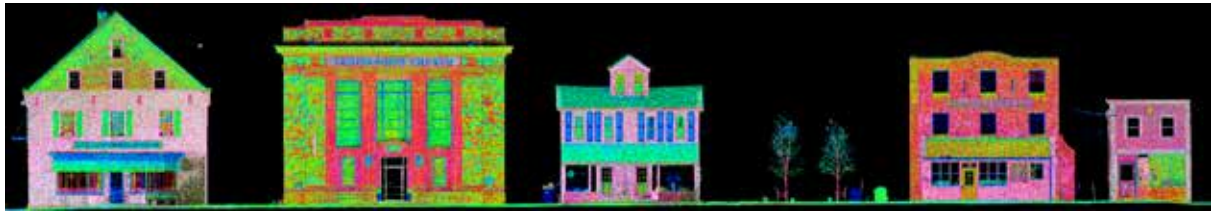
CAMERAS				
SPHERICAL CAMERA				
Camera type	No	Mounting	FoV	Focal length
Spherical camera, 72 MP (6 × 12 MP)	1	Fixed	90 % of full sphere	6.94 mm
Capture modes	By distance or by time at 10 fps max			
PLANAR CAMERAS				
Camera type	No	Mounting	FoV	Focal length
12 MP side facing camera	2	Adjustable (in horizontal and vertical positions)	H: 47.6° V: 35.9°	16.0 mm
12 MP backward/ downward facing camera	1	Fixed	H: 82.9° V: 65.9°	8.0 mm
Capture modes	By distance or by time at 9 fps max			

Surveying Technology









Surveying Technology

DRONE UAS SURVEYING

- Minimal location disturbance
- Second fastest data collection. Limited only by battery life.
- Potential for future growth in accuracy and deployment

Surveying Technology

OUR EQUIPMENT

- DJI Matric 350 RTK
- Equipped with a L2 Lidar sensor payload

Surveying Technology

SPECIFICATIONS

- Max flights time 55 minutes
- Max speed 23m/s (51.45 mph)
- Maximum tolerable wind speed 12m/s (23.3 knots)
- Zenmuse L2
  - 240,000 points per second
  - Horizontal Accuracy – 5cm @ 150 m (0.16 ft at 492 ft)
  - Vertical Accuracy – 4 cm @ 150 m (0.13 ft at 492 ft)

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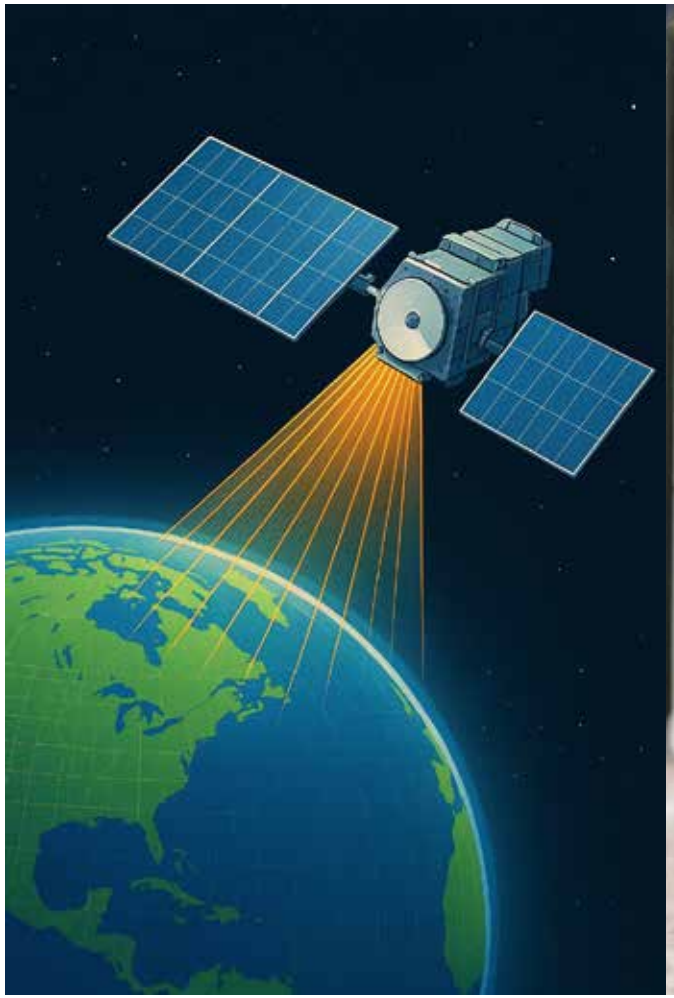
Surveying Technology

Surveying Technology

WHAT'S NEXT?



QUESTIONS?

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