Top Geospatial Trends to Watch in 2022

Dr. Qassim Abdullah, Woolpert, Inc.

VP & Chief Scientist

ASPRS EGLR Summer Technical Meeting | July 28, 2022 |
Cleveland, OH

Agenda

Top Geospatial Trends to Watch in 2022

1. Our industry: challenges and opportunities
2. Our resilience and recovery
3. Notable technology trends
4. Q&A and discussions

Our industry: challenges and opportunities

- The pandemic has imposed many daily challenges and created a sense of urgency that we had never witnessed before

- These challenges drove the need to rethink our business practices and regain some sense of normalcy

- The pandemic played a great role in bridging the digital divide between advanced and less advanced geospatial professionals and organizations

Our industry: challenges and opportunities

- Increased demands for digital communications presented great opportunities for the advancement of cloud-based data sharing and processing, which directly and indirectly resulted in improved 3D processing and modeling.

- The pandemic moved the geospatial data and GIS to a higher priority for the public policy makers and administrators, resulting in more demands. However, some aspects of businesses were disrupted or slowed down.

Our resilience and recovery

- Despite the pandemic changing how we conduct business, geospatial sensor manufacturers and technologies continued their upward trend, although more modestly than expected.

- Driven by the urge for survival, sensor manufacturers, data producers, application developers, and software companies heightened their creativities and innovations.

- Very few businesses, if any, disappeared due to market slow down

Notable technology trends to watch in 2022 and beyond

Virtual Collaboration Rooms and Mixed Reality

- The lowered costs of data processing, - computing power, algorithms, data compression and the cloud processing platform have advanced these technologies from video games to engineering and environmental solutions with direct societal benefits.

- Mixed reality platforms such as Microsoft HoloLens 2 and VR headsets, Bentley SYNCHRO XR, and NVIDIA Omniverse platform are designed for visualizing 4D construction digital twins.

- These accessible platforms generate the need for 3D data while providing a new means of data modeling and interpretation.

Deep into Miniaturized Sensors

- Apple achieved a great milestone in 2020 with the introduction of a lidar sensor on its iPhone 12 Pro. As a result, we have witnessed more surveyors and field technicians using smartphone-based lidar.
- Samsung, Dreametech, Narwal and iRobot have followed a similar design and added lidar to their products.

BIM and GIS, the Foundation for Digital Twin and Metaverse

- DT is often misunderstood and confused with a 3D model.

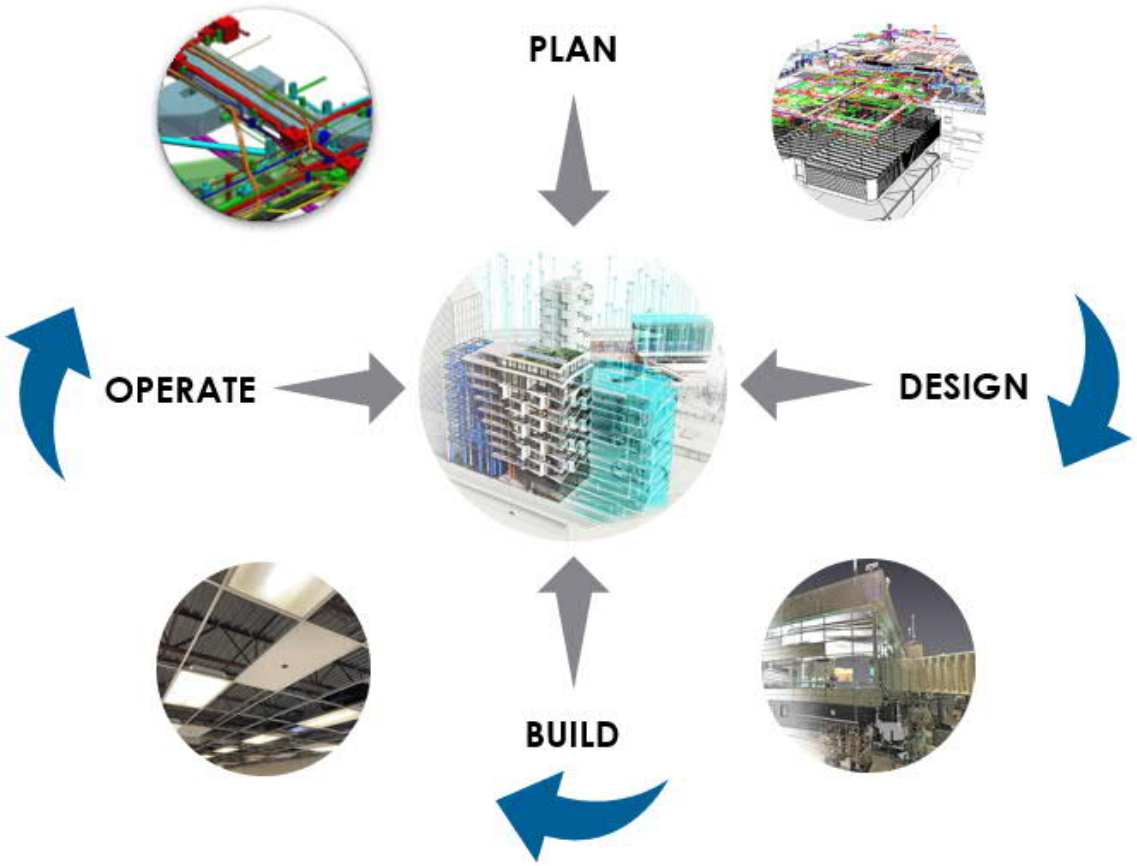
- Digital twin is much more complex. It encompasses multiple concepts—such as scan-to-BIM, 3D modeling and GIS—to produce the desired environment.

Digital twin is:

- A dynamic, up-to-date replica or representation of a physical object, an asset or system with a complete collection of data in one place

- Evolves with the flow of real-time input from sensors and other sources

- Is not a static 3D model or simulation; it continues to evolve with added data and information



High-Definition Maps for Autonomous Driving

- A high-definition (HD) map is a highly accurate map used in autonomous driving, containing details not normally present on traditional maps.
- The role and scope of digital maps must go beyond turn-by-turn navigation
- It is built specifically for self-driving vehicles.
- HD Map is the next generation, delivering highly accurate, up-to-date and realistic representations of the road.
- The geospatial industry will reap the benefits of the HD market as it is the main supplier for it.

Drones, Drones Everywhere

- While unmanned aircraft systems have been used for engineering and geospatial mapping applications for a few years, last year finally saw industry standardization.

- On the regulatory side, the Federal Aviation Administration issued positive modifications to Part 107 guidelines regarding flying restrictions over people and flying at night.

- We are witnessing increased use of UAS-based lidar fueled by the release of the affordable DJI lidar system (Zenmuse L1). Zenmus L1 complement other lidar systems by Riegl and Velodyne that are widely used in the industry.

Anatomy Of a UAS-based Lidar System

Impact relative accuracy

Impact absolute accuracy

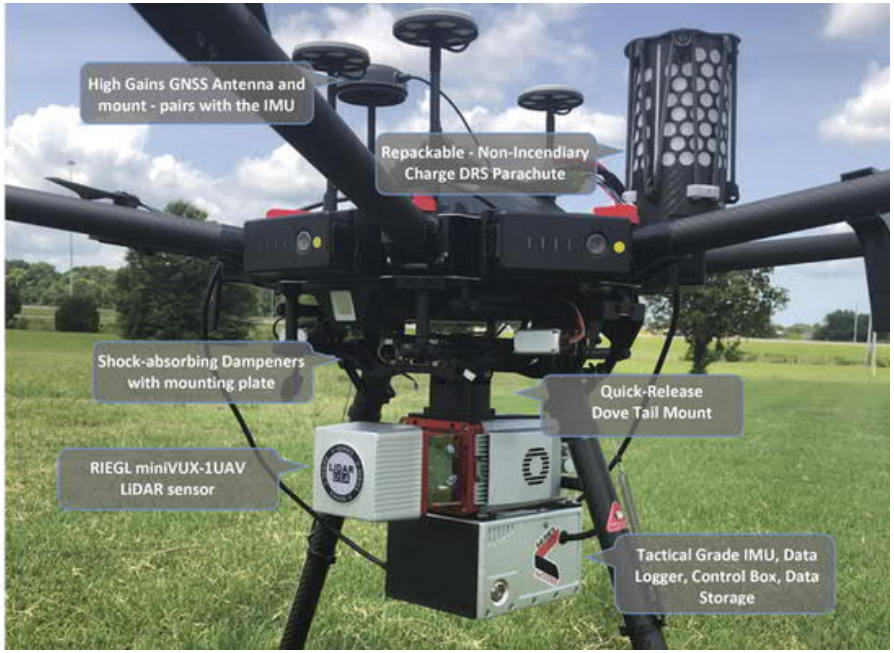
+

+

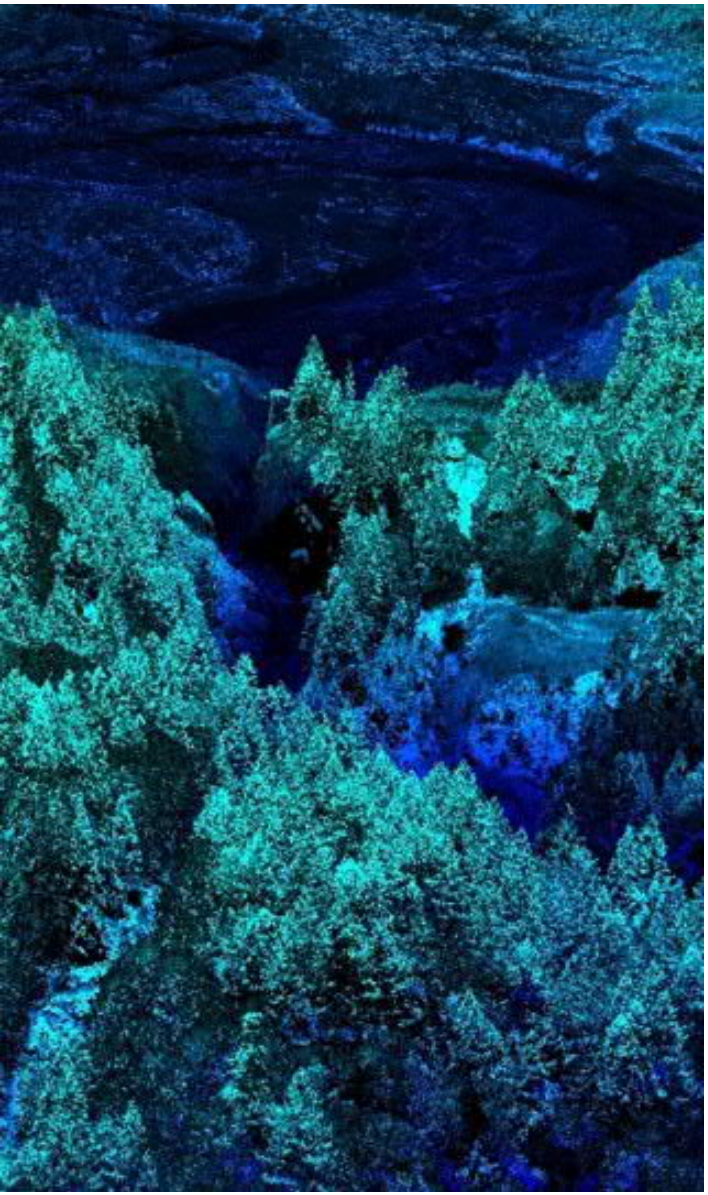
Laser

GPS-Aided INS

UAS



Images courtesy, Lidar USA, DJI, and VECTORNAV



Dynamics governing putting Lidar system on a drone

Must be light weight	Must be affordable to fly it on a small drone over a small size project

• Limited physical size and weight impact its performance
  • Lower power laser
  • Lower performance GPS and IMU
	• Low cost lidar means degraded performance
	  • Low cost lidar means lower quality laser, GPS, and IMU
	  • Lower quality sub-systems means lower quality points cloud

UAS-based Lidar and Current Market

Riegl

$100k to $230k

DJI

$20k

Points Density: 600-900 pts/m^2
Accuracy: 1 - 2 cm
Altitude: 70 to 300' AMT

Velodyne

$70k to $110k

Rock Robotic

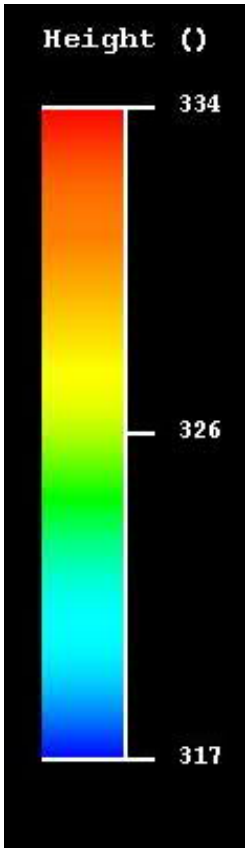
$45k

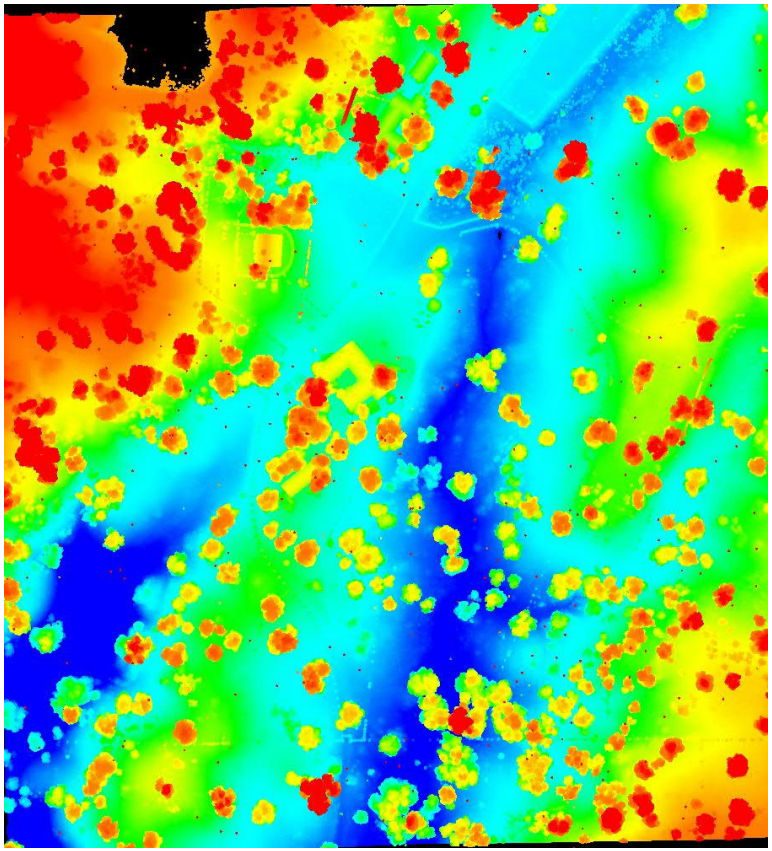
Quanergy

$70k to $110k

CSU Testing site, North of Fresno California

400x400 meter





We deployed four Lidar systems

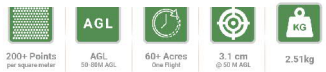
leased from Lidar USA through a contract with MODUS

Velodyne Lidar

HDL-32E

KEY FEATURES

- Dual Returns
- ± 2 cm accuracy
- 1kg (plus 0.3kg for cabeling)
- 32 Channels
- 80m-100m Range
- Up to ~1.39 Million Points per Second
- 360° Horizontal FOV
- +10° to -30° Vertical FOV
- Low Power Consumption
- Rugged Design



Velodyne Lidar

Puck LITE™

REVOLUTION 60

- 16 Channels
- Measurement Range: 100 m
- Range Accuracy: Up to ±3 cm (Typical)[1]
- Field of View (Vertical): +15.0° to -15.0° (30°)
- Angular Resolution (Vertical): 2.0°
- Field of View (Horizontal): 360°
- Angular Resolution (Horizontal/Azimuth): 0.1° – 0.4°
- Rotation Rate: 5 Hz – 20 Hz
- Integrated Web Server for Easy Monitoring and Configuration

RIEGL miniVUX®-1UAV

Laser Pulse Repetition Rate PRR [1)]	100 kHz
Max. Measuring Range [2)]	
natural targets ρ ≥ 20 %	150 m
natural targets ρ ≥ 60 %	250 m
Typ. Operating Flight Altitude AGL [1) 3)]	80 m (260 ft)
Max. Number of Targets per Pulse [4)]	5

Minimum Range	3 m
Accuracy [5) 7)]	15 mm
Precision [6) 7)]	10 mm

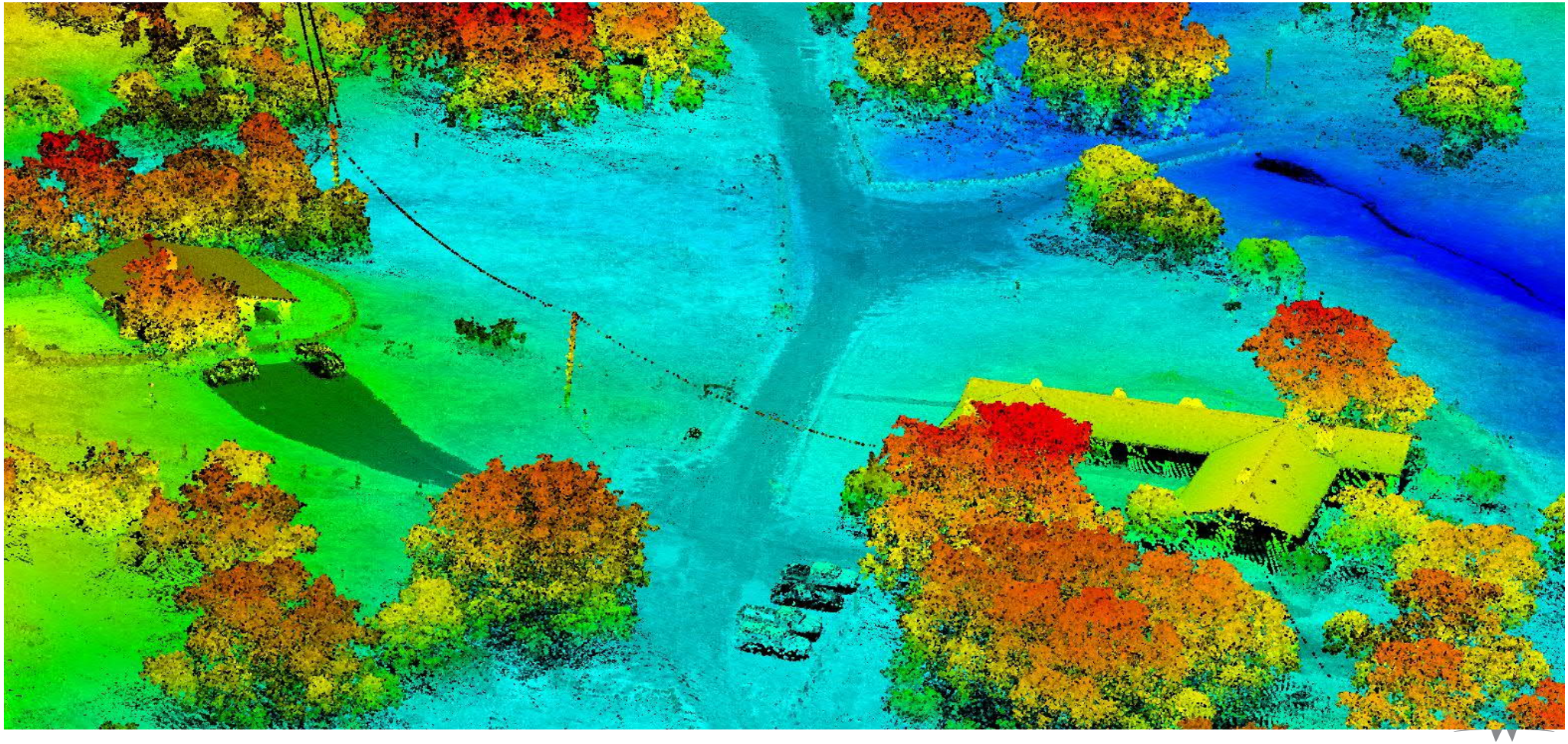
Quanergy M8

PARAMETER	SPECIFICATION
Laser Class	Class I (Eye Safety IEC 60825-1)
Wavelength	905 nm
Measurement Technique	Time of Flight (TOF)
Minimum Range	1 m (80% reflectivity)
Maximum Range	>150 m (80% reflectivity)
Range Accuracy (1σ at 50 m)	<3 cm
Frame Rate (Update Frequency)	5-20 Hz
Angular Resolution	0.03-0.2° dependent on frame rate
Detection Layers	8
Field of View (FOV)	Horizontal: 360°, Vertical: 20° (+3°/-17°)
Output Connection	100/1000 Mbps Ethernet
Data Outputs	Angle, Distance, Intensity, Synchronized Time Stamps
Returns	3
Output Rate	420,000 points per second (1 return) 1.26M points per second (3 returns)

MODUS

LiDARUSA
Fagerman Technologies Inc.

Power Lines with Rigel mini-VUX



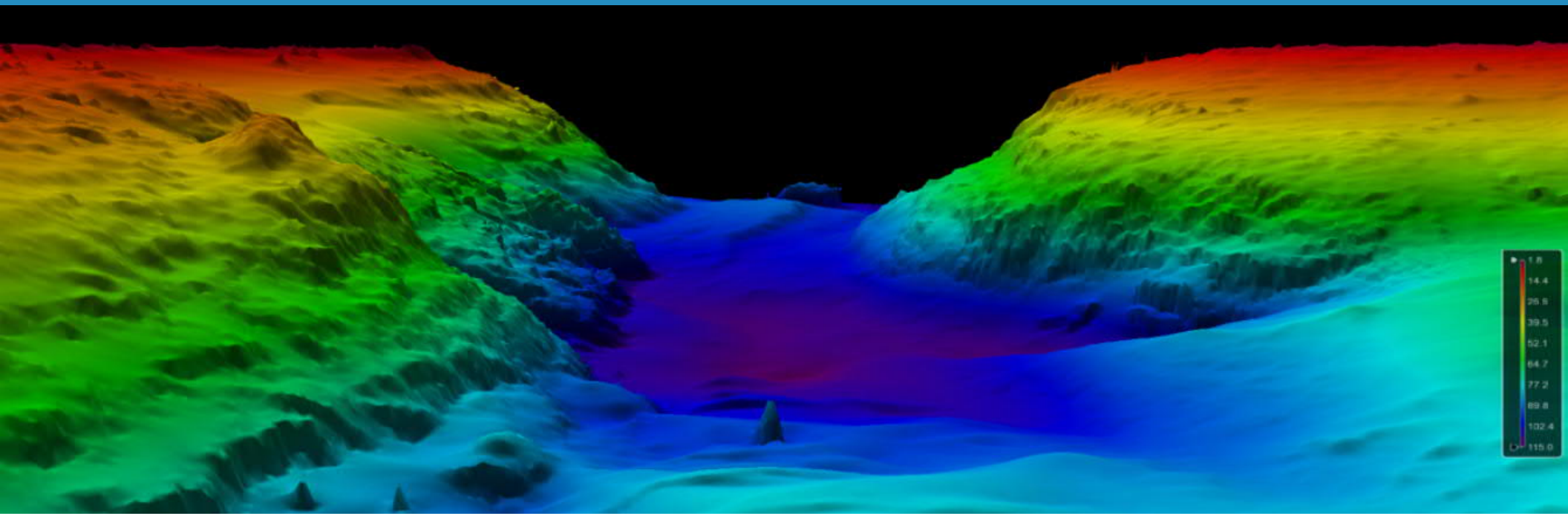
From Coastal and Deep into the Sea

- Here in the United States, deep ocean survey and advanced techniques for coastal and deep ocean mapping are in high demand fueled by NOAA's NOMEC strategy and Alaska Coastal Mapping.

- While Optech, Leica, and Rigel continued their innovations in topo/bathy lidar, the most notable development is the announcement of BULLDOG high altitude bathymetric lidar developed by Woolpert for the Joint Airborne Lidar Bathymetry Technical Center of Expertise (JALBTCX).

- BULLDOG which is based on Geiger mode is flown from 10,000' AGL, unprecedented altitude for bathymetric survey.

Seabed 2030 and the High Seas



- Seabed 2030 is a joint project of The Nippon Foundation and GEBCO with a goal of mapping 100% of the world's oceans by the year 2030.
- As of today, only 21% of the ocean is considered mapped to modern standards
- Many coastal nations, including the US, have plan to map their Exclusive Economic Zones (EEZ)

Whirl Around the Coastal Regions

- With the current U.S. administration backing renewable resources, that industry is expected to flourish in the coming years.

- Last year, the nation's first large-scale offshore wind farm was approved about 12 nautical miles off the coast of Martha's Vineyard, Mass.

- The geospatial industry is busy providing deep ocean surveys for these projects

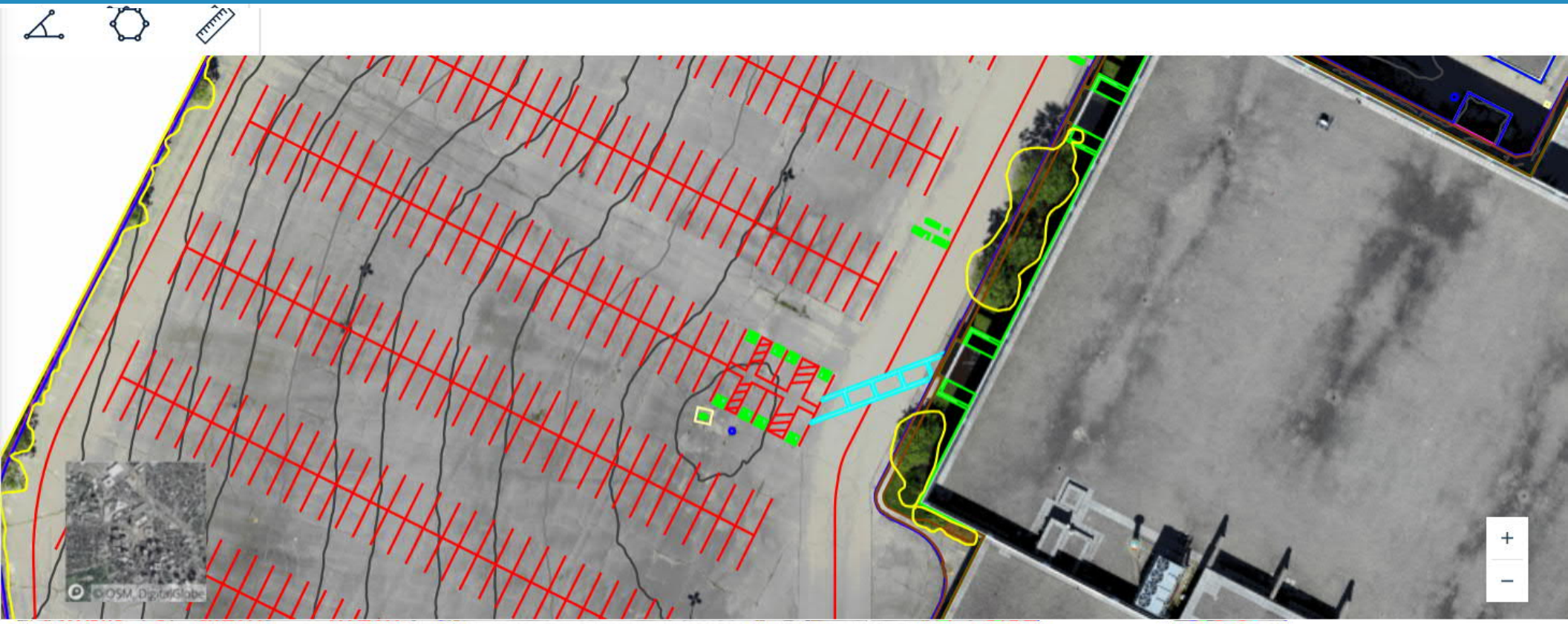
AI and Deep Learning are Living in the Cloud

- We are not short of data. Today's sensors technologies whether ground, aerial, or space-based are very productive in acquiring data.
- The challenges faces users, especially the defense agencies, is mining these data to extract information.
- Amazon, Google and Microsoft continue to lead that market and offer users and developers sophisticated platforms like serverless cloud computing.
- Microsoft Azure is a cloud platform that contains more than 200 products and cloud services designed to enable businesses to build, run and manage applications across multiple clouds, on-premises and at the edge, with the tools and frameworks of their choice.

AI and Deep Learning are Living in the Cloud

- As for geospatial application-based AI within the industry, on the commercial software level, Esri continues to push the envelope to help users streamline workflows with AI tools within ArcGIS. For example, in 2021, Esri added three ready-to-use geospatial AI models in the ArcGIS Living Atlas of the World.
- On the AI-based services side, only modest activities were observed this year. Companies like Airworks offered a cloud-based solution for extracting information from imagery and lidar point clouds. Although this Airwork offering has been welcomed by the surveying and mapping industry, massive work still needs to be done with AI, machine learning and deep learning to marry automation with GIS and geospatial applications to support mining the tremendous amount of data today's sensors acquire.

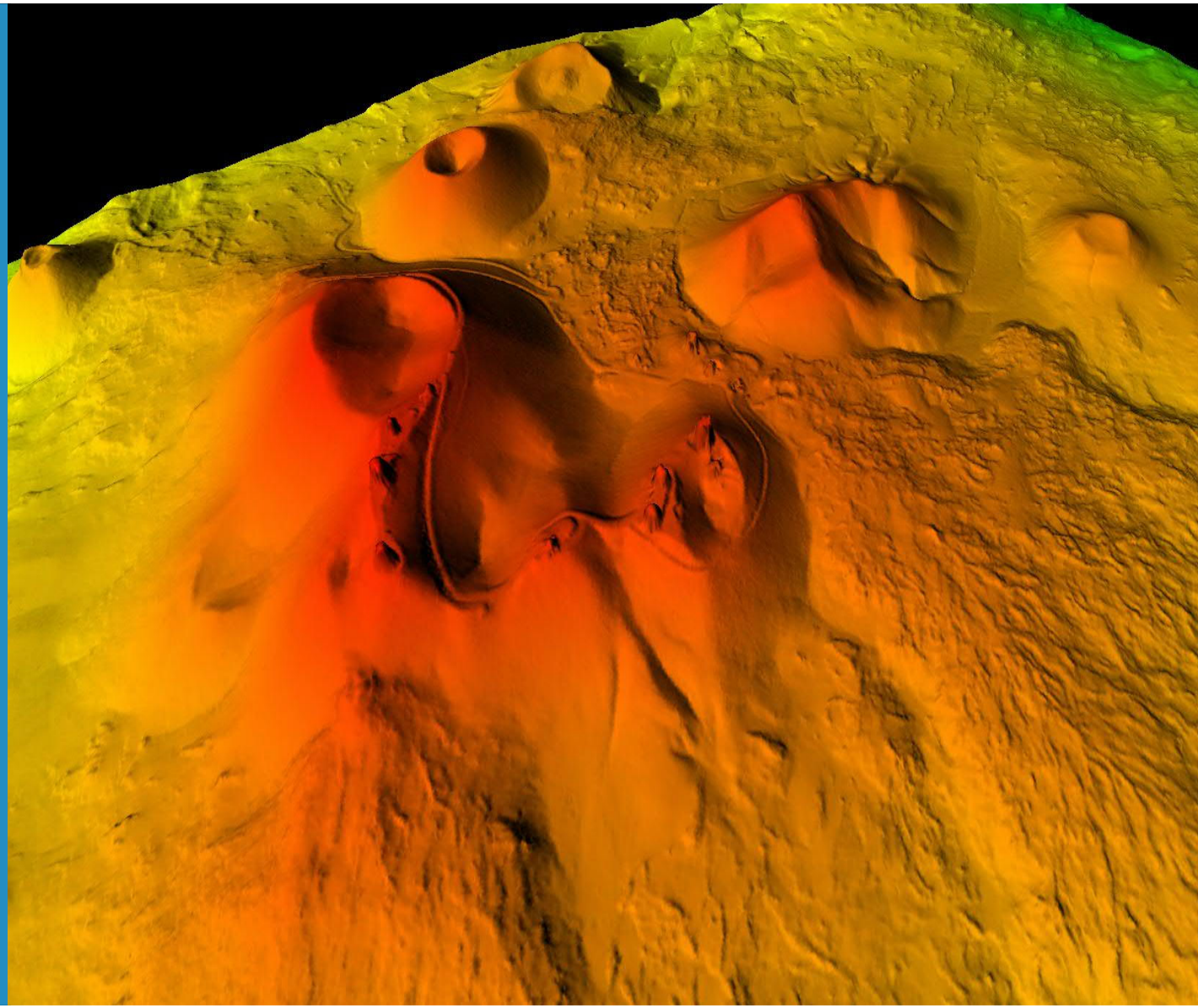
AI and Deep Learning are Living in the Cloud



Images Courtesy: Woolpert and Airworks

Lidar for Everyone

During 2021, lidar use and technologies continued to advance. But, aside from the bathymetric development noted earlier, there was not the big breakthrough from a major lidar system manufacturer I had hoped for this year in the development of AI-based applications.



TELEDYNE OPTECH

GALAXY PRIME

PulseTRAK

- Truly continuous operating envelope for maximum efficiency
- No data gaps or density loss across PIA/MTA zones

SwathTRAK

- Dynamic FOV: fewer flight lines and constant point distribution
- Increased range of motion: survey the steepest mountains

More Range, More Density

- 30% increase in range performance and/or increased point density
- “Night mode” increases range performance further still

Latest *RIEGL* Waveform-Lidar Technology

RIEGL®

- atmospheric clutter suppression
- acquisition of up to 300 km²/h at 8 pts/m²

RIEGL VQ-780i

ALS

- field of view optimized for corridor mapping
- 100 pts/m² for typical multi-rotor copters

RIEGL miniVUX-1DL

ULS

- 2 million measurements/sec
- flexible camera system with up to 9 cameras

MLS

RIEGL VMX-2HA

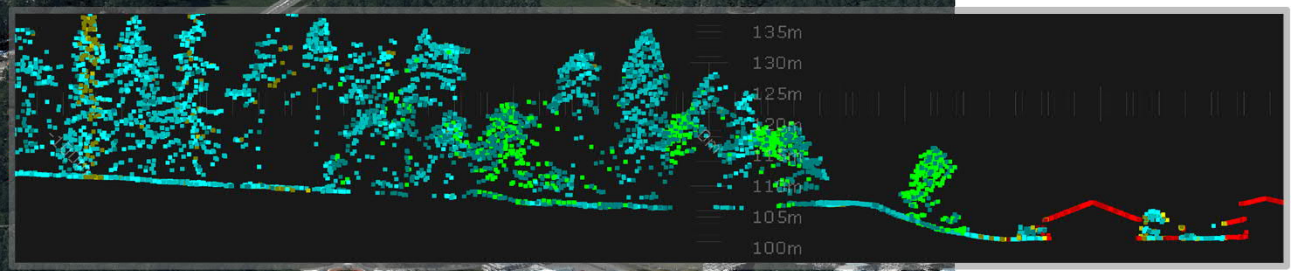
- up 60 scan positions/hour
- up to 2,500 m range

RIEGL VZ-2000i

TLS

www.riegl.com

Linear mode: TerrainMapper
- 2.0 MHz pulse rate
- Advanced scanning optics for 5500 m AGL
- Gateless MPiA (to 35 zones)



TerrainMapper

005 vs 004

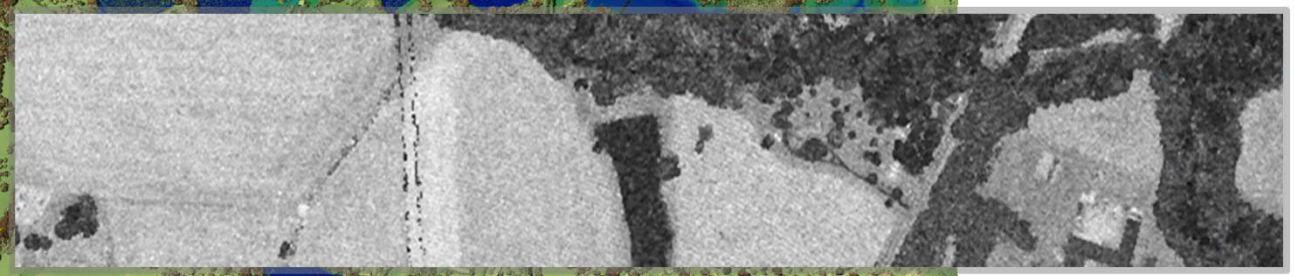
553572 valid patches with size of 2 m found. Only patches with standard deviation < 0.1 m and minimum of 5 points are included.

Color	Limits [m]	Number of patches	Proportion of total number of patches [%]
	<=0.03	514894	93.01
	0.03-0.05	31178	5.63
	0.05-0.1	7078	1.28
	>0.1	422	0.08

RealTerrain

Processing: RealTerrain
- Auto calibration
- Registration
- Line-line, intra-line QC
- Distributed processing

Single-photon mode: SPL100
- Automatic range gate
- Direct intensity measurement
- Hi-res scan angle encoding



Leica Geosystems

Lidar for Everyone

- AI-based solutions would help system users derive information from the massive and growing number of point clouds with minimal manual processing.

- However, this lack of investment in AI-based solutions may have been a casualty of the pandemic and its impact on the economy.

- With the introduction of QL0 to the USGS contracts, the industry is struggling to use RTK-based surveying techniques to achieve the 1.67-cm vertical accuracy (as RMSEz) needed to QC the data

Concluding Remarks

- the pandemic has adversely affected many segments of our industry while providing some relief to others.
- This has made it more difficult to accurately predict where our industry and technology are heading.
- However, one thing has become even clearer during this difficult time: Our success as an industry requires the collaboration of multiple tiers of government, the private sector, public utilities, community activists, building owners, average citizens, etc., to truly advance.

Thank You!

Dr. Qassim Abdullah, Woolpert, Inc.

VP & Chief Scientist

Qassim.Abdullah@woolpert.com

Mapping-matters@asprs.org

www.woolpert.com | www.asprs.org/asprs-publications/mapping-matters