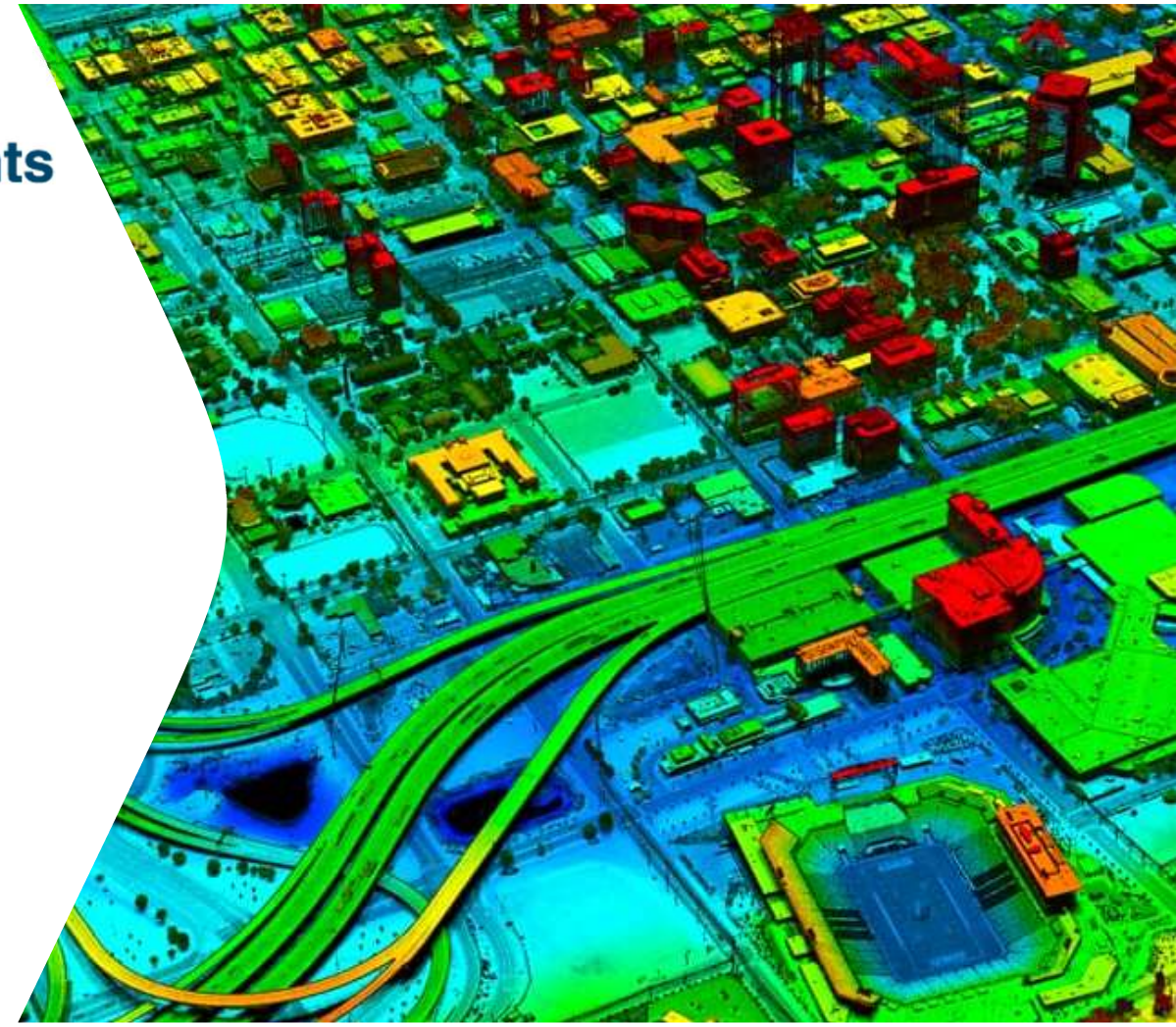
North Central Texas Council of Governments

Regional GIS Meeting
December 10, 2024

Photon Counting Lidar: What Is It & Why Use It?



Presented by:
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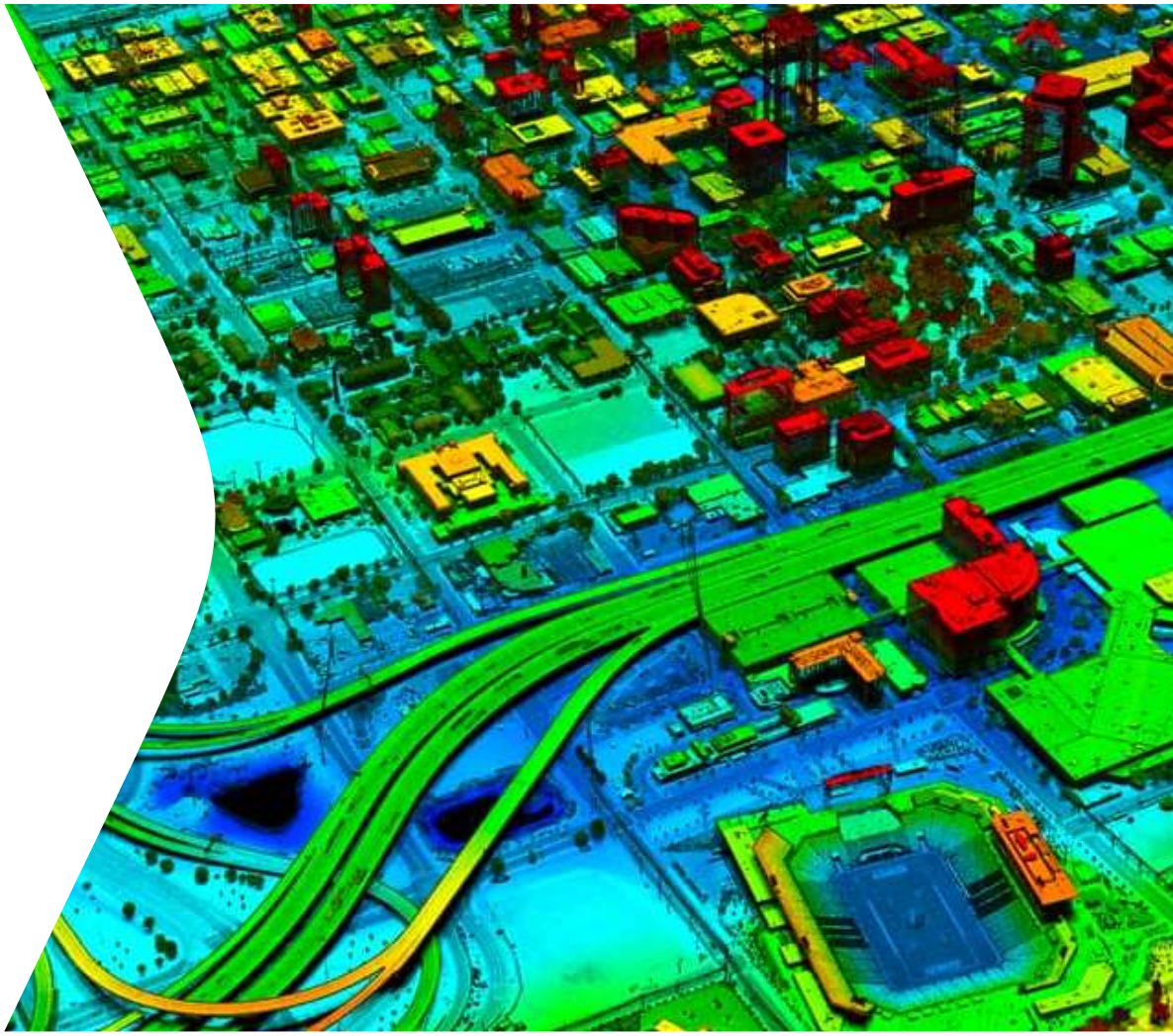
Agenda

1. Who is Sanborn?
2. What is Lidar?
3. What is Photon Counting Lidar?
4. Market Applications
5. Q and A



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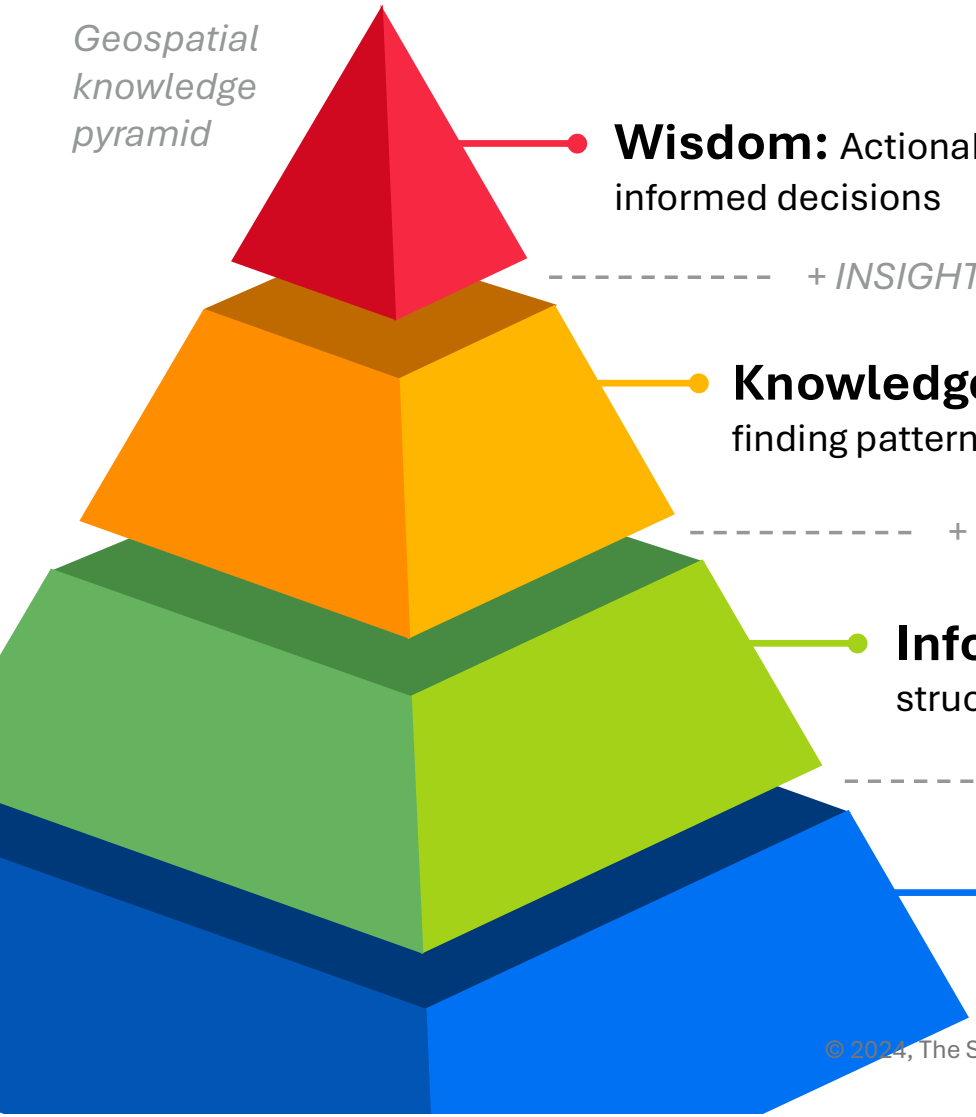
Geospatial knowledge pyramid



Wisdom: Actionable and informed decisions

+ *INSIGHT*

Knowledge: Analysis/interpretation, finding patterns and relationships

+ *MEANING*

Information: Organized, structured and contextualized

+ *CONTEXT*

Data: Foundational data; raw, unstructured facts without context

Location matters.

The most experienced mapping company.

1866
Founded and began ground surveys.

1966
Began aerial surveys.

1979
Began digital photogrammetric mapping.

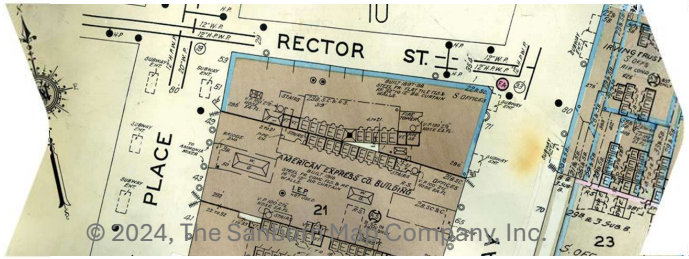
1984
Pioneered digital terrain modeling.

1988
First digital ortho production.

1998
Lidar collection and production

2004
Digital aerial imagery and web services

2010
Mobile and Ground Lidar



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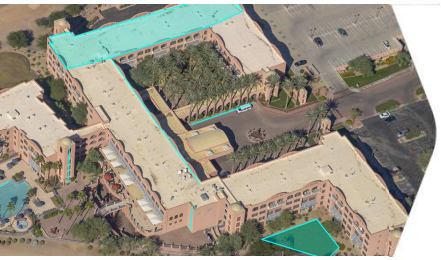
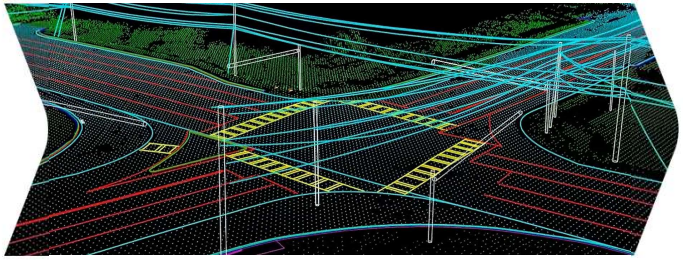




Oblique Imagery
2012

Building Information Mapping (BIM)
2014

Cloud Services
2018

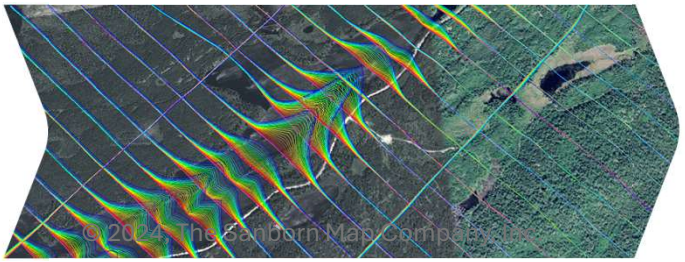
Founded Sanborn Geophysics
2024

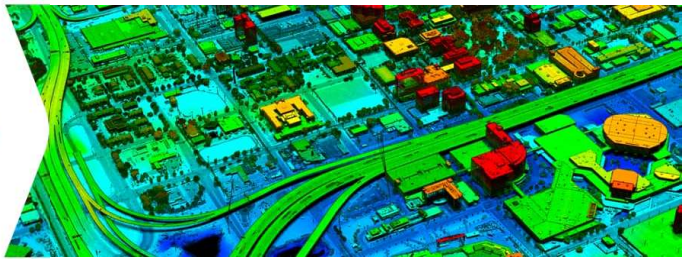
2013
Drone based imagery

2016
HD Maps

2022
Acquired Applied Geographics

2024
Acquired photon counting lidar patents and technology





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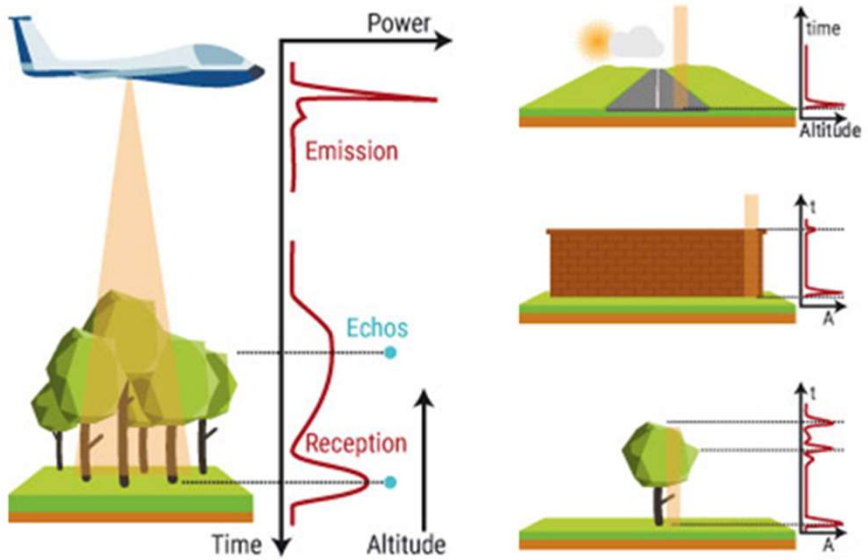
Lidar is fundamental to modern mapping.

Light Detection and Ranging – LiDAR – LIDAR – Lidar

Lidar uses ultraviolet, visible, or near infrared light to capture objects.

A wide variety of natural and man-made materials and surfaces can be captured including dirt, rocks, vegetation, concrete, and asphalt.

Each material and surface will react and/or reflect with different properties. Man-made objects will have a single return while vegetation allows for multiple returns through the tree canopy.



Advancements in lidar technology have allowed for additional attributes of the returning pulses to be captured and measured:

- Return/Echo Number
- Amplitude, Intensity, Reflectance
- Scan Angles

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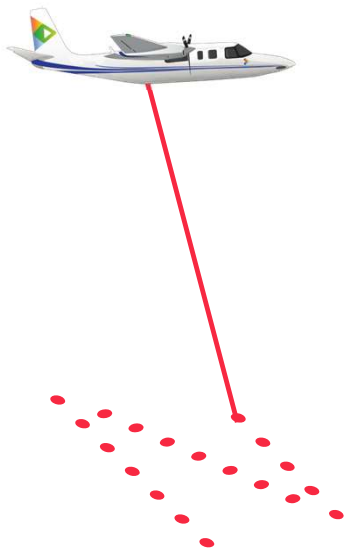
Sanborn offers both types of modern lidar.

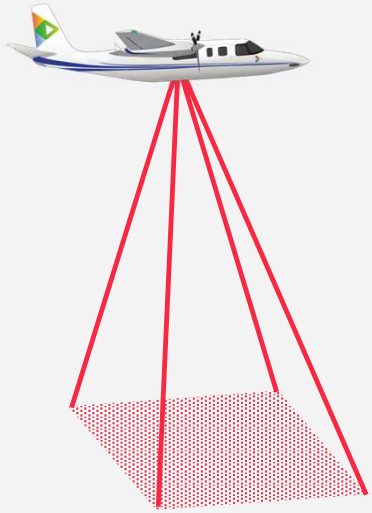
Traditional Lidar

Traditional lidar, sometimes called "linear mode" or “echo digitizing”, uses individual laser beams to measure range.



Photon-Counting Lidar

Photon-counting lidar, also called “photon-detecting”, is a new breed of lidar in which the sensors do not observe individual laser beam returns but rather the returns of individual photons.



Sanborn can offer the best technology to its clients based on their requirements and budget.

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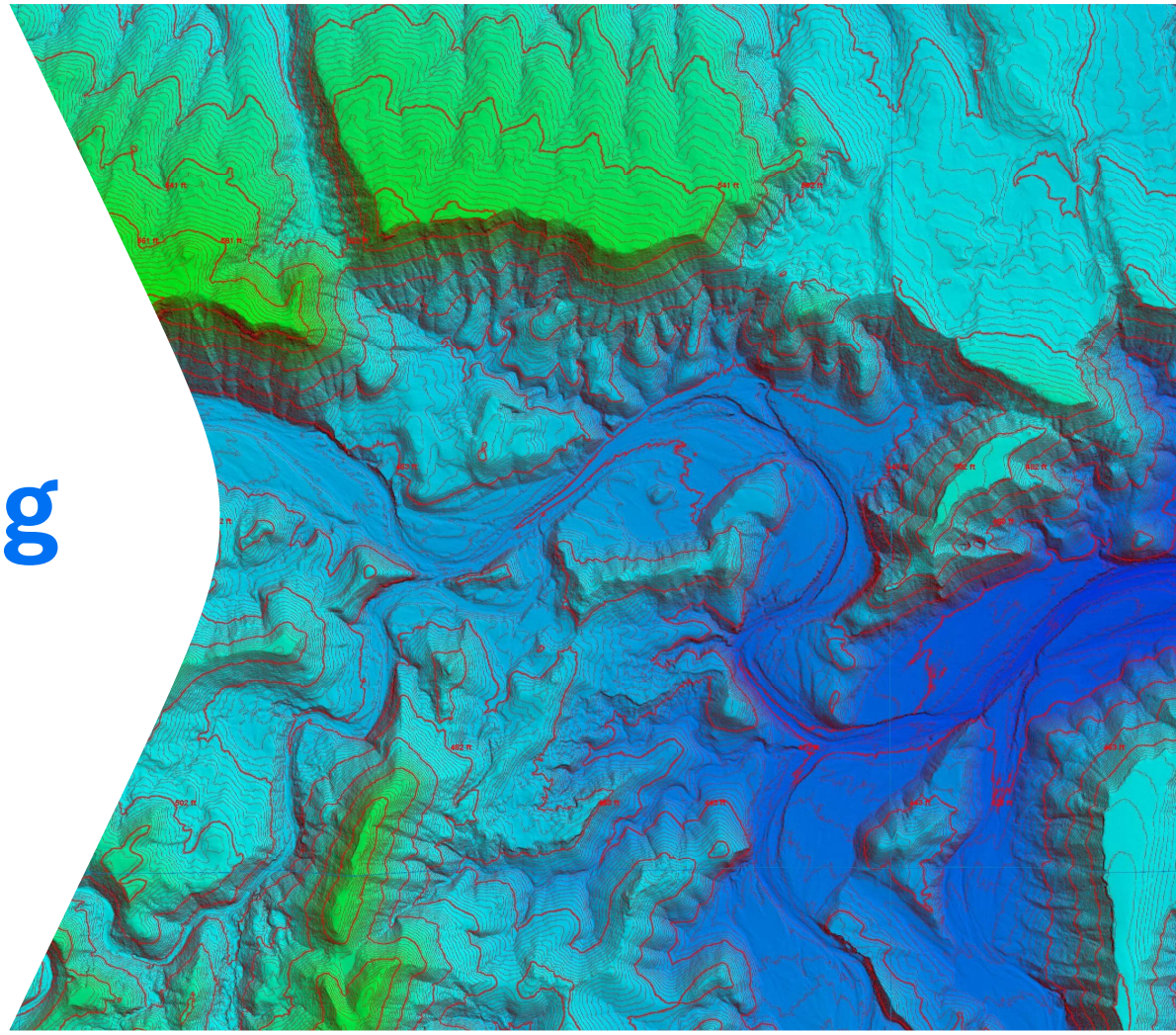
How does Photon-Counting Lidar work?



Photon-Counting Lidar Imaging

- **Low energy, highly sensitive**
- **Higher** collection heights, **faster** aircraft speed enabling 500 mi^2 per sortie
- **High-definition**, +70 ppsm point cloud to identify fine features like power lines
- Palmer Scanner's **Multi-look**, oblique angles enable excellent foliage penetration and **360-degree** capture of objects

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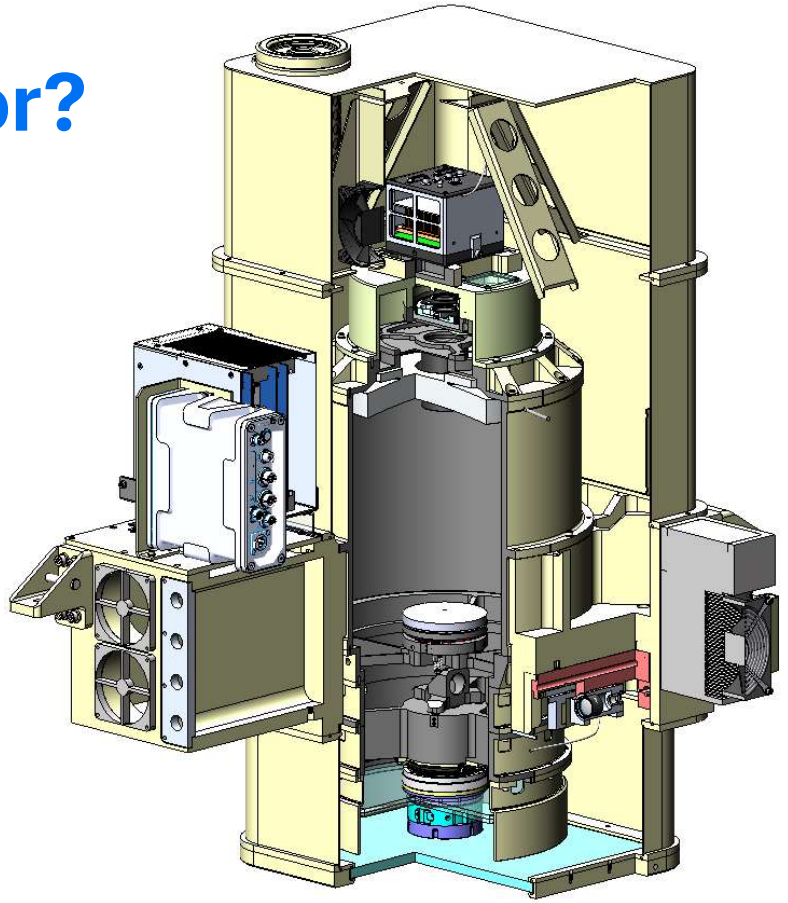
What is an Avalanche Sensor?

- Geiger Photo Diode Array (4096 detectors)
- Photon counting device (Low light sensitivity enables use of low power laser)
- Capable of sub-nanosecond operation (enables higher vertical measurement precision and vertical resolution)
- Supports high laser Pulse Repetition Frequencies (PRF)

Think of it as a 3D camera.



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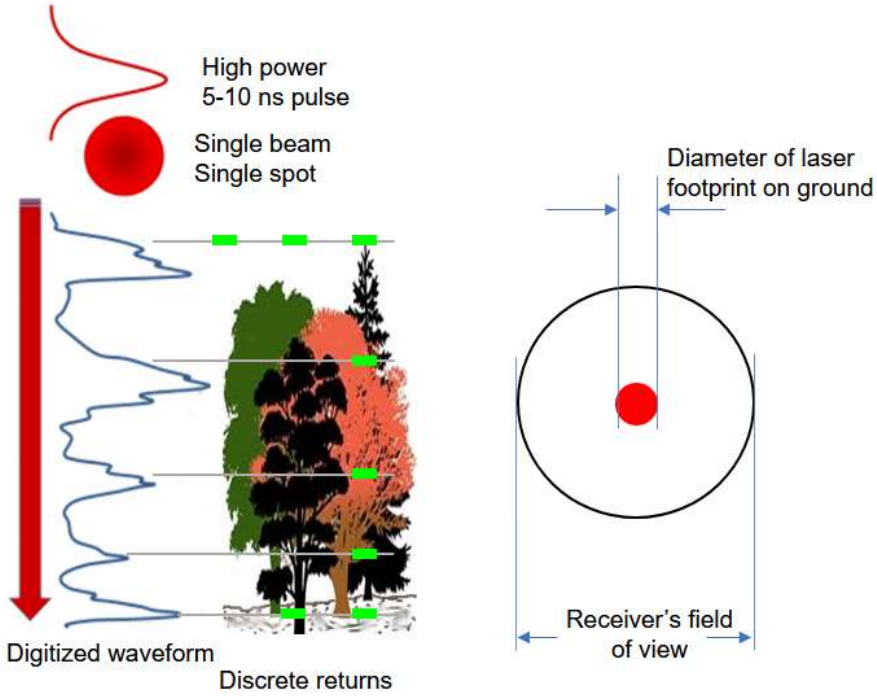
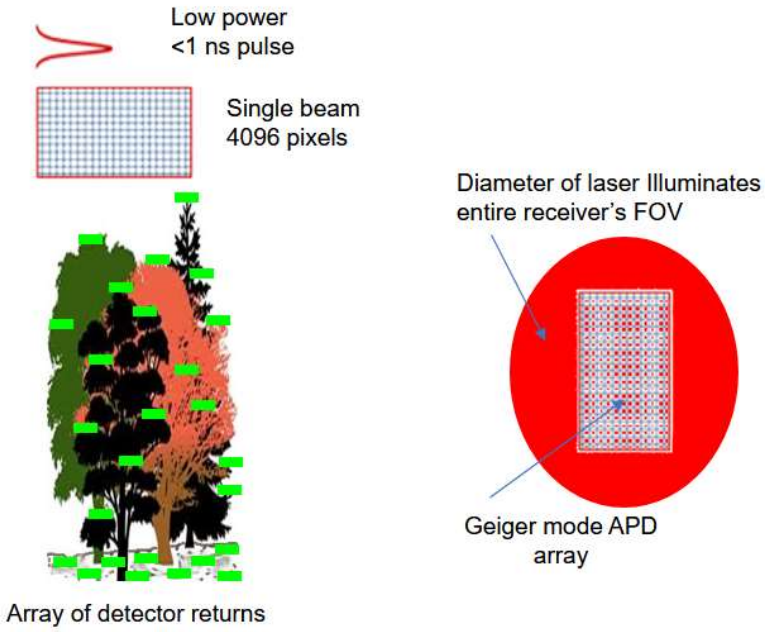
Linear VS. Photon-Counting Lidar

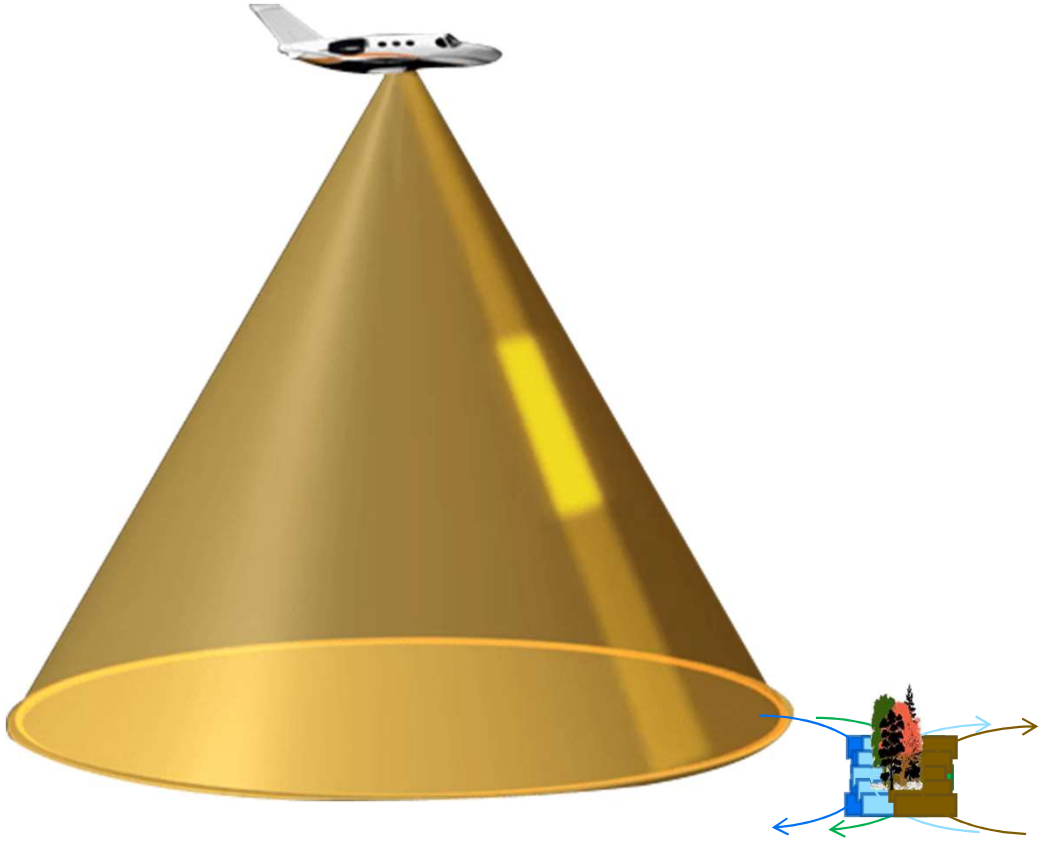
Convention Linear Mode Lidar



Avalanche Lidar (a 3D camera)



Essential Look Diversity



Palmer Scanner & Look diversity

- 4,096 measurements per laser flash or for each frame
- 50,000 flashes per second creating overlapping frames
- 205 million elevation measurement per second
- Rotating Palmer Scanner Creates Overlaps in Flight Direction of frames in direction of the Flight path
- Forward and Aft Looks for Each Rotation of Scanner

Think of it as a 3D camera.

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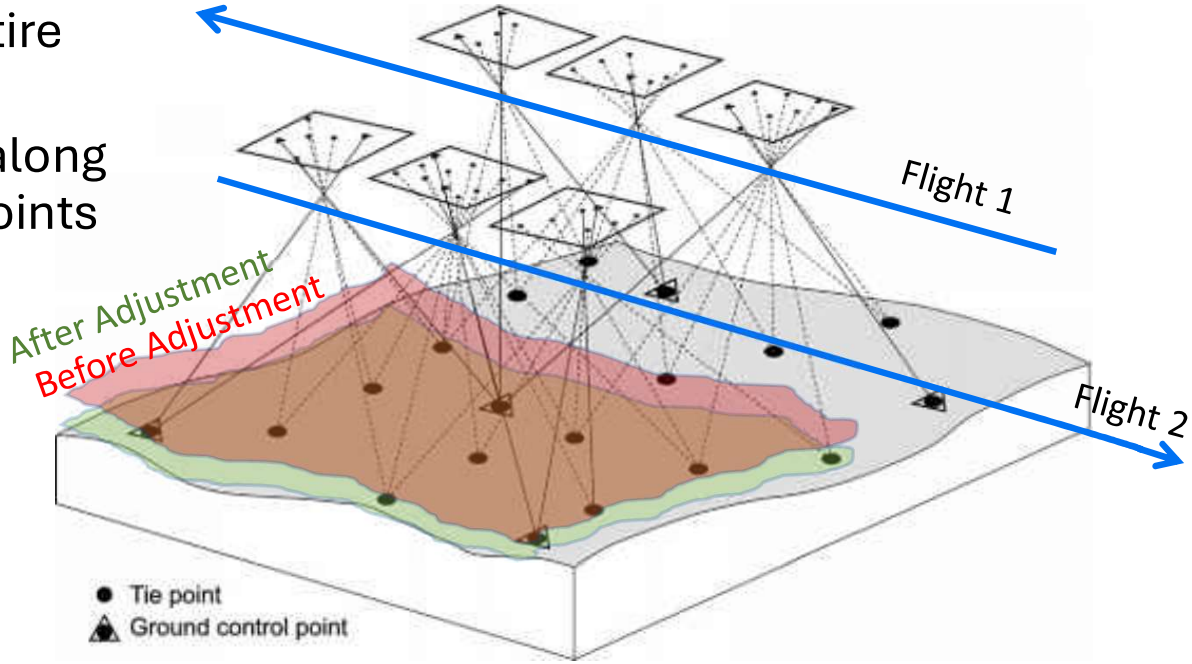
Photogrammetric Bundle Adjustment provides better accuracy.

Bundle Adjustment Advantage

- Least-squares approach
- Distribute the error across the entire project
- “Chips” automatically collected along swath overlaps and used as tie-points
- Many 10’s of thousands used

Perform bundle adjustment via data tie points, correcting both horizontal and vertical alignment from multiple look angles.



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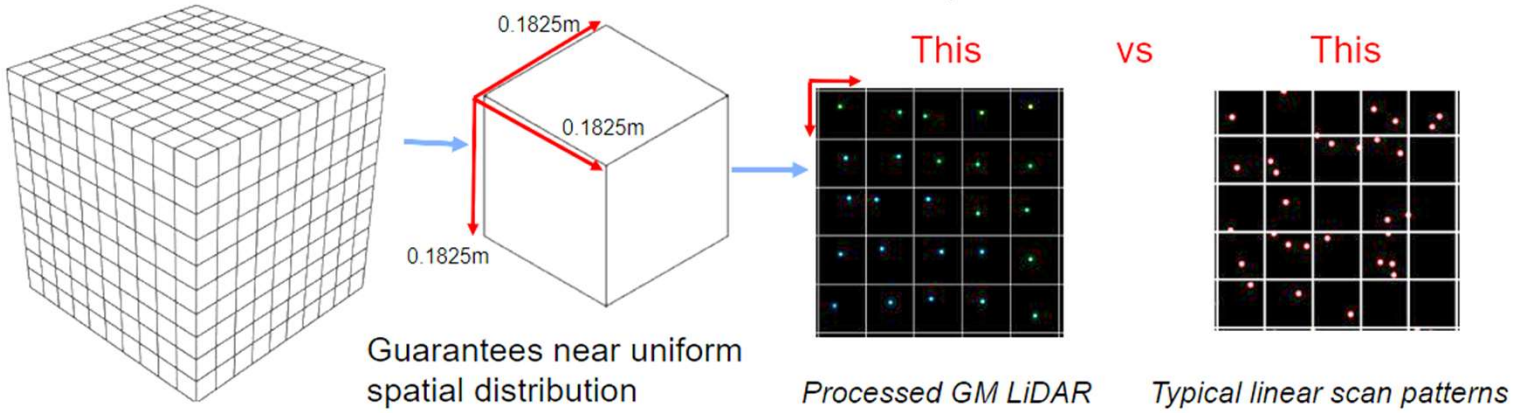
Voxel Product Generation Process

1. Calibrated point cloud data is created through Voxel Cell processing in LAS/LAZ 1.4 format
2. Filters are optimized to reduce noise in the aggregated point cloud
3. PPSM (Points per square meter) is determined by chosen Voxel size
4. Output in the customers desired geometric projection and tiling scheme

Example

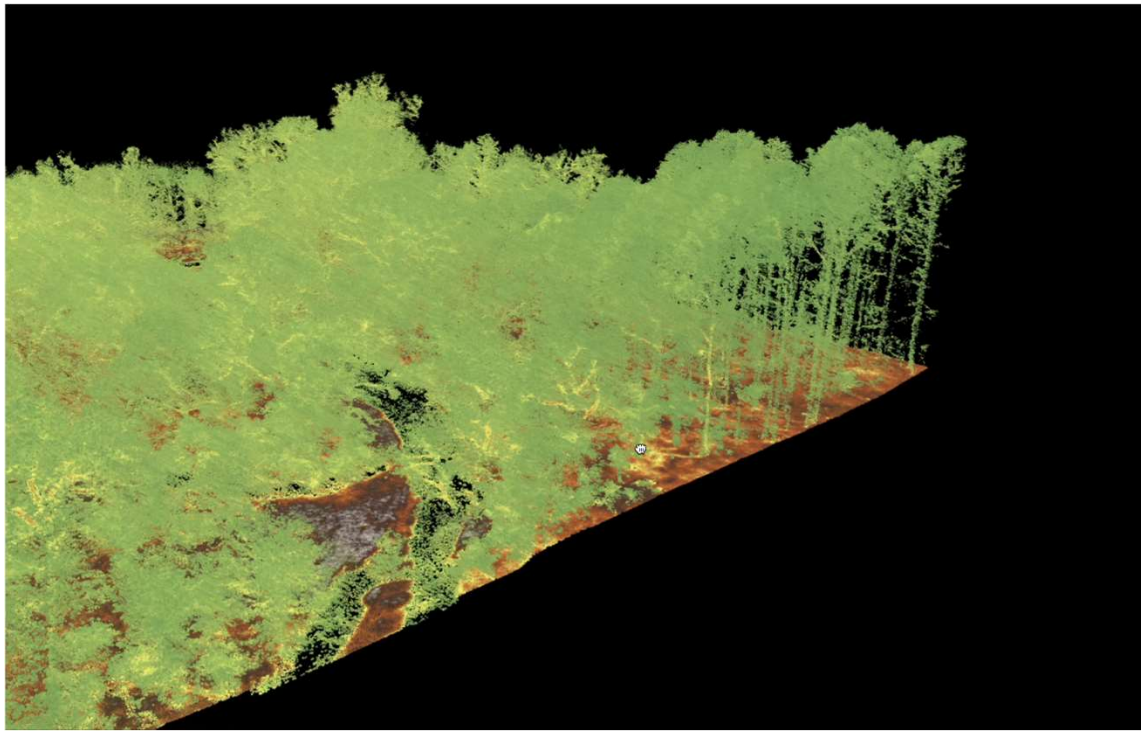
•To create 30 points per square meter calculation is $\frac{1}{\sqrt{30}} \approx 0.1825m$ voxel dimension



Example Project Results

Data acquired @ 12.5k ft, with Voxel Matrix Set for 30 ppsm

Point Cloud Area	Point Density
Ground non-vegetated	30
Ground under tree canopy	30
Vegetation Structure	172
Average Point Density in Forested Area	202
Vertical Accuracy	< 5 cm
Horizontal Accuracy	< 20 cm



Unmatched point densities at acquisition rates providing incredible ability to image ground under canopy and capture forest structure.

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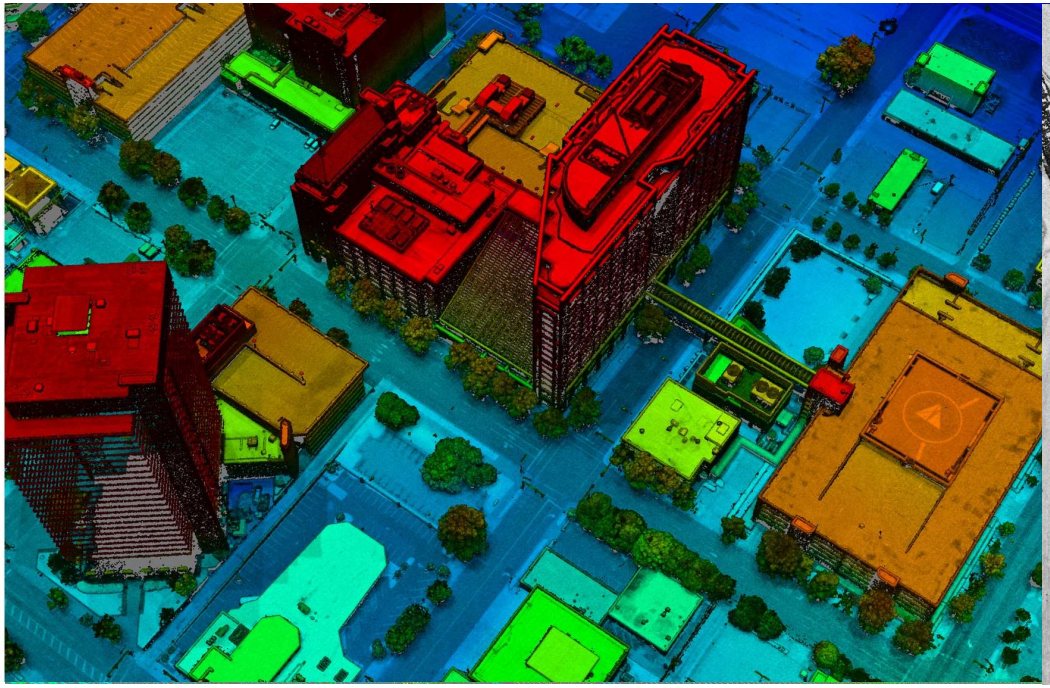
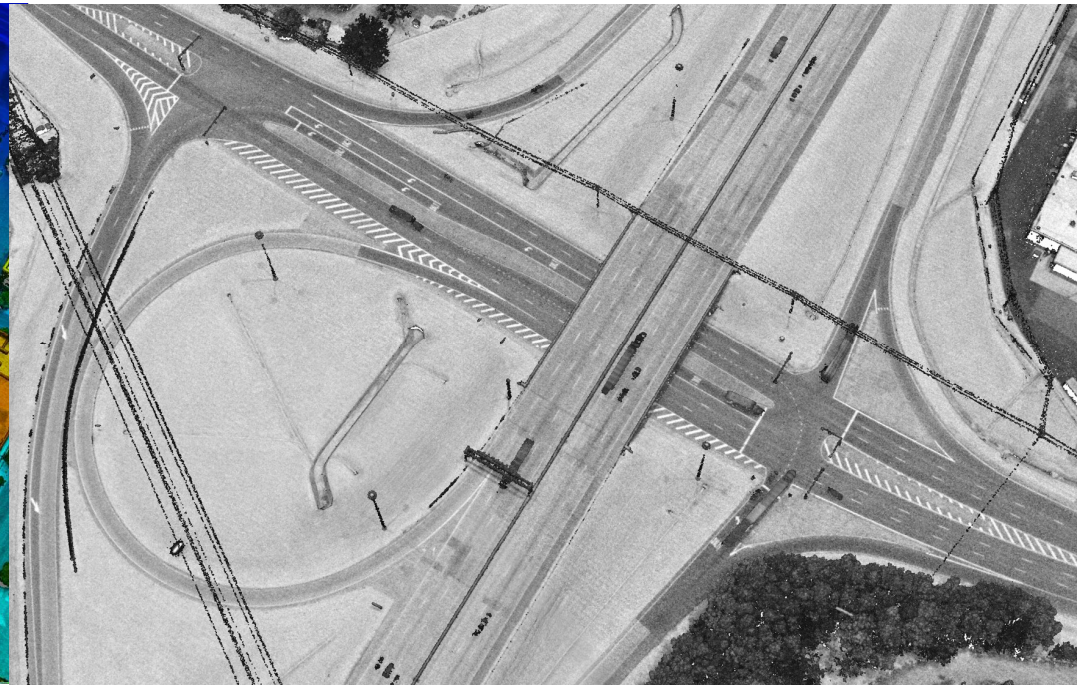
High-Definition (HD) LiDAR vs. Traditional LiDAR



High-Definition - 30 ppsm



High-Definition - 30 ppsm

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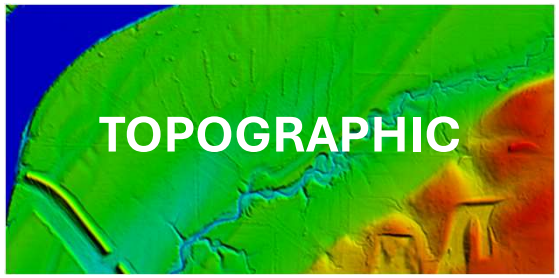
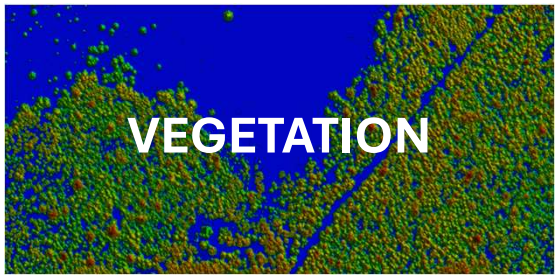
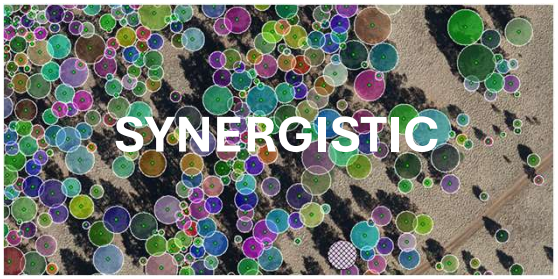
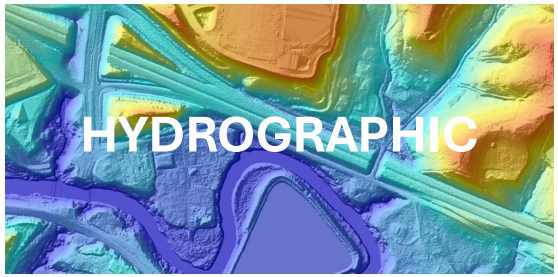
Classification of the lidar point cloud allows for a multitude of derivative products used for a large series of solutions.









All the products that can be derived from **Linear Mode Lidar** can be derived from **Photon Counting Lidar.**

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Derivative Products

Topographic Products

- Digital Elevation Model (DEM)
- Digital Surface Model (DSM)
- Normalized DSM (nDSM)
- Contours
- Slope
- Aspect
- Bare Earth Hillshade
- Highest Hit Hillshade

Hydrographic

- Hydro-flattened breaklines
- > 30m Wide Rivers & Streams
- > 2-Acre Lakes and Ponds
- Hydro-Flattened Bare-earth DEM

Buildings

- Buildings Outlines
- 3D Building Models

Vegetation Products

- Canopy Height Models
- Height Above Ground
- Tree Canopy Cover
- 3D Vegetation Polygons
- Vegetation Height Raster

Utilities

- Asset Mapping
- PLS CADD
- Vegetation Management

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Collection Comparison

	Linear Lidar	Photon Counting High-Density (USGS type project)	Photon Counting Ultra HD (Power line project)
Density (Points per meter)	8	30	70
Instantaneous Coverage Rate (mi^2/hr)	50	350	250
RSMEz (cm)	9.25	7.0	4.5
USGS Spec	QL1	QL1	QL0
Altitude (ft)	3,200	16,500	12,500
Swath Width (ft)	3,300	7,250	5,350
Ground Speed (kts)	90	220	220

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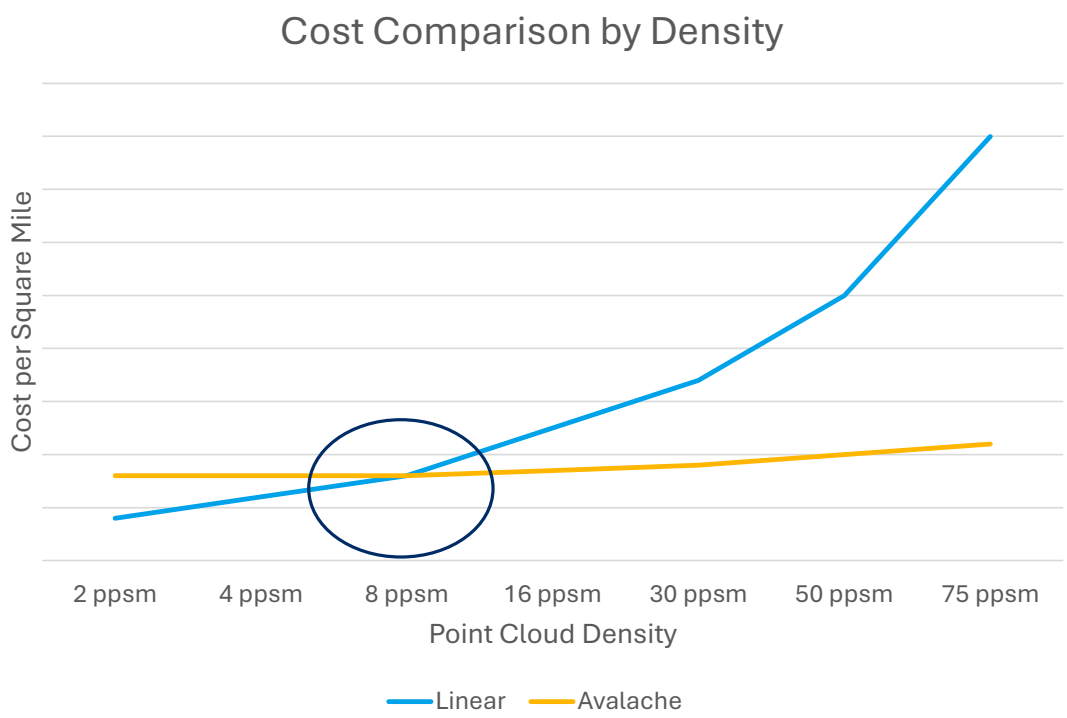
Reduced Cost at Higher Resolutions



- The graph clearly shows the sweet spots for both technologies
- Lower density Lidar can be easily achieved by Linear mode Lidar
- Higher density Lidar calls for Photon Counting Lidar
- Both technologies can achieve the QL0, QL1, and QL2 accuracies
- Collect once at high density and use many

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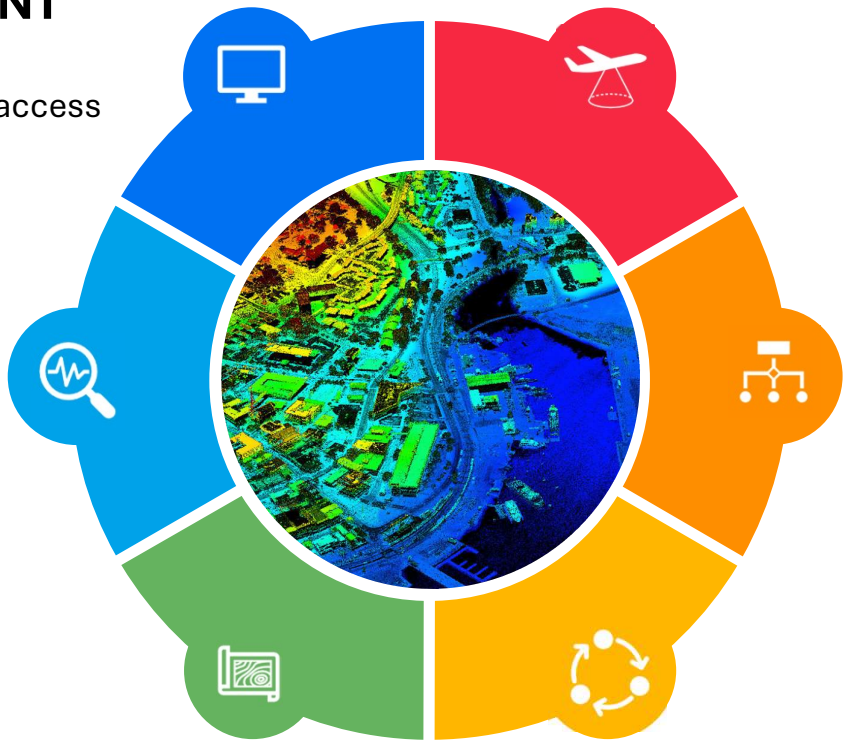
Sanborn provides end-to-end lidar services.

DATA MANAGEMENT
Online Geospatial Portal
Customer data archive and access
Value-added service access
Custom Product Archives

ANALYSIS
Flood Modeling
Power Line Encroachment
Change Detection
Volumetric Analysis
Data Fusion

MAPPING
Bare Earth
DSM/DTM Generation
Hydro Enforcement
Vegetation
Automated Feature Localization



SENSORS
Wide Area Mapping
Photon-Counting Lidar
Linear mode Lidar sensors
for Wide Area and Corridor

DATA COLLECTION
Mission Planning and Scheduling
Operations and Maintenance

DATA PROCESSING
Automated processing
Noise filtering
Calibration
Accuracy Validation
Mosaicking

DIR CONTRACT
Lidar, imagery, and services
https://dir.texas.gov/contracts/vendors/sanborn-map-company-inc

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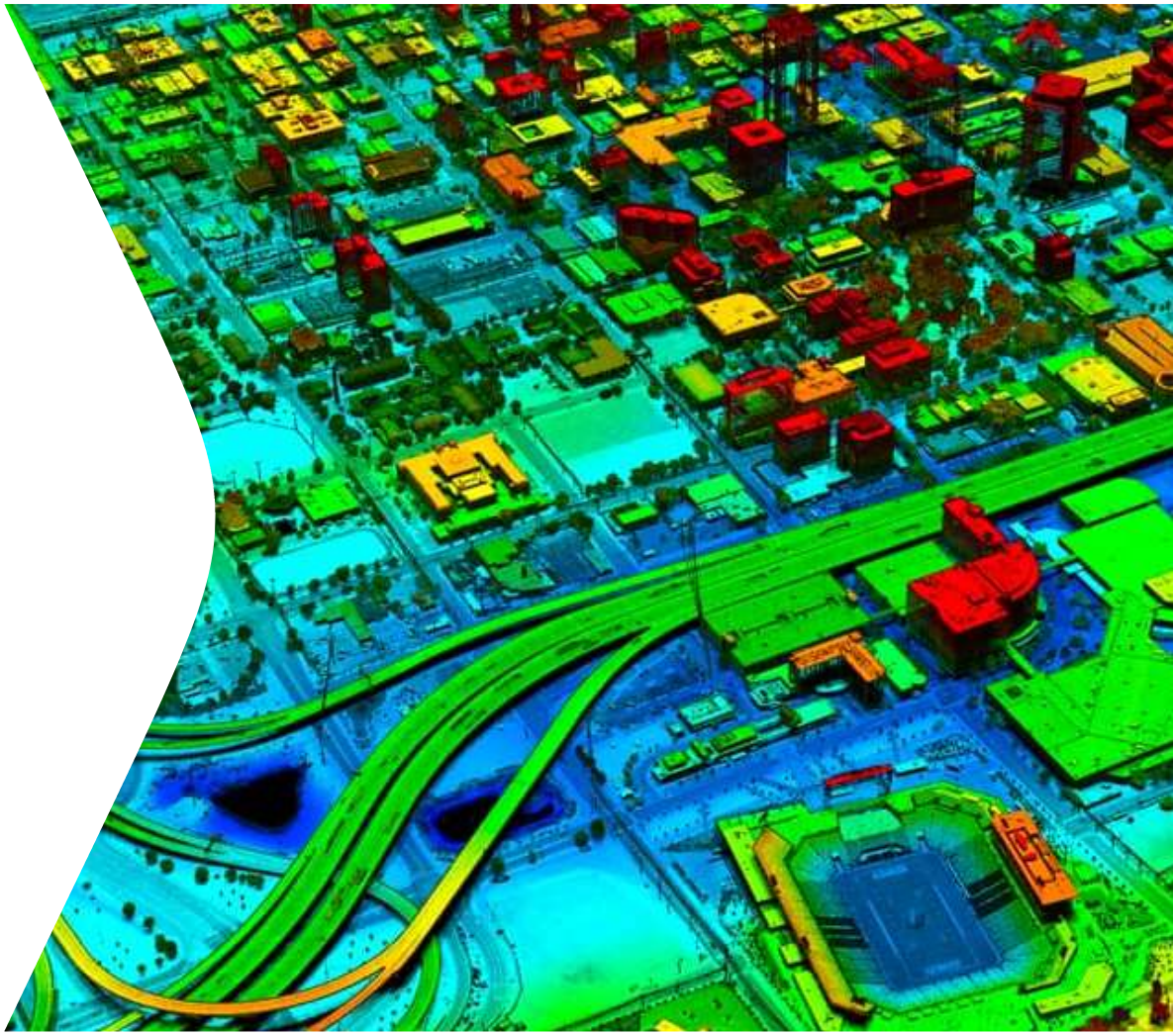
Thank You!
Questions?



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