

Terrapoint
aerial services

Introduction to LiDAR
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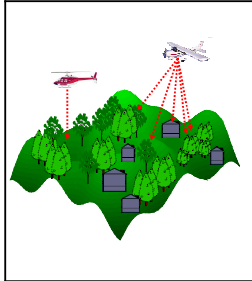
Terrapoint How do we get the Topography?

- Ground Survey
 - Levelling
 - Total Station
 - GPS
- Photogrammetric Compilation
 - Stereo Plotters
 - Softcopy Photogrammetry
- LiDAR - Light Detection And Ranging
 - Just another tool in the box to obtain topographic detail

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Terrapoint What is LiDAR?

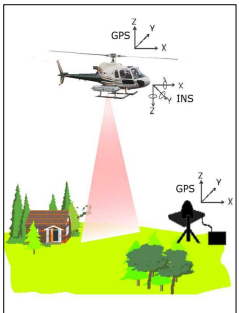
- Acronym for Light Detection And Ranging
- Basic laser ranging technology has been available for 20 years - eg. Distance measuring devices for surveying
- Can operate in the ultraviolet, visible or infrared regions of the electromagnetic spectrum
- Combines information from Physics, Engineering, Geodesy and GIS



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Terrapoint LiDAR Basics

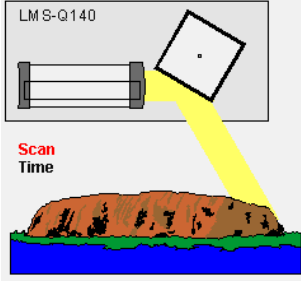
- The position of the laser is provided by GPS
- The orientation of the laser is provided by an IMU
- The scan angles and ranges of the laser are provided by the sensor
 - 1+2+3 data combined in post-flight processing to accurately determine the position of each point
 - Acquires up to 200,000 points per second
 - 2-8 raw points every square metre is now common



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Terrapoint Rotating Polygon Mirror

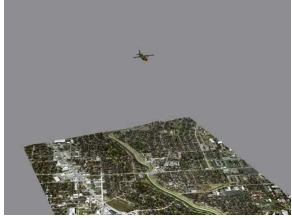
- Laser is directed at mirror
- Mirror rotates
- Pulses are spread out in a line perpendicular to the flight path
- Provides regular grid of points on the ground



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Terrapoint LiDAR Flight Simulation

- Missions contain a series of parallel flight lines
- Adjacent flight lines overlap to avoid gaps
- Data from all flight lines are merged
- Merged raw data set is processed to generate desired deliverables



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Terrapoint LIDAR Data Points – X, Y, Z

Top View

Side View

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Terrapoint Why all the Hype?

- High resolution 3D surface
 - "Point Cloud of Data"
 - Millions of points per square km
- Fast & accurate
 - Up to 100 square km per hour
 - 5 cm accuracy possible on hard surfaces
 - Cost effective
- Flexible collection
 - Maps through canopy
 - Independent of sun angle
 - Day or night
- Diverse data products
 - Full-feature, Bare Earth
 - Contours, Building Footprints
 - Land Usage
 - Transportation/Utility Corridors etc.

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Terrapoint Can LiDAR see Everything?

- Infrared lasers do not penetrate water
- Some surfaces are poor reflectors
 - Still water
 - Asphalt, coal and other dark materials
 - Wet surfaces or mud
 - Naturally dark or freshly turned soils
 - Surfaces at oblique angle to incident laser pulse
- These targets are not invisible to infrared LiDAR, but are more difficult to detect
- Non-reflective targets are a limitation of optical physics, not the LiDAR instrument itself

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Terrapoint Save the Key LiDAR Points

Key LiDAR Points
(filtered points of elevation change)

Highway #1 Afghanistan

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Terrapoint Cross Sections Anywhere

Highway #1 Afghanistan

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Terrapoint High Range LiDAR Systems


- 3 Optech 3100's
- 2000 to 9000 feet collection altitude
- Large area surveys

ALTM 3100EA

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Terrapoint Helicopter LiDAR Systems

- Portable/modular design
- Easy to install and operate
- Fly low and slow for high survey point density
- 2 to 20 pts per m2
- Higher accuracy than fixed winged systems
- Integrated with a digital camera and a digital video



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Terrapoint Low Range Systems



From ASTAR-350's, Hughes 500's, Robinson R44's, Bell 206 Jet Rangers

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Terrapoint Mobile Ground Based



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LiDAR Accuracy

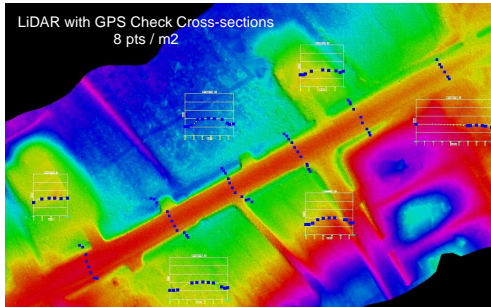
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Terrapoint System Comparison

	High	Low	TITAN
Typical platform	Fixed Wing	Helicopter	Vehicle
Operating altitude	600m - 3000m	2 - 300m	N/A
Full scan angle	36 deg	60 deg	360 deg
Swath width	65% of height	100% of height	Varies*
Returns per pulse	Up to 4	1 (first, last, alternating)	1 (first, last, alternating)
Intensities/pulse	4	1	1
Vertical Accuracy	15-30cm RMSE	5-15cm RMSE	2cm RMSE
Horizontal Accuracy	40cm RMSE	25cm RMSE	8cm RMSE

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Terrapoint How Do We Check?



LIDAR with GPS Check Cross-sections
8 pts / m2

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Terrapoint Accuracy: 300ft versus 450ft AGL

300 ft AGL:
Sample 294 points
RMSE 1.47 inch

450 ft AGL:
Sample 294 points
RMSE 1.88 inch

Site	Sample Size	RMSE
Centre Line	47	0.87"
Edge of Pavement	68	1.46"
Edge of Shoulder	45	1.10"
Guard Rail	20	1.57"
Property Line	30	1.93"
Toe Slope	44	1.89"
Ditch	40	1.81"

LIDAR points vs. total station cross sections
(table shows 450 ft AGL numbers)



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Processing to Products

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Terrapoint LiDAR Filtering to Bare Earth

- Also referred to as Classification or Vegetation Removal
- Classification is the process whereby the laser points are filtered to obtain a DEM that represents the ground, and it allows for the extraction of above ground objects and features
- i.e. Trees, Buildings, Towers, Hydro Lines, Overpasses, etc. are separated from the bare earth points

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Terrapoint QC and Editing

- Automated "devegging" software and routines used to remove non-ground points
- Manual QC of all tiles to remove other anomalies or non-ground points and to ensure valid ground points have not been removed
- More detailed QC against grounds checks to ensure overall accuracy

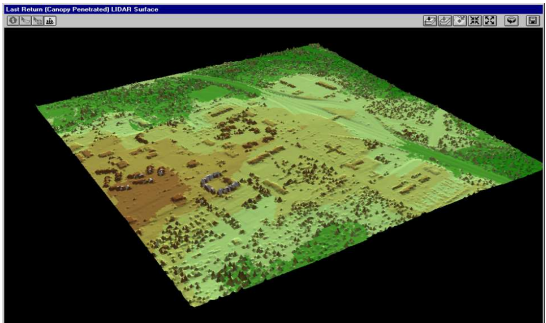
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Terrapoint After the Automatic Classification

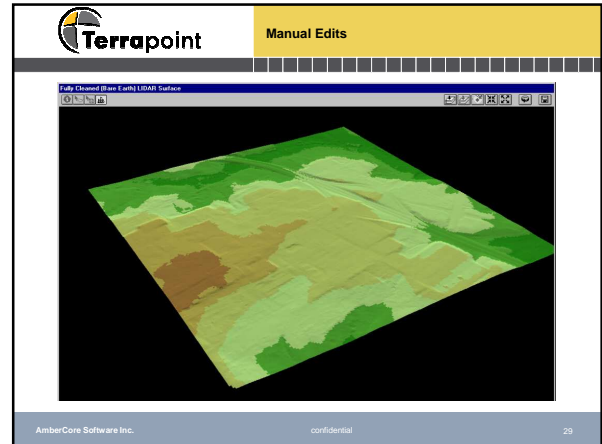
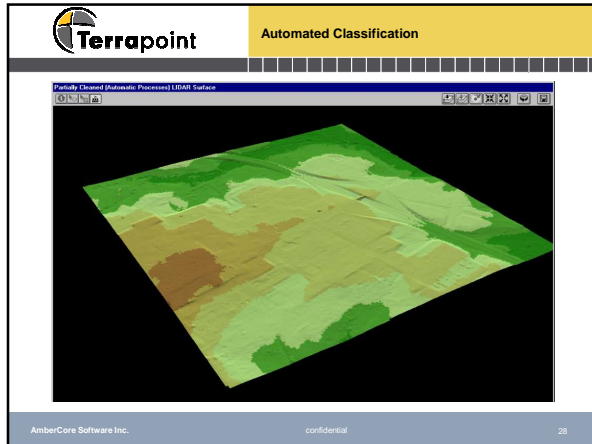
- Our experience shows that the process removes 99% of the non ground, but it also erroneously removes ground features
- Manually identify the final 1% of erroneous classification points

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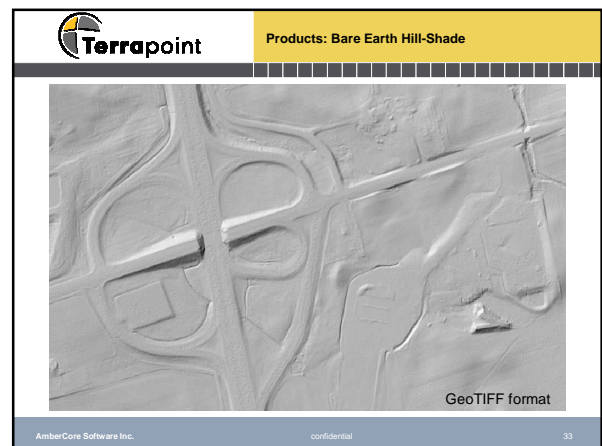
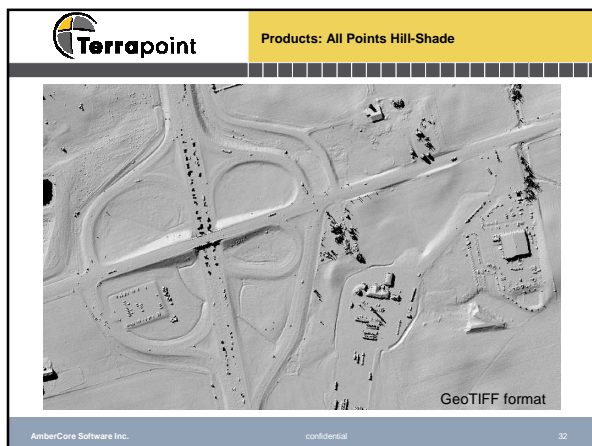
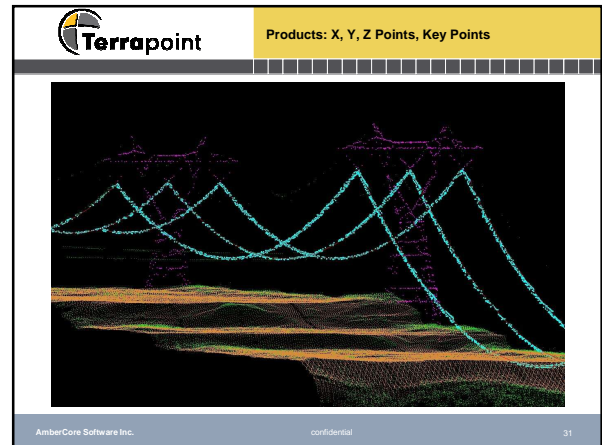
Terrapoint All Points or Raw Data




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- Terrapoint** Standard Deliverables
- Digital Elevation Model (DEM) / Digital Canopy Model (DCM)
 - Points at regular intervals showing ground or vegetation elevations
 - Can insert breaklines from LiDAR or photo
 - ASCII text, ArcView / ArcInfo grids, GeoTIFF, Surfer, etc...
 - LiDAR points
 - ASCII text or LAS / TerraScan binary files, no interpolation / gridding, showing ground, non-ground or other classified LiDAR returns
 - Keypoints
 - Intelligently thinned un-interpolated points with tolerances for both horizontal distance and vertical elevation change
 - Contours
 - LiDAR Hill-Shade imagery in GeoTIFF format
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Terrapoint Products: Raw Contours (25cm to 2m)



GeoTIFF format

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Terrapoint Products: Orthophoto

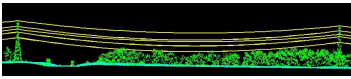
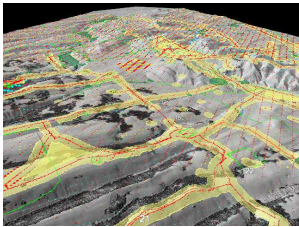


GeoTIFF format

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Terrapoint Custom Deliverables

- Feature Extraction
- 3D Visualisations
- Powerline Mapping and derivatives
- Erosion analysis
- Relative Flood Height Maps
- Projection / Datum Transformations
- Posters
- Vegetation Height Maps
- Point Density Maps
- Volume Calculations

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Thank You

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