

Managing Remote Sensing Data for Projects



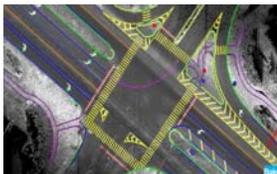
Brett Wood, PSM

Aerial Surveying and Mapping Manager

Surveying & Mapping Office

Session Objectives

- ◆ Why would we want to look at point clouds?
- ◆ Brief Review of Mobile LiDAR terminology and concepts
- ◆ Mobile LiDAR accuracies
 - General
 - Project Specific
- ◆ FDOT Terrestrial Mobile LiDAR (TML) Guidelines
- ◆ Other LiDAR documentation
- ◆ LiDAR Point Cloud file formats
- ◆ LAS Format Details
- ◆ Software & Hardware
- ◆ Questions



<http://www.ssi-mi.com/MobileLiDAR.html>



Light Detection And Ranging (LiDAR)

Lidar Definition

- LIDAR (*Light Detection and Ranging*) is an optical remote sensing technology which measures properties of scattered light to find range and/or other information of a distant target.
- The prevalent method to determine distance to an object or surface is to use laser pulses.
- Similar to radar technology, which uses radio waves instead of light, the range to an object is determined by measuring the time delay between transmission of a pulse and detection of the reflected signal.

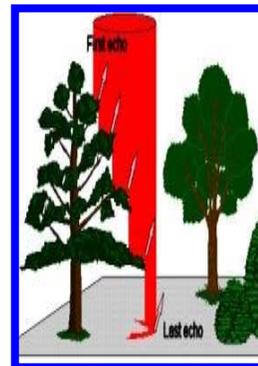
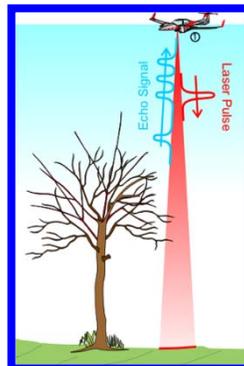
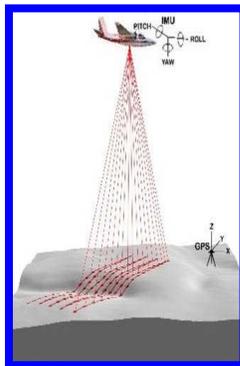


<http://en.wikipedia.org/lidar>



Some Pulse Laser Characteristics

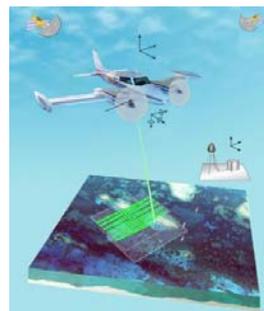
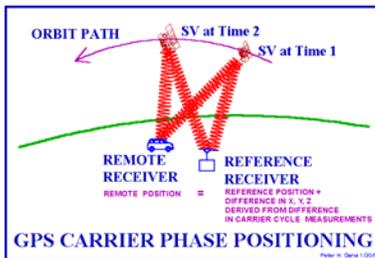
- ◆ Laser pulses can penetrate forest canopy through gaps.
- ◆ Some laser pulses reach forest floor, other returns reflect from canopy and sub-canopy vegetation.
- ◆ Recommend eye safe full wave form LiDAR for engineering projects.



<http://www.geodigital.com/>

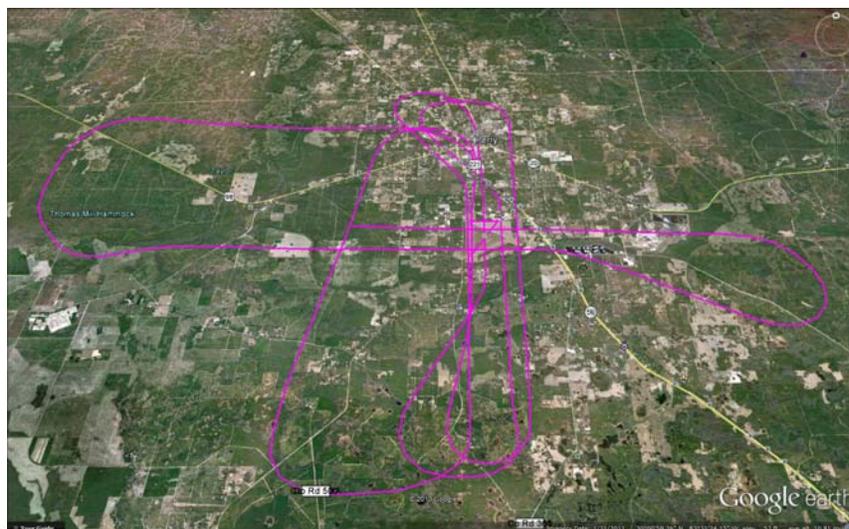


- ◆ Mobile Laser Scanning (MLS) uses a laser scanner(s) in combination with Global Navigation Satellite Systems (GNSS) and Inertial Measurement Unit (IMU) to produce accurate and precise geospatial data from a moving platform both in the air and on the ground.
- ◆ Traditionally the term Airborne LiDAR System (ALS) is associated with higher altitude airborne collection over a large area for surface mapping. In this document MLS from the air refers to low altitude scanning of higher accuracy from fixed wing and helicopter used for corridor projects.
- ◆ Most Mobile Remote Sensing Systems have the following critical components in common: *Image Sensor, GPS, IMU, Base Station*



Sensor Trajectory

- ◆ SBET – Smoothed Best Estimate of Trajectory



How Accurate is it?

- Why do I care?
- How does it fit in with 3D Design






Key Stakeholders and Process Elements

Who	DOT / Government	Contractor
	<p>Road Requirements (Site, location, EIR, etc.) & Prioritization</p> <p>Placement Design</p> <p>Structural</p> <p>Surveying</p> <p>Site Conditions</p> <p>Complete Design in 3D from Road Owner</p> <p>Several years old, sometimes</p> <p>2D Data Transfer</p> <p>DOT generates 2D drawings</p> <p>Design in 2D from Road Owner</p>	<p>3D Model</p> <p>3D Data Transfer</p> <p>Contractor Utilizes 3D Model for AMG</p> <p>3D Model</p> <p>Contractor Creation of 3D Model for AMG</p>

2013 Design Training Expo

Part 1 Introduction

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General LiDAR Survey Methods and Vertical Accuracies

	Fixed Wing Aerial LiDAR Mapping (ALS)	= +/- 0.5 – 1.0 feet
	Low Altitude MLS	= +/- 0.1 – 0.2 feet
	Vehicle TMLS	= +/- 0.050 – 0.1 feet
	Static Laser Scanning	= +/- 0.005 – 0.05 feet





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Accuracy

◆ *The best place to look is the Survey Report*

- *FDOT Design Projects*
 - Based on Current TML Guidelines
 - Based on Project Scope
 - Certified
- *Other Survey Projects*

County LiDAR Project



30.07	Transformation / Adjustment	Includes transformation / Adjustment of LiDAR point cloud to Project Control, accuracy analysis, NSSDA reporting of validation points, and includes cross section analysis. If this is performed by separate firm or is the final product delivered, it should be accompanied by a Survey Report certifying accuracy and meeting MTS. Also includes creation and delivery of adjusted point cloud data in digital LAS (see ASPRS) file(s) format.
	Choose Range Category	



Table 1-2 Notes:

TML Guidelines

1. Areas in the project that have poor satellite visibility should be identified and a plan to minimize the effect on the data developed.
2. If necessary project area shall be reconnoitered to determine the best time to collect the data to minimize GNSS outages and excessive artifacts in the data collection from surrounding traffic or other factors.
3. If safety conditions permit, additional validation points should be added in challenging GNSS environments such as mid sections of tunnels and urban canyons.
4. GNSS coverage of less than 5 satellites in view must not exceed the uncorrected position time or distance travelled capabilities of the TML system IMU.
5. Sufficient for data collected by TML system to meet or surpass accuracy requirement of the project.
6. Manufacturer's specifications for precision must be sufficient for TML system to meet or surpass accuracy requirements of the project.
7. Validation points may serve as NSSDA check points to meet the requirements of this section. However, if critical areas of the point cloud are to be used outside of the locations of the Validation points, then additional check points will be needed in those areas to meet this requirement.

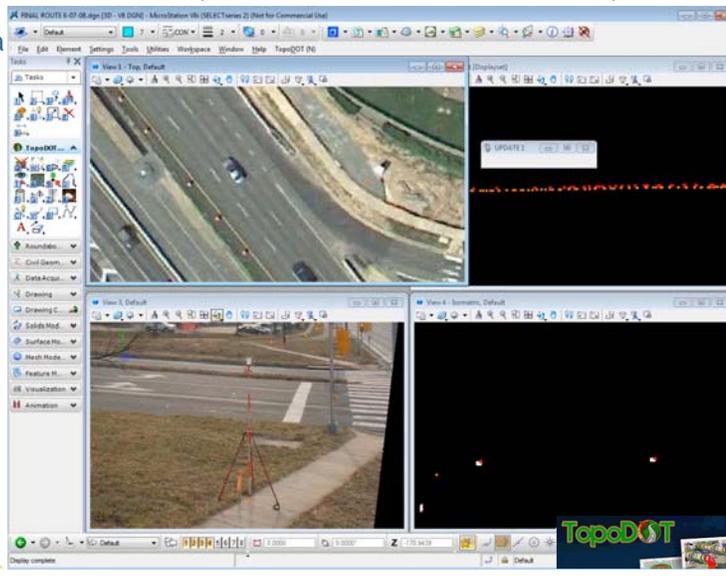
Operation/Specification	TML Application		
	TML Type A	TML Type B	TML Type C
GNSS positioning should be constrained to local project control.	Yes		
Minimum horizontal (H) and vertical (V) accuracy for GNSS control base stations.	Must meet or surpass TML local accuracy requirement of the project.		
Minimum accuracy of Local Transformation Points and Validation Points	See Note 5		
TML project positional accuracy requirements relative to Local Transformation Points and Validation Points	H ≤ 0.05'	H ≤ 0.10'	H and V
	V ≤ 0.05'	V ≤ 0.10'	See Note 5
Maximum post-processed baseline length	5 miles		10 miles
GNSS base stations located at each end of project	Recommended		
Minimum number of common healthy satellites in view for GNSS base stations and mobile scanner	See Notes 1 thru 5		
Maximum PDOP during TML data acquisition	5		
Allow sufficient time between runs to ensure that the satellite constellation has at least 3 different satellites in view	Each Overlapping Pass		
Minimum overlapping coverage between adjacent runs	20%		
Minimum orbit ephemeris for kinematic post-processing	Broadcast		
Observations - sufficient point density to model objects	Each pass		
Vehicle speed - limit to maintain required point density	Each pass		
Minimum number of local transformation points required	4		
Local transformation point maximum station spacing throughout the project on each side of scanned roadway	1500 foot intervals	2400 foot intervals	See note 5
Validation point maximum station spacing throughout the project on each side of scanned roadway for QA purposes as safety conditions permit. (See Note 3)	500 foot intervals	800 foot intervals	N/A
Minimum NSSDA Horizontal and Vertical Check Points	20 (see note 7)		



Other LiDAR Documentation

- ◆ It never hurts to have independent measurement data to compare.
- ◆ Metadata

LIDAR XML Document



LiDAR Point Cloud Data File Formats

- ◆ American Standard Code for Information Interchange (ASCII)
 - **X,Y,Z,I** - Easting, Northing, Elevation, Intensity
- ◆ Binary
 - **POD** - MicroStation
 - **LAS** - A binary file standard supported by ASPRS for storing point location and attribute information primarily used for LiDAR data.

	A	B	C	D	E	F	G	H
1	X	Y	ELEV	CLASS	GPS_TIME	INTENSITY	RETURN_CNT	SCAN_ANGLE
2	2037273.89	522141.27	170.479	1 (Unclassified)	413699.2	1020	1	-15
3	2037274.06	522139.92	187.670	1 (Unclassified)	413699.3	1100	1	-34
4	2037274.24	522140.67	185.505	1 (Unclassified)	413699.3	940	1	-31
5	2037274.31	522141.13	184.947	1 (Unclassified)	413699.3	1040	1	-31
6	2037274.38	522141.06	182.749	1 (Unclassified)	413699.3	800	1	-29
7	2037274.34	522140.67	181.272	1 (Unclassified)	413699.3	800	1	-27



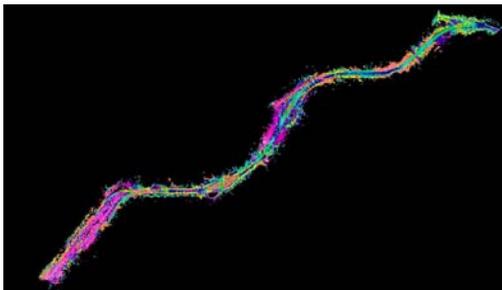
LAS Details (ver. 1.4)

- ◆ *Fields for Attribute Information*
- ◆ *Source*
- ◆ *Datum*
- ◆ *GPS Position and Timing*
- ◆ *Intensity Returns*
- ◆ *Scan Angle*
- ◆ ** Positional Accuracy*

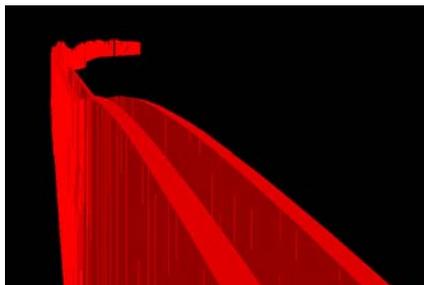
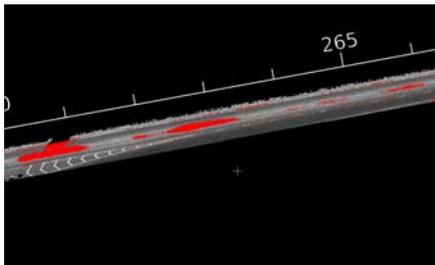


Can I use it yet?

- ◆ *Identify Source*
- ◆ *Identify Accuracy*
- ◆ *Maintain Associated Documentation*
- ◆ *Cut Into Smaller Bites*
- ◆ *Keep LiDAR data in one Location*

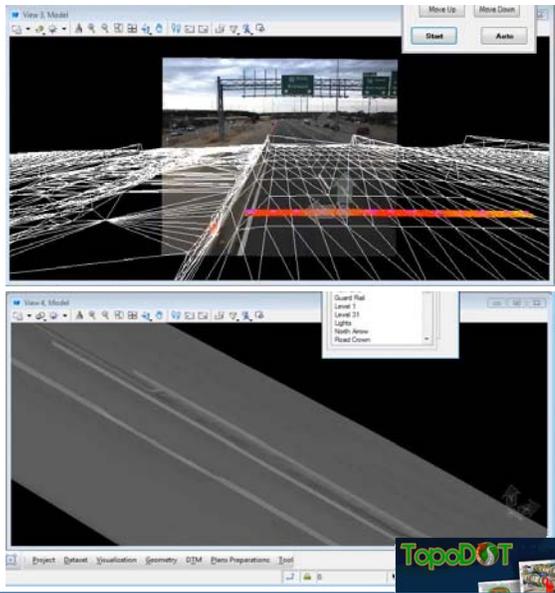


jasonamadori.com

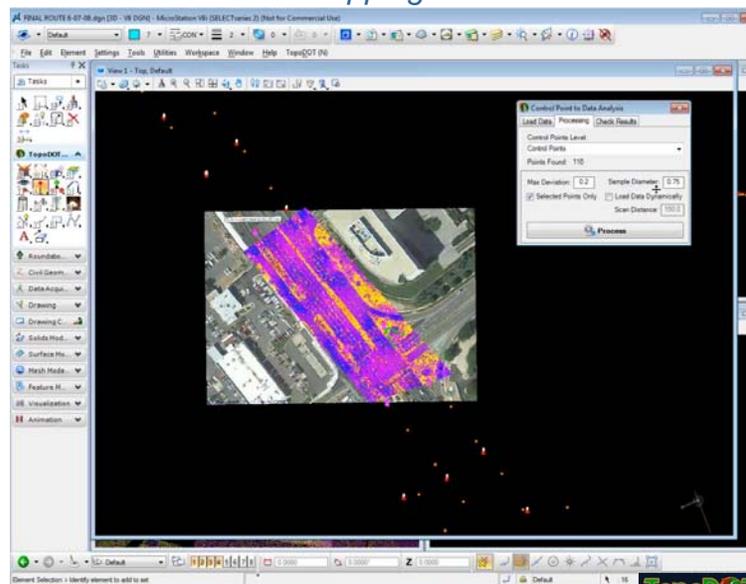


Point Cloud Software

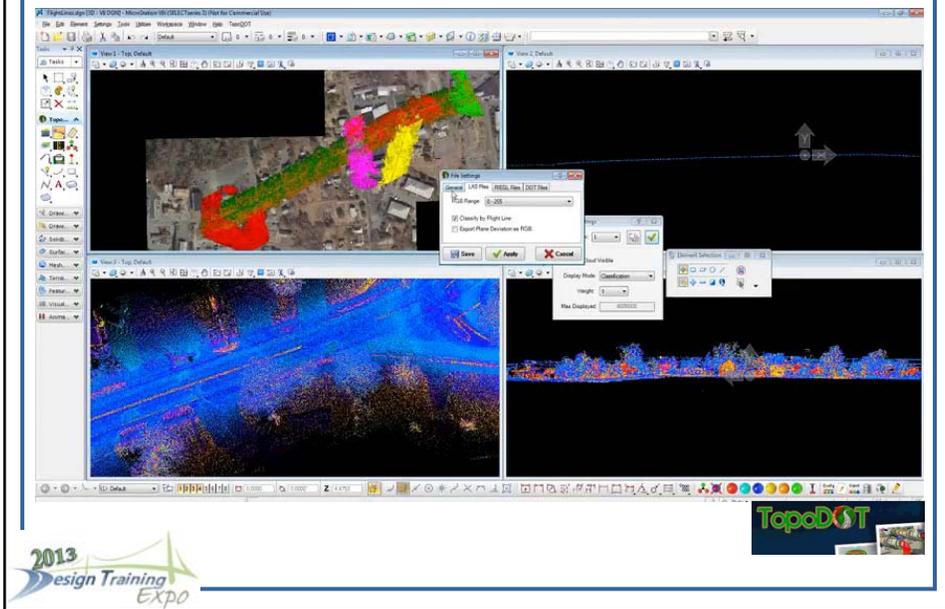
- ◆ Current Software in Use
 - MicroStation
 - AutoCAD
 - TopoDOT
 - GlobalMapper
- ◆ Becoming more mainstream
- ◆ Hardware
 - Solid State Drives
 - 64 Bit Platforms



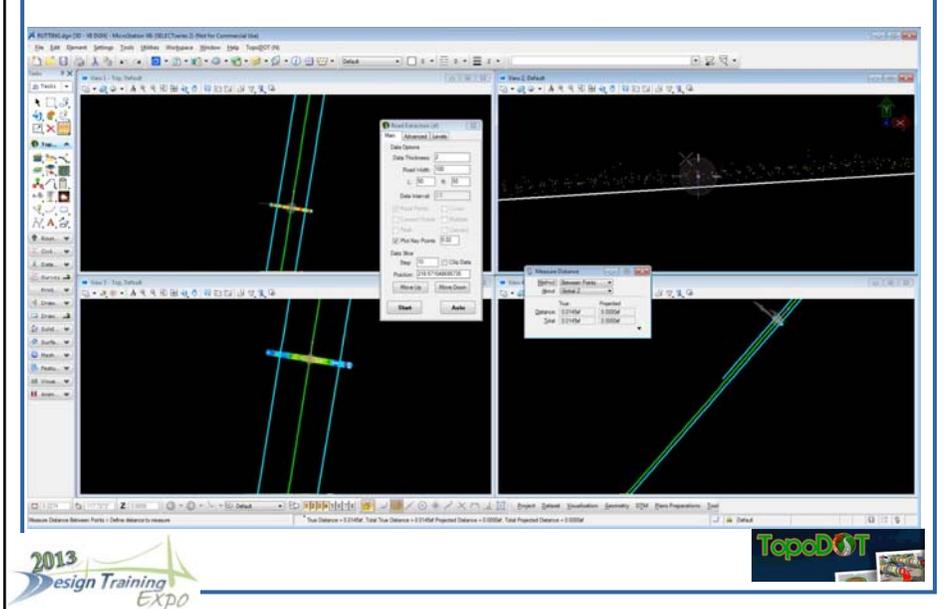
TopoDOT Software – Data Clipping



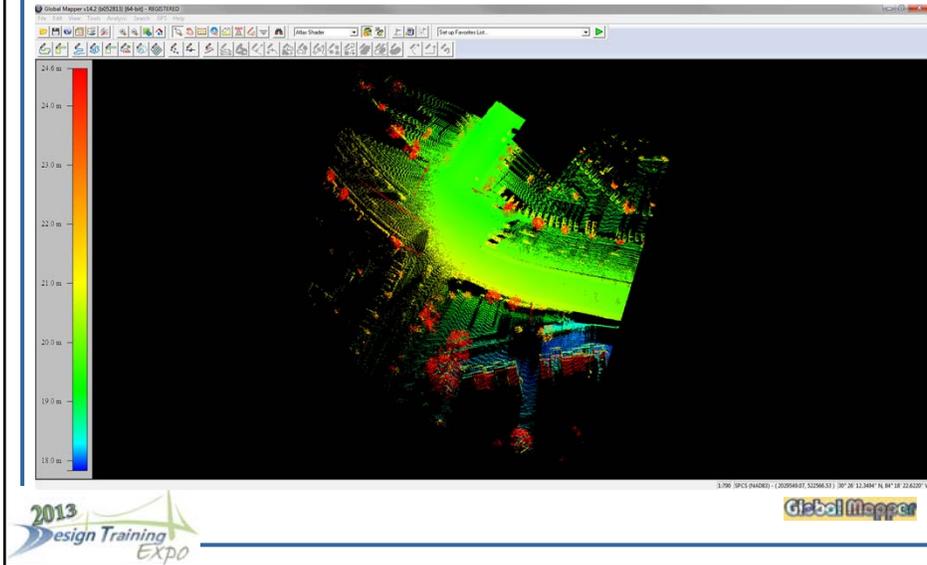
TopoDOT Software – Quality Control



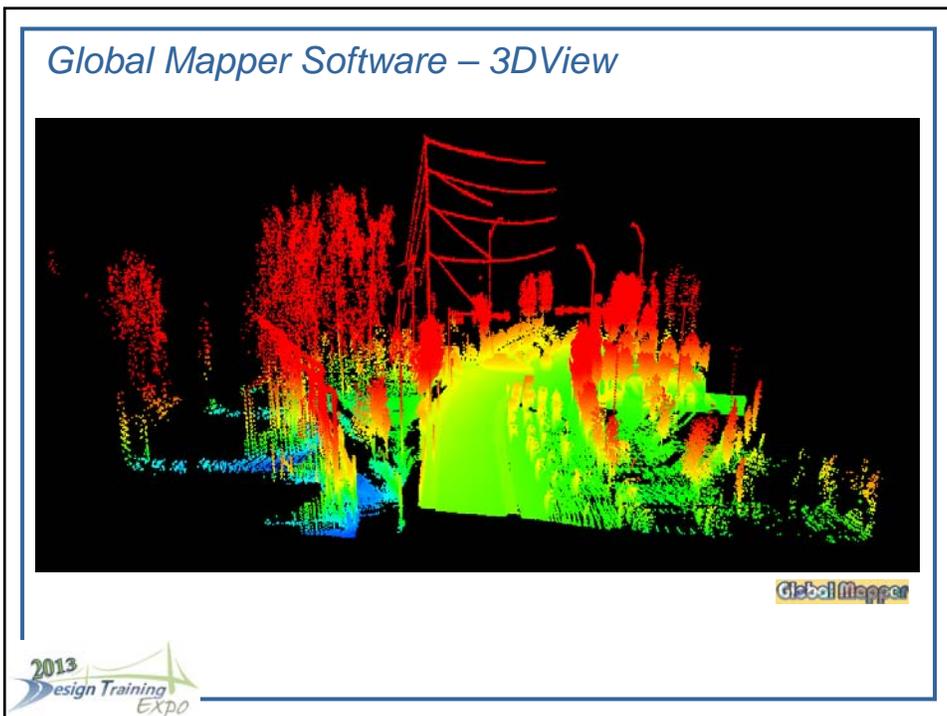
TopoDOT Software – Quality Control



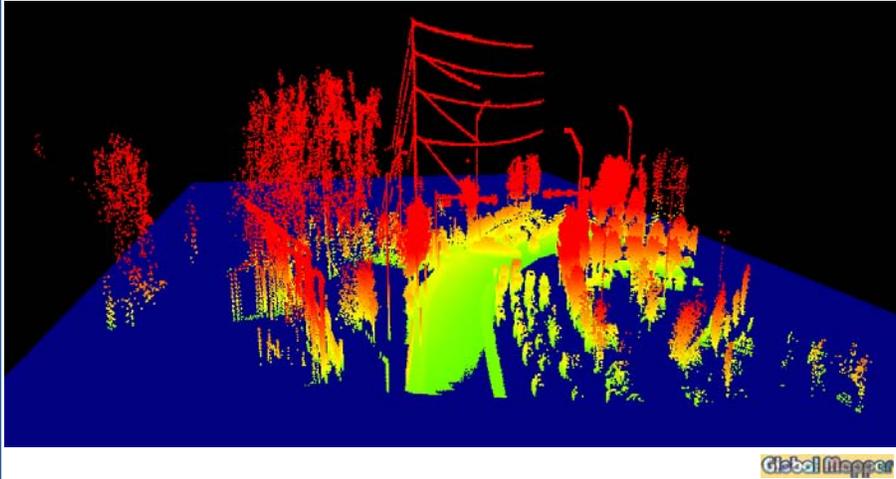
Global Mapper Software – Plan View



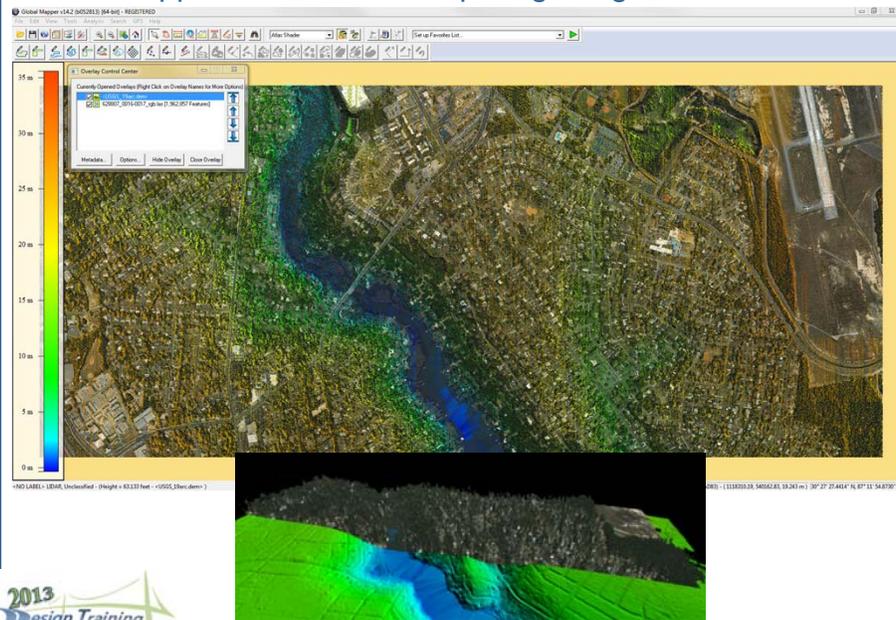
Global Mapper Software – 3DView



Global Mapper Software – 3D Analysis



Global Mapper Software – Comparing Image Data



Questions?

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Welcome

Our office leads statewide surveying and mapping efforts through spatial technology expertise in support of Florida's transportation system. We support surveying and mapping activities statewide by providing policies, procedures, guidelines, and training. Our areas of expertise include: Aerial Surveying and Mapping, Location Surveying, Right of Way Mapping, and Geographic Mapping which includes distributing aerial photography, producing the Florida Official Transportation Map, and providing Geographic Information Systems (GIS) support for engineering and operations.

News



The new - 2013 Official Transportation Map - March 26, 2013
Posted March 26, 2013

2012 - EFB for Windows (EFB 3) software - February 13, 2012
 EFB has been approved for production use and is available for download. Please visit the Surveying Software page for additional information and restrictions.
Please note: Prior to using the new EFB zones on any FDOT project, regardless of project status (in progress or planned), permission to use EFB must be obtained from the Surveying and Mapping Office of the District within which the project resides. Mobilization of EFB zones on Turnpike Enterprise projects requires an approval from the Surveying and Mapping Program Manager for the Turnpike Authority.
Posted February 12, 2012

<http://www.dot.state.fl.us/surveyingandmapping/>