# Managing Remote Sensing Data for Projects

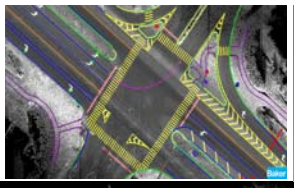
Brett Wood, PSM

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 (***Li***ght ***D***etection ***a***nd ***R***anging) 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.

USGS

http://en.wikipedia.org/lidar

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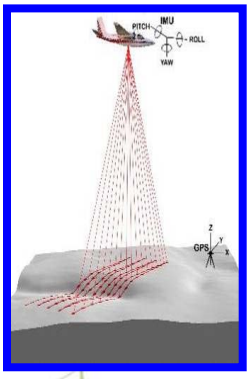
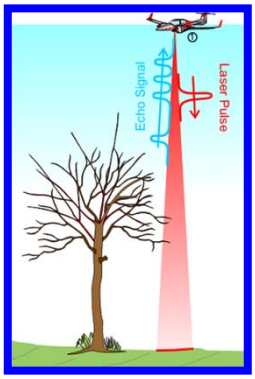
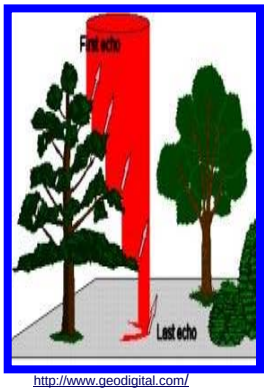
## Some Pulse Laser Characteristics

- 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/

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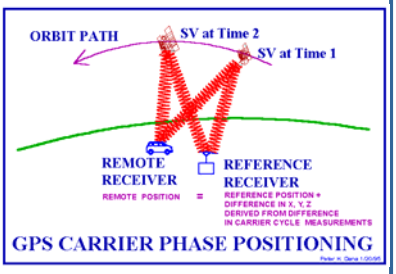
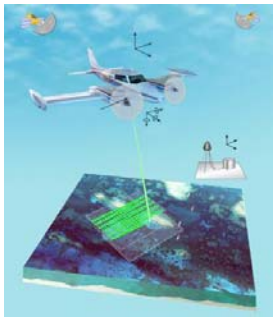
- Mobile Laser Scanning (MLS) uses a laser scanner(s) in combination with Global Navigation Satellite Systems (GNSS) and Inertial Measurement Unit (IMU) to produce accurate and precise geospatial data from a moving platform both in the air and on the ground.



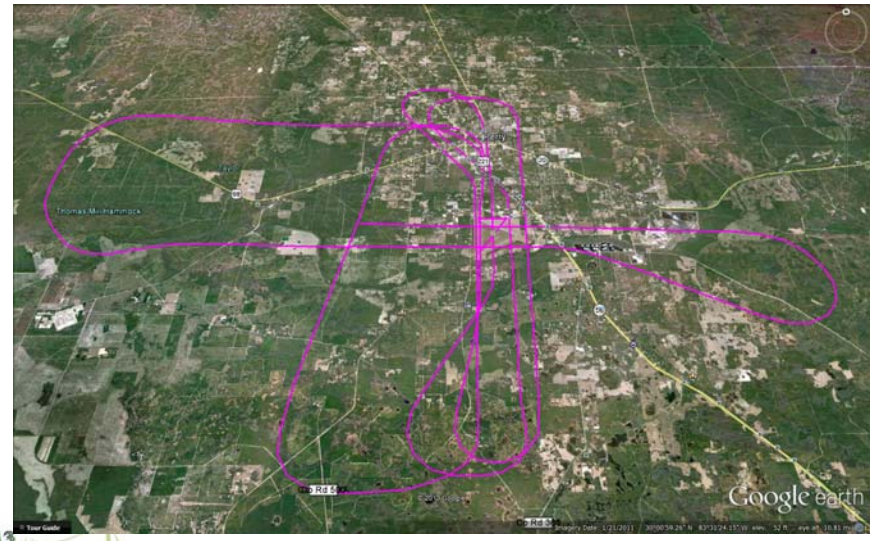

- Traditionally the term Airborne LiDAR System (ALS) is associated with higher altitude airborne collection over a large area for surface mapping. In this document MLS from the air refers to low altitude scanning of higher accuracy from fixed wing and helicopter used for corridor projects.



- Most Mobile Remote Sensing Systems have the following critical components in common: *Image Sensor, GPS, IMU, Base Station*

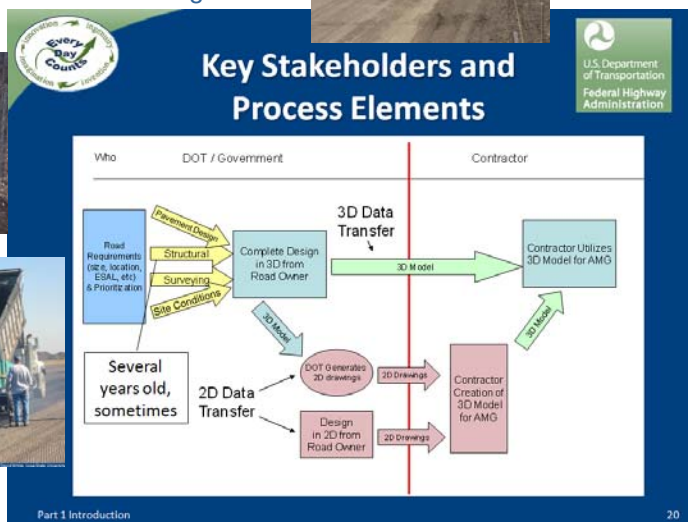
## *Sensor Trajectory*

- SBET – Smoothed Best Estimate of Trajectory



## How Accurate is it?

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

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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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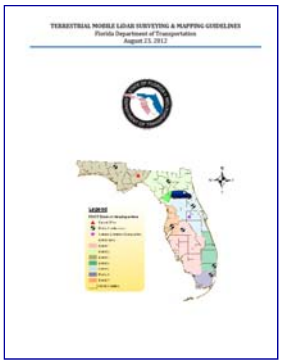
# Accuracy

- *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

TML Standard Scope

TML Staff Hour Form

| | | |
|---|---|---|
| 30.07 | Transformation / Adjustment | |
| | Choose Range Category | 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. |

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# TML Guidelines

***Table 1-2 Notes:***

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′<br>V ≤ 0.05′ | H ≤ 0.10′<br>V ≤ 0.10′ | H and V<br>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) | | |



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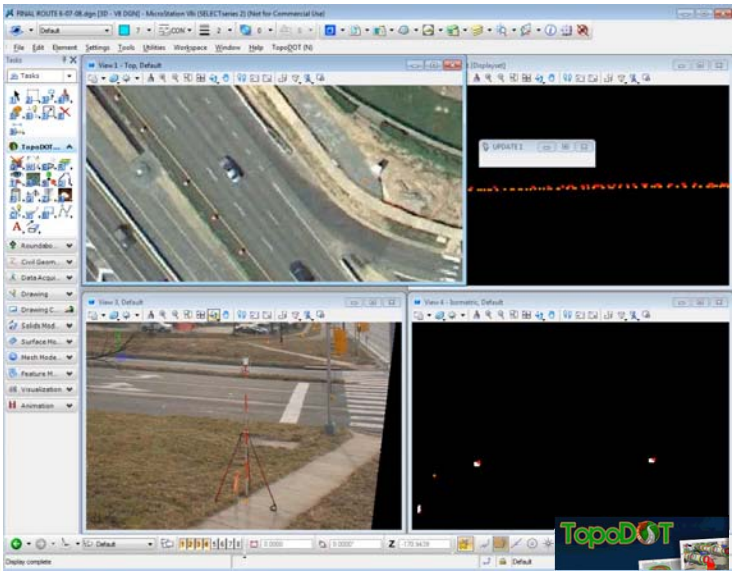
# Other LiDAR Documentation

- 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*

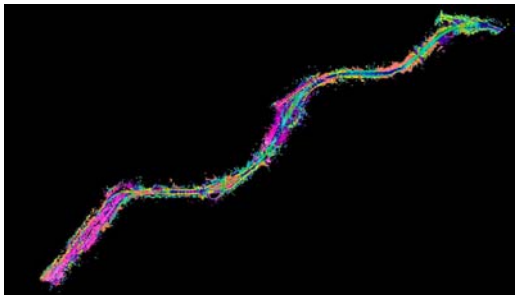

asprs

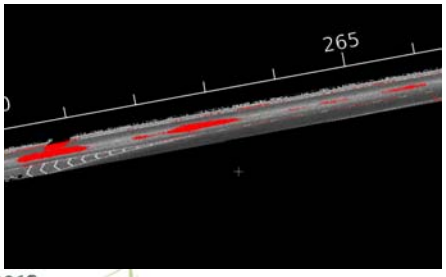
LAS SPECIFICATION
VERSION 1.4 – R12
10 June 2012

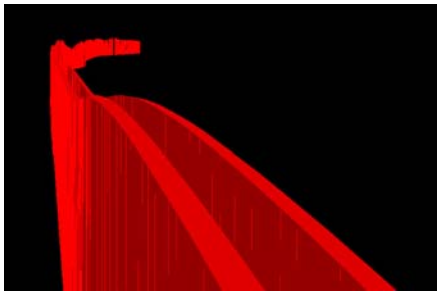
Approved:
November 2011

## Can I use it yet?

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

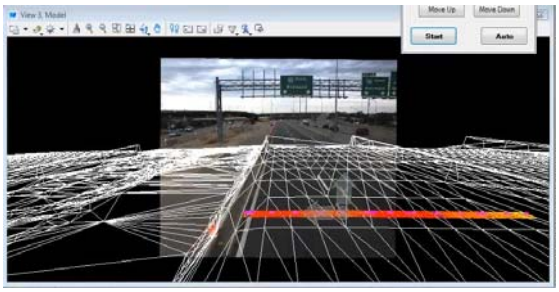

jasonamadori.com

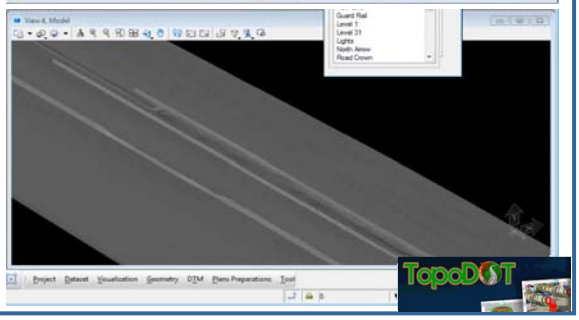


## Point Cloud Software

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



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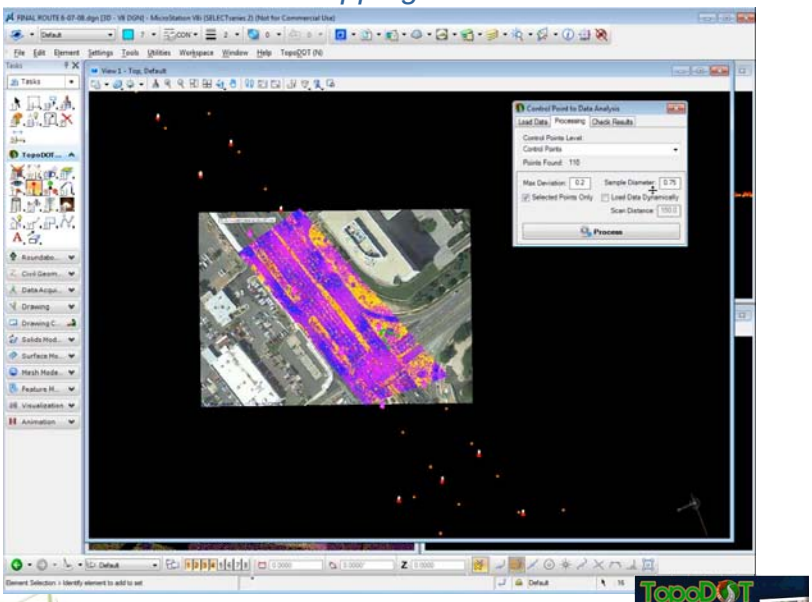
## TopoDOT Software – Data Clipping

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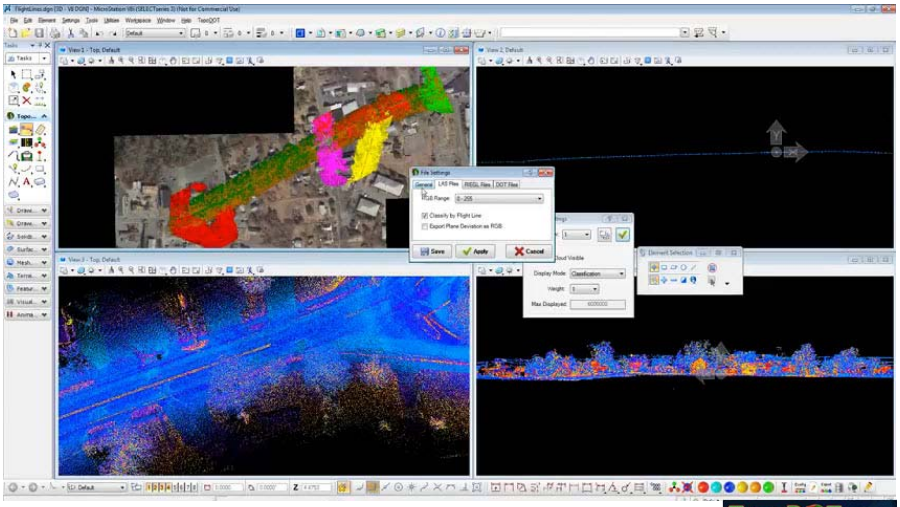
## TopoDOT Software – Quality Control



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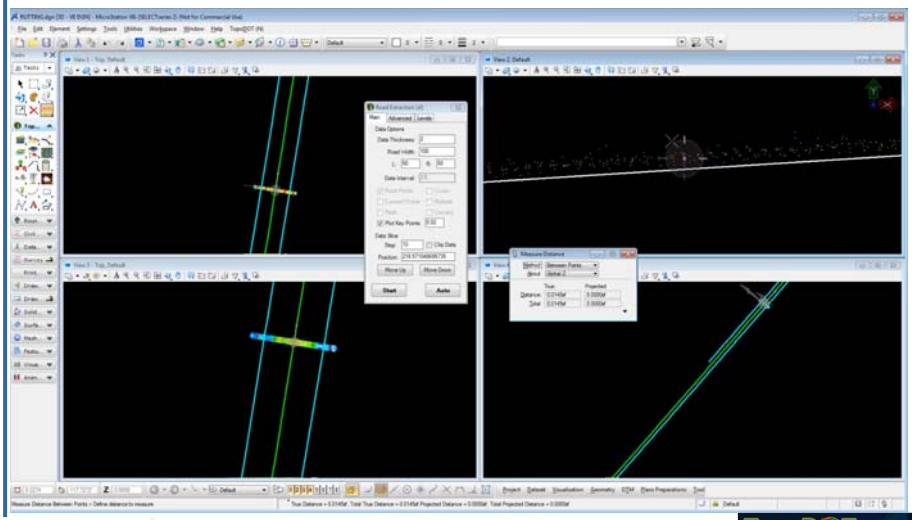
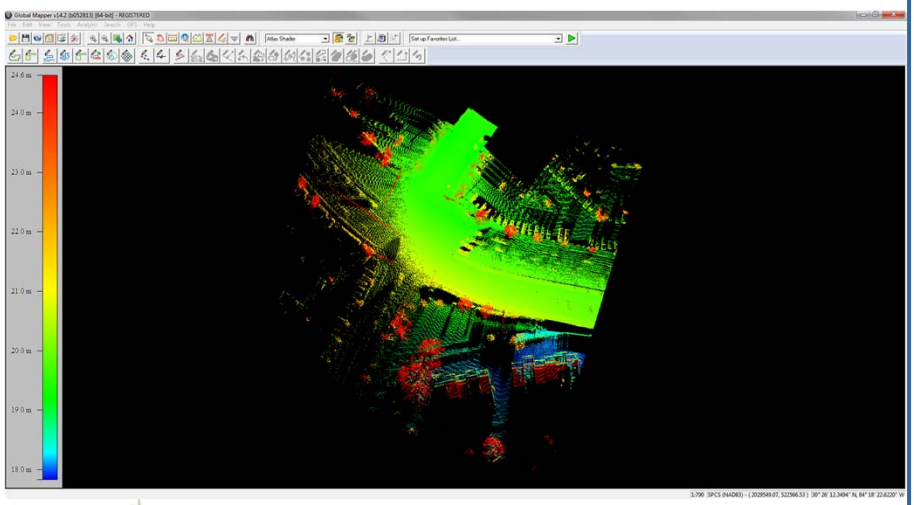
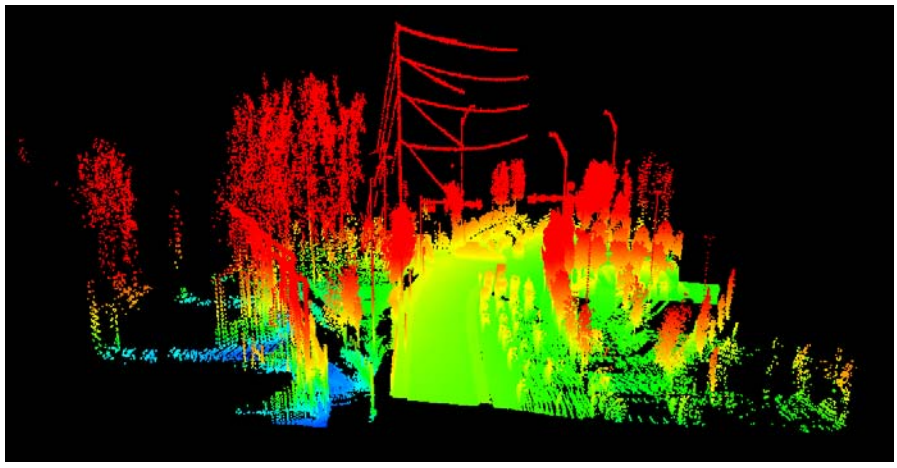


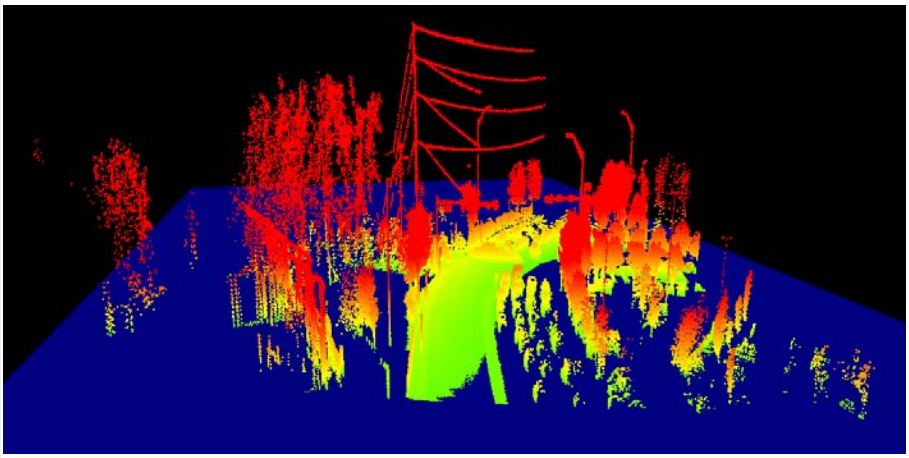
## Global Mapper Software – Plan View



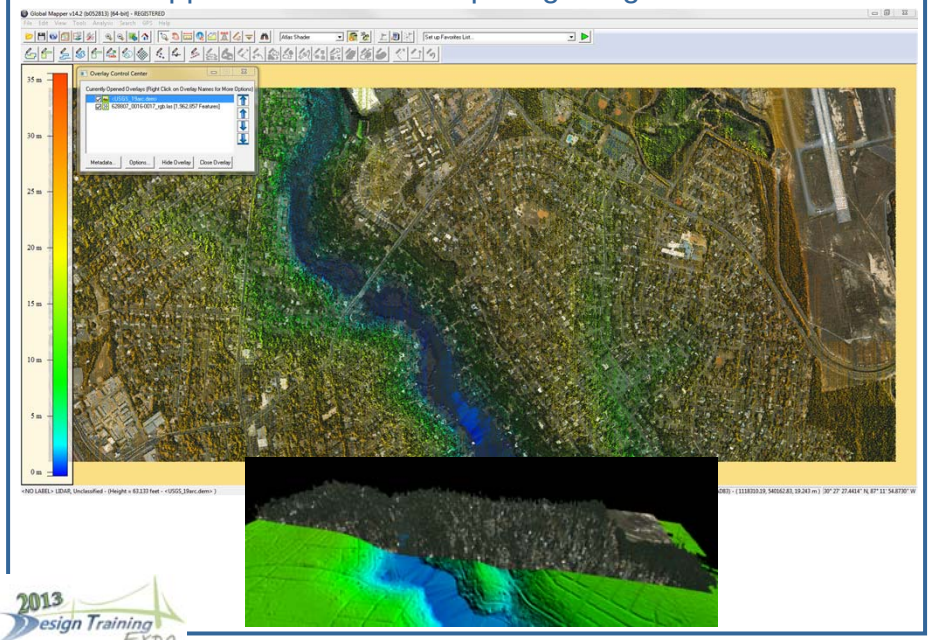
## Global Mapper Software – 3DView



## Global Mapper Software – 3D Analysis

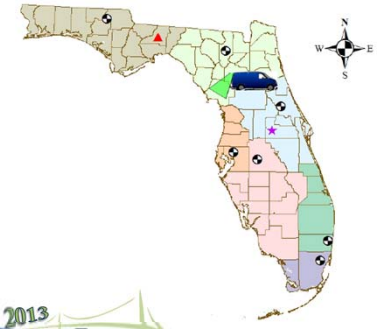


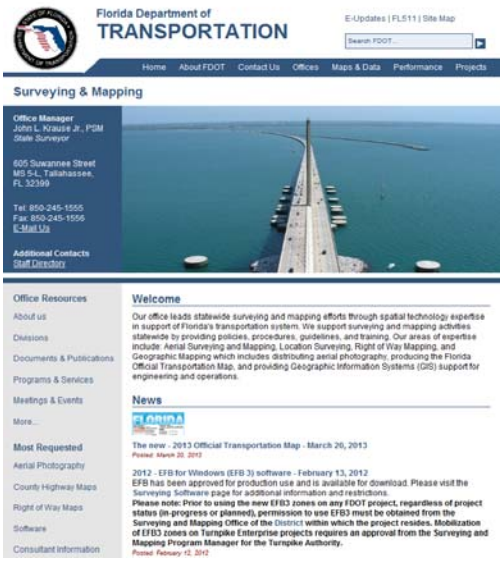

## Global Mapper Software – Comparing Image Data



# Questions?

*Brett C. Wood, PSM*
*Aerial Surveying & Mapping Manager*
*Florida Department of Transportation*
*Magnolia Centre II, Suite 100*
*1211 Governor's Square Boulevard*
*Tallahassee, Fl 32301*
*Phone (850) 245-1585*
*brett.wood@dot.state.fl.us*






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