ArcGIS 10.1 Lidar Workshop

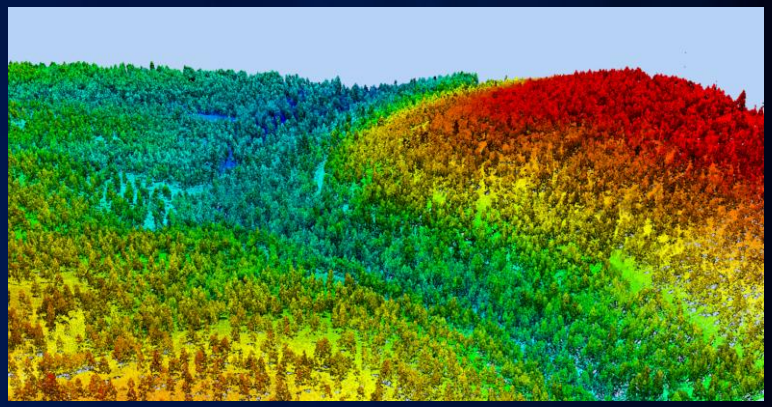
Lidar in ArcGIS 10.1

Amadea Azerki

November 2, 2012

Lidar Workshop Agenda

8:30 – 8:45am	Introductions
8:45 – 9:15am	Lidar in ArcGIS 10.1
9:15 – 9:25am	LAS datasets
9:25 – 10:05am	Exercise 1
10:05 – 10:15am	Break
10:15 – 10:25am	Terrain datasets
10:25 – 11:05am	Exercise 2
11:05 – 11:15am	Mosaic datasets
11:15 – 11:45am	Exercise 3
11:45 – 12:00pm	Summary and Q & A



GIS Software Has Evolved

Providing A Complete Geospatial Platform

Easy
Powerful
and Everywhere

- Discover
- Create
- Manage
- Visualize
- Analyze
- Collaborate

Making GIS Available to Everyone

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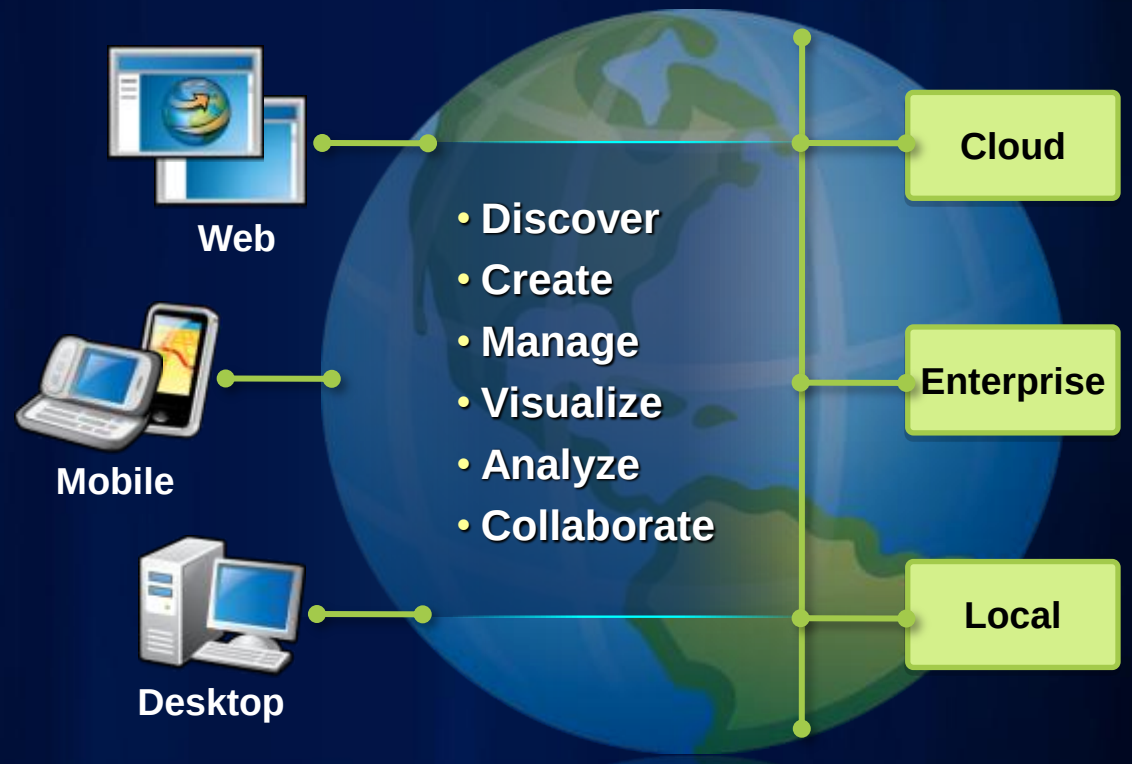


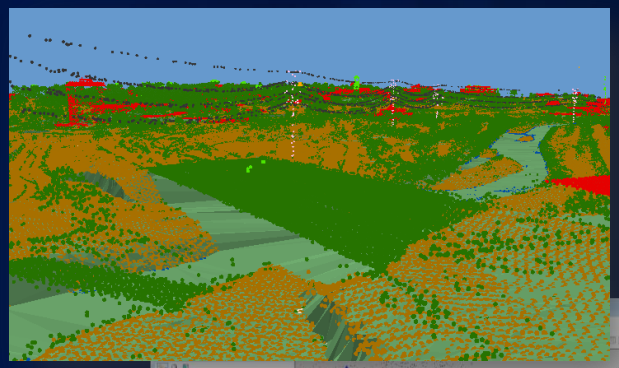
Making GIS Available to Everyone

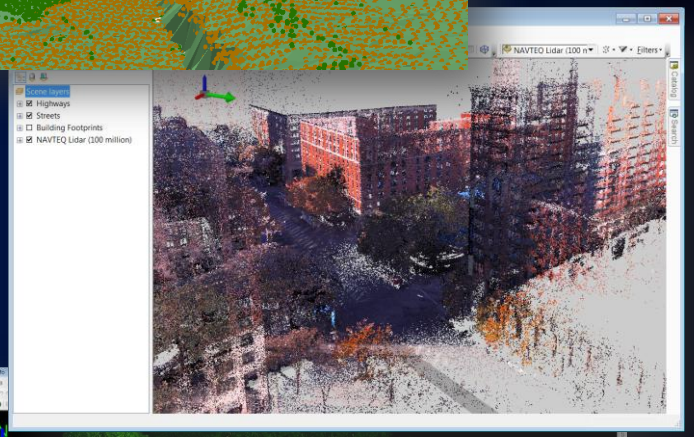
Lidar – Light Detection And Ranging

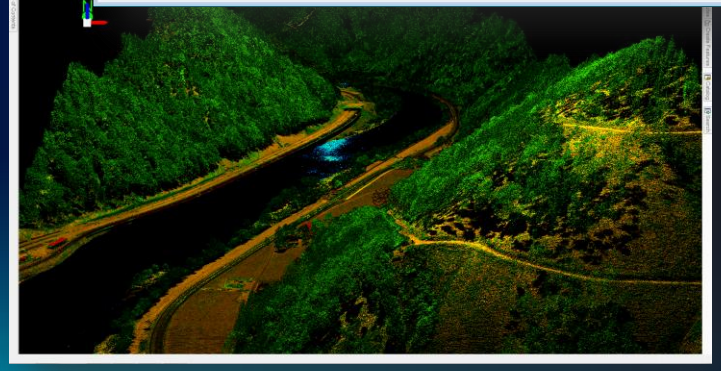
- Optical remote sensing technology that can measure the distance to, or other properties of a target by illuminating the target with light
- LAS—Binary file format for Lidar storage developed by the ASPRS in conjunction with private and government stakeholders
- Lidar data (LAS) is increasingly available and affordable, and many users want to leverage this data in their GIS

Types of Lidar

- Airborne
  - Captured from aircraft
  - Suitable for surface analysis
- Terrestrial and Mobile
  - Captured from the surface
  - Suitable for feature location and data validation
- Lidar is dense data can consist of all three sensors…

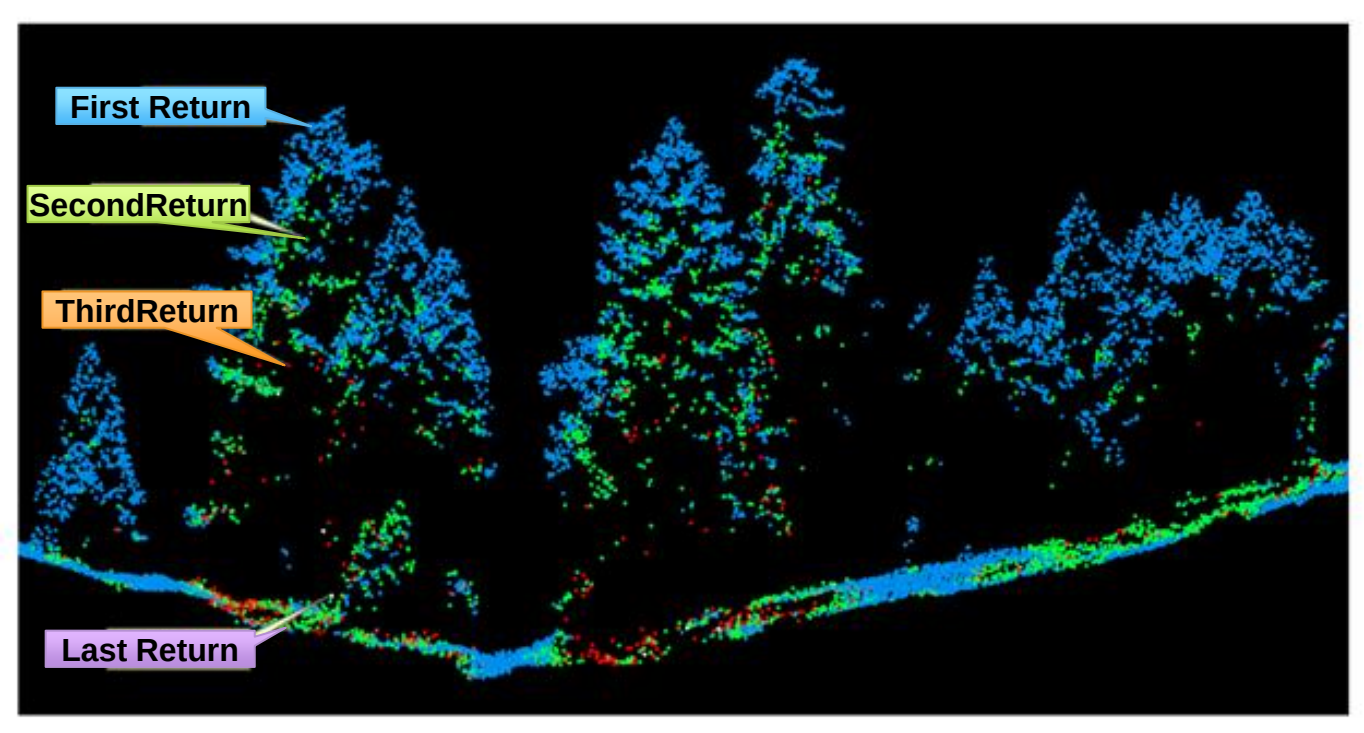






Lidar Data

Very rich, but contains a lot of data not required for many applications



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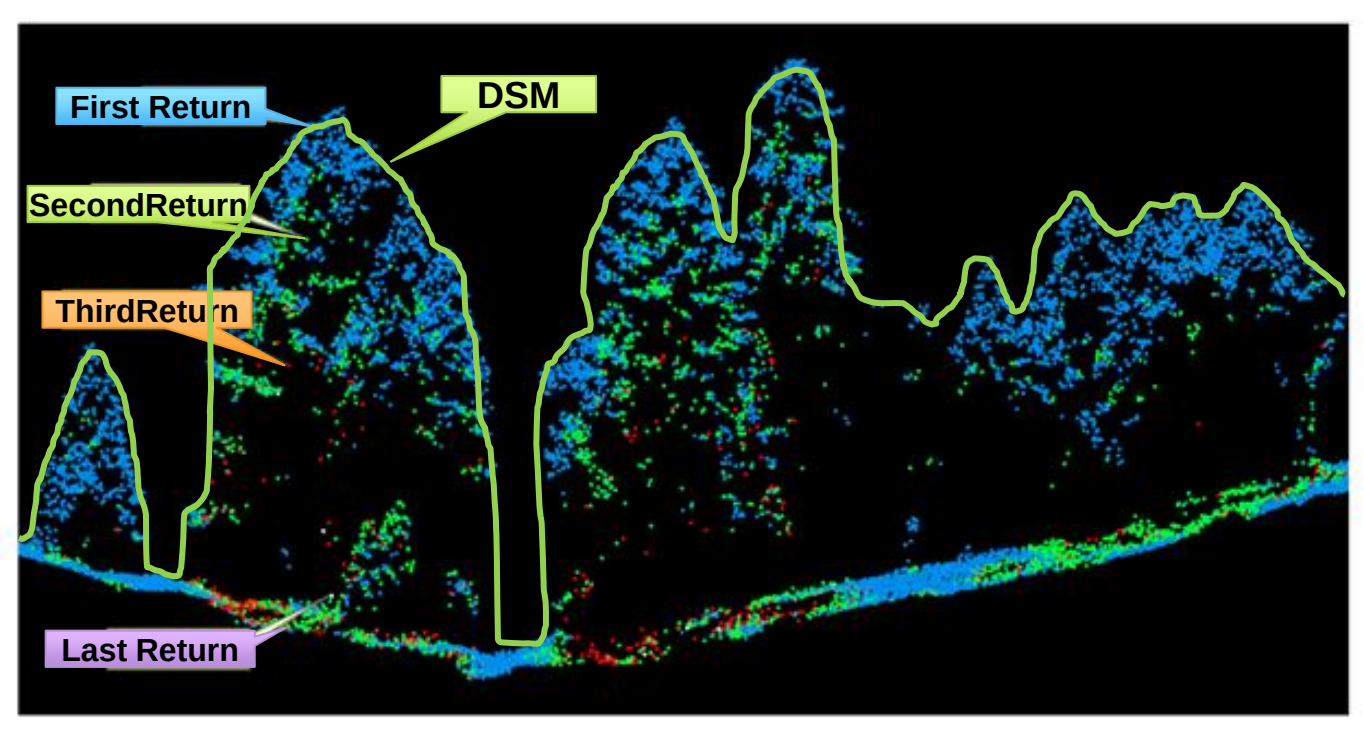

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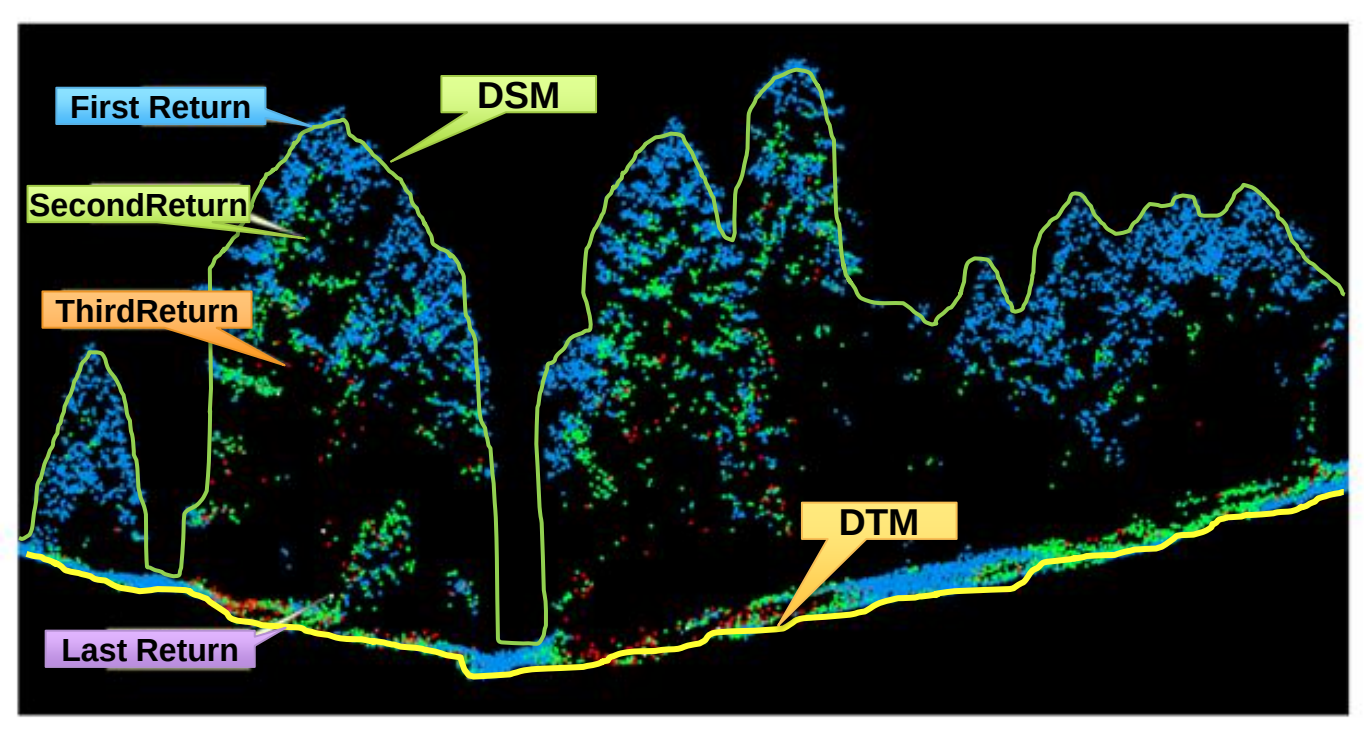
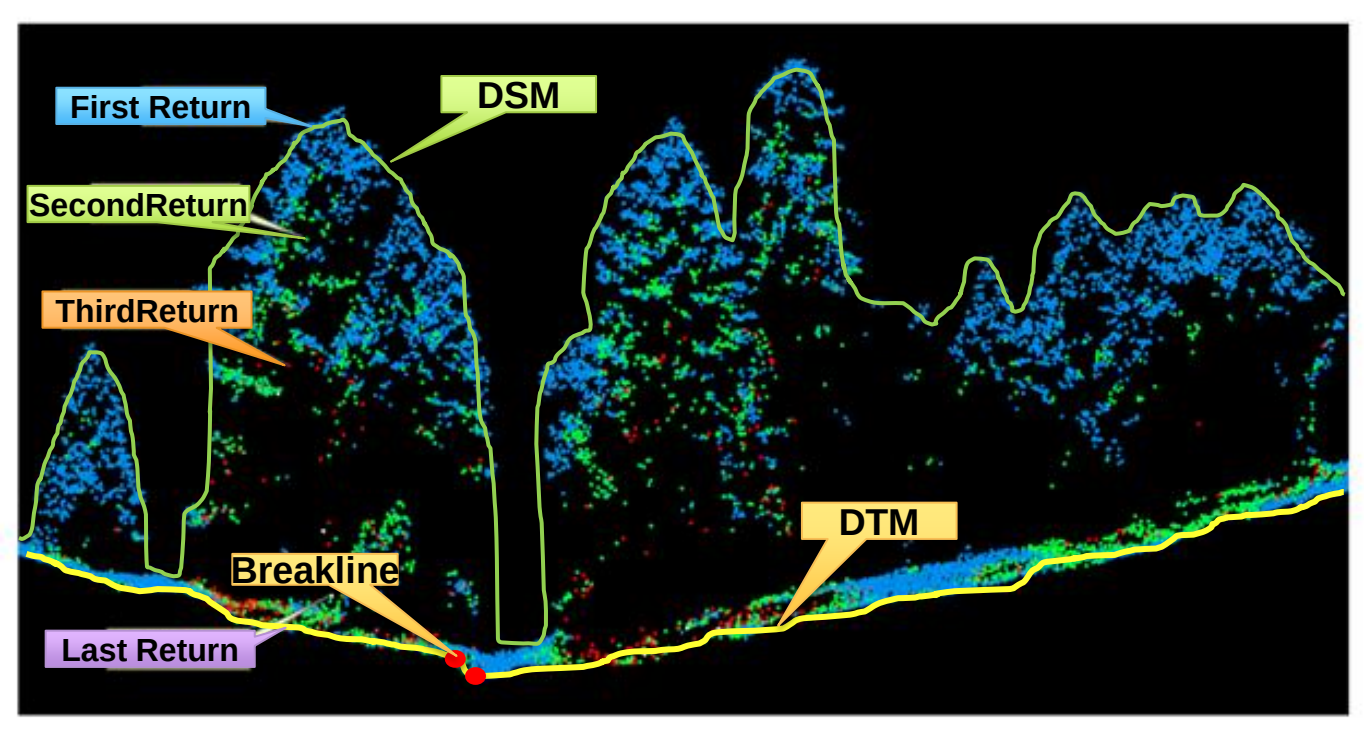


Lidar Data

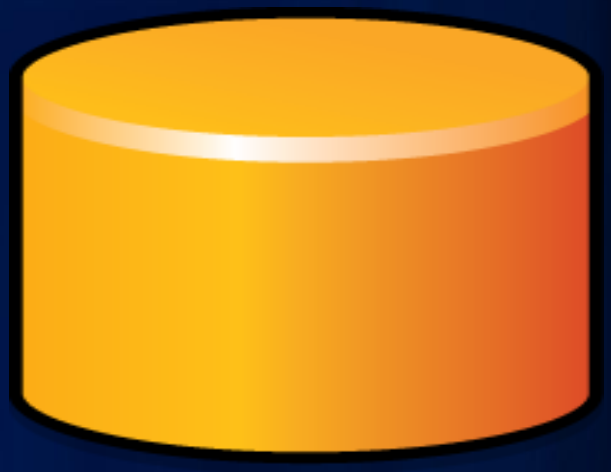
Very rich, but contains a lot of data not required for many applications
And is missing some data that is critical to some applications



Key Lidar Functionality

- Surface analysis
  - First-return
  - Bare-earth
- Feature extraction
  - Digitizing
  - Point classification
- Background information
  - Measuring
  - Data validation
- Sharing
  - Serving
  - Zip-and-ship

Challenges of Working with Lidar Data



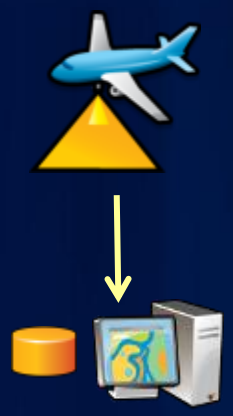
- Huge Volumes
- Multiple Sources
- Multiple Projections
- Varying Accuracy
- Multiple Representations

- How to manage?
- How to analyze?
- How to access?

Use of elevation data has been a challenge

Traditional Workflows

- Project based
  - Collection – Project based
  - Analysis – For specific project



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  - Archive data

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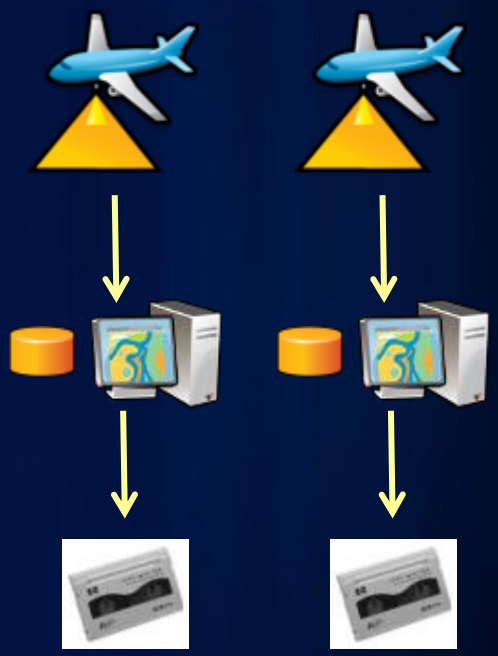
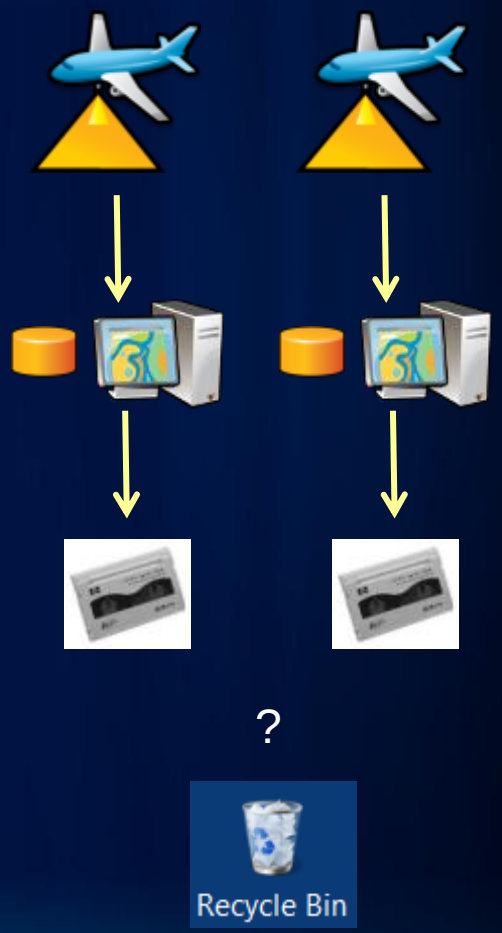
  - Move on to next project



Traditional Workflows

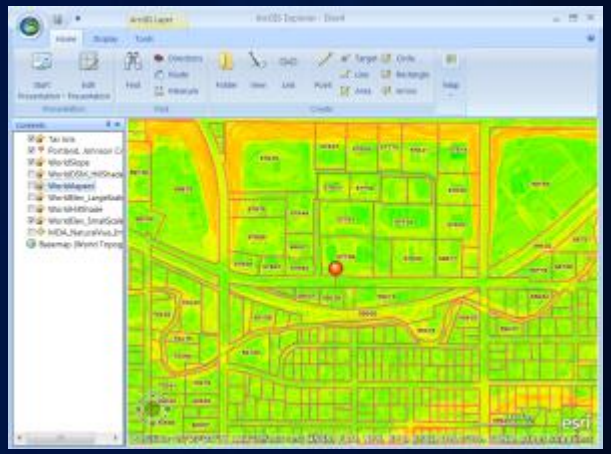
- Project based
  - Collection – Project based
  - Analysis – For specific project
  - Archive data
  - Move on to next project
- Data not accessible to
  - Multiple applications
  - Multiple users
- Value is lost



User Expectations

End Users and Decision Makers

- Lidar lives beyond project
- Information has to be:
  - Simple
  - Accessible
  - Timely

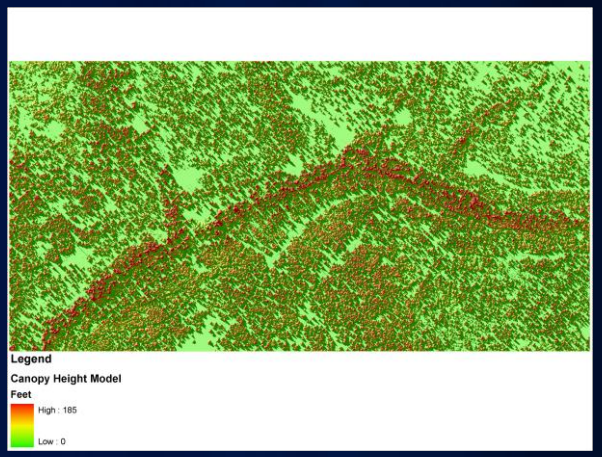


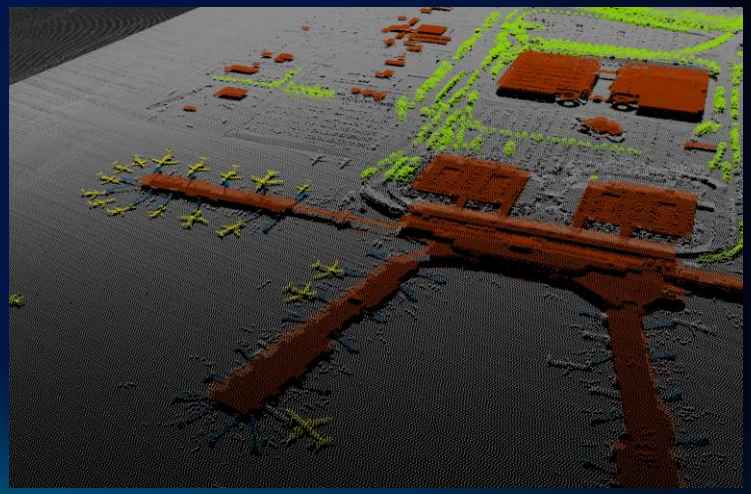
Application and data integration is critical

User Expectations: Simple

End Users and Decision Makers

- Single interface
- Zoom/Roam/Search
- Visualize data
- Perform analysis
- Discover relevant information

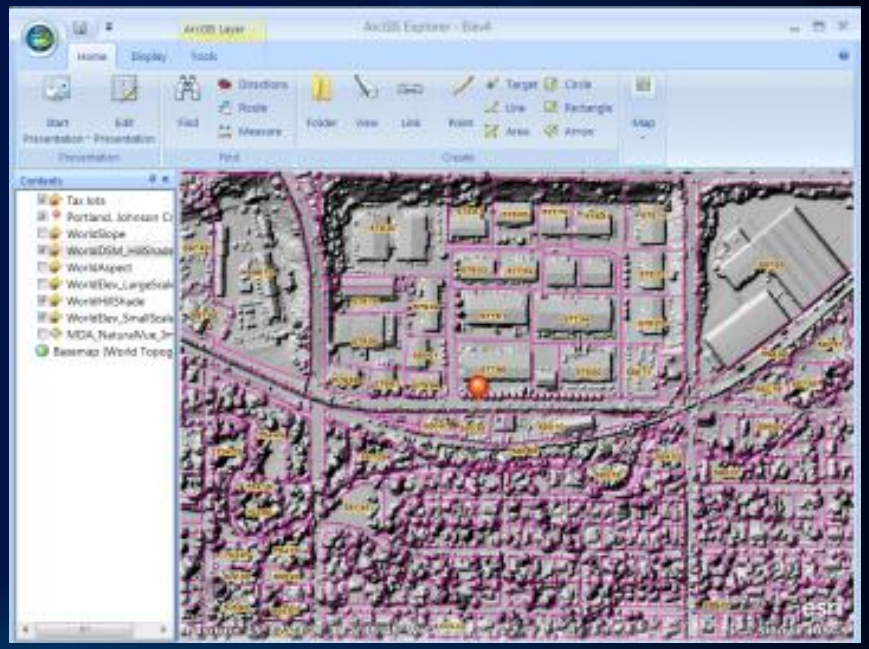




User Expectations: Accessible

End Users and Decision Makers

- Accessible with other data
  - Imagery
  - Base Maps
  - Operational Layers
- Internally within your organizations and online

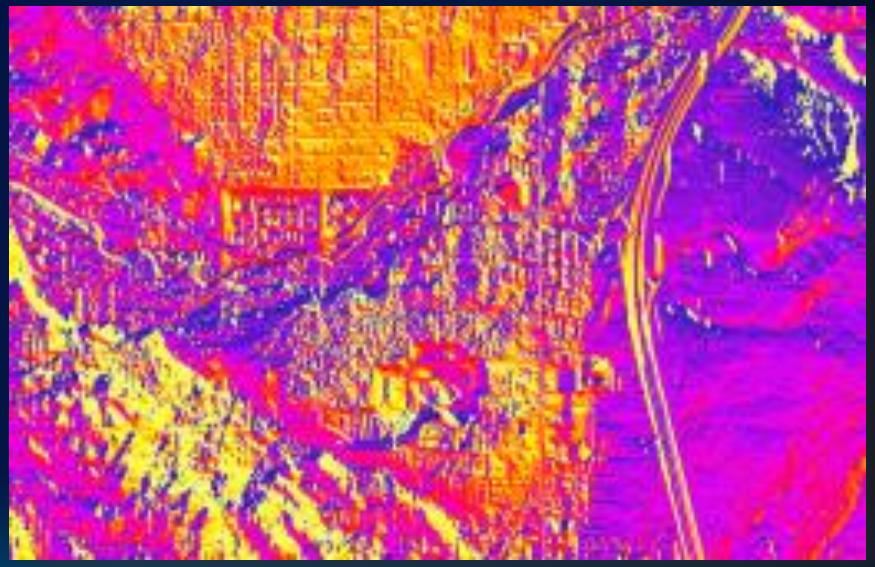


User Expectations: Timely

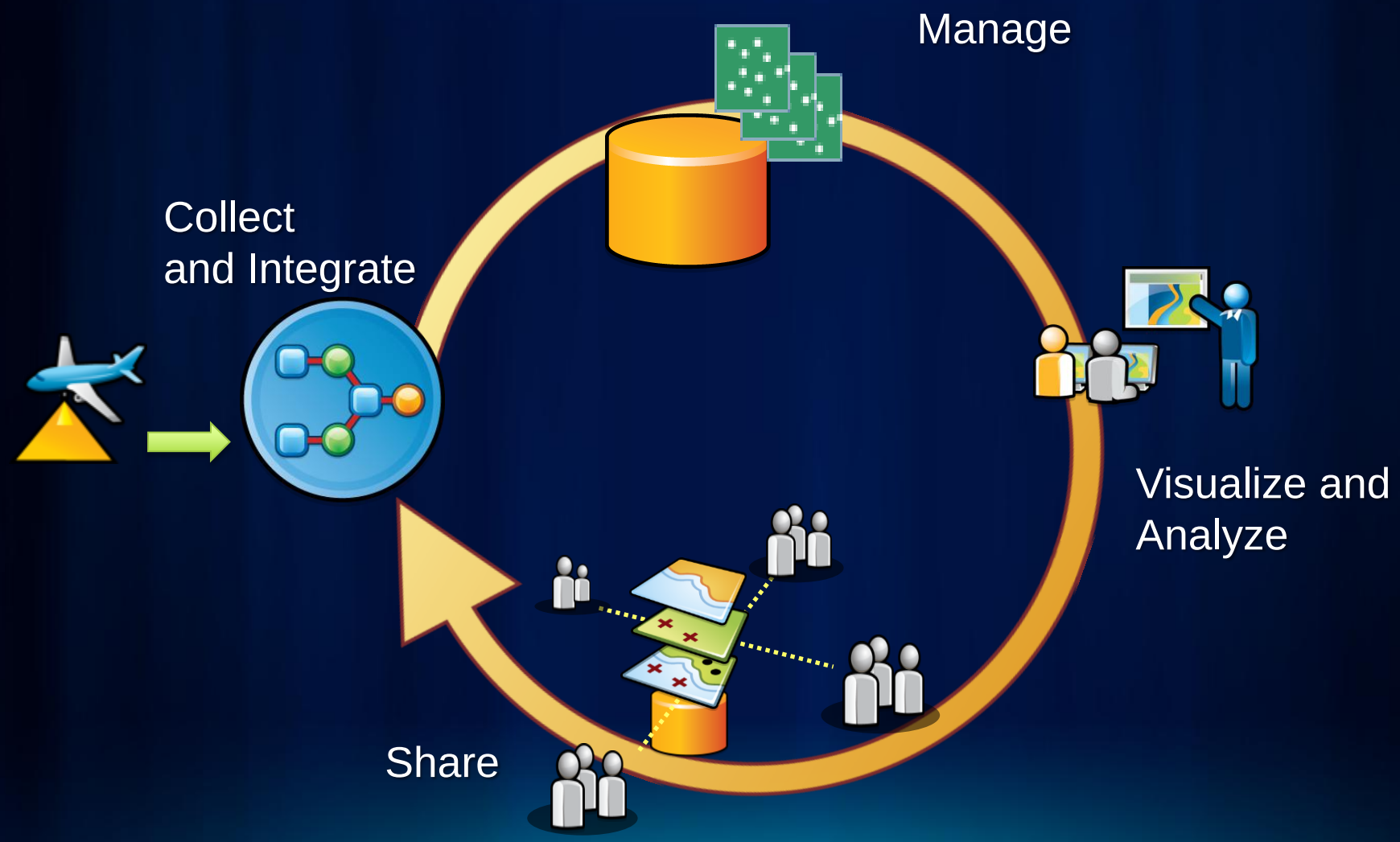
End Users and Decision Makers

ArcGIS enables timeliness by

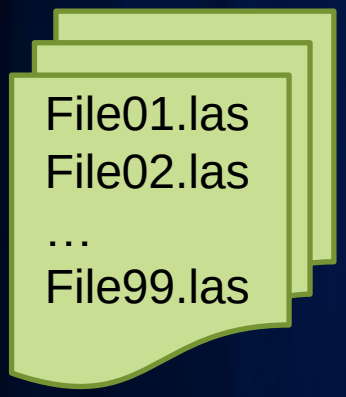
- Using server based on-the-fly processing
- Automated analysis and geoprocessing
- 2D and 3D visualization



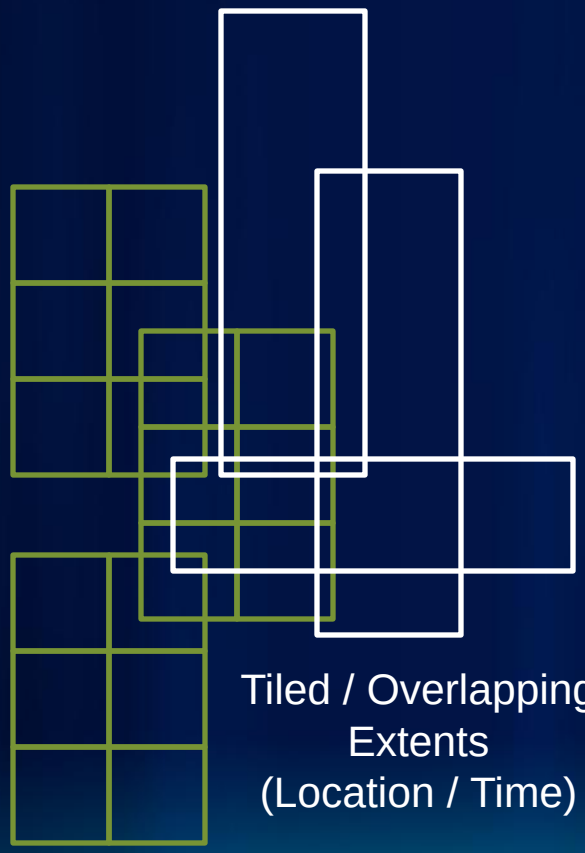
The Lidar Workflow



Overview of LAS Support in ArcGIS 10.1



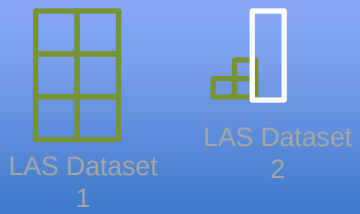
Multiple Files / Folders



Tiled / Overlapping Extents (Location / Time)

PROJECTS

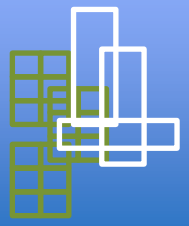
Analyze / Update Data



LAS Dataset

ORGANIZE

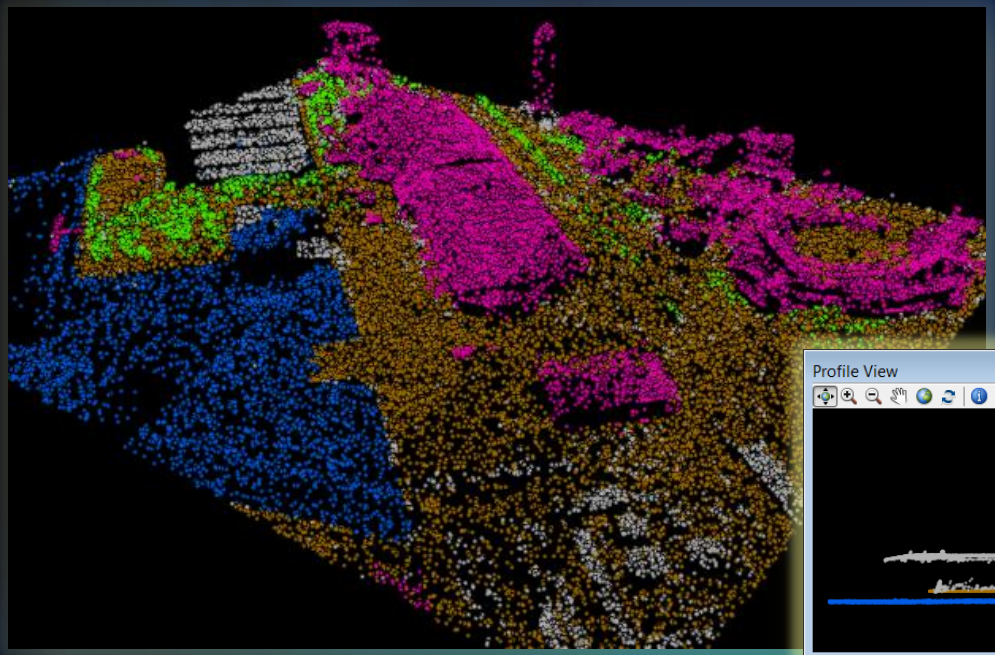
Manage Serve / Share

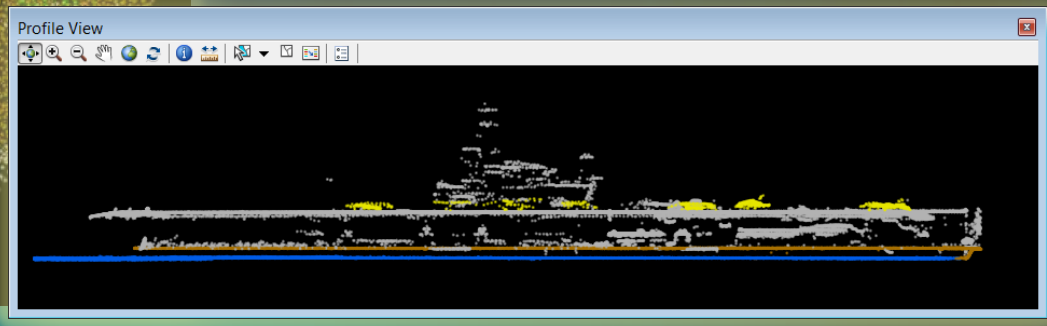


Mosaic Dataset

LAS Dataset

- New data type
- File based
- Treats a collection of LAS files as one logical dataset



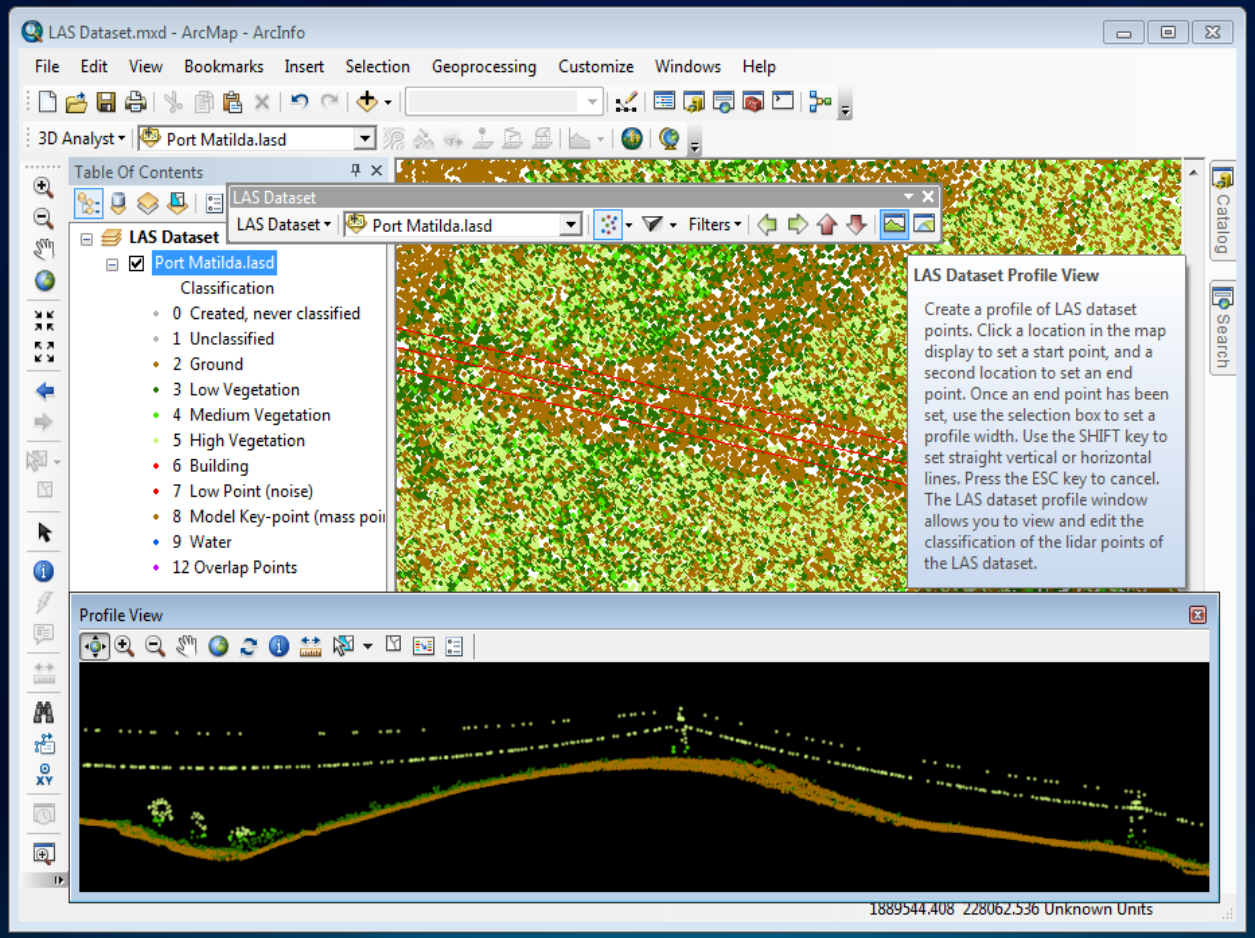


LAS Dataset – Visualize and Analyze

- Quick preview of point data in LAS format
- Display and query both as surface and as points
- Symbolize points by LAS attributes
- Support for breaklines
- Map and scene (2D and 3D)

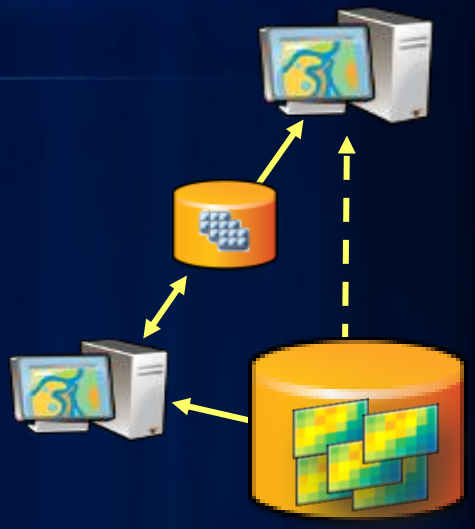
LAS Dataset – Manage

Interactive Editing



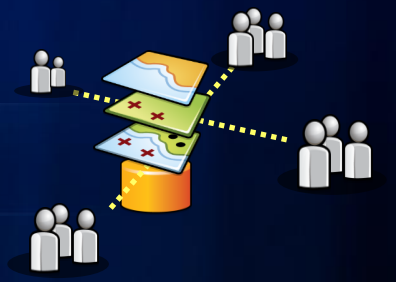
Mosaic Dataset

Optimum Model for Image Data Management

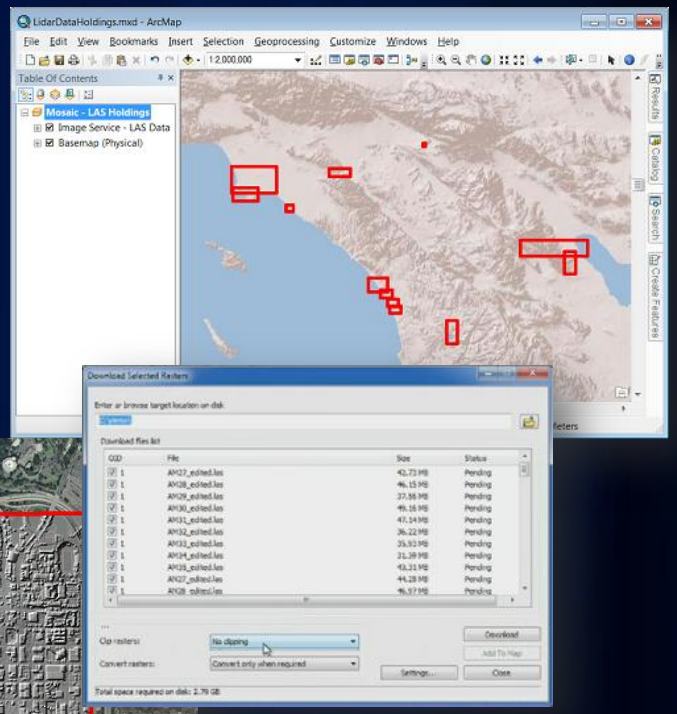


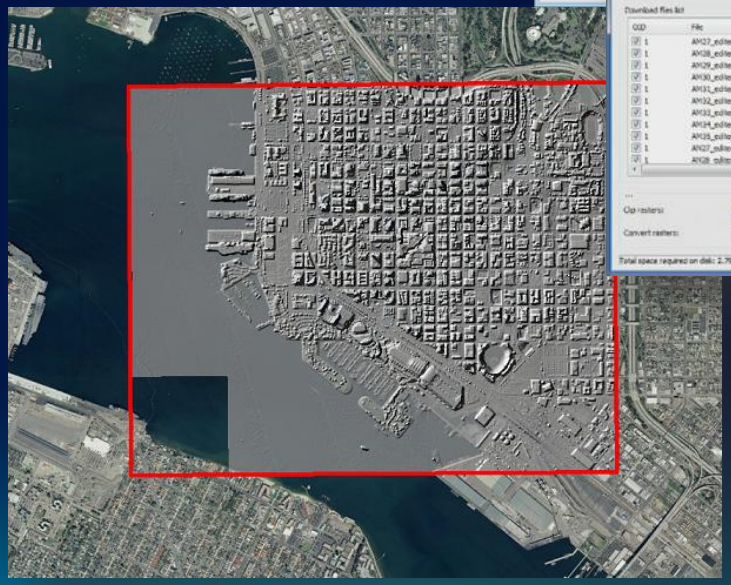
- Manage
  - Multiple projects as single dataset
  - Metadata
- Visualize
  - On the fly representation as surface or point cloud
  - View as 2D or 3D
- Share
  - As a single dataset
  - As an Image Service
  - WMS/WCS

Sharing Lidar Data

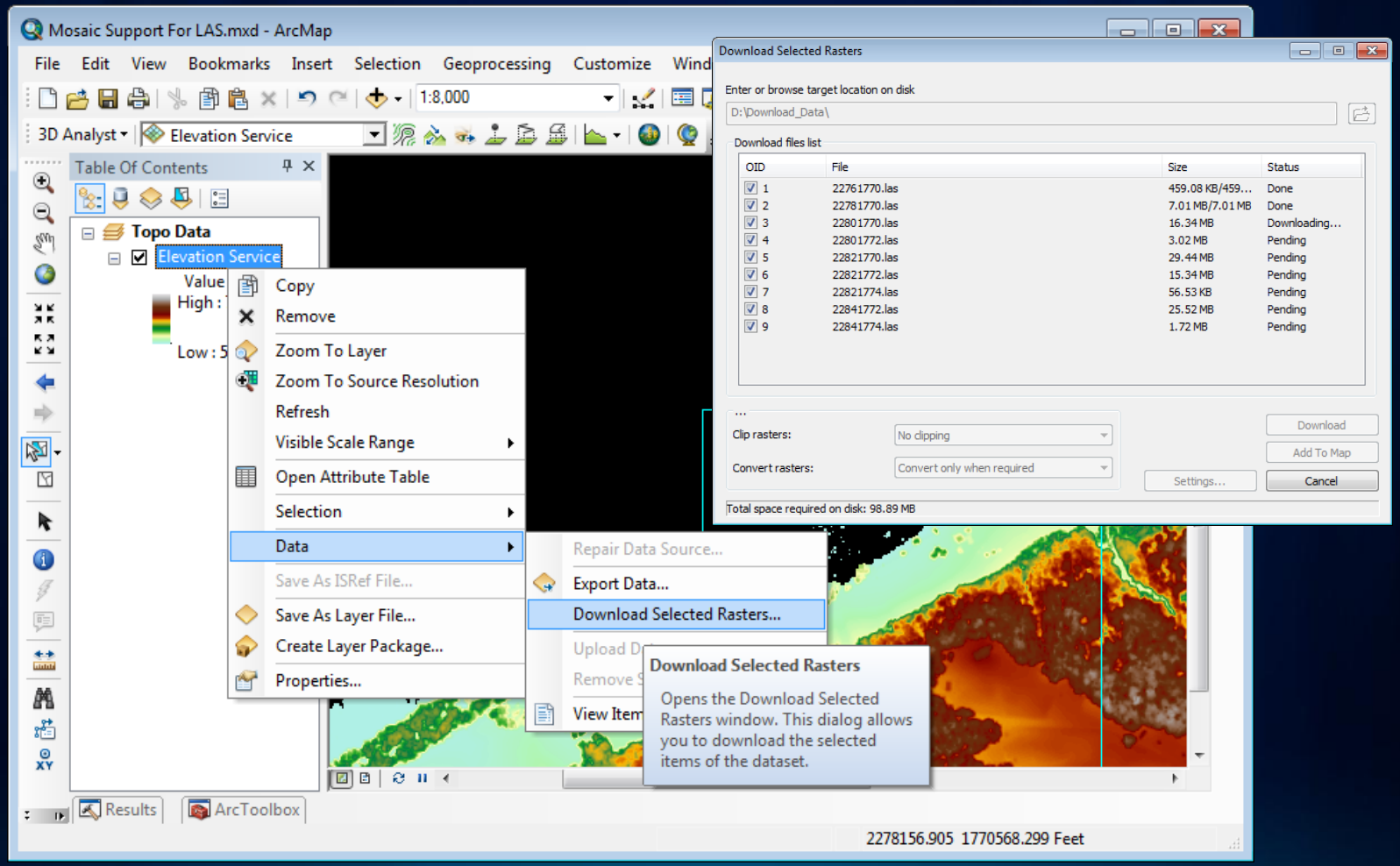


- Share via ArcGIS Server
- An image service
  - Access
  - Discover
  - Download
- A map service





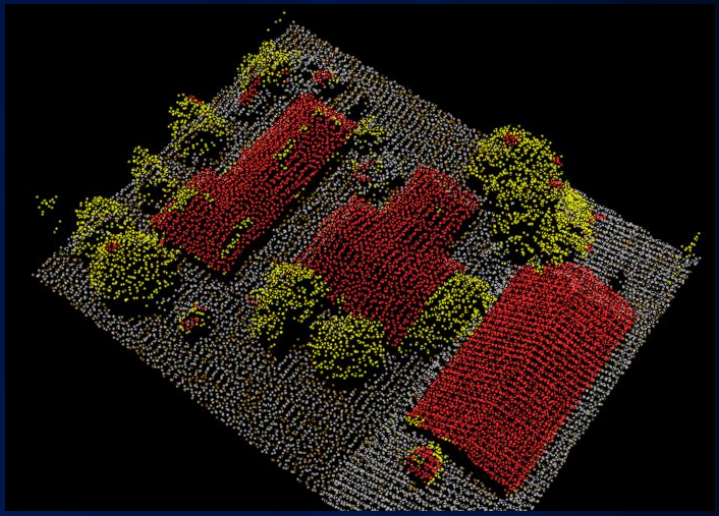
Elevation Service - Download

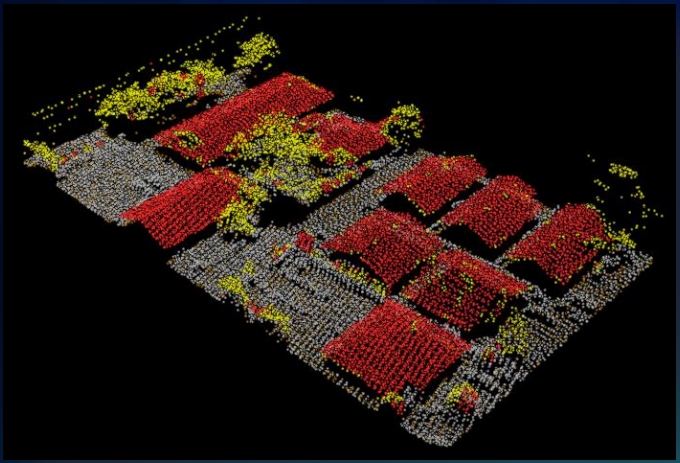


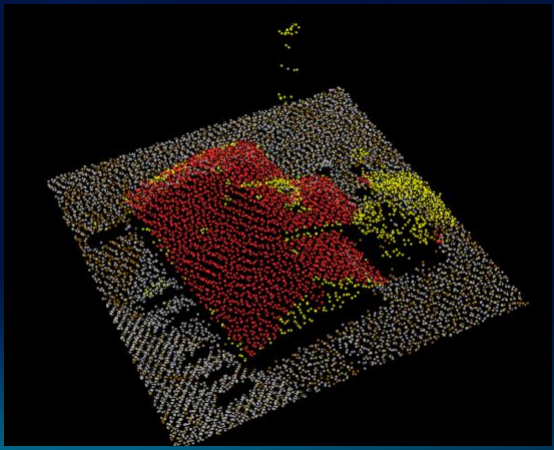
Expanding Analysis Capabilities

- Lidar API
- Raster API

- Detect planar surfaces
- Create 3D polygons





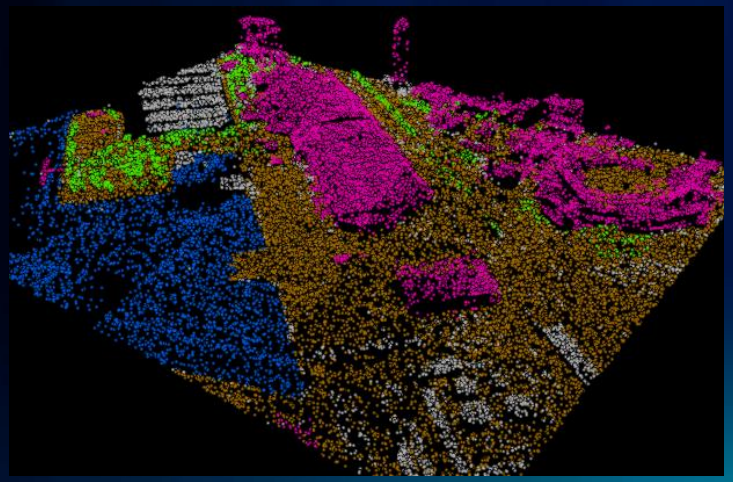


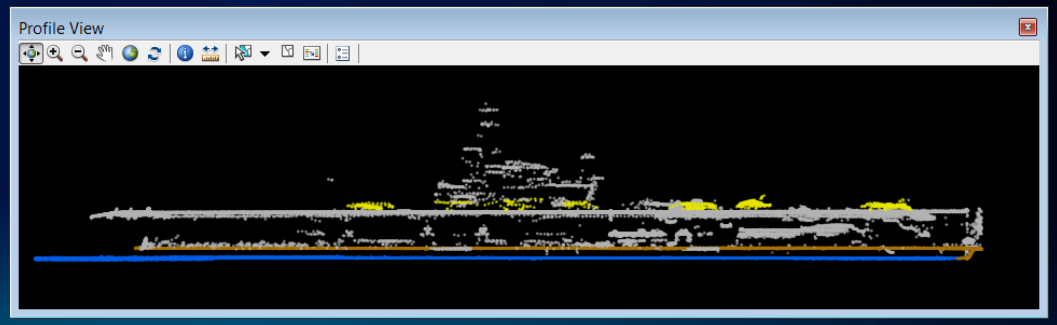
ArcGIS 10.1 Lidar Workshop

LAS Dataset

LAS Dataset

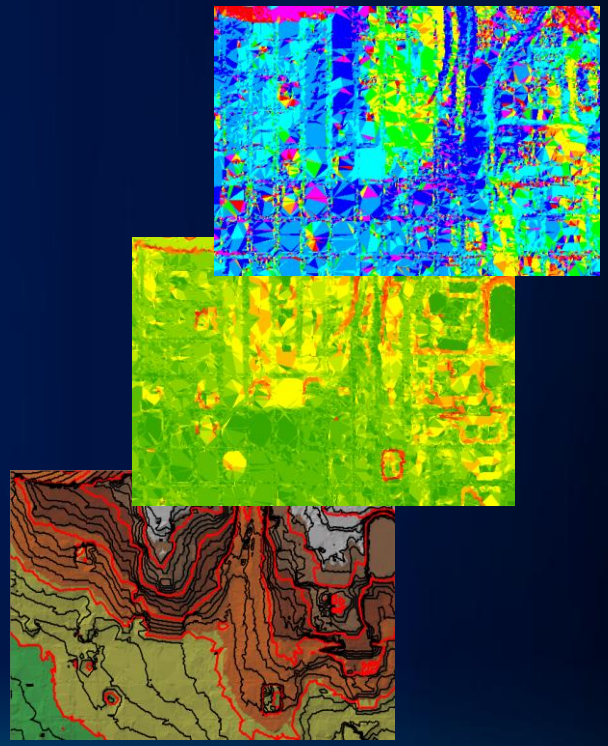
- New data type
- File based
- Stores references to LAS files on disk
- Optionally reference breakline data
- Treats a collection of LAS files as one logical dataset





LAS Dataset Strengths

- Scalability
  - Works directly on LAS files
- Data Integration
  - Point cloud and breakline support
  - Storage efficient
- Data Management
  - I/O efficient
  - Edit LAS classifications

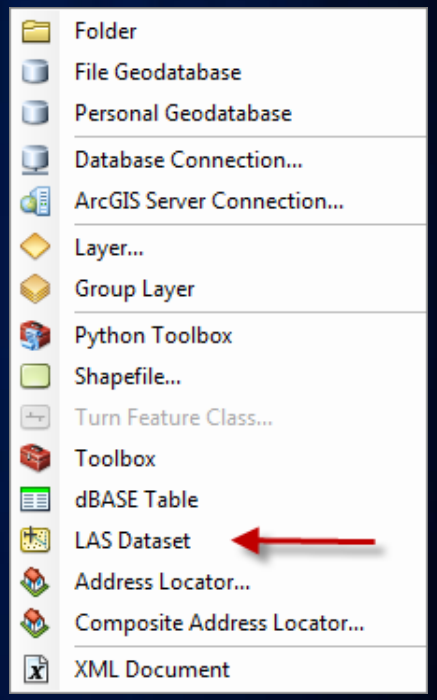


Relative Storage Cost – LAS vs. GDB

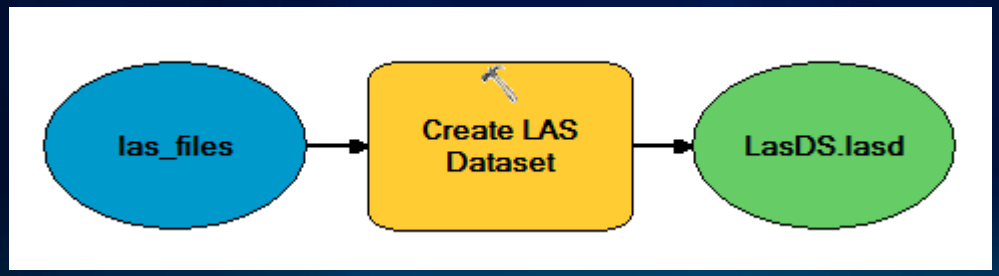
- One LAS file
  - LAS file (with attributes) 44MB
  - Shapefile (geometry only) 52MB
  - PersonalGDB (geometry only) 40MB
  - FileGDB (geometry only) 7MB
- Project of many LAS files
  - 338 LAS files 12.5GB
  - Bare earth terrain dataset with embedded data in FileGDB 1.3GB
  - 1st return terrain 2.2GB

LAS Dataset – Creation

- Interactively via Catalog
  - File folder context menu



- Using scripts and models with geoprocessing tools



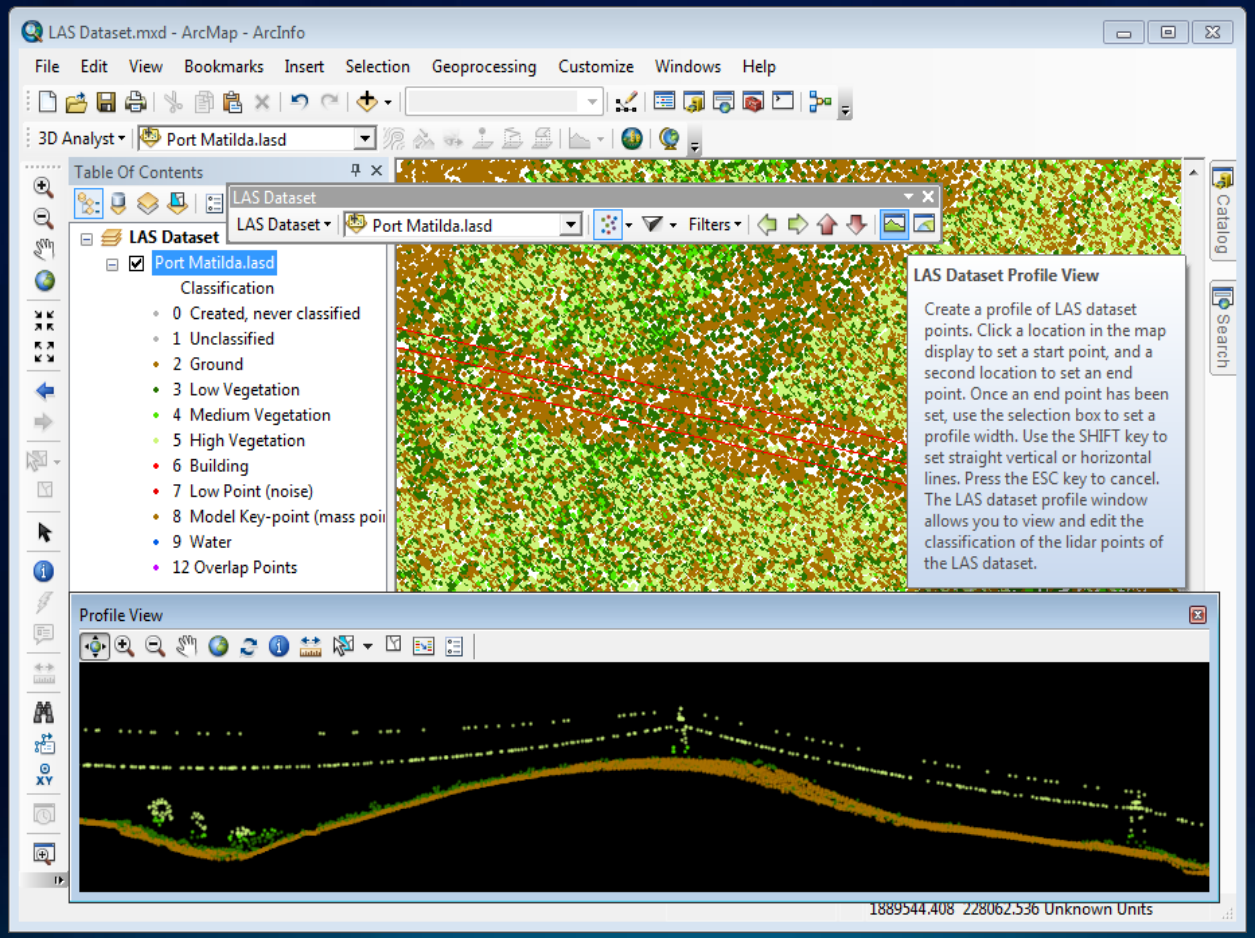
LAS Dataset

Editing Class Codes

- Manual
  - Fixing data anomalies and misclassifications via point profile window
- Automated (GP tools)
  - Classify relative to feature data
  - Reclassify to standard LAS specification

LAS Dataset

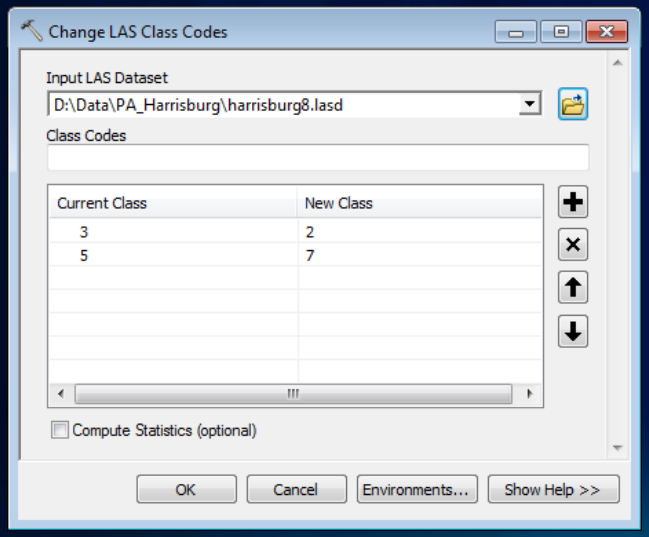
Interactive Editing

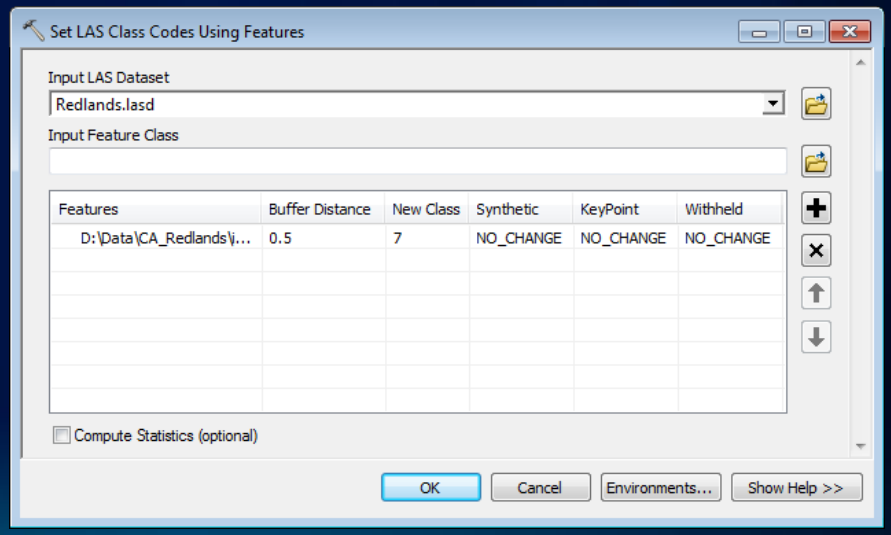


LAS Dataset – Manage

Batch Oriented Editing

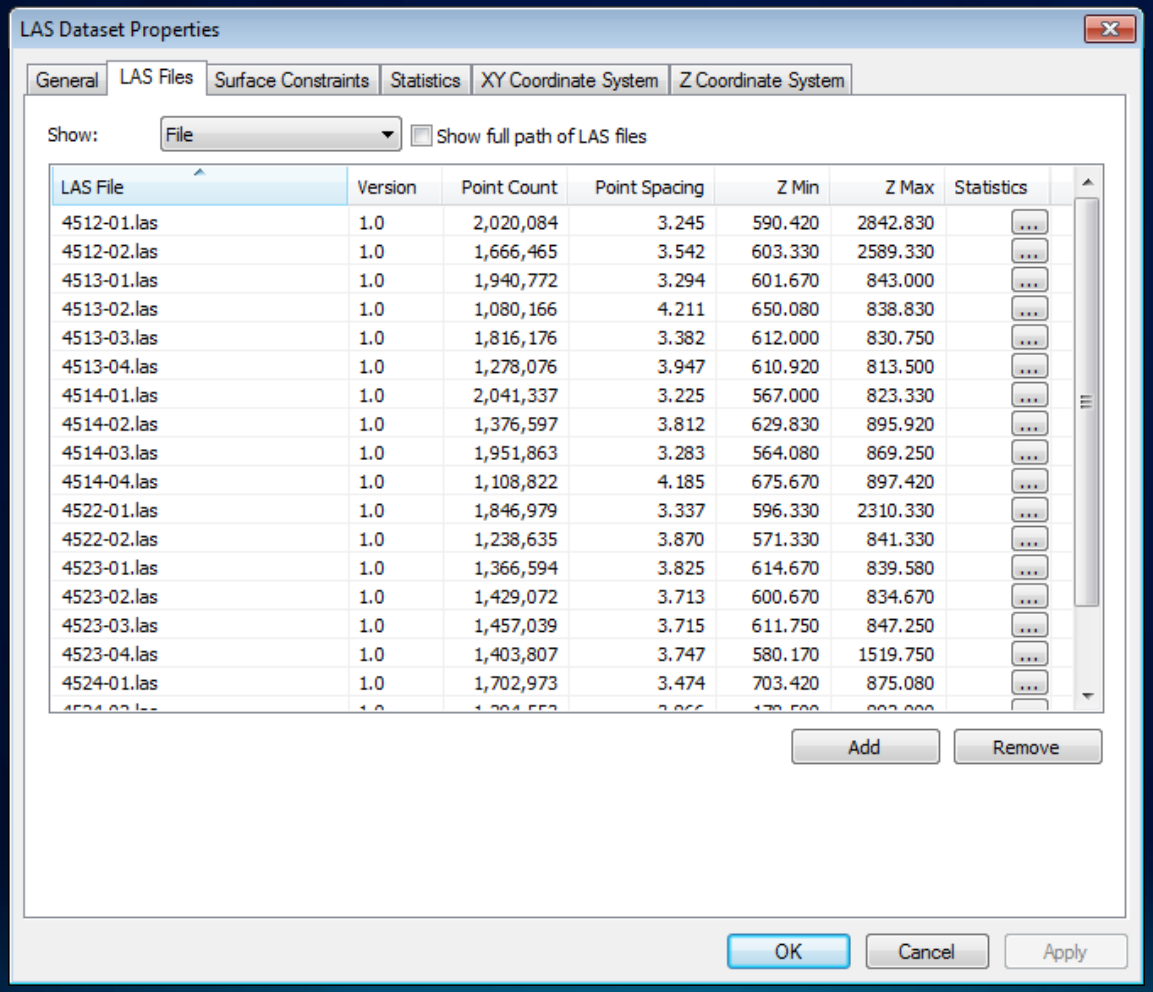
- Change LAS Class Codes tool
  - Set class by proximity to feature data
- Set LAS Class Codes Using Features
  - Reclassify old class to new class





LAS Dataset – Dataset based

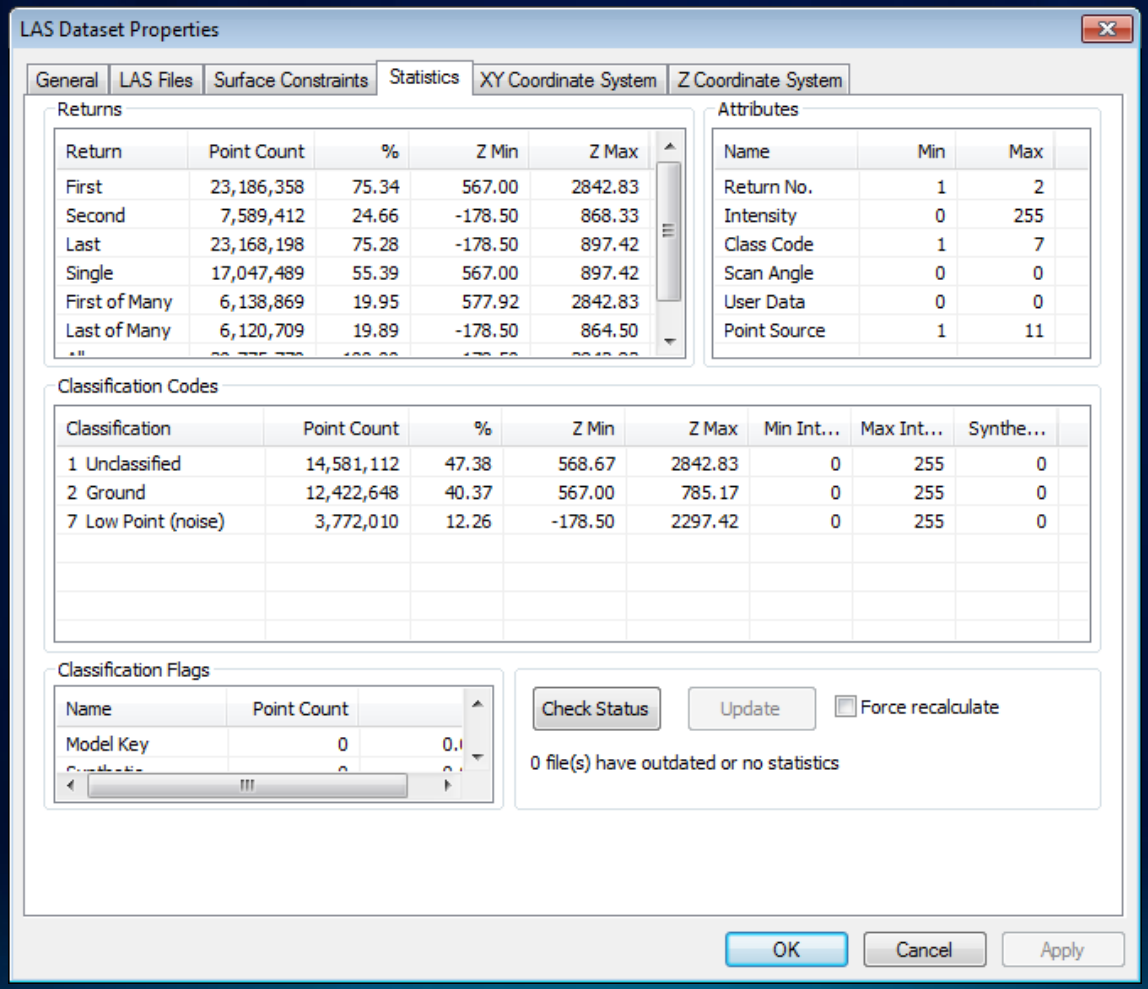
LAS Dataset Properties: LAS Dataset Statistics



LAS File	Version	Point Count	Point Spacing	Z Min	Z Max	Statistics
4512-01.las	1.0	2,020,084	3.245	590.420	2842.830	...
4512-02.las	1.0	1,666,465	3.542	603.330	2589.330	...
4513-01.las	1.0	1,940,772	3.294	601.670	843.000	...
4513-02.las	1.0	1,080,166	4.211	650.080	838.830	...
4513-03.las	1.0	1,816,176	3.382	612.000	830.750	...
4513-04.las	1.0	1,278,076	3.947	610.920	813.500	...
4514-01.las	1.0	2,041,337	3.225	567.000	823.330	...
4514-02.las	1.0	1,376,597	3.812	629.830	895.920	...
4514-03.las	1.0	1,951,863	3.283	564.080	869.250	...
4514-04.las	1.0	1,108,822	4.185	675.670	897.420	...
4522-01.las	1.0	1,846,979	3.337	596.330	2310.330	...
4522-02.las	1.0	1,238,635	3.870	571.330	841.330	...
4523-01.las	1.0	1,366,594	3.825	614.670	839.580	...
4523-02.las	1.0	1,429,072	3.713	600.670	834.670	...
4523-03.las	1.0	1,457,039	3.715	611.750	847.250	...
4523-04.las	1.0	1,403,807	3.747	580.170	1519.750	...
4524-01.las	1.0	1,702,973	3.474	703.420	875.080	...

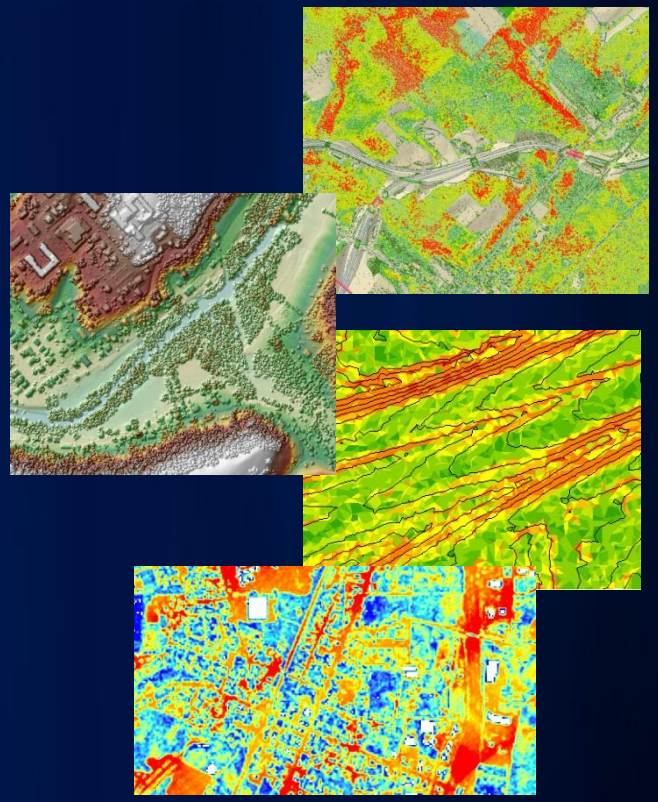
LAS Dataset – File based

LAS Dataset Properties: LAS File Statistics

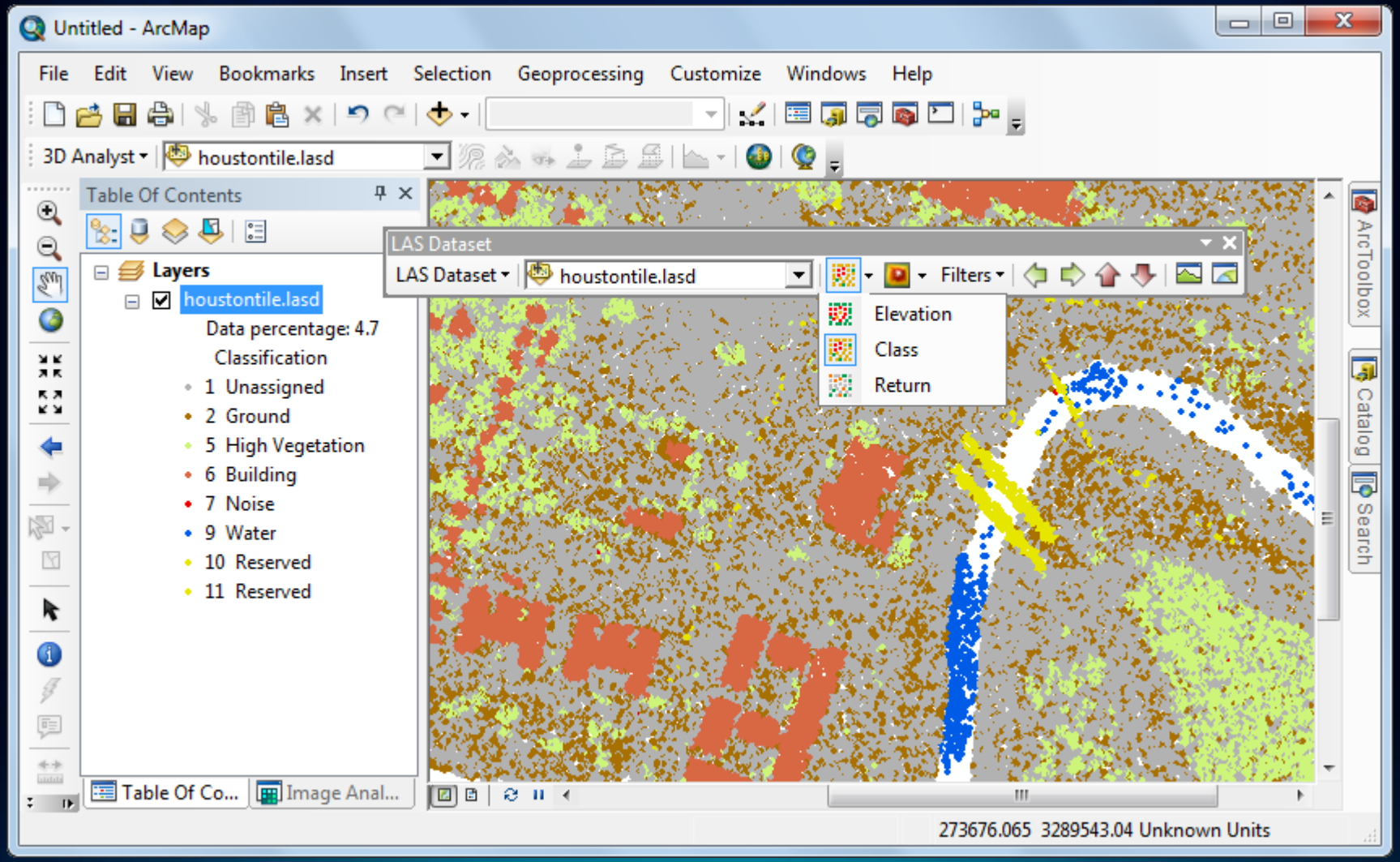


LAS Dataset – Analysis

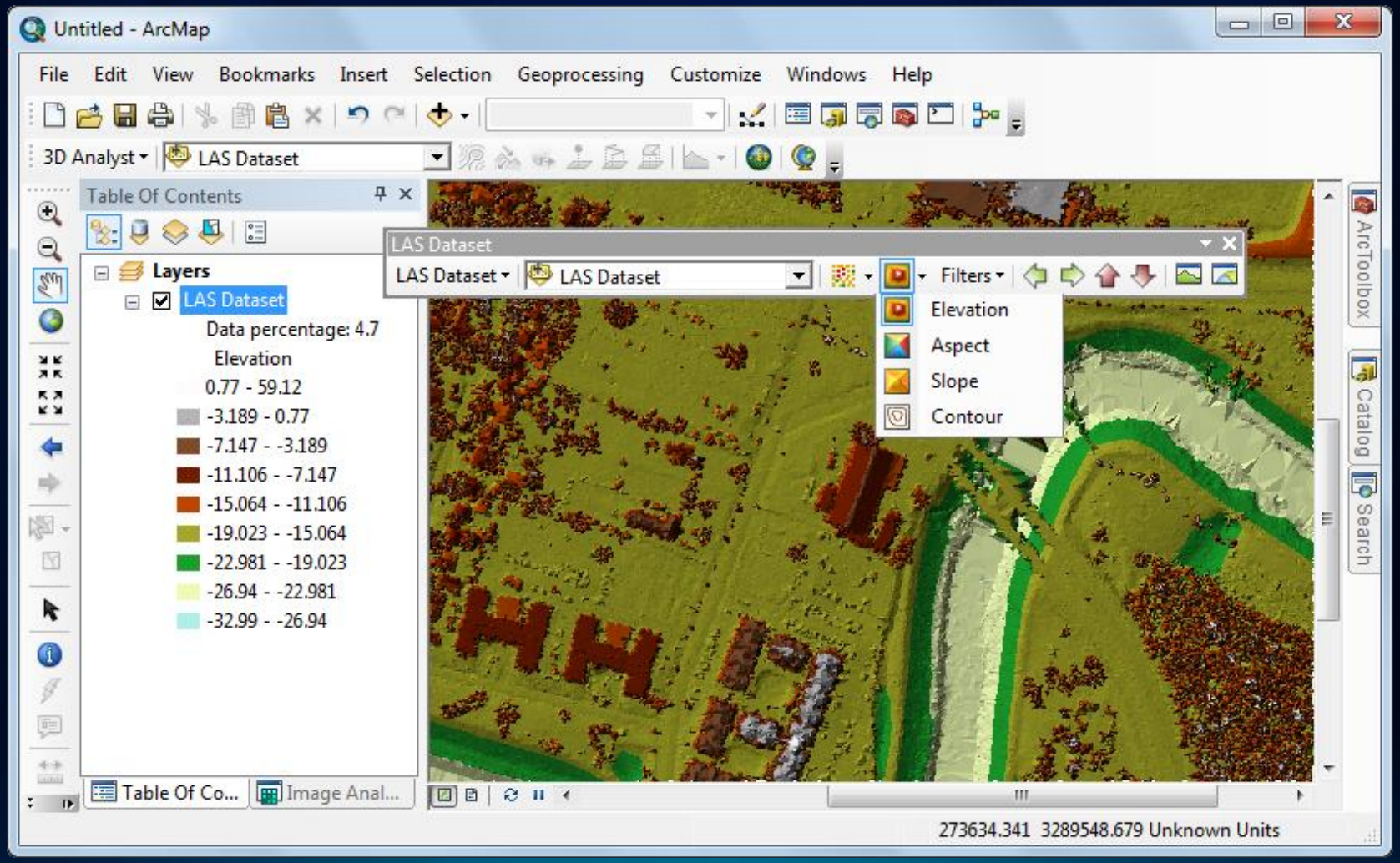
- Derive surfaces
  - As raster
  - As TIN
- Direct surface analysis
  - Interpolate shape
  - Add surface information
  - Line of sight
  - Skyline
  - Locate outliers
- Rasterize on point metrics
  - LAS point statistics as a surface



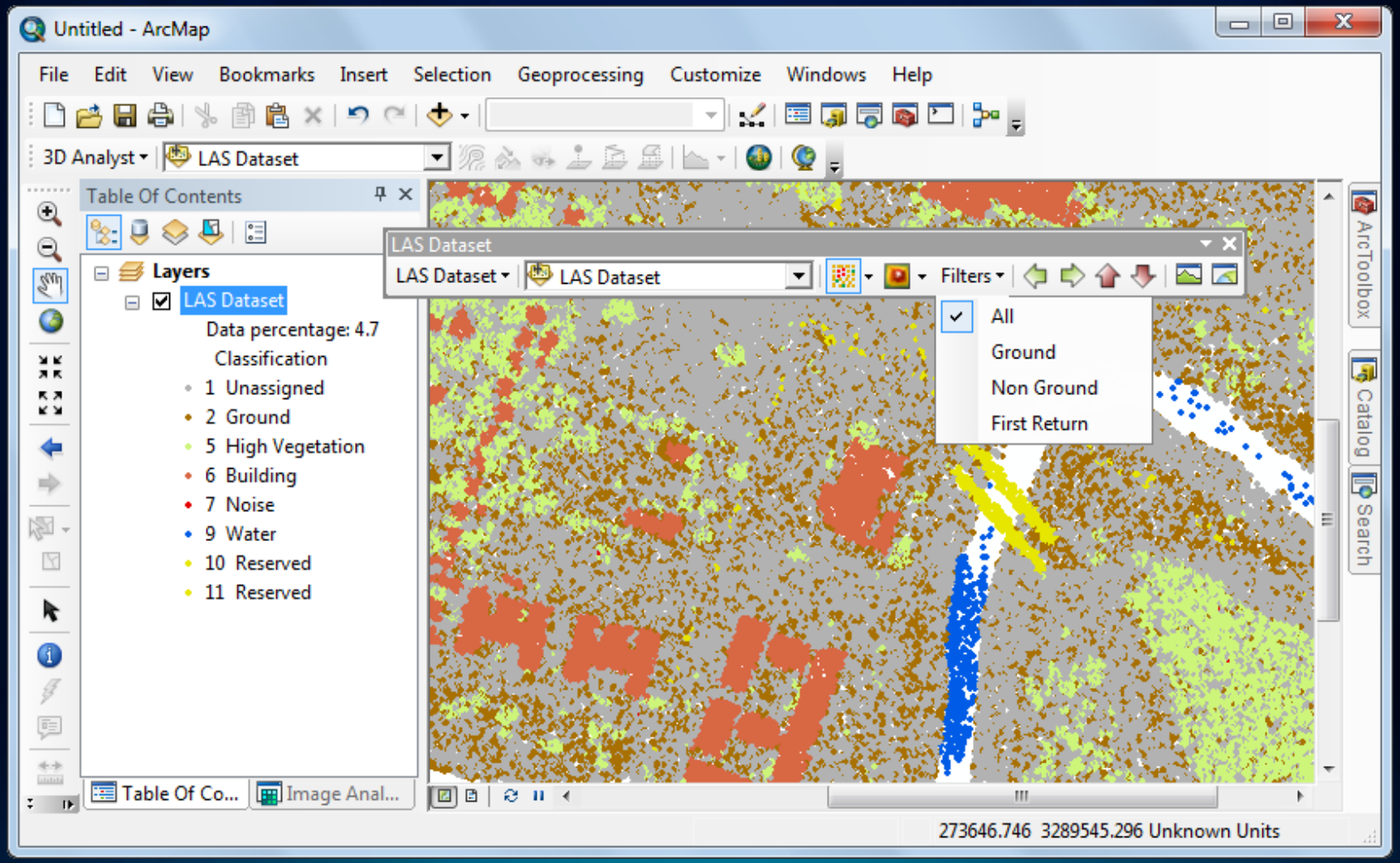
LAS Dataset – Point display



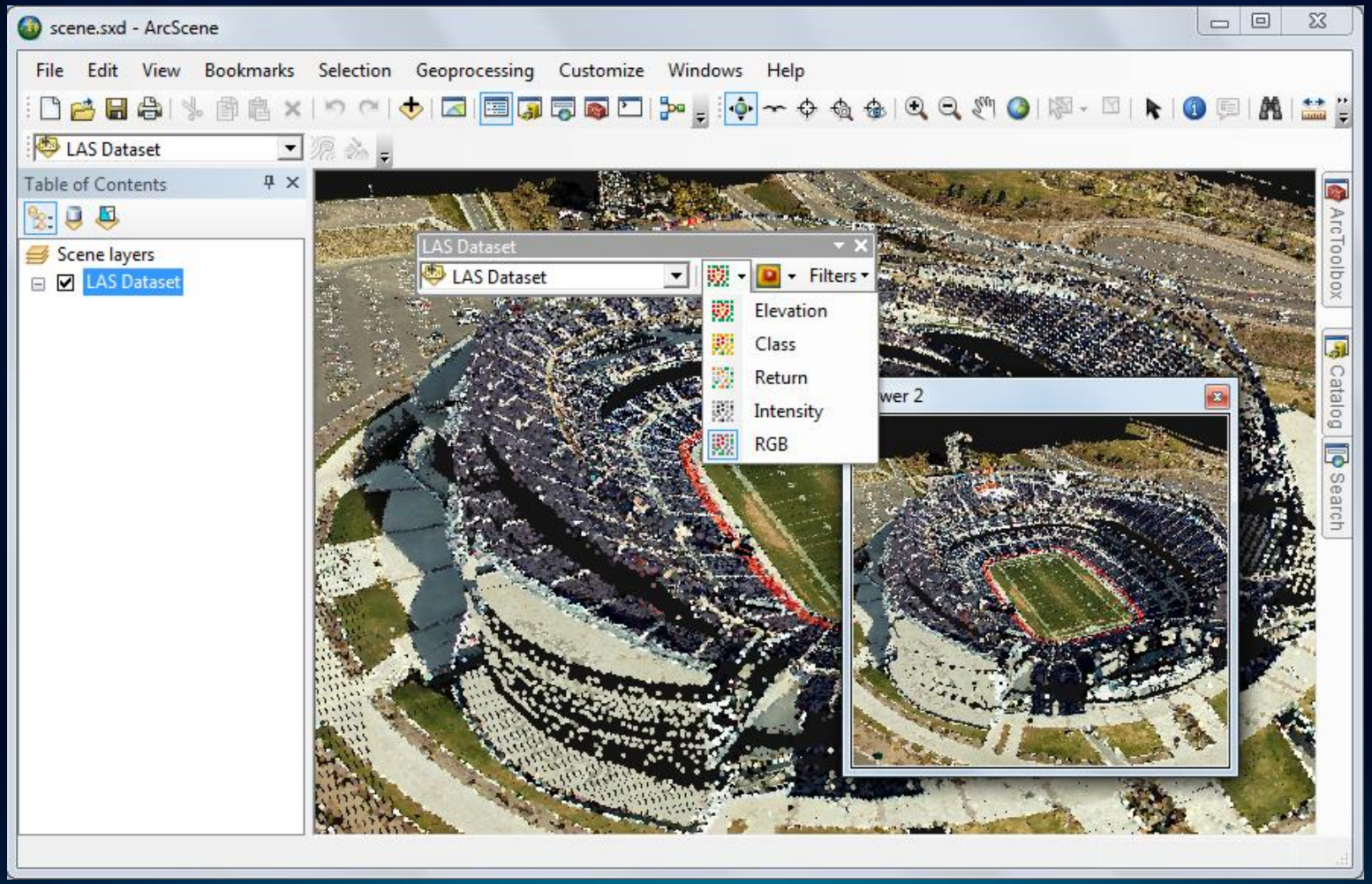
LAS Dataset – Surface Display



LAS Dataset – Point Filters

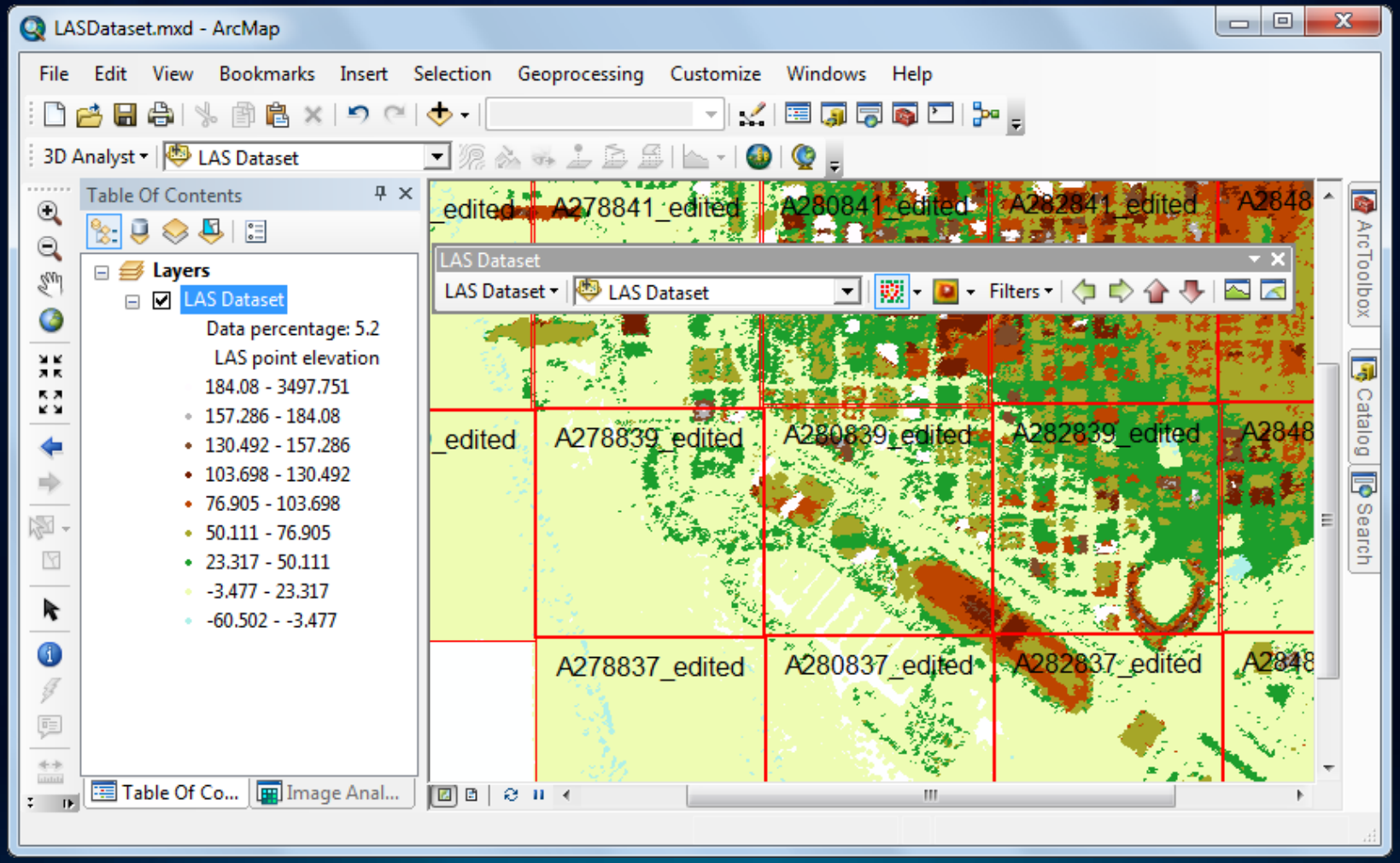


LAS Dataset – 3D Display in ArcScene



Data courtesy Merrick & Co.

LAS Dataset – LAS File Extents



Best Practices

- Tiled LAS, v1.1 or higher
- 1-2 million points per file
- Projected
- Keep file I/O local, avoid network
- Airborne
  - Classified (bare earth, non-ground)
  - Breaklines for hydro enforcement
  - Study area boundary included as constraint
- Terrestrial
  - RGB, intensity, or classified

Licensing

- Standard, 3D, or Spatial Analyst Extension
  - Create LAS dataset
  - Modify LAS dataset schema
  - Include in Mosaic dataset
    - Publishing requires Image extension for Server
  - View in 2D
  - Rasterize
- 3D Analyst Extension
  - Edit class codes
  - View in 3D
  - TIN based surface analysis

Exercise 1

In this exercise, you will:

- Create a LAS dataset
- Explore the properties of the LAS dataset
- Reclassify lidar points
- View the LAS dataset in 3D

ArcGIS 10.1 Lidar Workshop

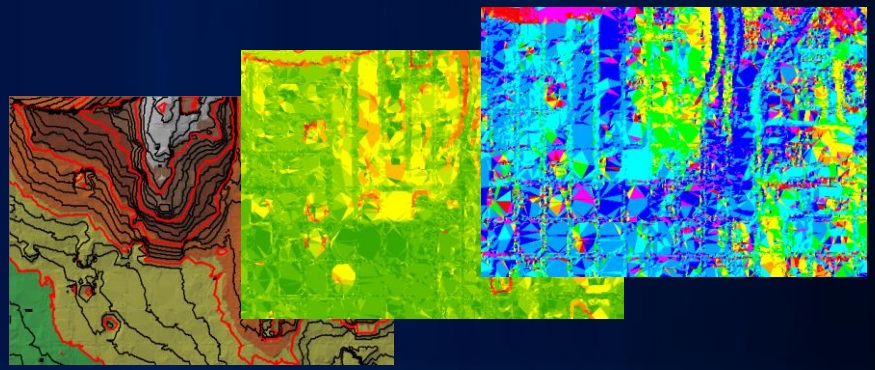
Terrain Dataset

Terrain Dataset

- A Terrain is a multi-resolution surface created from measurements stored in feature classes
- Typical applications:
  - Topographic mapping
  - Bathymetric mapping
- Typical data sources:
  - Photogrammetric data
  - Lidar
  - Sonar

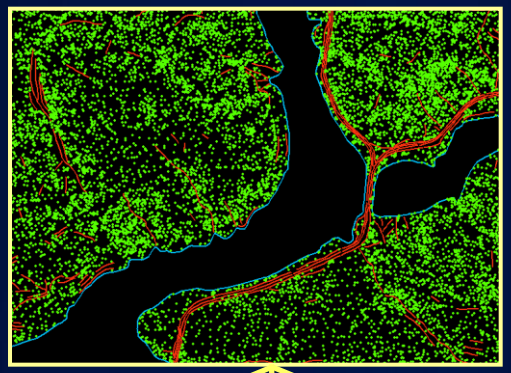
Terrain Dataset Strengths

- Scalability
  - Large data volumes
  - Spatially indexed
  - Pyramided
  - Z-tolerance and window size based thinning
- Data Integration
  - High quality surface
  - Storage efficient
- Data Management
  - I/O efficient
  - Geodatabase

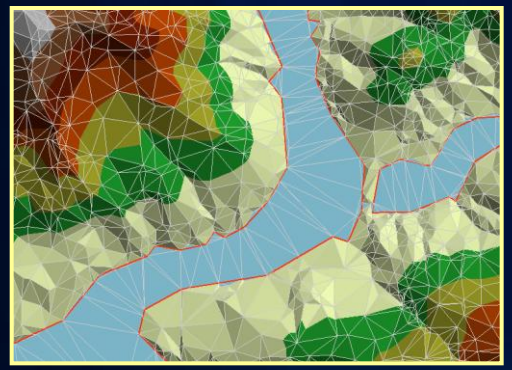


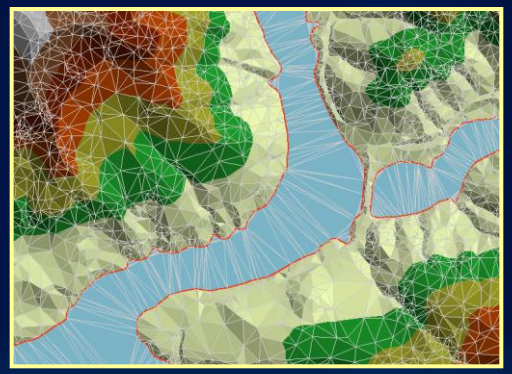
Multi-Resolution Surface Model

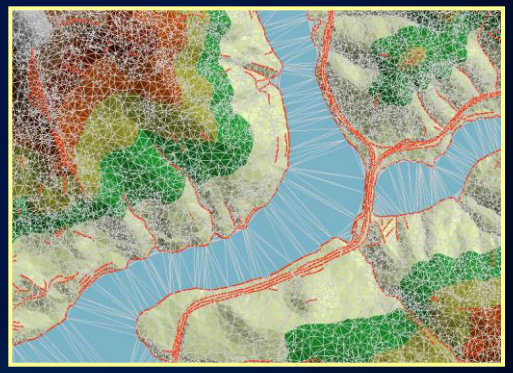
Points and Breaklines



Terrain Pyramids







Thinned Point Set

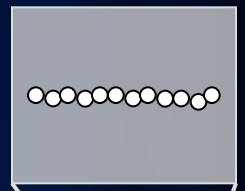
Full Resolution

Multi-resolution terrain dataset (TIN structure)

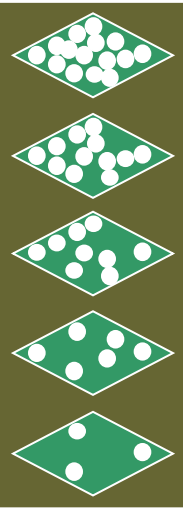
Vector Based Pyramids

- Comprised of source measurements
- Point thinning
  - Heavy thinning for coarse levels
  - Lighter thinning for more detailed levels
  - No thinning at full resolution
- User defined scale threshold associated with each level
- For analysis as well as display
- Two pyramiding techniques
  - Z Tolerance
  - Window Size

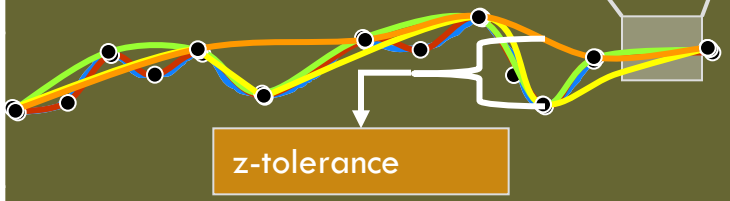
Z Tolerance Pyramid



Points



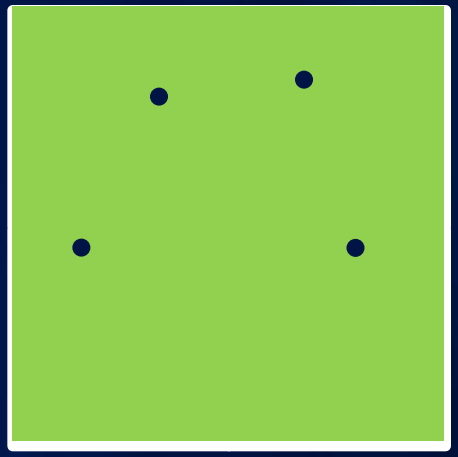
Levels of Detail	Z-Tolerance	Scale
0	0	1:1
1	1	2500
2	5	10,000
3	10	50,000
4	20	100,000



The distance between the lower resolution surfaces and the full resolution surface will not exceed a given Z-tolerance.

Window Size Pyramid

Level	Window Size	Scale
0	0	1:1
1	2	2500
2	4	5,000
3	8	10,000

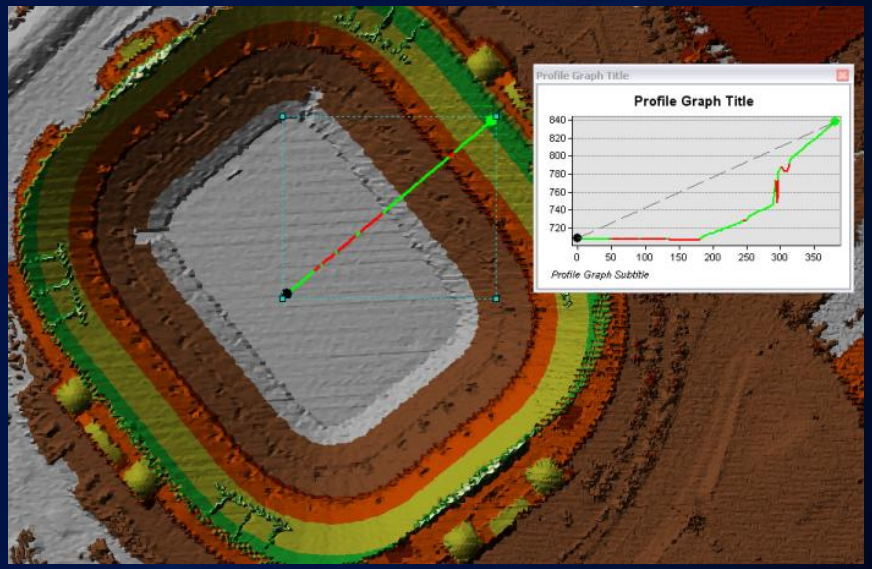


Editing

- Updates accomplished through edits to source measurements
- Coarse grained area operators to append, remove, replace mass points
- Standard/custom edit tools (e.g. ArcEditor) used to modify polylines, polygons, spot heights
- Terrain rebuild based on dirty-areas
- Support for versioning in enterprise geodatabases

Analysis Capabilities for Terrain Datasets

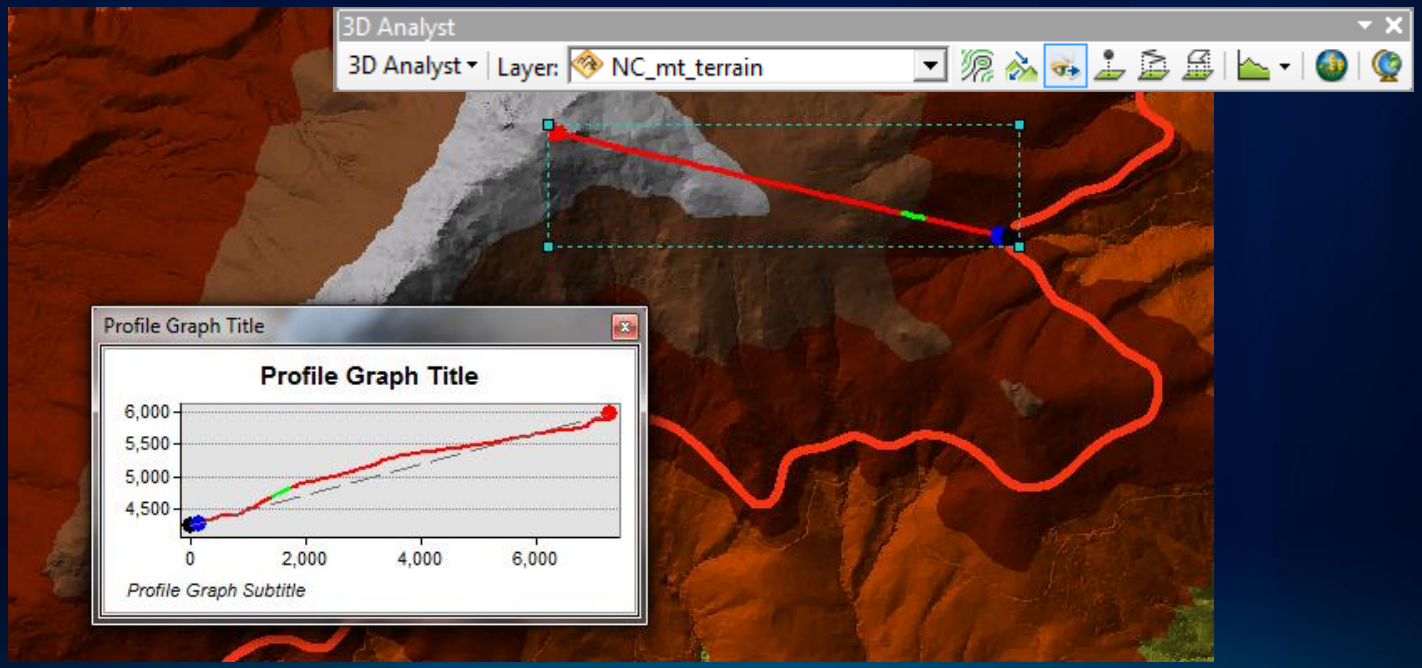
- QA / QC lidar data
- DEM / DSM creation
- Slope
- Aspect
- Contours
- Surface differencing
- Intensity image generation
- Estimating forest canopy
- Data area delineation
- Thinning / reducing noise
- Spot interpolation
- Profiling



Interactive Surface Analysis

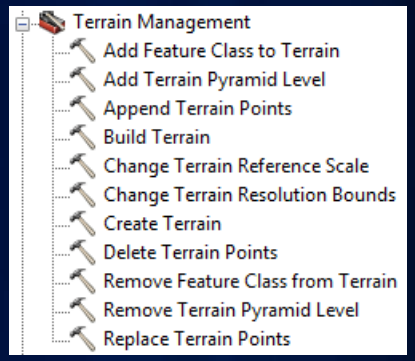
- Interactive surface tools

3D Analyst toolbar in ArcMap

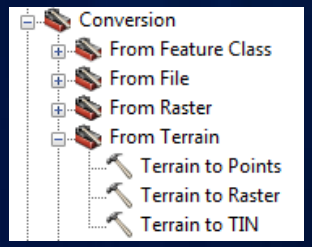


Geoprocessing Analysis with Terrain Datasets

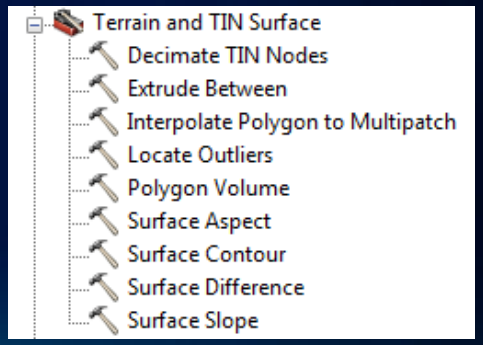
- Terrain Management toolset
  - Creation
  - Modification



- Data Conversion toolset
  - Data loading
  - Surface conversions

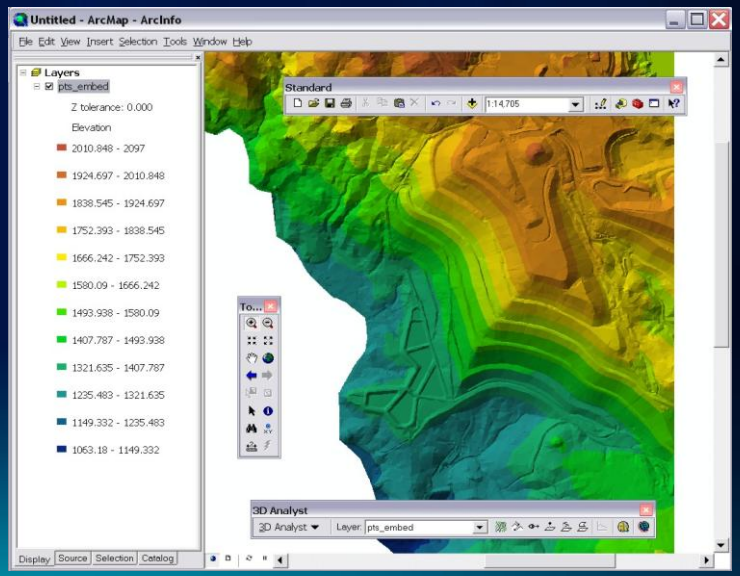


- Terrain and TIN Surface toolset
  - Analysis conducted directly on terrains



Mapping and Visualization

- Symbology same as TIN in ArcMap
- Resolution changes depending on zoom level in ArcMap
- Terrain datasets can be displayed as either elevation or draped layers in ArcGlobe
- Terrain datasets are not directly supported in ArcScene



Best Practices

- LAS over ASCII
- Use file or enterprise geodatabases
  - (personal has a 2GB Limit)
- Consider file or enterprise geodatabase for large datasets (> 1-2 billion points)
- Terrain dataset must be stored in a feature dataset
- Use projected coordinates
- Use consistent units (x, y, and z) and contiguous datasets
- Breakline enforcement
- Use ArcGIS for lidar derived rasters

Exercise 2

In this exercise, you will:

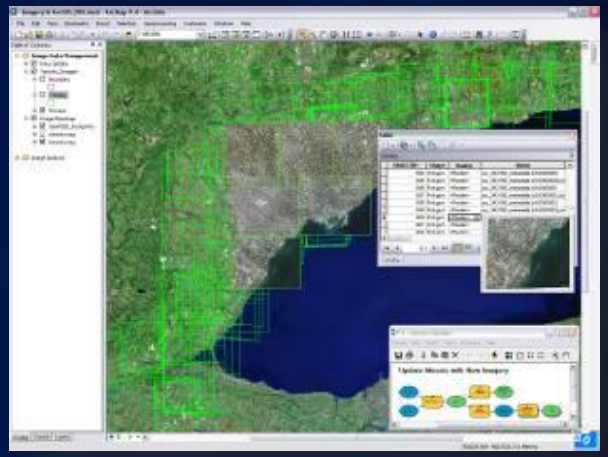
- Create a geodatabase and feature dataset
- Import ground lidar points into a multipoint feature class
- Build a terrain dataset using the ground-based multipoints
- Examine the terrain dataset
- Conduct interactive surface analysis
- Create an intensity image from first return points

ArcGIS 10.1 Lidar Workshop

Mosaic Dataset

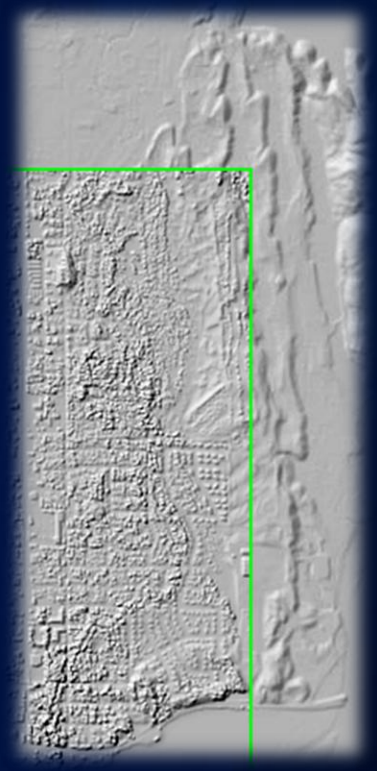
What is the Mosaic Dataset?

- A geodatabase data model used to catalog, process, visualize and share your collections of imagery and lidar data
- Support for NEW at 10.1
  - LAS files
  - LAS datasets
  - Terrain datasets
- Indirect data management
- Unlimited size*
- Provides dynamic rasterization, mosaicking, and on-the-fly processing



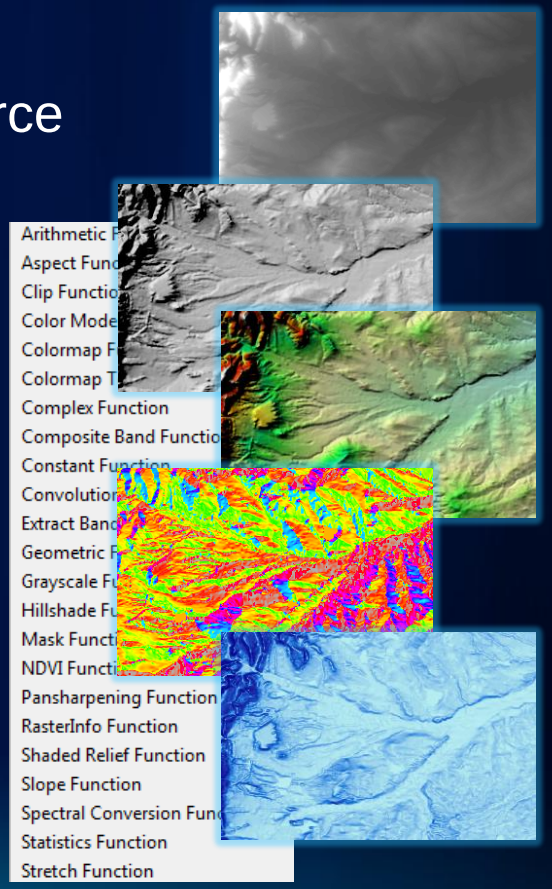
Dynamic Mosaicking and Rasterization

- Display multi-resolution data together
- Mosaicking rules
  - Control the order of display
    - By attribute
    - Closest to center
  - Ensure best data is always displayed
  - Can be controlled by user
- Queries
  - Refine selection of data



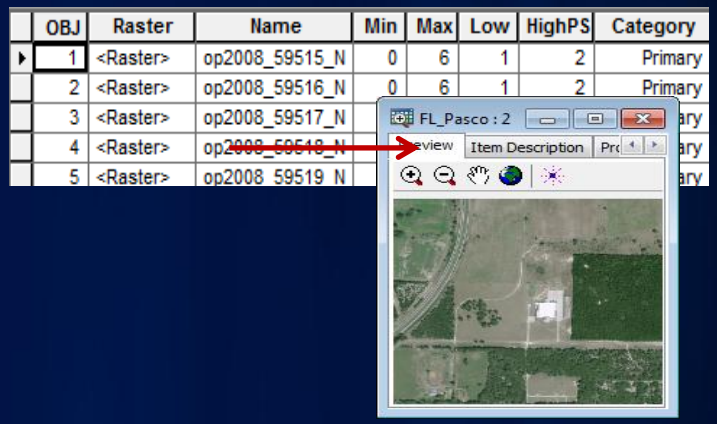
On-The-Fly Processing

- Data is processed as it is accessed
- Create multiple products from one source
- Processing for elevation
  - Hillshade
  - Shaded Relief
  - Aspect
  - Slope
  - Convolution Filters
- Define processing functions
  - On each item
  - On entire collection

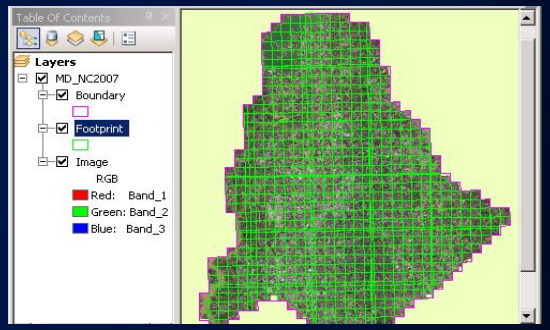


Using a Mosaic Dataset

- As a catalog
  - Selection/query
  - Add selected images to map
  - View data and metadata
  - Time aware



- As an image
  - Seamless display
  - Export a raster dataset
  - Perform pixel-based analysis
  - Use as an input to geoprocessing tool

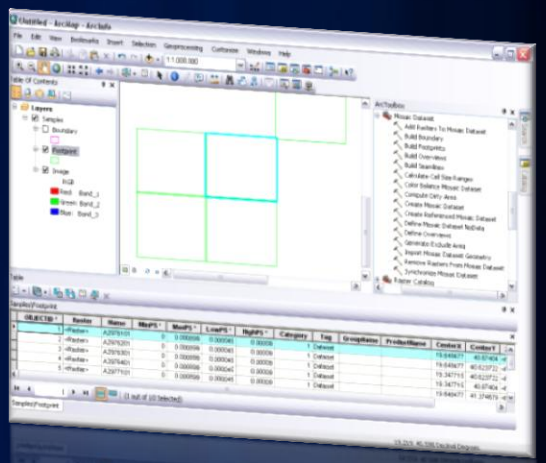


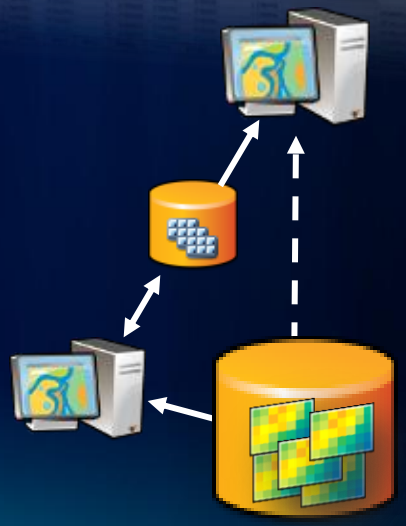
Benefits of Managing with the Mosaic Dataset

- Store multiple collections and projects
- Store variety of elevation data
  - Topographic or bathymetric
  - Point or raster
- Unlimited size
- Provide access to all data
  - As raster
  - As source data
  - Share internally and online

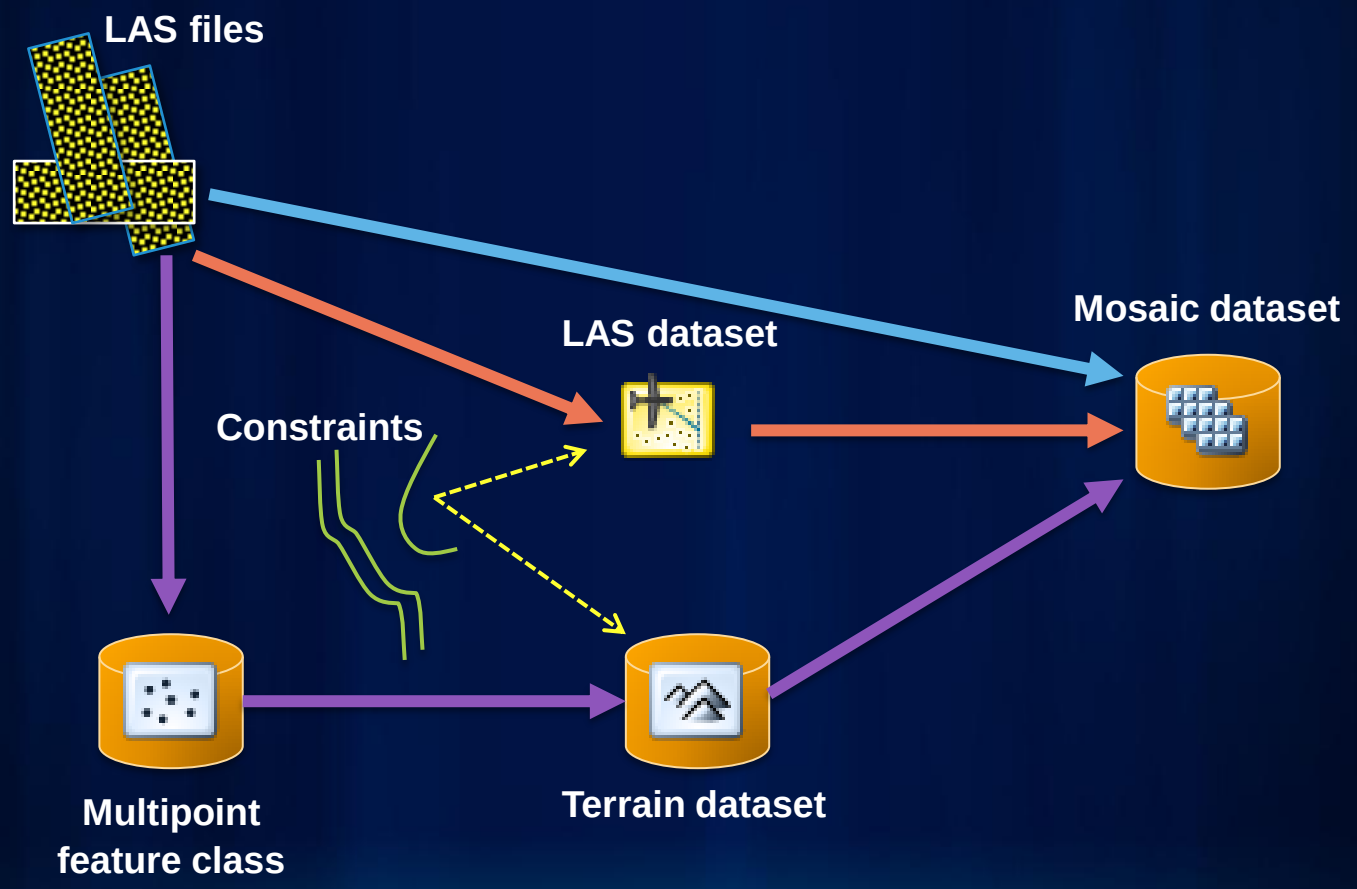
Building a Mosaic Dataset

- Store in a geodatabase
  - Build with geoprocessing tools
  - Automation with models or Python
- Simple workflow
  1. Create mosaic dataset
  2. Add imagery
  3. Optionally, edit properties and functions
- Can interactively edit and view in ArcMap
  - All layers are displayed
  - Edit and add fields in table window



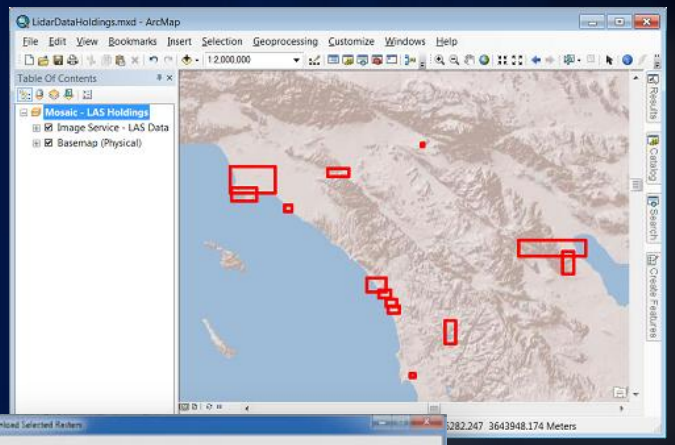


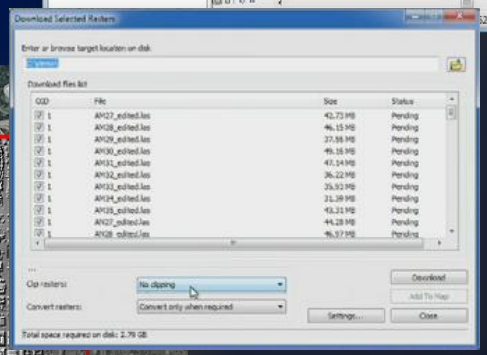
Adding Lidar to a Mosaic Dataset

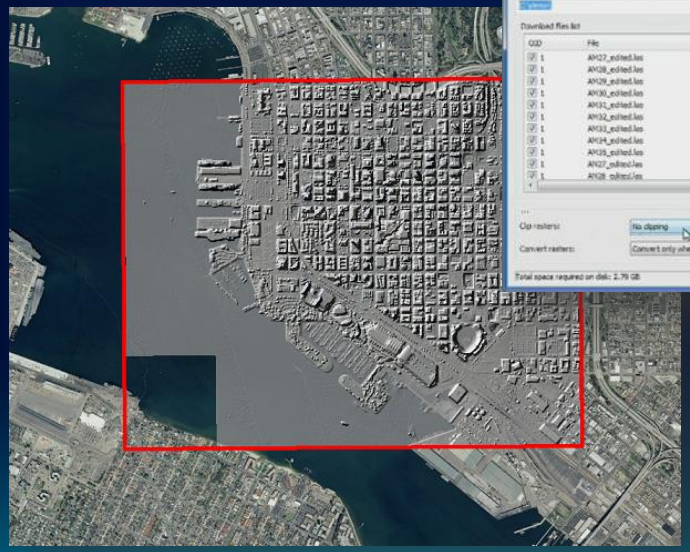


Sharing Lidar Data

- Share as image services
- Easy to
  - Access
  - Discover
  - Download



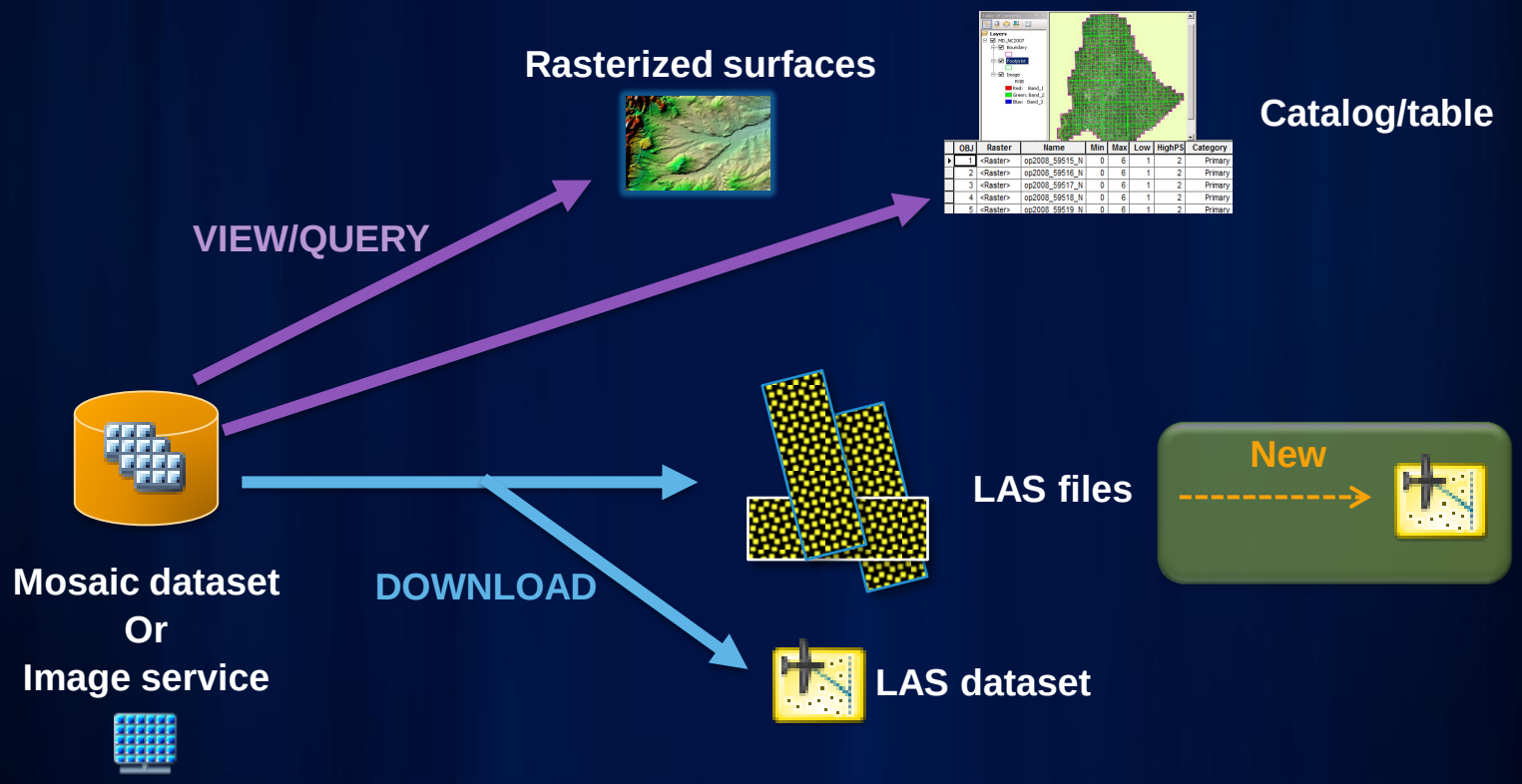




Sharing as an Image Service

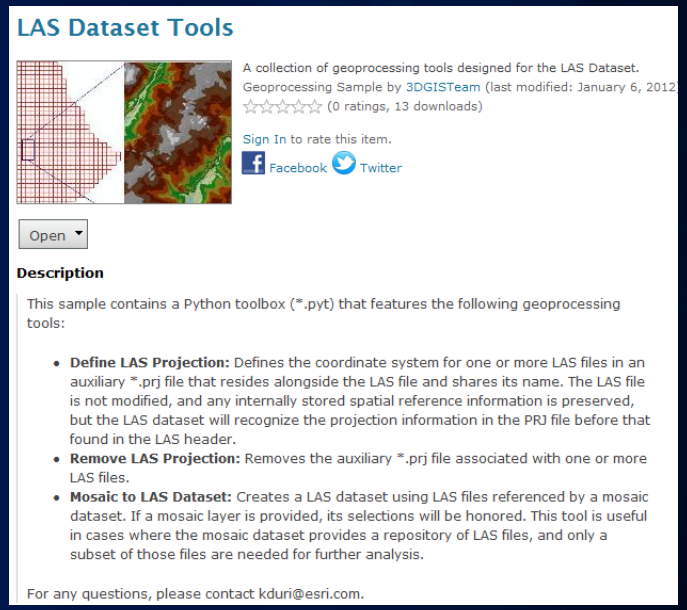
- Similar functionality as local mosaic dataset
- Access as a catalog
  - Select/download selected images
  - Time aware
- Access seamless mosaic
- REST
- WCS/WMS

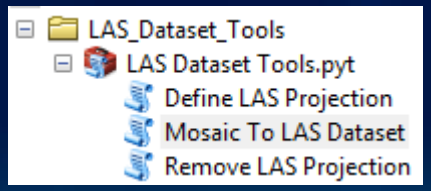
Getting Lidar From a Mosaic Dataset



Create LAS Dataset from Mosaic Dataset

- Download the toolset from ArcGIS Online
- Input: Mosaic dataset layer
- Output: LAS dataset
- Uses all or a selection
- Can link to source LAS files or create a local copy





Exercise 3

In this exercise, you will:

- Create a mosaic dataset and add lidar data
- View as:
  - Bare earth
  - With surface features
  - As a color shaded relief
- Interact with analysis tool and create surface difference

Demonstration

Sharing Lidar Data via the Web

- ArcGIS for Server
- Web Application – DOGAMI site
- Interactive selection
- Query and download

ArcGIS 10.1 Lidar Workshop

Questions?

Thank you!