



Esri International Developer Summit  
Palm Springs, CA

# Custom Lidar Solutions

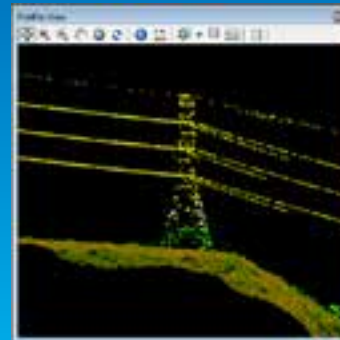
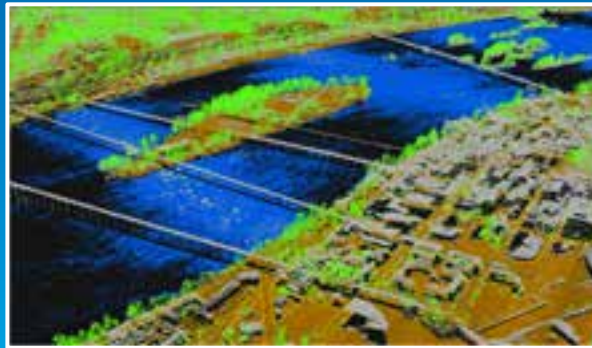
Clayton Crawford

# Outline

- **Introduction – LAS dataset**
- **ArcObjects API**
  - **Functional overview**
  - **Primary objects and interfaces**
- **Demos**
  - **Sample code walkthrough**
  - **Custom tools in action**
- **Resources**

# LAS Dataset

- Introduced with ArcGIS 10.1
- Reads lidar directly from LAS files
- Point and surface based representations
- Class/interface definitions inside GeoDatabaseExtensions
- Use of API requires 3D Analyst extension



# Types of Things Supported by API

- **File based**
  - Managing, cataloging, statistics and indexing
  - Filter, clip, assign projection, project
- **Point based**
  - Read points and their LAS attributes
  - Edit class codes
- **Surface based**
  - Derive TINs and rasters
  - Feature interpolation (spot height, profile)
  - Line-of-sight

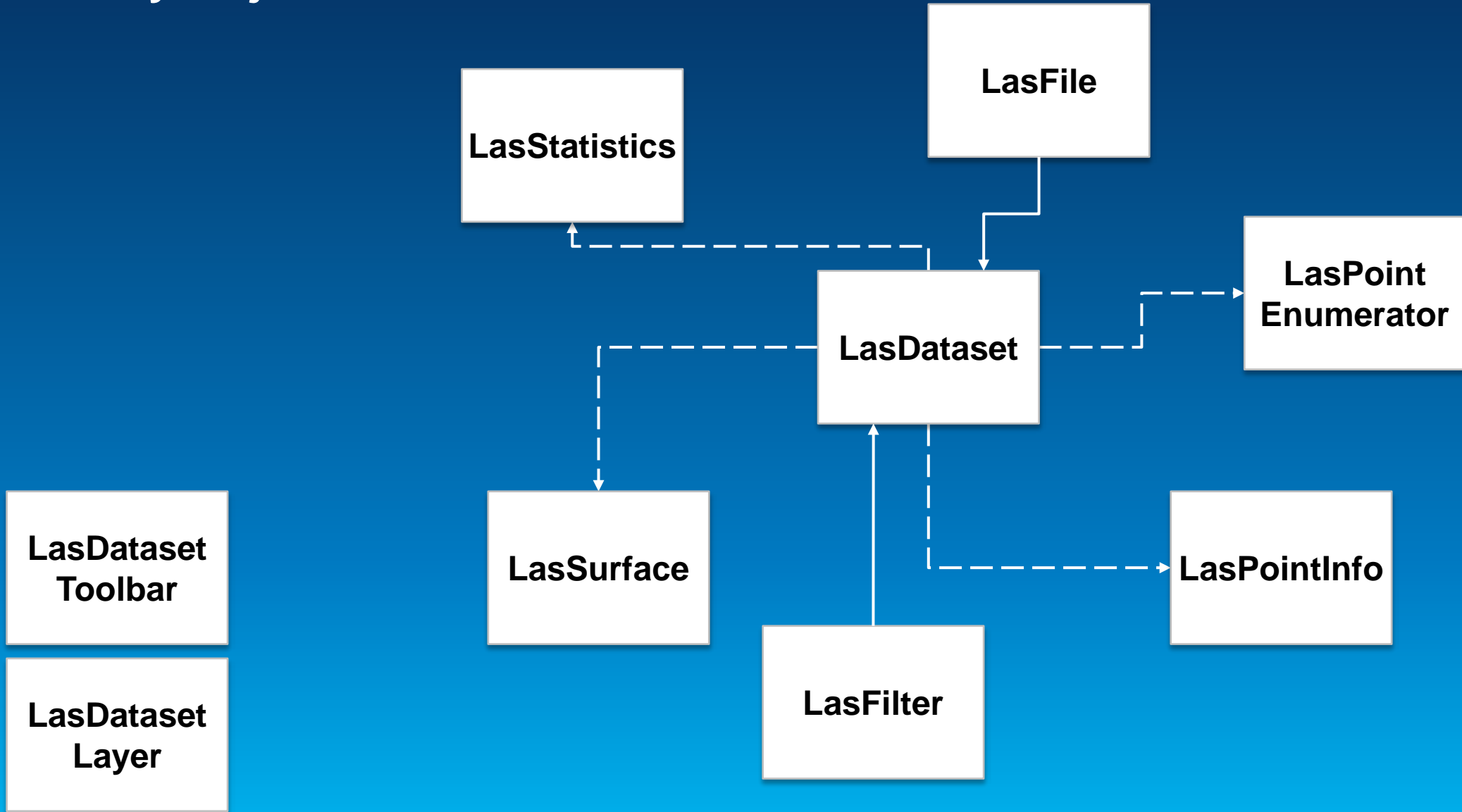
**GeodatabaseExtensions Object Model**

**LASDataset**

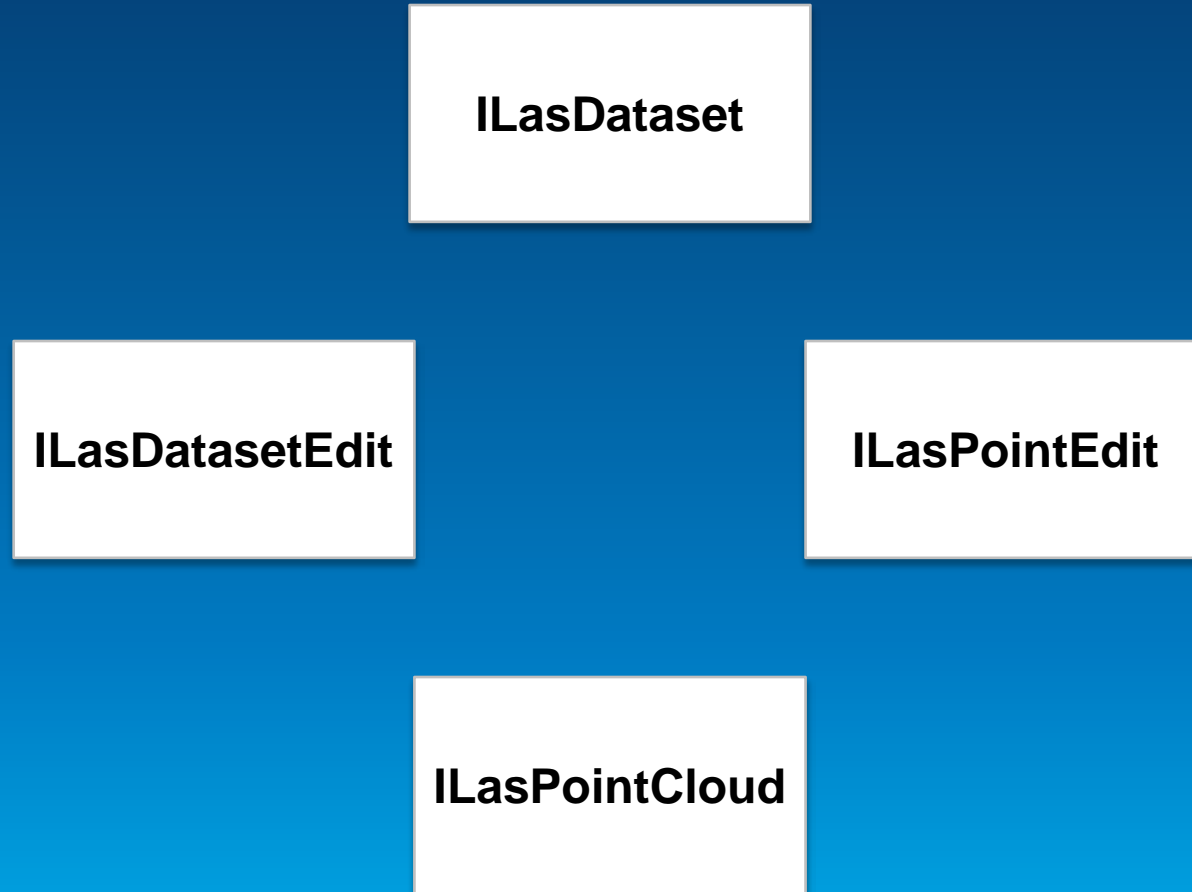
Esri® ArcGIS® 10.2.1

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# Key Objects



# LasDataset – Key Interfaces



# LasFile

- LAS file header info
- If calculated, summary statistics for point records:
  - Class codes
    - Unique values, counts, z-range per class
  - Returns
    - Percentages, z-range
  - Misc:
    - Intensity, scan angle, point source ID

**LAS File Properties and Statistics**

**General**

Name: 23001880PAN.las  
Version/Point Format: 1.0 / 1  
Point Count: 5,187,309  
Spatial Reference: NAD\_1983\_StatePlane\_Pennsylvania\_Nor  
Date Created:  
X, Y, Z Offsets: 0.000000, 0.000000, 0.000000  
X, Y, Z Scale Factors: 0.010000, 0.010000, 0.010000  
Model Key Points: 0

**Extent**

Min X: 188000.000000 Max X: 188999.990000  
Min Y: 220000.000000 Max Y: 229999.990000  
Min Z: 981.710000 Max Z: 1973.050000  
X Range: 999.990000  
Y Range: 999.990000  
Z Range: 991.340000  
XY Linear Unit: Foot\_US  
Z Unit: Foot\_US

**Returns**

Return	Point Count	%	Z Min	Z Max
First	3,617,372	69.74	981.71	1973.05
Second	1,569,937	30.26	984.29	1903.88
Last	3,556,131	68.55	981.71	1973.05
Single	1,986,194	38.29	981.71	1973.05
First of Many	1,631,178	31.45	999.39	1924.81
Last of Many	1,569,937	30.26	984.29	1903.88
All	5,187,309	100.00	981.71	1973.05

**Attributes**

Name	Min	Max
Return No.	1	2
Intensity	0	255
Class Code	1	30
Scan Angle	0	0
User Data	0	0
Point Source	4	9

**Classification Codes**

Classification	Point Count	%	Z Min	Z Max	Min Inten...	Max Inte...	Synthetic...
1 Unassigned	2,603,409	50.19	982.08	1973.05	0	255	0
2 Ground	1,982,326	38.21	982.83	1723.86	0	255	0
8 Model Key	574,836	11.08	982.67	1724.27	0	255	0
9 Water	6,754	0.13	981.71	1585.38	0	255	0
11 Reserved	16,611	0.32	987.54	1642.86	0	255	0
16 Reserved	16	0.00	1015.05	1208.33	59	254	0
30 Reserved	3,357	0.06	1009.32	1684.31	0	255	0

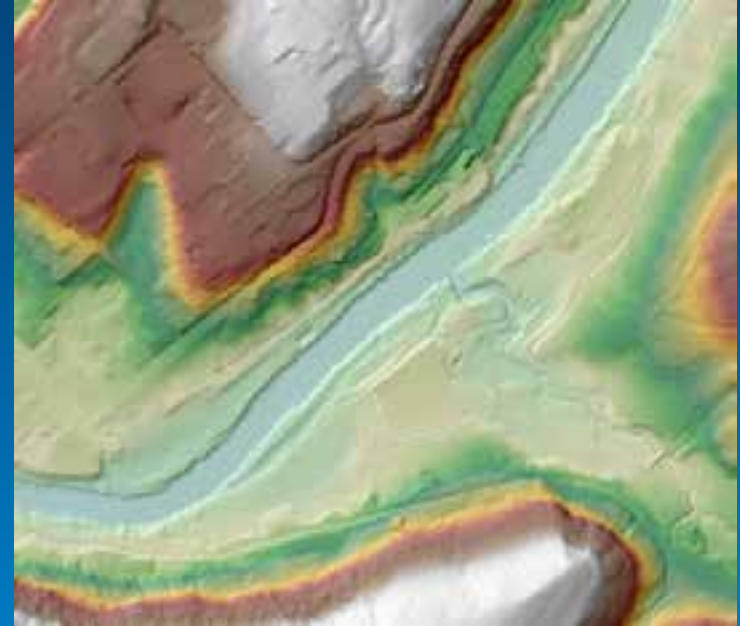
Previous File Next File Update  Force recalculate OK

# LasFilter

- Used on calls retrieving points or surfaces
- Area of interest
- Class codes/flags and returns
- Constraint feature classes (breaklines)



First returns

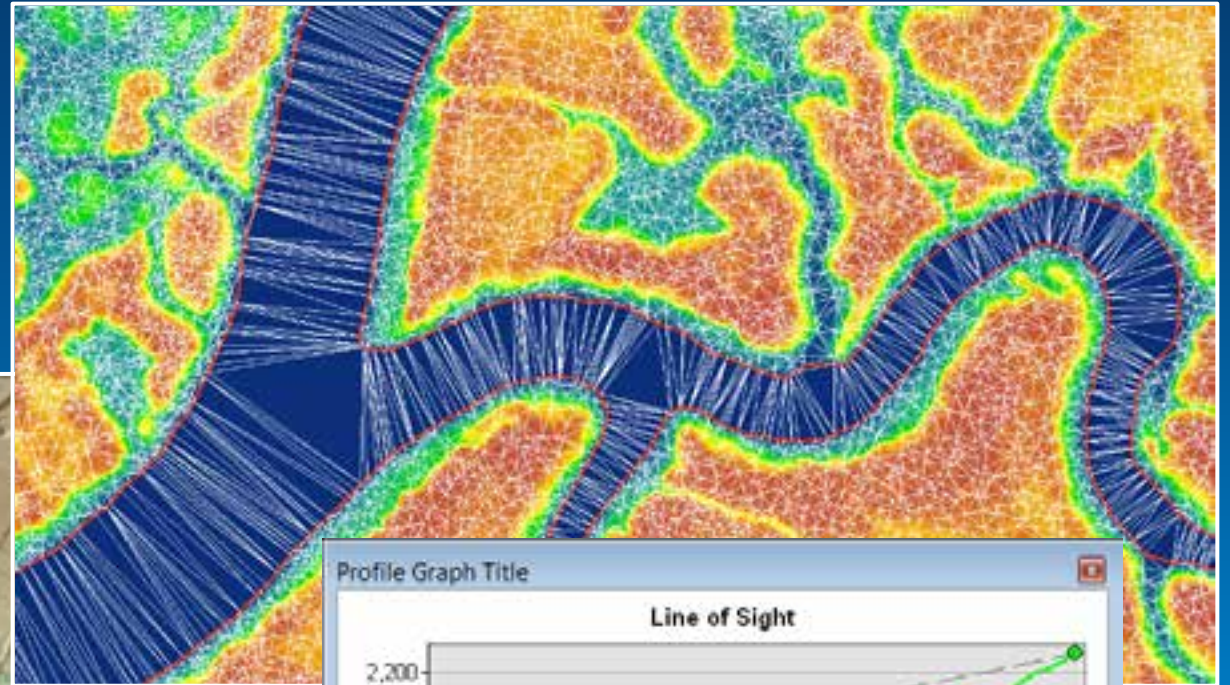
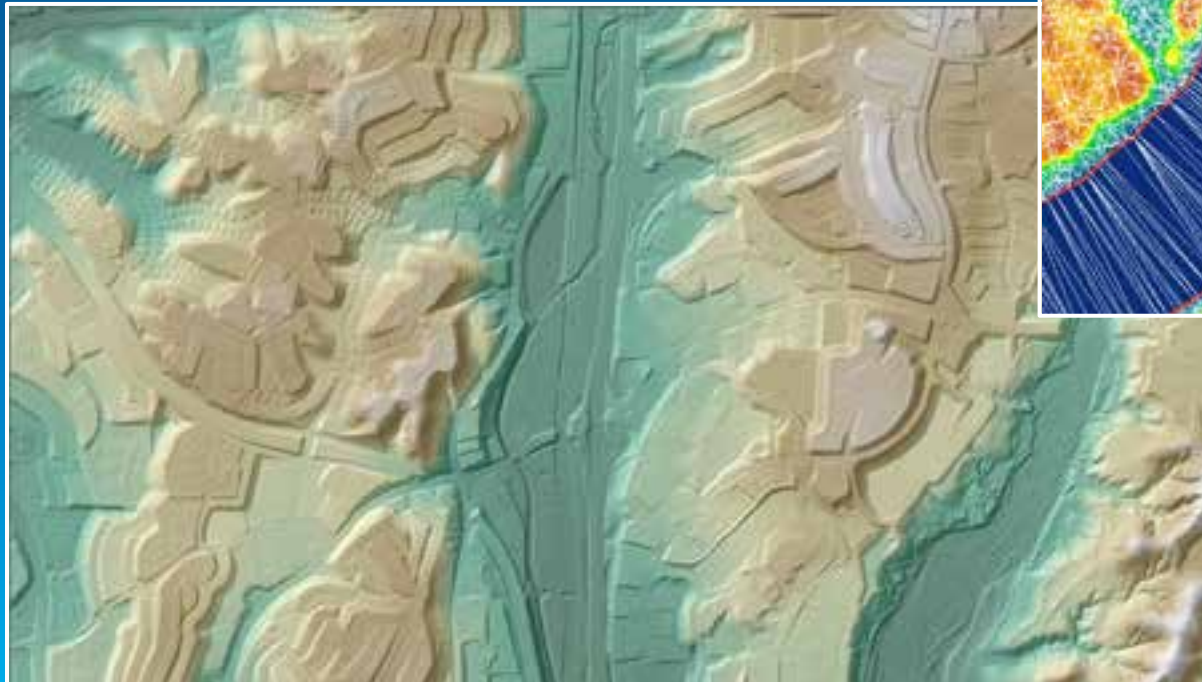


Bare earth



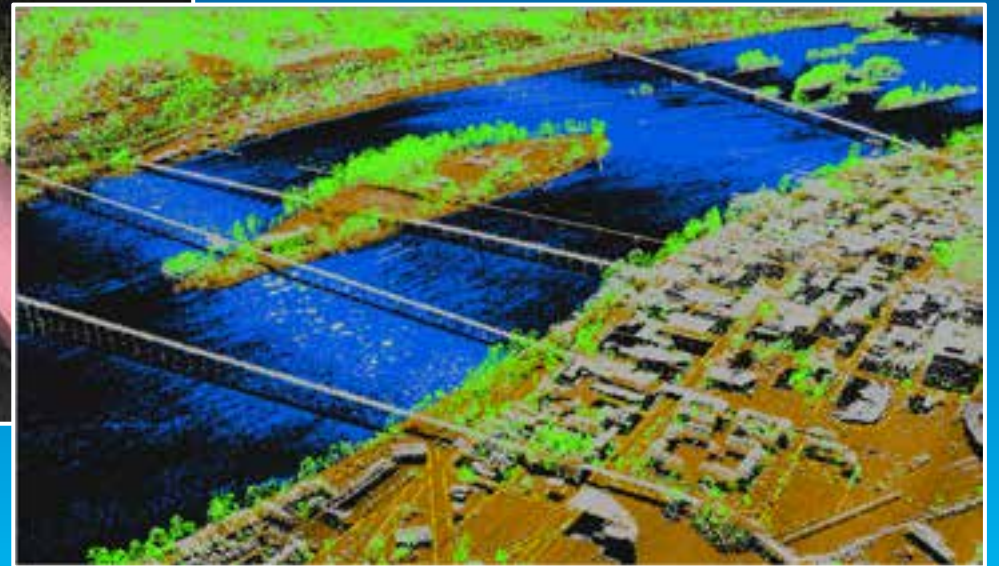
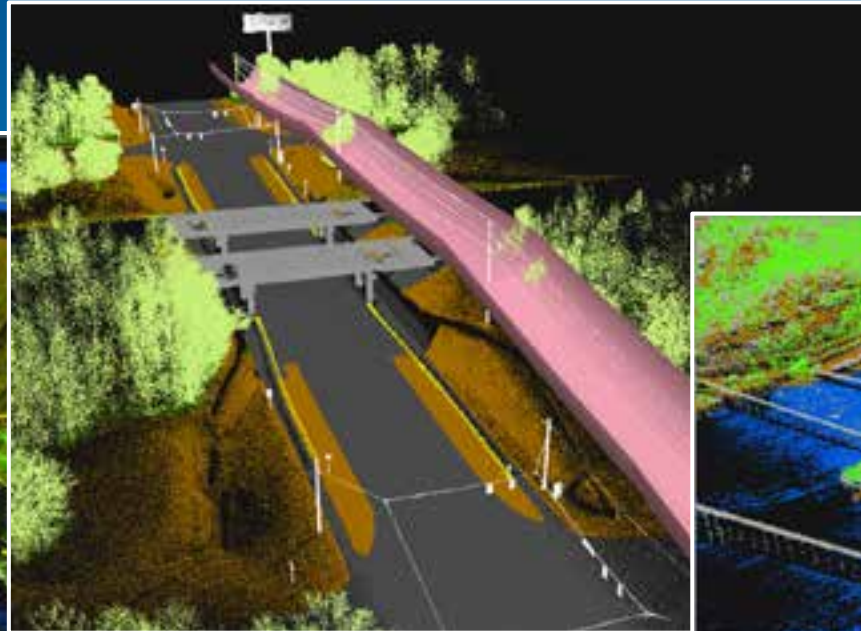
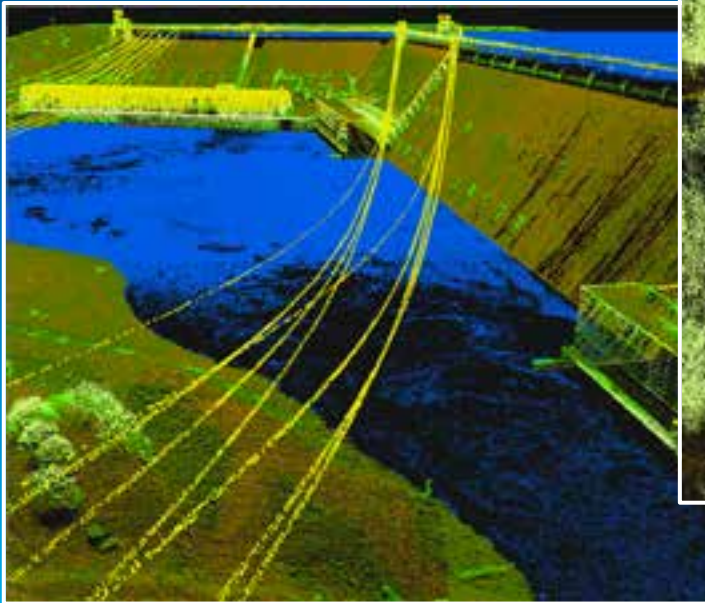
# LasSurface

- Extract TIN subsets
- Raster interpolation
- Feature interpolation / Analysis



# LasPointEnumerator

- Read point records
- Reads are done in chunks (arrays) of user defined size
- Use of WKSPointZ

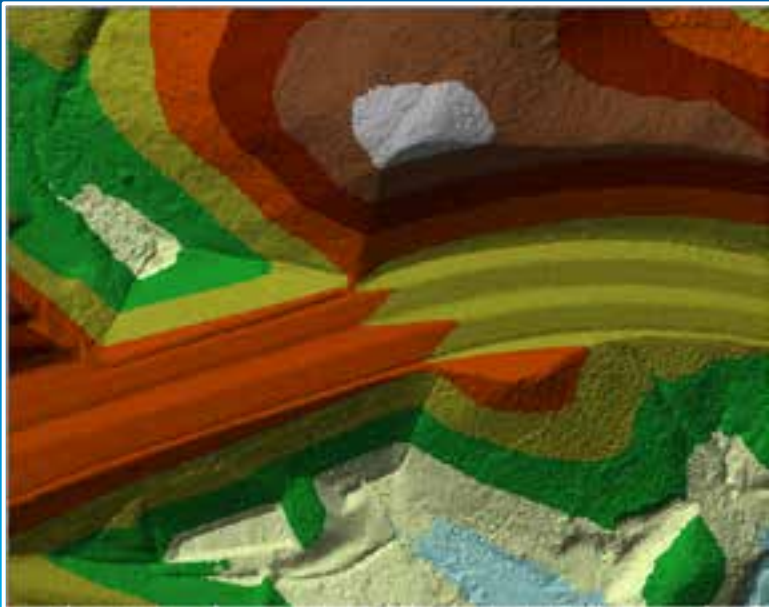


# Demos

- **Object Model Diagram (OMD)**
- **Code walkthrough**
- **Example custom tools**
  - **Classify model key points**
  - **Classify points relative to height above ground**
  - **Clip and filter LAS files to new files**
  - **Extract lake shorelines / hydro-flatten**

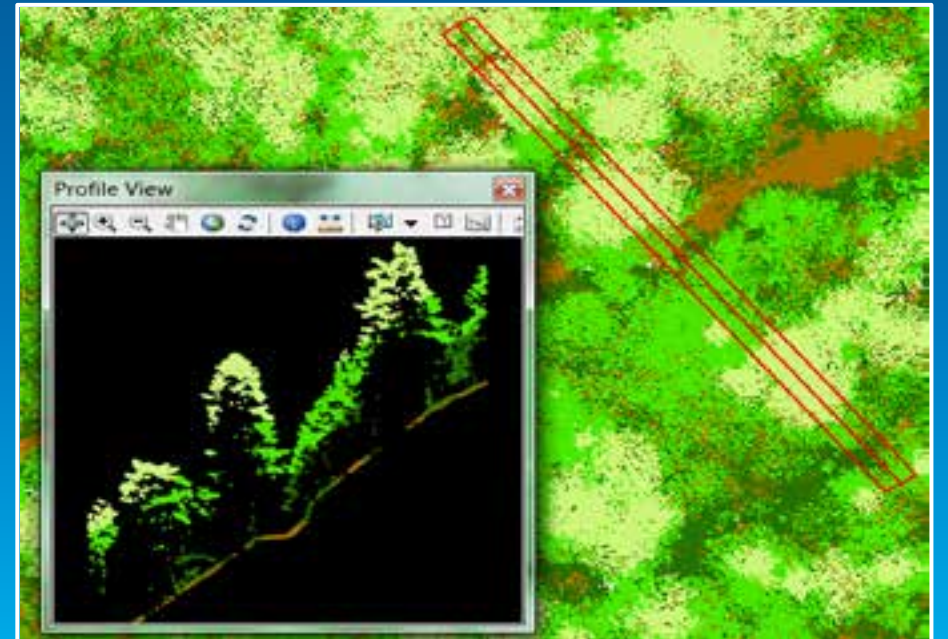
## Model Key Points – Intelligently Thinned

- Read ground points – retain record IDs
- Build TIN – use IDs as node tags
- DecimateTinNodes to thin based on z-tolerance
- Change class codes of retained points to 8



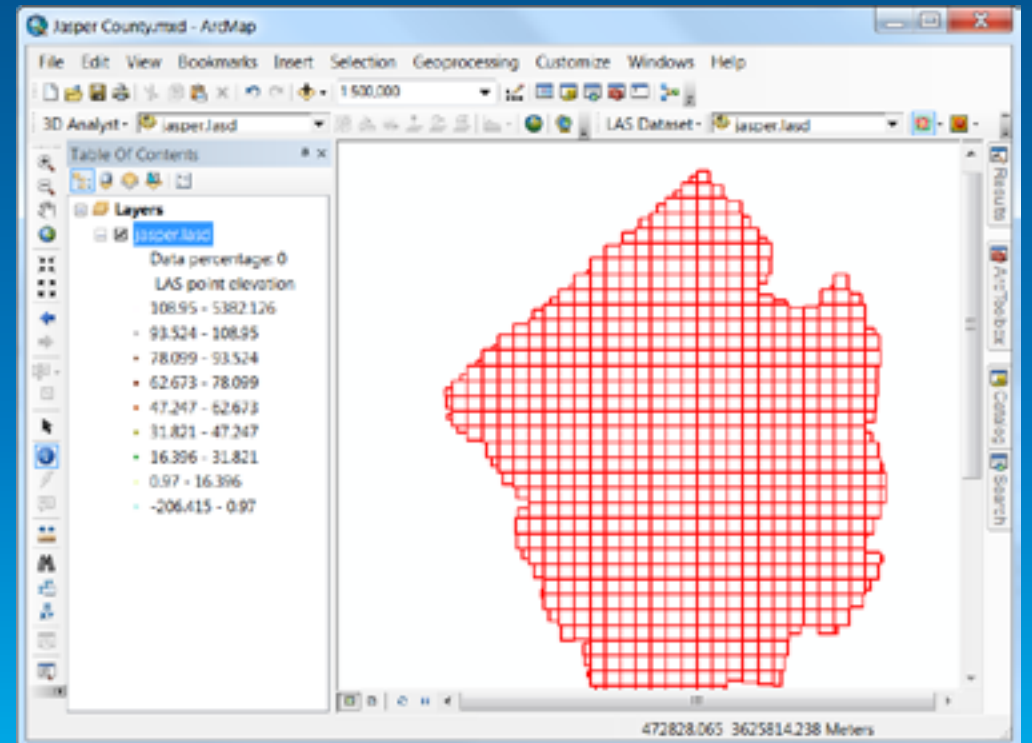
# Height Above Ground

- Construct ground surface
- Retrieve non-ground points
- Interpolate z from ground for their respective xy positions
- Subtract ground-z from point-z to get height
- Assign class codes



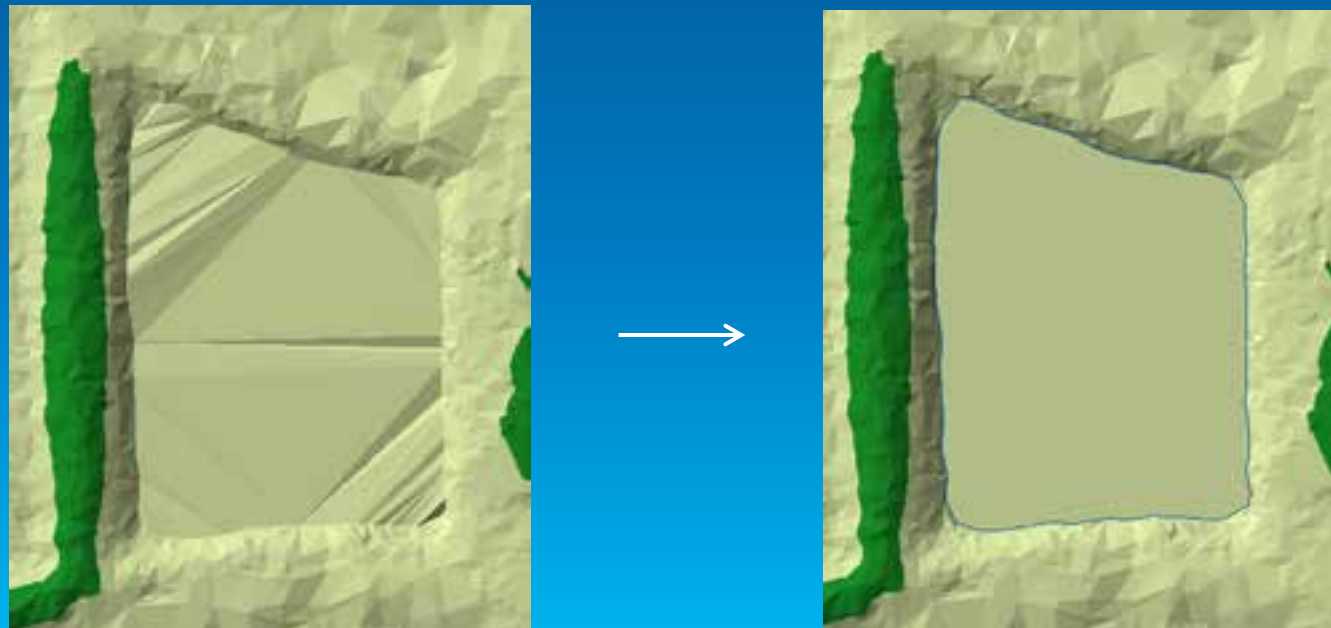
# Clip, Filter, Define Projection, Project

- Find LAS files with extents that intersect area of interest (AOI)
- Clone filter from layer
- Adjust AOI if clipping
- Set/get new spatial reference if projecting
- Call `ILasDataset.Export`



## Extract Breaklines – Hydro Flattening

- Retrieve TIN for display extent
- Find triangle from digitized seed point
- Use TIN topology to flood outward based on edge length
- Extract flooded area as polygon



## LasDatasetToolbar - Instantiation

```
UID toolbarUID = new UIDClass();  
toolbarUID.Value = "esri3DAnalystUI.LasDatasetToolbarEnvironment";  
  
IObjectFactory factory = (IObjectFactory)ArcMap.Application;  
mToolbarEnv = (ILasDatasetToolbarEnvironment)factory.Create(toolbarUID);
```



## LasDatasetToolbar – Current Layer

```
protected override void OnUpdate()
{
    if (ArcMap.Application != null)
    {
        ILayer layer = (ILayer) mToolbarEnv.CurrentSelectedLayer;
        Enabled = (layer != null);
    }
    else Enabled = false;
}
```

# Support for Optimized LAS (zLAS)

- **Losslessly compressed LAS with statistics and spatial indexing**
  - Information: <http://www.lidarnews.com/content/view/10214/2/>
  - Download: <http://esriurl.com/EzLAS>
- **Treated by API as LAS**
  - Adding files to LAS dataset
  - Retrieving file header info, statistics
  - Reading points and their attributes
  - Making surfaces
- **Limitations**
  - No editing class codes
  - No 'Export' (clip, filter, project) to new files

# Resources

- **3D resource center:**
  - <http://resources.arcgis.com/en/communities/3d/>
- **Sample code:**
  - Email: [ccrawford@esri.com](mailto:ccrawford@esri.com)
- **GeoDatabaseExtensions Object Model Diagram**
  - Comes with the SDK
- **ArcObjects API reference**
  - Member help

**Thank You!**

**Please fill out the Survey:**

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