

Cloud-Based LiDAR Visualization and Exploitation

ASPRS - 2015

Patrick Collins

A decorative V-shape formed by two diagonal orange lines extending from the center of a horizontal orange line at the bottom of the page towards the bottom left and bottom right corners.

LiDAR is a Growing Industry

According to a recent study¹, the LiDAR industry is expected to grow to over \$550 million dollars by the end of 2018. As the cost of acquiring LiDAR decreases, more industries will begin using LiDAR to solve some of the unique challenges that exist within those industries today. The solutions to these challenges will be driven by the advancements in collection and analysis capabilities that are being worked on by hardware and software companies today.

The GIS industry has also seen an increase in the use of cloud-deployed visualization and exploitation environments that allow users to discover, view, and extract information from large geospatial datasets by leveraging the power of server technology and web standards (figure 1). Cloud-based GIS analysis not only allows users to conduct analysis from remote environments, it also supports the execution of large, batch processing analysis tasks that can provide unique insight into problems through the fusion of different data types and derived information sets.

LiDAR is currently used to solve some of the most unique problems in the world today such as off-shore wind assessment for power production, the development of Advanced Driver Assistance Systems (self-driving cars), advanced agricultural assessment and monitoring, and urban development (figure 1). The combination of advanced LiDAR analysis techniques and the data dissemination and big data capabilities afforded by cloud computing will expand the industry's ability to solve new and existing problems across a myriad of different vertical markets.

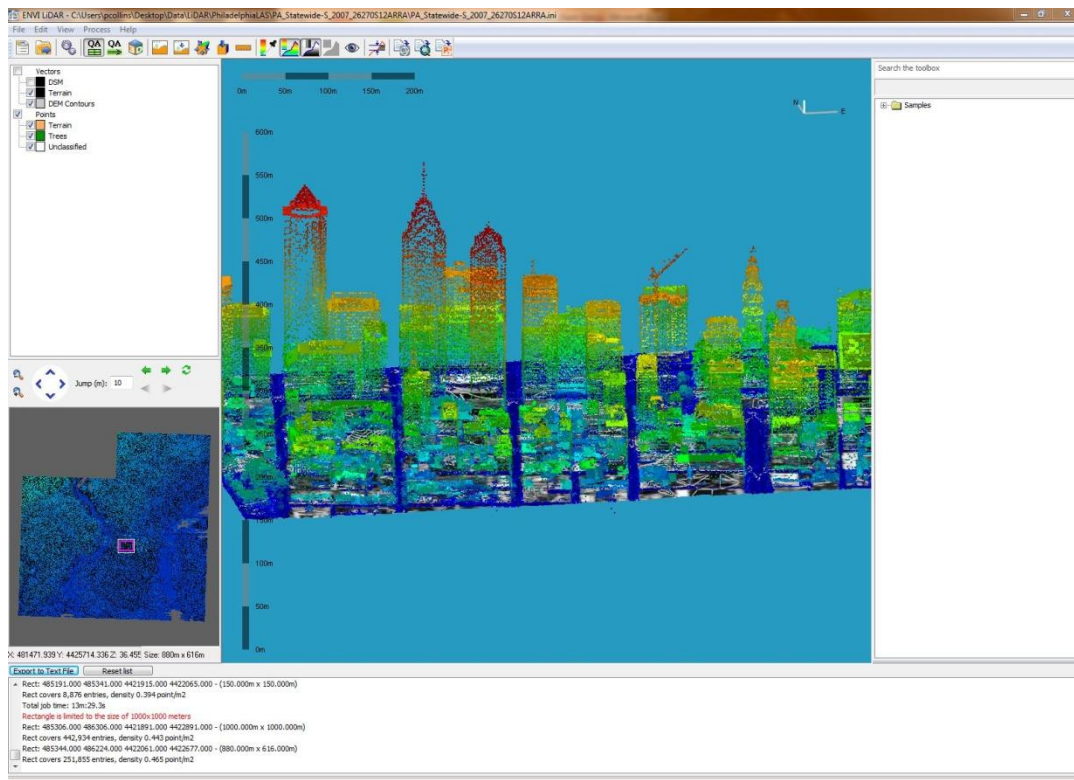


Figure 1 - A LiDAR Visualization of Philadelphia, PA

Solutions Must Be Intuitive

As an increasing number of users begin to consume cloud-based GIS and LiDAR analysis on the web, it is of utmost importance that the technology and user experience be user-friendly. As the deliverer of LiDAR solutions we must understand that making something possible is not the same as making it easy. The information and answers afforded by LiDAR analysis are useful to those outside of the geospatial sphere, and the process for accessing that information must be user-friendly if those solutions are going to be adopted by the majority of users across a large number of different industries.

What we've done at Exelis is to enable the streaming and analysis of LiDAR point clouds using server technology and a web-based browser (figure 2). Hosted in the ENVI Services Engine, the LiDAR streamer and 3D Web Viewer allow users to upload and stream large LiDAR point clouds at interactive frame rates and to automatically extract building vectors by leveraging the ENVI LiDAR API in a server environment.

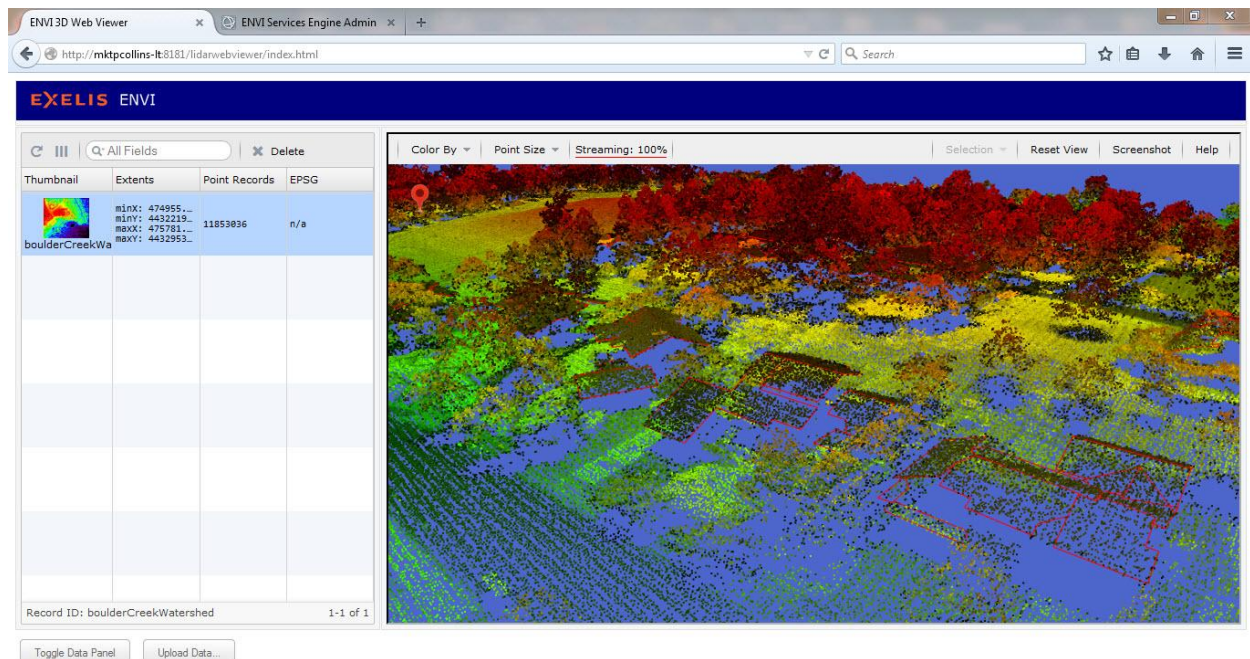


Figure 2 - The 3D Web Viewer

LiDAR provides unique challenges to traditional web-GIS, including both the large size of the data and the three-dimensional environment required to visualize it. Another challenge is the pre-processing work that needs to be done to the LiDAR to get it ready for streaming and consumption via the viewer. As mentioned before, making something possible does not make it easy, and while the technological capabilities needed to conduct cloud-based visualization and analysis are necessary, the thought that goes into the user experience is just as valuable to the success of the solution in the long run.

Visualization of LiDAR Point Clouds via the Web

In order to compensate for the extremely large size of most LiDAR point clouds, they must be broken into smaller subsets that can be streamed, when needed, into the viewer. This is similar to the way that tiled map services decrease bandwidth requirements by only serving up the tiles that are requested by the application. The breaking up of the point cloud is carried out by a Services Engine task which bins the data into a quadtree structure and makes it available for streaming by the engine. This allows for fast spatial queries against the data and provides the different levels of detail needed to display the data at different scales because the viewer doesn't need to download every piece of data within the view (figure 3).

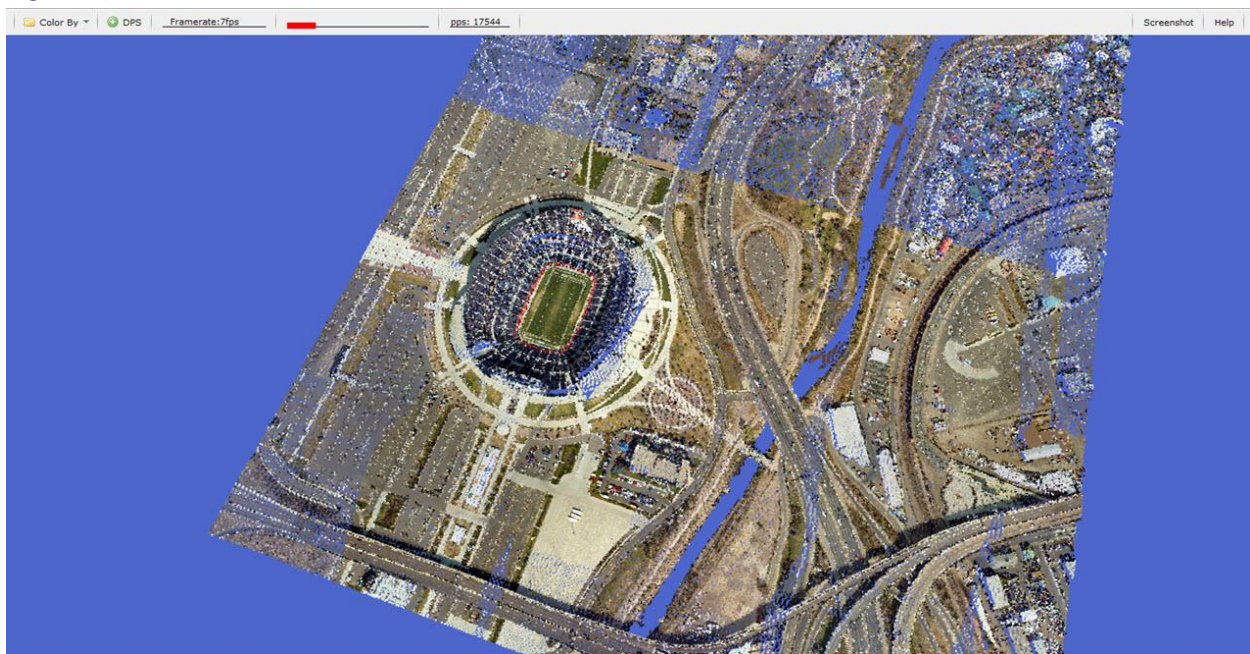


Figure 3 - 3D Web Viewer streaming data at different scales - data courtesy of Merrick

The viewer is a browser-based viewer that was built using JavaScript / WebGL technology. This technology was chosen for a number of benefits it brings to both the developer and the user. WebGL is platform independent and doesn't require any client download of software or executables. WebGL technology has also progressed significantly over the past few years, and it runs on desktop and mobile devices through the use of a simple web browser.

Use of the quadtree structure and 3D Web Viewer not only make visualization possible, it helps make it easier for the end-user. Eliminating the need to download client side software or libraries increases the number of people who can successfully access the functionality. Also, fast spatial queries combined with application 'smarts' that only load high resolution details in the area where the user is looking make for a smoother overall experience without detracting from the ability to fully exploit the data.

Exploitation of LiDAR Point Clouds via the Web

While the 3D Web Viewer enables the consumption of the streaming point cloud within the browser, it also contains the functionality necessary to send http://REST calls back to the server to kick-off LiDAR processing. In this case, we've enabled the ENVI LiDAR automated building extraction API method as a task in the Services Engine. The user can indicate a rectangle within the viewer that encompasses points that they want to extract buildings from (figure 4).

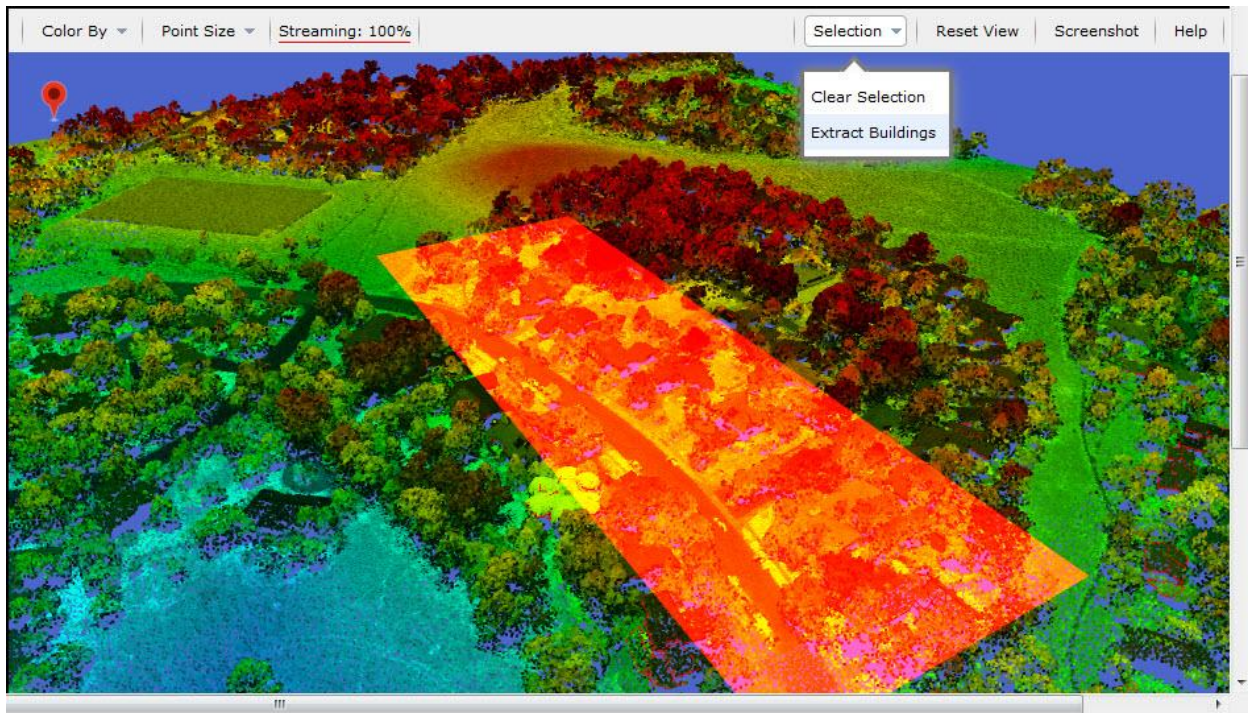


Figure 4 - 3D Web Viewer building extraction

Clicking on Selection -> Extract Buildings passes the coordinates of the rectangle back to the engine as part of the REST call along with the dataset to analyze and the analysis to run on it. Once the feature extraction algorithm has finished, the resulting shapefiles are written out to a specified directory and subsequently streamed from the server for display in the 3D Web Viewer (figure 5).

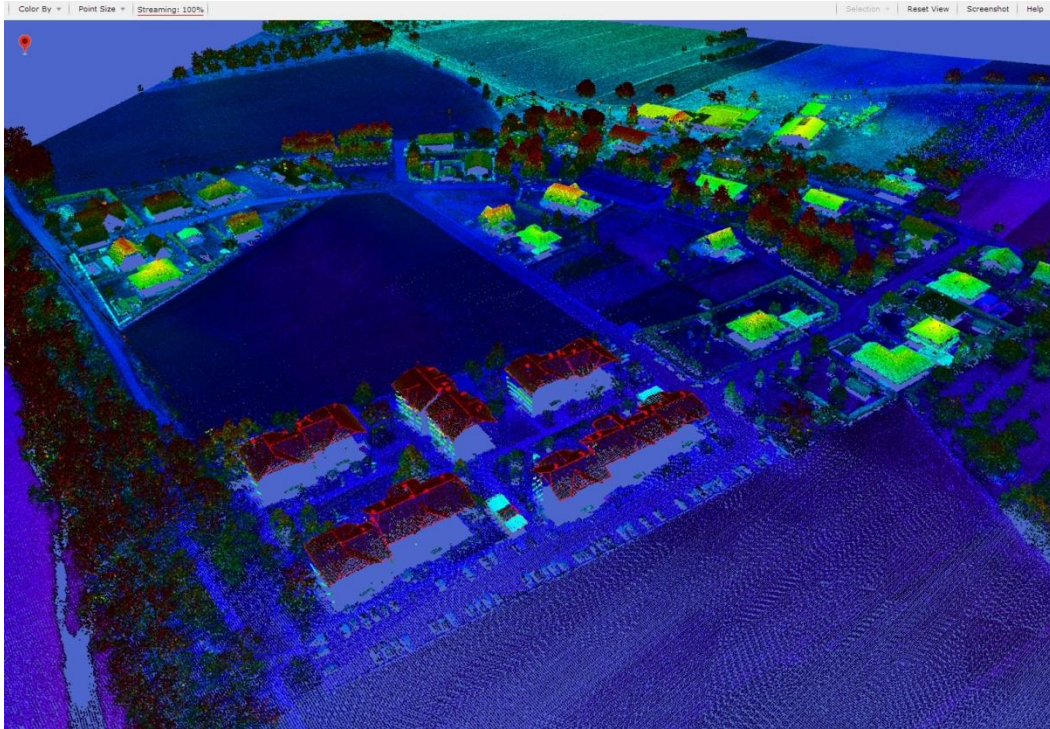


Figure 5 - 3D Web Viewer showing extracted building features

Building extraction is one of numerous automated tasks enabled through the API, which includes algorithms for extracting elevation and terrain models, power lines, trees, contours, and more. The code is also customizable so that advanced users can develop code to extract pretty much an feature they want from the point cloud. All of these algorithms can then be loaded into the engine and enabled as an <http://> REST endpoint for execution from a web-based resource such as the 3D Web Viewer.

Summary

The LiDAR industry is expected to grow immensely over the next few years, driven by a decreasing cost for data acquisition and breakthroughs in the analysis and dissemination of LiDAR and LiDAR-derived products. The technology behind cloud-based LiDAR visualization and exploitation has become reality, and it is now up to businesses to derive relevant solutions using this technology across a myriad of industries.

Interfaces must be intuitive for people who may not be familiar with GIS and geospatial analysis in order for the solutions provided by those interfaces to be widely adopted. Making something possible doesn't make it easy, and the developers of cloud-based LiDAR exploitation tools need to ensure that they are not alienating potential users with complex or non-intuitive workflows.

Here at Exelis we've enabled portions of the ENVI LiDAR API as tasks that have been exposed as REST endpoints via the ENVI Services Engine. These endpoints can be called from a browser-based interface, such as the 3D Web Viewer, in order to run automated feature extraction tasks on LiDAR datasets. The 3D Web Viewer also consumes streaming point clouds from the Services Engine through the use of

WebGL / JavaScript technology for visualization of both the point cloud and the derived results. The user can also upload their own data into the Services Engine, and automatically bin the resulting dataset into a quadtree structure for dissemination of the data through the viewer at interactive frame rates.

The LiDAR API, combined with the customization potential of the Interactive Data Language (IDL), make the development of custom extraction tasks a reality, allowing businesses to develop problem-specific LiDAR solutions and enable them in a web environment. This is the type of customizable technology that will help raise the industry to new heights in the coming years, driven by the innovative businesses that leverage the amazing amount of information contained within the point cloud.

Sources:

1.) LiDAR Market by Components (INS, Laser, GPS/GNSS, Camera, MEMS), Product Types (Airborne, Mobile, Terrestrial), Applications (Corridor Mapping, Forestry, Mining, Topographic Surveying, Volumetric Mapping) - Global Forecasts and Analysis 2013 – 2018

Exelis
4990 Pearl East Circle
Boulder, CO 80031

www.exelisvis.com

EXELIS

©2014, Exelis Visual Information Solutions, Inc. All rights reserved. Exelis, ENVI and IDL are registered trademarks of Exelis Inc. All other marks are the property of their respective owners.