# Mobile Mapping for Municipalities

Terrestrial LiDAR and Imaging as the New Solution for Surveying


## Summary

This White Paper will explore the use of mobile mapping through terrestrial LiDAR and imaging. The use of mobile LiDAR is replacing much of the need for traditional survey techniques with a comprehensive data capture directly to 3D. It will first explain the needs it can address, then a description of the basics of the technology, how it can be used to provide immediate benefits, and how the information can be transformed into geographic information systems for municipalities.


VERUS GEOMATICS

## Why Mobile Map?

First let's examine some of the related challenges that municipalities face:

- Budget pressure demands new ways to increase service efficiency.
- Most provinces now require municipalities to implement asset management strategies but manual surveys are expensive and time consuming.
- Sending municipal staff to inspect existing infrastructure is often an inefficient use of their time.
- Conducting on-street or street-side surveys puts staff in unnecessary jeopardy.
- Questions that arise during the winter may have to wait until snow melt to be answered.
- There is no easy, automated way to compare pre-construction work with post construction work.
- Traditional surveying is two dimensional and often does not capture all of the features that you may later want.
- Decision making and consensus building of municipal issues is often delayed by lack of coherent visualization and localization.
- Urban planning lacks 3D models and the ability to easily visualize various scenarios from perspectives of all users.
- A long term digital record of the evolution of a community is not available.
  New construction projects require a preliminary site survey.

Mobile mapping is the perfect solution to address these issues.

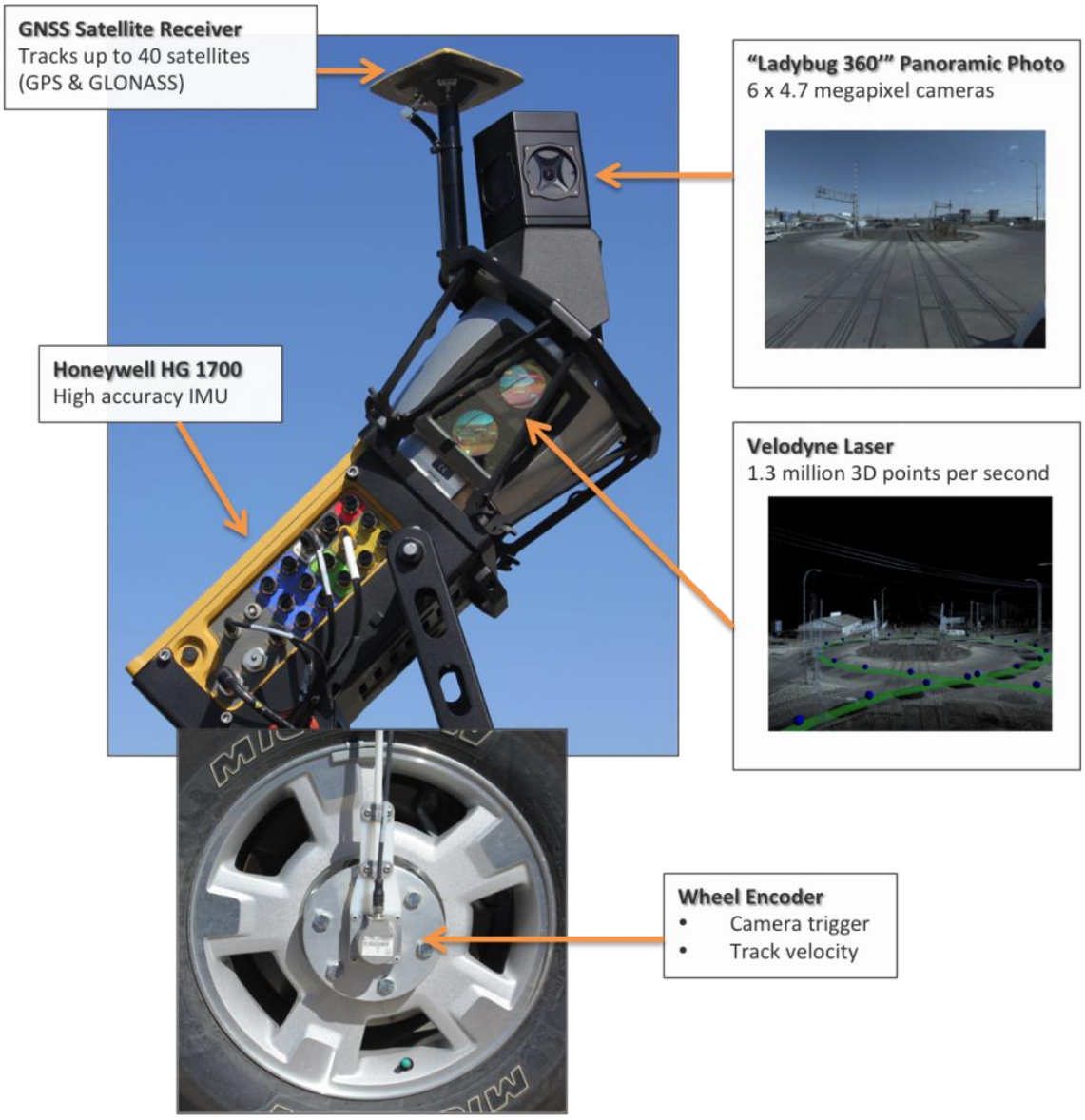
## The Technology

The advent of high accuracy LiDAR lasers combined with high accuracy GPS and advanced inertial measurement systems is redefining how surveys are performed.

Verus Geomatics uses a truck mounted with technologies to position the unit with accuracy of a couple of centimeters, a high accuracy, high density 360° laser as well as ladybug high resolution imaging.

The scanner is mounted at raised elevation of 2.1 metres. The system starts with very accurate positioning using three techniques. The first is with GPS via a cutting edge GNSS Satellite Receiver which can track up to 40 satellites from both the U.S. GPS (NAVSTAR) and Russian (GLONASS). The second is with a military grade inertial measurement unit, and the third is a wheel encoder, which combined allows the system to track underneath bridges, through tunnels and through urban corridors with amazing accuracy.

The advanced eye safe Light Detection and Ranging (LiDAR) laser can take 1.3 million point samples per second at a range of over 100 meters using 64 individual lasers/detectors. The unit spins at up to 900 RPM at an inclination to capture a full 360 view continuously, and captures an intensity reflectivity for every point. This technology outputs a timestamped point cloud which is then referenced against the positioning system for high accuracy. The LiDAR is detailed enough to identify overhead cables.




The ladybug camera is composed of six high definition Nikon 60D cameras and providing an experience that parallels Google Street View™ and can see up to the skyline for overhanging objects and down for road coverage, and is clear enough to read the identification tags from roadside assets such as light poles. Combined together, the system produces the highest density point cloud available in mobile mapping systems today. From manhole covers to the top of street lights, underpasses, buildings can all be surveyed. Vegetation has a distinct reflectivity so it can be easily detected with the LiDAR.

The Verus Geomatics truck can perform this scanning at up to 110 km/h – at the posted speed limit of any road in Canada. The truck mounting ensures that if a roadway is accessible, it can be mapped. Software applications stitch the images with the LiDAR measurements, so you can perform measurements within the photo or point cloud views.

The output includes industry standard LAS files for the LiDAR data, but can also be viewed using special purpose software that allows you to measure either within the point cloud or from the processed panoramic photo view. The data can also be used to compare against previous results, which forms an ideal solution to track erosion and any other surface change over time.

Compared to aerial LiDAR, the solution is far more accurate and provides a more useful viewpoint for the data capture. Airborne LiDAR solutions are accurate to roughly 50 cm, a calibrated Verus terrestrial solution is better than 3 cm. However, because common data formats are used, aerial LiDAR and terrestrial LiDAR can be combined to provide a powerful, comprehensive 3D model of a municipality. All features of interest can be recorded and viewed on Administration's desktop, whether they are searching for the number of streetlights on a road or the bolt size on a bridge railing, Verus can provide the required data.

**Impact of this Technology**

- Digital capture, in full 3D with the additional control of knowing exactly when the images were taken.
- Safer way to survey.
- 200 M detection swath.
- No traffic control is required.
- Data is accessible year round - plan and assess from the desktop even in the Canadian winter.
- Easiest way to populate a Geographic Information System (GIS).
- Relative accuracies to roughly 3 cm, and absolute point in space accuracies to +/- 5 cm.
- Survey and visualize most municipal fixed assets, such as utility infrastructure, buildings, overhead cables and trees.
- The technology focuses and aids a key spending area: transportation and linear infrastructure.

## Remote communities

Remote communities have obvious additional challenges. A mobile mapped community will benefit from:

- Reducing the need for surveying as an on-staff or local skill set.
- Limits travel expenses for consultant inspections, since information can be shared digitally.
- Improved citizen response times
- Reduced field time for GIS/Asset Management and Operations reconnaissance
- Reduced trips (and therefore Greenhouse Gases) due to routine inspections and fact gathering by Administration staff

## Assessing the Point Cloud and Imaging

The data delivered by Verus Geomatics is large, and is typically done via a USB drive. Verus Geomatics can recommend software packages to be used and include those as part of the deliverables.

With a basic software package, the data is available within days of collection and useful to municipal staff. With the point cloud data loaded, some basic operations are immediately available:

| Operation | Examples |
|---|---|
| Measure distance between any points | Setback of buildings, width of a road, height of a curb |
| Colourize the point cloud based on elevations | Understanding drainage |
| Measure areas | Measure lot sizes, parking lots |
| View from any perspective | Confirm sightlines, plan, assess signage |
| Tag and document assets | Add meta data to any features of interest for quick reference and create custom maps of anything of interest |
| Export views | Export screenshots or specific data, import into GIS or CAD software. |

This information can be used to answer many questions promptly and without leaving your desk.

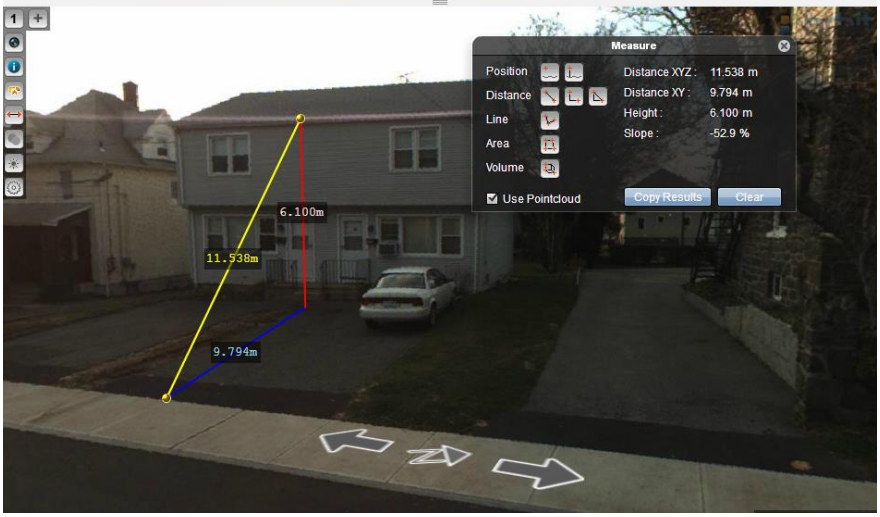
More advanced software can be used for automated feature extraction, volumetric calculations (such as measure piles of materials), speciality modules for particular applications, such as for utilities.

## Other Applications and Benefits

- Pre-construction preliminary survey allows you to instantly reach 30% completion for municipal projects.
- Pre-construction / post-construction comparisons. E.g. verify new developments and adherence to plan against as built.
- Clarity in work specifications, RFPs, and sharing information with the community can be produced with clear supporting materials.
- Safety and security planning.
- Plan special events, disaster preparedness, build customized maps.
- Perform asset management logging and updating.

3D Point cloud captured from LiDAR

Section of ladybug photo view

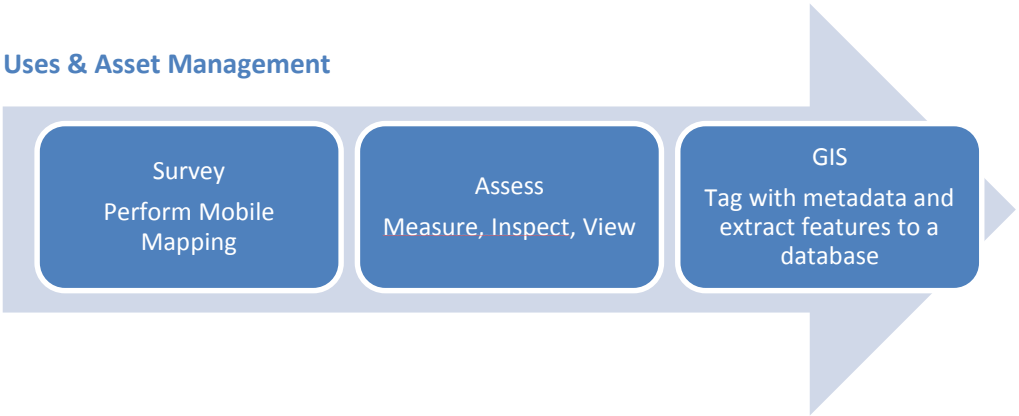

Users can measure features with the photo with high accuracy.

### Transportation Infrastructure

The municipal transportation infrastructure usually forms a very large part of the budget. Timely maintenance is the most effective means to maximize cost efficiency. Timely maintenance requires good information to perform assessment. Besides the grade and other static information from the LiDAR, the mobile mapper is most effective at gathering high resolution images of roadway conditions for inspection.

- Surface condition inspection
- Radius curvature
- Super elevation analysis
- Edge condition detection
- Striping analysis
- Profile Analysis
- Vegetation encroachment
- Oversized load transfers: underpass sizing, any other obstructions
- Alternate route planning during renovation / construction periods
- Embankment erosion
- Signage and traffic signalization
- Road Inventories

### Advanced Uses & Asset Management




A Geographic Information System (GIS) is a solution for capturing, storing, manipulating and presenting all types of geographic data. A terrestrial mobile map is the easiest way to capture data to populate a GIS system with a local survey, as it has the necessary resolution, definition and accuracy to identify and locate surface assets.

Some municipalities are in the (difficult) process of moving to 3D and a mobile map has the additional benefit of properly placing not just the location but the altitude of the asset.

Verus Geomatics, Verus' partners, municipal staff or a contractor can use the point cloud imaging to tag features, assets and add metadata, and combine it with other data sources. There are many choices of software to support a full GIS management system. Tagging assets through a colourized LiDAR output is the most efficient means to identify features and gather the most useful physical information for a GIS. The solution is more efficient than handheld GPS solutions, as well as more accurate, and by going back to the initial data other features can be added as the GIS database is grown.

From there, questions such as:

- Which roads are most in need of maintenance? At what rate are roads degrading compared to others?
- Which streets could best support the addition of a bike path/HOV?
- Could roadside parking spaces be added? Should some be removed to improve intersection visibility? Are there suitable streetlights nearby a problem intersection?
- How many fire hydrants are in that section of town? Which houses are furthest from fire hydrants?

Can easily be answered from a user's desktop, any time of the year.

The 3 dimensional data gathered is ideal for urban planning. Sightlines, sunlight and service planning can all be undertaken with the data. The surveyed features can be digitized, vectorized and be exported in planimetric views using standard formats such as ESRI shapefiles.

## Conclusion

Mobile mapping is the breakthrough in the evolution from traditional surveying to aerial LiDAR and satellite photography. Aerial and satellite view are of limited resolution and perspective, while Google Street View™ is uncontrolled and cannot be used to accurately measure and build upon in a separate system. The new paradigm is conducting surveys from your desk with timely, detailed and informational data within your control.