Optech

Power Line Corridor Mapping

Lynx Application Note: LY-005 Rev A

The Challenge: Survey 450,000 Miles

The blackout of August 2003 crippled the mid-west and northeastern United States plus southern Ontario and Quebec. After the greatest electrical outage in U.S. history, the North American Electric Reliability Corporation (NERC) issued an industry-wide alert mandating that electrical power suppliers submit plans to identify the methods they use to monitor infrastructure. Along with identifying their in-field status monitoring, utility companies must also disclose how they will remedy discrepancies discovered between in-field conditions and “as-designed” engineering documentation.

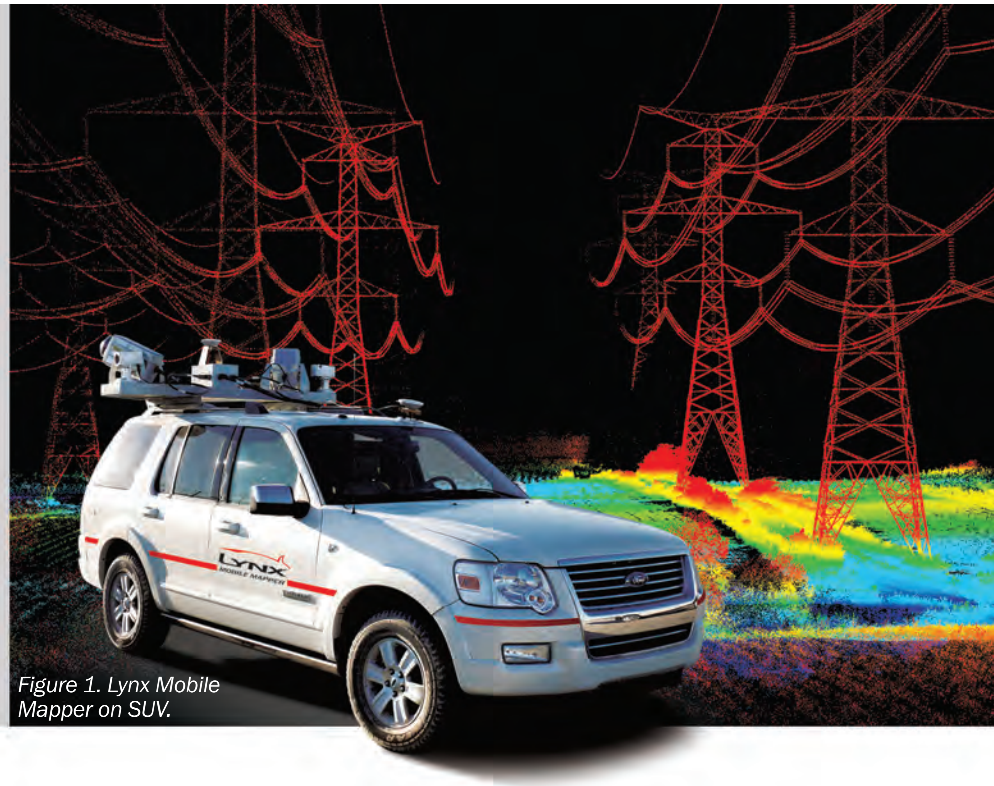

Figure 1. Lynx Mobile Mapper on SUV.

Since increasing its regulatory range from power lines with a carrying capacity of over 200 kV to include those over 100 kV, NERC's purview has expanded to over 450,000 miles of power transmission lines. But how can utilities accurately assess the in-field condition of their power lines? In a word, lidar.

Airborne lidar mapping (Light Distance and Ranging) is a well-proven technology for obtaining georeferenced point cloud data of power line corridors. The more recent emergence of terrestrial mobile mapping (mounting a laser scanner on a ground vehicle instead of an aircraft) has opened up whole new possibilities for electrical power providers to monitor their infrastructure.

Survey Workflow

A survey crew equipped with a Lynx Mobile Mapper mounted on an SUV (Figure 1) drove along a power transmission corridor right-of-way while scanning the surrounding towers, cables and related infrastructure.

The lidar scan acquired high-density georeferenced XYZ points that, after post-processing, were output as LAS files and also rendered through PolyWorks, a graphical visualization software application, as 3D color-coded point clouds (Figure 3).

From the LAS data, processors extracted XYZ points co-located within user-defined limits surrounding the power transmission cables.

Choosing the right tool: Airborne or terrestrial mobile lidar?

Airborne Lidar	Terrestrial Mobile Lidar
▸ **Large-area mapping:** Flying at higher altitudes and faster speeds covers large areas quickly.	▸ **High-density data:** Shorter range concentrates laser points, producing extremely high-density data.
▸ **GPS coverage:** Aircraft may incur fewer GPS signal dropouts caused by multipath interference at ground level in dense urban areas.	▸ **Virtually no laser shadowing:** The Lynx Mobile Mapper's unique two-sensor configuration scans a near-360° field of view (FOV)—areas outside the line-of-sight of one sensor are within the line-of-sight of the companion sensor.
▸ **"Bird’s-eye" view:** In some cases, an overhead (plan) view can be advantageous.	▸ **"From the ground-up" perspective:** The near-360° FOV provides data from the ground up, a distinct advantage in assessing the field conditions of power corridor infrastructure.
▸ **Inaccessible terrain:** Airborne systems can survey terrain inaccessible to land vehicles (e.g., ravines, mountains, wetlands).	▸ **Restricted air space:** Lynx accesses areas inaccessible to aircraft (e.g., surrounding busy airports).

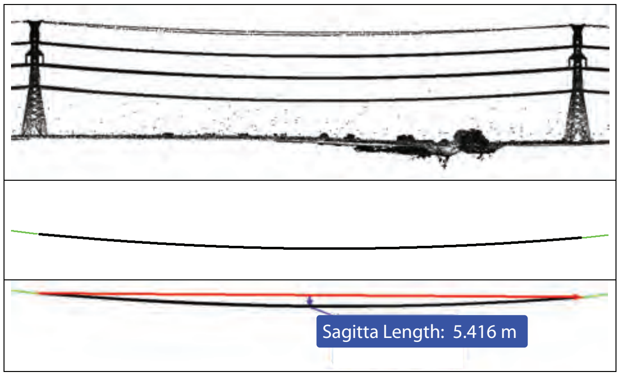

Figure 2. Top: Lidar point cloud of electrical transmission corridor section. The towers serve as known GPS reference points. XYZ points extracted from the lidar point cloud are co-located within user-defined limits surrounding the power transmission cables. Middle: Electrical transmission line extracted from between two towers. Bottom: Sagitta of a transmission line calculated from lidar scan data.

After extracting the data, the team measured the amount of sag in the selected power line. Calculating sag is essentially an exercise in plane geometry: once the transmission line is isolated, PolyWorks' IMSurvey wire extraction routine was used to trace a section of the line. From this traced section a polyline was manually cut. Then, lidar point cloud data was selected, and a best fit arc was calculated based on the extracted polyline.

The *sagitta* of the chord was determined by measuring the radius of curvature in the resulting arc. This semi-automated procedures used a PolyWorks macro that generates a maximum wire deflection for each transmission line.

With this information, the team determined potential trouble spots and dispatched a field crew to investigate and remedy any faults.

The Payback

Achieve NERC compliance. Once a utility company identifies the method they will use to monitor in-field infrastructure status, they are in compliance with NERC regulations. This is not only beneficial for safety and efficiency, it also nets significant savings by avoiding substantial non-compliance penalties.

Reduce costs. Emergency repair costs are reduced by identifying, and then pre-empting, potential trouble spots. Such intervention minimizes the occurrence of flashover incidents that can lead to "cascading failure", the cause identified behind the massive electrical blackout of August 2003.

Build a database. An enduring benefit of using lidar scanning to monitor and assess power line infrastructure is that it enables the utility company to develop a georeferenced and searchable database of all in-field assets. Having this vital information easily accessible lays the foundation for future in-depth analyses and ongoing change-detection studies.

Critical decision-makers no longer depend on outdated "as-designed" engineering documents—they make quick and accurate decisions based on up-to-date field conditions.

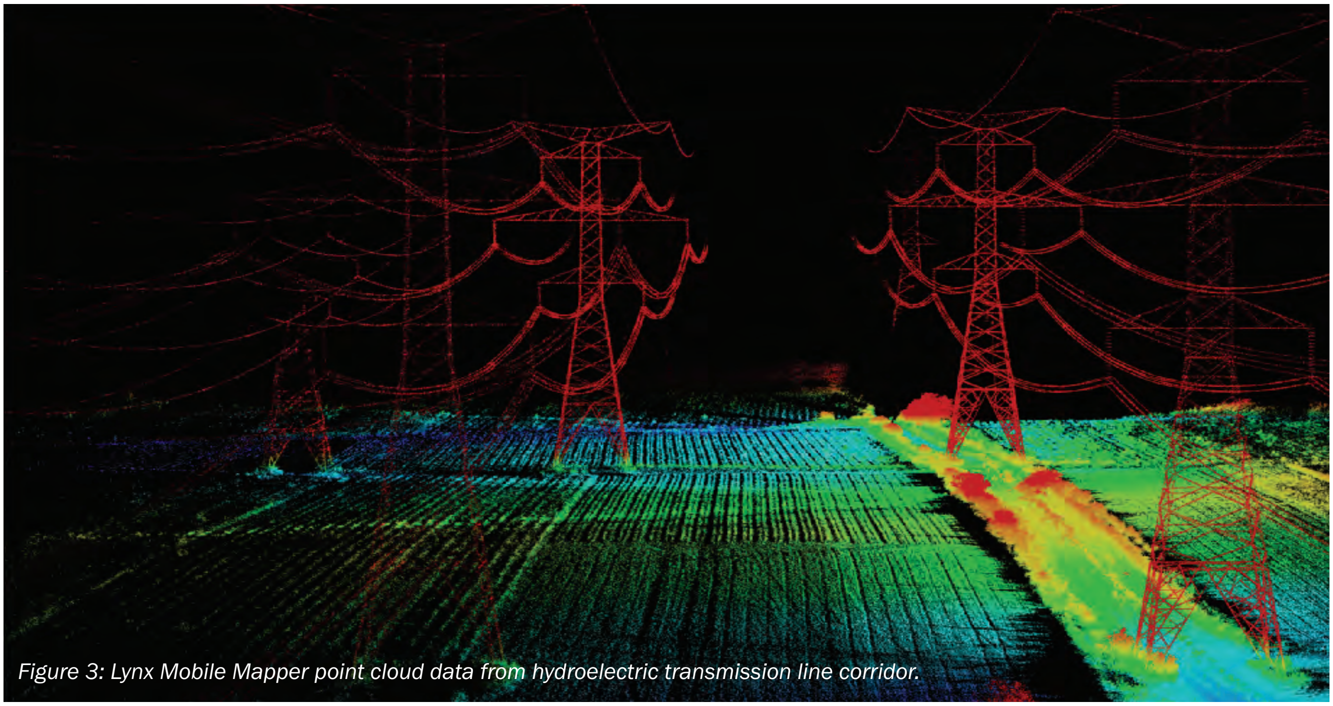

Figure 3: Lynx Mobile Mapper point cloud data from hydroelectric transmission line corridor.

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