LANDMark™ Marine

A fully integrated marine vessel based mobile mapping solution for producing accurately georeferenced LiDAR point cloud data, even in the most difficult environments.

Combining the renowned accuracy of the Applanix POS MV™ positioning and orientation system with the precision of proven LiDAR technology, LANDMark Marine delivers a fully integrated workflow.

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Applanix LANDMark™ Marine

LANDMark Marine is a complete shoreline mapping solution for marine vessels. The system enables geospatial data acquisition and analysis to be conducted at a fraction of the cost and time compared to static methods. Where access to the shoreline is difficult or dangerous, LANDMark Marine allows the acquisition of precisely georeferenced data from a safe platform.

By combining position and orientation data from POS MV with point cloud data from multibeam or swath sonar, a seamless model of the surface both above AND below the water line may be created. Current POS MV users may easily upgrade to include the increased functionality afforded by LANDMark Marine.

LANDMark Marine provides immediate return on investment.

APPLANIX LANDMARK MARINE WORKFLOW

EASE OF USE

LANDMark Marine includes a built-in boresighting utility to accurately and repeatably measure IMU to LiDAR misalignment angles. It also provides a well defined workflow, ensuring data is collected successfully the first time, every time.

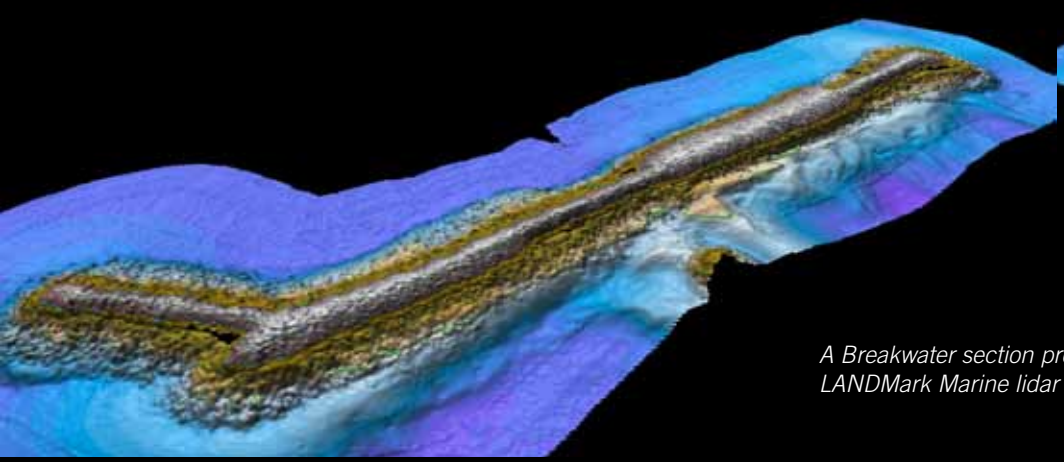
LANDMark Marine is the safest, most convenient and most cost effective way to acquire accurate high-quality shoreline mapping data from a marine vessel. It collects very accurate directly georeferenced LiDAR and associated camera images by utilizing:

- POS MV – The marine survey industry standard for georeferencing and motion compensation
- Microsecond accurate time stamping
- POSPac MMS – a uniquely powerful GNSS aided inertial processing package
- Built-in digital camera

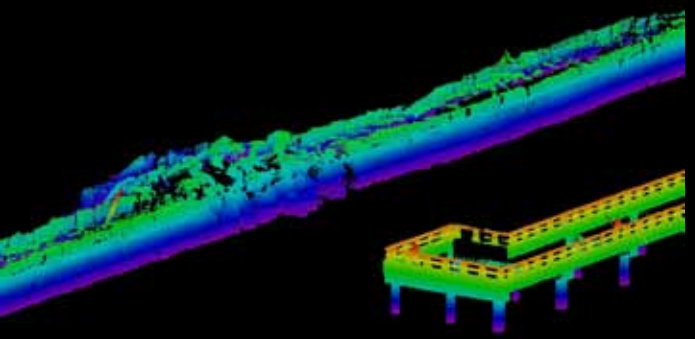
APPLICATIONS

LANDMark Marine provides the users with accurately georeferenced point cloud data. This has application in a wide variety of scenarios including:

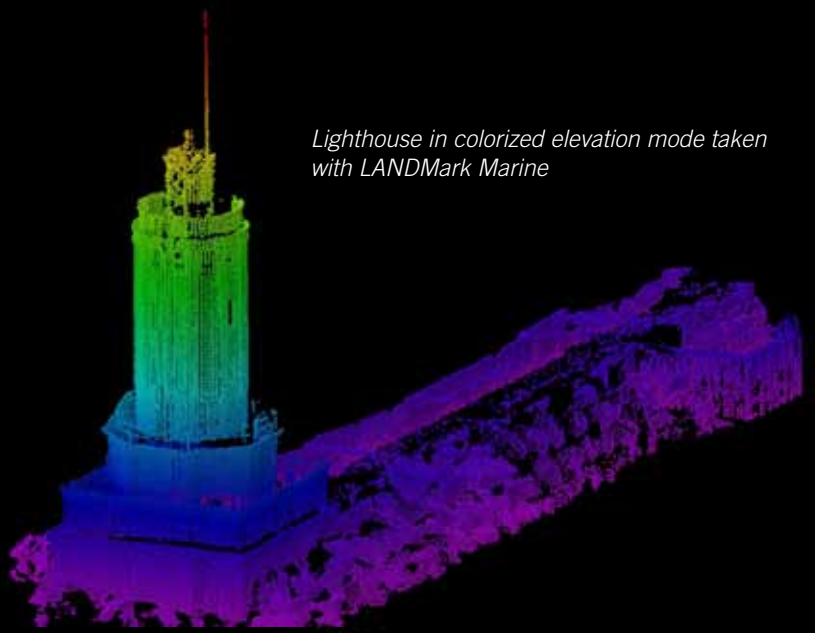
- Environmental monitoring (erosion, disaster mapping, change detection, habitat)
- Structural analysis (docks, vessels, bridges, oil rigs)
- Charting
- Port and Harbour Security
- As-built surveys
- Coastal zone management



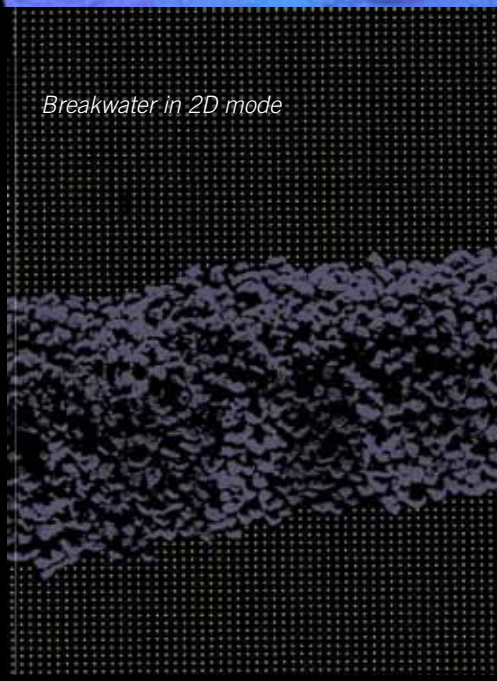
A Breakwater section produced with the LANDMark Marine lidar



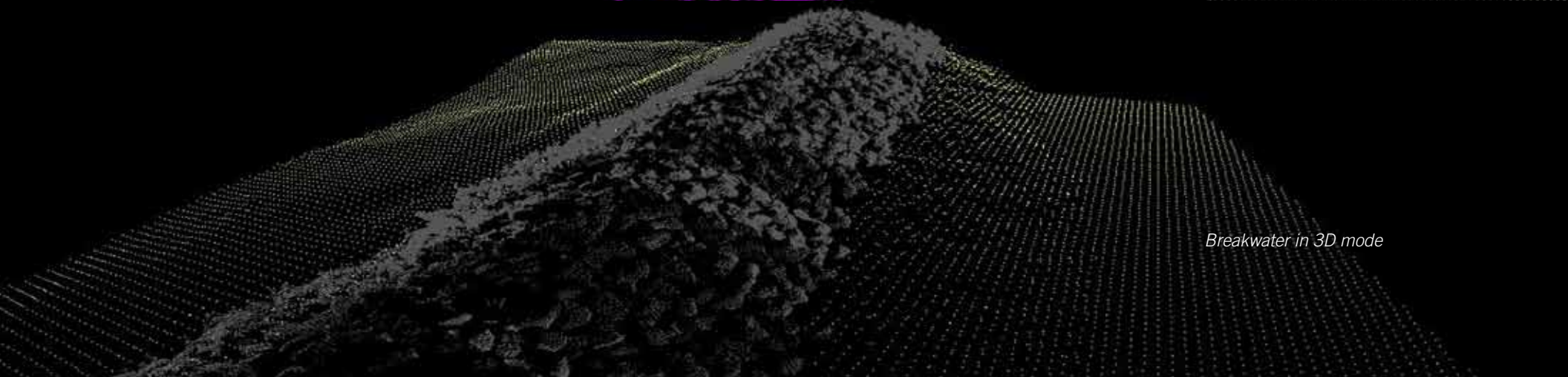
Pier in Monterey CA showing elevation in color mode



Lighthouse in colorized elevation mode taken with LANDMark Marine



Breakwater in 2D mode



Breakwater in 3D mode

HOW WE DO IT: APPLANIX TECHNOLOGY AND LANDMARK MARINE

Applanix pioneered the first commercial GNSS-Aided Inertial based Direct Georeferencing system for mobile mapping in 1995, and continues to blaze a trail of innovation today, supplying unequaled know-how and expertise to our customers, partners, and equipment manufacturers around the world.

THE POS MV™

The Applanix POS MV™ system is a GNSS-aided inertial navigation system which provides a complete set of position and orientation measurements. Launched onto the world market in 1996, POS MV is a tightly-coupled system which uses Applanix' unique approach to Inertially-Aided Real-Time Kinematic (IARTK) technology. With its high data-update rate, POS MV delivers a full six degree-of-freedom position and orientation solution. It is designed for use with multibeam sonar systems enabling adherence to IHO (International Hydrographic Survey) standards on sonar swath widths of greater than ± 75 degrees under all dynamic conditions. The POS MV offers users the highest degree of accuracy in in-motion measurement for marine applications.

Using our proprietary IARTK technology and POSPac MMS software, Applanix has paved the way in providing centimetric level accuracy of ellipsoidal altitude, enabling true Direct Georeferencing of multibeam data. In addition, our TrueHeave™ product leads the industry in computing accurate heave estimates.

OBTAINING HYDROGRAPHIC DATA WITH MULTI-BEAM SONAR

TrueHeave™ Technology
Applanix has redefined accuracy and reliability of heave data with TrueHeave. Based on advanced two-sided filtering techniques, TrueHeave uses both past and present vertical motion to compute a highly accurate and robust heave estimate.

Hydrographic Mapping on the Ellipsoid
Applanix provides centimetric level accuracy of the ellipsoidal altitude, allowing for coherent sea floor images to be obtained in even the most difficult tidal regimes.

OBTAINING GEOREFERENCED SURFACE DATA

Combining LiDAR imaging for high accuracy Digital Surface Models, a built-in digital camera, and the Applanix POS MV positioning and orientation system, LANDMark Marine delivers highly accurate georeferenced laser imaging data.

CONFIGURATION

LANDMark Marine includes:

- **Dual Axis, 10 KHz Scanning Laser**
- **Digital Camera**
- **POSPac MMS:** post-processing for the ultimate positioning and orientation accuracy
- **Point Cloud Analysis software** for measurement and exploitation of laser data

iSurveyor decked out with all the gear, including LANDMark Marine


Univeristy of Rhode Island vessel with LANDMark Marine before heading out to do the Providence RI survey

LANDMARK MARINE SPECIFICATIONS

RANGE AND ACCURACY

Range 80% Reflectivity	1700 m
Range 10% Reflectivity	650 m
Minimum Range	3 m
Laser Repetition Rate	10,000 Hz
Raw Range Accuracy *1	7 mm @ 100 m
Raw Positional Accuracy	8 mm @ 100 m
Raw Angular Accuracy (µrad)	80
Scanning Method	Single or Dual Axis Scanner (user selectable)

SCANNER PROPERTIES/DIGITAL CAMERA

Minimum Step Size*2 (degrees) (µrad)	0.001146 20 2 mm @ 100 m
Beam Diameter in mm @ 100 m (1/e2)	19
Beam Divergence (degrees) (µrad)	0.008594 150
Laser Wavelength nm	1535
Laser Class*3	1 M
Integrated Camera	Integrated digital camera (CMOS sensor) optional external camera 40° x 40°

ENVIRONMENTAL

Temp Operating	0 to 40 ºC
Temp Storage	-20 to 50 ºC
Power Consumption	75 W
Battery Life (standard battery pack)	5 hours operation hot swappable for continuous operation
Data Storage	Removable USB
Standard Accessories	Universal voltage AC Power supply Automated Alignment Software
Optional Accessories	Batteries and chargers

* Note 1 – All accuracies are one sigma, as performed under Factory test conditions. Details available upon request.
* Note 2 – Independent fully selectable vertical and horizontal step size selection
* Note 3 – Laser Class in accordance with IEC 60825-1, US FDA CFR 21, 1040

PHYSICAL SIZE

Scanner weight and physical size	13 kg, 320 (L) x 320 (W) x 220 (H) mm
Power supply and consumption	24 VDC, 75 W
Data storage	Solid state, removable USB memory field-interchangeable
Standard software	Data output to a variety of metafile and XYZ coordinates, including active laser intensity photograph and digital photo.

EYESAFETY

Laser class	Class 1 laser product** IEC 60825-1, US FDA 21 CFR 1040 Eyesafe in all modes of operation

**Note: ER option is Class 1M.

All information is subject to change without notice.

CASE STUDY
Building seamless models of port and coastal environments, both above and below the water line, with LANDMark Marine

Combining accurate georeferencing and the motion compensation from POS MV, together with point cloud data from lidar and multibeam sonar, a seamless model of a port and coastal environment, both above and below the water line, can be built.

Mapping Providence Harbor, Rhode Island

THE CLIENT:

The Coastal Institute at the University of Rhode Island's Graduate School of Oceanography has been involved in an ongoing program to protect and preserve the Narragansett Bay estuary and its watershed through partnerships with other agencies. One of those agencies is the Rhode Island Coastal Resources Management Council (CRMC). The CRMC endeavors to balance economic considerations with environmental protection through comprehensive and coordinated long-range planning and management.

The Coastal Institute and CRMC expressed an interest in investigating the efficacy of acquiring georeferenced LiDAR data for shoreline stability analysis and change-detection studies. In addition, they were interested in integrating the LiDAR data (3-dimensional XYZ point positions) of the Providence River shoreline with bathymetric (water depth) data.

THE CHALLENGE

An integrated system was needed to scan and produce high-resolution, high-accuracy spatial data for above-water shore features from a boat that was simultaneously obtaining bathymetric soundings. The bathymetry and LiDAR data needed to be integrated to produce 3D georeferenced data above and below the water line; a considerable technical challenge. Any total solution proven to be viable for this task and in this environment would be used to provide 3D georeferenced data in ongoing change-detection studies, shoreline stability analysis, beach erosion monitoring, cliff erosion/deformation, and inventorying natural and as-built physical features throughout Providence harbor.

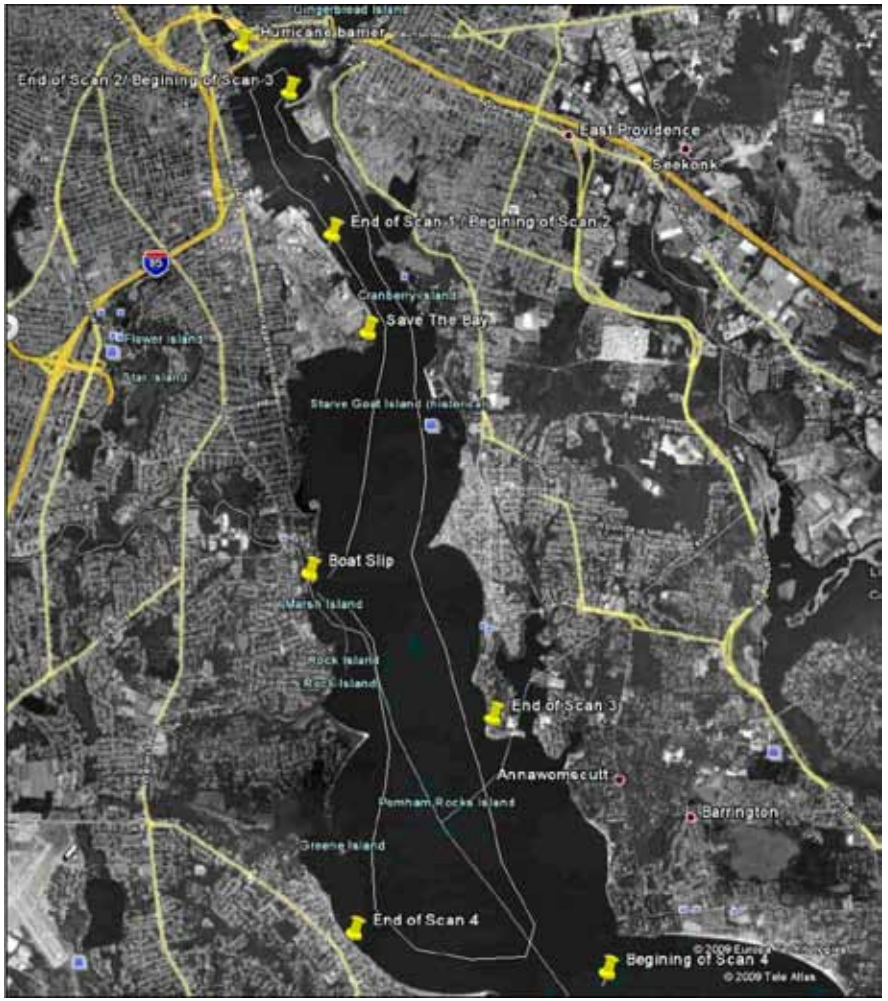


Figure 1: Route of LANDMark Marine scan along Providence River shoreline

THE SOLUTION: Applanix LANDMark Marine

In January, 2009 a LiDAR survey team set out to collect 3D images of the beaches, the hurricane barrier and other prominent features along the river's edge using the new LANDMark Marine system to scan the shoreline area along the Providence River south of the city (Figure 1) from a boat. Applanix' industry-leading combination of POS MV (Position and Orientation System for Marine Vessels), a GNSS-aided inertial navigation system, and POSPac MMS software were used to provide the accurate and robust georeferencing and motion compensation solution , enabling the production of a seamless point cloud from the bathymetric and georeferenced LiDAR data.

A GPS base station was deployed in order to log satellite observables for later post processing. The crew then mounted the LANDMark Marine and POS MV equipment on the boat. LANDMark Marine was positioned such that it was scanning from the port side of the boat, at approximately 90° to the vessel's direction of travel. One of the most important considerations in obtaining precisely georeferenced data is in determining the misalignment angles and lever arms between the POS MV IMU and laser scanner. In LANDMark Marine, this is done using the built-in MatchView utility, which automatically determines these values based on the known coordinates of survey marks in the scanner field of view.

After scanning the inner harbor of Providence, with a particular focus on the hurricane barrier, they proceeded south, scanning the eastern shore. Having completed the circuit of Providence harbor, downloading data from the GPS base station at the dock began, taking approximately 20 minutes.

The GPS base station observables, together with the raw GNSS and inertial data logged by POS MV were then processed in POSPac MMS, Applanix' unique post mission aided inertial processing package. This produced the Smoothed Best Estimate of Trajectory (SBET). The SBET and the predetermined calibration numbers from the MatchView routine could then be used to produce a georeferenced point cloud from the LANDMark Marine scans.

Processing the data on the boat took only about 15 minutes, thus enabling the results to be viewed and analyzed before even leaving the vessel.

THE RESULT:

This survey succeeded in demonstrating that LANDMark Marine technology provides a fast, safe and efficient method of obtaining both short- and long-range spatial data from the boat's perspective and of scanning terrain features beyond the water's edge. When traveling at speeds of 2.5 to 4 knots—typical of the speed of a vessel operating multibeam sonar—LANDMark Marine is capable of generating point clouds of suitable density for use in shoreline change-detection studies.

One benefit of being able to operate LiDAR and sonar devices at the same time is that the data sets are referenced using the identical navigational data sets derived from the GNSS aided Inertial Navigation System (INS). Additionally, by operating LiDAR and sonar systems together, only one data gathering mission is required, and no additional personnel need be deployed in potentially hazardous areas onshore.

Above are various LiDAR and camera imagery taken at Providence Harbor, Rhode Island. At left are LiDAR images, right are the actual camera images taken at the same time.

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