Onboard Data Processing with Autonomous Surface Vehicles in the Bering Sea

Near real time data processing facilitates the success of pioneering autonomous survey operations in support of national charting surveys of the USA.

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Introduction

TerraSond, a hydrographic services company based in Palmer, Alaska (USA), recently used a C-Worker 5 (CW5) unmanned Autonomous Surface Vessel (ASV) in conjunction with a 105' (32 m) research vessel from June through August, 2016 for a major hydrographic survey in the Bering Sea region of Alaska. The project was an industry first in using ASV technology to maximize productivity in a hydrographic survey in remote areas, and the work proved the benefits of using autonomous vehicles.

One of the key technologies used throughout the survey was the use of CARIS Onboard, a near real time data processing software that enabled rapid generation of processed datasets from the ASV.

Background

TerraSond has worked with autonomous technologies for hydrographic survey for some time, and is experienced in realizing the benefits of autonomy to reduce survey time and increase data productivity. In the case of surveys in Alaska,

autonomy is particularly beneficial due to the remote locations of survey areas. Much of the Alaska coastline is far from ports and requires expensive mobilizations of relatively large vessels and time-consuming transits to reach. By utilizing a force multiplier such as an ASV, a survey can be completed in a smaller timeframe, which is of particular benefit when the area is only open to surface traffic during the summer months due to sea ice pack.

In 2016 TerraSond was awarded a U.S. National Oceanic and Atmospheric Administration (NOAA) contract for a 570 square nautical mile survey area in the Bering Sea region of Alaska, near Nunivak Island in Etolin Strait. This survey was well suited for ASV deployment.

Survey Area

Like much of Alaska's Arctic coast, the area is remote, with fuel and supplies days away by water. The 105' research vessel, the RV Q105, would need to be mobilized in Homer, Alaska – the "closest" port to the survey area on the road system – and transit 900 nautical miles for four days to reach the survey area. The closest source of fuel and supplies was Bethel, a roundtrip transit of 600 nautical miles or about three days.

Survey Hardware

A C-Worker 5 (CW5-ASV) was chartered from ASV, LLC. The CW5-ASV was developed from the ground-up as a hydrographic force multiplier. At 18' (5.5 m) the vessel is large enough to handle marginal weather conditions and support a variety of survey instrumentation but small enough to fit on the deck of small to mid-sized support vessels like the Q105. Other features which made it well-suited for this project include 4-5 days of continuous survey endurance and 6 to 7 knot survey speeds

Both the ASV and Q105 were configured with identical survey systems. Major components consisted of Reson 7101 multibeams, Edgetech 4200 sidescans, and Applanix POSMVs. The decision to equip both vessels with the same equipment was intentional – this meant the survey data quality would be comparable and minimized logistical concerns of spares in such a remote location.

Data Management

Controlling and monitoring the ASV required an additional four dedicated personnel aboard the Q105 for 24 hour operations. This consisted (per 12-hour shift) of one ASV person-

nel to monitor the CW5-ASV and one TerraSond personnel to monitor the survey equipment suite. A fifth person from ASV was also aboard to assist with issues if needed, especially since the CW5 was a new survey platform for 2016.

The survey systems on the ASV were monitored by remote desktop methods over a standalone IP radio system. This allowed the two survey grade PCs on the ASV and the associated survey software to be monitored in real time. However, transmission of raw data over the radio link to the Q105 was not possible because of the large data volume generated.

Although having the additional vessel increased the rate of data production, two challenges were presented - first how to provide quality control for data that was not accessible in real-time, and second how to deal with twice the amount of data due to the additional vessel. To address these challenges a new software package offered by CARIS was used, CARIS Onboard.

CARIS Onboard is a near real time survey data processing software, which monitors the directory where survey data lines are logged and automatically processes them in accordance with a pre-defined workflow. The software was run on the ASV's multibeam computer, and was used to generate both a processed CARIS dataset and survey products, such as TIN models showing both the quality of the data and the bathymetry.

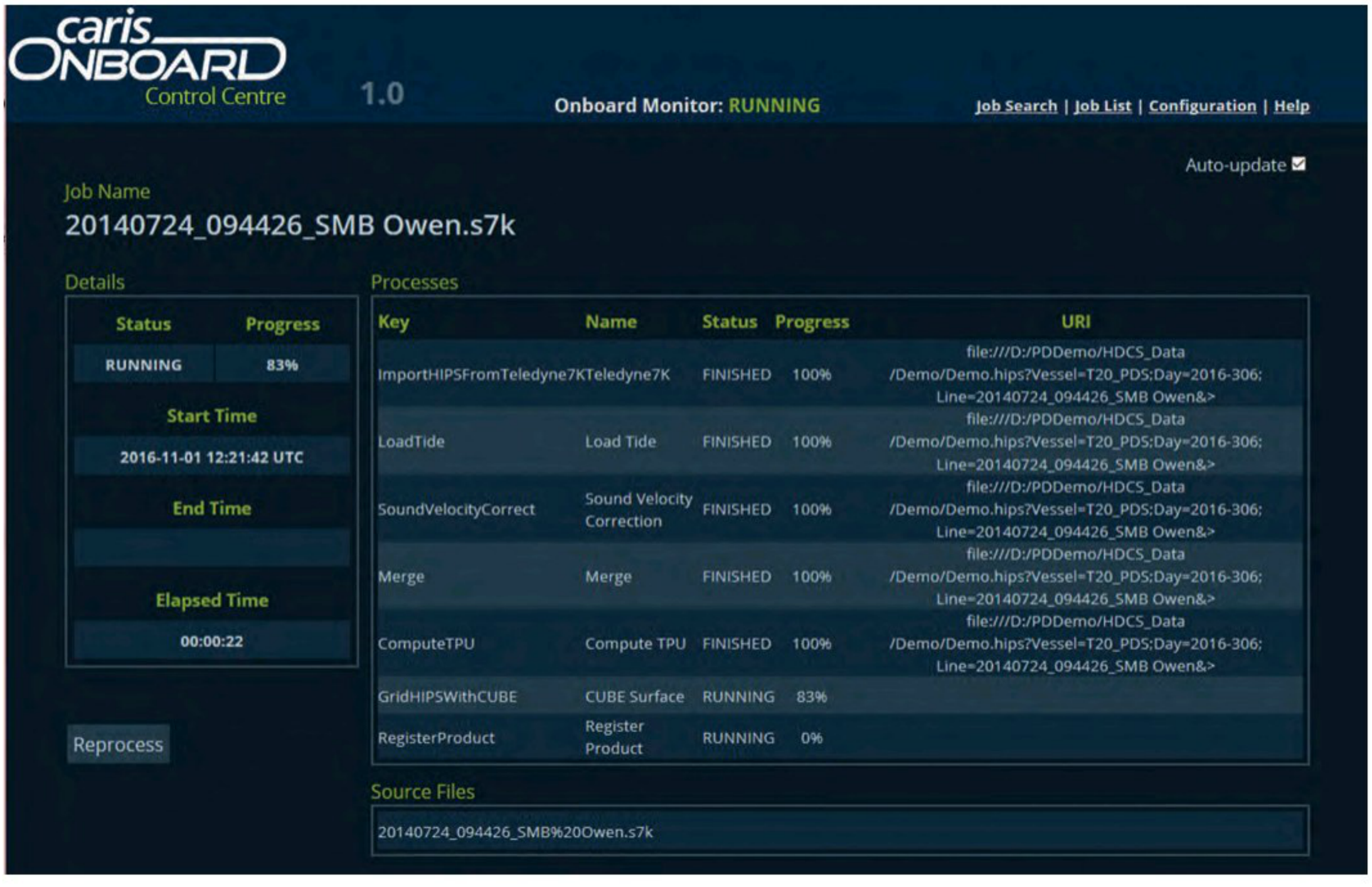
This approach allowed quality control of processed data to occur despite a limited bandwidth connection, as the surveyor on the Q105 could check that data was meeting the required survey standards. The second challenge of data volume was also met by the use of CARIS Onboard, as a processed dataset was available both during the survey and immediately upon recovery of the ASV.

Operations

Radio bandwidth was adequate for real-time monitoring and tuning of the acquisition systems but insufficient to transfer raw sensor data, which could be up to 100 GB/day. To prevent a data bottleneck, firstly CARIS Onboard was used to allow the surveyors on the manned platform to visualize the processed dataset to look at the bathymetry and also monitor the quality of the processed dataset. Secondly, data was downloaded whenever the ASV was recovered aboard the Q105, which on one occasion was 3 ½ days after deployment. By using CARIS Onboard the duration between recoveries could be maintained with greater confidence at this long interval.

Results

Despite a relatively complex survey instrumentation suite that included towed sidescan, the CW5-ASV acquired 2,275 nautical miles of the project total of 5,200 nautical miles of



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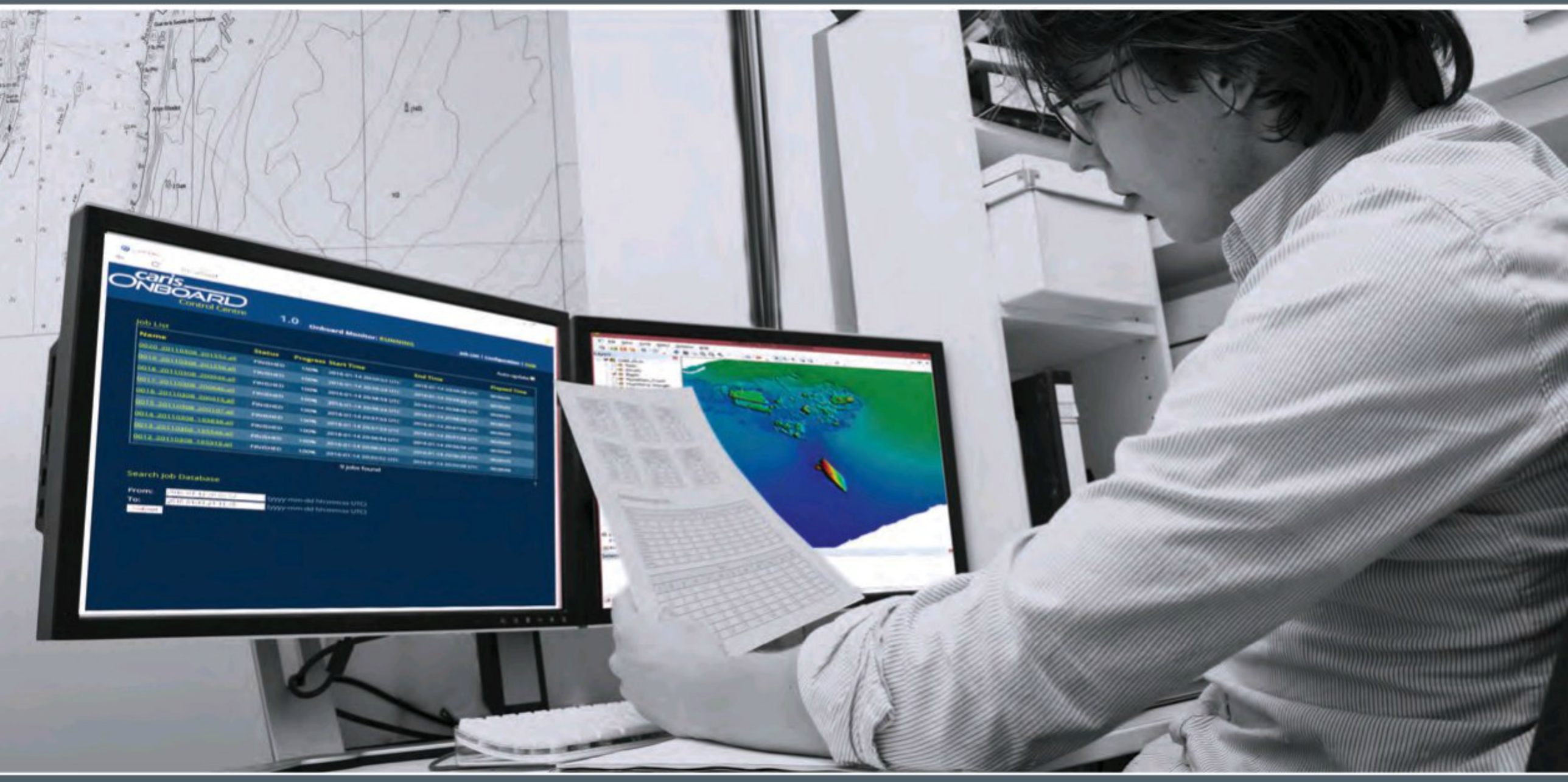

FOCUS ON THE TOUGH STUFF

CARIS Onboard™ automates many of the standard processing steps required in a modern hydrographic survey that not only reduces subjectivity but allows your skilled staff to work on the most important tasks. With the ever expanding volume of data being collected at higher resolutions CARIS Onboard will reduce your data Ping-to-Chart™ timeline.

Built on decades of hydrographic data processing expertise and supported by the highly scalable CSAR framework, CARIS Onboard enables users to process data in near real-time resulting in minimized data conversion and processing times. Designed with autonomous operations in mind, CARIS Onboard will save valuable time so you can focus on the tough stuff.

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sidescan and multibeam data, or 44% -- with the Q105 collecting the remainder. This production rate was much higher than the anticipated 30% and resulted in an on-site time savings of almost 25 days, allowing the project to be completed well ahead of schedule and during the optimal part of the Arctic summer.

Without using software for efficient data management such as CARIS Onboard, the full benefits of using autonomy for this survey would not have been realized. The additional data load from the ASV was mitigated somewhat by processing it autonomously onboard, and in this case a separate copy of CARIS Onboard was also used on the Q105 to reduce the processing workload even further.

Future Plans

The successful deployment of the CW5-ASV in conjunction with the data management provided by CARIS Onboard for this project demonstrates the potential of ASVs to increase efficiency and productivity by operating concurrently with a larger survey vessel. Future plans may include deployment of multiple ASV platforms like the CW5-ASV off a single larger vessel to realize even greater production capacity.

Biography of Author

Andrew Orthmann manages NOAA charting work for TerraSond. He has 16 years of experience in the field of hydrographic survey, consisting of 9 years for Fugro-Pelagos and 7 years for TerraSond. He holds a B.S. in Geography (2000) from the University of Alaska Fairbanks and is a NSPS-THSOA Certified Hydrographer (#225). ***aorthmann@terrasond.com***

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