Remote Processing of Ship-based Hydrographic Multibeam Data

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SUMMARY

Canada's obligation to provide safe navigation through the Arctic has increased hydrographic survey operations. Collection and processing of data traditionally takes place onboard larger survey vessels; smaller survey launches are deployed to acquire bathymetry along coastal areas. The goals: to have a nearly completed product ready within a short timeframe after survey operations end; and to conduct quality control on the data before departing the survey area.

A component of the survey cost is related to the number of data processors onboard the survey vessel. This coupled with potential skilled workforce shortages for offshore operations has led to increased challenges to deliver an effective and viable survey program. In addition, it is quite conceivable that unmanned surface vehicles can be used to collect hydrographic information thus leading to a completely remote operational environment for data collection and processing.

Processing hydrographic data by logging onto a shore-based centralized server from a shore-based remote location has proven to be a viable technique in hydrographic data processing (Peyton et al, 2010). Taking this concept one step further, the Canadian Hydrographic Service conducted a trial survey whereby a Citrix remote client was installed on a survey vessel and multibeam data was cleaned and processed from a remote shore based facility.

This paper describes the survey setup, system configuration and processing results using the above methodology during a demonstration survey on board a 22-foot survey launch. Potential for remote field access to production databases for real-time product revision will also be discussed.

Key words: hydrography, Citrix, data processing, QC/QA, multibeam

1. BACKGROUND

Competitive pricing, ease of use, and market preferences have made multibeam echo sounding surveys a mainstream tool for hydrographic surveys. At the same time efficiency of use has become an important component of all surveys. The primary reasons being to keep costs down, to acquire final results as near real-time as possible and to have a more effective use of human resources and assets.

Processing hydrographic data by logging onto a ship-based centralized server from a shore-based remote location has proven to be a viable technique in hydrographic data processing [ibid.]. The approach involves the concept of "desktop virtualization," which is an approach whereby just about any computing device can be turned into a fully functional desktop without completely sacrificing IT security rules. Citrix and Wyse Technologies, for example, have extended Windows desktops to the Apple iPad.

The Citrix-enabled central server and remote clients exchange a small amount data. This highly optimized data stream consists of: compressed screen data, keyboard keystrokes and mouse movement instructions only resulting in small bandwidth requirements (www.citrix.com). In effect, the remote machine is a dumb terminal and "sees" the screen of the central server "being controlled" where all data processing actually takes place.

One of the main benefits of Citrix is the elimination of the need to transfer enormous quantities of data (either physically or via the Internet), which in turn reduces the latency and expense associated with moving data, while also making data management and data security much simpler. A related benefit is better utilization and version control of software packages used to process data. Using Citrix enhances data security over traditional approaches as no data actually resides outside of the central server.

Taking this approach one step further, the Canadian Hydrographic Service (CHS) Pacific Region conducted a shallow-water survey in British Columbia, Canada using the CHS vessel Shoal Seeker (Figure 1). The Shoal Seeker was an ideal candidate for this test in that it fit the profile of a typical modern survey launch with limited space aboard for equipment and personnel. Consequently the ship-board data acquisition system was separated from the shore-based data processing. This has necessarily meant the quality control of the collected data is only finalized well after the survey acquisition has been completed. This can often lead to missed lines, bad data and a need to return to the survey area to complete the job. In essence, this is not a cost effective or efficient use of the available hydrographic assets. This made it an ideal candidate for testing the concept of real time remote multibeam data processing.

Figure 1 - Shoal Seeker - 22 foot survey launch

2. SET-UP AND SURVEY SITE

In order to test the concept of remote processing of multibeam data for near real-time QA/QC, a demonstration survey within predicted 3G cellular coverage (Figure 2) was devised. The laptop computer (Figure 3) aboard the Shoal Seeker was configured with a Telus Mobility wireless mobile Internet stick for Internet access.

The idea was to process the collected data aboard the vessel in near real time using remote access software (**GoTo**MyPC from Citrix) by a shore-based data processor (Figure 4). We note that the distance between the survey site and the shore-based processor is approximately 4000 km (Victoria, British Columbia to Toronto, Ontario, Canada).

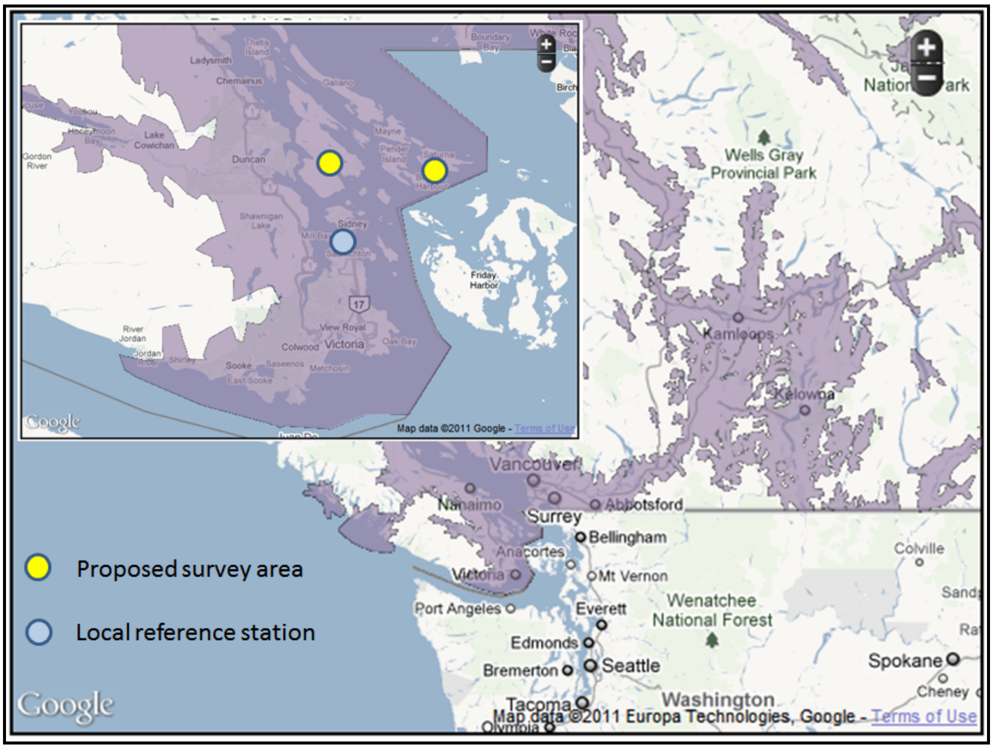

Figure 2 - Predicted 3G cell phone coverage, SW British Columbia

Figure 3 - Citrix-enabled central server aboard Shoal Seeker (initial set-up)

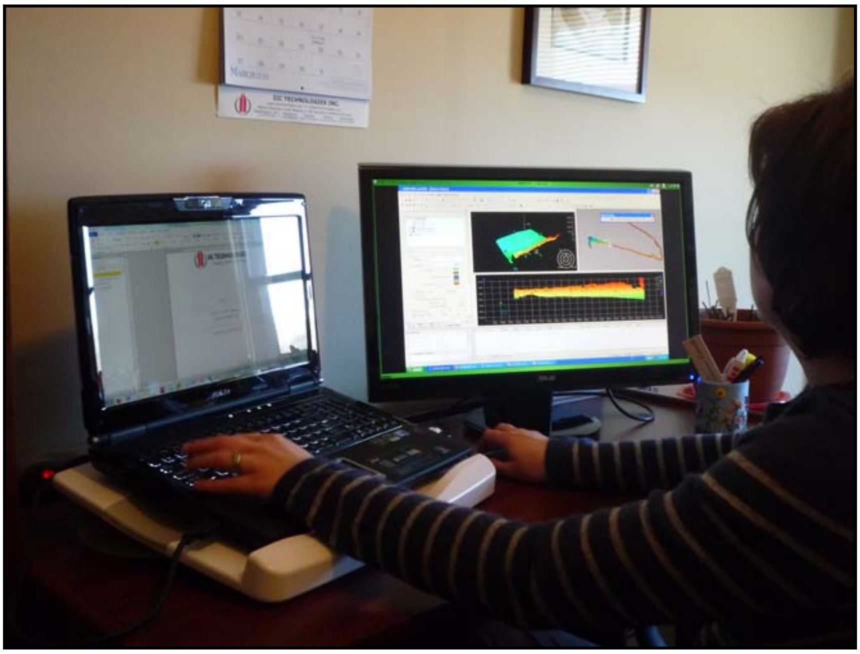

Figure 4 - Remote HIPS processing in Toronto

Initially, Fulford Harbour (Number 1 in Figure 5) was selected as a good candidate site for the demonstration survey, believed to be not only in good 3G coverage, but also covered by local RTK service (local reference station near Number 3 in Figure 5). While the latter service proved to be available at Fulford Harbour, the former coverage did not. Consequently, a second candidate survey area was chosen – Lyall Harbour (Number 2 in Figure 5). Lyall Harbour did have good 3G coverage, but sadly was not covered by the RTK service – so predicted tides would be required for sounding reduction.

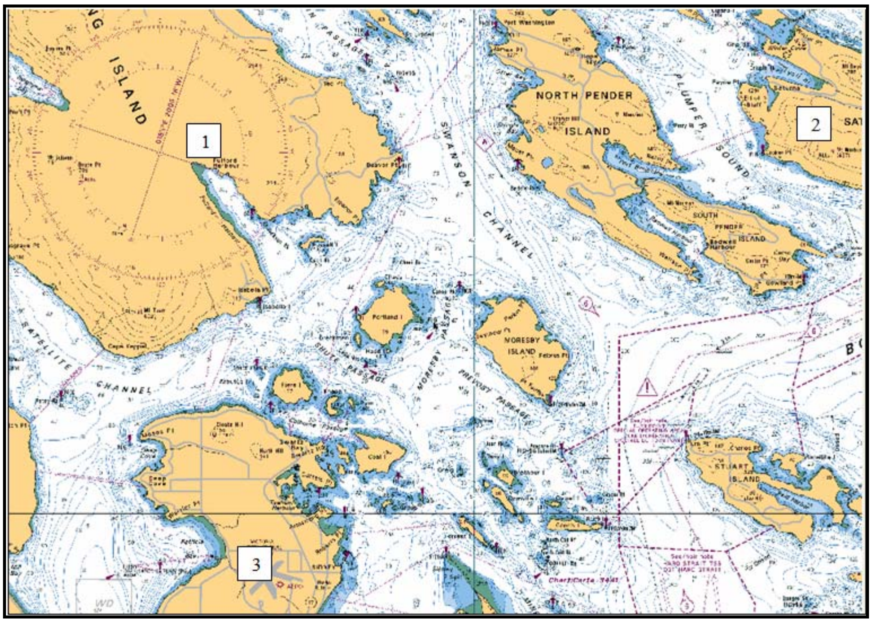

Figure 5 - Project areas (southern BC)

3. METHODOLOGY

IIC Technologies, Inc. configured a laptop computer with Citrix software and a CARIS HIPS licence, which would act as the central server. This laptop was then attached to the Shoal Seeker's on-board network, which allowed connection to the data acquisition computer RAID drives, where all the raw sonar files, tide files, sound speed profiles, etc. are stored. The ship-board configuration process took less than 1 hour.

With the vessel alongside at Institute of Ocean Sciences (IOS) (near Number 3 in Figure 5) and the laptop having Internet connectivity via the Telus stick, an IIC Technologies, Inc. bathymetry processor in Toronto with a pre-configured user account was able to connect via Citrix remote access software (**GoTo**MyPC) directly to the processing laptop. She was able to open a CARIS HIPS session, grab logged sonar files from the RAID drives over the on-board network, open them in HIPS and start processing. To someone onboard the vessel, the speed at which this happened made it appear as though the data processor was aboard the boat.

It is important to note that the reason for this performance is that all the data remains aboard the vessel, so a broadband Internet connection is not required and the costs associated with moving huge amounts of data over the Internet are avoided. The data and the processing horsepower needed are on the on-board computers; only the command keystrokes/mouse clicks and an optimised replica of the computer screen are passed across the Internet link, requiring far less bandwidth. Both the remote processor and the data acquisition hydrographer aboard the vessel can view the processing in action and can stay in constant communications using, e.g. Notepad (Figure 6), a text-based conversation.

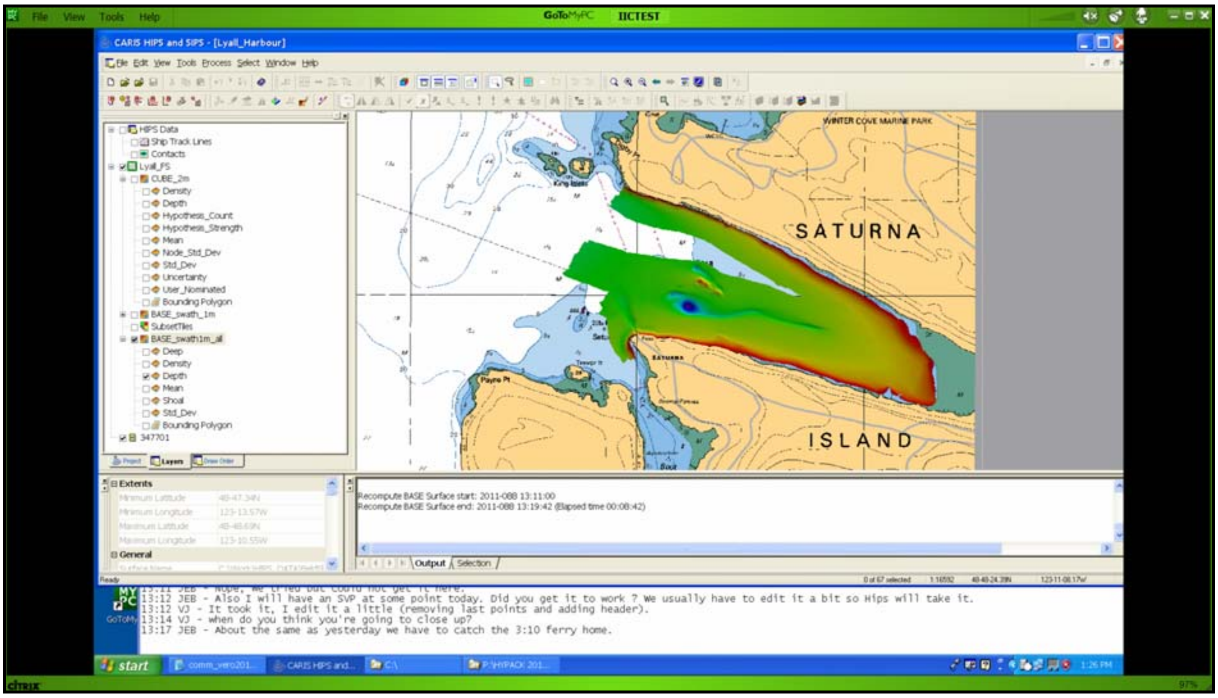

Figure 6 - Example of processor (VJ) and acquisition hydrographer (JEB) communications using Notepad (bottom of image)

4. RESULTS

After the initial configuration and remote connection test at IOS had proved successful, a test survey was planned for nearby Fulford Harbour, thought to be well within Telus 3G coverage and RTK range from the local reference station. A BSB chart backdrop, adjacent BASE surface and predicted tides were provided to the remote processor, who uploaded them to the processing PC. In addition, the vessel configuration file, including TPU values was also provided. As it turned out, local topography on Saltspring Island prevents cell phones from working in Fulford Harbour. Several attempts at connection failed. The hydrographer on the Shoal Seeker phoned from a land line to confirm that his cell phone was not getting coverage.

Plan B – Lyall Harbour. Lyall Harbour, while further away from local cell phone towers, proved to be in excellent 3G coverage, although not within range of the local RTK signal. Predicted tides and a different BSB chart backdrop were made available to the remote data processor. Unfortunately, no adjacent BASE surface was available for this area.

On March 28, 2011, the crew of the Shoal Seeker confirmed good cell coverage and contacted the remote processor in Toronto, who was able to connect and start processing lines shortly after they had been completed. The data acquisition hydrographer was able to inform the remote processor using Notepad on the laptop computer of the status of each line, and the remote processor was able to advise the hydrographer on-board of problems (Figure 7; Figure 8) with the data as they arose. Most importantly, near real-time QA/QC of the data was being performed so the survey could be adapted to correct defects (data gaps, uncertainties outside of specifications, more data needed over certain features to resolve multiple hypotheses, etc.) before the survey crew left the project area (Figure 9).

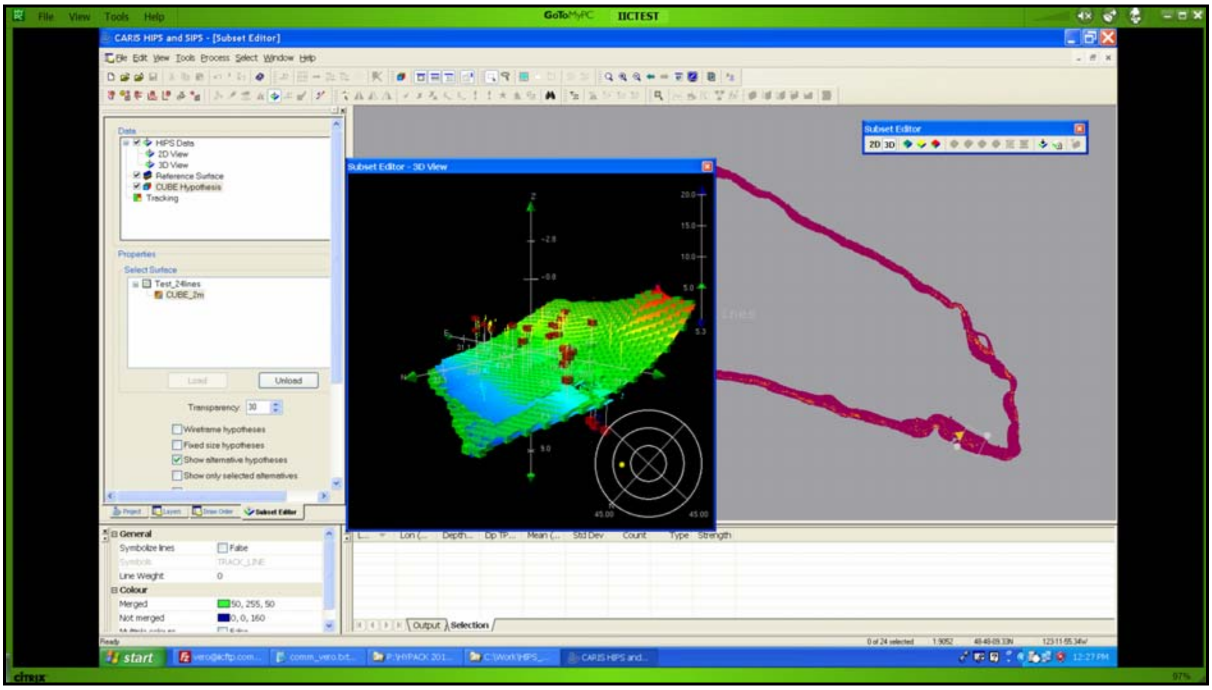

Figure 7 - Remote processing: CUBE hypotheses

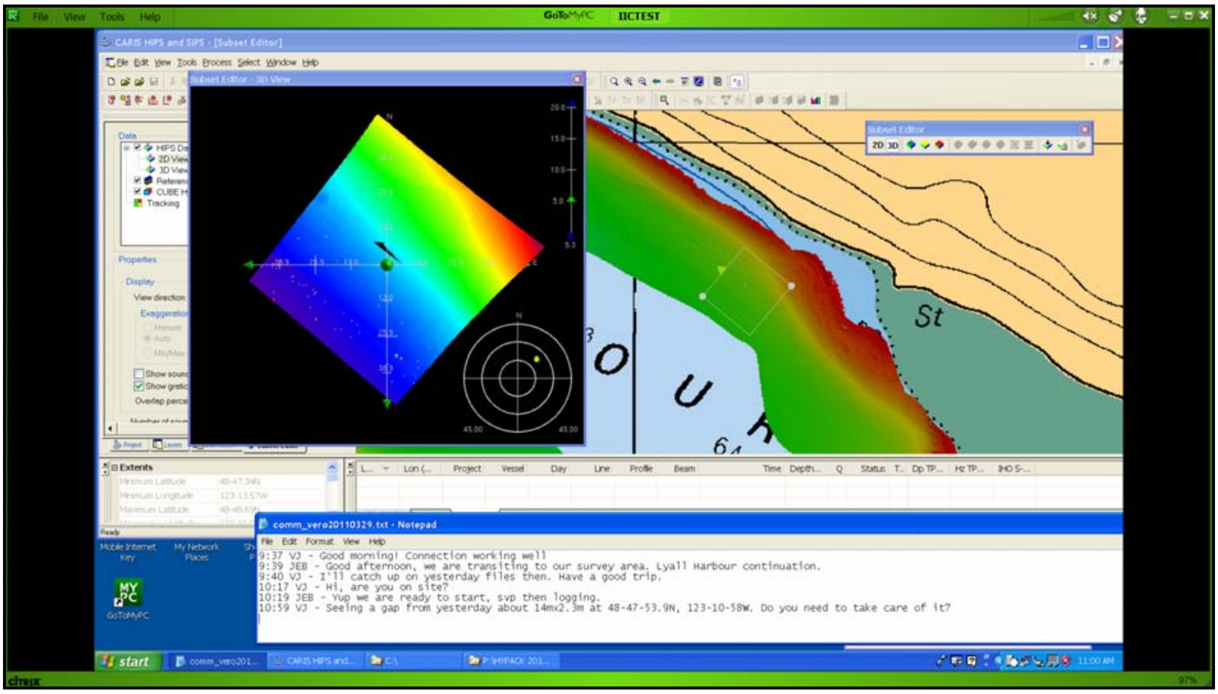

Figure 8 - Remote processing: identifying an acquisition data gap

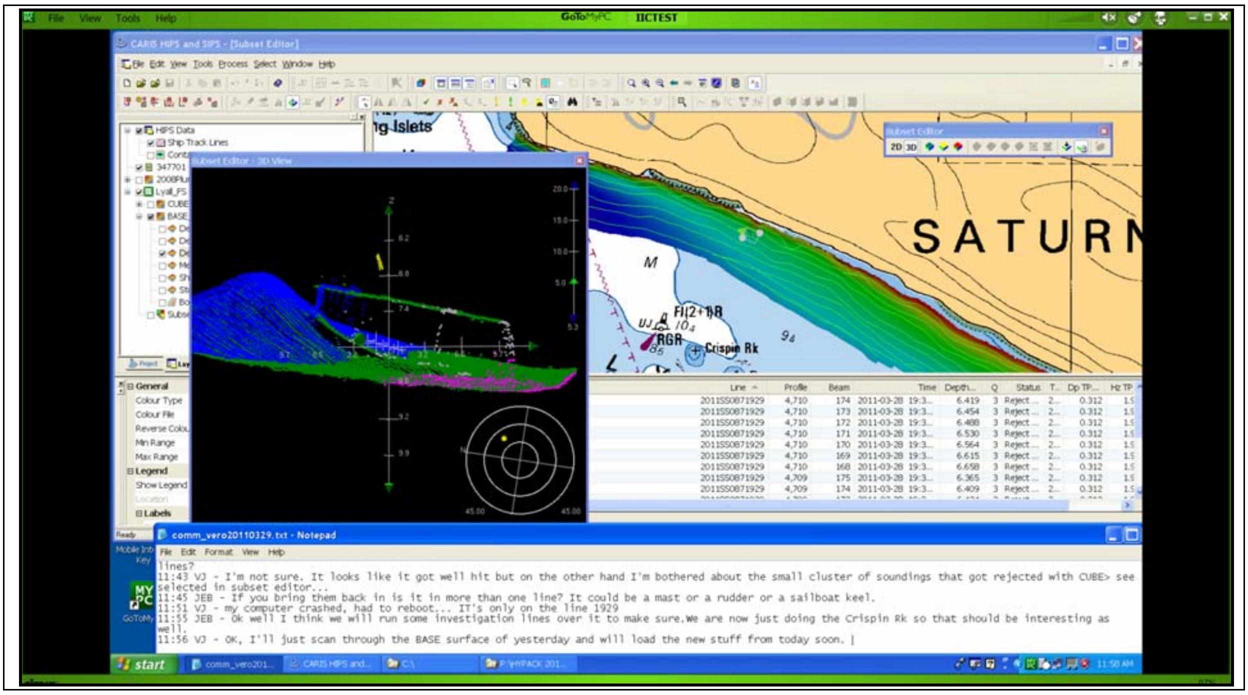

Figure 9 - Remote processing: identifying problem soundings above a wreck

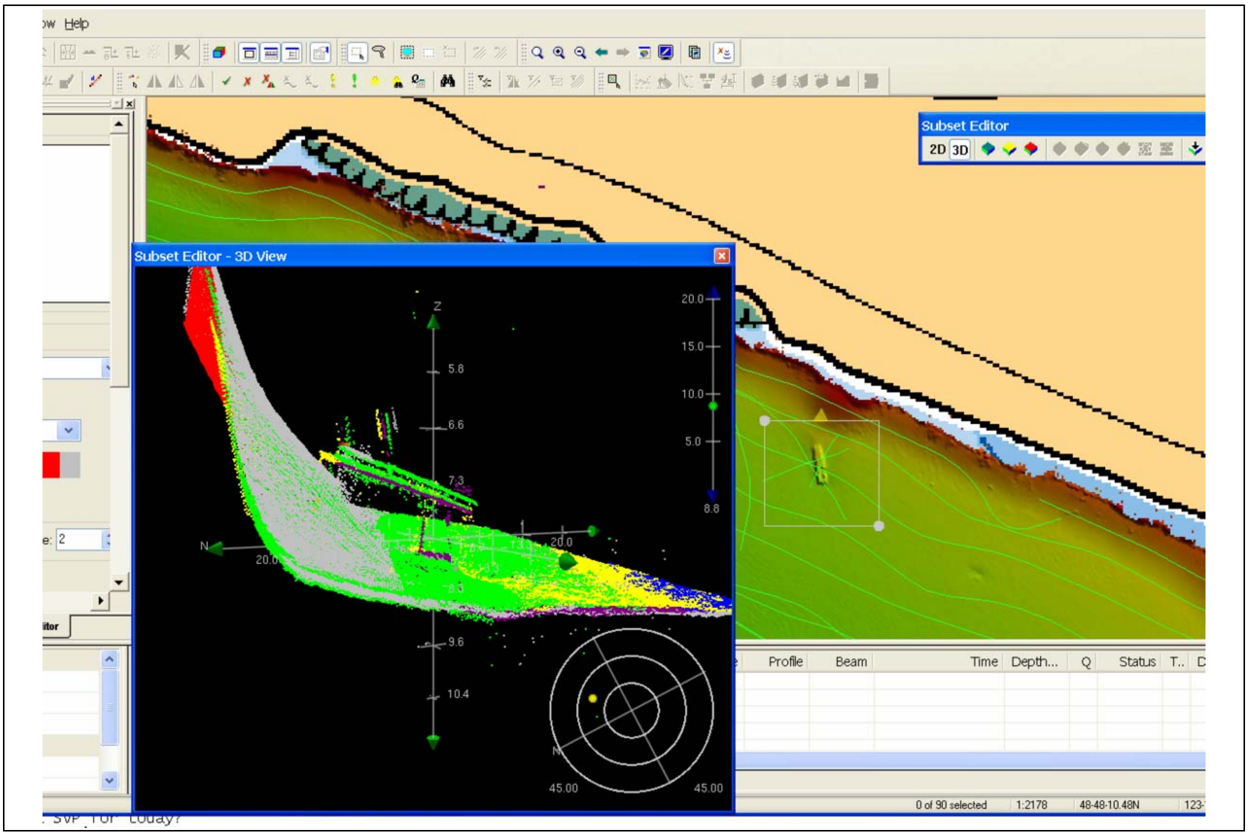

Figure 10 - Remote processing: unsubstantiated hypothesis over wreck resolved after additional lines run

The remote processor found that the speed at which the lines were being collected lead to an adapted processing strategy in order to keep up with near real-time QC and feedback to the crew on-board the vessel. Time did not permit a fully detailed processing strategy to be applied. Still, she was able to inform the crew of a data gap, which was resolved by running an additional line. Also, more detailed information above a wreck was required to aid in deconfliction of multiple hypotheses on the wreck's superstructure (Figure 10). At the end of the day March 29, 2011, the project was completed (Figure 11); including preliminary processing sufficient to identify and correct all the data acquisition defects before the vessel left the project area.

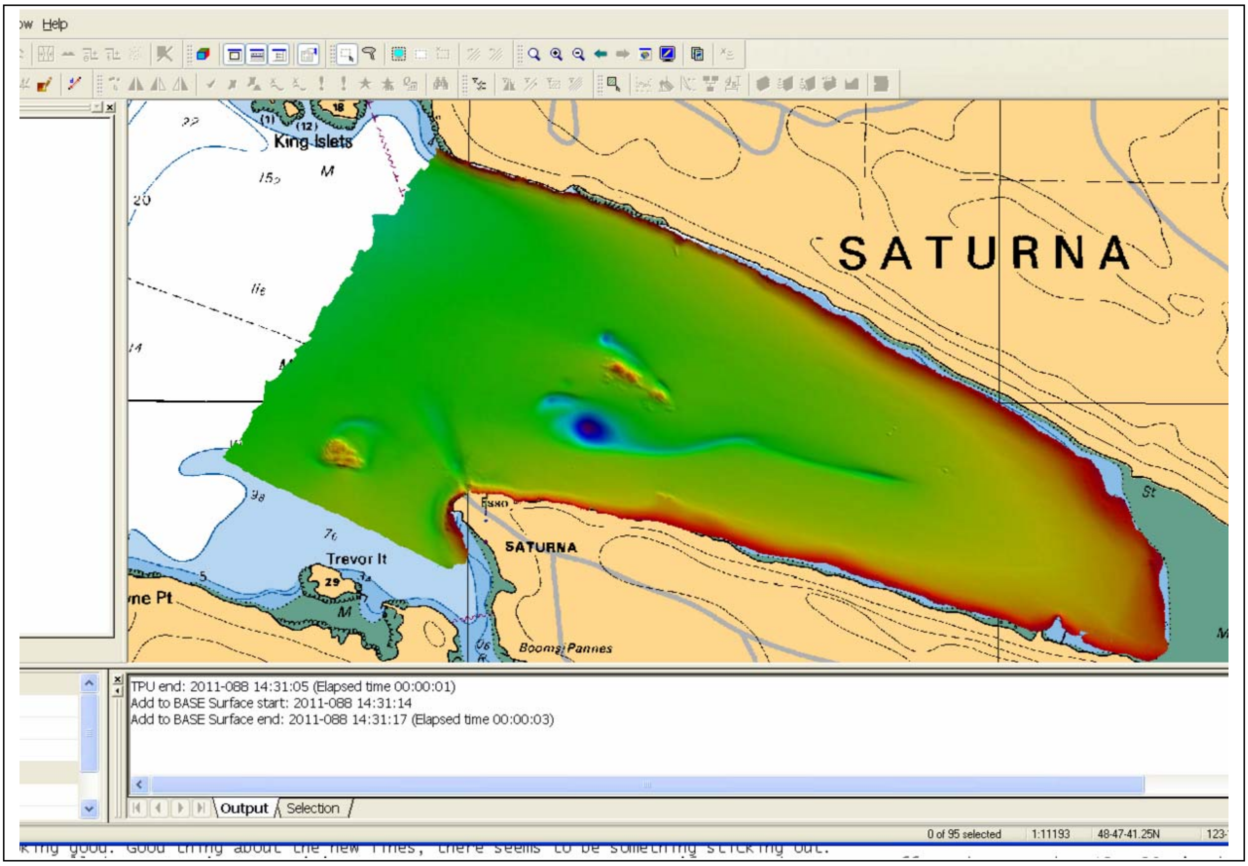

Figure 11 – Remote processing: final BASE surface for Lyall Harbour

5. DISCUSSION

The Lyall Harbour phase of the project worked very well and showed the many benefits of utilizing remote access to a survey vessel to conduct data processing and QA/QC procedures. For example, instances occurred where the remote data processor identified data gaps that needed to be filled and guided the survey team to a more detailed wreck investigation. In essence, communications between the survey crew and the remote processor were simplistic and reliable.

In addition to the use of CARIS HIPS for checking the internal consistency of the newly-collected data, it was quite conceivable to also check the external consistency of the data by comparison to a validated overlapping BASE surface using CARIS BASE Editor.

On March 30, 2011 the survey project area changed from Lyall Harbour to Whaler Bay, where limited to no 3G coverage was available, final processing of the Lyall Harbour project was not possible. A strategy may be required to download the data to a shore-based server with reliable Internet connection after each project completes. This would allow final processing and QC of the project. This would also ensure the project data (raw and processed) are fully backed up.

The time zone of the acquisition was Pacific Standard Time; the time zone of the remote processor was Eastern Standard Time – a 3 hour difference. For the processor, this meant a late start and late end of working hours each day. While this did not appear to be a big problem, one does need to consider strategies to ensure that acquisition and processing remotely stay in synchronization. The processor was able to begin working on the project as soon as Internet connection was established, often while the vessel was in transit to/from the work area. This allowed time for catching up on work from the previous day.

5.1. Start-Up Costs

For the most part, project costs were primarily on the survey vessel side. The remote processing side used the existing Internet and existing hardware. No special purpose set-up costs were necessary.

- PC box: (~$1000) small form factor (e.g. Shuttle PC) or any industrial/marine PC if desired; launch power supply and space on-board might be considerations;
- Standard IT software: (OS, antivirus, text editor, ftp client etc.) site licensing and/or open source so the cost is small (~$100);
- Wireless mobile Internet stick: ~$150 on a month to month plan (or free on a 3-year contract);
- Specialized software: CARIS HIPS, BASE Editor, Fledermaus, etc. – pricing dependent on individual vendor agreements;
- Two to three days if IT support to set it all up and test it.

5.2. Ongoing Costs

- Citrix GoToMyPC remote access @ $25/month/station – (PC-grade option from Citrix); other options (some free) are also available;
- Mobile data plan @ ~$50/month; or flexible plan $35/month first 500MB + $5 for each additional 500MB; daily usage is about 100MB/day; one might need to be wary of roaming charges in areas close to an international boundary;
- Ongoing IT support and system maintenance.

6. SUMMARY

A demonstration (proof-of-concept) survey of Lyall Harbour successfully showed that remote processing of high-density bathymetry can be of benefit for real-time QA/QC. The hardware, software and ongoing costs are reasonably affordable and can make more effective use of hydrographic assets (small vessels, hydrographic expertise).

There were some start-up glitches encountered, however, and one must take caution in believing 3G coverage maps produced by the service providers – these may be over-generalized and not show potential small outage areas. Processing of the data is only possible while the vessel is within good 3G coverage, unless other strategies are worked out for daily transfer and back-up of raw and processed data from the vessel to a network with more reliable Internet (or internal network) connection. It might be possible to set-up one’s own local wireless network to service small areas or use a WIMAX system configuration to cover wider areas. Another alternative to 3G is to explore satellite internet services (i.e. Galaxy Broadband).

7. FUTURE DIRECTIONS

For follow-on projects, the CHS will seek a more permanent installation on the Shoal Seeker – one that is a little more robust, space-conserving and ergonomic. The laptop worked fine for a temporary survey in calm waters. We need to test that the remote connection will work from within government networks through our security firewalls; it worked fine from an outside connection.

In addition, for future projects we plan to have a full suite of processing and QC tools (e.g. CARIS BASE Manager, Fledermaus) on the processing machine so that external consistency of the data can be confirmed in near real-time. This would require that we work in areas where existing validated BASE surfaces are available.

Lastly, we plan to conduct another trial using a Citrix client in the field to connect to CARIS HPD on a Citrix server in the office, create a scratch layer and do chart revisions directly in the HPD database instead of on a stand-alone HOB file in CARIS Notebook as has traditionally been done.

8. WHAT ABOUT THE ARCTIC?

The theme of this conference is *The Arctic: Old Challenges; New Approaches*, so a discussion of remote desktop for processing aboard vessels in the Arctic seems appropriate. For about $5K equipment cost and a $10/MB data plan, each vessel could have 100% Arctic coverage, reasonable bandwidth (128 kbps is small, but enough for Citrix remote desktop) and low latency required for a workable solution (100ms theoretical, but 300ms real world, which is just doable). 10 MB/day is a reasonable volume for Citrix, so 500 MB/month is on the safe side - approximate cost: $5K/month for data for each vessel. While this may seem expensive, when compared to the costs of getting people to the Arctic and keeping them there, it is at least worth considering, if not for cost savings, then at least for optimizing the short Arctic field season and limited amount of ship time for conducting data acquisition operations.

The service: http://www.groundcontrol.com/Iridium_Openport.htm

Some real world testing when the system was still in beta (a worst case scenario): http://www.unols.org/meetings/2009/200911rvt/200911rvtap10.pdf

There's another service planned to enter the market in 2015 or so, which should be even better (huge bandwidth, 7ms latency): http://www.commstellation.com/constellation/index.html

Polar Communication and Weather satellite may also provide access and data options: http://www.asc-csa.gc.ca/eng/satellites/pcw/overview.asp

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Biographical Notes and Contact Information

Rob Hare is a Manager with the Canadian Hydrographic Service. He has worked as a hydrographer and geomatics engineer with CHS since 1982. He is author of numerous papers and reports on hydrographic uncertainty and is Canada's representative on the IHO working group on Standards for Hydrographic Surveys (S-44) and on the IHO Data Quality Working Group (DQWG). He is a Professional Engineer in British Columbia and a Canada Lands Surveyor.

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John Conyon has over twenty years of experience in digital chart production as well as the technologies and workflows involved, from both a technical and managerial perspective. During this time he has worked in partnership with over two dozen hydrographic offices on projects related to S-57, digital paper chart production, product maintenance, and geospatial databases. Mr. Conyon is employed by IIC Technologies Inc in Vancouver BC as Director, Hydrographic Operations.

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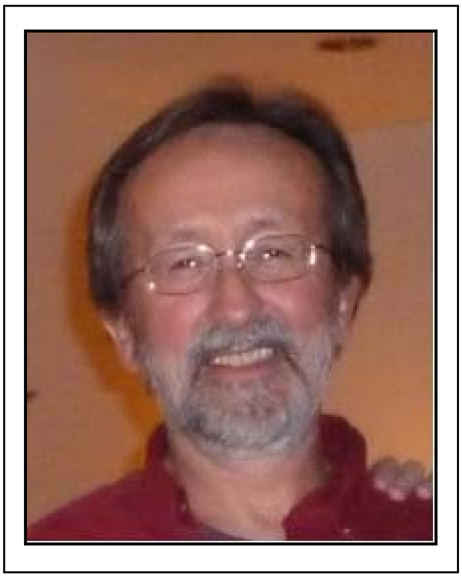
Derrick R. Peyton has over three decades of experience in geomatics covering surveying and civil engineering technologies, oceanography and hydrography, offshore oil and gas, UNCLOS and defense. He holds a Diploma in Surveying Technology, a BSc and MSc in Geodesy and Geomatics Engineering, and an MBA. He is a Professional Engineer (Nova Scotia) and has a Canadian Lands Surveyor (CLS) certification. He also has an IHO Category "A" recognition. Derrick is presently the CEO of IIC Technologies and the Governing Council Chairman for the IIC Academy.



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