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Pour les tarifs et les spécifications publicitaires, se référer à la page 44 de cette édition.

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Spring Issue	February 1/1er février	Édition du printemps
Fall Issue	September 1/1er septembre	Édition de l'automne

COLLECTION OF CHS ARTIFACTS

For many years CHS has retained and collected artifacts that help to tell the story of our character and development. Unfortunately these items have never had a proper home and consequently many hydrographers have never seen them. Of even more consequence is the disappearance of several of these items. CHS has cooperated with the Marine Museum in Kingston, Ontario, and the Historic Naval and Military Establishment in Penetanguishene, Ontario, by lending some of these artifacts for specific displays.

To further the recognition of our heritage we have decided to set aside space at 615 Booth Street to display and protect the collection and to let the hydrographic community know of the project with the hope that new items can be attracted. The initial steps of this project will be undertaken by Ross Douglas who has volunteered his time. The display room (attached to the main CHS Boardroom) will be known as the Boulton Room after Capt. John George Boulton, the Officer-in-charge of the Georgian Bay Survey, 1883 - 1893.

In the initial cataloguing of items, Ross has noted several items which would enhance the proposed displays. It is also hoped that items may "come-out-of-the-woodwork" now that a proper home is being provided.

By way of this letter, I would appeal to anyone who may have items of historic value to contact me with the hope that we might be able to borrow these items for short periods of time. For example, one item in particular that is a large part of our past is the copper plate. There are none of these prized works of art left in the CHS and it would be most helpful if one or more could be located.

I believe it is in all of our interests to ensure the success of this project so that everyone interested in hydrography may enjoy the technology, techniques and products of the past. I look forward to hearing from you.

Yours sincerely,

S. B. MacPhee
Dominion Hydrographer
Canadian Hydrographic Service

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Message from the National President
Mot du Président national

Ken McMillan

It is a pleasure for me to be able to write my first President's Message to you in Lighthouse. After thirty years, the Canadian Hydrographic Association still fosters the credo as outlined in our charter, particularly the furthering of the knowledge and professional development of our members. For example, this issue of Lighthouse, the second all-digital issue (contents), features an all-GPS issue and credit must be extended to our volunteer staff. Without the efforts of the Editor and support staff this issue would not be in your hands. While I'm discussing volunteers, all members of CHA from coast to coast are supported by volunteer efforts of each Branch Executive. An organization is only as good as its members, and over the years CHA has had many outstanding members who have given their time and efforts enthusiastically. To list all these people would extend well beyond my allotted space. You know who you are and I would like to take this opportunity as President to thank you on behalf of all members. If we all work together and offer some of our valuable time to the CHA, everybody benefits. If you are approached to assist, consider the opportunity which is being offered to you, not the amount of time it will take.

Editor's Note / Note du redacteur

Terese Herron

Here it is at last...Edition 53 hot off the press. Field assignments and busy schedules have affected the production of this edition. I would like to thank everyone for their patience.

There are two new columns in this Edition and I'm anticipating they will become regular features. The first is Go FIGure by Dennis St. Jacques, a column to keep us up to date on FIG Commission 4. The second is a column by Jim Simpson, Executive Director of The Association of Canada Lands Surveyors (ACLS), to generate interacton between the ACLS and hydrographers. Both columns provide information of interest to the hydrographic community.

In this age of the Internet, communication should be much easier. To keep current with the times, Lighthouse now has an email address; we are at *lighthouse@bur.dfo.ca*. Information on the CHA and Lighthouse can also be found under the CHS Home Page here in Burlington, the address is *http://csx.cciw.ca/dfo/chs/cha*. Over the next few months we will be adding information such as current advertisers and sustaining members and a bibliography of the papers published in Lighthouse. The first page of the current edition will also be posted. Any suggestons for other items we could add are welcome.

On another note, you should notice a change in our Advertising Manager. Due to other commitments, Keith Weaver has stepped down as advertising manager after thirteen editions. Keith deserves a big thank you for a job well done. Stepping in as Advertising Manager is CHA Past President Dave Pugh; thank you Dave for volunteering, without advertisers Lighthouse would perish.

As always I am searching for papers. If you have a paper that would interest our readers, send me a copy for review. A larger selection of papers for the journal will help us provide quality and variety in Lighthouse.

You will find, on the previous page, a letter from the Dominion Hydrographer Steve MacPhee, asking for items of historic interest for the CHS Heritage Display. Please contact Steve if you have items of historic value that you could loan or donate to the display.

Abstracts / Résumés

Canadian Active Control System – Delivering The Canadian Spatial Reference System
by
Robert Duval, Pierre Héroux and Norman Beck

The Geodetic Survey Division (GSD)'s primary role is to maintain the Canadian Spatial Reference System (CSRS), ensure its compatibility with current positioning technology, and to facilitate efficient access to it. For over 80 years, GSD has been providing a system for referencing horizontal and vertical coordinates for Canadians. With the advent of GPS and the subsequent demands of a rapidly expanding positioning and navigation community, GSD has upgraded the traditional reference service by developing and operating the Canadian Active Control System (CACS) in collaboration with Geological Survey of Canada. Current plans allow for the Canadian Active Control System to play a key role in the delivery of integrated GPS services across Canada through efficient access to the Canadian Spatial Reference System and by improving the effectiveness and accuracy of GPS applications.

Canadian Active Control System products are already used for post-processing applications requiring accuracies ranging from a centimetre to a few metres. The Canadian Geodetic Bulletin Board Service (CGBBS) provides subscribers with on-line access to these products. New post-processing positioning approaches provide metre-level accuracy economically and efficiently anywhere in Canada with a single GPS receiver for many applications, including many within the marine environment.

GSD is developing this technology further to provide similar capabilities in real-time. Current developments will combine real-time acquisition of data from the Canadian Active Control System network of stations, the prediction of GPS orbits, and the real-time evaluation and distribution of corrections for the satellite clocks. Additional stations are being added to the existing network with the collaboration of partners such as British Columbia's Geographic Data BC and Geological Survey to further improve the efficiency and reliability of the system. The real-time service is expected to support metre-level positioning accuracies for any location in Canada. The prototype GPS Correction service, GPS•C, will be introduced in the spring of 1996.

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Le système de contrôle actif canadien – Livraison du système canadien à référence spatiale
par
Robert Duval, Pierre Héroux et Norman Beck

Le rôle primaire de la Division des levés géodésiques (DLG) est de maintenir le système canadien à référence spatiale (SCRS), d'en assurer sa compatibilité avec les technologies courantes de positionnement et d'en faciliter un accès efficace. Depuis plus de 80 ans, la DLG fournit aux canadiens un système de référence de coordonnées horizontales et verticales. Avec l'avènement du GPS et les exigences subséquentes à l'expansion rapide du monde de la navigation et du positionnement, la DLG a amélioré le service offert traditionnellement en développant et en opérant le Système de contrôle actif canadien (SCAC) en collaboration avec la Commission géologique du Canada (CMC). Actuellement, le SCAC joue un rôle clé dans la livraison de services GPS intégrés partout au Canada en donnant un accès performant au SCRS et améliorant l'efficacité et la précision des applications GPS.

Les produits du SCAC sont déjà utilisés dans les applications de post-traitement exigeant des précisions de l'ordre du centimètre à quelques mètres. Le service du Bureau du bulletin géodésique canadien (SBBGC) fournit aux abonnés un accès en direct à ces produits. Les nouvelles approches de post-traitement des positions avec un seul récepteur GPS donne économiquement et efficacement une précision au mètre près partout au Canada pour plusieurs applications, incluant l'environnement marin.

La DLG développe présentement cette technologie pour produire des capacités similaires en temps réel. Les développements en cours combineront l'acquisition en temps réel des données des stations du réseau du SCAC, les prédictions des orbites GPS ainsi que l'évaluation et la distribution en temps réel des corrections des horloges des satellites. De nouvelles stations s'ajouteront au réseau existant avec la participation de la British Columbia's Geographic Data BC et de la CMC pour améliorer l'efficacité et la fiabilité du système. La précision attendue du service en temps réel est au mètre près n'importe où au Canada. Le prototype du service de correction GPS (GPS•C) sera introduit au printemps 1996.

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GPS application and real-time On-The-Fly approach for bathymetric surveys
by
Guy Marceau, Dr. B. Morse, G. Bouchard, Dr. R. Santerre, D. Parrot and É. Roy

Canadian Coast Guard – Laurentian Region (GCC-RL) annually performs bathymetric surveys on the St.Lawrence River, in order to keep at a given depth, a 300-km navigation channel. Tide measurements are made through the use of a tide gauge network. To ensure valid representation of the tide level, this equipment must be installed within a few kilometres of each sector to be surveyed. This requires the deployment of 60 to 70 tide gauges every year.

Application du GPS et l'approche On-The-Fly en temps réel pour les relevés bathymétriques
par
Guy Marceau, Dr. B. Morse et G. Bouchard, Dr. R. Santerre, D. Parrot et É. Roy

La Garde Côtière Canadienne – région Laurentienne (GCC-RL) effectue annuellement sur le fleuve Saint-Laurent, des relevés bathymétriques servant à maintenir, à une profondeur nominale, un chenal navigable d'une longueur 300 km. La hauteur de la marée est obtenue via le déploiement d'un réseau de planches de marées et de télémarémètres. Pour obtenir une représentation valable de la hauteur de la marée ces équipements doivent être installés à l'intérieur de quelques kilomètres

Such a technique no longer meets today's technological reality. As a replacement, Coast Guard intends to use GPS technology with automatic determination of carrier phase ambiguities in Kinematic Real Time mode (OTF-TR). Thanks to the use of OTF-TR, one will be able to obtain directly and precisely, within a few centimetres, the soundings' true heights compared with a reference level (ellipsoid). All errors associated with a water-transfer technique are then eliminated, as well as those resulting from ship's movement (Heave and Squat).

During the fall of 1995, there have been 'real-operation conditions' trials, evaluating the potential of the OTF-TR approach and comparing it to the conventional approach. The results so far are interesting, to such an extent that Coast Guard Laurentian Region is now ready to implement its own OTF-TR project, using the Coast Guard DGPS network.

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de chacun des secteurs à sonder. Cette situation nécessite le déploiement annuel de 60 à 70 planches de marée.

Cette technique ne répond plus à la réalité technologique d'aujourd'hui. Pour les remplacer, la GCC compte utiliser le positionnement GPS et la détermination automatique des ambiguïtés de la phase de l'onde porteuse en mode Cinématique Temps Réel (OTF-TR). L'utilisation de l'approche OTF-TR va nous permettre d'obtenir, avec une précision de quelques centimètres, directement la hauteur des sondes par rapport à un niveau de référence (l'ellipsoïde). Toutes les erreurs associées à une technique de transfert d'eau sont ainsi éliminées ainsi que certaines erreurs associées au comportement du navire (Heave et Squat).

À l'automne 95, des essais visant à évaluer le potentiel de l'approche OTF-TR dans des conditions réelles d'opérations ont eu lieu. Ils ont permis d'évaluer l'approche OTF vs l'approche conventionnelle. Les résultats obtenus sont intéressants et vont permettre à la GCC-RL de procéder à la mise en oeuvre du projet d'implantation de l'approche OTF-TR en temps réel basé sur l'utilisation du réseau DGPS de la GCC.

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GPS Reality Checks
by
Dave Wells

President Clinton signed a Presidential Decision Directive (PDD) on 28 March 1996 which sets out a comprehensive policy on the future management and use of GPS and DGPS. This policy statement is the culmination of a historical trend over the 20-year history of GPS - the struggle to find an appropriate balance between its dual roles: national security, or military, benefits, and economic and social, or civilian, benefits. This historical trend is reviewed in this article, in the form of several "GPS reality checks".

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GPS, à chacun sa réalité
par
Dave Wells

Le Président Clinton a signé le 28 mars 1996 un arrêté présidentiel définissant une politique détaillée sur la gestion et l'utilisation future du GPS et du DGPS. Cet énoncé politique est l'aboutissement de plus de 20 ans d'effort à essayer de trouver un juste milieu entre les deux rôles du GPS, soit: les bénéfices pour la sécurité nationale et militaire et les bénéfices économiques et sociaux pour le civil. Cet article passe en revue cette orientation historique sous la forme de plusieurs "réalités GPS".

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Association of Canada Lands Surveyors / Association des Aprenteurs des Terres du Canada

by Jim Simpson

This is the first column in Lighthouse by the Association of Canada Lands Surveyors (ACLS). We are grateful to the Editor and to the Executive of the CHA for this opportunity and we plan to be here on a regular basis. We hope the CHA will be making similar appearances in the ACLS Newsletter COMMUNIQUE, once we resume regular publication.

This Lighthouse column resulted from discussions between ACLS President Ian Edwards and CHA Past President David Pugh. For some time now the ACLS Executive has believed it important that we have better communications with the 'non-traditional' Canada Lands Surveyors (CLS's), i.e., the Hydrographers, Geodesists, Photogrammetrists and Land Information Specialists. CLS hydrographers are, by far, the largest single group of such persons and are the only group of non-traditional CLS's who are also members of a similar organisation, the CHA. Obviously this fact makes it easier to communicate with you, compared to the other non-traditional CLS's.

From the ACLS point of view, we hope improved communications will help demonstrate to hydrographic CLS's the benefits of being a member of the only national, multi-disciplinary organisation representing the interests of CLS's. Moreover it is the only organisation which regularly communicates CLS matters to CLS's. As most CLS's know, once the Board of Examiners has granted a person a CLS commission, you usually do not hear from them again. That is simply because they are what their name says - an examining body. Although the Legal Surveys Division frequently communicates with CLS's, it is usually only with those who are doing work for them.

When CLS hydrographers are considering new or renewed membership in the ACLS, we often hear the argument they have no reason to belong, because they are not using the CLS commission in their work. At present, for the most part that is probably true. On the other hand, we understand that obtaining the CLS commission provided those hydrographers working for Fisheries and Oceans with professional status. So the rebuttal is that if the CLS commission provides a person with professional status, is it not in their professional interests to belong to the only organisation of Canada Lands Surveyors?

Another factor to be considered is that, as ACLS members know, the Canada Lands Surveyors Act will soon be presented to the Parliament of Canada by the Minister of Natural Resources. If everything goes well, the Act could be passed later this year. The proposed Act will regulate Canada Lands Surveyors who are engaged in cadastral surveying on Canada Lands, or to be more precise, engaged in any activity leading to the establishment of a boundary. As a CLS hydrographer recently pointed out, when he is using hydrographic methods to establish the toe of the Continental shelf, he is in fact establishing a boundary and will come under the provisions of the Act. Therefore, he will be using his Commission in his work. One of the responsibilities of the ACLS after self-regulation will be the development of an effective and interesting Continuing Professional Development (CPD) program for our members. This program is already under development by our CPD Committee and we intend to arrange its structure and content so that it will be of professional interest to all CLS's.

Perhaps of equal interest is that the ACLS recently sent a letter to the federal Minister of Natural Resources pointing out the potential for chaos in offshore Canada Lands because of the lack of a comprehensive Property Rights System. Copies were sent to the Minister of Fisheries and Oceans and the President of the Treasury Board. We hope this letter will lead to meaningful discussions on establishing a Property Rights system in the Offshore, in which case CLS hydrographers will undoubtedly be asked to provide significant input.

Those of you who attended CHC'96 in Halifax in June will perhaps have seen or visited the ACLS booth in the exhibit area. We exhibited at CHC'96 as a further step in establishing more and improved communication with CLS hydrographers.

Canadian Active Control System—Delivering The Canadian Spatial Reference System[1]

R. Duval, P. Héroux and N. Beck

Introduction

Since its inception, the primary role of the Geodetic Survey Division (GSD) has been to establish the basic infrastructure for a national spatial reference system, and to maintain and improve it as surveying technology evolves. The reference system is fundamental for ensuring compatibility of all geomatics, navigation and other spatial information from various sources, allowing it to be exchanged and merged in a seamless and economical fashion. Traditionally, access to the national spatial reference system was provided through the use of monumented geodetic control points established by various government agencies throughout the country and then used by surveyors for integration of local or regional surveys. Today, the Global Positioning System (GPS)-based Canadian Active Control System (CACS) not only allows for efficient access to the national reference system without occupying monumented control, but also improves the effectiveness and accuracy of end user GPS applications.

The Canadian Active Control System is supported by a network of ten unattended tracking stations (Figure 1), referred to as Active Control Points (ACPs), which continuously record carrier phase and pseudo-range measurements for all GPS satellites within station view. A Master Active Control Station (MACS), operated by GSD in Ottawa, assures the coordination of the system [8]. It facilitates GPS integrity and performance monitoring; computation of precise satellite ephemerides (GPS orbits) and precise satellite clock corrections [13]; generation of accurate GPS corrections *(GPS•C)* applicable to the Canadian landmass; and other applications, such as geodynamics and precise time transfer. Through participation in the International GPS Service for Geodynamics (IGS), the Canadian Active Control System also contributes to the maintenance of the International Terrestrial Reference Frame (ITRF) and the improvement of the NAD83 national reference system [9]. Likewise it ensures global consistency and accuracy at the centimetre level to meet current and future positioning requirements in Canada.

The following brief description of the Canadian Spatial Reference System is provided as background for understanding the significance and role of the Canadian Active Control System.

The Canadian Spatial Reference System

The Canadian Spatial Reference System (CSRS) is being continuously improved and maintained in collaboration with federal, provincial and local government agencies, industry and the user community to support positioning applications whether they relate to geomatics (land management, geodesy, mapping, Geographic Information Systems, etc.), navigation (marine and air) or scientific studies.

The Very Long Baseline Interferometry (VLBI) network provides the highest layer of the Canadian Spatial Reference System hierarchy (Figure 2). VLBI is a radio astronomical technique using extragalactic radio sources providing the inertial reference frame to determine direction and inter-station distances on a global scale with millimetre accuracy. The VLBI sites, collocated with ACPs, are used as fiducial reference to provide the orientation and scale for the terrestrial reference networks. Repeated VLBI observations are used for the determination of earth orientation parameters and station velocities due to crustal motion. VLBI observations have been carried out at

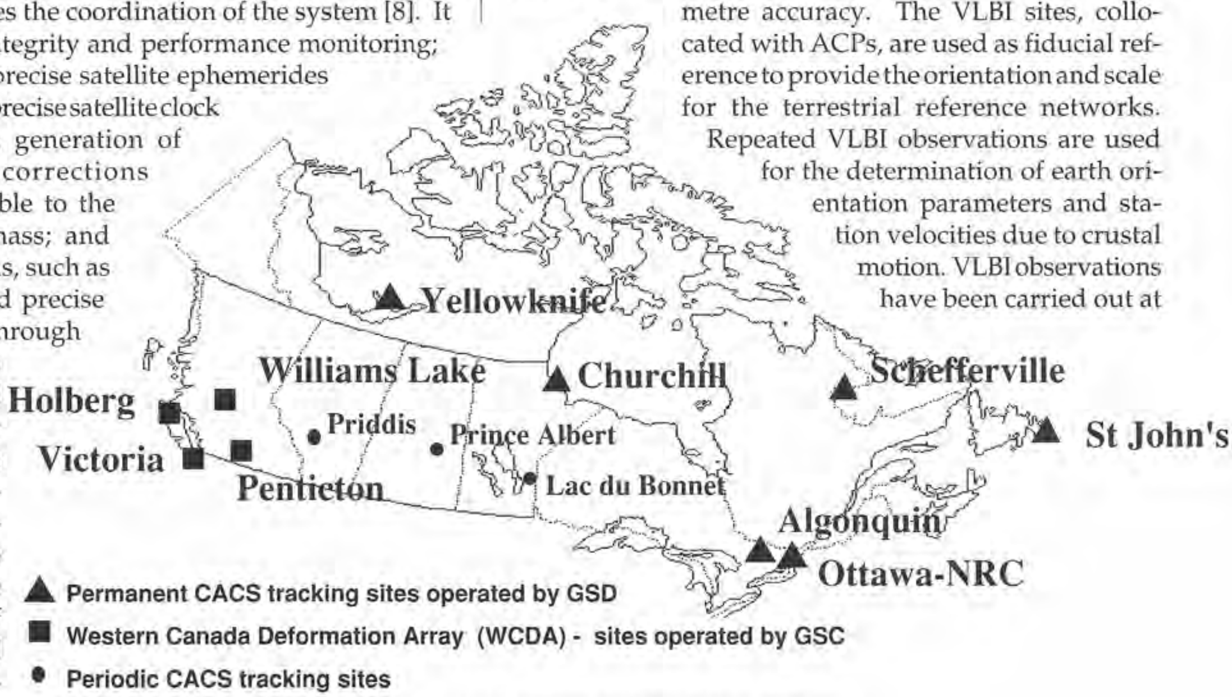

Figure 1: CACS network of automated tracking stations.

five sites in Canada with international cooperation. These are located at Whitehorse, Yukon; Yellowknife, Northwest Territories; Penticton and Victoria, British Columbia; and Algonquin Park, Ontario. The last four sites are collocated with ACPs.

The second most important layer of the Canadian Spatial Reference System is the Canadian Active Control System. It contributes to the refinement of the national reference system assuring its stability, accuracy and compatibility with international standards through continuous observation and cooperation at the international level. It also provides the means for end users of GPS to directly integrate their spatially referenced data to the Canadian Spatial Reference System [10].

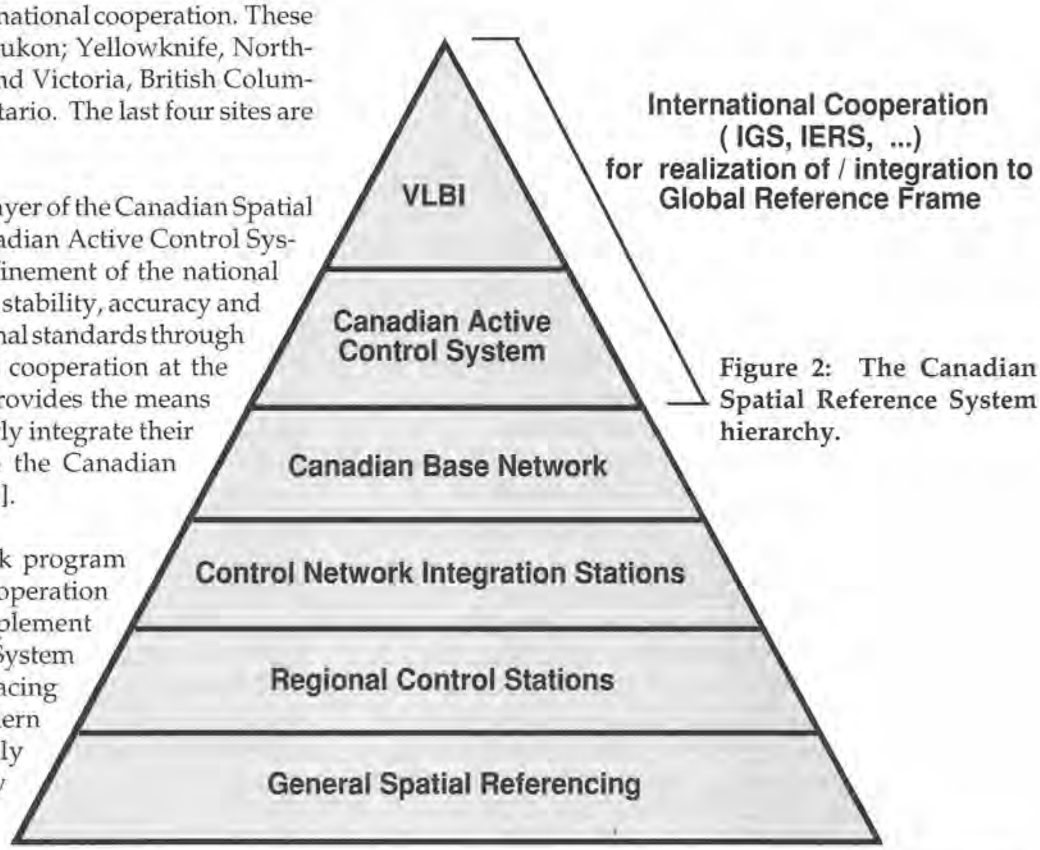

Figure 2: The Canadian Spatial Reference System hierarchy.

The Canadian Base Network program was initiated in 1994, in cooperation with the provinces, to complement the Canadian Active Control System network. With a nominal spacing of 200 kilometres in the southern latitudes, it provides easily accessible high accuracy control (at centimetre accuracy with respect to the Canadian Active Control System). It also provides the means to evaluate the lower layers of traditional monumented control points established throughout the years by various government agencies. As Canadian Active Control System data products gain acceptance, the need for large numbers of these monumented control points should be greatly reduced.

International Cooperation

The Geodetic Survey Division also contributes Canadian Active Control System data to the International GPS Service for Geodynamics (IGS) and participates as an analysis centre [6]. In return, the Division has access to data from globally distributed fiducial sites for use in the computation of precise satellite ephemerides. Through the IGS, Geodetic Survey Division data are included in global adjustments for the realization of the ITRF which ensures integration and compatibility of the Canadian Spatial Reference System at a global scale. Canadian Active Control System data and related products are also made available to international organizations such as NASA Crustal Dynamics Data Information System, the U.S. National Geodetic Survey, the U.S. Naval Observatory and many other organizations around the world studying Earth dynamics, natural hazards and global change.

The IGS currently has seven contributing international analysis centres. For the past two years, the Geodetic Survey Division has assumed, at the request of the IGS Governing Board, the international role of coordinator of analysis centres. This includes the computation of the final IGS combined precise GPS satellite ephemerides and other products derived from data submitted by the seven international centres.

The Canadian Active Control System data products are based on the products submitted to the IGS.

Canadian Active Control System Data Products

Observational Data

The ACPs are presently collecting dual frequency pseudo-range and carrier phase observations at a 30 second sampling interval by continuously tracking all GPS satellites in station view. Data are normally retrieved from the sites by the Master Active Control Station every four hours. They are then run through a validation process [4] to ensure that they are complete and that ACP operations are normal. Data are then archived in daily files in RINEX format [3]. Data files for each ACP are currently made available on-line four hours after the end of the day.

Precise Ephemerides

The precise ephemerides are computed from data collected at ACPs augmented by up to 24 globally distributed core GPS tracking stations of the IGS. Based on IGS orbit comparisons, the NRCan precise ephemerides have a precision at the 10 cm level (one sigma) in each coordinate. Precise ephemerides are provided as daily files and are available typically within 2 to 5 days following the observations. They are currently distributed in the internationally accepted NGS-SP3 format [14] containing X, Y, Z positions along with clock information for all satellites at 15 minute intervals.

Precise Satellite Clock Corrections

Precise offsets between individual GPS satellite clocks and the Canadian Active Control System reference clock are computed for satellite arcs visible in Canada based on the precise ephemerides and ACP observational data. These precise satellite clock corrections also account for the dithering effect introduced by selective availability (SA). Although the clock corrections are archived at 30 second intervals, they can be interpolated to a higher rate - (i.e.) one second intervals - with no significant degradation in the resulting pseudo-range positioning accuracy. Precise clock corrections are archived in an ASCII format. Each complete file contains the clock corrections for each satellite for a 24-hour period. They are currently available on-line within 2 to 5 days following the observation. Clock corrections based on predicted ephemerides will become available by mid-1996 within a day following the observation.

How To Use Canadian Active Control System Products

The availability of precise ephemerides, precise satellite clock corrections and observational data from the ACPs can offer significant benefits for GPS applications in Canada. These products make it possible to position any point on or near the Canadian landmass, with a precision ranging from a centimetre to a few metres, in relation to the Canadian Spatial Reference System, without actually occupying an existing control monument or base station.

For the Most Precise Applications

For applications requiring the highest precision and using carrier phase measurements, the utilization of the precise ephemerides during the data processing reduces orbit-related errors in baseline determinations to less than 0.05 parts per million. These errors can reach 3 parts per million or more when ephemerides broadcast by the satellites are used. Scale and orientation are provided for the resulting coordinates through the precise ephemerides. Furthermore, by including observational data from the ACPs in the data processing, a direct tie to the Canadian Spatial Reference System is established without occupying any monumented control point. This increases the efficiency of field operations and data processing. Depending on the GPS software, further advantages may be realized, such as improved cycle slip detection and correction capability, enhanced carrier phase ambiguity resolution as well as improved and more consistent aposteriori error estimates. Recent surveys, combining Canadian Active Control System station data and precise ephemerides, have shown static positioning precision at the centimetre level in each of the three-dimensional components for distances over 1,000 kilometres, when appropriate software and procedures are used.

Precise Point Positioning with a Single Receiver

Positioning at the metre level from pseudo-range (code) observations without the use of a base station is possible with precise satellite clock corrections. These corrections can be applied anywhere in Canada to correct the user's observed ranges, and together with precise ephemerides, provide positioning accuracies at the one-metre level depending on the user's receiver measurement noise, multipath, satellite geometry and residual atmospheric effects.

The accuracies normally achievable using single-point positioning are 100 metres (2 DRMS) horizontally and 156 metres vertically, assuming favourable satellite geometry. The error sources that limit the accuracy can be grouped under three categories (Figure 3) [1]: those that are satellite-related (inaccuracies of the broadcast satellite orbital and clock information); those that originate as the signal travels through the atmosphere (ionospheric and tropospheric biases); and those that are site-related (user's receiver measurement noise and multipath). Currently, the largest error source is Selective Availability which is introduced by dithering of GPS clocks. Selective Availability appears as a random process having a period of a few minutes and an amplitude of about 100 nanoseconds or 30 metres in the direction of the range measured to the satellite.

Local differential GPS techniques provide a method to reduce errors introduced by Selective Availability, orbital errors and atmospheric effects. With this approach, the combined effect of these errors is determined at a base station of 'known' coordinates. The difference between the observed pseudo-range measurements and the expected ranges for the known coordinates are applied to roving receiver measurements under the assumption

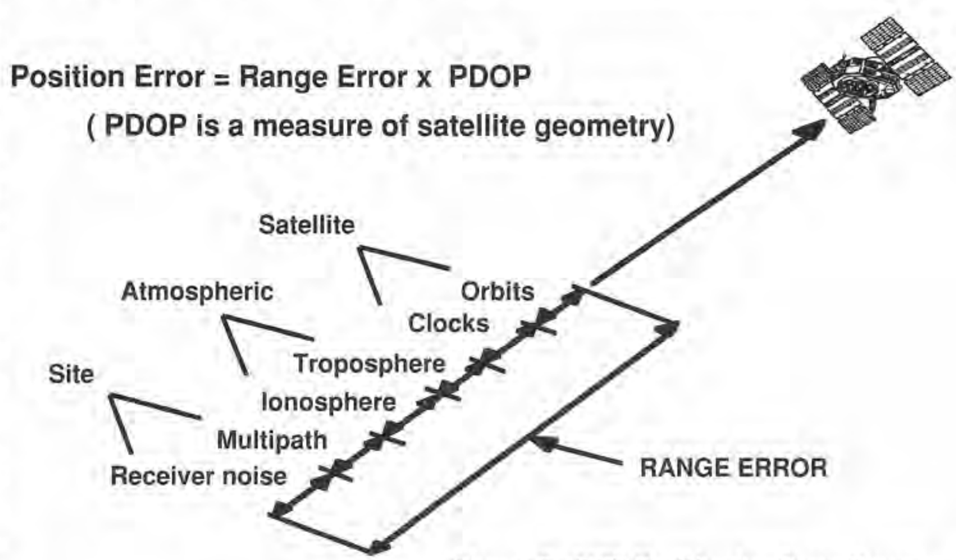

Figure 3: GPS Positioning Error Sources

that the observed errors are common to receivers operating in the same area. As the distance between reference and roving receivers increases, the correlation of these errors is reduced and applying pseudo-range corrections from a single base station does not produce optimal results. Site-related errors are not reduced through differential corrections and may be propagated to the network if they exist at the base station.

Alternatively, similar positioning accuracies are achieved with a single receiver by directly applying a correction for each of the error sources. Broadcast orbits and clock parameters are replaced by precise orbits and precise clock corrections, which are available products of the Canadian Active Control System. The Canadian Active Control System orbits have an accuracy of approximately 10 centimetres, compared to the 5 to 20 metre accuracy of the broadcast orbits (Figure 4). Similarly, the Canadian Active Control System precise clocks are accurate at the one nanosecond (30 cm) level, whereas the broadcast clocks are only accurate to 70 to 100 nanoseconds (21-30 m). This represents an improvement in satellite data accuracy of about 100 times.

Dual-frequency users can take advantage of the dispersive nature of the ionosphere to correct the ionospheric delay from their observations. For single-frequency users, Geodetic Survey Division is presently developing a single-layer ionospheric model based on the Canadian Active Control System data to improve ionospheric delay corrections. As for the tropospheric error, it is reduced through the use of standard mapping functions and input of surface meteorological data.

Since the Canadian Active Control System products are based on a network of accurately known reference points equipped with high performance GPS receivers, the uncertainty associated with using coordinates and data from a single base station is effectively removed. The well distributed stations of the Canadian Active Control System also ensure complete satellite visibility to users at any Canadian location at any time of day. This eliminates the problem of "matching" observations between remote and reference sites sometimes associated with local differential GPS. The use of Canadian Active Control System products results in positions automatically linked to the Canadian Spatial Reference System.

GPSPace Software

Single-point positioning with precise Canadian Active Control System orbits and clocks, as described above, was recently introduced in the GPS community [2,5] and was specifically discussed with respect to the marine environment in Lachapelle et al., Sept. 1994. Lachapelle et al. indicates that single-point positioning, based on Canadian Active Control System products, produces results comparable to those obtained by DGPS techniques for marine applications. To demonstrate and facilitate its application, GSD has developed the program GPSPace (GPS Positioning from ACS Clocks and Ephemerides) as an interface program for Canadian Active Control System products. Any user with the capability to convert GPS observation data, collected in static or kinematic mode, into the standard RINEX format [3], can use GPSPace for data reduction. This software is now being licensed to value-added re-sellers. Several commercial point-positioning software suites are also compatible with Canadian Active Control System data.

Figures 5 and 6 compare the quality of positioning from a single receiver using precise orbits and clocks versus one using broadcast information. Independent positions

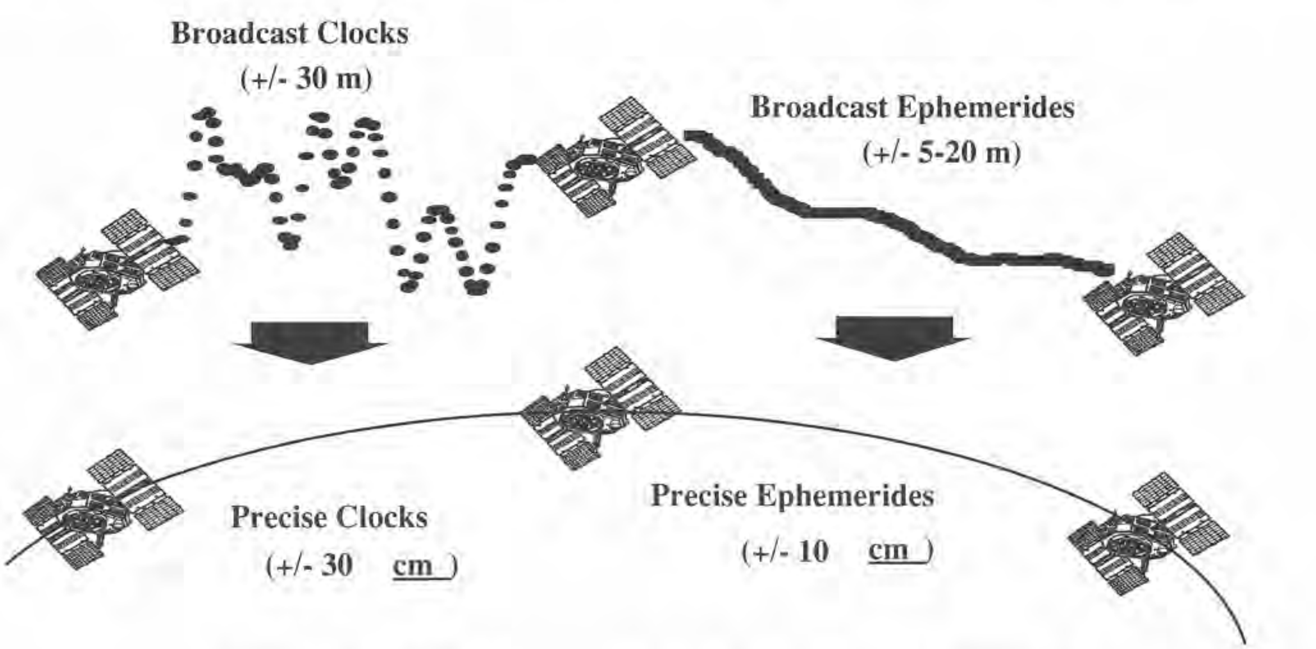

Figure 4: Satellite data improvements resulting from CACS processing.

were computed every second over a 25 minute period using program GPSPace in post-processing. The data was collected via a NovAtel single-frequency receiver.

Using broadcast information, the variations (RMS) of each independent determination, with respect to the known position (Figure 5), are 27 metres in latitude and 13 metres in longitude. After applying precise satellite ephemerides and clocks, the variations (RMS) are reduced to 0.45 metres in latitude and 0.42 metres in longitude.

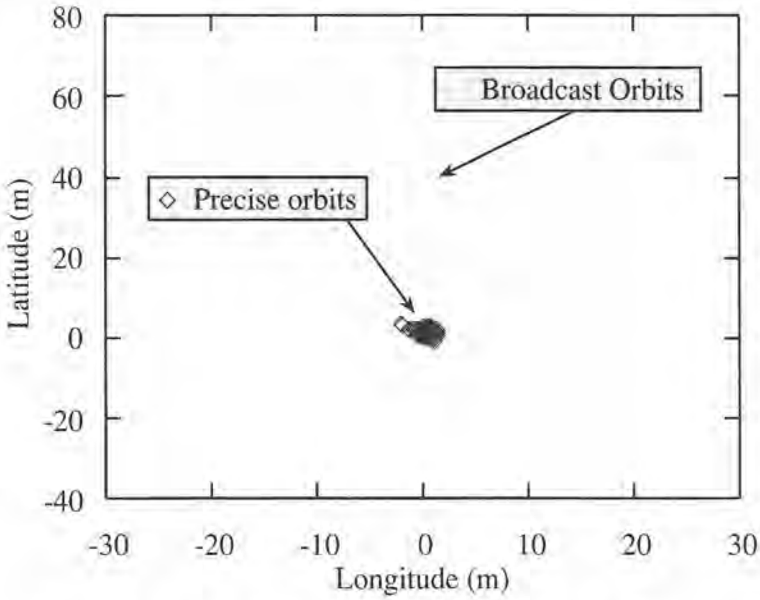

Figure 5: Comparison of latitude and longitude from single point positioning using broadcast orbits and clocks and CACS precise orbits and clocks.

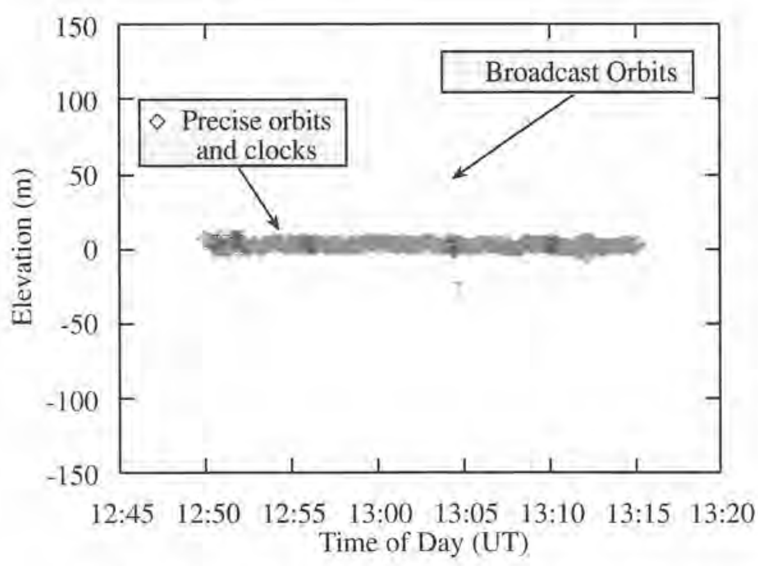

Figure 6: Comparison of heights from single point positioning using broadcast orbits and clocks and CACS precise orbits and clocks.

Similarly, the variations (RMS) with respect to the known ellipsoidal height (Figure 6) is 65 metres when using broadcast information. After applying Canadian Active Control System precise satellite ephemerides and clocks, the variation (RMS) is 1.5 metres.

<u>Real Time GPS Corrections</u>

The precise GPS satellite and clock information provided by the Canadian Active Control System, available since 1992, has been obtainable from the Canadian Geodetic Bulletin Board Service since the spring of 1995. The Canadian Geodetic Bulletin Board Service can be accessed:

- on Internet via telnet —'bbs.geod.nrcan.gc.ca';
- on the World Wide Web at URL — 'htpp://www.geod.nrcan.gc.ca'; or,
- by dial-up modem— (613) 947-7660.

Many users and agencies now subscribe to this service, download the orbit and clock information from the electronic bulletin board, use post-processing techniques, and improve the accuracy of their point-positioning results from a single receiver to the metre level or better. This same technology and capability is reaching a level of maturity by being developed into a real-time service.

The prototype operation of this real-time component is scheduled for spring 1996. Initially, this new GPS Correction service, called *GPS•C*, is expected to support metre-level or better positioning accuracies for any location in Canada. It will continue to provide the advantages offered by the post-processing service but with the additional advantage of being provided to users in real-time.

While Geodetic Survey Division is establishing this capability in collaboration with other agencies such as Geographic Data BC and Geological Survey of Canada, it does not intend to directly distribute this information itself. GSD is relying on private and public sector partners to develop the real-time distribution and support systems to serve the vast GPS application user base (Figure 7). Geodetic Survey Division is committed to maintaining the basic infrastructure required to support and facilitate spatial referencing and to collaborating with companies or agencies wishing to develop and offer, to end-users, services based on the national Canadian Active Control System. Geodetic Survey Division will provide a real-time data stream of accurate satellite orbits and clocks and other GPS error corrections, and will work with collaborators to distribute this information and transform it into local GPS corrections for their users. Software to perform this transformation and conversion will be made available to service providers.

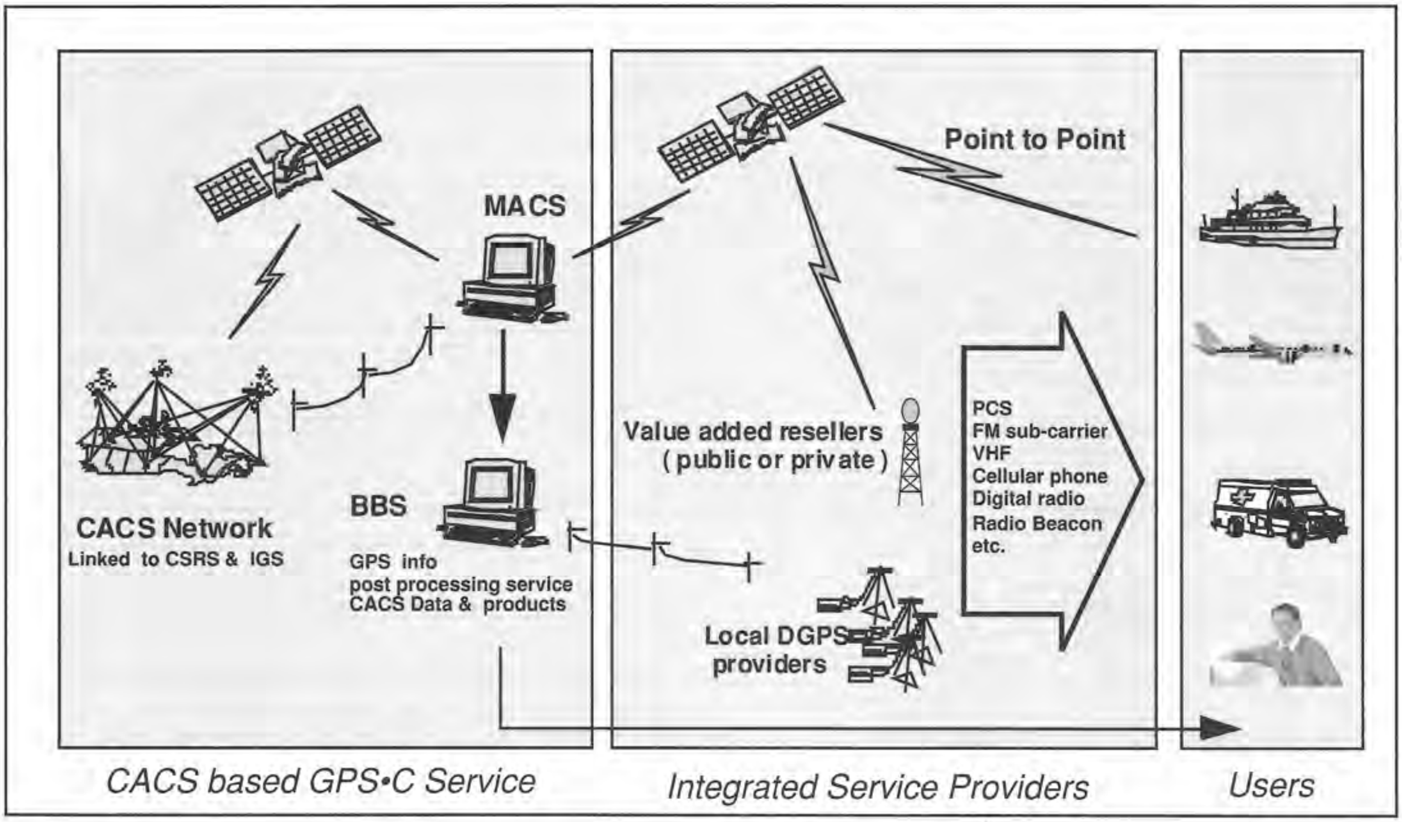

Figure 7: Integrated GPS Correction Services

GPS•C information can complement local differential or wide-area differential correction services by offering these service providers the opportunity to validate and enhance their products, provide independent quality assurance, and directly tie into the national reference system in real-time. The present differential GPS market is generally characterized by considerable activity and variety, but to a certain degree, lacks standards, compatibility and quality assurance, and offers limited coverage. Many of these deficiencies can be addressed by the *GPS•C* service, which can also potentially reduce a service provider's total operating costs while increasing the system's reliability and integrity.

In the future, it is expected that there will be a combination of integrated service provision systems, including local differential GPS systems, to satisfy local niche markets, wide-area differential systems to provide wider area coverage with networked differential technology; and the internationally based *GPS•C* service providing more global coverage (without differential corrections) and positioning accuracies at the sub-metre level.

This real time information will provide unparalleled opportunities for Canadian industry. Demands for real-time services have been growing rapidly since GPS became fully operational in 1993, with studies estimating GPS-related worldwide revenues at $30 billion (U.S.) by the year 2005 [7].

Summary

The Canadian Active Control System is part of a national infrastructure that supports geo-referencing applications and the progression towards a spatial reference system that is no longer based solely on a network of monumented stations, but increasingly on satellite-based positioning technology. The Canadian Active Control System provides current users with a simple means of relating their positioning information to an accurate and stable reference frame while being well suited for continuous improvement of the national spatial reference system.

Access to Canadian Active Control System products through the CGBBS supports GPS post-processing applications requiring centimetre to metre accuracy. Availability of the real-time *GPS•C* service will further meet evolving user needs and enhance the system by ensuring lower end-user costs through shared infrastructure. Other benefits to Canadians will be realized in terms of validated and quality-assured data, improved accuracy, and a standard and accessible spatial reference system.

Acknowledgement

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References

1. Erickson, C., *GPS Positioning Guide*, Geodetic Survey Division, Natural Resources Canada, 1993.

2. Erickson, C., and Héroux, P., *GPS Locations for GIS: Getting them Right the First Time*, Paper presented at Decision 2001, Toronto, Canada, September 12-16, 1994.

3. Gurtner, W., *RINEX: The Receiver-Independent Exchange Format*, GPS World, July, pp. 48-52, 1994.

4. Héroux, P., Caissy, M., and Gallace J., *Canadian Active Control System Data Acquisition and Validation*, Proceedings of the 1993 IGS (International GPS Service for Geodynamics) Workshop, University of Bern, pp. 49-58, 1993.

5. Héroux, P., and Kouba, J., *GPS Precise Positioning with a Difference*, 1995 Canadian Geomatics Proceedings (CD-ROM), Ottawa, June 13-15, 1995.

6. IGS, *International GPS Service for Geodynamics, 1994 Annual Report*, IGS Central Bureau, JPL, California, September, 1995.

7. National Academy of Public Administration and National Research Council: *Charting the Future*, National Academy Press, May 1995.

8. Kouba, J., Tétrault, P., Ferland, R., and Lahaye, F., *IGS data processing at the EMR Master Active Control System Centre*, Proceedings of the 1993 IGS (International GPS Service for Geodynamics) Workshop, University of Bern, pp. 123-132, 1993.

9. Kouba, J., and Popelar, J., *Modern Geodetic Reference Frames for Precise Satellite Positioning and Navigation*, Inter. Symp. on Kinematic Systems in Geodesy, Geomatics & Navigation (KIS 94), Banff, Canada, August, pp. 79-86 1994.

10. Kouba, J., Héroux, P., Gao, Y., and Popelar, J., *WADGPS based on IGS/CACS*, Presented at IEEE PLANS 94, Las Vegas, April 11-15, 1994.

11. Lachapelle, G., Klukas, R., Qiu, W., and Melgard, T.E., *Single Point Satellite Navigation Accuracy - What the Future May Bring*, Presented at IEEE PLANS 94, Las Vegas, April 11-15, 1994.

12. Lachapelle, G., Klukas, R., Roberts, D., Qiu, W., and McMillan, C., *One-Meter Level Kinematic Point Positioning Using Precise Orbits and Satellite Clock Corrections*, Presented at ION GPS 94, Salt Lake City, September 20-23, 1994.

13. NRCan., *Canadian Active Control System Products*, Geodetic Survey Division, Geomatics Canada, Natural Resources Canada, Ottawa, August, 1995.

14. Remondi, B., *Extending the National Geodetic Survey Standard for GPS Orbit Formats*, NOAA Technical Report NOS 133 NGS 46, National Geodetic Information Branch, NOAA, Rockville, MD, 20852, November, 1989.

[1] Based on a paper with the same title presented at GIS '96, Vancouver, Canada, March 1996.

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Application du GPS et l'approche On-The-Fly en temps réel pour les relevés bathymétriques

G. Marceau, Dr. B. Morse, G. Bouchard,
Dr. R. Santerre, D. Parrot et É. Roy

Introduction

L'utilisation de l'approche On-The-Fly (OTF) de la technologie GPS permet à un véhicule en mouvement de déterminer automatiquement les ambiguïtés de la phase de l'onde porteuse. Beaucoup moins limitative que l'approche Cinématique pure, qui nécessite une période d'initialisation, l'OTF ouvre donc la porte à la navigation précise en temps réel à quelques centimètres. Utilisé par la GCC depuis 1992, l'approche Cinématique pure et par la suite l'approche OTF ont permis la réalisation de travaux qui n'auraient pu être réalisables auparavant notamment pour la validation de systèmes de navigation et, depuis 1994, pour le projet de la détermination du dégagement sous-quille des navires commerciaux. Dans le cadre de son programme de sondage, la Garde Côtière canadienne (GCC) compte utiliser l'approche OTF en Temps Réel (OTF-TR) pour l'élimination des planches à marée. Ce texte décrit le projet d'implantation de l'approche OTF-TR appliqué aux besoins des relevés bathymétriques sur le fleuve Saint-Laurent. On y présente également des résultats du banc d'essai de l'automne 95.

Description du Projet

La GCC effectue annuellement sur le fleuve Saint-Laurent des relevés bathymétriques servant à contrôler la profondeur nominale du chenal navigable d'une longueur de 300 km. Pour effectuer ces sondages, l'approche actuelle nécessite la pose de planches à marée à des endroits stratégiques le plus près possible du secteur de travail. Les données sont obtenues via un observateur qui effectue à cadence régulière des lectures sur la planche de marée (figure 1). Ces lectures sont effectuées d'une façon continue lors du relevé et sont transmises de façon verbale au navire par un lien radio. Dans certains cas, il sera nécessaire d'utiliser simultanément plusieurs planches à marée ce qui implique une interpolation linéaire des lectures. Pour obtenir la hauteur des sondes, il faut corriger les lectures de la marée, des influences du Squat et de la Houle (Heave) du navire. Pour une saison de sondage, la GCC utilisera de 60 à 70 planches à marée ce qui ne répond plus au contexte économique d'aujourd'hui.

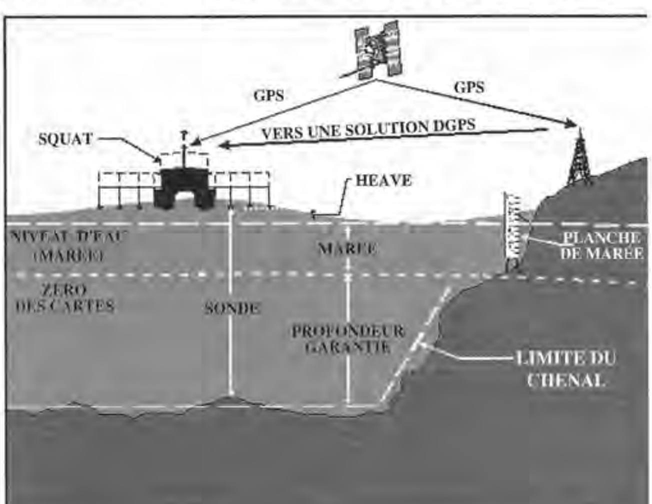

Figure 1: Méthode actuellement utilisée par la GCC

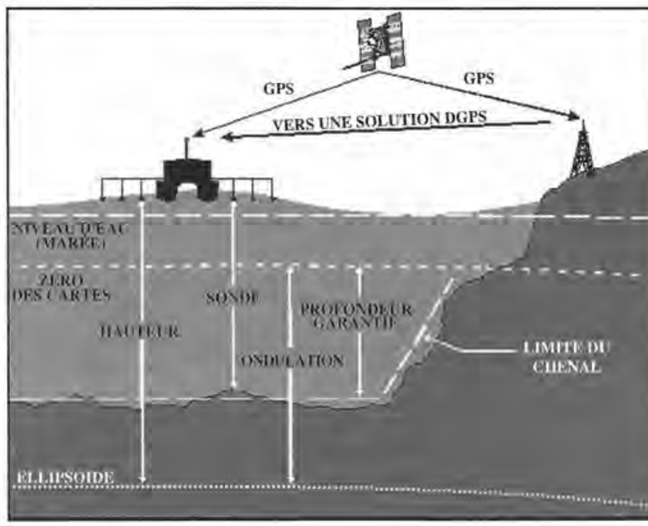

Figure 2: Méthode OTF-TR proposée

En 1995, la GCC a procédé à l'acquisition de récepteurs GPS pour le renouvellement du système de positionnement de ses unités de sondage. En juillet 96, le déploiement de son infrastructure permanent du réseau DGPS (phase 1) sera finalisé. Pour la région Laurentienne les stations DGPS seront Lauzon, Trois-Rivières et l'Acadie. Tous les équipements utilisés sont des récepteurs double fréquence (12 canaux). Ce contexte technologique ouvre donc la porte au potentiel de l'approche OTF-TR sur une grande échelle. Appliqué aux relevés bathymétriques, la GCC pourra éliminer l'utilisation des planches à marée et obtenir avec une précision équivalente, sinon meilleure, la hauteur des sondes par rapport à un niveau de référence (l'ellipsoïde). Toutes les erreurs systématiques associées à une technique de transfert d'eau seront éliminées ainsi que certaines erreurs systématiques associées au comportement du navire (Heave et Squat).

Déploiement de l'approche OTF-TR

Le projet OTF-TR est donc basé sur l'infrastructure GPS et DGPS existante et également sur l'utilisation des algorithmes OTF développé par VIASAT et le Centre de Recherche en Géomatique de l'Université Laval (CRG). Les algorithmes OTF proposés permettent d'obtenir une solution OTF en moins de quelques secondes avec une précision de 10 cm à 95% en planimétrie et en altimétrie jusqu'à une distance de 75 km. Les équipements GPS utilisés seront le Ashtech Z-12 pour les stations de références et le Trimble 4000SSI pour les vedettes de sondages.

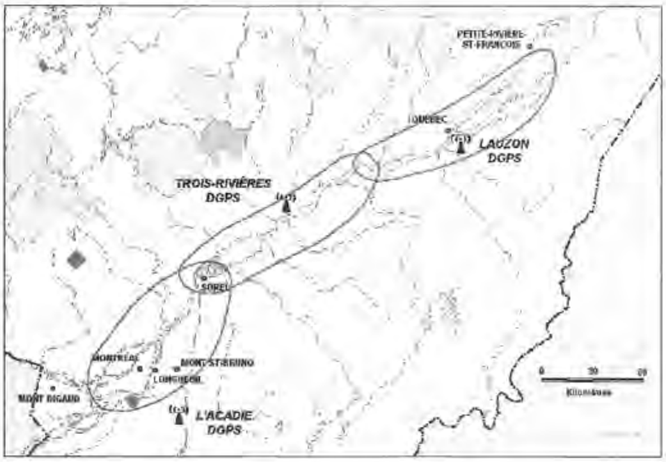

Figure 3: Couverture OTF-TR

L'information de la station de référence sera transmise selon le standard RTCM-SC104, les messages de type 18 et 19 pour les mesures de phase de L1 et L2 et le message de type 3 (ou type 59) pour les paramètres de la station de référence. Un lien de communication radio VHF à 9600 bits par seconde sera utilisé pour la transmission des messages RTCM-SC104. Pour ne pas nuire au fonctionnement du récepteur GPS de la station de référence dédié aux besoins du réseau DGPS, nous utiliserons un logiciel indépendant dont les fonctions principales seront de recevoir les observations brutes des récepteurs Ashtech Z-12, d'encoder les messages RTCM-SC104 et de gérer la communication avec modem pour latransmission radio.

Sur le navire sondeur, les fonctions principales du logiciel OTF seront de fournir deux solutions OTF à la seconde, de filtrer les altitudes obtenues et de les réduire au zéro des cartes (ZC). Le logiciel prédira également des altitudes le cas échéant, gérera la communication avec le modem et le récepteur GPS (4000SSI) du navire et effectuera des opérations de contrôle d'intégrité. Pour obtenir une solution OTF, il y aura également la possibilité d'effectuer le post-traitement des données brutes GPS recueillies simultanément sur le navire et à la station de référence. Le logiciel fonctionnera dans un environnement Windows NT et un ordinateur avec un processeur Pentium Pro (P6/150 MHz) sera utilisé.

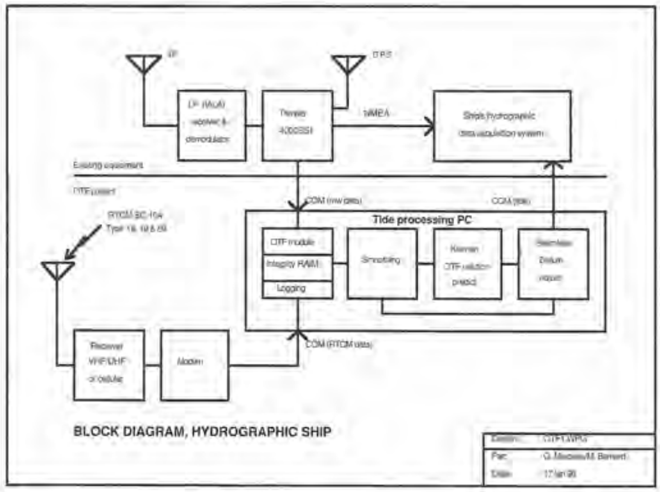

Figure 4: Schéma du système OTF-TR à bord du navire

Réduction des altitudes géodésiques OTF par rapport au Zéro des Cartes

En attendant la mise au point d'un nouveau datum adapté aux besoins du GPS par le SHC et de l'approche OTF-TR, la GCC utilisera une approche simple utilisée depuis des années pour ces relevés bathymétriques et qui est décrite dans ce texte. Celle-ci a d'ailleurs été utilisée pour le banc d'essai qui a eu lieu à l'automne 95.

Le ZC est une surface de référence à partir de laquelle la GCC établit les cotes bathymétriques. Cette surface de référence peut être calculée pour un point quelconque sur le fleuve, par interpolation ou extrapolation de valeurs connues sur des repères à proximité. Dans le but de ramener les altitudes ellipsoïdales (déterminées par OTF) par rapport au ZC, la première étape est de réduire celles-ci par rapport au géoïde (altitude orthométrique). Ainsi pour chaque altitude calculée par OTF, le logiciel devra interpoler une ondulation du géoïde à partir de la table GSD95E.

La figure 5 illustre graphiquement la procédure d'interpolation du ZC pour une position du navire sondeur. Sur cette figure, *zc* signifie le Zéro des Cartes et *nmm* signifie le Niveau Moyen des Mers, ce qui correspond à l'altitude orthométrique. Connaissant l'altitude au ZC et l'altitude orthométrique pour certains points à proximité des secteurs de sondage, l'écart entre le ZC et l'altitude orthométrique (ZC - NMM) peut être calculé pour chaque station de la rive.

Le ZC pour chaque position OTF a été calculé comme suit: une perpendiculaire à la ligne de référence passant par la position OTF, et l'écart entre le ZC et l'altitude orthométrique est interpolé à l'intersection de cette perpendiculaire et de la droite liant les deux points de référence pour lesquels les altitudes orthométrique et au ZC sont connus. Le logiciel OTF devra effectuer cette opération mais il y aura la possibilité de constituer une grille à partir de la méthode décrite.

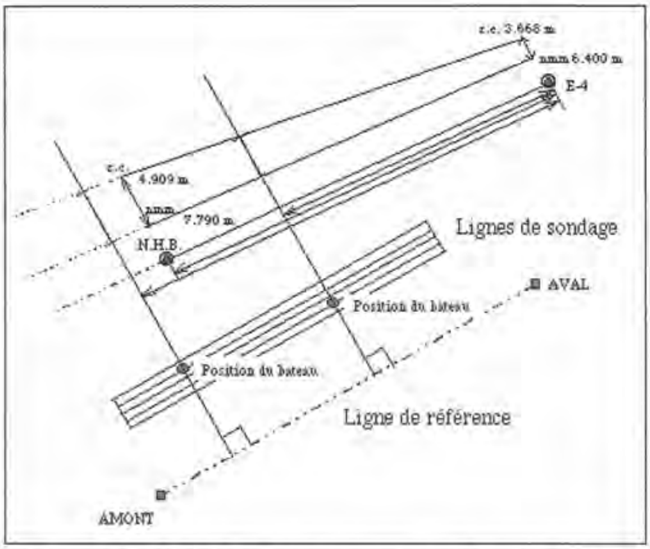

Figure 5: Réduction par rapport au zéro des cartes.

Description du banc d'essai (automne 1995)

Les deux principaux objectifs du banc d'essai étaient de démontrer la capacité de l'approche OTF à déterminer des hauteurs avec précision à partir des données GPS enregistrées dans des conditions réelles d'opération et de les utiliser dans un relevé bathymétrique dans le but de comparer l'approche OTF à l'utilisation des planches à marée. Pour ce banc d'essai nous avons utilisé deux stations de référence distantes de 5 et 75 km. La distance maximale de 75 km est justifiée parce qu'elle représente la distance maximale des secteurs à sonder sur le fleuve Saint-Laurent par rapport aux stations de référence de la GCC. De plus, afin de valider et d'estimer la précision (relative) des solutions à 75 km; des stations situées à 5 km des secteurs de sondage ont été choisies, puisqu'à ces distances les erreurs systématiques sont grandement réduites. Les algorithmes OTF utilisées sont décrits dans Parrot et al. [1995a].

Les essais en mer se sont déroulés sur une période de 3 jours; soit du 17 au 19 octobre 1995 inclusivement (correspondant aux jours 290 à 292 de l'année 1995). Le secteur de sondage de Trois-Rivières a été observé aux jours 290 et 291 tandis que celui de Neuville a été observé lors de la journée 292. Les sondages ont été faits sur une distance de 1.5 km pour le secteur de Trois-Rivières et de 2.5 à 3 km pour le secteur de Neuville.

Lissage des altitudes obtenues du traitement OTF

Les altitudes provenant de la solution OTF sur 5 ou 75 km sont lissées afin d'amoindrir le bruit. L'altitude lissée à un temps *t* est déterminée à l'aide d'un polynôme dont les coefficients sont obtenus avec les altitudes observées au voisinage de l'époque *t*. Le polynôme est de la forme:

$$h_{lissée}(t) = \sum_{i=0}^{4} a_i \cdot t^i$$

Les coefficients sont obtenus avec un échantillon de 121 époques (secondes). L'altitude déterminée avec les coefficients de ce polynôme est l'altitude centrale de l'échantillon . Ainsi à chaque époque, l'altitude lissée a été calculée à l'aide du polynôme formé par les soixante altitudes précédant cette époque et les soixante suivant celle-ci. L'ordre du polynôme utilisé est de 4. La figure 6 présente un exemple de résultats du lissage des altitudes.

Résultats OTF

Cette section présente un résumé des différents résultats obtenus. L'analyse complète des résultats du banc d'essai se retrouve dans Parrot et al. [1996].

Afin de valider la qualité du positionnement GPS sur les vecteurs de 75 km (bande L3), les coordonnées horizontales (dN: nord et dE: est) et verticale (dh) décrivant la trajectoire du bateau ont été comparées à celles obtenues avec la station de référence située à 5 km. La précision des résultats obtenus à partir de la station de référence la plus rapprochée est évaluée à ±1 cm. On retrouve au tableau 1, les valeurs des rss des différences de coordonnées pour différentes sessions d'observations. Ces valeurs varient entre 1 et 4 cm (2 et 8 cm, à 95%) pour

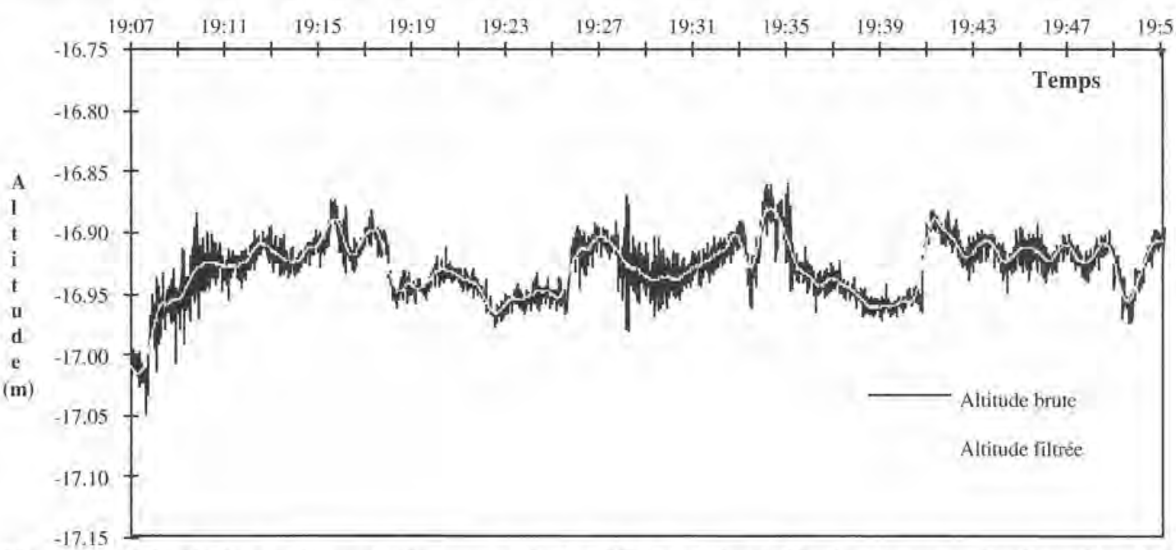

Figure 6: Altitude brute déterminée par méthode OTF et altitude lissée par un polynôme d'ordre 4.

les coordonnées horizontales, et entre 2 et 6 cm (4 et 12 cm, à 95%) pour les altitudes. Typiquement, les erreurs sur l'altitude étaient de 8 cm, à un niveau de probabilité de 95%.

Comparaison				rss (m)		
De	Dist. (km)	Avec	Dist.	dN (km)	dE	dh
68K32901	75	E0432901	5	0.023	0.018	0.058
68K32902	75	E0432902	5	0.024	0.027	0.061
68K32903	75	E0432903	5	0.013	0.009	0.031
68K62901	75	E0462901	5	0.020	0.035	0.030
68K62902	75	E0462902	5	0.014	0.042	0.054
68K62903	75	E0462903	5	0.013	0.010	0.032
CH132922	75	77K32922	5	0.028	0.039	0.047
CH132923	75	77K32923	5	0.012	0.022	0.022
CH162922	75	77K62922	5	0.017	0.014	0.043
CH162923	75	77K62923	5	0.010	0.017	0.022

Tableau 1: Valeurs des rss obtenues de la différence des solutions (L3) entre une station de référence située à 75 km et une autre à 5 km.

La figure 7 présente les différences en altitude des solutions obtenues par rapport à une station située à 75 km et 5 km du secteur de sondage. Il s'agit d'une session d'une durée d'environ 3 heures avec un taux d'échantillonnage de 1 seconde. Lors de cette session, la valeur du rss des différences entre les solutions obtenues sur les vecteurs de 5 et 75 km était de 4 cm.

Tous les vecteurs de 5 km ont été résolus sur la bande sans effet ionosphérique (L3). 10 vecteurs de 75 km sur un total de 14 ont été résolus (pour trois d'entre eux, la trajectoire complète n'a pu être calculée). Les raisons des quelques insuccès sur les vecteurs de 75 km sur la bande sans effet ionosphérique (L3) peuvent être expliquées par les facteurs suivants:

- la constellation nécessaire à la résolution des ambiguïtés de phase pour des vecteurs au-delà de 40-60 km nécessite un minimum de 6 satellites visibles simultanément afin de s'assurer de la fiabilité des positions obtenues et de la résolution des ambiguïtés. Malheureusement, lors des jours 290 et 291, les satellites 12 et 26 étaient hors d'usage;
- l'effet des multitrajets sur les bateaux et aux stations de référence devront être réduits au minimum afin d'augmenter la fiabilité des résultats du positionnement. L'utilisation d'antennes avec anneaux d'étranglement ("choke ring") pourrait aider à réduire ces effets;
- le délai ionosphérique sur de longs vecteurs devrait être modélisé a priori afin d'obtenir les ambiguïtés le plus près possible de leurs "vraies" valeurs entières.

Concernant ce dernier point, il est important de comprendre que pour effectuer une solution OTF sur la bande L3 (qui élimine les effets causés par l'ionosphère), il faut fixer a priori les ambiguïtés de phase sur les bandes L1 et L2. Cependant, afin de réaliser cette première étape, une bonne connaissance du délai ionosphérique relatif entre les sites d'observations est requise, pour de longs vecteurs. Cette information pourrait être extraite des observations recueillies par les stations de référence de la GCC situées le long du fleuve Saint-Laurent. Une équipe du CRG de l'Université Laval travaille actuellement sur une telle approche, inspirée des travaux de Wanninger [1995]. Une telle procédure sera d'autant plus nécessaire, pour la résolution des ambiguïtés sur de longs vecteurs, d'ici quelques années lorsque l'activité ionosphérique sera à son maximum.

Il est important de mentionner que la résolution des ambiguïtés sur la bande large (L4) a été réussie dans tous les cas (100% de succès). La validation de la qualité des résultats (du jour 292) obtenus avec les observations de la bande L4, sur les vecteurs de 75 km, est présentée au tableau 2. La comparaison des solutions (en altitude) L4-75 km est effectuée par rapport aux solutions respectives L3-5 km. L'élément qui différencie de façon importante la solution L3 de la solution L4, est l'effet ionosphérique

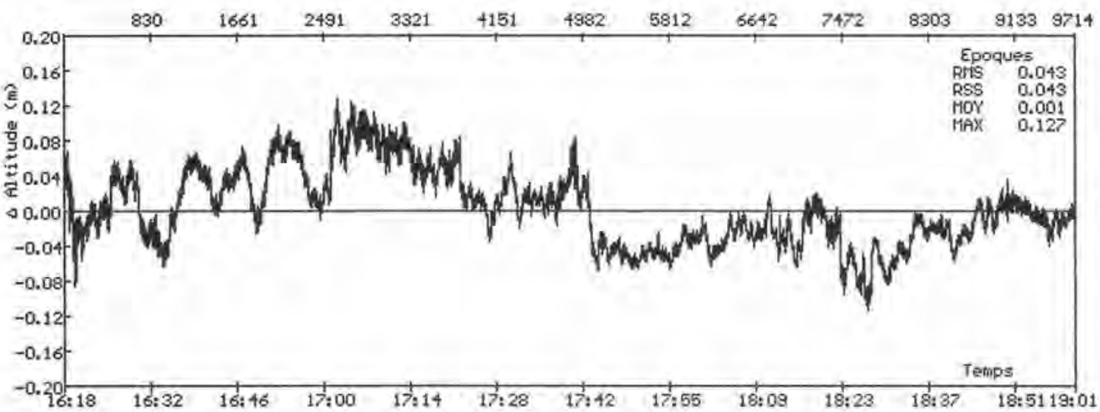

Figure 7: Différence d'altitude du navire entre les stations de référence à 75 et 5 km (bande L3).

relatif (entre les deux stations). Cet effet ionosphérique relatif augmente selon la distance. Au tableau 2, on remarque que les erreurs en altitude varient entre 5 et 11 cm (à un niveau de probabilité de 68%). À un niveau de 95% cette précision est d'environ 10 à 22 cm (typiquement les erreurs en altitude sont de 12 cm).

Jour 292				
Comparaison				dh (68%)
De (L4)	Dist. (km)	Avec (L3)	Dist. (km)	(m)
CH132921	75	77K32921	5	0.05
CH132922	75	77K32922	5	0.07
CH132923	75	77K32923	5	0.05
CH162921	75	77K62921	5	0.05
CH162922	75	77K62922	5	0.11
CH162923	75	77K62923	5	0.05

Tableau 2: Valeurs des rss obtenues de la différence entre les altitudes des solutions L4-75 km par rapport aux altitudes des solutions L3-5 km.

Comparaison de l'approche OTF à l'utilisation des planches à marée

Le second objectif du banc d'essai était donc d'utiliser les résultats obtenus de l'approche OTF et de les utiliser pour le traitement d'un relevé bathymétrique effectué en même temps et de comparer les deux approches. Ainsi, du fichier de sondage obtenu, les données de la marée, le squat, la houle et le tirant d'eau du navire ont été remplacés par les hauteurs OTF préalable réduites de l'ellipsoïde au ZC tel que décrit précédemment.

Pour les tests effectués à Trois-Rivières, une seule planche de marée a été utilisée. Elle était située à moins de 300 mètres du secteur à sonder. L'amplitude des marées à cet endroit est moins de 30 centimètres. Dans le contexte des relevés bathymétriques, ce secteur est considéré comme n'ayant aucune anomalie dans la détermination du ZC. Pour les tests effectués dans le secteur de Neuville, trois planches à marée, situé à 1000 mètres du secteur à sonder, sont nécessaires. Ce secteur est caractérisé par une forte pente (35 centimètres sur 3000 mètres) ce qui nécessite l'utilisation de plusieurs planches à marée. Ces planches sont donc situées au centre et aux deux extrémités du secteur à sonder dont l'amplitude de la marée à cet endroit est de l'ordre 4 mètres.

Les résultats obtenus sont intéressants, pour le secteur de Trois-Rivières l'écart entre l'approche OTF et l'utilisation des planches à marée ne dépasse pas ± 5 cm à 95% pour la détermination d'une sonde et cela pour l'ensemble du secteur. Par contre, pour le secteur de Neuville les sondages ont été effectués à la marée baissante, l'écart entre les deux méthodes varie de -3 cm à -15 cm pour 95% des données. Cette différence s'explique du fait que l'eau se retire plus rapidement dans le chenal ce qui cause une dépression de la surface de l'eau par rapport à la rive. L'utilisation seule des planches à marée près des rives ne permet pas de percevoir ce phénomène puisqu'on transfert le niveau d'eau lu au centre du fleuve sans aucune correction.

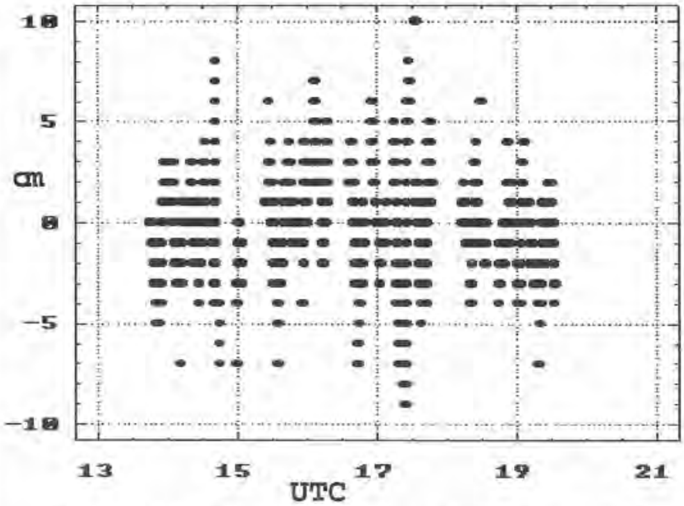

Figure 8: Écart entre la solution OTF et la solution utilisant les planches à marée dans le secteur de Trois-Rivières.

Lors de ces tests, nous avons effectué 4 fois le sondage de ces 2 secteurs dans le but de pouvoir valider la répétabilité des sondages. Nous avons donc obtenu 4 sondages avec l'approche OTF et 4 sondages avec l'utilisation des planches à marée. Pour effectuer cette analyse, nous comparons l'écart des profondeurs moyennes pour chacun des sondages et pour chacune des approches. Les résultats obtenus sont intéressants, ± 2 centimètres dans le secteur de Trois-Rivières pour les 2 approches et dans le secteur de Neuville ± 5 centimètres pour l'approche OTF et ± 10 centimètres avec l'utilisation de planches à marée.

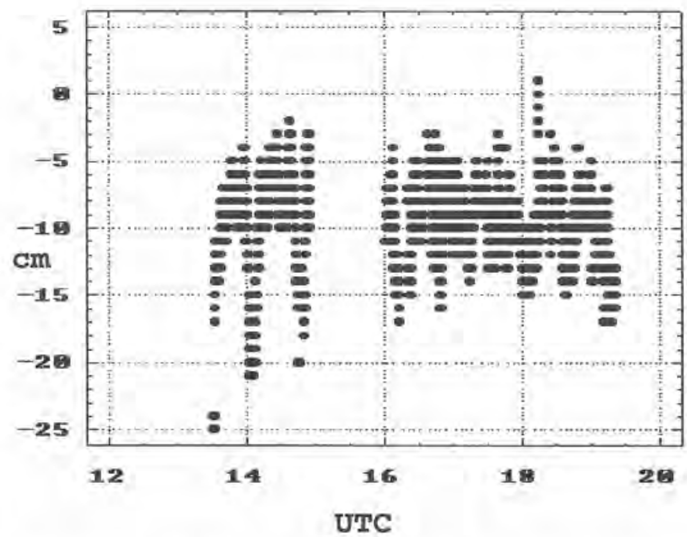

Figure 9: Écart entre la solution OTF et la solution utilisant les planches à marée dans le secteur de Trois-Rivières.

Conclusion

La démonstration de l'utilisation du GPS et de l'approche OTF pour les besoins de la GCC dans le contexte des relevés bathymétriques est concluante. L'utilisation de l'OTF permet d'obtenir des relevés bathymétriques similaires sinon meilleurs que ceux obtenus par l'utilisation des planches à marée. L'utilisation de l'approche OTF permet de constater certains phénomènes non perceptibles par l'utilisation des planches à marée installés sur les abords du fleuve ce qui est un élément majeur. Finalement, l'utilisation du GPS et de l'OTF-TR permettra à la GCC d'accroître sa productivité tout en diminuant ses coûts d'opérations.

Références

1. Ayers, H., Marceau G.,et Larrivée L., *Performance du système GPS WILD 200 en mode cinématique pur*, Projet FAPSM de la Garde côtière Canadienne, LEICA, avril, 23 p., 1992.

2. Frodge, S.L., Shannon, Remond B.W., Lapucha,D., and Barker R., *Result of Real-Time Testing of GPS Carrier Phase Ambiguity Resolution On-The-Fly*, Proceedings of the Institute of Navigation ION GPS-93, Salt Lake City, Utah, 22-24 September, pp. 711-719, 1993.

3. Goguen, J.P. Thomas, Timo Allison, *Precise RTK Positioning Using the New RTCM-104 V2.1 Standard*, Proceedings of the Institute of Navigation ION GPS-95, Palm Springs, California, 12-15 September, pp. 1461-1466.

4. Marceau, G., Bouchard, G., *Projet FAPSM, Tests de précision - Rapport d'évaluation*, Garde côtière canadienne, novembre, 150 p., 1992.

5. Parrot, D., Roy, É, et Santerre, R., *Évaluation en conditions réelles de l'approche OTF pour les levés bathymétriques*, Rapport de recherche pour la Garde Côtière Canadienne - Région des Laurentides, janvier, 119 p., 1996

6. Parrot, D., Roy, É, et Santerre, R., *Évaluation du potentiel et détermination des limites de l'approche OTF*, Rapport de recherche pour la Garde Côtière Canadienne - Région des Laurentides, mai, 73 p., 1995b

7. Parrot, D., Roy, É, et Santerre, R., *Tests de l'approche OTF en mode cinématique*, Rapport de recherche pour la Garde Côtière Canadienne - Région des Laurentides, septembre, 97 p., 1995a.

8. Parrot, D., Roy, É, et Santerre, R., *Positionnement GPS pour les besoins de la navigation sur le fleuve Saint-Laurent*, Arpenteur-Géomètre, Revue de l'Ordre des Arpenteurs-Géomètres du Québec, 22(1):15-17, 1995.

9. Parrot, D., Roy, É, et Santerre, R., *Positionnement cinématique GPS avec des mesures de pseudodistance filtrées et lissées*, Lighthouse, Journal de l'Association Canadienne d'Hydrographie, 52:21-29, 1995.

10. Parrot, D., Roy, É, et Santerre, R., *Positionnement cinématique GPS à l'aide des mesures de pseudodistance lissées*, Rapport scientifique du Module Télédétection-GPS, Projet PREDIR, Centre de Recherche en Géomatique, Université Laval, mars, 109 p., 1994.

11. Lambert, W., *Improved ambiguity resolution by regional differential modelling of the ionosphere*, Proceedings of the Institute of Navigation ION GPS-95, Palm Springs, California, 12-15 September, pp. 55-62, 1995.

12. David, W., Kleusberg, A., et Vanicek P., *A Seamless Vertical - Reference Surface for Acquisition, Management and ECDIS Display of Hydrographic Data*, UNB tech Report-179, Department of Geodesy and Geomatics Engineering, University of New Brunswick, february, 64 p., 1996.

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GPS Reality Checks

D. Wells

Introduction
I contend that the fundamental problem with the Global Positioning System (GPS) is that its performance has consistently exceeded what was expected of it.

This has challenged those responsible for managing GPS. The evolution of GPS technology has been so successful that it has resulted in serious political and management problems. The most serious of these has been the twenty-year struggle to establish and maintain an appropriate balance between the military and civil uses to which GPS can be put. GPS management has had to adapt to new realities resulting from this technological success of GPS. I have selected some of these past "reality checks" for examination in this article. Each reality check is presented as a vignette, in a standard format.

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Reality Check 1: C/A-Code Accuracy

GPS Design: The GPS pseudo-ranging signal designed for civilian use, the C/A-code, was designed with a chip rate which was one tenth that of the pseudoranging signal designed for military use, the P-code.

Planned result: C/A-code GPS positioning accuracy was expected to be about 400 m [3].

Event: Initial field tests.

Reality: C/A-code GPS positioning accuracy (first generation, or Block I GPS satellites) was 20 to 40 m, and C/A code velocity measurements were a fraction of a metre per second.

Response: Intentionally dither the satellite clocks to degrade civilian velocity accuracy, and add deliberate errors to the satellite ephemerides to degrade civilian position accuracy. This process, initially called "Denial of accuracy" eventually was relabelled as "Selective Availability", or SA, and was designed into the second generation (Block II) GPS satellites. Military receivers are able to unscramble SA errors, civilian receivers are not.

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Reality Check 2: SA Increased In Emergencies

Design: The "SA level" or amount of degradation can be varied. The peacetime setting for SA can be "dialed up" (the accuracy available to civilians and hostile forces further degraded) in times of emergency, or when required for United States national security purposes.

Planned result: Non-US-military GPS accuracy will be worse in wartime than in peacetime.

Event: The Gulf War, 1990 to 1991

Reality: Military applications of GPS had far outstripped the military receiver procurement process, particularly of relatively inexpensive hand-held units to be used in vehicles and on foot. Hand-held C/A code civilian receivers, easily available on short notice, were used instead.

Response: During the Gulf War, and later during the invasion of Haiti, SA was dialed down to zero or nearly zero, not dialed up.

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Reality Check 3: GPS With SA Meets User Needs

Design: The civilian mode of GPS, called the Standard Positioning Service, or SPS, differs from the military mode of GPS, called the Precise Positioning Service, or PPS, in two ways: SPS is degraded by SA, and uses a single signal frequency; PPS is not degraded by SA, and is a dual frequency system. SPS was designed to match the performance of existing navigation aids, as far as transportation safety is concerned.

Planned result: SPS (with SA on) will meet most civil user needs.

Event: Explosive growth in civilian GPS use for innovative transportation information systems (Electronic Chart Display and Information Systems, or ECDIS, in the marine world, Future Air Navigation Systems, or FANS, in the aviation world, and Intelligent Transportation Systems, or ITS, in the land world). These applications provide transportation safety and efficiency advantages which go far beyond that available from navigation aids which predate GPS. But they are also "accuracy-addicts".

Reality: Many civilian users have also become accuracy-addicts, and need (or at least want) better performance than that provided by SPS with SA dialed up to its present level, which is officially 100 metres or less horizontally, and 140 metres or less vertically (95% of the time).

Responses: There have been two responses. The first has been political - the rise of an anti-SA lobby among the civilian user community, both within the United States and internationally. The second has been a technological end-run around SA – the development of

Differential GPS (DGPS) systems. SA clock dither errors affect all users identically. SA ephemeris errors affect receivers within the same region of the earth very similarly. A GPS receiver at a stationary known location can monitor SA (and other) errors and broadcast corrections to nearby users. DGPS performance is much better than SPS, even **without** SA.

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Reality Check 4: GLONASS No Threat to SPS

Design: Russia has designed a system similar to GPS in most essential ways, called GLONASS [4]. One difference is that the clocks in GPS satellites are better than clocks in GLONASS satellites.

Planned result: GLONASS (which has no degradation equivalent to SA) will not displace the military or commercial advantages of GPS (with SA dialed to its present level).

Event: Since the collapse of the Soviet Union, GLONASS development has continued for commercial rather than military purposes. One result has been the design of civilian receivers capable of tracking both GPS and GLONASS satellites.

Reality: A civilian GPS + GLONASS receiver achieves accuracies comparable to SPS with SA dialed to zero [5]. The intention of SA can be defeated by using such receivers.

Response: The Presidential Decision Directive (PDD) of 28 March 1996 states that:

"It is our intention to discontinue the use of GPS Selective Availability (SA) within a decade in a manner that allows adequate time and resources for United States military forces to prepare fully for operations without SA."

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Reality Check 5: DGPS is not a Security Threat

Design: DGPS systems require a monitor station at a known location. Hostile forces are unlikely to have the sophistication, or to make the effort, to exploit DGPS. Monitor stations can be rendered inoperative by jamming the corrections, or by detection and destruction.

Planned result: Even though DGPS performance defeats the effect of SA, DGPS poses no threat to military security.

Event: Development and widespread implementation of DGPS technology. Wide-Area DGPS (WADGPS) technology, using many widely distributed DGPS monitor stations, communicating with each other and with users, often via communication satellites, provides DGPS services on a continental or larger scale. At least two commercial non-U.S.-controlled WADGPS services are available around the world: the Racal Skyfix system, and the Fugro Starfix II system. At least 12 agencies of the U.S. government operate permanent DGPS systems (Army Corps of Engineers, Bureau of Land Management, Coast Guard, Defense, Environmental Protection Agency, Federal Aviation Administration, Forest Service, Geological Survey, NASA, NOAA, National Science Foundation and the St. Lawrence Seaway). Marine DGPS services have been or are being implemented by governments in over a dozen other countries (Canada, Australia, China, India, Finland, Poland, Sweden, Norway, Denmark, Germany, The Netherlands, Iceland and South Africa). WADGPS services for aviation are planned by the United States, Canada, Australia, New Zealand and Japan. Two companies are using add-ons to the broadcast signals of existing FM radio stations to provide Local Area DGPS (LADGPS) services in North America and around the world. Differential Corrections Inc. (DCI) has an agreement to add LADGPS to any Canadian Broadcasting Corporation FM station within whose signal coverage area there is a sufficient demand for LADGPS services. Pinpoint has an agreement with practically all other FM stations in Canada for a similar service. Each company plans to operate soon from over 100 FM stations in North America and many more stations around the world. Clients use a DGPS correction receiver resembling a telephone paging unit. In addition to all these permanent DGPS services, users can buy and deploy at will their own small, inexpensive, reliable, easy to operate, temporary DGPS equipment, available from many U.S. and international GPS manufacturers.

Reality: The proliferation of permanent DGPS systems, and the availability of simple user-friendly equipment for temporary DGPS systems, removes barriers to the hostile use of DGPS, and greatly increases the difficulty of rendering inoperative all possible DGPS services in a region of conflict.

Response: The Presidential Decision Directive (PDD) of 28 March 1996 states that the Department of Defense will:

"Develop measures to prevent the hostile use of GPS [and DGPS] to ensure that the United States retains a military advantage without unduly disrupting or degrading civilian uses."

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Reality Check 6: GPS is the Ultimate Navigation System

Design: GPS is designed to meet all expected military and civilian navigation and positioning needs.

Planned result: GPS is the ultimate navigation system. There is no need for a successor system to eventually replace GPS.

Events: Many civil, commercial and scientific positioning needs which could be met by GPs are not, impeded by the balance between national security benefits and economic and social benefits. Proposals are made in other countries for superior, civil, non-US-controlled successors to GPS.

Reality: Continued growth of GPS, and full realization of its economic benefits, depends on better meeting civil, commercial and scientific needs.

Response: The Presidential Decision Directive of 28 March 1996 states that the United States will:
"cooperate with other governments and international organizations to ensure an appropriate balance between the requirements of international civil, commercial and scientific users and international security interests."

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Reality Check 7: GPS Controlled Solely by U.S. Military

Design: From the beginning GPS was designed as a dual use technology, meeting both military and civilian needs.

Planned result: National security (military) benefits from GPS are primary. Economic and social (civilian) benefits from GPS are secondary.

Event: Demonstration of significant GPS civil, commercial and scientific benefits. In addition to marine, air and land transport uses for which GPS was intended, new applications have emerged in resource management (farming, forestry, open-pit mining), facilities management (road and rail inventory systems), geomatics, geodesy and earth science, timing and telecommunications, and recreational personal use (hiking, biking, golf). It has been estimated that the economic impact of servicing these applications (the size of the GPS supplier industry) for the North American market totals $42 billion over the decade starting in 1994, and that this would increase to $64 billion if the use of SA were discontinued [2]. This does not include the economic impact (efficiencies, productivity, new goods and services) of GPS within the user sector.

Reality: Pressure to find a new balance between national security GPS benefits and economic and social GPS benefits.

Responses: Starting in 1980, and updated biennially, a United States Federal Radionavigation Plan has been prepared jointly by the Departments of Defense and Transportation (representing all civilian users). Several studies were commissioned recently to suggest changes in the management and policies regarding GPS [1,5,6,7,8]. The Presidential Decision Directive of 28 March 1996 states that GPS (and U.S. government DGPS systems) will be managed by an interagency GPS Executive Board, jointly chaired by the Departments of Defense and Transportation, and that this Board will:
"consult with U.S. government agencies, U.S. industries, and foreign governments involved in navigation and positioning system research, development, operation, and use."

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Summary

The Presidential Decision Directive of 28 March 1996 has removed the uncertainties surrounding the future of GPS, which in recent years had begun to affect the full exploitation of the benefits which GPS can provide. Clear policies for the future of GPS have been established. A balance between national security benefits and economic and social benefits has been struck. A process has been established for regularly reviewing this balance, taking into account military and civil concerns, both within the United States and among other nations.

It is appropriate to conclude with a final passage from the Presidential Decision Directive:
"We will continue to provide the GPS Standard Positioning Service for peaceful civil, commercial and scientific use on a continuous, worldwide basis, free of direct user fees."

This generous gift of accurate positioning, timing, and velocity from the taxpayers and government of the United States to the rest of the world is perhaps the greatest of the successes of GPS.

References

1. DoD/DoT, *The Global Positioning System: Management and operation of a dual use system - a report to the secretaries of Defense and Transportation*, Joint DoD/DoT Task Force, December, 1993.

2. Dyment, M., *North American GPS markets: analysis of SA and other policy alternatives.* Booz.Allen & Hamilton Inc. Appendix E in *The Global Positioning System, a shared national asset. Recommendations for technical improvements and enhancements*, Committee on the future of the Global Positioning System, Commission on Engineering and Technical Systems, National Research Council. National Academy Press, Washington, pages 179-200, 1995.

3. Kremer, G.T., Kalafus,R.M., Loomis, P.V.W, and J.C. Reynolds, *The effect of selective availability on differential GPS corrections* , Navigation, Journal of The Institute of Navigation (U.S.), Vol. 37, No. 1, 39-52, 1990.

4. Kleusberg, A., *Comparing GPS and GLONASS*, GPS World, November/December, Vol. 1, No. 6, pp. 52-54, 1990.

5. NRC, *The Global Positioning System, a shared national asset. Recommendations for technical improvements and enhancements.* Committee on the future of the Global Positioning System, Commission on Engineering and Technical Systems, National Research Council, National Academy Press, Washington, 264 pages, 1995.

6. NAPA, *The Global Positioning System, Charting the future,* Joint report of the National Academy of Public Administration and the National Research Council, Washington, 336 pages, 1995.

7. OMB (1994)

8. Rand (1995)

APPENDIX
THE WHITE HOUSE
Office of Science and Technology Policy
National Security Council

EMBARGOED FOR RELEASE ON
March 29, 1996 Contact: (202) 456-6020

FACT SHEET
U.S. GLOBAL POSITIONING SYSTEM POLICY

The President has approved a comprehensive national policy on the future management and use of the U.S. Global Positioning System (GPS) and related U.S. Government augmentations.

Background

The Global Positioning System (GPS) was designed as a dual-use system with the primary purpose of enhancing the effectiveness of U.S. and allied military forces. GPS provides a substantial military advantage and is now being integrated into virtually every facet of our military operations. GPS is also rapidly becoming an integral component of the emerging Global Information Infrastructure, with applications ranging from mapping and surveying to international air traffic management and global change research. The growing demand from military, civil, commercial, and scientific users has generated a U.S. commercial GPS equipment and service industry that leads the world. Augmentations to enhance basic GPS services could further expand these civil and commercial markets.

The "basic GPS" is defined as the constellation of satellites, the navigation payloads which produce the GPS signals, ground stations, data links, and associated command and control facilities which are operated and maintained by the Department of Defense; the "Standard Positioning Service" (SPS) as the civil and commercial service provided by the basic GPS; and "augmentations" as those systems based on the GPS that provide real-time accuracy greater than the SPS.

This policy presents a strategic vision for the future management and use of GPS, addressing a broad range of military, civil, commercial, and scientific interests, both national and international.

Policy Goals

In the management and use of GPS, we seek to support and enhance our economic competitiveness and productivity while protecting U.S. national security and foreign policy interests.

Our goals are to:

(1) Strengthen and maintain our national security.

(2) Encourage acceptance and integration of GPS into peaceful civil, commercial and scientific applications worldwide.

(3) Encourage private sector investment in and use of U.S. GPS technologies and services.

(4) Promote safety and efficiency in transportation and other fields.

(5) Promote international cooperation in using GPS for peaceful purposes.

(6) Advance U.S. scientific and technical capabilities.

Policy Guidelines

We will operate and manage GPS in accordance with the following guidelines:

(1) We will continue to provide the GPS Standard Positioning Service for peaceful civil, commercial and scientific use on a continuous, worldwide basis, free of direct user fees.

(2) It is our intention to discontinue the use of GPS Selective Availability (SA) within a decade in a manner that allows adequate time and resources for our military forces to prepare fully for operations without SA. To support such a decision, affected departments and agencies will submit recommendations in accordance with the reporting requirements outlined in this policy.

(3) The GPS and U.S. Government augmentations will remain responsive to the National Command Authorities.

(4) We will cooperate with other governments and international organizations to ensure an appropriate balance between the requirements of international civil, commercial and scientific users and international security interests.

(5) We will advocate the acceptance of GPS and U.S. Government augmentations as standards for international use.

(6) To the fullest extent feasible, we will purchase commercially available GPS products and services that meet U.S. Government requirements and will not conduct activities that preclude or deter commercial GPS activities, except for national security or public safety reasons.

(7) A permanent interagency GPS Executive Board, jointly chaired by the Departments of Defense and Transportation, will manage the GPS and U.S. Government augmentations. Other departments and agencies will participate as appropriate. The GPS Executive Board will consult with U.S. Government agencies, U.S. industries and foreign governments involved in navigation and positioning system research, development, operation, and use.

This policy will be implemented within the overall resource and policy guidance provided by the President.

Agency Roles and Responsibilities

The Department of Defense will:

(1) Continue to acquire, operate, and maintain the basic GPS.

(2) Maintain a Standard Positioning Service (as defined in the Federal Radionavigation Plan and the GPS Standard Positioning Service Signal Specification) that will be available on a continuous, worldwide basis.

(3) Maintain a Precise Positioning Service for use by the U.S. military and other authorized users.

(4) Cooperate with the Director of Central Intelligence, the Department of State and other appropriate departments and agencies to assess the national security implications of the use of GPS, its augmentations, and alternative satellite-based positioning and navigation systems.

(5) Develop measures to prevent the hostile use of GPS and its augmentations to ensure that the United States retains a military advantage without unduly disrupting or degrading civilian uses.

The Department of Transportation will:

(1) Serve as the lead agency within the U.S. Government for all Federal civil GPS matters.

(2) Develop and implement U.S. Government augmentations to the basic GPS for transportation applications.

(3) In cooperation with the Departments of Commerce, Defense and State, take the lead in promoting commercial applications of GPS technologies and the acceptance of GPS and U.S. Government augmentations as standards in domestic and international transportation systems.

(4) In cooperation with other departments and agencies, coordinate U.S. Government-provided GPS civil augmentation systems to minimize cost and duplication of effort.

The Department of State will:

(1) In cooperation with appropriate departments and agencies, consult with foreign governments and other international organizations to assess the feasibility of developing bilateral or multilateral guidelines on the provision and use of GPS services.

(2) Coordinate the interagency review of instructions to U.S. delegations to bilateral consultations and multilateral conferences related to the planning, operation, management, and use of GPS and related augmentation systems.

(3) Coordinate the interagency review of international agreements with foreign governments and international organizations concerning international use of GPS and related augmentation systems.

Reporting Requirements

Beginning in 2000, the President will make an annual determination on continued use of GPS Selective Availability. To support this determination, the Secretary of Defense, in cooperation with the Secretary of Transportation, the Director of Central Intelligence, and heads of other appropriate departments and agencies, shall provide an assessment and recommendation on continued SA use. This recommendation shall be provided to the President through the Assistant to the President for National Security Affairs and the Assistant to the President for Science and Technology.

About the Author / À propos de l'auteur

Dave Wells *is a Professional Engineer, and President of Canadian GPS Associates. Since 1980 he has been a faculty member in the Department of Geodesy and Geomatics Engineering (formerly Surveying Engineering) at the University of New Brunswick. For 15 years prior to that he worked at the Bedford Institute of Oceanography as an engineer and research scientist. He holds degrees in physics, engineering physics, nuclear physics, and surveying engineering, is the author of over 200 technical papers and reports, and has presented over 30 introductory courses on GPS , and 6 courses on multibeam sonar surveying in the United States, Canada, Europe and Asia.*

For more information please contact:
Dave Wells*, University of New Brunswick, Geodesy and Geomatics Engineering*
P.O. Box 4400, Fredericton N.B., Canada E3B 5A3
Telephone: (506) 453-5147, Fax: (506) 453-4943, email: dew@unb.ca

Go FIGure

by Dennis St. Jacques

This is the first edition in what I hope will be a regular column about the activities of Commission 4 of the Fédération Internationale des Géomtres (FIG). For this issue, I think it's appropriate to give you some background information on FIG itself.

FIG is an international federation of national surveying associations that was founded in 1878. The aim of FIG is to ensure that the disciplines of surveying and all who practice them meet the needs of the markets and communities that they serve. It realizes this aim by promoting the practice of the profession and encouraging the development of professional standards.

Nearly 100 countries are represented in FIG. In Canada, the Canadian Institute of Geomatics is our national member. In countries that have yet to form national associations, correspondents can be appointed to represent the surveying community in their country.

The administrative work is carried out by the FIG Bureau, national delegates of the member associations, and the chairmen of the nine technical Commissions. Together, these groups make up the Permanent Committee of FIG.

The technical work of FIG is carried out by the following 9 Commissions:

1. Professional Standards and Practice
2. Professional Education
3. Land Information Systems
4. Hydrography
5. Positioning and Measurement
6. Engineering Surveys
7. Cadastre and Land Management
8. Spatial Planning and Development
9. Valuation and the Management of Real Estate.

These Commissions prepare the programme for the FIG International Congress which is held every four years. The next Congress, will be held in Brighton, United Kingdom, on July 19 - 25, 1998.

Information about the activities of FIG is available on the World Wide Web at *http://www.ps.ucl.ac.uk/figtree/* and in the quarterly newsletter—the FIG Bulletin.

In the next column, I will describe the activities of Commission 4. In the meantime, you can visit our own web site at *http://csx.cciw.ca/dfo/chs/fig4/* for information about our executive and our latest newsletter.

Ends of the Earth
Au bout du monde

by Fred Oliff

*The **Ends of the Earth** feature describes the activities of hydrographers and those practising related disciplines. We encourage readers everywhere to send accounts of their own work.*

While Sir John Franklin is most famous for his fatal last voyage, and for leading the Arctic expedition that lost the most lives (Franklin's 1819-21 expedition lost eleven lives to starvation and murder, and 139 lives were lost on Franklin's last expedition of 1845), Sir John Richardson's accomplishments are less well known. The focus of this article is Franklin's second expedition, during which a party led by Richardson surveyed the Arctic coast between the Mackenzie and Coppermine rivers.

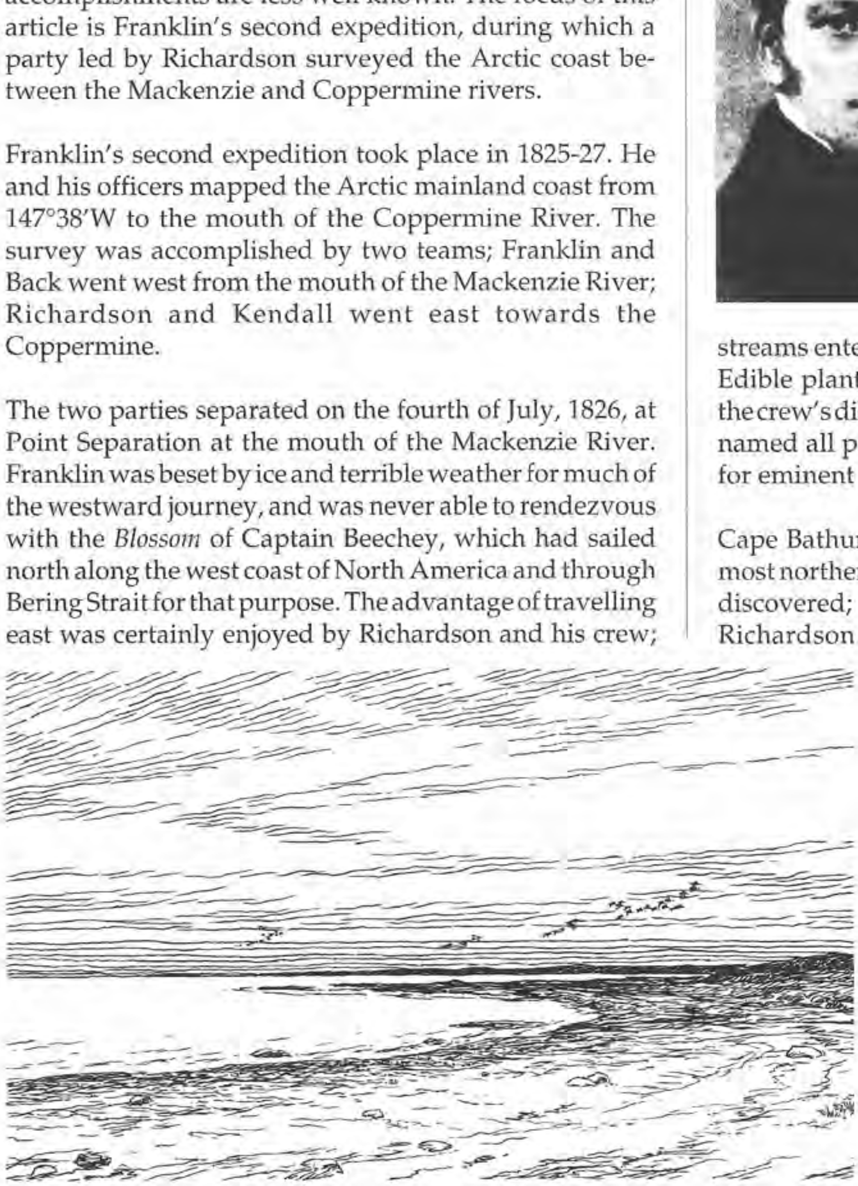
Franklin's second expedition took place in 1825-27. He and his officers mapped the Arctic mainland coast from 147°38'W to the mouth of the Coppermine River. The survey was accomplished by two teams; Franklin and Back went west from the mouth of the Mackenzie River; Richardson and Kendall went east towards the Coppermine.

The two parties separated on the fourth of July, 1826, at Point Separation at the mouth of the Mackenzie River. Franklin was beset by ice and terrible weather for much of the westward journey, and was never able to rendezvous with the *Blossom* of Captain Beechey, which had sailed north along the west coast of North America and through Bering Strait for that purpose. The advantage of travelling east was certainly enjoyed by Richardson and his crew; even though the weather was not the best, they had the prevailing winds behind them, and the coast allowed deeper routes than the shallow coastline to the west.

Sir John Richardson was born at Dumfries, Scotland on November 5, 1787. He apprenticed under the auspices of his uncle, and, after a tour of duty as surgeon with the Royal Navy in the 1812-14 war between Canada and the United States, gained his MD degree from Edinburgh in 1816.

During Richardson's journey, fresh drinking water was obtained from ice floes and small streams entering the Arctic Ocean from the barren coast. Edible plant species were gathered as a supplement to the crew's diet. As they journeyed eastward the expedition named all points, promontories, bays, inlets, and rivers for eminent persons of the day.

Cape Bathurst, named for the Earl of Bathurst, was the most northerly point of the North American continent yet discovered; the cape encloses Franklin Bay, named by Richardson in honour of his superior. Cape Parry, enclosing the bay on the east, was named after the Arctic explorer William Edward Parry, who in 1819-21 had reached the farthest west to Melville Island. Richardson's party reached Franklin Bay on the 22nd of July after sailing and rowing for 18 days. Observations were taken for latitude and longitude, and for ocean depths (sounding by leadline); also studied were tides, temperature, and geology.



Turnagain Point, NWT. Drawn by Dr. Albert Hochbaum.

A month after departing Separation Point, Richardson and his men reached the western end of the Dolphin and Union Strait, and the start of the last leg of the sea journey that would end at the mouth of the Coppermine River. It was determined that Dolphin and Union Strait would be dangerous for the navigation of ships, owing to the presence of the many shoals and sunken rocks. (One hundred and seventy years after the first maps of this area were drawn, the Canadian Hydrographic Service is still conducting surveys of the area, most recently Dolphin and Union Strait.

Dolphin and *Union* were the names of the boats which first traversed those waters, in 1826.) Cape Krusenstern, named after the famous Russian hydrographer, was the most easterly point gained by the expedition; it forms the northern coast of Coronation Gulf.

John Richardson's contribution was not confined to maps. His extensive and meticulous collection and recording of plant, animal, fish, and bird species of the Canadian Arctic can be found in the appendices of *Arctic Ordeal*, [1]. Many of the plant species were named after Richardson, as he was the first to identify and collect examples of them.

Richardson's party had the honour of completing a portion of the Northwest Passage and connected up the coast with the section previously mapped by Franklin in 1819-21. It took Richardson's party only one month and four days to travel from the Mackenzie to the mouth of the Coppermine River, a distance of 902 statute miles. Though the daily distances and positions had to be corrected by lunar distances, due to the breaking of two chronometers during the previous winter, Kendall's reckoning of position of a campsite used by Franklin in 1821 was only off by 20" in time or 2.5 miles.

Credit must be given to John Richardson for completing his journey early in the season, thereby allowing the overland trek to be completed during the short summer season, and for keeping his men both in good health and spirits. The whole journey, including the arduous land trek back from the Coppermine River to Fort Franklin on Great Bear Lake, was accomplished without loss of life.

Fred Oliff (pictured here) is a native of Ontario, Canada, where he graduated from Sir Sandford Fleming College before taking a degree at the University of Waterloo. He joined the Canadian Hydrographic Service in 1993. Fred's love of the outdoors manifests in a zest for canoeing; he is approaching the 3,000km mark paddling the rivers of northern Ontario and Quebec.

Chute de la Chaudière, Ashuapmushuan River, Quebec

Illustrations

The portrait of John Richardson and the drawing by Dr. Hochbaum, which appear in The journal of John Richardson, are reproduced here by permission of McGill-Queens University Press.

References

1. Houston, C.S., *Arctic Ordeal: The journal of John Richardson: surgeon-naturalist with Franklin, 1820-22*, edited by C. Stuart Houston, McGill-Queens University Press, Kingston, 1984.

Bibliography

Back, George, Sir, *Arctic Artist: the journal and paintings of George Back, midshipman with Franklin, 1819-22*, edited by C.Stuart Houston, McGill-Queens University Press, Montreal, 1994.

Franklin, John, Sir, *Narrative of a second expedition to the shores of the polar sea in the years 1825, 26, 27, and including an account of the progress of a detachment to the eastward by John Richardson*, Greenwood, New York, 1969.

Houston, Clarence Stuart, *To the Arctic by canoe, 1819-21: the journal and paintings of Robert Hood, midshipman with Franklin*, edited by C. Stuart Houston, McGill-Queens University Press, Montreal, 1974.

Lighthouse Puzzler
Casse-tête du Lighthouse

by Beth Weller

Lighthouse Puzzler # 14

Four International Members were talking about having tamed some very special golf courses on their last vacation. Knowing that one of them had played Glen Abbey on Pro-Am day at the Canadian Open, can you figure out from the clues who used which club?

The clues:

1. No one has the same first and last initials.
2. The one who tamed Glen Abbey was not Karl or Randall or the one with the 1 iron.
3. Ron, who is not Furness, and George have never been to Bermuda or used a spoon.
4. Frank Randall did not tame St. Andrews Old Course or like his driver.
5. Goldsteen (who is not Karl) does not have a 1 iron or a 7 wood.
6. Furness has never been away from North America.
7. The spoon was not used at the Royal Hamilton in Bermuda.

	Kieninger	Furness	Randall	Goldsteen	Glen Abbey	St. Andrews	Augusta, Georgia	Royal Hamilton	Driver	Spoon	1 Iron	7 Wood
Karl												
Ron												
Frank												
George												
Driver												
Spoon												
1 Iron												
7 Wood												
Glen Abbey												
St. Andrews												
Augusta, Georgia												
Royal Hamilton												

Solution to Fall Puzzler (#13)

O'Connor is staying with CHS (Clue 6) but is not Neil from Quebec (Clue 4) or Carol or Jane (Clues 1 and 2) so must be Phil and from CHS Central, and Corkum is not Carol (Clue 1) so must be Neil, and Carol must be Rogers. Carol is not from CHS Quebec (Clue 4) or going to CHS (Clue 1) so is not from Offshore (Clue 5) and so must be from Universal, and Jane must be from Offshore.

The one going to CHS Atlantic is not Carol or Neil or Jane (Clues 1 and 2) so must be Phil O'Connor, and Jane is the one going to CHS Pacific (Clue 5). By elimination, Carol is retiring and Neil is going to NDI.

The Canadian Hydrographic Association
L'Association canadienne d'hydrographie
Academic Award / Bourse d'étude

(established / constituée en 1992)

Rules for eligibility:

1. The applicant must be a full-time student registered in an accredited program related to Hydrography (these programs include Geomatics, Geography, Cartography, or Survey Sciences) in a university or technological college in Canada. The CHA Academic Award administrators reserve the right to determine applicability of the program.
2. The award will be available only to students who have completed at least one year of instruction in the program.
3. The applicant will be required to write a 500 word paper on the relationship of their academic work to hydrography.
4. The applicant will be required to write a short paragraph explaining how this financial award will assist them in their academic career.
5. The awards applications must be submitted to the CHA Academic Awards Manager by the end of June of the applicable year. The award will be given by September 15th of the same year. All officials from the academic institutes of students submitting applications will be notified by mail of the results.
6. The value of the award will be $ 2,000.00.
7. The successful candidate will receive a special Canadian Hydrographic Association certificate.
8. The successful candidate will be requested to write a letter of appreciation to the CHA for publication in "Lighthouse".
9. The award will be presented to an individual only once.
10. At the time of application, the applicant will be required to submit an official transcript from their academic institute indicating their previous years' grades.
11. The applicant must submit one letter of reference from an official of the university or college at which the applicant spent the previous year. The letter of reference must include the address and phone number of the official.
12. Applications must be made on forms supplied by, and submitted to:

    Barry Lusk,
    Academic Awards Manager,
    CHA Academic Awards Program,
    4719 Amblewood Dr.,
    Victoria, B.C.
    V8Y 2S2

Critères d'admissibilité:

1. Le postulant doit être un étudiant à plein temps, inscrit à un programme reconnu dans le domaine de l'hydrographie (comme géomatiques, géographie, cartographie ou sciences des levés) à responsables de la bourse d'étude seréservent le droit de décider si le programme est conforme.
2. La bourse ne sera disponible qu'aux étudiants ayant complété au moins une année de formation dans un programme avec diplôme ou licence relié à l'hydrographie.
3. Le candidat devra présenter un travail de 500 mots portant sur la relation entre sa formation scolaire et l'hydrographie.
4. Le candidat devra présenter un court paragraphe expliquant comment cette bourse aidera à son état d'étudiant.
5. Les formulaires d'inscription pour une bourse doivent être soumis au directeur aux bourses d'études de l'ACH d'ici la fin juin de l'année concernée. La bourse sera versée avant le 15 septembre de la même année. Les responsables du corps enseignant d'un établissement dont des membres ont postulés recevront les résultats par la poste.
6. Le montant de la bourse est de 2,000 dollars.
7. Le candidat sélectionné recevra un certificat spécial de l'ACH.
8. L'étudiant qui reçoit la bourse devra remercier l'ACH par lettre, lettre qui sera publiée dans «Lighthouse», revue de l'ACH.
9. La bourse n'est remise qu'une seule fois à une personne.
10. Le postulant devra fournir au moment de la demande, une copie officielle provenant de l'établissement d'enseignement des notes obtenues lors des années précédentes.
11. Le postulant doit présenter une lettre de référence d'un représentant de l'université ou du collège où il a passé la dernière année. Cette lettre doit porter l'adresse et le numéro de téléphone du représentant.
12. On doit utiliser les formulaires fournis et les faire parvenir à:

    Barry Lusk,
    Directeur aux bourses d'études,
    Programme de bourses d'étude de l'ACH,
    4719 Amblewood Dr.,
    Victoria (C.-B.)
    V8Y 2S2

Sustaining Members
Membres de soutien

Sustaining membership allows companies closely linked with the hydrographic field to become more involved with the activities of the CHA and to maintain closer contact with users of their products. Through LIGHTHOUSE these Sustaining Members are also able to reach a world-wide hydrographic audience. The benefits of Sustaining Membership include:

- a certificate suitable for framing;
- three copies of each issue of Lighthouse;
- copies of the local Branch newsletters, where available;
- an invitation to participate in CHA seminars;
- an annual listing in Lighthouse;
- an annual 250 word description in Lighthouse; and
- discounted advertising rates in Lighthouse.

Annual dues for CHA Sustaining Membership are $150.00 (Canadian).
Current Sustaining Members are listed below.

Aanderaa Instruments Ltd.
100 - 4243 Glanford Avenue
Victoria, British Columbia
Canada V8Z 4B9 Fax: (250) 479-6588
contact: Gail Gabel *(affiliation - CHA Pacific Branch)*

Cansel Survey Equipment
3751 Napier Street
Burnaby, British Columbia
Canada V5C 3E4 Fax: (604) 299-1998
contact: Bo Skapski *(affiliation - CHA Captain Vancouver Branch)*

Garde côtière canadienne
104 rue Dalhousie, Suite 311
Québec, Québec
Canada G1K 4B8 Téléc: (418) 648-4236
contact: Claude Duval *(affiliation - ACH Section du Québec)*

l'Institut maritime du Québec
53 St-Germain Ouest
Rimouski, Québec
Canada G5L 4B4 Téléc: (418) 724-0606
contact: Claude Jean *(affiliation - ACH Section du Québec)*

NovAtel Communications Ltd.
6732 8th Street N. E.
Calgary, Alberta
Canada T2E 8M4 Fax: (403) 295-0230
contact: Art Silver *(affiliation - CHA Central Branch)*

Quester Tangent Corporation
9865 West Saanich Road
Sidney, British Columbia
Canada V8L 3S3 Fax: (250) 655-4696
contact: John Watt *(affiliation - CHA Pacific Branch)*

Simrad Mesotech Systems Ltd.
202 Brownlow Avenue
Dartmouth, Nova Scotia
Canada B3B 1T5 Fax: (902) 468-2217
contact: John Gillis *(affiliation - CHA Central Branch)*

terra surveys ltd.
1962 Mills Road,
Sidney, British Columbia
Canada V8L 3S1 Fax: (250) 656-4604
contact: Rick Quinn *(affiliation - CHA Pacific Branch)*

• Institute Maritime du Québec •
Rimouski, Québec, Canada

Le Camp maritime Ulysse vise à faire vivre durant six jours, (28 juin - 9 août) en toute sécurité, une expérience maritime divertissante et formatrice à une douzaine de jeunes, de 12 à 15 ans, formant deux équipages.

Après avoir découvert l'institute, ses laboratoire, ses ateliers, son mur d'escalade..., après avoir appris et expérimenté des choses nouvelles à travers des jeux et diffèrentes activités, tu apprendras à manoeuvrer un kayak de mer et tu partiras en exploration du littoral du Saint-Laurent. Puis tu t'installeras pour deux jours à bord d'un batuau qui croisera dans les îles du Bic. Pour information ou réservation: Institute maritime du Québec, a/s M. Denis Saint-Laurent, 53, rue Saint-Germain Ouest, Rimouski, Québec G5L 4B4

Canadian Hydrographic Association
Association canadienne d'hydrographie

The **Canadian Hydrographic Association (CHA)** is a non-profit, scientific and technical group of about 500 members with the objectives of:

- advancing the development of hydrography, marine cartography and associated activities in Canada;
- furthering the knowledge and professional development of its members;
- enhancing and demonstrating the public need for hydrography;
- assisting in the development of hydrographic sciences in developing countries.

It is the only national hydrographic organization in Canada. It embraces the disciplines of:

- hydrographic surveying;
- marine cartography;
- marine geodesy;
- offshore exploration;
- tidal and tidal current studies.

The Canadian Hydrographic Association is formally affiliated with the Canadian Institute of Geomatics. It is informally associated with the Hydrographic Society.

What the CHA Can Do For You

- advance your knowledge of hydrography, cartography and associated disciplines, and keep you abreast of the latest development in these disciplines;
- enable you to develop and maintain contacts with others involved with hydrography, nationally and internationally.

These benefits are provided through the publication of LIGHTHOUSE (one of only three journals in the world devoted exclusively to hydrography), through the sponsorship of seminars, colloquiums, training programs, national conferences, and branch and national meetings.

Lighthouse
The journal of the Canadian Hydrographic Association, LIGHTHOUSE, is published twice yearly and distributed free to its members. Timely scientific, technical and non-technical papers and articles appear in the journal, with authors from national and international academia, industry and government. Present circulation of LIGHTHOUSE is approximately 700.

Membership
Membership is open to all hydrographers, those working in associated disciplines, and those interested in hydrography and marine cartography.

Branch & Regional Activities
The Canadian Hydrographic Association has seven (7) branches located across Canada. National headquarters is located in Ottawa.

For further information write to:

National President
Canadian Hydrographic Association
P.O. Box 5378, Station F
Ottawa, Ontario
Canada
K2C 3J1

L'Association canadienne d'hydrographie (ACH) est un organisme sans but lucratif réunissant un groupe scientifique et technique de plus de 500 membres ayant des objectifs communs, comme:

- faire progresser le développement de l'hydrographie, de la cartographie marine et de leurs sphères d'activités au Canada
- permettre les échanges d'idées et le développement professionel de ses membres
- rehausser et démontrer l'importance de l'hydrographie auprès de public
- assister au développement des sciences de l'hydrographie dans les pays en voie de développement

Au Canada, l'Association est la seule organisation hydrographique qui embrasse les disciplines suivantes:

- levé hydrographique
- cartographie marine
- géodésie marine
- exploration extra-côtière
- étude des marées et courants

L'Association canadienne d'hydrographie est affiliée à l'Association canadienne des sciences géomatiques, et non-officiellement liée à la Hydrographic Society.

Ce qu'elle peut faire pour vous
L'ACH vous offre des avantages tels que:

- parfaire vos connaissances de l'hydrographie, de la cartographies et des disciplines connexes, tout en vous tenant au courant des nouvelles techniques et des derniers développements réalisés dans ces domaines;
- établir et maintenir des contacts avec ceux qui oeuvrent en hydrographie, au niveau national et international.

Ces avantages sont transmis par l'entremise de LIGHTHOUSE (une des trois revues au monde traitant exclusivement d'hydrographie) et par la tenue de séminaires, de colloques, de programmes de formation et d'assemblées régionales et nationales.

Lighthouse
La revue de l'Association canadienne d'hydrographie, LIGHTHOUSE, est publiée deux fois l'an et distribuée gratuitement aux membres. Des articles scientifiques, techniques et non techniques, provenant du milieu de l'industrie ou du gouvernement autant national qu'international, apparaissent dans cette revue. Le tirage actuel de la revue est d'environ 700 copies.

Comment devenir membre
Le statut de membre est offert aux hydrographes et à tout ceux oeuvrant ou ayant un intérêt dans des disciplines associées à hydrographie ou à la cartographie marine.

Sections et activités régionales
L'Association canadienne d'hydrographie possède sept (7) sections à travers le Canada. L'administration central se trouve à Ottawa.

Pour plus d'informations, s'adresser au:

Président national
Association canadienne d'hydrographie
C.P. 5378, station F
Ottawa, Ontario
Canada
K2C 3J1

News From Industry
Nouvelles d l'industrie

• Royal Ausralian Navy (RAN) Hydrographic Service •

The 75th Anniversary of the RAN Hydrographic Service occurred on October 1, 1995. A publication entitled *Leadline to Lasar, The Hydrographic Service, Royal Austrailan Navy 1920 to 1995,* has been compiled by Commander R.J. Hardstaff RAN Rtd to mark the 75th Anniversary. The volume, with a foreword by Admiral Ritchie, is a compendium of detail from reports of surveys, submitted fair charts, H.O. files and numerus other sources including the remembrance of a number of persons mentioned in the book. Copies of the softcover edition are available from the author at a cost of A$30 plus packaging and postage (overseas A$19 per copy). Write: Commander R.J. Hardstaff RAN Rtd, 2 Upper Cliff Road, Northwood, NSW, 2066, Australia.

• Chelsea Instruments •

West Molesey, Surrey, UK

Racal Survey and Chelsea Environmental have launched a new hire service offering a wide range of advanced oceanographic and environmental monitoring tools. These are aimed specifically at the offshore exploration and construction, dredging and environmental monitoring sectors. Browse through the Chelsea Instruments web site at http://**www.chelsea.co.uk** where a range of new instruments are displayed.

• Lasar Technology Inc. •

Englewood, Colorado, U.S.A.

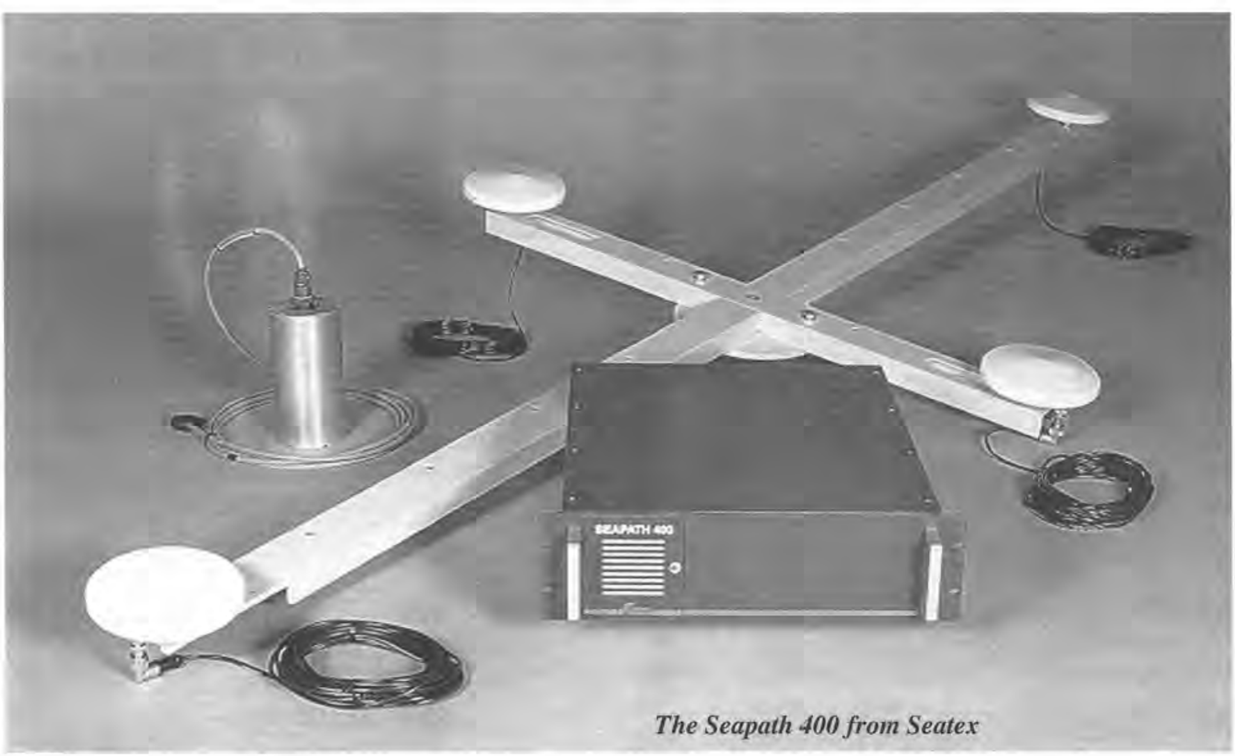
Lasar Technology Inc. announces the introduction of the GeoLasar, an affordable handheld survey and mapping tool. The GeoLaser incorporates laser range finding, digital compass technology, and accurate tilt sensing into a compact simple-to-operate package. Just point and shoot. In about one second, the GeoLaser calculates range, azimuth, and inclination to any target, all without prisms or reflectors. "The GeoLaser is paticularly designed to facilitate GPS/GIS data collection. The laser's ability to acquire remote targets eliminates having to take the GPS antenna to each point, which saves time and money in the field."

• Seatex •

Trondheim, Norway.

Seatex announces a broader range of motion sensors for the survey markets. The new MRU-H provides heave compensation of echo sounders in small vessels that require highly accurate heave measuements even during extreme sea conditions.

Also from Seatex, the Seapath 400 is the newest heading, altitude, and positioning system. The Seapath 400 is specially designed for compensation of multibeam echo sounders, acoustic positioning, ROV applications, dynamic positioning, dredging and calibration of gyro compasses.



The Seapath 400 from Seatex

• Nautical Data International •

St. John's, Newfoundland, Canada.

NDI has entered an agreement to provide technology training to the Hydrographic Office of the Chilean Navy. In January 1996, NDI signed a contract with the Canadian International Development Agency (CIDA) to work with other countries to determine the feasibility of setting up joint ventures in the area of digital charting. See the NDI internet site for a catalogue of available electronic charts: **http://www.ndi.nf.ca**

• Raytheon •

Manchester, New Hampshire, U.S.A.

Raytheon's ***DE719D MK2,*** electronic precision depth recorder, features a built-in digitizer with RS232 and RS422 output interfaces. When interfaced to a NMEA 0183-compatible position sensor the ***DE719D MK2*** provides the user with a complete, integrated hydrographic survey environment.

Raytheon's ***DE719D MK2***

• SeaBeam Instruments Inc. •

East Walpole, MA, USA.

The SEA BEAM 2100 is SeaBeam Instruments latest-generation survey system. Series systems are capable of co-located, co-registered, and geometrically-correct bathymetry, sidescan, and sub-bottom profiling data. Thirteen SEA BEAM 2100 Series systems have been sold to date.

• Novatel •

Calgary, Alberta, Canada

Novatel welcomes US based Steve Lieber & Associates to its world-wide network of dealers. Steve Lieber & Associates, located in Webster, Texas, offers a unique combination of sales, service, training, and leasing of products for navigation, positioning, and wireless telemetry.

Canadian Hydrographic Service
Service Canadien Hydrographique

Headquarters

Electronic Charting
The Electronic Charting division in Ottawa has spent the past several months completing the checking, processing and releasing of NTX ENCs in anticipation of the completion of the ECDIS Pilot Project. As the pilot project wraps up, all NTX ENCs will be released and supported as official CHS products and made commercially available. As of February 1996 there were approximately 500 NTX ENCs commercially available in Canada.

Looking towards the future, Electronic Charting is currently participating in a number of activities related to the implementation of S-57 production tools and the supporting infrastructure. This has included tasks such as software evaluation, conducting user training for all CHS regions, developing production support documentation, developing test data sets, and participating in a number of projects and committees. Of specific note, the group is participating in the Updating Project, where CHS and NDI are working together to develop an IMO-compliant updating infrastructure.

The division is also working on the next generation of CHS catalogues. The current focus is the digital production of a national book-format catalogue which will be called the "CHS Products Catalogue". The group is also working on the construction of an interactive World Wide Web version of the catalogue that will be tied to CHS databases in order for CHS clients to acquire the most up-to-date information on products of interest.

For more information on these and other activities of the Electronic Charting division, please contact Paul Holroyd by e-mail at paul_holroyd@chshq.dfo.ca or by phone at (613) 995-4520. Also, please visit the CHS home page at http://www.chshq.dfo.ca and look for the Electronic Charting division's home page.

Central and Arctic Region

Central and Arctic Reorganizes
The management and staff of Central and Arctic Region devoted considerable effort to the restructuring of the activities of Central and Arctic Region. This process began by identifying the needs of our stakeholders and defining the products and services that we should be providing to meet those needs. This was followed by an analysis of our present situation and a forecast of where we should concentrate our resources and efforts in the future. As a result, the following initiatives were identified as key to the success of our organization:

- Pay more attention to client needs and develop client-driven products and services.
- Continue to improve the quality and coverage of ENCs and paper charts to meet the demands of commercial shipping, commercial fishermen and recreational boaters.
- Place a greater emphasis on maintaining existing products, both ENC and paper.
- Maintain support for the above activities by providing computing services, electronic support, information and data management, product and systems development.

The management team looked at our existing organizational structure to determine if this was the best way to organize our activities to achieve the desired results. We found that there were some changes required to realign our organizational structure with our new direction. Effective April 1, we implemented the following organization on a one year trial basis:

Director's Office	manage the Hydrographic program in C&A Region and develop our marketing program.
Data Acquisition and New Products	collect data and produce new products where existing chart coverage does not meet the needs of our clients.
Product Maintenance	maintain existing products and produce new editions where required.
Electronic Charts	improve the quality and coverage of ENCs to meet demands of clients for accurate and up-to-date information.
Technical Services	provide technical support to the operational divisions.

Dennis St. Jacques will head the Data Acquisition and New Products Division; Bruce Richards will be responsible for the Product Maintenance Division; Sean Hinds will lead the Electronic Chart Division, and Ed Lewis will look after Technical Services Division.

Arctic Charts Come to the Region
In 1995 Central and Arctic Region assumed responsibility for 25 Central Arctic charts and work has begun to incorporate outstanding source data. One new edition of what was completed and work continues on two new editions and three Notices to Mariners chart correction patches in this area. All Arctic charts continue to be printed on-demand, thus eliminating reprographic and traditional high-volume press costs. Central and Arctic Region will undertake survey activities aboard a Canadian Coast Guard ice breaker as part of a program to improve the quality of our Arctic charts.

Dolphin and Union Strait Survey Completed
This was the final year of our survey program to verify a safe shipping route through the southern Northwest Passage for freighters to carry ore from the Coppermine area to southern markets. The survey, which received funding support from the Northwest Territories Government, Inmet Corporation, Natural Resources Canada, and the Department of Indian and Northern Affairs, started in mid-February and was completed in early April 1996. The airborne Towed Inflight Bathymetry System (TIBS) was used to collect continuous depth profiles. TIBS data was supplemented with spot soundings and gravity measurements.

St. Lawrence River Charts Released
Two new paper charts were produced of the St. Lawrence River as part of the continuing CHS metrication and cooperative (U.S./Canada) charting programs. Chart 1434 covers the area from Croil Islands to Cardinal and Chart 1435 from Cardinal to Whaleback Shoal. These new charts cancel three imperial unit charts (1415,1416 and 1417).

ECDIS Purchase Impacts EC Program
The recent purchase of ECDIS systems by a consortium of shipping companies led by Algoma and Upper Lakes Shipping has had a substantial impact on the Electronic Chart Program in the Region. Although these companies were willing to work with existing NTX-based ENCs, they are more interested in obtaining International Maritime Organization (IMO) S57 compliant ENC files. As a result, approximately 40 IMO S57 compliant files have been produced under contract.

Raster ENCs a Reality
The production of raster charts for the Region has been accelerated and we now have an inventory of 73 raster chart files. We have also acquired new hardware and software to permit the updating of the raster files. This new technology may also have significant spin-off benefits in the maintenance of paper chart products.

Multibeam Acceptance Trials Completed
Mike Crutchlow was appointed project leader for the acceptance trials for three EM-3000 multibeam systems from Simrad. The new systems were delivered, installed on modified Nelson launches, and field tested in Halifax Harbour. Two of the launches were subsequently shipped to Pacific and to Central and Arctic Region for integration into their survey activities.

The multibeam system will be used during the upcoming field season in Rankin Inlet. As a result, many staff have been involved in training related to the operation of the system and the processing of the data.

Pacific Region

Hydrographic Surveys
Major surveys were undertaken for navigation safety on the British Columbia coast and for new charting and navigation safety in the Western Arctic.

On the B.C. coast, revisory surveys were conducted to update existing charts and to identify possible horizontal datum errors in presently available ENCs (CSS R.B. Young).

In the Western Arctic, the survey of a safe navigation corridor between Coppermine and Victoria Strait was completed (CCGS Nahidik). In addition, navigation aids were positioned with GPS, several current meters were deployed, and a CTD survey was conducted (CCGS Arctic Ivik).

Revisory surveys were carried out in Howe Sound and Jervis Inlet, on Kootenay Lake, and on the Mackenzie River.

Processing of data from EM100 multibeam surveys conducted in the Strait of Georgia in 1994 was completed. Assistance was also provided in the use of RoxAnn for substrate mapping initiatives on the central British Columbia coast.

A survey was carried out under contract to use Lidar and other remote sensing techniques for surveys in Baynes Sound. In addition to collecting bathymetric data, the potential of Lidar for substrate classification and for herring spawn mapping was also assessed.

Throughout the year Pacific Region staff were involved with a contract for the purchase of three EM3000 multibeam echo sounder systems from Simrad. They provide the CHS with the capability to do high resolution mapping in shallow waters (100 metres depth to less than 1 metre below the transducers) and to meet IHO specifications for accuracy.

The final year of a multiyear program to measure surface currents on the Northern B.C. coast was completed. In April, 14 current meter moorings were installed in Queen Charlotte Sound (CSS John P. Tully), and measurements made of surface currents and water properties. During cruises in August (Vector and Narwhal) more water property and surface current measurements were made and the 14 current meter moorings were recovered with the loss of only one instrument. The field portion of this program is complete and work will now focus on processing and analyzing the data, integrating the information into models for current and oil spill prediction, and servicing equipment.

A network of 24 tide gauges was maintained on the B.C. coast and in the Western Arctic. Several temporary gauges were also operated in support of hydrographic surveys and special projects. Tsunami warning stations were operated on the British Columbia coast at Bamfield and Winter Harbour on Vancouver Island, and at Langara Island in the Queen Charlotte Islands.

Work continued on the re-engineering of the production software for the Canadian Tide and Current Tables. This software is used to compute, edit and format the predictions of currents and water levels in camera-ready format. Operational trails of this software are scheduled to begin in June 1996.

A report "A Seamless Vertical Reference Surface for Acquisition, Management, and Display (ECDIS) of Hydrographic Data", prepared under contract by the University of New Brunswick, was received in January.

Nautical Publications

The highlight of this year for chart production was the completion and release of the Chart 3313, the cruising atlas of the Gulf Islands. The atlas was featured at the Vancouver and Victoria Boat shows. If the early sales and comments received from the boat show are any indication, this chart is a success.

Other New Charts released were two charts of Clayoquot Sound, two charts in the Sooke Harbour area, and a chart in the previously uncharted Spiller Channel area. The timing of the release of Spiller Channel was of particular interest to the fishing fleet participating in this year's herring fishery.

ENC production is moving steadily ahead with 35 charts submitted to HQ for final check. This achievement was partially obtained by utilizing local co-op student programs.

Chart Production is actively participating in the Multidisciplinary Hydrography program by supplying two staff members to field surveys. One member was assigned to the CCG Nahidik for a six week survey in the western Arctic while another was assigned to the Fraser River revisory survey.

This year, Chart Production obtained UNIX-capable workstations for each of the staff. This will facilitate the transition from VMS to UNIX as well as aid in the building of Topology and running the Object Manager.

Downsizing has cut into our resources while the work load remains constant. To offset the work load, chart production has supplied 51 charts to contractors for scanning, vectorizing and updating. Returned digital chart files will be used for New Editions and ENC production.

NDI has now received enough scanning positives from Pacific Region for almost complete raster coverage of the British Columbia coast. It is proposed, by NDI, that the Pacific Region supplied charts will be available on three separate CDs by the end of this year.

Geomatics Engineering

The three sections within Geomatics Engineering work towards providing efficient access to Tides, Currents and Water level data, to hydrographic field data and to the resources of the Hydrographic Data Center.

Source Data

Work was completed during the year on the updating of charted coastline and other data around King William Island in the western Arctic. Portions of the charted coastline in this area were up to four kilometres off-datum. Satellite imagery was used for this project with a resolution of 35 metres. Several indications of shoaling were found and remain to be investigated in the field.

Product Data and the Hydrographic Data Center

During the year the Source Directory System was implemented for Pacific Region. The system has met with a growing level of acceptance. A successor meta-data base system (CHSDIR) will be operational in the region next year. An assessment was made of storage and preservation methods for the early 20th century field documents. Work also continued on editing and upgrading charts digitized in 1994/95.

Computer Systems Support and Tides, Currents and Waterlevels Data

All the available resources for computer software development expertise were targeted on the creation of a new tide and current table prediction editing and formatting system. An elegant editor for current prediction time series has been created and work is underway on a similar tool for editing height time series. Considerable support was also injected into field operations for current data collection of the north coast of British Columbia.

Other Activities

In a completely different field, the division undertook a public liaison role in disseminating information about the Canada Oceans Act that was in second reading in Parliament during the autumn of 1995.

Client Liaison and Support

Hydrographic and Marine Support

Radio systems were improved aboard the Tully and the Vector, which involved improved wiring, antennas and equipment. GPS was improved by receiver upgrades and system design. To support differential GPS, the IOS-developed HF base station at Cambridge Bay was deployed.

A competitive tender and thorough evaluation process led to the selection of Knudsen single-beam sounders. An EM3000 swath system is also being procured.

Hydrodynamics Applications

Re-evaluation and quality control of tidal constituents for BC ports with more than one year of data was completed. In Queen Charlotte Sound there was a program to measure and predict surface currents. There were several consulting projects, one to include effects of wind forcing and air pressure into a numerical tide model. A workshop on numerical models of currents on continental shelves was co-organized by Bill Crawford.

Client Liaison

The following shows were attended: Fish Expo (Seattle), Seattle Boat Show, Vancouver Boat Show, Victoria Boat Show, Fraser Valley Boat and Sportsmen's Show, and the BC Great Outdoor Show.

Big events were the launching of Chart 3313, the Cruising Atlas of the Gulf Islands, the release of new charts of Spiller Channel and two charts in the Clayoquot Sound area. The launching of Chart 3313 was hosted by Minister Brian Tobin in December, 1995.

The dealer network remains strong and healthy. There are about 300 dealers worldwide supplying products from Pacific Region.

Fisheries Assistance

CHS Pacific has been very supportive of quantifying fisheries management. A Flowmeter is producing convincing estimates of upstream-migrating adult salmon in the Fraser River. An in-house six beam sonar has been a useful testbed for estimating abundance of herring and salmon. During the past year, echo integration was implemented, and an extensive field season led to work with data visualization.

Bottom classification made quite amazing progress. There was a large experiment involving lidar, oblique and vertical video, seafloor mounted upward-looking sonar, and bottom classification instruments attached to echo sounders. In another study, there are suspicions that geoduck clams, which are buried in the shallow sea floor, can be detected .

Temperature, current, sound velocities, and site surveys in Discovery Passage were made. It is widely believed that this information is crucial to understanding salmon abundance in the Georgia Basin.

Fishery workshops in Vancouver, Ottawa, Nanaimo and Aberdeen (Scotland), were attended.

CHA News
Nouvelles de l'ACH

Pacific Branch

Member Activities
Vern Crowley is retiring from the CHS after 30 years of service. Vern joined the CHS on the East coast in 1966 and then spent the next ten years working for Central Region. In 1977, Vern transferred to the West coast to join Pacific Region. A reception was held in Vern's honour, where he was presented with a CHS bronze crest, a copy of Chart 3313, and a hand-held GPS receiver, just so he doesn't get lost in his old age. All your colleagues wish you the best of luck in your retirement, Vern.

Congratulations to Tom and Doreen McCulloch on the occasion of their 50th Wedding Anniversary. Tom and Doreen were married at Rock Ferry, Cheshire, England, on March 26, 1946. A celebration is planned in Victoria with their five children, spouses and grandchildren.

George Schlagintweit has been noticeably missing from Pacific Region lately. He is in the Arctic working with Central Region in Dolphin and Union Strait.

Pete Wills (Central Region) decided to shed the snow tires and chains and drive out to Sidney, BC, to start his one year assignment in April with Pacific Region. He might want to bring a shovel to dig his way out of the blossoms that fall this time of year !

Barry Lusk and Ken Holman are in Reno, Nevada. You can only leave it to your imagination what those two are doing there!

Social Events
The CHA Photo Contest was held in November last year. Winners were James Wilcox (people), Doug Cartwright (wildlife) and Alex Raymond (places). There were also a number of home-made wines available for evaulation (or was that consumption?) during the photo judging.

The Ninth Annual CHA/Quester Tangent H2O Bonspeil was held in February with John Larkin putting an impressive family team together to win this year's trophy. The match was close after two games but after scoring 12 points in a thrashing of the Lyngberg/Raymond team the Larkin rink had it made.

Between games, the ten teams competed in a turkey shoot. Several curlers were disqualified for coming up short of the hog line, some even hitting the frozen turkey. Sabina Gregory came up the winner, throwing her rock to within 0.9 metre of the twenty five pound bird.

This years' major sponsor was Quester Tangent Corporation who provided funds for the ice fees. Other sponsors included P.S.A.C. Local 20076, the Canadian Institute of Geomatics, Terra Surveys and CHA National. Due to all of the support from this years sponsors, all curlers went home with some great prizes.

Seminars
Mike Muirhead of Western SubSea gave a well attended luncheon presentation at the Glen Meadows Golf and Country Club on the search for and recovery of the luxury yacht, the Panache IV.

In February, Graham Scholes, a local Sidney artist, gave a demonstration of his Japanese woodblock printmaking. Graham has captured images of West Coast lighthouses in a very unique manner. He generously donated one of his framed prints of the Estevan Point Lighthouse for a raffle. Tony Mortimer was lucky enough to hang this beautiful print in his home.

Ottawa Branch

Ottawa Branch held its annual meeting on Feb. 21, 1996. The following Branch executive was acclaimed:
Vice President: Joel Box
Secretary -Treasurer: Sheila Acheson
Directors: Mike Casey, Denis Pigeon, Michel Blondin
Past Vice President: Ilona Monahan

The Branch is very grateful to Ilona Monahan for her great work as Branch Vice President these past two years.

Troy Holcomb of the US National Oceanographic and Atmospheric Administration spoke on NOAA's new bathymetric mapping program in the Great Lakes, at the first lunch time Pizza Seminar of the year.

Our second Pizza Seminar was on May 9, 1996. Gordon Fader of the Geological Survey of Canada, Atlantic, presented the very informative and entertaining talk: "The Other Side of the Moon: New Ways of Mapping the Seafloor".

Upcoming Events
On June 11, the Branch enjoyed a guided tour of the Port of Montreal, with Harbour Master Jean-Luc Godard.

The Branch is offering a new service to its members this year - a CHA Web service (on a commercial service provider) including space for individual personal home pages for all members. An upcoming Pizza Seminar will provide information on "How To Build My Own Web Page".

Sun Wee, of the Canadian Coast Guard, talked to us at the June 19 Pizza Seminar, about the CCG Differential GPS Program.

Social Notes

Joel Box organized another successful Christmas luncheon. On Dec. 20, 1995, 65 "friends of hydrography" gathered together at the RA Centre to celebrate the holidays. Once again we have several sponsors to thank, including: Terra Surveys, Sirius Solutions, Universal Systems Limited and Nautical Data International.

Congratulations to Paul and Shelley Holroyd on the birth of their second daughter, Jessica.

John Warren retired in March after 30 years with the Canadian Hydrographic Service. John's retirement reception was enlivened by Bob Burke and Steve Forbes who shared some secrets about John's past life while he was a hydrographer at the Bedford Institute. Paul Warren also provided insights into John's eventful early years. John is starting his retirement off in style; he and Sherry are on a three week vacation in Europe. We wish John and Sherry many happy (and safe!) years of cycling ahead. Happy Trails, John!

Section du Québec

Le 24 février 1996, la Section du Québec tenait son assemblée générale annuelle des membres à Rimouski. Aucun Conseil d'administration n'a été élu, Bernard Labrecque assumera encore cette année la poste de vice-président. La Section doit susciter l'intérêt des membres à venir siéger sur le Conseil d'administration pour créer un renouveau dans ses activités.

Pour la troisième année consécutive, la Section du Québec a conclu une entente avec le Service hydrographique du Canada, région Laurentienne, pour réaliser une publicité en commun de son réseau de dépositaires de cartes et publications marines. Cette publicité a paru dans cinq revues à grand tirage dont notre Carnet de bord 1996.

La publicité en commun, le Carnet de bord et notre magasin de cartes marines et topographiques permettent à la Section de maintenir un poste d'agente de bureau. Ce poste est comblé depuis plus d'un an par Linda Grégoire. Linda aide aussi le vice-président dans plusieurs tâches concernant le suivi administratif de la Section du Québec.

Le 14 avril 1996, La Section du Québec a tenu son activité traditionnelle de la cabane à sucre. Le tout a commencé par un dîner à la sucrerie de monsieur Charles-Eugène Deschênes de St-Gabriel-de-Rimouski, suivi d'une dégustation de tire sur la neige en après-midi. La Section tient à remercier Denis Proulx pour son dévouement dans l'organisation de cette activité.

Application for Membership
Formule d'adhésion

I hereby make application for membership in the Canadian Hydrographic Association and if accepted agree to abide by the constitution and by-laws of the association.

Je désire devenir membre de l'Association canadienne d'hydrographie en tant que et si ma demande est acceptée je m'engage à respecter la constitution et les règlements de cette association.

☐ Member / membre $30.00 (for most branches/pour la plupart des sections)

☐ Sustaining Member / membre de soutien $150.00

☐ International Member / membre international $30.00

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Spring 1996

Lighthouse

Journal of the Canadian Hydrographic Association
Revue de l'Association canadienne d'hydrographie

LIGHTHOUSE originally began as an internal newsletter of the Canadian Hydrographers' Association (CHA) in the winter of 1969. It was conceived as a means of stimulating discussion between the branches of CHA. Over the years, **LIGHTHOUSE** has become Canada's national hydrographic journal. It still remains faithful to the original goal of providing a mix of technical, historical and social information of interest to those associated with hydrography in Canada. But its circulation has expanded to include over 700 individuals, companies and hydrographic organizations in Canada and around the world.

Printemps 1996

Lighthouse

Revue de l'Association canadienne d'hydrographie
Journal of the Canadian Hydrographic Association

Originalement à l'hiver 1969, **LIGHTHOUSE** était le journal de l'Association canadienne des hydrographes (ACH). Il représentait un moyen pour stimuler les discussions entre les Sections de l'ACH. De par les années, **LIGHTHOUSE** est devenue la revue hydrographique nationale du Canada. Elle reste fidèle à son but original de fournir une source d'information technique, historique et sociale à ceux qui s'intéressent à l'hydrographie au Canada. Son tirage a augmenté pour inclure au-delà de 700 membres, compagnies et organisations hydrographiques au Canada et dans le monde entier.

Tarifs publicitaires 1996

EMPLACEMENTS

L'approbation et l'emplacement de l'annonce sont à la discrétion de l'éditeur. Cependant, toute demande d'emplacement spécifique sera considérée si une prime de 25 $ est ajoutée à la demande de parution.

EXIGENCES MÉCANIQUES

L'annonce publicitaire doit être un prêt à photographier ou sur film négatif (les couleurs supplémentaires doivent être sur film négatif) et être fournie aux dates de tombée. La préparation de copie couleur, à fond perdu et de photos, sera chargée au tarif de l'imprimeur plus 10 %. Les épreuves devraient être fournies avec tous les suppléments.

Les insertions d'une page seront chargées au tarif d'une pleine page. Le matériel devra être fourni par le client.

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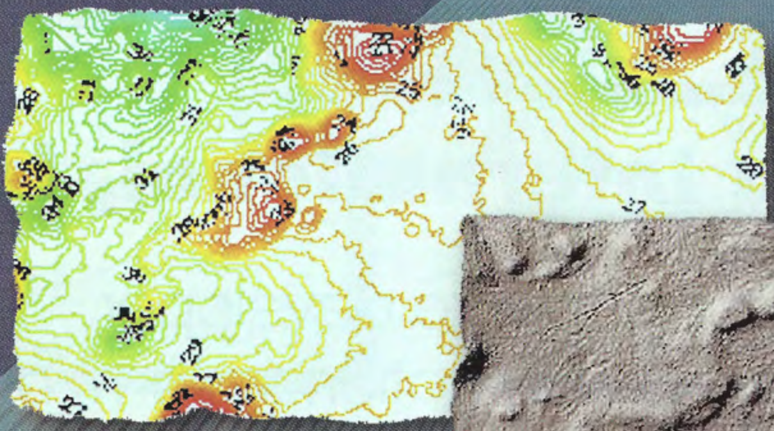

Survey in Halifax Harbor courtesy Canadian Hydrographic Service (CHS)

Contour map - EM 3000 built in software.

Shaded depth presentation to reveal more details on seafloor (possibly anchor tracks shown above) - EM 3000 built in software.

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