Canadian Coast Guard
Review to Implement a Resilient Position, Navigation and Timing Solution for Canada

Mariners’ Workshop
January 31st, 2018
Outline

• Overview of GNSS use in the marine sector
• CCG Activities
• Service User Survey
• Canadian DGPS Service
• Resilient PNT Backup
• R-Mode technology
• Next Steps
Mariners around the world use Global Navigation Satellite Systems (GNSS) as the primary source of position, navigation and timing information to navigate safely.

In Canadian waters, GNSS observations are complemented by a terrestrial augmentation system, the Differential Global Positioning System (DGPS) which improves accuracy and integrity.

- We also understand that some marine stakeholders, such as Pilotage Authorities, use their own receivers to access two of the four GNSS constellations while they are at work piloting ships i.e. the US GPS and the Russian GLONASS systems.

- GNSS signal broadcasted from 20,000 km above the Earth are very weak and are vulnerable to both intentional and unintentional disruptions like jamming, spoofing.
Under the Modern Navigation Systems Initiative, the Canadian Coast Guard is:

- Undertaking technical analyses and engineering studies to determine Canada's requirements for a Global Navigation Satellite System (GNSS) system—that is, a resilient position, navigation and timing backup solution for Canada north and south of 60.
- Reviewing the requirement for the Canadian Coast Guard’s Differential Global Positioning System (DGPS).
- Consulting with marine stakeholders through surveys to assist us in assessing GNSS requirements and the future of DGPS.
- Examining the feasibility of existing technologies and emerging technologies as backup systems.
Coast Guard consulted external stakeholders on the potential need to implement a resilient PNT solution for Canada, as well as current usage and future needs related to DGPS.

Survey sent by email in May 2017
• User views on utility and accuracy of DGPS
  – 76% of respondents’ vessels were equipped with GNSS receivers.
  – 84% of respondents’ scored their GNSS usage as a 3, 4 or 5 on a scale of 1-5, where 1 indicated that GNSS was not used at all and 5 indicated that they use GNSS ‘all the time’.
  – With regards to stakeholders’ level of confidence with the accuracy and reliability of DGPS, 84% responded that they were mostly confident or have full confidence in CCG’s DGPS service.
  – 82% of respondents see a future need for accuracy and integrity as provided by DGPS.
User views on accuracy and reliability of GNSS/GPS

- 92% of respondents were mostly confident or had full confidence in the accuracy and reliability of GNSS/GPS.
- 89% of respondents saw the need for a contingency system to be put in place if position, navigation and timing signals became unavailable from space.

User views on a terrestrial contingency system

- A majority of respondents wanted accuracy levels of 5 meters or less for compulsory pilotage areas.
- The averaged minimum recommended accuracy outside of compulsory pilotage areas was approximately 20 meters.
• **Current status:**
  – Canadian DGPS is 20 years old (aging equipment, obsolete hardware and software)
  – Next 2019 GPS week rollover compliance test
  – modernized GNSS and new frequency (L5) in 2021
  – USDGPS decommissioning (from 84 to 39 sites as of 2017)
• **CCG continues to analyse options for the future of the DGPS service.**
• **Maintain discussion with USCG on their plan for the National Differential GPS system (NDGPS).**
West Coast DGPS Coverage – Canada and US

West Coast DGPS Can-US
13 Oct 2017

Legend
- US DGPS

Google Earth
US Dept of State Geographer
Image Landsat / Copernicus
© 2017 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Great Lakes and East Coast DGPS Coverage – Canada and US

East Coast DGPS Can-US

Legend
- US DGPS

13 Oct 2017
Why we need a resilient PNT backup

- Increasing jamming and spoofing events
- Jammers available on eBay (30-500$)
- 10 W can disrupt an unprotected receiver for about 30 kilometres (line of sight)
- Vulnerability of GNSS signal
- Ships’ heavy reliance on GNSS

June 2017 Black Sea spoofing event
Resilient PNT backup solution

- Resilient PNT system requires three complementary components to be robust:
  - A core GNSS,
  - An augmentation system (e.g.: DGPS) and
  - An adequate backup system independent of GNSS to protect against GNSS failure and to ensure safe navigation

- Technologies being investigated include:
  - eLoran, R-Mode, Absolute Radar Positioning, Locata, Signal of Opportunity, and others..

- Ranging-Mode (R-Mode) technology has been developed in recent years by the German Federal Waterways and Shipping Administration.

- R-Mode technology consists of providing a pseudo-range between a transmitter station and a receiver. Users need signal reception from at least 3 different base stations to solve for lat. and long. DGNSS corrections continue to be transmitted as usual however in a GNSS-denied environment, position will be available from R-Mode signals.
Coast Guard is participating in a pilot project on the development of this technology through trials in Canadian waters.

An R-Mode transmitter and an R-Mode receiver have been acquired and being tested this year at the Lauzon DGPS site near Quebec city to validate the performance of R-Mode technology in the Canadian environment.

- Initial tests indicate the DGPS transmitter is not compatible with R-Mode signals.
- Collaboration with the Germans to find a solution
• The Canadian Coast Guard is keeping itself apprised on the technologies development for a GNSS backup in other countries.

• Canadian Coast Guard is not at the decision-making stage.

• CCG is working with its partners from the Position, Navigation and Timing Board (PNTB) to develop a recommendation to determine Canada’s technical requirements for a GNSS Backup system and evaluate the future of DGPS.

• The decision will have to consider the international scheme.

• The recommendation will have to be an interdepartmental decision.