

Modernization of Maritime DGPS in Poland

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ABSTRACT: Some new techniques and functionality adopted for modernization of national DGPS systems by maritime administrations in Europe are presented. Any solution adopted must meet international requirements: IMO standards and IALA e-NAV Committee recommendations. The results of DGPS Recapitalization Meeting in Gdynia 2008 are presented. Modernization and re-engineering of maritime DGPS must take into account backward compatibility with existing onboard receivers as well as future trends towards e-Navigation. Operational and legal status of the Polish DGPS network is also mentioned in this context.

1 INTRODUCTION

Most of mariners use Global Navigation Satellite Systems (GNSS) as a primary means of navigation. Currently available GNSS does not fulfil the requirements of IMO with respect to accuracy and integrity. The use of IALA maritime DGNSS does fulfil these requirements. International maritime standards exist for both: onboard receiver and land based DGNSS service. The system has been widely adopted as the international maritime standard for providing differential corrections to GNSS. The IALA DGPS beacon systems were installed in many countries over the period 1993-2000 and now became obsolete. The Radio-navigation (presently e-Navigation) Committee concluded that there is a requirement to recapitalise national systems. It is potentially a good reason to re-organise the system for the benefit of existing users and to enhance DGNSS capabilities taking into account technical innovations. At the same time some countries are considering submission of their DGNSS services to IMO as components of the World Wide Radio Navigation System.

2 IALA OPTIONS

The key system of secure marine navigation and accurate hydrographic survey is reliable radionavigation service. The IALA Radio-navigation Committee has assessed the current and potential use of the DGNSS system and concluded that there is a requirement to continue existing service and to modernise the system and develop enhanced GNSS capabilities as well as alternative technologies to meet the requirements of IMO Resolution A.915(22). There are several alternatives to the IALA beacon system for the transmission of differential corrections and safety related information. There are methods of providing enhanced services, like e-Loran, Eurofix, EGNOS, AIS, Real Time Kinematic (RTK) or pseudolites. Their related basic features and a subjective cost are listed in Tab. 1., [2].

Table 1. Alternative techniques for IALA DGNSS

System	Accuracy	Coverage	Instant warning Integrity/Continuity	Cost Provider/user	Maritime standard
IALA DGNSS	1-3 m	local/regional	Yes/High	Moderate/low	yes
EGNOS	5-10 m	regional/global	Yes/High	Very high/low	no
AIS	1-20 m	local	Can be/Moderate	Low/low	yes
Pseudolites	sub-meter	local	Yes/Moderate	High/moderate	no
Eurofix	2-10 m	regional	Yes/High	low/moderate	no
RTK	sub-meter	local	Can be/Low	Moderate/high	no

The simplest modernization option may be replacement of existing equipment with new dedicated hardware Reference Stations and Local Integrity Monitors (RSIM). This solution could limit the potential for future development. Additionally modernization of DGNSS should be considered in the context of position-fixing requirements for e-Navigation.

The future need could be providing additional messages relating to Galileo, GPS L2C/L5 and GLONASS M should be taken into account.

Other possibilities include:

- Software Reference Stations and Integrity Monitors (RSIM)
- Virtual Reference Station (VRS),
- SBAS (EGNOS, WAAS) Integration

Above options are explored further in IALA Recommendation R-135, [3].

Finally IALA members are encouraged to:

- Recapitalize existing DGNSS systems prior to their obsolescence, noting the advice given in R-135,
- Consider the options for replacement systems, with reference to the documents listed below,
- Share information regarding studies carried out and specifications of replacement solutions, and report progress to IALA,
- Investigate potential future developments compatible with the development of shore based e-Navigation architecture,
- Investigate techniques for adding value to transmissions, such as transmission of safety related information and/or backup positioning capabilities, [1].

3 DGPS RE-CAPITALIZATION MEETING IN GDYNIA

The meeting “*DGPS re-capitalization*”, was hosted in May 2008 by Maritime Office Gdynia, in Gdynia. The development of a strategy for future implementing of local and regional augmentation systems was noted. The response of representatives at the meeting indicate that most administrations providing DGNSS services are undertaking re-capitalisation or

are planning such activities based also on co-operation with National Geodetic Networks.

- Sweden is currently studying options for software RSIM solutions and transmissions of VRS data via MF beacon system taking into account also geodetic network SWEPOS.
- Germany is planning to implement DGNSS re-capitalization plan by creating RAAS and VRS based on national network operated from national centre of control. The new concept of “moving centre of system accuracy” was presented. Also a new type of MF transmitting antenna (NTA) was presented. Germany also announced a feasibility study to investigate the addition of Ranging signals (R-Mode) on MF beacon and AIS carriers, [1].
- Scotland referred to the common UK and Ireland studies of DGPS replacement options which concluded that the lowest risk option for the GLAs would be hardware replacement, although the flexibility provided by the software option would better meet emerging requirements and should not be ruled out. The GLAs have tendered for new RSIM equipment, which may be fulfilled by either hardware or software solution, [1].
- Russia is testing broadcast of DGLonass and DGPS corrections via AIS system in Golf of Finland.

4 MODERNIZATION OF POLISH RADIONAVIGATION

Maritime Office Gdynia (MOG) has established and operates shore based/costal network to support DGPS, RTK, and AIS systems. These were built and organized to fulfill international IMO standards and recommendations endorsed by IALA.

Table 2. Polish DGPS marine stations

Table of DGNSS Stations			Country: POLAND		Date of last amendment: Sept 2008			
Station name	Identification Reference Station(s)	Transmitting beacon	Geographical Position Lat/ Lon	Station in operation	Integrity Monitoring	Transmitted message types	Freq (kHz)	Bit Rate (bps)
Dziwnów	741	481	54°01' N	yes	yes	9,3,7,16	283.5	100
	742		14°44' E					
Rozewie	743	482	54°49' N	yes	yes	9,3,7,16	301.0	100
	744		18°20' E					

Polish DGPS system has already been fully modernized during the period 2007-8, to meet all the requirements set out in IMO Resolution A.915(22) for Future GNSS. The hardware RSIM solution has been adopted for the re-capitalisation, on grounds of low cost and market availability. The conception is based on a network of reference stations and remote integrity monitors continuously operated via IT links from a common control center..

The DGPS-PL system is composed of two reference beacon stations which are remotely operated and controlled via wide area network from the Control Station located in Gdynia. Both existing reference stations RS Dziwnów and RS Rozewie are equipped with two reference L1, L2 receivers, two MSK modulators and dual LF beacon transmitters. Local integrity monitors (RSIM model) are being under permanent control via WAN from Central Station in Gdynia. A dedicated server at the control center continuously gathers operational information from all sites. Thus living database of Regional Area Corrections can be created in the future. There are also plans to integrate marine system with a national geodetic network EUPOS to transmit VRS data via MF beacons

4.1 Integrity of DGPS-PL

To ensure signal availability at required level of (99,5%) for single site beacon station, a redundancy of major hardware is fundamental, therefore each RS station is doubled and operation will continue in case of a hardware failure. The set of RTCM messages and broadcast frequencies from Polish DGPS beacon stations is shown in Table 2.

Quality of DGPS broadcast is being checked and evaluated by local integrity monitors (RSIM). Additionally the range and signal availability will be monitored by remote LF DGPS monitors. Daily reports and data on availability of the system are gathered in data base of Central Control server in Gdynia.

4.2 Integrity Settings (IM)

It was recognised that certain integrity monitor threshold settings are vital to the proper performance of the RS station. IALA Recommendation R-121

contains the list of parameters and recommended settings, [4]. The local integrity monitor continuously checks the quality of the own DGPS transmissions by receiving and applying own corrections. Thus the IM software monitors position accuracy, signal availability (SNR), tracked satellites, GPS geometry (DOP), RTCM data correctness and quality, as well as radiated signal level (SS). When alarm condition is detected, an alarm message is immediately set for local response and switching to optional equipment (secondary configuration) can happen. Any IM message warning will automatically be broadcast to all users/ships in the area within 10s.

5 RTK SERVICE

Permanent reference RTK station was established on Peninsula Hel to cover Gdańsk, Gdynia ports and approaching routes. Real Time Kinematics solution using carrier-phase corrections has the enhanced accuracy, but there are constraints imposed by the bandwidth and spatial de-correlation. For single RTK station, the range is up to 10-40 km (Table 3). This is sufficient for hydrographical and engineering applications in the Gulf of Gdańsk, can also be used during docking phase in the ports. Station operation is fully controlled via network from RL Gdynia, however radio signal strength and position accuracy is being monitored by IM receiver situated permanently in the port of Gdynia. It is highly recommended that in the near future RS-Hel will be incorporated into Polish geodetic RTK network ASG-PL. In result the whole system would benefit of better marine coverage and VRS technique would become available along the Polish coastal zone.

Table 3. Characteristics of RTK RS-Hel

Name	Receiver type	Corrections output	Radio-transceiver	Options
RS- Hel	Net R-5	RTCM 18, 19,20, 21	Satellite 3AS Epic, simplex	VRS
System	GPS, Glonass	Binary code CMR, CMR+	UHF 2-10W range 10-40km	RTK, DGPS
Application	L1,L2,L5	1Hz	434.25 MHz	+/-1MHz
Frequency	Network (LAN)	serial, NMEA	RS com	VPN

6 CONCLUSIONS

- Re-capitalization process of national DGNSS systems is well advanced, however IALA members are at different stages of developing, concerning available options versus budgetary constraints.
- All of new solutions must meet the need of existing users taking into account existing and future IMO, IALA regulations.
- Re-capitalization of national DGNSS gives good opportunity to modernize technique and functionality towards new e-Navigation requirements.

REFERENCES

1. IALA Working paper of e-NAV Committee, e-NAV5-13-07 “*IALA DGNSS Modernisation*”, 2008.
2. N. Ward, Paper for ENC GNSS 2006, “Options for Re-engineering Maritime DGNSS”.
3. IALA Recommendation R-135, “*On The Future of DGNSS*”, Edition 2, December 2008.
4. IALA Recommendation R-121, “Recommendation on the Performance and Monitoring of DGNSS Services in the Frequency Band 283.5 – 325 kHz”, December 2004.