About the survey

The General Lighthouse Authorities of the United Kingdom and Ireland (GLA), are conducting a short survey to gauge the current and future use of their Differential Global Positioning System (DIFFERENTIAL GPS) service.

The GLA operate 14 DIFFERENTIAL GPS reference stations which provide corrections to GPS (single frequency) enabling greater positional accuracy and integrity in the user's position. The survey results will be used by the GLA to assess this service in relation to the current and future user needs. More information on the GLA DIFFERENTIAL GPS system and other related technologies is provided in the annex.

All responses will be kept confidential and any identifiable information will be managed in accordance to GDPR.

It is important to understand that this is a survey about your use of the Differential service and not GPS / GNSS.

The survey can be completed online at: https://www.surveymonkey.com/r/29N3SX3

Survey responses can be provided until 31st August 2018 and may be posted or emailed to the addresses below:

Post: Dr Alan Grant
The General Lighthouse Authorities of the UK & Ireland
C/O Trinity House, The Quay, Harwich, Essex. CO12 3JW

email: requests@gla-rrnav.org

Q1) Your Details (optional)

Name:	Click here to enter text.
Organisation:	Click here to enter text.
Phone:	Click here to enter text.
Email:	Click here to enter text.

Q2) What is your present position?

Master at Sea ☐ Navigating Officer at Sea ☐ Other: *(please state below)* ☐

Comments: Click here to enter text.

Q3) Do you use the GLA's DIFFERENTIAL GPS service for maritime or non-maritime purposes?

Maritime: ☐ Non-maritime: ☐ *(see below)* Not currently used: ☐ *(Please go to Q4)*

Non-maritime users, please describe what you use the GLA DIFFERENTIAL GPS service for:

Click here to enter text.

(Please continue to complete the questionnaire based on your use, rather than a vessel)

Q4) Please indicate the purpose(s) for which you use GNSS (e.g. GPS, GLONASS etc.):

General navigation	☐	Dynamic Positioning	☐
Pilotage	☐	Surveying	☐
Monitoring of anchored position(s)	☐	Commercial fishing	☐
Passenger ships standing off points of interest	☐	Policing/border protection	☐
Other (*Please state*)	☐	Click here to enter text.	

Q5) Please indicate how important marine beacon DIFFERENTIAL GPS is for these operations:

	Critical	Nice to have	Not required
General navigation	☐	☐	☐
Pilotage	☐	☐	☐
Monitoring of anchored position(s)	☐	☐	☐
Passenger ships standing off points of interest	☐	☐	☐
Dynamic Positioning	☐	☐	☐
Surveying	☐	☐	☐
Commercial fishing	☐	☐	☐
Policing/border protection	☐	☐	☐
Other (*as above*)	☐	☐	☐

Q6) If you use Dynamic Positioning (DP) – which positioning systems do you use and what back-up systems do you have available?

Primary systems:	Click here to enter text.
Back-up systems:	Click here to enter text.

Q7) Which aspect of the GLA DIFFERENTIAL GPS service is most important to you? Please indicate in the comment box how you use the integrity or accuracy information.

Integrity: ☐ Accuracy: ☐ Both: ☐

Comments:	Click here to enter text.

Q8) Please provide details of your vessel

Ship size (Gross tonnage or length):	Click here to enter text.
Ship type:	Click here to enter text.
Ship Flag:	Click here to enter text.

Q9) How many GPS receivers on board are fitted with or interfaced with a DIFFERENTIAL GPS receiver?

1: ☐ 2: ☐ More than 2: ☐ Not sure: ☐

Q10) Does your DIFFERENTIAL GPS receiver give an indication of “unhealthy” (operating outside normal parameters) GPS Satellites?

Yes: ☐ No: ☐ Not sure: ☐

Comments:	Click here to enter text.

Q11) Have you experienced service degradations, outages or other such incidents with the GLA DIFFERENTIAL GPS service?

Yes: ☐ No: ☐ Don't know: ☐

Comments: Click here to enter text.

Q12) Do you find the GLA DIFFERENTIAL GPS service useful?

Yes (*please say why*): ☐ No (*please say why*): ☐

Comments: Click here to enter text.

Q13) Do you use any non-GLA DIFFERENTIAL GPS services (e.g. commercial differential services such as STARFIX, or Space Based Augmentation Systems (EGNOS across Europe, WAAS across North America)) for either maritime or non-maritime services?

Yes (*please give details*): ☐ No: ☐

Additional information : Click here to enter text.

Q14) How much experience do you have in using DIFFERENTIAL GPS?

0-5 years: ☐ 5-10 years: ☐ 10 or more years: ☐

Q15) How many GNSS receivers are fitted to your vessel?

1: ☐ 2: ☐ 3: ☐ 4: ☐ 5 (or more): ☐

Q16) Which satellite constellations do you use today? (*tick all that apply*)

GPS: ☐ GLONASS: ☐ Galileo: ☐ BeiDou: ☐ Other: ☐

Q17) Which satellite constellations do you expect to use within the next 5-10 years? (*Tick all that apply*)

GPS: ☐ GLONASS: ☐ Galileo: ☐ BeiDou: ☐ Other: ☐

Q18) Do you expect to replace your (D)GNSS receiver within the next 5 years?

Yes: ☐ No: ☐

Q19) What would be the impact to your normal operations if the GLA DIFFERENTIAL GPS service was deactivated? *(Please detail in comment box)*

No impact: ☐ Some impact: ☐ Change approach: ☐ Use alternative DIFFERENTIAL GPS: ☐

Comments: Click here to enter text.

Q20) Please provide any additional information or relevant comments.

Click here to enter text.

Thank you for completing the GLA DIFFERENTIAL GPS survey!

Brief overview of GNSS, DIFFERENTIAL GPS and augmentation options

Global Navigation Satellite Systems (GNSS)

Global Navigation Satellite Systems is the generic name given to satellite navigation systems such as GPS, GLONASS, Galileo and BeiDou. GPS and GLONASS were both launched in the mid-1990s and are military systems providing both military and civilian services. GPS is the most commonly used GNSS as the GLONASS system was underfunded for many years. Galileo and BeiDou are more recent constellations and are not yet fully operational.

All GNSS work on the principle that each satellite broadcasts a message with a known start time which the user's receiver captures and tags with a time of receipt. By assuming the message travels at the speed of light a range estimate (known as the pseudorange) to each satellite can be estimated. By estimating the location of each satellite on transmission, and repeating the process for multiple satellites, the user's receiver can then estimate the position of the receive antenna in relation to the modelled surface of the earth. Errors in satellite position estimate, message propagation time and the lack of a precise clock in the user's receiver all contribute to the GPS position error. Most GNSS use a common frequency, 1.575.42 MHz, known as L1, to enable interoperability.

The accuracy of the system has continued to improve, and while the GPS service documentation reports accuracy levels of 7.8m (95%), users generally achieve positional accuracies in the order of 3-5m (95%). All constellations are undergoing improvement programmes, with the current move to provide civilian users with data on different frequencies, which will allow some error sources to be mitigated.

GNSS does not provide real-time alerts (position integrity) to position errors or system failures. The systems are monitored but corrective action may take many hours to effect, during which the user must rely on comparison with other position sources to detect and adjust for any errors.

Marine radiobeacon differential corrections

Marine radiobeacon differential correction systems, sometimes known as IALA beacons, were devised in the mid-to-late 1990's primarily to provide position integrity and to improve position accuracy which at that time was circa 100 metres.

Marine radiobeacon differential services, such as the GLA DIFFERENTIAL GPS, work on the basis that receivers located at selected fixed monitoring sites, known as reference stations, calculate the difference in the estimated range to each satellite with the known calculated range to each satellite. The calculated difference is the total error introduced by the various estimates and inaccuracies in the system and is referred to as the pseudorange error. These errors will be common for users within the vicinity of the reference station and are broadcast to mariners over a 300 kHz radio transmission. The mariner's receiver applies the measured pseudorange errors as corrections to improve its accuracy estimate.

As each reference station is constantly comparing the estimated position of the reference station receiver to the known location, and the estimated range to each satellite is being checked to confirm they are within a set error bound, any position errors are highlighted in real-time and alerts are provided to mariners in the vicinity, within 10s, thereby providing system integrity.

Marine beacon DIFFERENTIAL GPS can provide position accuracies in the range of 1-3m (95%), depending on the users distance to the reference station (accuracy decreases with distance as the errors seen by the user and the reference station become uncorrelated).

The GLA marine radiobeacon differential network consists of 14 reference stations located around the United Kingdom and the Republic of Ireland. They currently provide corrections for GPS only, but the technology is developing to enable corrections to be provided for all GNSS in the future, should there be a requirement. The GLA is considering the future needs for this system, including whether there is any requirement for it at all.

Satellite Based Augmentation Systems (SBAS)

Satellite Based Augmentation Systems (SBAS) is the generic name given to systems which provide GPS error correction information via satellites. Developed primarily for aviation, they use a network of ground reference stations which operate in a similar manner to marine reference stations described above to calculate corrections, but in this system the correction information is broadcast to the user on the L1 frequency via dedicated satellites.

There are several SBAS systems in operation, with the two most commonly considered systems being the United States Wide Area Augmentation System (WAAS) and the European Geostationary Navigation Overlay Service (EGNOS). Each has a dedicated network of reference stations positioned over large areas, for example most of North America and across Europe for WAAS and EGNOS respectively. Using the data received at the reference stations, they model corrections for different error sources, rather than considering them collectively, providing a wide-area correction for the region served. This approach means that they provide a constant accuracy performance over the larger region. As the performance of the GNSS is being monitored constantly, SBAS also provide integrity alerts.

Many maritime receivers are SBAS enabled, including some marine beacon DIFFERENTIAL GPS receivers and therefore care is often required to establish and understand which system is being used at any given time. SBAS systems are also evolving, with plans to provide corrections to other constellations in due course.