THE G4 SERVICE: REAL-TIME MULTI-CONSTELLATION PRECISE POINT POSITIONING INCLUDING GPS, GLONASS, GALILEO AND BEIDOU

INTRODUCTION

In 2009, Fugro launched the G2 service, the first global Precise Point Positioning (PPP) service including GPS and GLONASS constellations. Making use of a global reference station network, satellite orbits and clocks are computed in real-time and broadcast to users in the field over geostationary satellites, enabling homogeneous accuracy worldwide. The system has been tailored for professional maritime applications requiring a high-level of accuracy and availability.

With the development of new GNSS systems, such as Galileo and BeiDou, an enhanced G4 service was introduced in 2015, supporting also the new constellations. The enhanced number of satellites increases robustness, availability and robustness for the PPP solution.

SYSTEM ARCHITECTURE

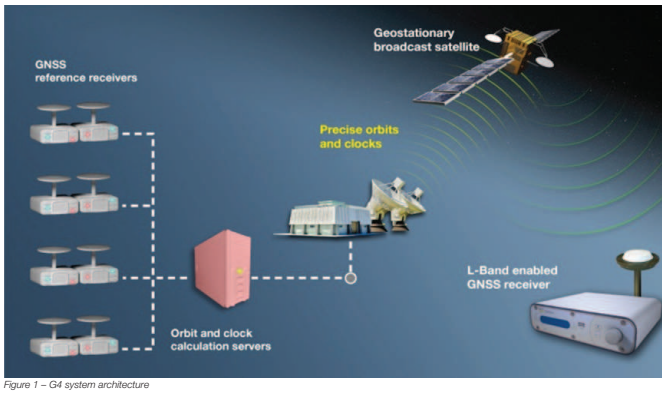

Figure 1 – G4 system architecture

System architecture is depicted in Figure 1. A network of about 45 dedicated reference stations sends real-time GPS, GLONASS, BeiDou and Galileo dual-frequency tracking data to the orbit and clock processing servers. The station network distribution is shown in Figure 2. The processing servers receive the data in real-time and generate accurate orbit and clock estimates, which are then broadcast by geostationary satellites giving redundant coverage worldwide.

G4 (GPS, GLONASS, Beidou, Galileo) and G2/SGG (GPS, GLONASS) **Orbit/Clock** Reference Stations (Fugro)

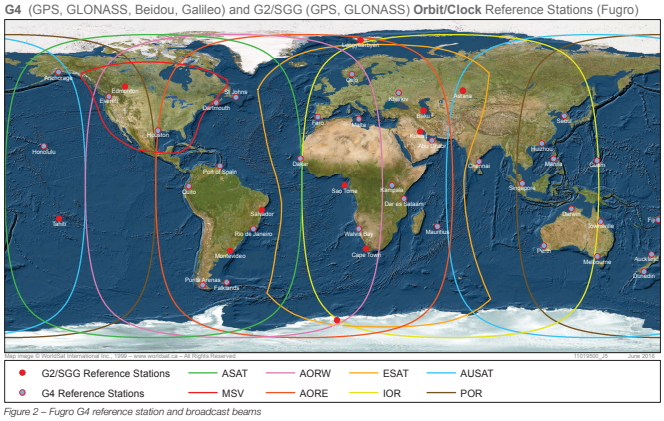

Figure 2 – Fugro G4 reference station and broadcast beams

G4 supports all BeiDou satellites, including Medium Earth Orbit (MEO), Inclined Geosynchronous Orbit (IGSO) and Geostationary Orbit (GEO) satellites. The Galileo constellation is under fast development and it is expected that Initial Operational Capability (IOC) will start before end of 2016. G4 has been fully qualified to support Galileo as soon as it becomes operational.

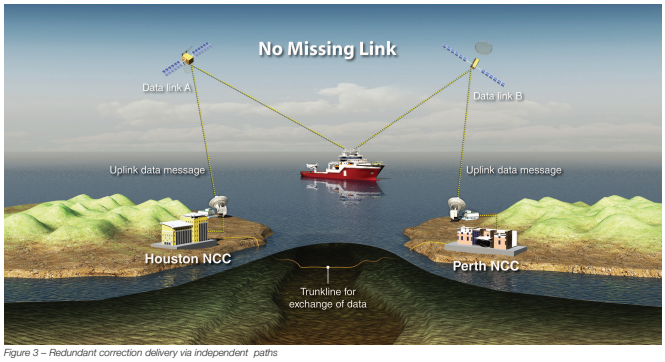

Figure 3 – Redundant correction delivery via independent paths

G4-subscribed receivers equipped with Fugro processing engine are able to combine GPS, GLONASS, BeiDou, Galileo measurements together with high-accuracy orbit and clock corrections in order to provide the user with sub-decimeter real-time position. Additionally, integer ambiguity resolution in PPP allows centimeter level positioning for those users requiring the highest level of accuracy.

ORBIT AND CLOCK GENERATION

Inside the processing servers, precise orbits and clocks are generated as a combination of a batch process for orbit prediction and a Kalman filter for real time clock estimation, as shown in Figure 4. This allows to obtain orbit accuracy better than 4 cm (RMS) and clock accuracy better than 0.1 ns (standard deviation), for GPS. The batch process is also in charge of the quality control of the station network.

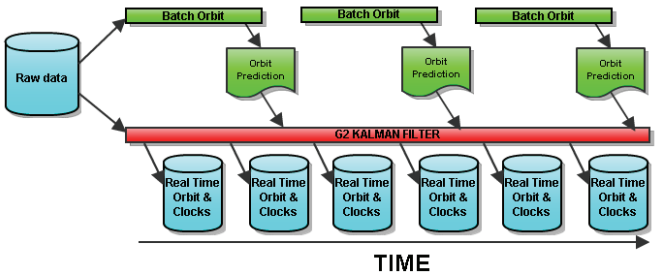

Figure 4 – Orbit and clock generation

G4 REAL-TIME PPP RESULTS

Multi-constellation real-time PPP results are shown in Figure 5. These were obtained in Oslo using a Fugro 9205 mobile receiver (Figure 5).

As shown in Figure 7, G4 delivers higher accuracy by taking profit of the higher number of satellites available for positioning.

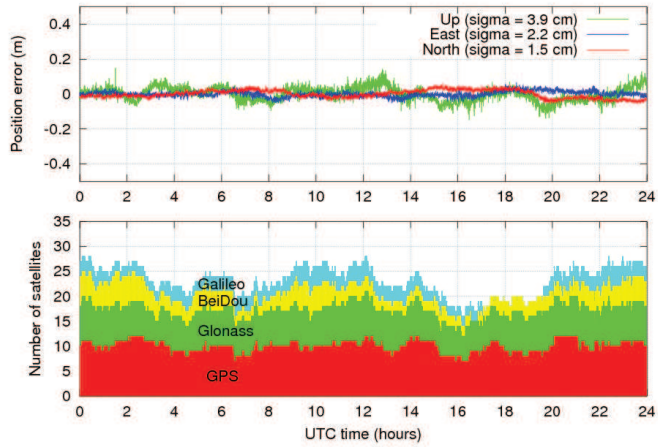

Figure 5 – Real-time G4 results from Fugro mobile GNSS receiver (9205), Oslo April 26th 2016

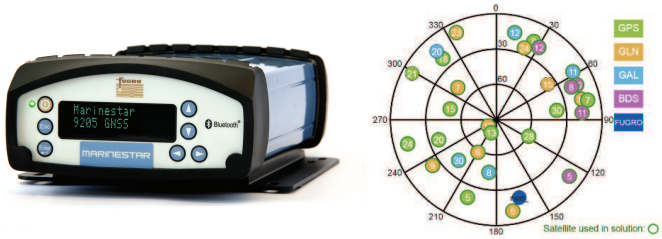

Figure 6 – Fugro mobile GNSS receiver (9205) with skyplot view

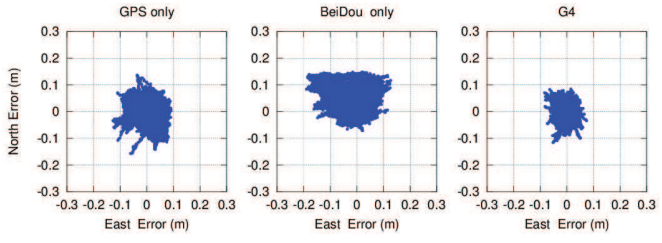

Figure 7 – Horizontal positioning results using GPS-only, BeiDou-only and G4 PPP, Perth (Australia) on September 6th 2015.

FUGRO SATELLITE POSITIONING AS
Karenslyst Alle 2, 0278 Oslo (Norway)

www.fugrosatellitepositioning.com