International Civil Aviation Organization

THE SIXTH MEETING OF THE ASIA/PACIFIC GBAS/SBAS IMPLEMENTATION TASK FORCE (GBAS/SBAS ITF/6)

(Bangkok, 7- 9 May 2024)

Agenda Item 4: GNSS Interference and its impact to GBAS & SBAS

Experience with the effect of GNSS Radio Frequency Interference to GBAS operations in Australia

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SUMMARY

This paper provides information on Global Navigation Satellite System (GNSS) Radio Frequency Interference (RFI) events observed in Australia, their impacts to the Ground Based Augmentation System (GBAS) and measures in place in Australia to mitigate the effect of GNSS interference to GBAS Landing System (GLS) operations.

1. INTRODUCTION

1.1 Australia has been supporting Category I GBAS Landing System (GLS) approaches since 2014. The GBAS installed in Australia, augments the Global Positioning System (GPS) Standard Positioning Service which operates in the L1 Aeronautical Radio Navigation Service (ARNS) band (1575.42 MHz).

1.2 Elevated levels of noise in the GPS L1 band (herein referred to as GNSS RFI) can effect both the GBAS ground station and/or aircraft. Since the GBAS was first implemented in Australia, there have been a limited number of occasions on which GNSS RFI has affected GLS operations in Australia.

1.3 This paper provides information on GNSS RFI events observed in Australia, their impacts to GLS operations and measures in place in Australia to mitigate the effect of GNSS RFI. This paper does not address other types of GNSS interference such as Spoofing as these types of scenarios have not been observed in Australia. Furthermore, Australia has not observed any instances of interference to the VHF Data Broadcast (VDB) signal in space.

2. OBSERVATIONS IN AUSTRALIA

2.1 Observed interference to the GBAS Ground Station

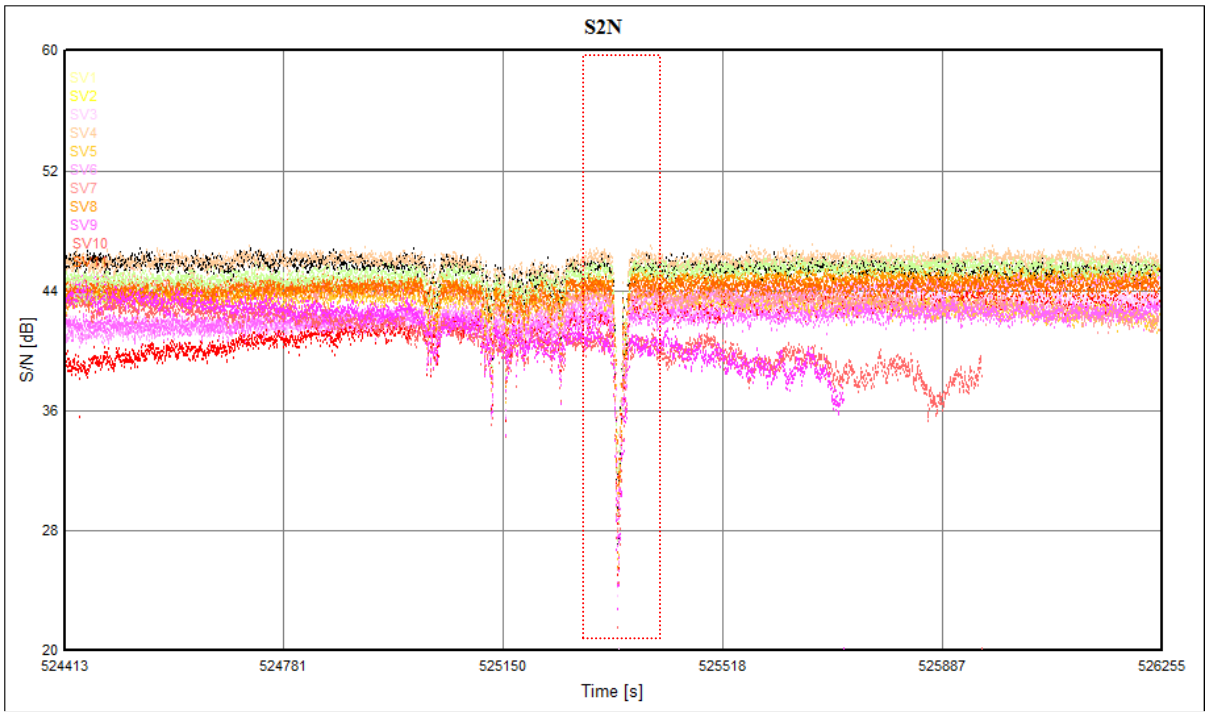
2.1.1 The GBAS is intended to detect elevated levels of noise in the GPS L1 band surrounding the facility. In response to elevated levels of noise the GBAS will take appropriate action

which may include temporarily ceasing the broadcast of pseudo-range corrections or continuing operation for a limited time.

2.1.2 Since the GBAS was installed, there has only been one instance were the GBAS ground station stopped broadcasting pseudo-range corrections due to GNSS RFI. This resulted in a momentary loss of GLS service for a period of ten seconds. There were no aircraft performing a GLS approach at the time of the event and hence there was no discernible impact to operations.

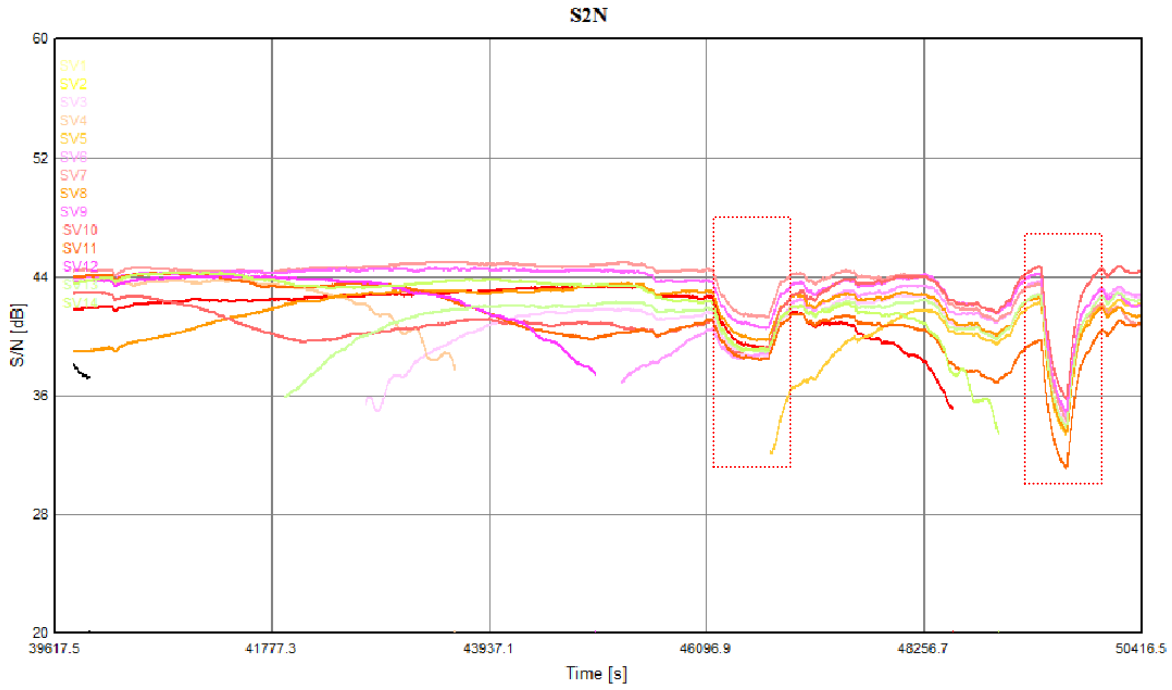
2.1.3 Subsequent investigations identified a substantive reduction in the C/No ratio for all valid satellites on more than two Reference Receivers. The variation in the C/No on one of the Reference Receivers is depicted in Figure 1. Given the relatively short duration of the event, the source of the GNSS RFI could not be definitively identified and has not re-occurred.

Figure 1 - Reduction in satellite unfiltered C/No for a single Reference Receiver



2.1.4 At one of the GBAS sites there was a single instance where the GBAS ground station operated for a limited time in the presence of GNSS RFI. This was the first and only time this type of event occurred in Australia. There was an observable reduction in the C/No level for multiple satellites which is illustrated in Figure 2. Due to the intermittent nature of the event the root cause of the reduction in the C/No could not be identified. This event has not re-occurred since this single isolated event.

Figure 2 - Reduction in satellite filtered C/No for a single Reference Receiver

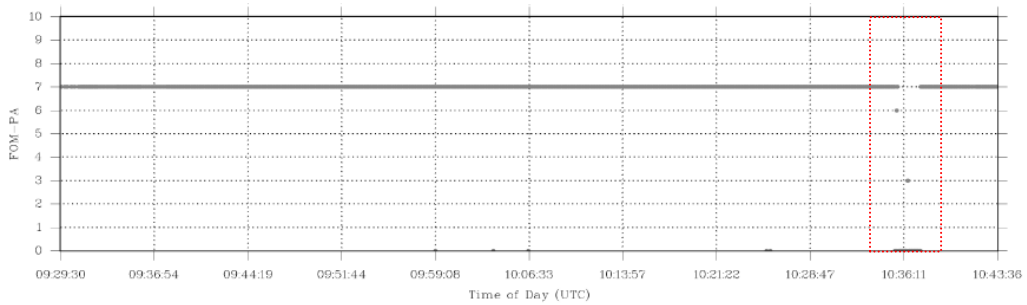


2.2 Observed GNSS interference to Aircraft

2.2.1 Shortly after the GBAS was first commissioned at Sydney, several aircraft had observed an unanticipated loss of GLS guidance just prior to the Decision Height. The loss of GLS guidance was only observed to a single runway end. For all of these observations there were no issues with the performance of the GBAS ground station, and the satellite constellation was adequate to support GLS approaches.

2.2.2 The Automatic Dependent Surveillance Broadcast (ADS-B) data for these aircraft provided some useful insights. It was identified that there was either a reduction in the ADS-B Figure of Merit (FOM) Position Accuracy (PA) or complete loss of ADS-B data for those aircraft during the period the pilots observed a loss of GLS guidance. The reduction in the FOM PA during one of these observations is depicted in Figure 3.

Figure 3 - Variation in ADS-B FOM PA for aircraft impacted by GNSS interference



2.2.3 The FOM PA is closely linked to satellite geometry and the latter is influenced by the location and number of satellites being tracked. Interference to the GNSS signal in space may impact the ability of an aircraft to track all satellites in view which in-turn effects satellite geometry and the corresponding FOM PA.

2.2.4 Therefore, Australia concluded that these observations were most likely attributable to elevated levels of GNSS interference on the aircraft during the approach. The interference impacted the ability of the GBAS receiver on the aircraft to track all satellites in view. The reduction in the number of satellites being tracked impacted the satellite geometry as seen by the aircraft, which inflated the protection levels to a level above the alert limits resulting in the loss of GLS guidance. **The system performed as designed in this scenario. These observations impacted Continuity of Service only. There was no impact to integrity.**

2.2.5 This conclusion was further supported by an observation during a Routine Flight Inspection in the area. During a Routine Flight Inspection there was an observable reduction in the number of GPS satellites tracked by the GBAS receiver on the Flight Inspection aircraft. Depicted in Figure 4 is the reduction in the number of GPS satellites tracked by the GBAS receiver as the Flight Inspection aircraft approached the runway. There is a noticeable reduction in the number of satellites tracked by the GBAS receiver at approximately 1.7 NM from the runway threshold. The reduction in the number of satellites tracked was closely correlated with an observable reduction in the received satellite signal strength as depicted in Figure 5.

2.2.6 In response to these observations, the Air Navigation Service Provider in collaboration with the Australian spectrum management authority performed several field investigations. Furthermore, the Australian spectrum management authority initiated a campaign to enhance awareness within the community of the potential effect of interference to GNSS on aviation operations. The interference ceased shortly after the commencement of the awareness campaign.

2.2.7 Additionally, in response to these observations, some operators performing GLS approaches into Sydney elected to restrict the use of GBAS to Visual Meteorological Conditions only. This temporary restriction was subsequently rescinded after a sustained period of no further observations.

Figure 4 - Number of satellites visible and tracked by the GBAS receiver

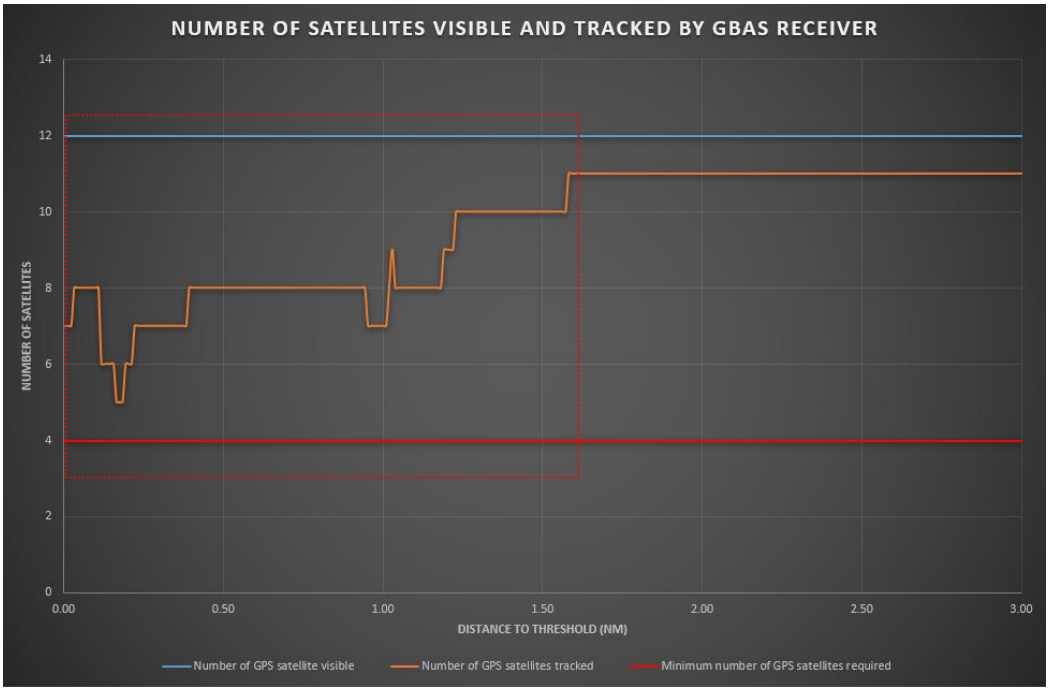
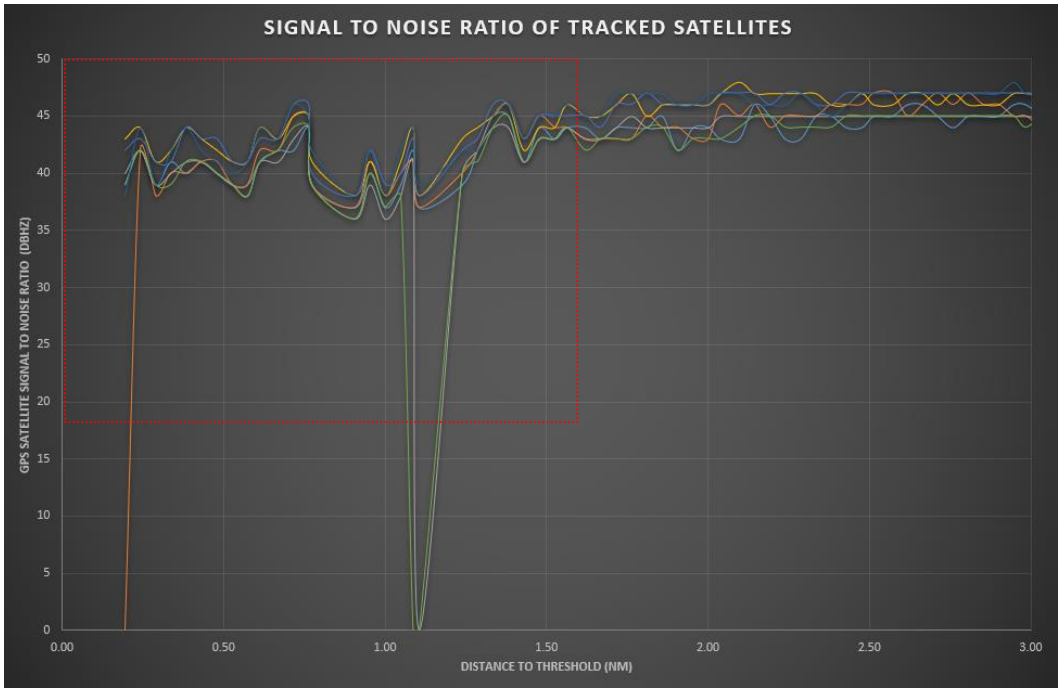


Figure 5 - Signal to Noise ratio of satellites tracked by the GBAS receiver (sample set only)



3. PROTECTION AGAINST GNSS INTERFERENCE IN AUSTRALIA

3.1 The following points provide a summary of measures in place in Australia to mitigate against GNSS interference:

- the GBAS siting process assesses the likelihood of interference from the environment that may impact Reference Receiver performance. This will include the collection of GPS data at candidate sites to identify any potential interference sources;

- the GBAS ground station Reference Receivers are sited as far as practicable from public roadways to minimise the likelihood of interference from any Personal Privacy Devices;

- prior to the introduction of GBAS at a site, aircraft ADS-B FOM PA data is analysed to identify any potential interference along approach paths that will be supported by the GBAS;

- Australia has a robust regulatory framework in place to protect the Aeronautical Radio Navigation Service band. All devices operating within this band must be appropriately licenced by the Australian spectrum management authority. Furthermore, Personal Privacy Devices (e.g. jammers) are prohibited in Australia;

- the Australian spectrum management authority conducts awareness campaigns.

4. ACTION REQUIRED BY THE MEETING

4.1 The meeting is invited to:

a) note the information contained in this paper; and

b) discuss any relevant matters as appropriate.