International Civil Aviation Organization

THE FIFTH MEETING OF PERFORMANCE BASED NAVIGATION IMPLEMENTATION COORDINATION GROUP (PBNICG/5)

Nadi, Fiji, 2-4 May 2018

Agenda Item 6: Update of the PBN implementation challenges

UPDATE OF THE GNSS SIGNAL PROTECTION ISSUE

(Presented by Secretariat)

SUMMARY

This paper provides information on the GNSS signal protection issue, which was discussed after the Fourth Meeting of PBN Implementation Coordination Group (PBNICG/4). The Philippines and Indonesia encountered GNSS interference near their airports and took a measure to resolve the problem.

1. INTRODUCTION

1.1 The protection of GNSS signal have been a main concern within aviation community since the use GNSS in civil aviation, especially the introduction of PBN. In this regard, the Twenty Second Meeting of the Asia/Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG/22) adopted the following conclusion in 2011.

Conclusion APANPIRG 22/28 – Protection of aviation utility of GNSS

That, State aviation authorities in partnership with other agencies of the State prohibit malicious and unintentional interference to GNSS and regulate legitimate uses of technology to preserve aviation utility of GNSS.

1.2 Recognizing more and more States including China, Republic of Korea and Australia faced the reality of GNSS jamming; the APANPIRG/27 adopted the following Conclusion to complement *Conclusion 22/28* and point out the mitigations in 2016.

Conclusion APANPIRG 27/36 – Protection of GNSS signal against jamming

That, considering the reported occurrences of jamming of GNSS signal in APAC Region and their effects on safety of civil aviation operations, States are urged to:

1. *protect all the Aeronautical Radio Navigation Service (ARNS) frequencies;*
2. *take proactive measures to educate public about potential consequences of GNSS spoofing and jamming on civil aviation operations;*
3. *detect and eliminate jamming through an efficient response mechanism, in particular in the vicinity of aerodromes; and*
4. *continue to report occurrences of GNSS interference and their effects to ICAO APAC Regional Office.*

1.3 Regardless of these Conclusions and State's effort, GNSS interference events had been reported continuously. Therefore, to measure the effectiveness and difficulties of APANPIRG Conclusion implementation, APANPIRG/28 has a workshop session on the implementation of APANPIRG Conclusion in 2017.

2. DISCUSSION

GNSS interference in the Philippines

2.1 The Philippines presented a paper describing their efforts to locate the GNSS interference sources and actions taken as mitigation measures at the Regional Preparatory Group (RPG) meeting for WRC-2019 held in Bangkok, Thailand from 27 to 28 March 2017. The Civil Aviation Authority of the Philippines (CAAP) had received many reports of GPS interference/signal degradation mostly during the critical instrument approach phase (RNAV GNSS) to runway 24 of Manila (Ninoy Aquino) International Airport. The followings were the impact on airline flight operations:

- loss of on-board GNSS functionality
  - ✓ [GPS-L INVALID] and/or [GPS-R INVALID] messages appear.
- decrease in navigation performance leading to RNP alert
  - ✓ through increasing aircraft horizontal error, Actual Navigation Performance (ANP) decreases beyond RNP requirement. - [NAV UNABLE RNP] message appears.
    - This sometimes has led to missed approaches.
  - ✓ in some aircraft, navigation reverted to inertial (IRU) or DME/DME after GNSS loss.
- impact on Navigation Display
  - ✓ a large "map shift" was observed.
- impact on GPWS - [TERR POS] and [EICAS TERRAIN POSITION] messages appear.
- loss of auto-land and ADS reporting capabilities

2.2 The CAAP together with National Telecommunication Commission (NTC), the agency in charge of identifying and mitigating sources of harmful interference in the Philippines tried to locate the GNSS interference sources. The suspected sources were TV broadcasting station tower and various Cel towers along the final approach course. The CAAP asked the owner of the suspected towers to stop the use of tower while examining the interference source, but the GNSS interference was reported continuously (see **Attachment A** for details).

2.3 The CAAP informed ICAO that GNSS interference was finally resolved on 20 December 2017.

Response mechanism against jamming in Indonesia

2.4 Indonesia presented activities against interference in Aeronautical Spectrum during APANPIRG/28. They informed that the Ministry of Communications and Informatics of Indonesia had deployed more than 64 Transportable Radio Frequency Monitoring System (RFMS) in 2016 mostly near the airport to detect jammer. They mentioned that no GNSS interference was reported by the time of reporting.

APANPIRG/28 workshop session in CNS field

2.5 During the APANPIRG/28, there was a workshop session in CNS field to discuss the effectiveness and difficulties of APANPIRG Conclusion implementation. Thirty two (32) States/Administrations/Territories and four (4) International Organizations participated in the workshop.

2.6 Four (4) Conclusions adopted by the APANPIRG/27 were discussed by the three (3) groups. Among them, *Conclusion 27/36 – Protection of GNSS signal against jamming* was included. Four questions were given to the groups to facilitate the discussion. They were

Question 1- Was this APANPIRG Conclusion applicable in your context? If not, Why?

Question 2 - Is this APANPIRG Conclusion implemented now? (States should come prepared to report on the implementation status)

Question 3 - What implementation issues did you face/are you facing? (States should come prepared to elaborate on the issues to the workshop)

Question 4 - If implemented, would you be able to assist other States through sending an expert team or sharing information/point of contact details to other States?

2.7 Regarding the applicability of *Conclusion 27/36* (**Question 1**), nine (9) States provided positive response and one (1) State mentioned they had not received any GNSS interference report. For the implementation of Conclusion (**Question 2**), eight (8) States responded positively and one (1) State mentioned there were under study. For the implementation issues encountered (**Question 3**), five (5) States expressed difficulties in monitoring and elimination of jamming and one (1) State mentioned they had no issue on implementation because of the close relationship with regulatory authority to mitigate GNSS interference. Finally, regarding assisting other States on GNSS interference issue (**Question 4**), three (3) States answered that they could assist other States if requested. More information can be found in **Attachment B**.

3. ACTION REQUIRED BY THE MEETING

3.1 The meeting is invited to:

a) note the information contained in this papers;

b) share experiences and difficulties on GNSS signal protection; and

c) discuss any relevant matters as appropriate.

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International Civil Aviation Organization

REGIONAL PREPARATORY GROUP (RPG) MEETING FOR WRC-2019
Bangkok, Thailand, 27 - 28 March 2017

Agenda Item 3: Spectrum issues and challenges, not on the specific agenda for WRC-19
GPS interference and detection

GPS INTERFERENCE/SIGNAL DEGRADATION IN MANILA, PHILIPPINES AFFECTING FLIGHT AND ATM OPERATIONS

(Presented by Charlemagne Gilo, Philippines)

SUMMARY

This information paper describes the current situation in Manila regarding the specific impact of GNSS interference/signal degradation to flight and ATM operations.

1. INTRODUCTION

1.1 IATA has brought to the attention of the Civil Aviation Authority of the Philippines (CAAP) numerous reports of GPS interference/signal degradation mostly during the critical instrument approach phase (RNAV GNSS) to runway 24 of Manila (Ninoy Aquino) International Airport.

2. DISCUSSION

2.1 The Philippines, as an ICAO Member State, is urged to take action to ensure that sources of GNSS interference signals are identified and mitigated. The agency in charge of identifying and mitigating sources of harmful interference in the Philippines is the National Telecommunications Commission (NTC), a separate government entity from the Civil Aviation Authority and thus reports of this nature are endorsed to that agency for proper action.

2.2 Unfortunately, reports of harmful interference to GNSS from various airlines and airspace users are still being received by CAAP to date. Based on IATA's report, within the second quarter of 2016 alone, IATA and IFALPA together received more than fifty reports relating to harmful interference to GNSS (see attachment). Based on the information in these reports, the impact on airline flight operations include:

- loss of on-board GNSS functionality
  - [GPS-L INVALID] and/or [GPS-R INVALID] messages appear.
- decrease in navigation performance leading to RNP alert
  - through increasing aircraft horizontal error, Actual Navigation Performance (ANP) decreases beyond RNP requirement. - [NAV UNABLE RNP] message appears.
    - This sometimes has led to missed approaches.
  - in some aircraft, navigation reverted to inertial (IRU) or DME/DME after GNSS loss.
- impact on Navigation Display
  - a large "map shift" was observed.
- impact on GPWS - [TERR POS] and [EICAS TERRAIN POSITION] messages appear.
- loss of auto-land and ADS reporting capabilities

2.3 Noting the on-going worldwide deployments of automatic dependent surveillance – broadcast (ADS-B), harmful interference to GNSS will also adversely impact ATM operations. A degradation or complete interruption of ADS-B surveillance services will automatically occur as a consequence of GNSS signals being interfered. This adverse impact to ATM operations can be quite significant, especially in the area where ADS-B is deployed as the sole means of ATM surveillance.

Example of ADS-B track of aircraft flying under GNSS interference

2.4 The first clue that we received in identifying the possible source of this anomaly was a report from one airline suspecting a cell tower of possibly causing the interference.The following is a direct quote from the airline:

According to illustration data (Figure 1), you can recognize ANP (actual navigation performance) is over 0.5NM temporary at around 14 NM DME on line graph. And then, ANP have been within 0.3NM gradually. So we can expect that there is some cause like a tower for cell phone radio in around 14NM DME because almost JAL flight encountered unreliable ANP at 14NM DME as indication of data.

2.5 This limited information was passed on to NTC after determining that there indeed was a cell phone tower within 1NM of the area on top of terrain approximately 1,300 feet high. Thus began CAAP and NTC's quest for the ultimate source of this GPS interference.

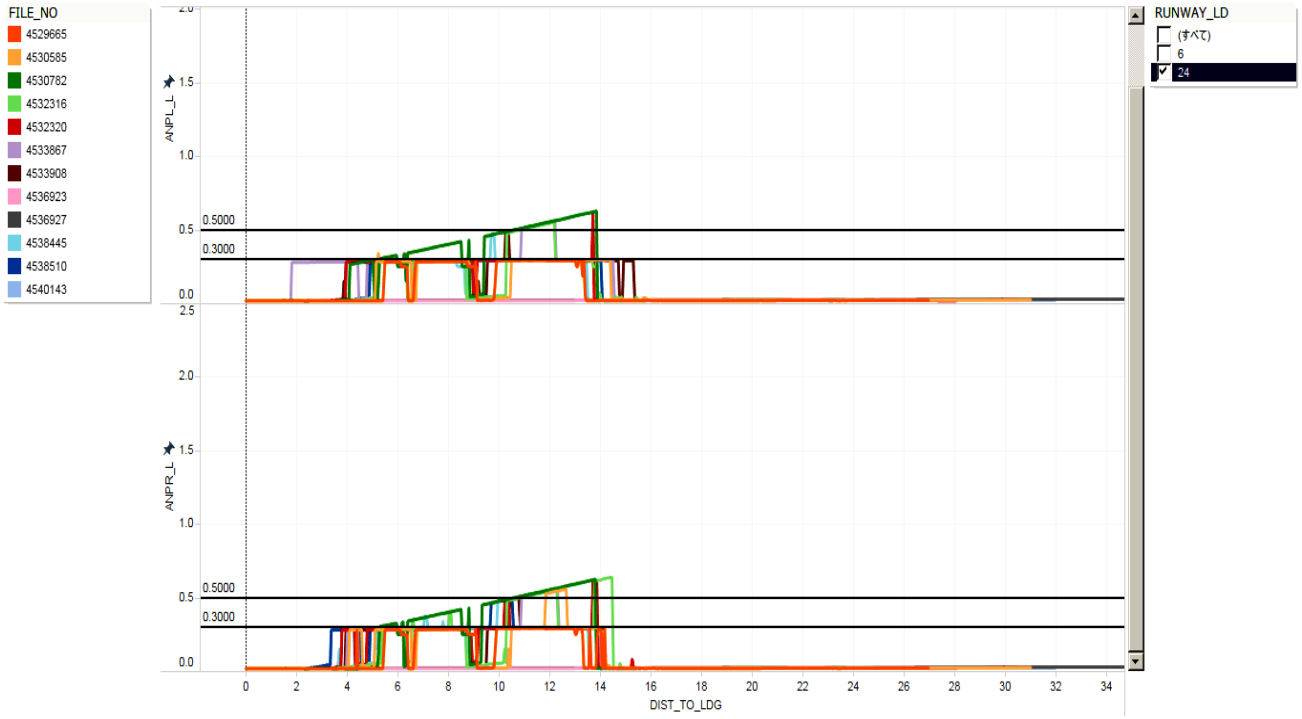

Figure 1 - Actual Navigation Performance recorded on aircraft

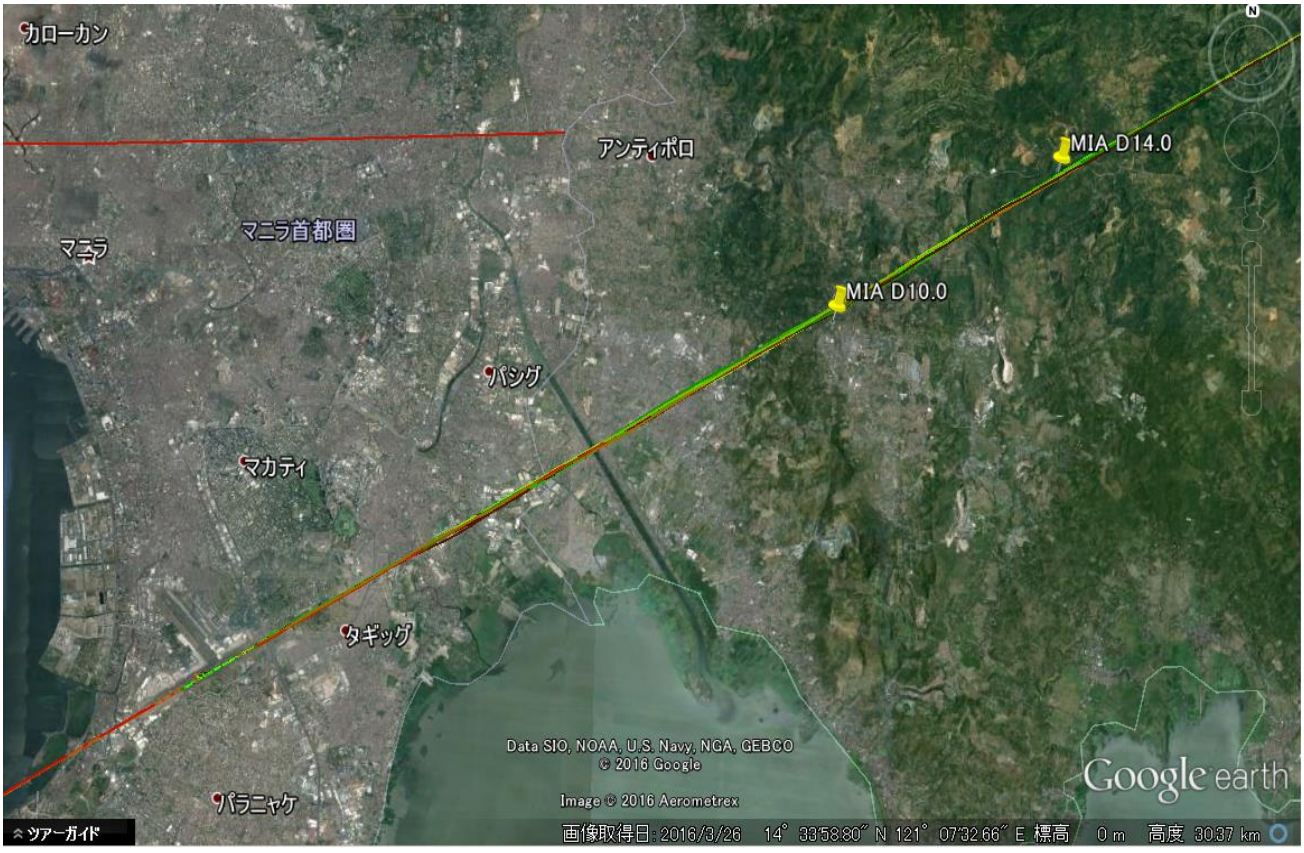

Figure 2 - 14 DME to Manila RWY24

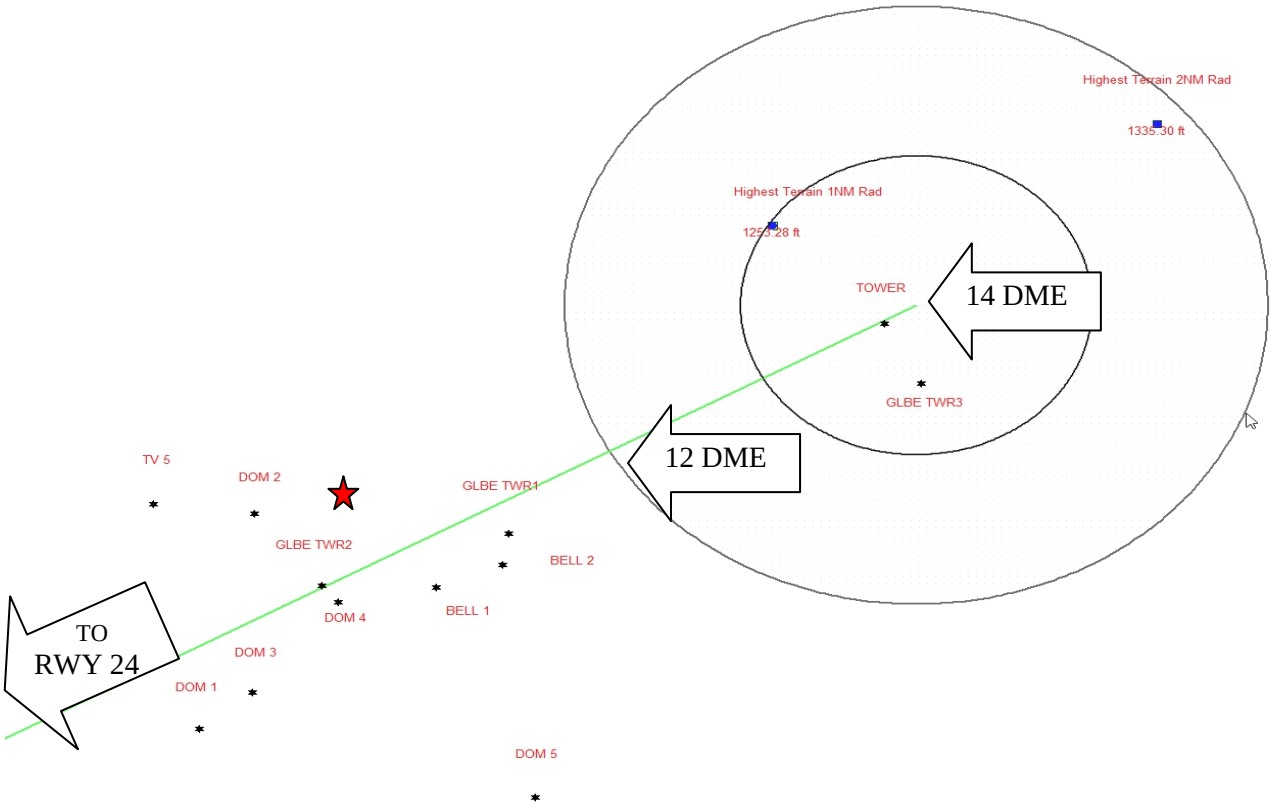

Figure 3 - Suspected Cell Phone and TV Broadcast Towers Location

2.6 The 1st suspect, after some initial investigation of the area, was not a cell tower but instead a TV broadcasting station tower. When we requested a momentary shutdown of their broadcast, CAAP's flight check aircraft was able to received good GPS signal that led to good data to put Localizer RWY24 for use. GPS signal was lost again when flight check was about to be done on the glide slope for the ILS and thus the TV station was ruled out as the source.

2.7 The 2nd were various Cel towers, that initially indicated emitting transmissions specifically on the GPS frequency itself, were also investigated, tested, turned off with corresponding flight check but was later pronounced not the source again.

2.8 A 3rd suspect is again a TV broadcasting station of a very influential religious group in the Philippines. Letters have been dispatched after initial readings also indicate signals on the GPS frequency emanating from their compound. The whole process will be repeated again and hopefully we'll have some good news before the next FSMP meeting.

2.7 In the interim, due to the continued reported occurrences of these events, CAAP continues to enforce the NOTAM advising the availability of other instrument approaches to runway 24 and the reported occurences of GPS interference and signal degradation in the area.

3. CONCLUSION

3.1 The meeting is invited to note the information on this paper and the action that the Philippines have undertaken to identify and mitigate the situation.

— END —

ATTACHMENT

Date	Flight	Airline	Details
6-Jul-16	CX901	CX	GPS1 + GPS2 lost during RNAV approach
10-Jul-16	CX935	CX	Approaching FAF RNAV 24 GPS signal briefly lost. Continued visually with NAV UNABLE RNP.
8-Jul-16	CX934	CX	GPS primary lost on both sides on both arrival and departure at RPLL. Ops normal for remainder of the flight.
9-Jul-16	CX905	CX	GPS primary lost at 1500 feet ASL RWY24 time 1600Z
12-Jul-16	CX919	CX	GPS Primary lost during RNAV 24 approach at position LL24D. GPS Primary and GPS Primary Lost fluctuated on and off.
12-Jul-16	CX935	CX	GPS Signal Lost Twice on Approach: 1128-1130Z at POSN 14'28.4'N, 120'34.8' E 1144-1148Z on final appraoch, POSN 12 DME MIA. VOR APPR requested and flown due NOTAM. TERR POSS and NAV unable RNP message received.
13-Jul-16	CX908	CX	Loss of GPS signal on RNAV RWY 24 approach at FAF.
13-Jul-16	CX903	CX	RNAV24 INERTIAL 3600ft, UNABLE RNP 1600ft, landed visually, GPS displayed again 800ft.
13-Jul-16	CX902		GPS dropped out of use on departure between 7000 and FL120
12-Jul-16	CX901	CX	GPS anomalies occurred on LNAV track to 24. No VDEV on ND. Approaching the FAF we appeared displaced right of track. We then got VERIFY POSITION and UNABLE RNP. We disconnected to conduct a visual landing.
14-Jul-16	CX901	CX	Loss of GPS with NAV UNABLE RNP EICAS. Continued visual approach. At 3NM on VNAV path but 300ft high and well right of C/L
15-Jul-16	CX919	CX	During RNAV approach R/W 24 GPS interference commenced at LL24D with loss of GPS signal. Guidance reverted to inertial. ANP drifted to out of tolerence by LL24E with NAV unable RNP msg. VMC conditions with RWY in sight so approach continued. GPS signal re-aquired at approximately 3nm final.
16-Jul-16	CX901	CX	Loss of GPS at position LLZHE. RNAV 24 Manila. Inertial on ND, EICAS NAV unable RNP, approach converted to visual. Normal landing with nil consequence.
17-Jul-16	CX903	CX	VORDME Z 24 flown ITO RNAV 24. GPS signal lost on final with drift 0.51. Not recommended for use in IMC/marginal weather.
15-Jul-16	CX901	CX	TERR POS EICAS then NAV UNABLE RNP EICAS shortly after FAF approx 1500ft
20-Jul-16	CX919	CX	RADAR VECTORS ON APPROACH INTO MNL, ILS 06. ON INTERCEPT HDG 120 TO LOCALIZER, 12NM FROM MIA VOR, "GPS PRIMARY LOST" (APPROX 0830UTC) BOTH FO AND CAPT SIDE. GPS SIGNAL LOST FOR APPROX 1MIN, AND SIGNAL CAME BACK. SUBSEQUENTLY, AT 2NM FROM THRESHOLD (0834UTC), SAME SITUATION (BOTH FO AND CAPT SHOW "GPS PRIMARY LOST") AND AGAIN THIS LASTED APPROX 1MIN. SUSPECT GPS INTERFERENCE AS ALL OTHER TIMES DURING FLIGHT, GPS WAS NORMAL. EXTRA INFO: SAME SITUATION OCCURRED ON THE RETURN FLIGHT LEAVING MNL SOON AFTER TAKE OFF. RADAR VECTORS FOR DEPARTURE. "GPS PRIMARY LOST" FOR APPROX 2 MINS (APPROX 1009UTC) LOCATION BETWEEN VOR MIA RADIAL050/5NM AND RADIAL040/15NM.
7-Jul-16	JL741	JL	“UNABLE RNP” AND "TERR POS" APPEARED DURING APPROACH. THE VALUE OF ANP INCREASED TO 0.35.
8-Jul-16	JL741	JL	“UNABLE RNP” AND "TERR POS" APPEARED DURING DESCENT. BOTH GPS L & R OF CDU PAGE BLANKED DURING APPROACH.

Date	Flight	Airline	Details
8-Jul-16	JL745	JL	“UNABLE RNP” APPEARED DURING DESCENT SEVERAL TIMES.
21-Jul-16	CX938	CX	Cleared for RNAV approach runway 24 MNL On approach inside 3000 feet, GPS update changed to INERTIAL. Fair conditions on the approach and UNABLE RNP followed shortly thereafter. Approach continued visually for the landing
24-Jul-16	CX900	CX	GPS signal loss during departure RWY06. Loss for approximately 5-10 seconds
24-Jul-16	CX901	CX	Loss of GPS on close in left base for RWY06. 3 times 5-10 seconds per event.
24-Jul-16	CX918	CX	HKG-MNL sector GPS interference 24 VOR APP Lost GPS at MIA070/13 Recovered at MIA060/5NAV UNABLE RNP advisory
24-Jul-16	CX903	CX	TERN POS message at FAF RNAV 24 followed by NAV UNABLE RNP APP continued as visual.
20-Jul-16	CX918	CX	GPS lost on departure MIA radial 050/5NM lost for 2 minutes until MIA 040/15NM
25-Jul-16	CX903	CX	VOR Z 24 APP for us. Loss of GPS signal a few times. No EICAS msg.
28-Jul-16	CX935	CX	GPS signal lost 10NM NW MIA VOR for 20 seconds at 1225Z
30-Jul-16	CX901	CX	RNAV APP 24 NAV UNABLE RNP at 1,300FT Approach completed visually
30-Jul-16	CX903	CX	Loss of GPS signal on approach at FAF 1134Z VOR Z approach flown so loss of GPS no effect on approach
2-Aug-16	CX903	CX	MNL RNAV24 loss of GPS signal on base leg.NAV UNABLE RNP at 5 miles to land. GPS signal returned soon after and normal RNP/ANP resumed.
4-Aug-16	CX901	CX	RNAV 24 APP NAV UNABLE RNP EICAS at FAF
5-Aug-16	CX905	CX	Loss of GPS 8NM final RNAV24. EICAS UNABLE RNP. Approach continued due visual with RWY24
6-Aug-16	CX912	CX	On departure lost GPS signal approx 8NM MIA regained GPS signal approx 12NM
4-Aug-16	CX903	CX	Conducted VOR Z 24 MNL. Radar vectors from the south. Lost both GPS at about 8NM final / 2,500FT. GPS acquired position again on the ground.
6-Aug-16	CX919/920	CX	On RNAV/GPS approach loss of GPS primary. Recovered within LOC. On departure up to 10 losses of GPS primary. Self recovered. All occurred within 15Nm of RPLL
30-Jul-16	CX935	CX	RNAV 24 approach via NATAY, fully managed. GPS signal momentary lost at waypoint LL24D. Approach continued using VIS guidance. For info other aircraft also lost GPS signal during approach.
6-Aug-16	CX904	CX	GPS primary lost both sides on departure MNL between 2,000FT and 5,000FT and again at 9,000FT for several minutes. RWY24 departure.
6-Aug-16	CX913	CX	GPS primary lost on both sides at approximately 4,000FT turning final approach. GPS primary returned approximately 2,500FT. Visual approach conducted to landing.
7-Aug-16	EK332	EK	TURNING TO BASE LEG WITHOUT EICAS ANP WENT BEYOND REQUIRED CORRECTED ITSELF. APPROACH CONTINUED. AT 1800 FEET FULLY CONFIGURED EICAS NAV RNP UNABLE AND TERRAIN POS EOCAS MESSAGES RECEIVED . APPROACH CONTINUED MANUALLY IN VFR VMC CONDITIONS LANDING UNEVENTFUL. MESSAGES CLEARED THEMSELVES AT SHORT FINAL
7-Aug-16	EK335	EK	Around 1000' climbing RWY HDG, EICAS 'RWY POS' and navigation status on ND display showed inertial. Switched off RAD NAV INHIBIT and NAV status on ND became DME-VOR followed shortly by DME-DME. When GPS became available 'RAD NAV INHIBIT' was turned ON.

Date	Flight	Airline	Details
5-Aug-16	EK336	EK	RNAV approach 24- on final EICAS TERR POS followed by unable RNP. In visual conditions, visual with ground and runway, TRK HOLD was selected whilst aircraft was slightly to left of centreline. At 1700' autopilot was disconnected approach continued visually. Company NOTAM CO714/16 was discussed during the briefing in the cruise.
29-Jul-16	EK334	EK	Cleared for the RNAV (GNSS) 24 approach in night VMC, an EICAS 'TERR POS' activated. The crew actioned the respective non-normal checklist and continued the approach. At approximately five miles final the EICAS 'NAV UNABLE RNP' activated and the crew identified the aircraft deviating left of the lateral track. The crew elected to continue the approach visually. An ATC instructed go-around was flown due to the preceding aircraft being still on the runway (ASR applies). The EICAS 'NAV UNABLE RNP' activated on the subsequent RNAV (GNSS) as well and required that the approach was continued to landing based on visual cues. Ground personnel advised the crew that this was a recurring issue at the airport. Flight Safety update: State NOTAM 1B2554/16 and company NOTAM CO714/16 CO714/16 advise arriving flights to exercise caution when using the RNAV approach due to 'aircraft reports of GPS interference and jamming'.
24-Jul-16	EK332	EK	On RNAV GNSS approach to runway 24 EICAS NAV UNABLE RNP and TERR POS were displayed. As the crew had visual contact with the runway, the approach was continued using PAPI. A CONOTAM exists to warn pilots for this approach in Manila for possible GPS jamming. ATC was advised. Flight Safety update: The report has been forwarded to FOS and the ASM. External electronic jamming is the most probable cause of the reported GPS signal loss. FOS escalated the reports to the Regional IATA Office in Singapore, and Manila Airport published a Class-1 NOTAM on 22 July 2016 to warn of the same.

Conclusion No. C 27/36 - Protection of GNSS signal against jamming
That, considering the reported occurrences of jamming of GNSS signal in APAC Region and their effects on safety of civil aviation operations, States are urged to
1. protect all the Aeronautical Radio Navigation Service (ARNS) frequencies;
2. take proactive measures to educate public about potential consequences of GNSS spoofing and jamming on civil aviation operations;
3. detect and eliminate jamming through an efficient response mechanism, in particular in the vicinity of aerodromes; and
4. continue to report occurrences of GNSS interference and their effects to ICAO APAC Regional Office.

			Question 1		Question 2		Question 3		Question 4	
			Was this APANPIRG Conclusion applicable in your context? If not, Why?		Is this APANPIRG Conclusion implemented now? (States should come prepared to report on the implementation status)		What implementation issues did you face/are you facing? (States should come prepared to elaborate on the issues to the workshop)		If implemented, would you be able to assist other States through sending an expert team or sharing information/point of contact details to other States?	
Group	**No**	**States/ Administrations**	**Answer Y/N**	**Comment**	**Answer Y/N**	**Comment**	**Answer Y/N**	**Comment**	**Answer Y/N**	**Comment**
A	1	China								
	2	Hong Kong	Y	Nil	Y	Already Implemented	N	No issue as we have been collaborating closely with Office of the Communications Authority (OFCA) (regulatory authorities in Hong Kong) to mitigate GNSS interference	Y	Hong Kong, China is willing/ready to share our experience/lessons learnt, if resource permitting, provide other necessary support
	3	Macao	Y	GNSS based PBN flight procedures are available.	Y	1. protection all the Aeronautical Radio Navigation Service (ARNS) frequencies through radio regulations of Macao relevant authority; 2. education to public about jamming or interference with regulated frequencies including aeronautical frequencies is undertaken by radio regulations of Macao relevant authroity; 3. detection and elimination of jamming through routine surveillance by Macao relevant authority.	Y	The territory of Macao is small. The jamming or interference on GNSS is usually located as foreign. Coordination with authority of adjacant districts is necessary for the elimination of jamming instead of taking action directly.	N	N/A
	4	Kiribati								
	5	New Zealand								
	6	Pakistan								
	7	Republic of Korea								
	8	Sri Lanka	Yes	No comments	Yes, partial	Having constant dialog with Telecommunication Regulatory commission of Sri Lanka (TRCSL). Mechanism has been established with TRCSL, with the assistance with ITU. Will be extending this procedure to keep APAC office informed.	-	At time TRCSL unable to in force preventive measures to Broadcasters. Atmospheric Issues.	Yes	Information could be shared / details of point of contact could be provided, once implemented.
	9	Thailand	Y	it was applicable because Thailand has been using GNSS as the main navigation aids infrastructure for aviation many years. Any disruption to GNSS service will have serious impact on the safe and efficient operations of aircraft in Thailand.	Y	Thailand action on this APANPIRG Conclusion is as follows: All of aeronautical frequency spectrum are all protected by the Radio Communications Act B.E. 2498 (1955). It is unlawful and punishable by law for any interference on ARNS frequencies which include GNSS signal. The National Broadcasting and Telecommunications Commission (NBTC) and Aeronautical Radio of Thailand Ltd. (AEROTHAI) have been working together for preventing the ARNS frequency interference from local radio stations. The detection and enforcement mechanism are already established, including an inference reporting database.		However, the current detection system cannot isolate the interference source as the GNSS signal interference in particular. The GNSS signal interference detector implementation is during in the feasibility study phase. In the meantime, the GNSS training and seminars organized by the Civil Aviation Authority of Thailand (CAAT) and other organizations haveal ready included the GNSS jamming and spoofing topics. as part of the trainings/seminars. In addition, the potential consequences of GNSS spoofing and jamming on civil aviation operations and the penalty will be published as an article in the media and as an infographic for the public education later in this year.		As we are still learning more about the issue, Thailand is not ready to assist other Statues through sending an expert team or sharing information/point of contact details to other States at this moment
	10	Viet nam								
	11	Papua new Guinea								

	12	IATA								
	13	IBAC								
	14	ICCAIA								
	15	IFAIMA								
B	1	Bangladesh								
	2	DPR Korea								
	3	French Polynesia	Y		Y	National agency for Radio frequencies , Inflight		Difficulties to monitor all the path in real time		
	4	New Caledonia	Y		Y	check,				
	5	India								
	6	Maldives								
	7	Mongolia								
	8	Myanmar	Y		N	Case study	N		N	
	9	Philippines								
	10	Singapore	Yes		Yes	In process of implementing	Yes	Elimination of jamming	Yes	Yes, after implementation, Singapore can share relevant information and point of contact details with other States.
	11	United States								
	12	IATA								
	13	ICCAIA								
	14	IFALPA								
C	1	Australia								
	2	Bhutan								
	3	Cambodia								
	4	Fiji								
	5	Indonesia								
	6	Japan								
	7	Lao								
	8	Malaysia	Y	-	Y	The work is in progress. Cooperation with Malaysian Communication & MultiMedia (MCMC) and Commission Malaysia National Aerospace Agency (ANGKASA)	Y	No reported case of jamming	N	
	9	Nepal	NO	NO REPORTED JAMMING						
	10	CANSO								
	11	IATA								
	12	ICCAIA								