GNSS/GPS Interference
Reported in MENA Region

Global Aviation Data Management
November 11th, 2020

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Background – GNSS/GPS Vulnerability

- GNSS/GPS vulnerability, including intentional and unintentional signal interference, identified as a **major safety issue** as GNSS is embedded into numerous critical infrastructures.

- In 2019, IATA released [a working paper](#) into the 40th ICAO Assembly to urges States to adopt and implement measures to manage and reduce causes and impact of the interference.

- RASG-MID released the [guidance material to GNSS vulnerabilities](#) to mitigate the safety and operational impact of GNSS service disruption.

- Conducted analysis of the aviation safety reports filed by airlines and NOTAM issued in MENA region **from 2019 January to 2020 September.**

- Analysis is made up with two dataset in GADM: Aviation Safety Reports (ASR) and NOTAM data

- Identified hot spots and trends of reported GNSS/GPS interference

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Analysis Scope – Data Coverage

Aviation Safety Reports (Airline sourced data)

Total **461** GNSS/GPS jamming or suspected interference reports in MENA States and total **831** reports from MENA and neighboring States have been extracted from Incident Data Exchange (IDX) dataset.

- 2019 January ~ 2020 September (1 year 9 months)

NOTAM (FAA sourced data)

21 GNSS/GPS interference NOTAMs were extracted from NOTAM archive issued over MENA States.

- 2020 June ~ 2020 September (4 months)

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Analysis Scope – Definition

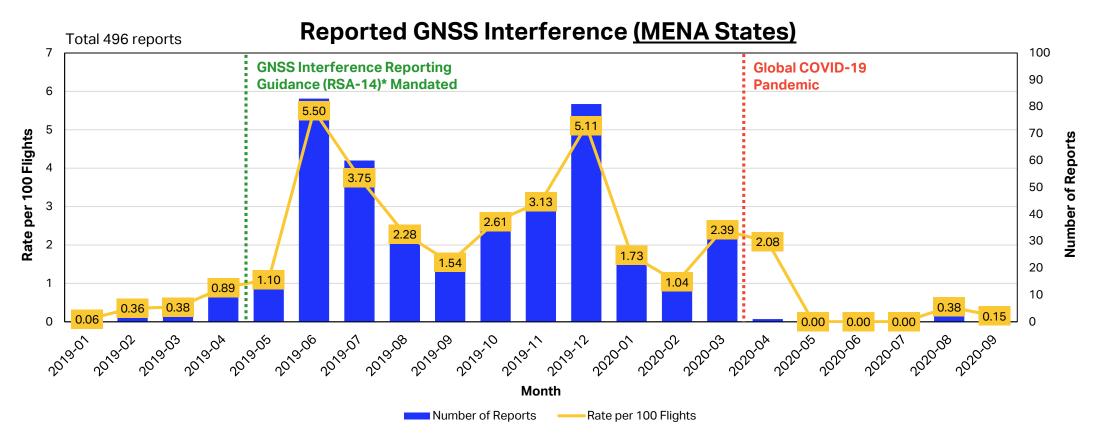**The GNSS/GPS Interference reports or NOTAMs in this analysis typically includes the following cases:**

- GNSS/GPS signal loss or degeneration over certain airspace.
- EICAS/ECAM warning with GPS out or fault over certain airspace (ADS-B out or EGPWS TERR POS message may follow).
- GPS timing failing (e.g. GPS clock/chronometers running backwards) over certain airspace.
- Pilot reporting suspected GNSS/GPS interference including GPS jamming and spoofing.
- NOTAMs with planned military activities with GNSS/GPS interference.

The following cases <u>WERE NOT</u> considered as GNSS/GPS inference:

- EICAS/ECAM warning without GPS faults.
- Mechanical or technical defects of GPS receiver in aircraft, which are not related to GNSS/GPS signal interference.
- NOTAMs with GNSS procedure became unavailable without reason of unreliable or interfered GNSS/GPS signal.
- NOTAMs with GNSS procedural change (e.g. category, waypoints, decision heights, etc).

GNSS/GPS Interference Monthly Trend – MENA only

Reported GNSS Interference (MENA States)
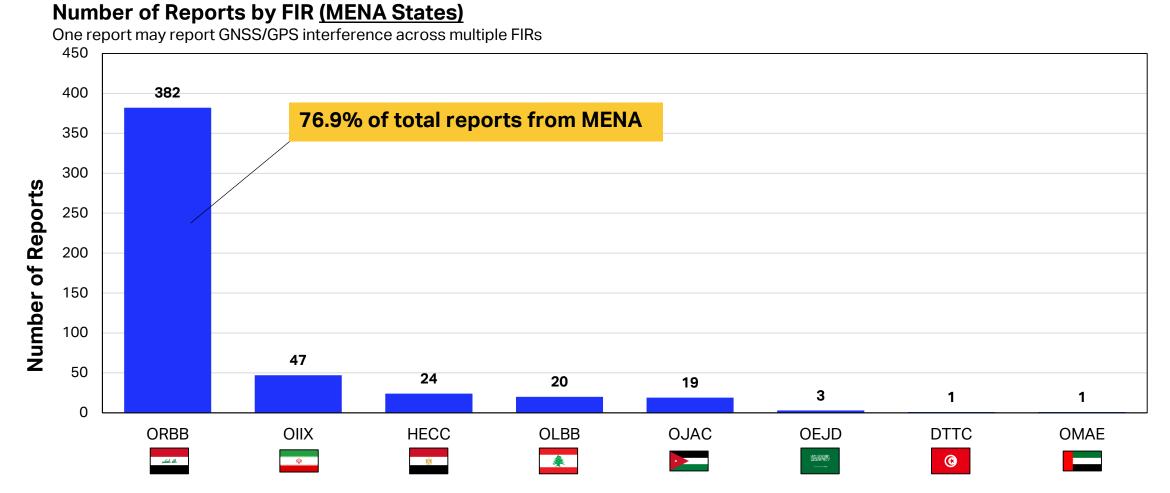
Total 496 reports

In MENA States, the number of GNSS/GPS interference reports shows a surge after 2019-05 and reduced significantly after 2020-04 (COVID-19 Pandemic).

In the highest peak (2019-06), 5.5 out of 100 flights reported GNSS/GPS interference over MENA States to GADM.
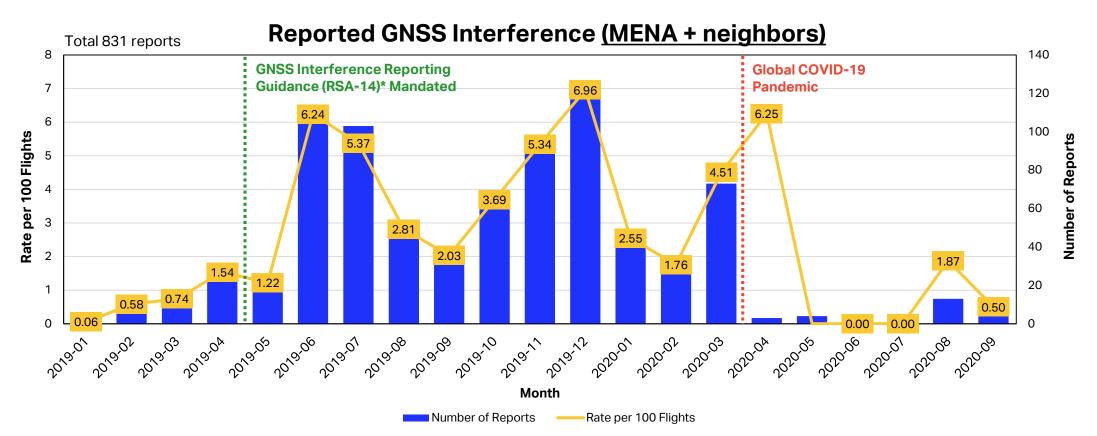
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FIR / States Distribution – MENA only

Number of Reports by FIR (MENA States)
One report may report GNSS/GPS interference across multiple FIRs

76.9% of total reports from MENA

Chart: Number of Reports by FIR
- ORBB (Iraq): 382
- OIIX (Iran): 47
- HECC (Egypt): 24
- OLBB (Lebanon): 20
- OJAC (Jordan): 19
- OEJD (Saudi Arabia): 3
- DTTC (Tunisia): 1
- OMAE (UAE): 1

Majority of GNSS/GPS interference were reported in ORBB (Baghdad FIR), which represents up to 76.9% of total reports, followed by OIIX (Tehran FIR) – 9.5%, HECC (Cairo FIR) – 4.8%, OLBB (Beirut FIR) – 4.0% and OJAC (Amman FIR) – 3.8%.
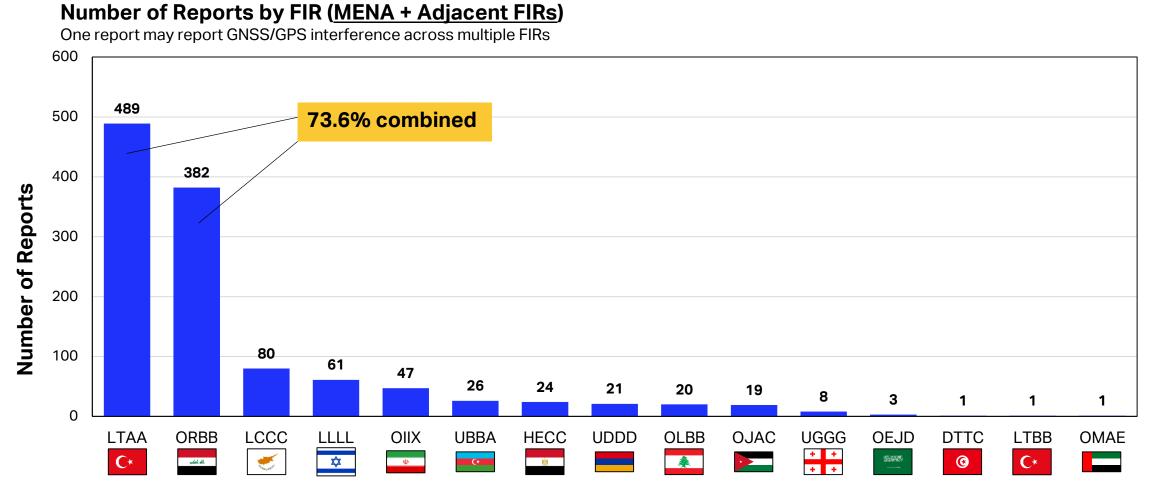
GNSS/GPS Interference Monthly Trend – MENA + Adjacent FIRs

Reported GNSS Interference (MENA + neighbors)

Total 831 reports

Expanding the scope to MENA and neighboring States**, the number of GNSS/GPS interference reports shows a surge after 2019-05 and reduced significantly after 2020-04 (COVID-19 Pandemic).
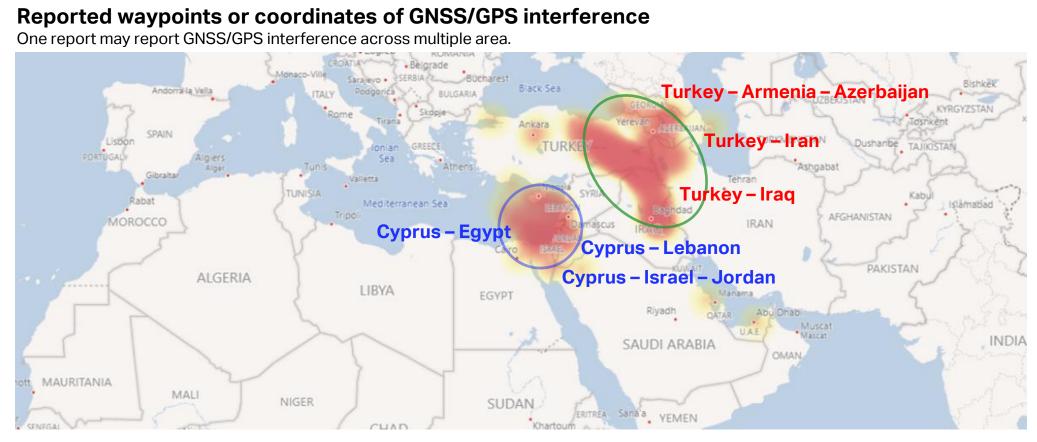
In the highest peak (2019-12), 7 out of 100 flights reported GNSS/GPS interference over MENA and nearby airspace to GADM.

** MENA countries + Armenia, Azerbaijan, Cyprus, Georgia, Israel, Turkey

FIR / States Distribution - MENA + neighbors

Number of Reports by FIR (MENA + Adjacent FIRs)
One report may report GNSS/GPS interference across multiple FIRs

When expanding scope into **MENA and neighboring States***, majority of GNSS/GPS interference were reported in LTAA (Ankara FIR), ORBB (Baghdad FIR) and their border, which sums up to 73.6% of total reports, followed by LCCC (Nicosia FIR) and LLLL (Tel Aviv FIR) combined representing 11.9% of total reports.

** MENA countries + Armenia, Azerbaijan, Cyprus, Georgia, Israel, Turkey

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GNSS/GPS Interference Hot Spots

Reported waypoints or coordinates of GNSS/GPS interference
One report may report GNSS/GPS interference across multiple area.

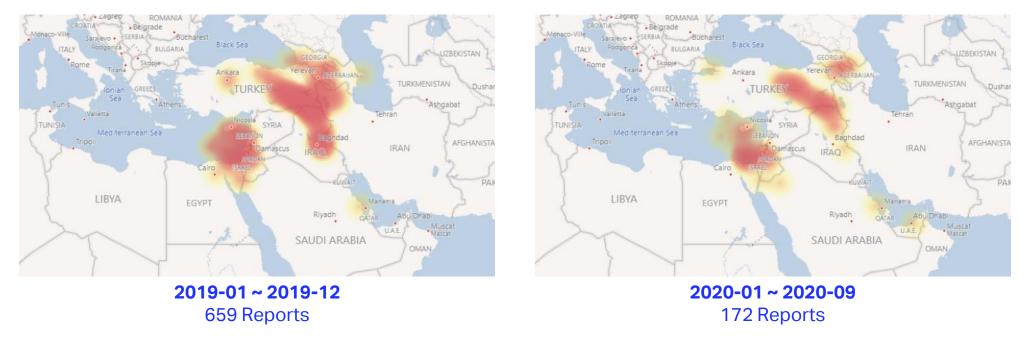**Two major clusters were observed:**

- **Eastern Turkish airspace to Iraq, Iran, Armenia** (extended to border between Armenia and Azerbaijan)
- **Southern Cypriot airspace to Egypt, Lebanon and Israel** (extended to a corridor between Israel and Jordan)

Notably, these clusters locate around the Syrian airspace, where there is no regular civil operation.

GNSS/GPS Interference by Year

Reported waypoints or coordinates of GNSS/GPS interference

One report may report GNSS/GPS interference across multiple area

2019-01 ~ 2019-12
659 Reports

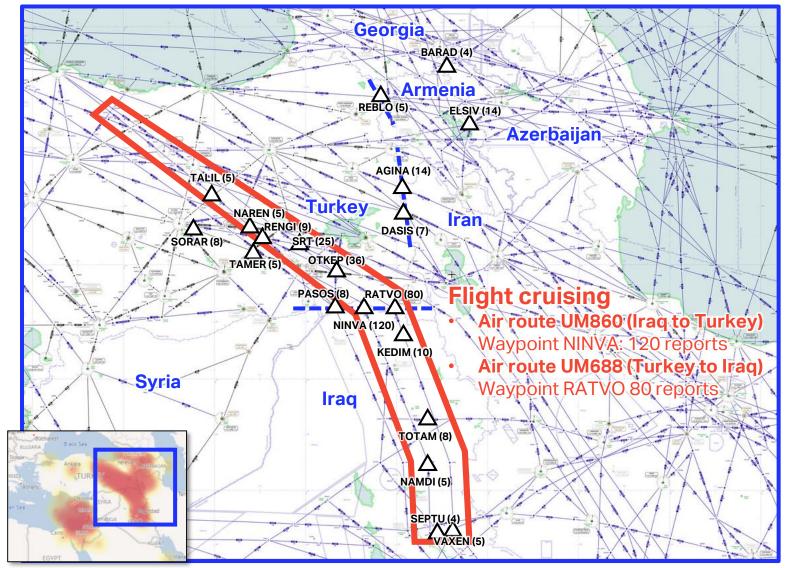
2020-01 ~ 2020-09
172 Reports

There was no significant difference between the year 2019 and year 2020.

The density difference between two figures is due to reduced flights due to COVID-19 pandemic.

Location of Reported GNSS/GPS Inferences

Reported waypoints (number of reports)

Findings

- **89.6%** of the GNSS/GPS interference reports near Turkish airspace were reported during the **cruising** phase.

- Most of the reported waypoints are distributed near **FIR borders**, especially the one between **Turkey (LTAA)** and **Iraq (ORBB).**
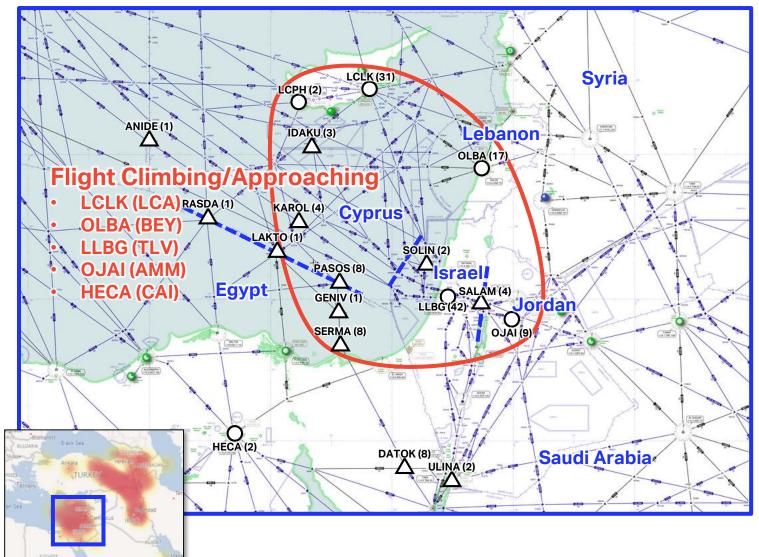
Insights

- Major airlines avoid flights over Syrian airspace, and thus, numerous traffic is concentrated over air route UM680 and UM688 (e.g. routes from Europe to Persian Gulf, a.k.a Arabian Gulf, or to India).

Location of Reported GNSS/GPS Inferences

Reported waypoints (number of reports)

Findings

- **58.7%** of the GNSS/GPS interference reports near Cypriot airspace were reported during the **approach, descent or climbing** phase. In contrast, cruising flights represent only 26.6% of total reports.

- Most of the reports are distributed near airports, such as **LCLK**, **OLBA**, **LLBG**, **OJAI** and **HECA**. But some reports were collected in the border between **Cyprus (LCCC)** and **Egypt (HECC)**.

Insights

- The GNSS/GPS inference near Cyprus are reported with altitude lower than typical cruising altitude.

Example Narratives

When transiting between Iraq and Turkey via position NINVA at FL400, we experienced failure of both GPS on the aircraft. This led to Nav unable RNP EICAS cautions followed by Terr Pos EICAS caution. Both ECL checklists actioned. DME updating selected and Navigation performance restored. The GPS both returned to normal operation after approximately 25 minutes. Suspect GPS jamming.

Entering Northern Iranian airspace we experienced repeated ADS-B OUT EICAS ADVISORY messages, QRH actions followed and transponder changed, but advisories persisted for approx 12 minutes. This is a common event in this area and probable cause is GPS jamming.

In cruise at FL370 over waypoint REBLO on airway P130 started at 2250z. Started in Turkish FIR, ADS-B OUT L EICAS message received and checklist actioned. Same status message. Inertial displayed on ND. Event lasted 20 mins before GPS recovered and displayed on ND. Lasted until Baku FIR

On Dep from BEY, throughout climb until north of Cyprus, multiple NAV fm/gps pos disagree and multiple GPS 1 faults. All transient, no apparent map shift occurred. Transient faults self clearing but numerous and distracting.

Over the Eastern part of Mediterranean, from Nicosia Airspace entering into Cairo Airspace. EICAS ADS-B OUT L msg with associated status, QRH actioned. GPS lost, "Inertial" displayed on ND. GPS signal then intermittently lost for next 20 mins all the way through Cairo Airspace & Amman Airspace. GPS signal returned on entry into Saudi Airspace, no further recurrence during flight.

From approximately 15nm until landing on Rwy 05C at CAI, GPS interference occurred. GPS updating was lost a number for of times for a few seconds before returning.
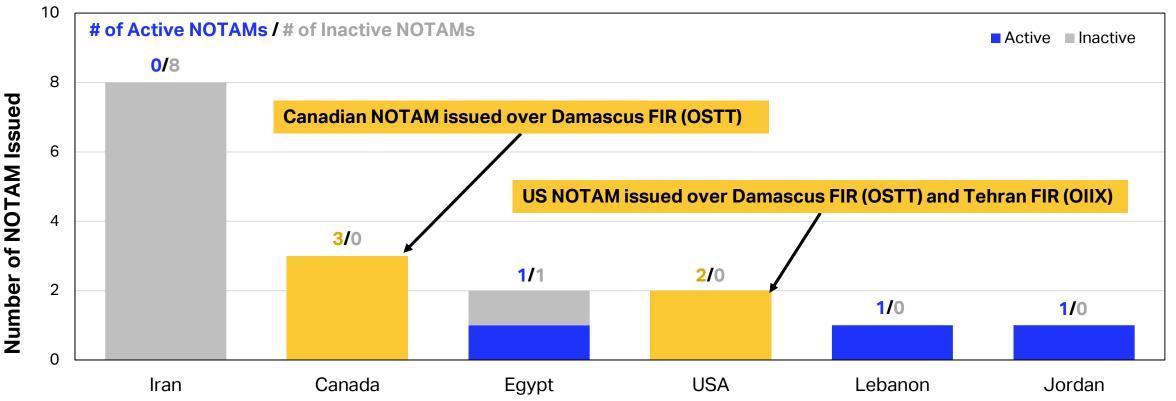
Number of Received Reports in Other Regions

By States	Reports
United States	6
Russia	5
China	3
United Kingdom	2
Greece	2
Indonesia	2
Hungary	1
France	1
Slovakia	1
Mexico	1
Portugal	1
Pakistan	1
Total	**26**

By FIR	Reports	By FIR	Reports
Los Angeles (KZLA)	3	San Juan (TJZS)	1
Moscow (UUWV)	2	Paris (LFFF)	1
Athens (LGGG)	2	Lahore (OPLR)	1
London EGTT	2	Mexico (MMFR)	1
Beijing (ZBPE)	2	Budapest (LHCC)	1
Jakarta (WIIF)	2	Wuhan (ZHWH)	1
Rostov-Na-Donu (URRV)	2	Lisboa (LPPC)	1
New York (KZNY)	1	Bratislava (LZBB)	1
Seattle (KZSE)	1	Paint Petersburg (ULLL)	1

There are not enough GNSS/GPS interference reports collected in GADM database outside of MENA region to derive any meaningful conclusion.

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GNSS/GPS Interference NOTAM Issued in MENA

GNSS/GPS Interference NOTAMs issued by <u>MENA States</u> from 2020-06 to 2020-09

NOTAM Status (active vs inactive) as per September 30th, 2020

In MENA and neighboring States, 17 NOTAMs were issued. Among them, 8 NOTAMs were active as of September 30th.

GNSS/GPS Interference Report and NOTAM

"ANSP must be prepared to act when anomaly reports from aircraft or ground-based units suggest signal interference. If an analysis concludes that interference is present, ANS providers must identify the area affected and issue an appropriate NOTAM."

RASG-MID Safety Advisory -14, Chapter 6. Reporting.

List of FIRs of MENA States with GNSS/GPS interference reported in GADM Incident Database.

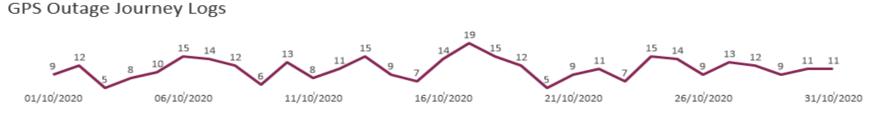| FIR	ORBB	OIIX	HECC	OLBB	OJAC	OEJD	DTTC	OMAE
States	Iraq	Iran	Egypt	Lebanon	Jordan	Saudi Arabia	Tunis	UAE
# of Reports	382	47	24	20	19	3	1	1
NOTAM issued	No	Yes	Yes	Yes	Yes	No	No	No
NOTAM ID		A3484/20	A0322/20 (HECA)	A0064/20 (OLBA)	A0243/20			
NOTAM Status		Inactive	Active	Active	Active			

FIRs with significant number of GNSS/GPS interference reports in RASG-MID are: ORBB, OIIX, HECC, OLBB and OJAC.

Among them, HECC, OLBB and OJAC had active GNSS/GPS Interference NOTAMs issued. OIIX had NOTAMs issued, but they were inactive as per September 2020. ORBB <u>DID NOT</u> have any active/inactive NOTAMs warning about GNSS/GPS interference.

One operator GPS Jamming

Total Number of
GPS Outage
Journey Logs
Received: **340**

GPS Outage Journey Logs

Top 10 FIRs with GPS Outage Journey Logs

FIR	JL Count	%
	270	100%
Amman FIR	6	1%
Ankara FIR	243	35%
Baghdad FIR	248	36%
Beirut FIR	5	1%
Bratislava	4	1%
Bucharest	5	1%
Budapest	4	1%
Damascus FIR	153	22%
Tehran FIR	6	1%
Others	**12**	**2%**

Reported GPS Outage per 1000 flights

AC_IATA_CODE	Reported Flights
	31
77W	47
77L	43
77X	30
788	28
320	25
33X	23
359	17
351	13

Reported GPS Outage per 1000 flights

AC_REG	Reported Flights	J
	31	
A7-BEU	137	
A7-BAJ	122	
A7-BBH	114	
A7-BAL	110	
A7-BAW	100	
A7-AHI	98	
A7-BED	92	
A7-BAC	91	
-	87	
A7-BER	79	
A7-BAB	76	
A7-AHU	75	
A7-BEI	74	
A7-BEB	69	
A7-BBB	68	
A7-BEN	68	
A7-ANR	67	
A7-BAK	66	
A7-BAQ	65	
A7-AHP	65	
A7-BAG	65	
A7-BAY	64	

Reported GPS Outage per 1000 flights

SECTOR	Reported Flights	J
	31	
CDG-DOH	144	
DOH-FRA	135	
FRA-DOH	132	
DOH-LHR	127	
DOH-MAD	123	
LHR-DOH	120	
DOH-ZAZ	118	
DOH-CDG	113	
MAD-DOH	106	
DOH-MST	94	
LGG-DOH	94	
MUC-DOH	83	
AMS-DOH	82	
MAN-DOH	76	
DOH-LUX	73	
MST-DOH	65	
OSL-DOH	65	
DOH-SAW	63	
SAW-DOH	62	
DOH-MUC	61	
DOH-MAN	61	
MXP-DOH	58	

2 December 2020

Another Operator

3047 Reports Jan 2019-Feb.2020

2 December 2020

Thank you

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