

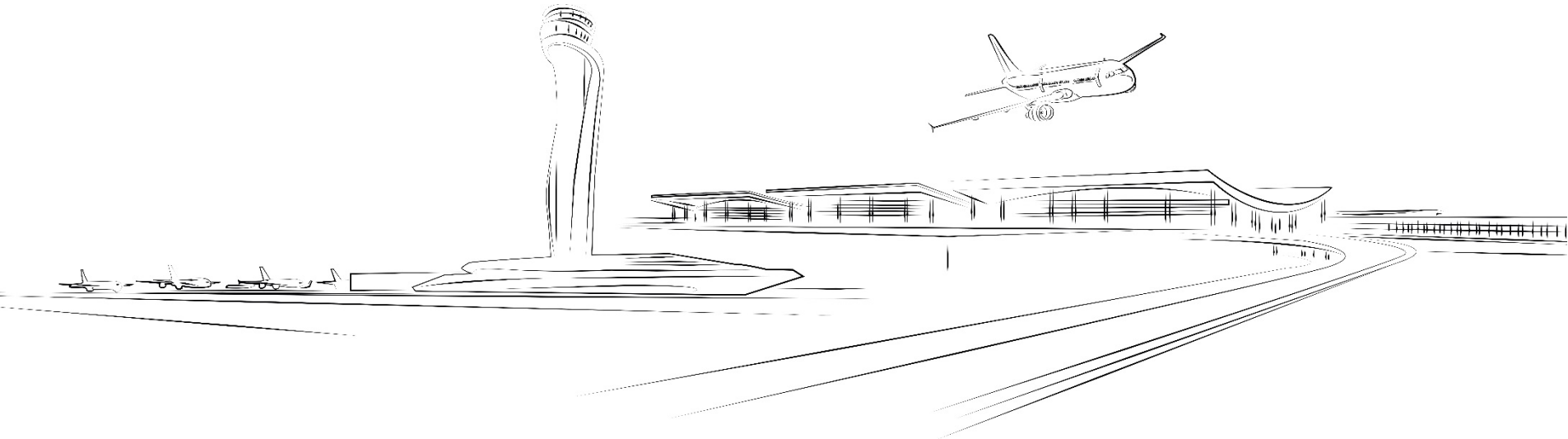


STATE AIRPORTS AUTHORITY of TÜRKİYE
AIR NAVIGATION SERVICE PROVIDER
(DHMI)



Preventive Mechanism: DME-DME
Applications in Türkiye

Ufuk ŞAN





Preventive Mechanism: DME-DME Applications in Türkiye



Overview

- ❖ Preventive Mechanism: DME – DME Navigation
- ❖ DME-DME Applications in Türkiye
- ❖ A Realized Application: Van Airport
- ❖ Second Application : Gaziantep Airport
- ❖ Future Perspective



Preventive Mechanism: DME-DME



Preventive mechanisms : DME – DME Navigation:

State Responsibilities: ICAO ANC/12:

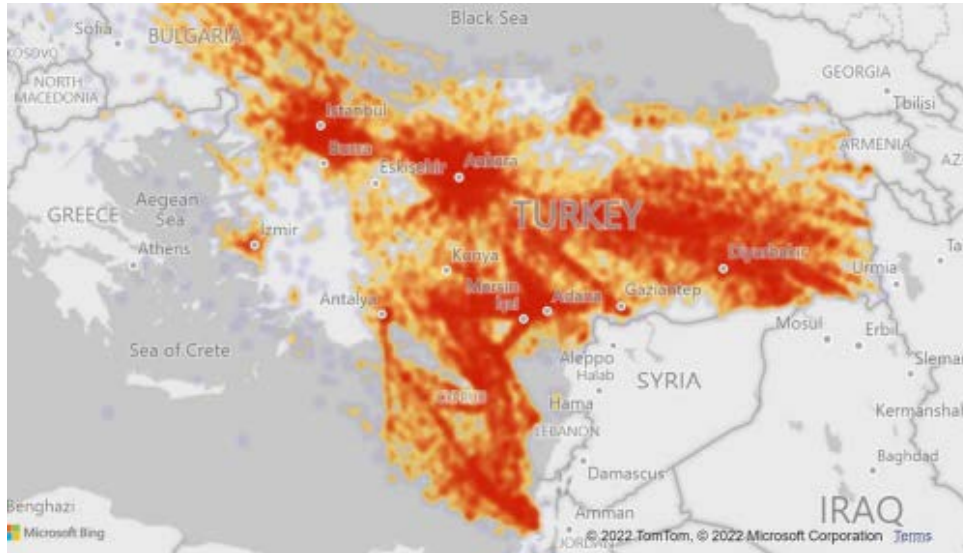
Recommendation 6/8 – Planning for mitigation of global navigation satellite system vulnerabilities That States:

....

f) where it is determined that terrestrial aids are needed as part of a mitigation strategy, give priority to retention of distance measuring equipment (DME) in support of inertial navigation system (INS)/DME or DME/DME area navigation, and of instrument landing system at selected runways.



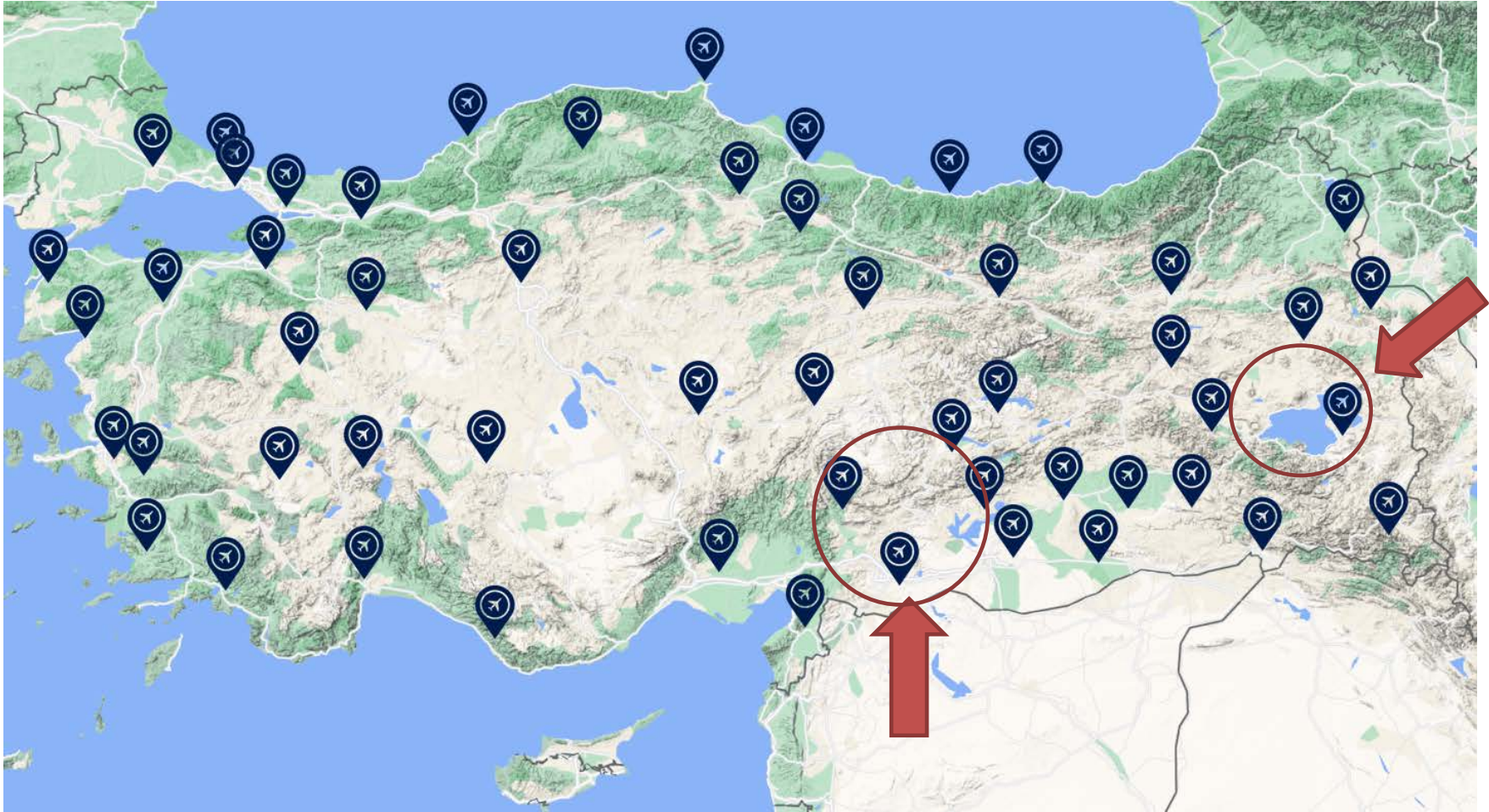
GPS Outages in the Region



- As seen in the above picture there are lots of GPS problem especially in the South East and middle of the country.
- That's why we have selected these two airports, **Van and Gaziantep** in the region as pilot Project of DME-DME navigation procedure as complementary to the present aids.



Van and Gaziantep Airports





Geography of Van Ferit Melen Airport



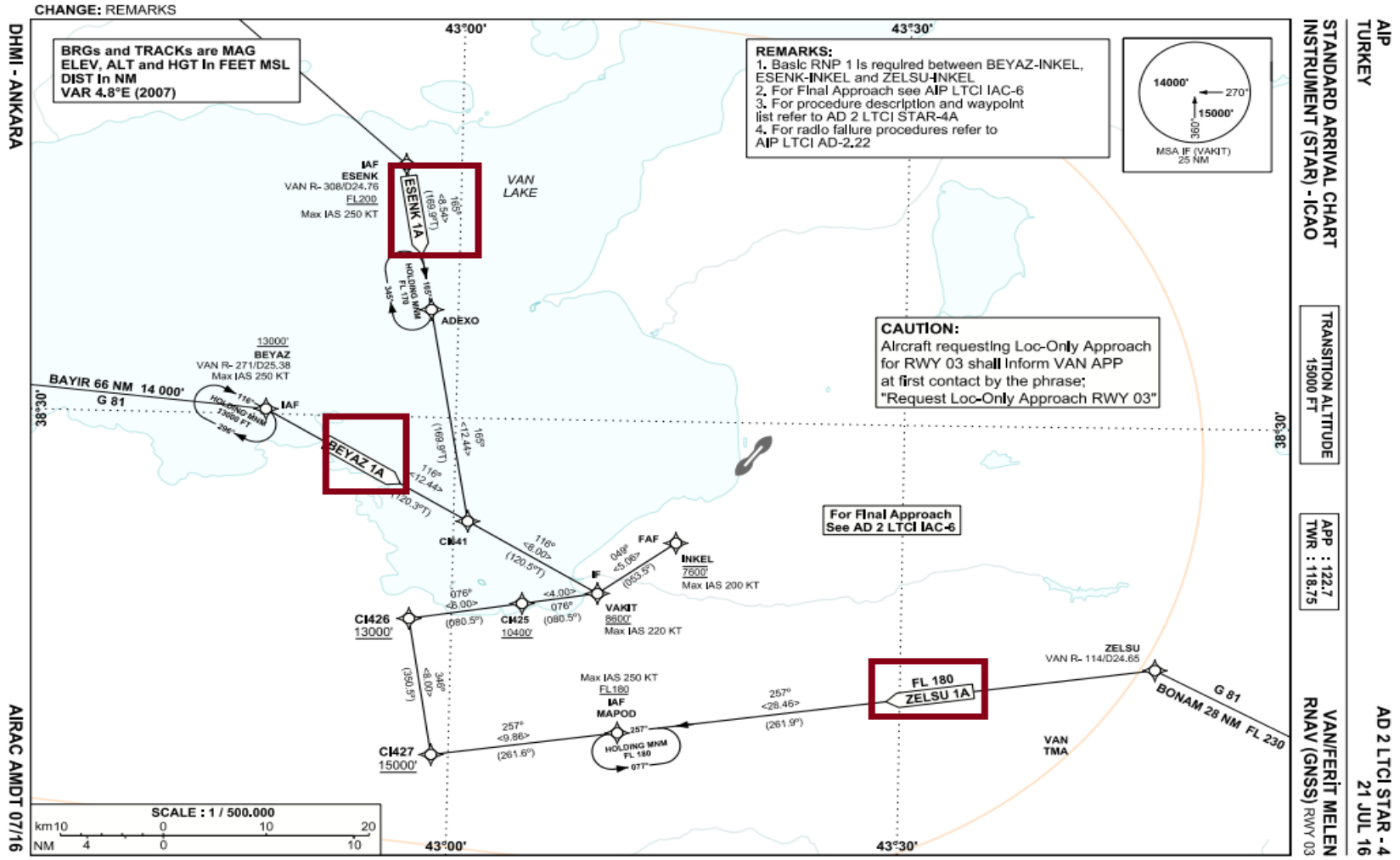
Some of the highest mountains in Türkiye are located in the South part of Van Ferit Melen Airport.

Elevation of the airport is : 1670 m





Van Ferit Melen Airport





Van Ferit Melen Airport





Van Ferit Melen Airport



Firstly, ESENK 1A, BEYAZ 1A and ZELSU 1A procedures were created on DEMETER. At the beginning, there was a DME (Id name: Van) in this area. In order to obtain satisfactory results, two more DMEs (DME-1 and DME-2) were created. Then, simulation was runned.

AD 2 LTCA STAR-4A
14 NOV 13

AIP
TURKEY

VAN AIRPORT RNAV (GNSS) APCH PROCEDURE DESCRIPTIONs for RWY 03

A- RNAV (GNSS) ARRIVAL PROCEDURE

| Name | Path descriptor | Waypoint name | Flyover | Course °M (°T) | Turn direction | Altitude (Ft) | Speed limit (IAS) | Navigation performance |
|----------|-----------------|---------------|---------|----------------|----------------|---------------|-------------------|------------------------|
| BEYAZ 1A | IF | BEYAZ | --- | --- | --- | + 13000 | 250- | RNP 1 |
| | TF | CI641 | --- | 116 (120.3) | --- | --- | --- | RNP 1 |
| | TF | VAKIT | --- | 116 (120.5) | L | +8600 | 220- | RNP 1 |
| | TF | INKEL | --- | 049 (053.5) | L | 7600 | 200- | RNP 1 |

B- RNAV (GNSS) ARRIVAL PROCEDURE

| Name | Path descriptor | Waypoint name | Flyover | Course °M (°T) | Turn direction | Altitude (Ft) | Speed limit (IAS) | Navigation performance |
|----------|-----------------|---------------|---------|----------------|----------------|---------------|-------------------|------------------------|
| ESENK 1A | IF | ESENK | --- | --- | --- | +FL200 | 250- | RNP 1 |
| | TF | ADEXO | --- | 165 (169.9) | --- | --- | --- | RNP 1 |
| | TF | CI641 | --- | 165 (169.9) | L | --- | --- | RNP 1 |
| | TF | VAKIT | --- | 116 (120.5) | L | +8600 | 220- | RNP 1 |
| | TF | INKEL | --- | 049 (053.5) | L | 7600 | 200- | RNP 1 |



Van Ferit Melen Airport





Van Ferit Melen Airport



EPSG:4326 - WGS 84 1:647,983

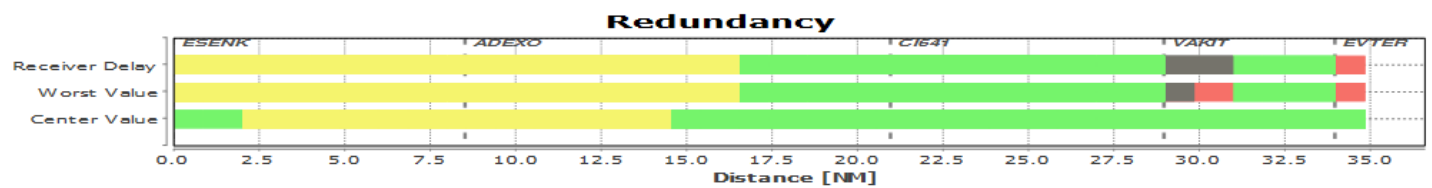
Procedure Performance #1

Procedure Performance

Redundancy legend

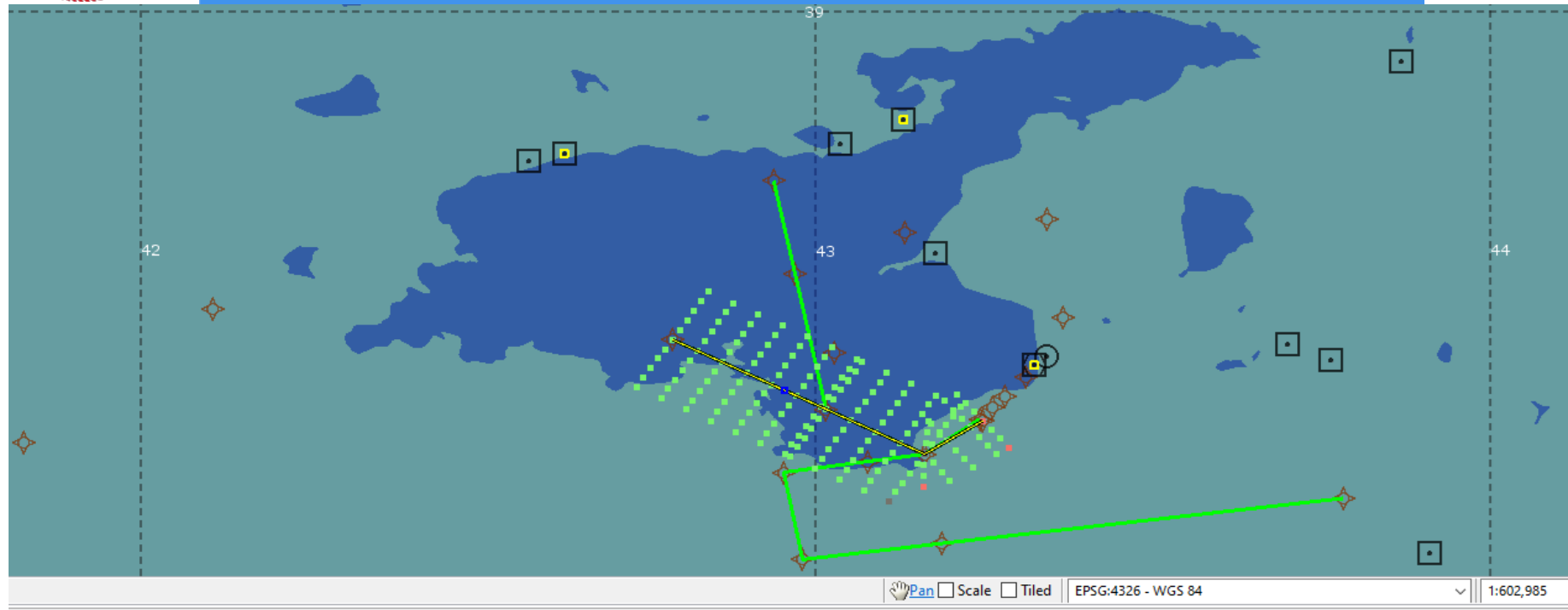
- No Coverage
- No Redundancy
- Limited Redundancy
- Full Redundancy
- High Redundancy

Redundancy information





Van Ferit Melen Airport



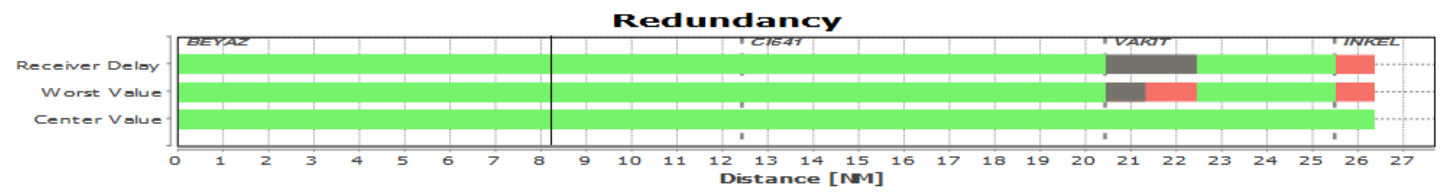
Procedure Performance #1

Procedure Performance

Redundancy legend

- No Coverage
- No Redundancy
- Limited Redundancy
- Full Redundancy
- High Redundancy

Redundancy information



Continuity Information



Van Ferit Melen Airport



Determinations of DME Locations



Van Ferit Melen Airport

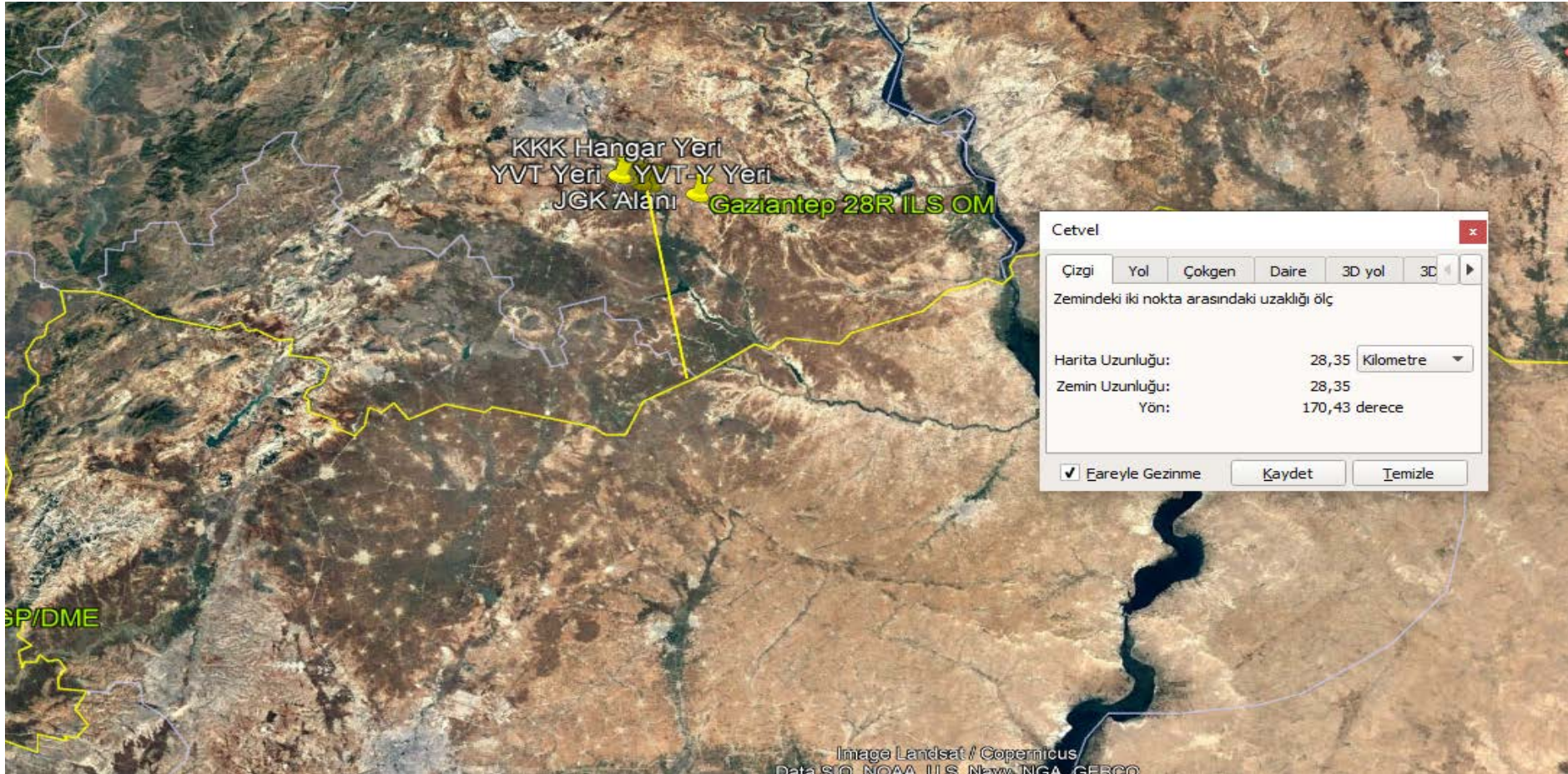




Second Application: Gaziantep Airport

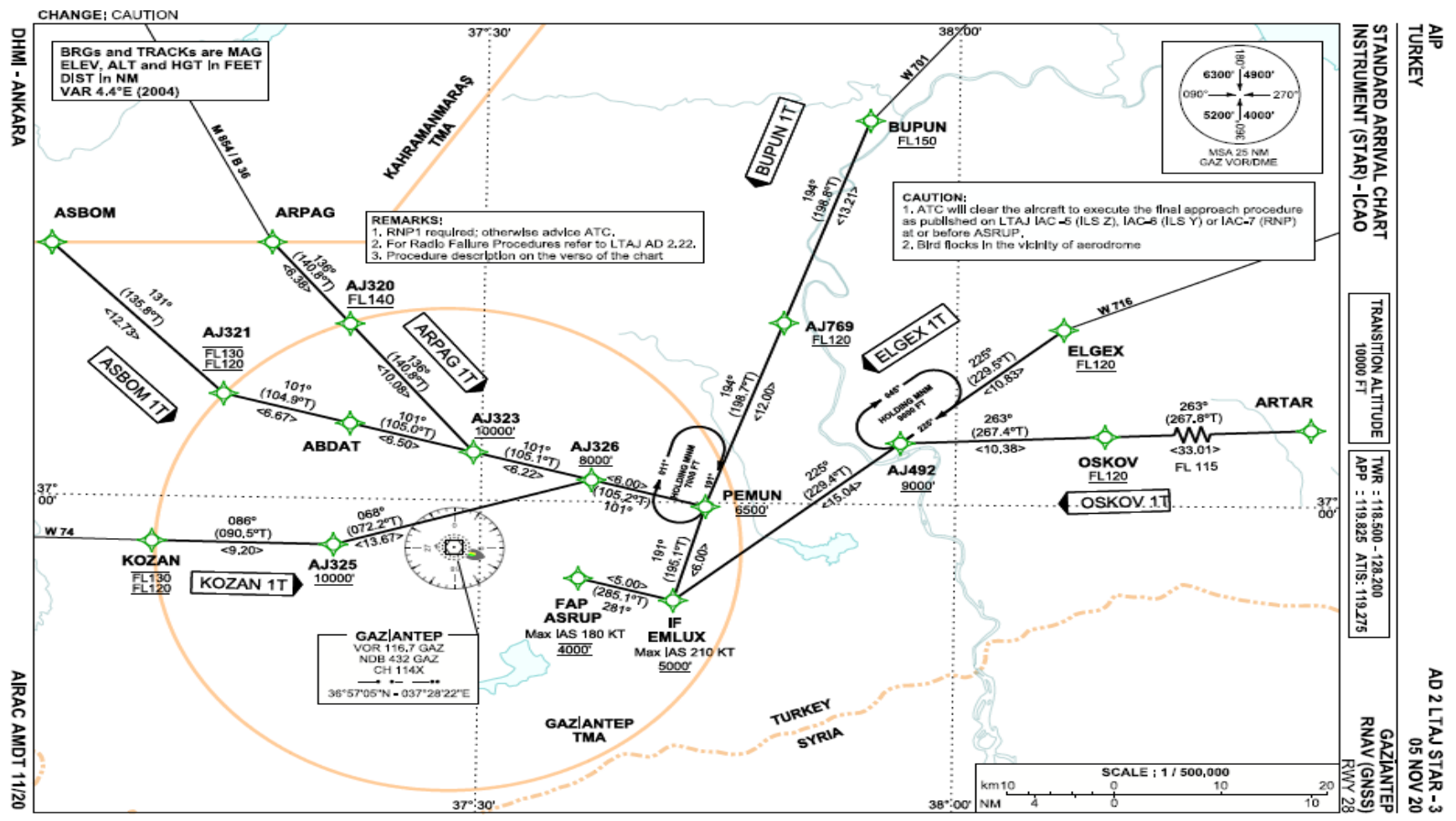


Gaziantep Airport is close to Syria border.





Gaziantep Airport





Gaziantep Airport



Waypoints on STAR-3 were defined one by one. Each procedure was implemented and result of each procedure analyzed.

| Type | Fix identifier (Waypoint name) | Latitude | Longitude |
|-------|--------------------------------|---------------|----------------|
| FlyBy | ABDAT | 37:04:39.42 N | 037:21:37.77 E |
| FlyBy | AJ320 | 37:10:47.72 N | 037:21:31.15 E |
| FlyBy | AJ321 | 37:08:22.97 N | 037:13:34.78 E |
| FlyBy | AJ323 | 37:02:57.92 N | 037:29:28.38 E |
| FlyBy | AJ325 | 36:57:09.67N | 037:20:43.84E |
| FlyBy | AJ326 | 37:01:20.27N | 037:36:58.54E |
| FlyBy | AJ492 | 37:03:47.06N | 037:56:29.29E |
| FlyBy | AJ769 | 37:11:08.66N | 037:49:00.99E |
| FlyBy | ARPAG | 37:15:45.00 N | 037:16:28.00 E |

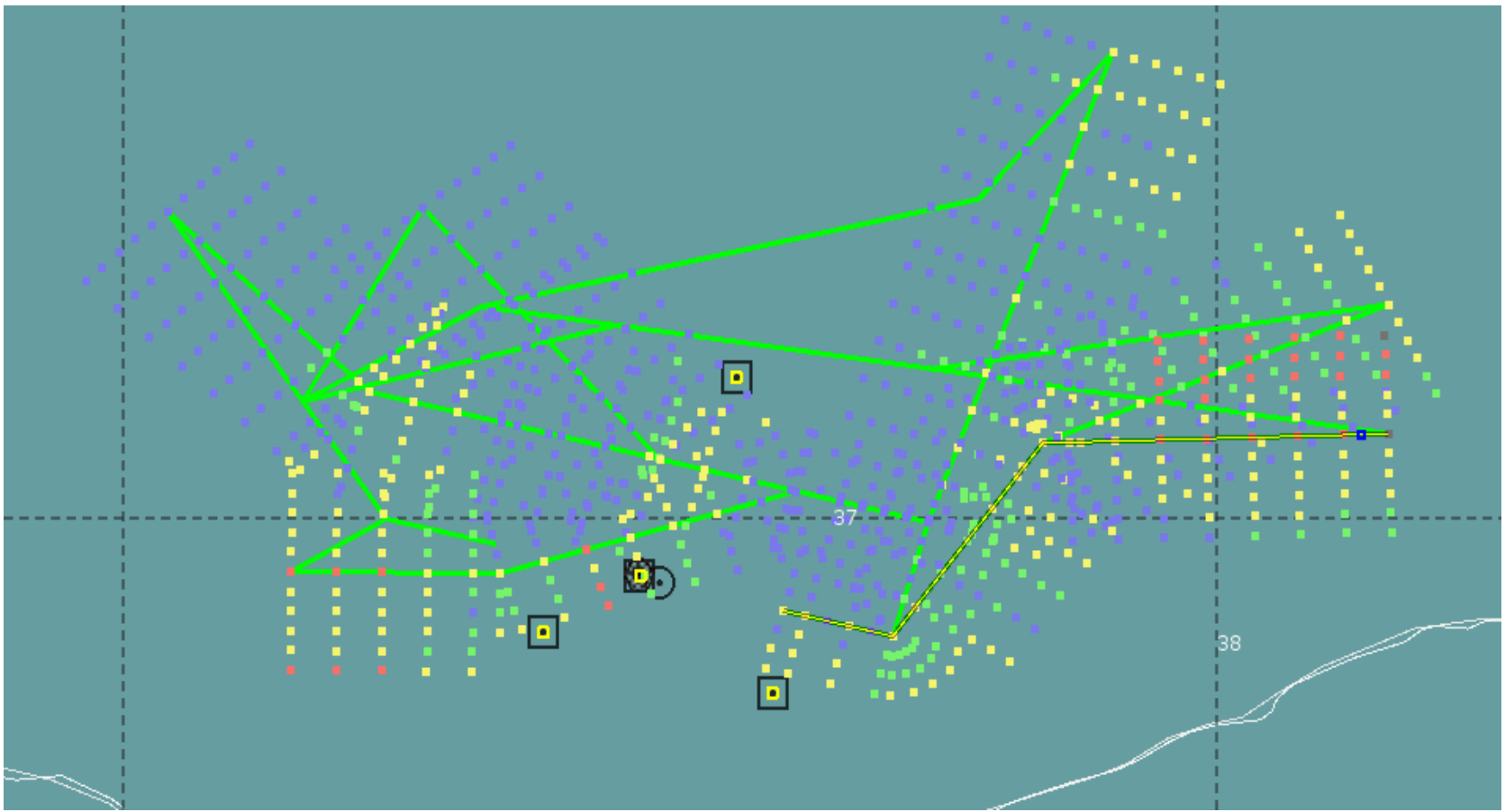
| Type | Fix identifier (Waypoint name) | Latitude | Longitude |
|-------|--------------------------------|--------------|---------------|
| FlyBy | ASBOM | 37:15:32.00N | 37:02:29.00 E |
| FlyBy | ASRUP | 36:55:15.79N | 037:36:14.02E |
| FlyBy | BUPUN | 37:23:40.01N | 037:54:20.23E |
| FlyBy | ELGEX | 37:10:50.32N | 038:06:46.25E |
| FlyBy | EMLUX | 36:53:57.56N | 037:42:15.27E |
| FlyBy | KOZAN | 36:57:15.00N | 037:09:15.00E |
| FlyBy | OSKOV | 37:04:15.85N | 038:09:26.95E |
| FlyBy | PEMUN | 36:59:45.64N | 037:44:12.35E |



Gaziantep Airport

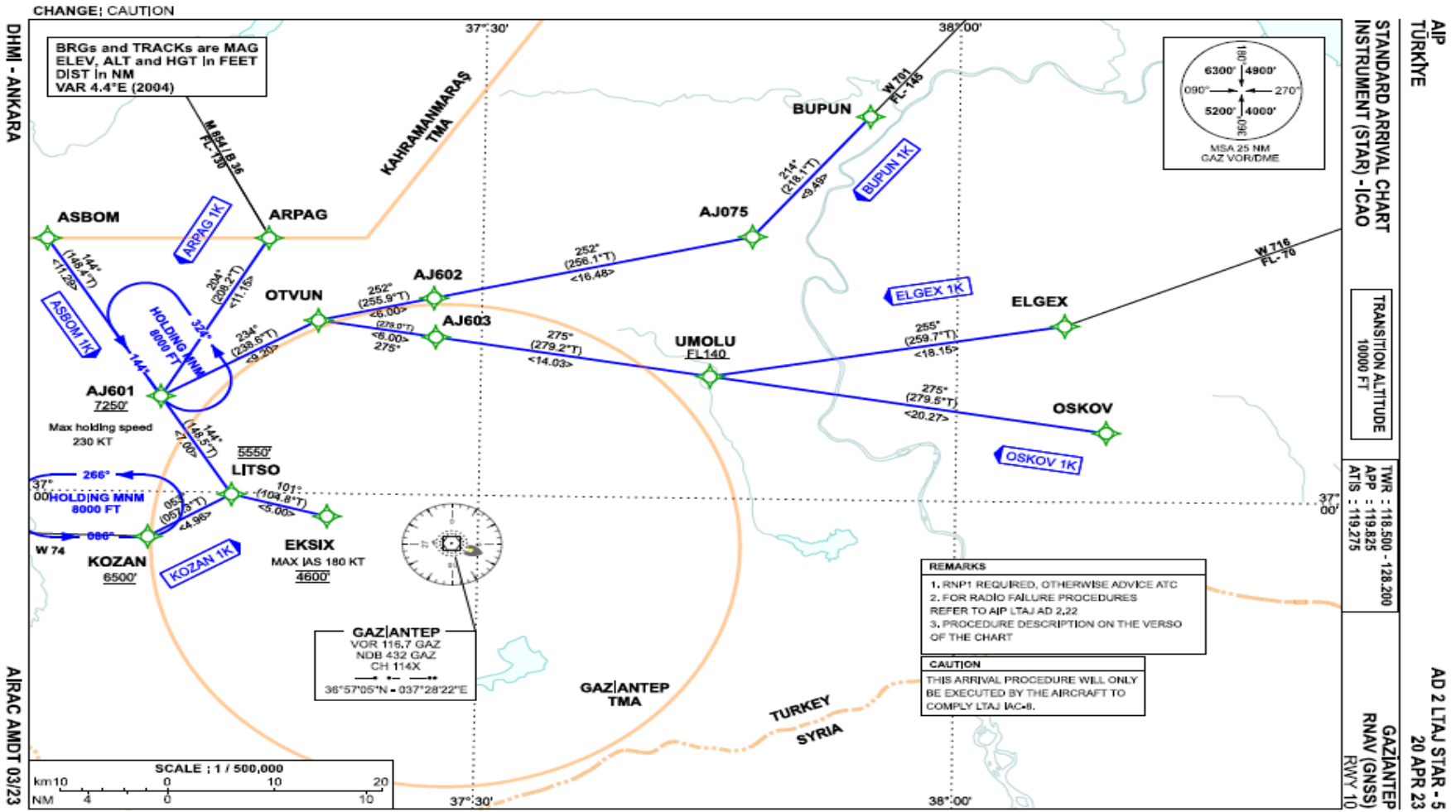


All procedures in STAR-3 for Gaziantep Airport were created and the result is:





Gaziantep Airport



| | | | | |
|---------------|--|---------------------------------|--|--------------------------------|
| AIP TURKYE | STANDARD ARRIVAL CHART INSTRUMENT (STAR) - ICAO | TRANSITION ALTITUDE 10000 FT | TWR : 116.500 - 126.200 APP : 119.825 ATIS : 119.275 | AD 2LTAJ STAR - 5 20 APR 23 |
| | | | GAZ/ANTEP RNAV (GNSS) RWY 10 | |

DHMI - ANKARA

AIRAC AMDT 03/23



Gaziantep Airport



Waypoints on STAR-5 were defined one by one. Each procedure was implemented and result of each procedure analyzed.

| Type | Fix identifier (Waypoint name) | Latitude | Longitude |
|-------|--------------------------------------|---------------|---------------|
| FlyBy | ASBOM | 37:15:32.00N | 037:02:29.00E |
| FlyBy | ARPAG | 37:15:45.00N | 037:16:28.00E |
| FlyBy | BUPUN | 37:23:40.01N | 037:54:20.23E |
| FlyBy | OSKOV | 37:04:15.85 N | 38:09:26.95 E |
| FlyBy | ELGEX | 37:10:50.32N | 038:06:46.25E |
| FlyBy | KOZAN | 36:57:15.00 N | 37:09:15.00 E |
| FlyBy | UMOLU | 37:07:33.31N | 037:44:26.49E |

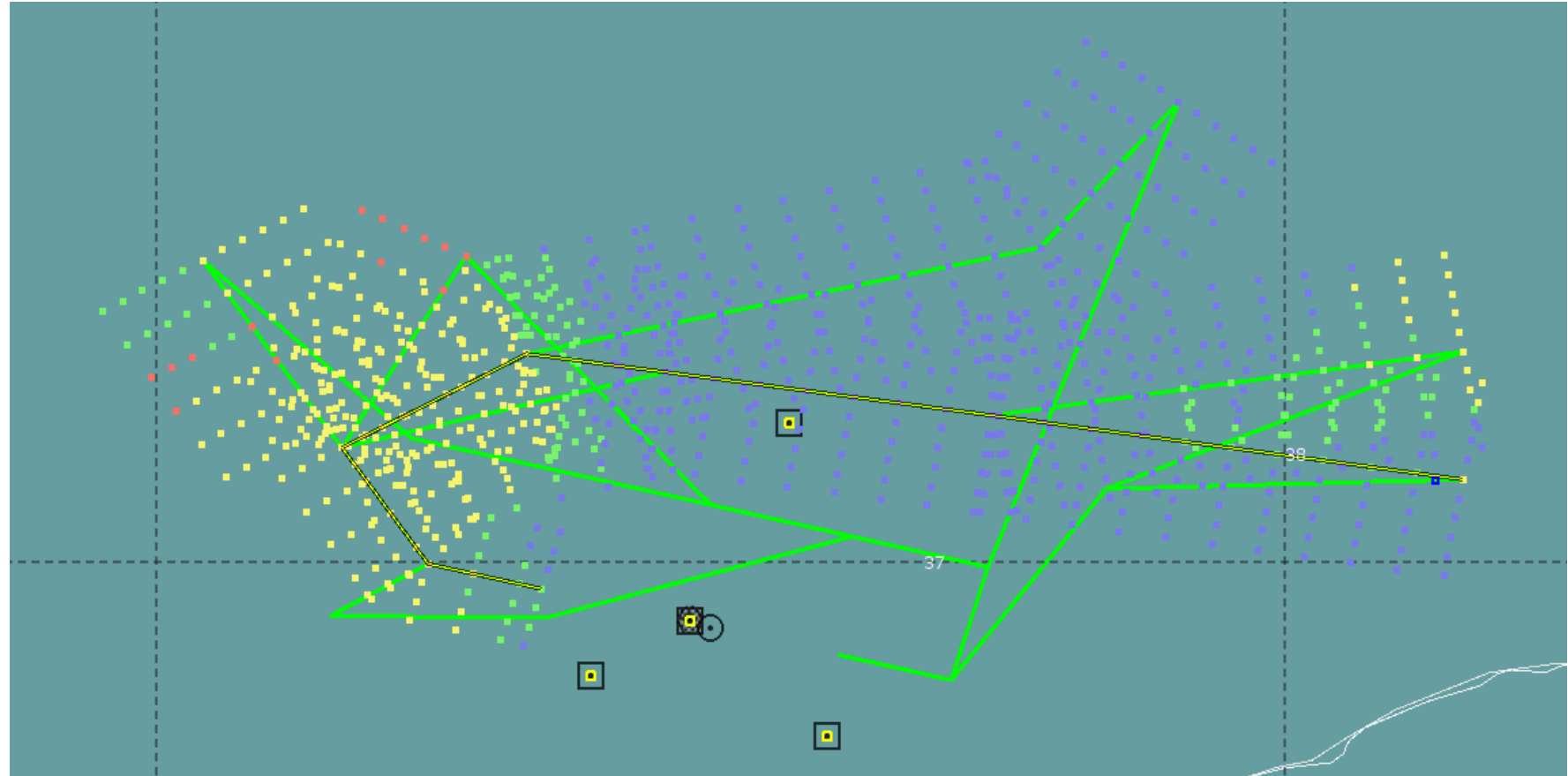
| Type | Fix identifier (Waypoint name) | Latitude | Longitude |
|-------|--------------------------------------|---------------|---------------|
| FlyBy | AJ601 | 37:05:54.36N | 037:09:52.91E |
| FlyBy | AJ075 | 37:16:11.44N | 037:46:59.66E |
| FlyBy | AJ602 | 37:12:11.45N | 037:26:58.58E |
| FlyBy | AJ603 | 37:09:46.88N | 037:27:06.63E |
| FlyBy | OTVUN | 37:10:43.22N | 037:19:41.67E |
| FlyBy | LITSO | 36:59:55.86N | 037:14:27.26E |
| FlyBy | EKSIX | 36:58:38.75 N | 37:20:29.21 E |



Gaziantep Airport



All procedures in STAR-5 for Gaziantep Airport were created and the result is:





Coordination During Flight Checks



- Before the all flight inspections of our NAVAIDs equipments, in order to prevent, at least minimize the adverse effects of possible interference sources which may cause unintentional GPS outages, we contact in advance by correspondence to relevant authorities and system operators for critical regions in Türkiye.
- However in some regions we are not able to maintain stable GPS signals as the interfering sources are located out of country borders.



Future Perspective



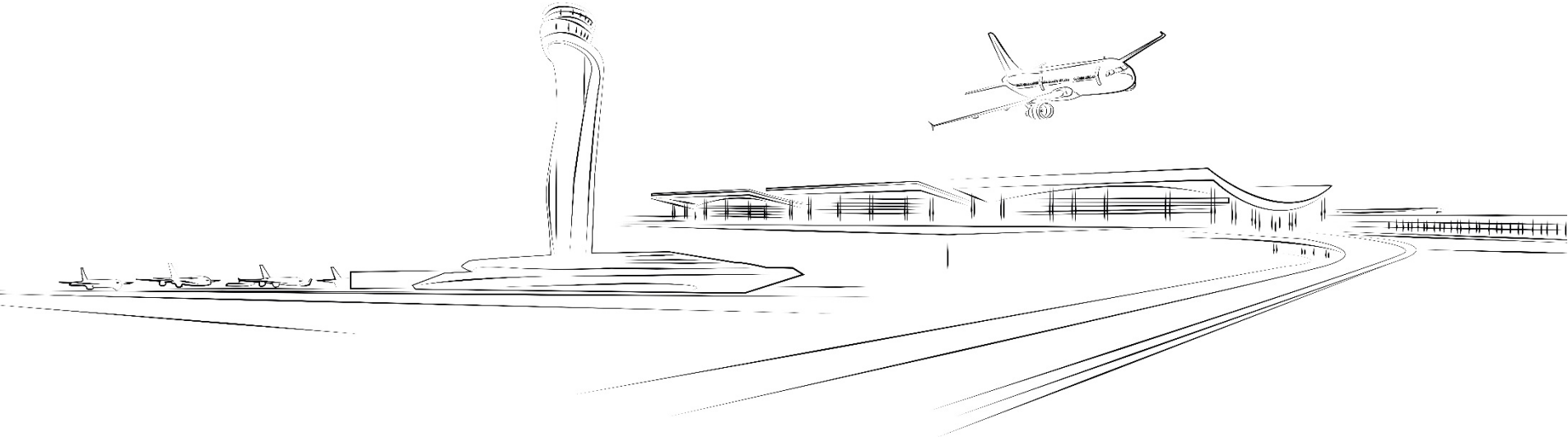
In conclusion, the rising concern of GNSS outages, particularly GPS spoofing, demands a harmonised, collaborative, and holistic approach to monitoring and safeguarding navigation systems.

Civil-military coordination, enhanced cooperation among states and stakeholders, and the implementation of countermeasures are essential steps in mitigating the impact of GNSS outages.



Thank You

Questions?



ICAO EUR/MID Radio Navigation Symposium, Antalya, 6-8 February 2024