The new ADS–B based aircraft avoidance system at the MLRO

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The Matera Laser Ranging Observatory (MLRO) has been equipped since the beginning with a pulsed radar aircraft avoidance system.

We have added redundancy in the safety subsystem by means of the integration of a new aircraft avoidance system based on the ADS–B technology.
Due to the difficulty in obtaining the position of aircrafts flying far from ground based pulsed radar systems, international air traffic control authorities are supporting the use of virtual radar systems with GPS-based technology. The ADS–B (Automatic Dependent Surveillance – Broadcast) technology allows for a continuous information transmission between aircraft and ground stations.
Advantages

- Improved safety
  - Info available to pilots as well
  - Increased aircraft range

- New services
  - Meteo info
  - Maps
  - Pilots know their position relative to nearby aircraft

- Cheaper ground stations
Main international programs

• **NextGen** (*Next Generation Air Transportation System*), FAA

• **SESAR** (*Single European Sky ATM Research*), Eurocontrol

Eurocontrol decided that all new aircrafts from January 2015 on shall carry a ADS–B based transmitter. Older aircraft shall comply from December 2017.
ADS–B communication system
RadarBox (AirNav Systems)
Antenna and amplifier

**Antenna GP-1090**

<table>
<thead>
<tr>
<th>Spec</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwith</td>
<td>1070 - 1110 MHz</td>
</tr>
<tr>
<td>Gain</td>
<td>5 dB + / - 0.5 dB</td>
</tr>
<tr>
<td>Connector</td>
<td>N-type</td>
</tr>
<tr>
<td>Length</td>
<td>55 cm</td>
</tr>
<tr>
<td>Cable</td>
<td>RG58, 20 mt</td>
</tr>
</tbody>
</table>

**Amplifier AS-1090**

<table>
<thead>
<tr>
<th>Spec</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Bandwidth</td>
<td>1030 - 1090 MHz</td>
</tr>
<tr>
<td>Gain</td>
<td>12 dB</td>
</tr>
<tr>
<td>NF</td>
<td>0.9 dB</td>
</tr>
<tr>
<td>Power supply</td>
<td>12 VDC</td>
</tr>
<tr>
<td>Current</td>
<td>100 mA</td>
</tr>
<tr>
<td>Max input level</td>
<td>+2 dB</td>
</tr>
<tr>
<td>Connector</td>
<td>N-type</td>
</tr>
<tr>
<td>Size</td>
<td>74 x 93 x 45 mm</td>
</tr>
</tbody>
</table>
In case of a low flying aircraft the RadarBox is not reliable due to the 1s period of its «Mode S» transmission; hence it cannot replace the pulsed radar (750 Hz pulse rate) but only complement it. Moreover, any aircraft flying over the MLRO area is not necessarily equipped with such a transmitter (such as Georg’s glider 😊) so at this time it is not yet possible to get rid of the pulsed radar.
### MLRO virtual radar specs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azimuth</td>
<td>$(AZ_{MLRO} - 10^\circ) \leq AZ_{aero} \leq (AZ_{MLRO} + 10^\circ)$</td>
</tr>
<tr>
<td>Elevation</td>
<td>$(EL_{MLRO} - 10^\circ) \leq EL_{aero} \leq (EL_{MLRO} + 10^\circ)$</td>
</tr>
<tr>
<td>Range max</td>
<td>40 Km</td>
</tr>
<tr>
<td>Latency of aircraft position</td>
<td>5 sec</td>
</tr>
<tr>
<td>Latency of MLRO pointing</td>
<td>5 sec</td>
</tr>
</tbody>
</table>
AirNavBox 3D SW

Air Nav radar box

PC CONSOLE (Win XP)

TCP/IP, on port 7879

PC GO/NOGO (linux)

Generates XML datastream on TCP/IP port 7879 containing aircraft LAT/LON coordinates + range aircraft info
Mode-S data packet

<MODESMESSAGE>
  <DATETIME>20130328132800</DATETIME>
  <MODES>390E31</MODES>
  <CALLSIGN>AIZ271</CALLSIGN>
  <ALTITUDE>36000</ALTITUDE>
  <GROUNDSPEED>378</GROUNDSPEED>
  <TRACK>285</TRACK>
  <VRATE>0</VRATE>
  <AIRSPEED>000</AIRSPEED>
  <LATITUDE>40.5656</LATITUDE>
  <LONGITUDE>16.4516</LONGITUDE>
  <SQUAWK>3755</SQUAWK>
</MODESMESSAGE>
MainRangingPanel 2.2 SW
VirtualRadarControl SW

PC GO/NOGO (Linux)

VirtualRadarControl

1) Convert Aircraft LAT/LON = range in X-Y-Z w.r.t. WGS 84
2) Convert X-Y-Z w.r.t. WGS 84 in AZ/EL w.r.t. MLRO site log position
3) Compare Aircraft data w.r.t. MLRO pointing data and generates RANGING STOP CONDITION

udp_client

udp_yyyyymmdd_hh.txt

bash script
verify_udp
verify if connection on port 5000 is active

vrc_alert_yyyyymmdd_hhmmss.txt

bash script
vrc_clean.sh
Clean data file every day, launched by crontab

vrc_status.txt

vrc_log_yyyyymmdd_hh.txt

bash script
verify_term
verify if connection on port 7879 is active

PC CONSOLE (Win XP)

TCP/IP, on port 7879

SW

SW C language

udp client

udp_yyyyymmdd_hh.txt

PC Console

TCP/IP, on port 7879

MLRO HP2 (HP-UX)

TCP/IP, on port 5000

udp MLRO

udp client

udp_yyyyymmdd_hh.txt

bash script
verify_udp
verify if connection on port 5000 is active

vrc_alert_yyyyymmdd_hhmmss.txt

bash script
vrc_clean.sh
Clean data file every day, launched by crontab

vrc_status.txt

vrc_log_yyyyymmdd_hh.txt

bash script
verify_term
verify if connection on port 7879 is active

PC Console

TCP/IP, on port 7879

MLRO CONSOLE (interlock)
Conclusions

- The new ADS–B based aircraft avoidance system has been designed, built and integrated into the MLRO system by e-Geos.
- The new system is currently set up as a backup system in case of main radar system failure.
···ooops····!