

# The new ADS-B based aircraft avoidance system at the MLRO

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# Intro

- 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.



# ADS-B

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

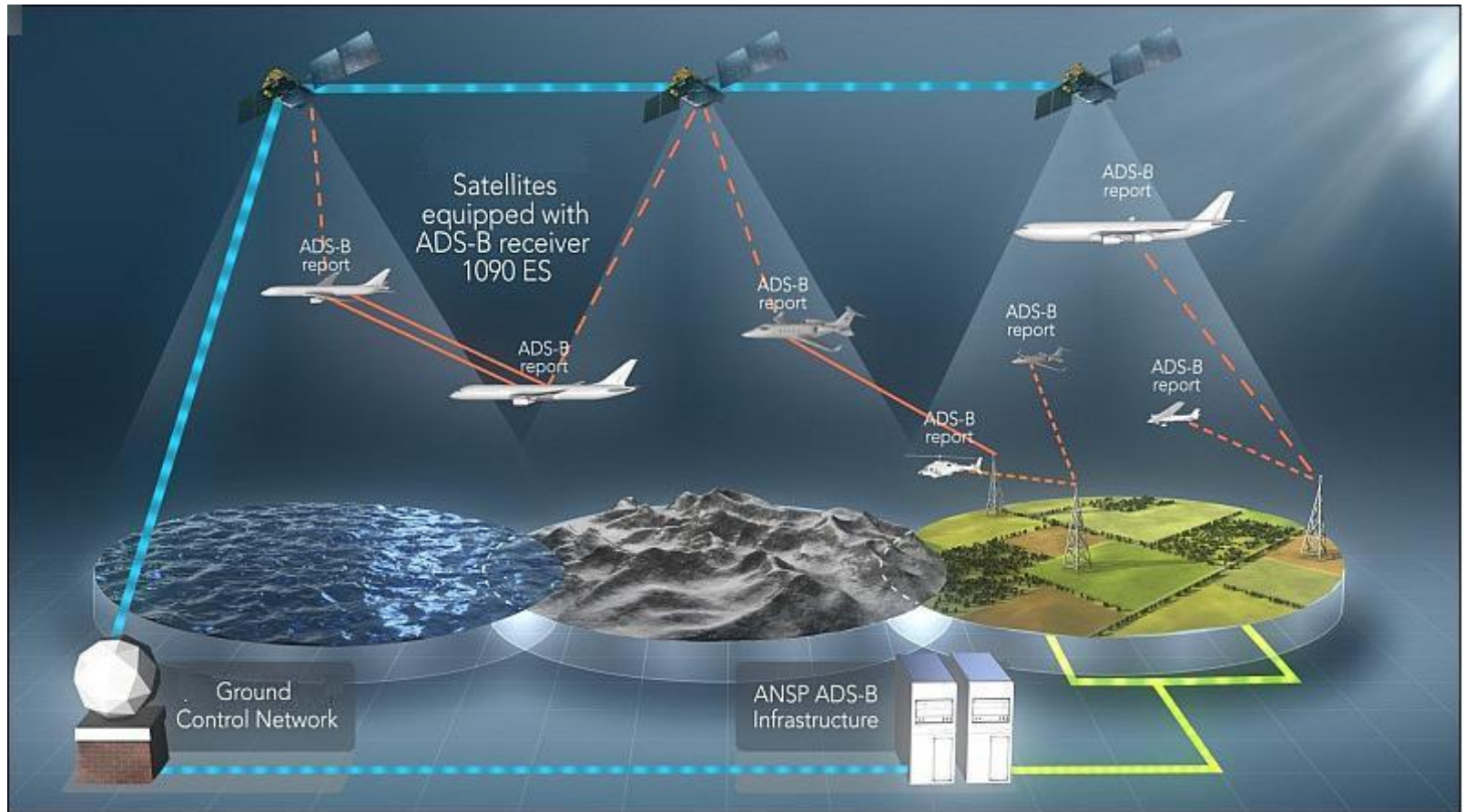
- Improved safety
  - Info available to pilots as well
  - Increased aircraft range
- New services
  - Meteo info
  - Maps
  - Pilots know their position relative to nearby aircraft
- Cheaper ground stations

# 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)

The screenshot displays the AirNav RadarBox 3D software interface. On the left, a table lists flight data with columns for 'Changed', 'Tracked', 'Status', 'Mode S', 'Flight ID', and 'Registration Aircraft'. The main window is divided into three panes: a radar display (center), a 3D terrain view (right), and a flight information panel (bottom left). The radar display shows a map centered on England with various flight paths and aircraft icons. The 3D terrain view shows a 3D perspective of the landscape with aircraft icons and flight paths. The flight information panel shows details for a specific flight, including the aircraft type, registration, and origin/destination.

Changed	Tracked	Status	Mode S	Flight ID	Registration Aircraft
18:00:54	18:00:54	Approach	800087	3A1122	VT-XH B77W
18:00:54	18:00:54	Cruise	80040C	A0C111	
18:00:54	18:00:54	Cruise	860212	3A-406	3A736J B773
18:00:54	18:00:54	Cruise	860340	3A15	
18:00:54	18:00:54	Cruise	88001E	THA-H802	HS-TGR B744
18:00:54	18:00:54	Cruise	88002F	THA-016	HS-TGT B744
18:00:54	18:00:54	Cruise	89402C	GFAD08	
18:00:54	18:00:54	Levelled	89402E	GFAD17	
18:00:54	18:00:54	Cruise	896019	LAC103	A6-40U A330
18:00:54	18:00:54	Cruise	896075	LAC095	A6-EAR A330
18:00:54	18:00:54	Cruise	896078	LAC055	A6-E8B B773
18:00:54	18:00:54	Approach	896071	LAC037	A6-E83 B773
18:00:54	18:00:54	Descent	896003	LAC119	A6-E8L B773
18:00:54	18:00:54	Cruise	896004	LAC050	A6-E84 B773
18:00:54	18:00:54	Cruise	89610A	LAC051	A6-ECC B77W
18:00:54	18:00:54	Landing	89610B	LAC053	A6-ECC B773
18:00:54	18:00:54	Cruise	89610C	LAC030	
18:00:54	18:00:54	Levelled	896117	LAC075	
18:00:54	18:00:54	Cruise	896118	LAC128	
18:00:54	18:00:54	Approach	896119	LAC019	A6-ECT B773
18:00:54	18:00:54	Cruise	89611D	LAC046	
18:00:54	18:00:54	Cruise	89611F	LAC08	
18:00:54	18:00:54	Cruise	89620D	AY1281	
18:00:54	18:00:54	Ground	899004	EWAC11	B-146C B744
18:00:54	18:00:54	Cruise	89900A	EWAC27	B-1671 B773
18:00:54	18:00:54	Cruise	ADK777	LAL887	N117UA B744
18:00:54	18:00:54	Cruise	A11PCL	COA438	N37133 B752
18:00:54	18:00:54	Cruise	A12E71	AA11709	N150AN B752
18:00:54	18:00:54	Cruise	A129A7	AA1120	N150AN B752
18:00:54	18:00:54	Cruise	A1A424	AW15707	N206AW B752
18:00:54	18:00:54	Landing	A2AB4C	LP52904	N270LP ME11
18:00:54	18:00:54	Approach	A2AC03	LP5213	N271LP ME11





# Antenna and amplifier

## Antenna GP-1090

Spec	Value
Bandwith	1070 -1110 MHz
Gain	5dB +/- 0.5 dB
Connector	N-type
Length	55 cm
Cable	RG58, 20 mt



## Amplifier AS-1090

Spec	Vakue
Bandwith	1030 -1090 MHz
Gain	12dB
NF	0.9 dB
Power supply	12 VDC
Current	100 mA
Max input level	+2dB
Connector	N-type
Size	74 x 93 x 45 mm



# Risk scenarios

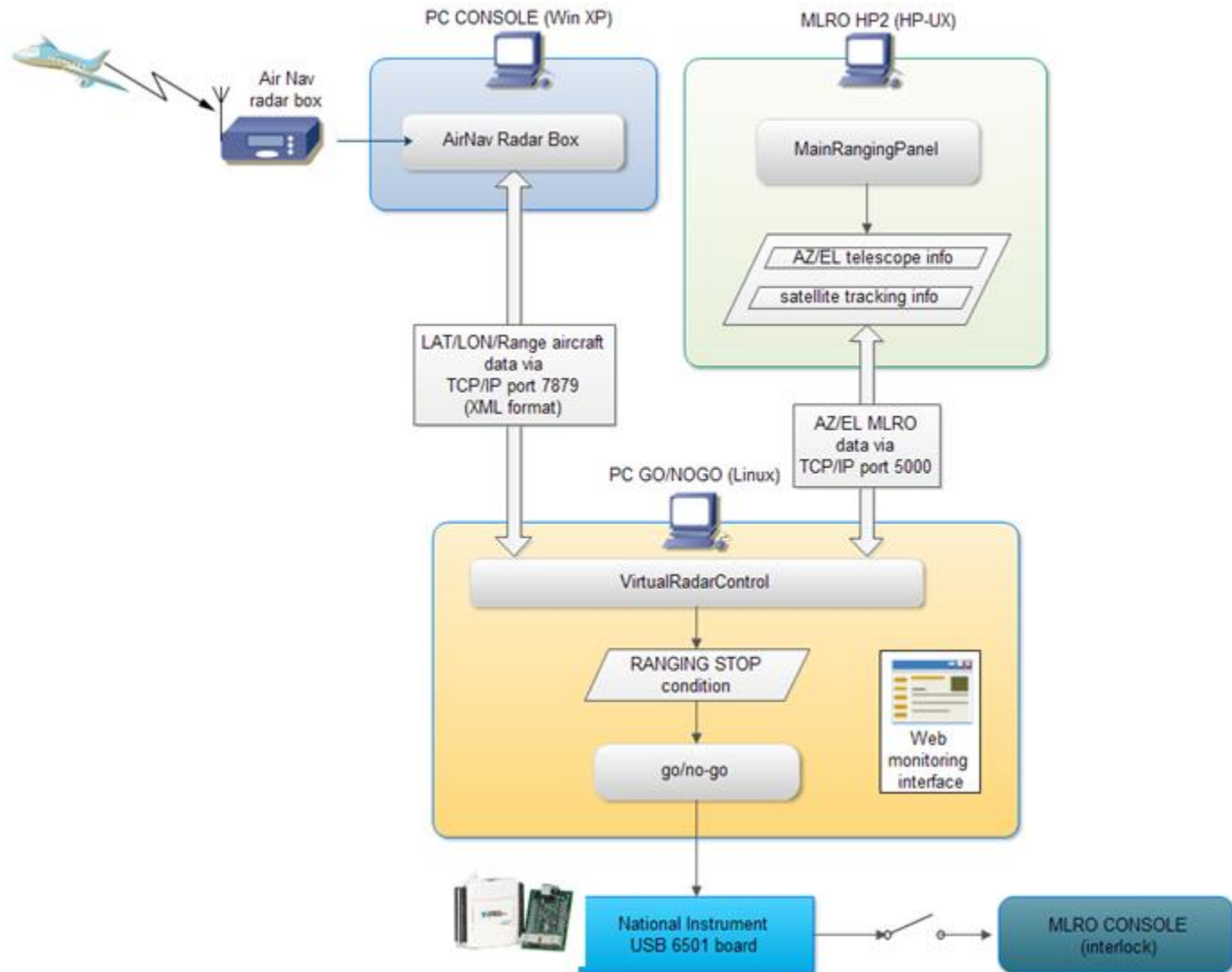
Aircraft	Best case	Worst case
Military	$V_{aereo} = 600 \frac{m}{s} @ 40 km$	$V_{aereo} = 600 \frac{m}{s} @ 300 m$
	$\omega_{aereo} = 0.86 \text{ } \frac{\circ}{s}$	$\omega_{aereo} = 63 \text{ } \frac{\circ}{s}$
Civilian	$V_{aereo} = 220 \frac{m}{s} @ 40 Km$	$V_{aereo} = 220 \frac{m}{s} @ 300 m$
	$\omega_{aereo} = 0.32 \text{ } \frac{\circ}{s}$	$\omega_{aereo} = 36 \text{ } \frac{\circ}{s}$

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.

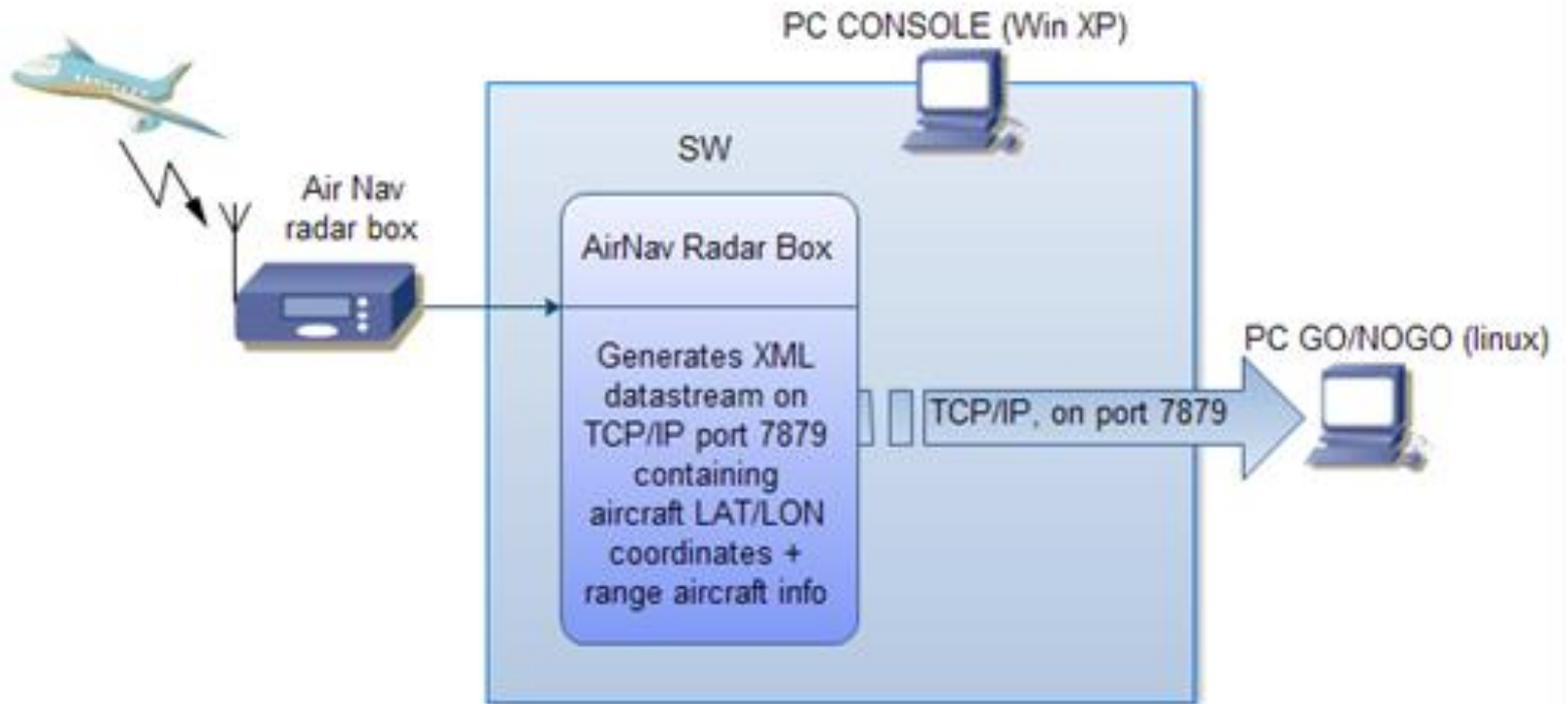
# MLRO virtual radar specs

Parameter	Value
Azimuth	$(AZ_{MLRO} - 10^\circ) \leq AZ_{aereo} \leq (AZ_{MLRO} + 10^\circ)$
Elevation	$(EL_{MLRO} - 10^\circ) \leq EL_{aereo} \leq (EL_{MLRO} + 10^\circ)$
Range max	40 Km
Latency of aircraft position	5 sec
Latency of MLRO pointing	5 sec

# SW Architecture



# AirNavBox 3D SW



# 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>

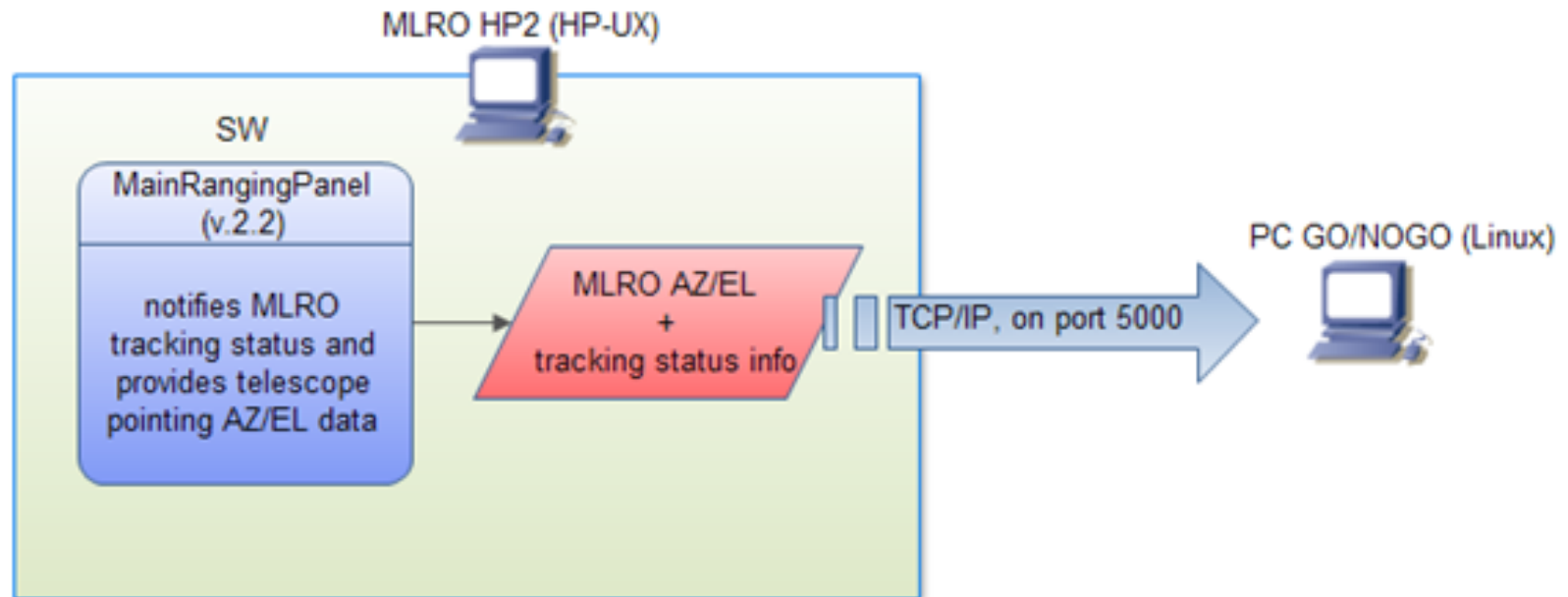
<LATITUDE>40.5656</LATITUDE>

<LONGITUDE>16.4516</LONGITUDE>

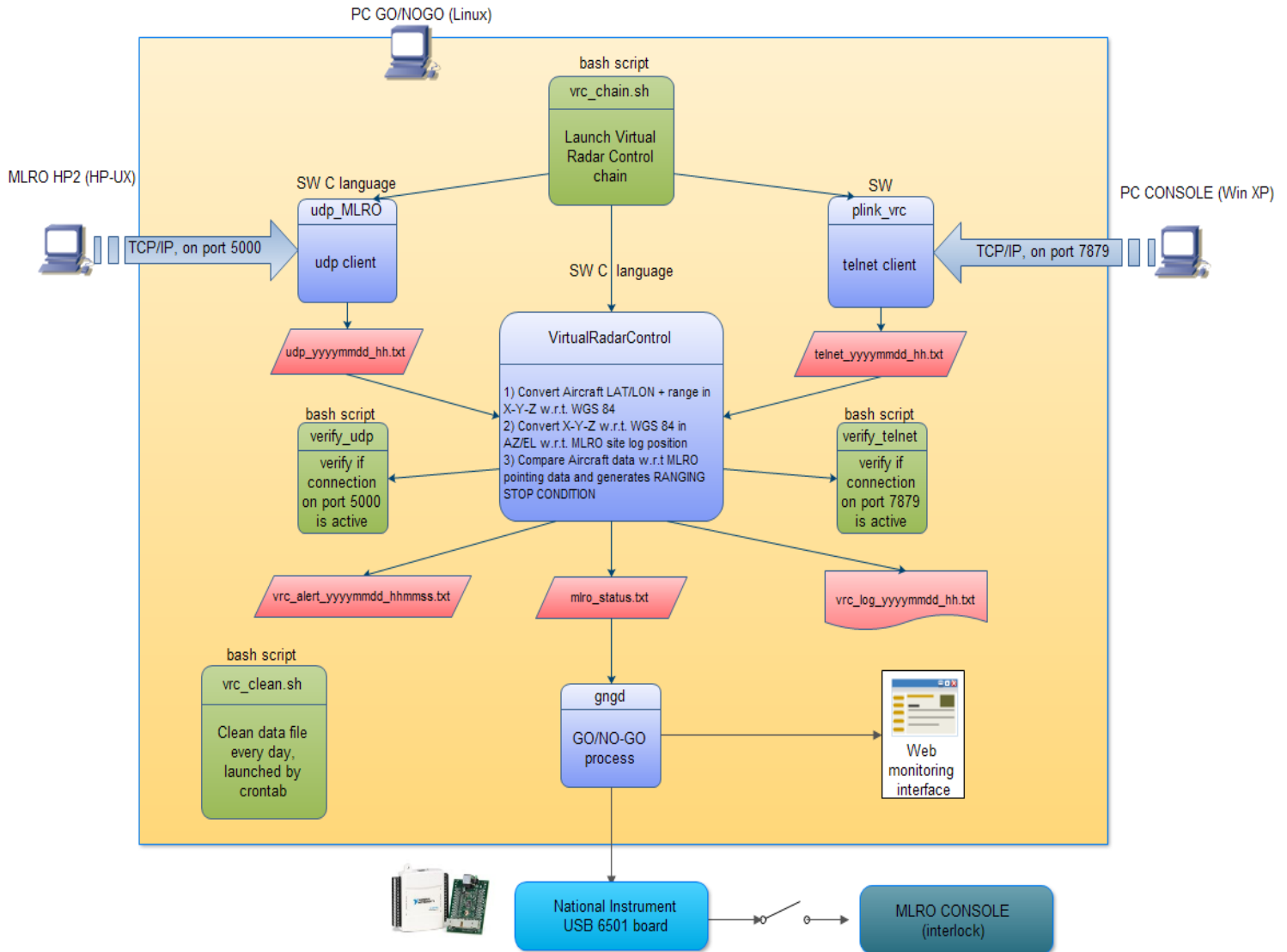
<SQUAWK>3755</SQUAWK>

</MODESMESSAGE>

# MainRangingPanel 2.2 SW



# VirtualRadarControl SW





# 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.



...oops...!