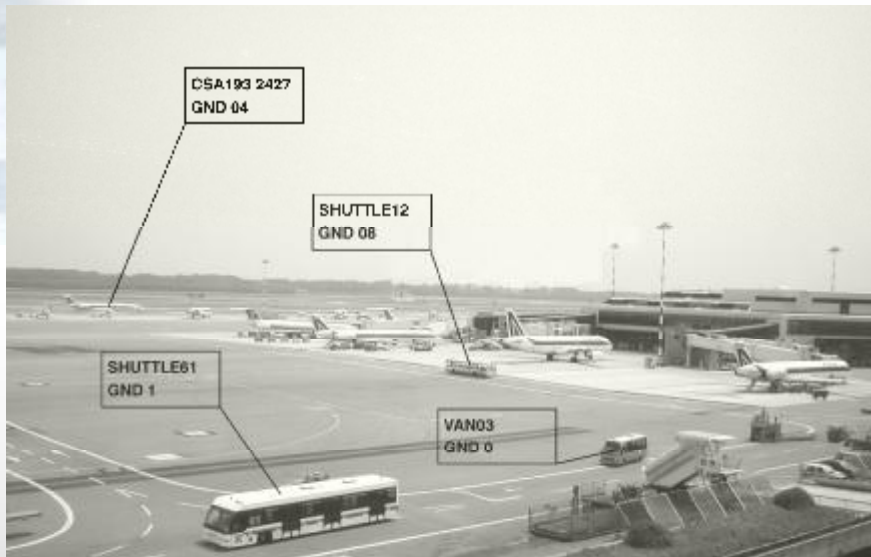




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RADAR TECHNOLOGY

DSS-1090: The Compact Mode S-ES ADS-B Ground Station

Nadi, Fiji

Oct 24-25, 2005

Introduction



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ERA at Glance



- § Founded in 1994 as Joint Stock Company
- § Cooperative Surveillance Systems
 - Multilateration Systems for ATC – MSS family
 - ADS-B Systems – DSS family, SQB
 - MLAT Systems for Military (ELINT/ESM and Air Defense)
- § Staff with years of experience
- § Global partnership on current R&D projects
 - RVSM, EMMA
 - EUROCAE WG-41 (active member)
 - EUROCAE WG-70 (chairmanship)
- § Certifications and Standards
 - ISO 9001 Certification
 - CAA Certificates
- § Headquarters: Pardubice, Czech Republic
Production: Pardubice, Czech Republic
Research Branch: Prague, Czech Republic



Czech Republic

- § Central Europe
- § Developed industrial country with rich history



Long Experience & Tradition

Evolution

former  **TESLA**

KOPAC PRP-1
first generation
1 to 6 targets/manual



RAMONA KRTP-81
strategic ELINT
20 targets



TAMARA KRTP-86
ELINT & Surveillance
23 radar + 48 SIF t.



BORAP
ELINT/ESM system
Wideband interferometric
direction finder



AP
Long range Multilateration
surveillance system



VERA-E
ELINT/ESM and Air Defense
system based on TDOA
technique



HME
Height measurement element



ADSB
Mode S Ground Station with
ADS-B processing



ASCS
Airport surveillance system



P3D
Mid range 3D Multilateration
Surveillance System



1963

1979

1987

1989

1994

1998

2001

2005

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How to classify ATC systems of ERA?

ATC Surveillance Systems

Primary
(Non-cooperative with targets)

- § Primary Radars
- § Surface Movement Radars (SMR)

Secondary
(Mode A/C/S Cooperative)

- § Secondary Surveillance Radars (SSR)
- § Multilateration Surveillance Systems (MSS)
- § Airport
- § Wide-Area

ADS
(Cooperative, GNSS dependent)

- § VTS - Vehicle Tracking System
- § DSS - Mode S-ES Depended Surveillance System

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ATC Surveillance Systems of ERA

§ Based on Time Difference of Arrival (TDOA) Multilateration of Mode A/C/S Transponders

§ **MSS-A** – Airport Surveillance Cooperative System

§ **MSS-W** – TMA and En-route Surveillance System

§ Based on GNSS position decoding (ADS-B) and on Mode S Extended Squitter

§ **VTS** – Vehicle Tracking Systems

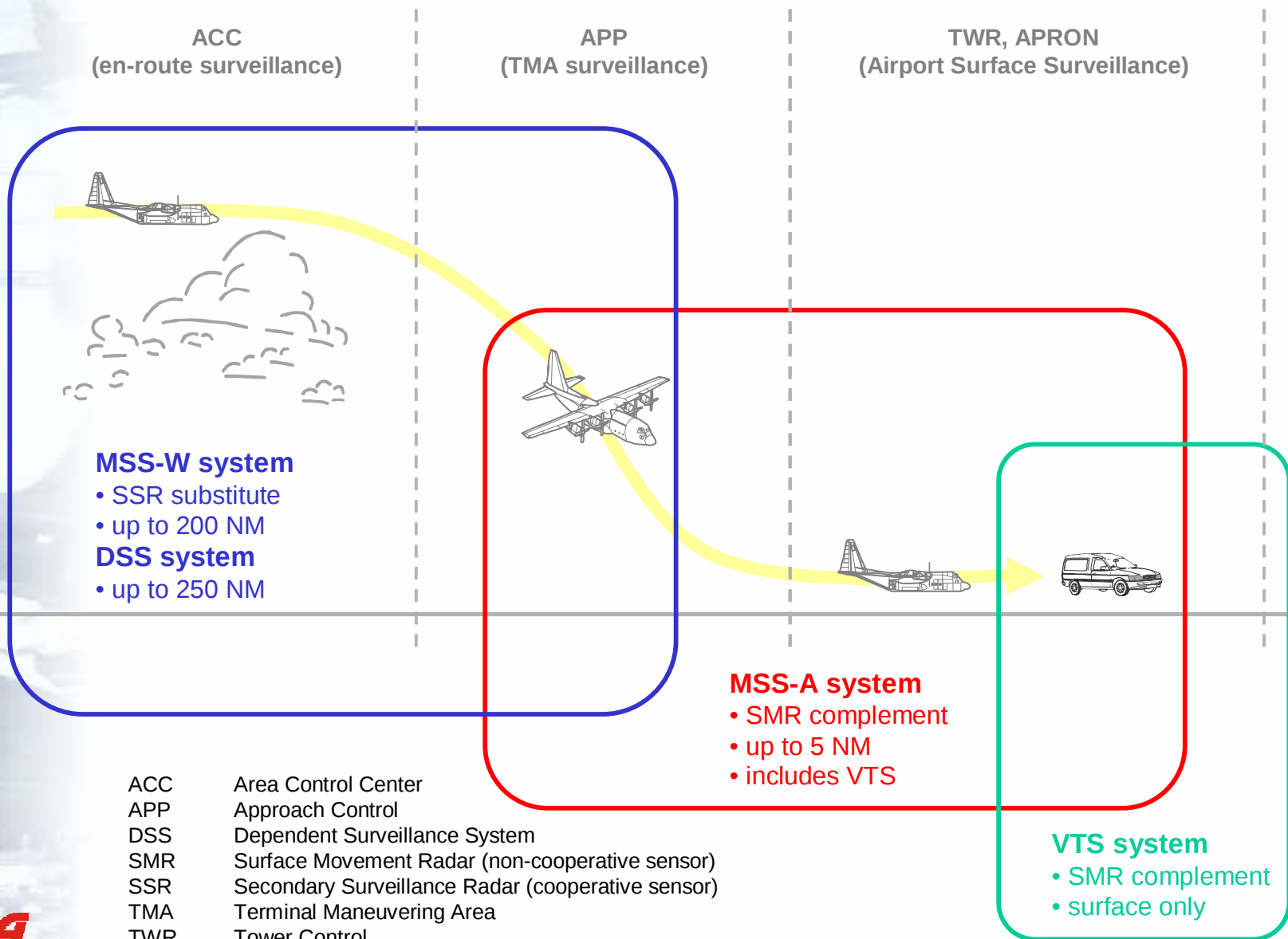
§ **DSS** – ADS-B Ground Stations

Note: MSS are also capable of ADS-B functions.

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How to understand their applications?



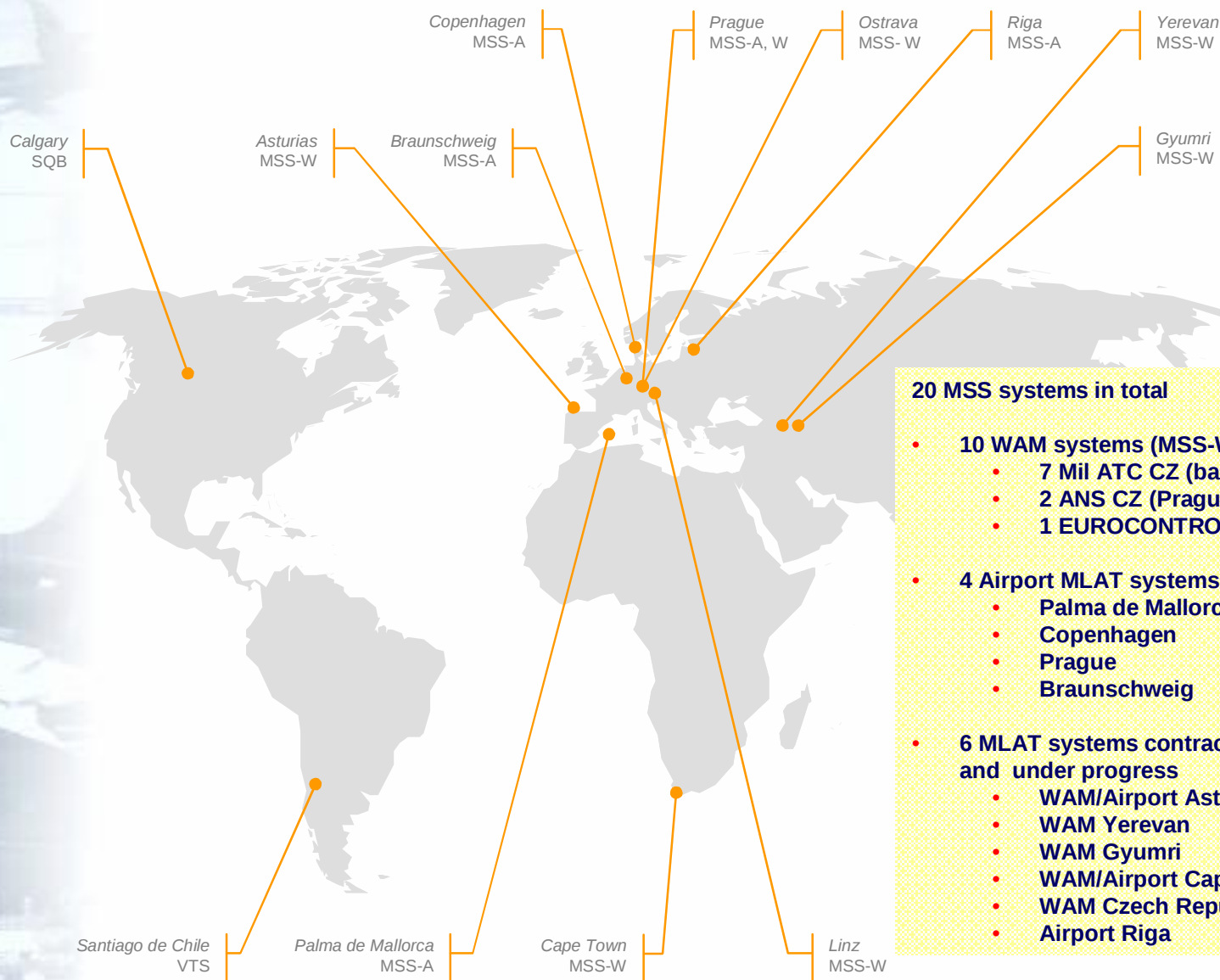
ACC	Area Control Center
APP	Approach Control
DSS	Dependent Surveillance System
SMR	Surface Movement Radar (non-cooperative sensor)
SSR	Secondary Surveillance Radar (cooperative sensor)
TMA	Terminal Maneuvering Area
TWR	Tower Control

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DSS-1090: The Compact Mode S-ES ADS-B Ground Station

Relevant References



20 MSS systems in total

- **10 WAM systems (MSS-W)**
 - 7 Mil ATC CZ (backup to radar net)
 - 2 ANS CZ (Prague, Ostrava)
 - 1 EUROCONTROL (Linz)
- **4 Airport MLAT systems (MSS-A)**
 - Palma de Mallorca
 - Copenhagen
 - Prague
 - Braunschweig
- **6 MLAT systems contracted and under progress**
 - WAM/Airport Asturias
 - WAM Yerevan
 - WAM Gyumri
 - WAM/Airport Cape Town
 - WAM Czech Republic
 - Airport Riga

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Relevant ADS-B References

§ VTS

- Santiago de Chile

§ ADS-B GS

- Integrated with MLAT: Braunschewig, Asturias, Riga, Cape Town, Armenia, Palma de Mallorca, Copenhagen
- 2005: Czech Army

§ SQB

- Prague (96), Copenhagen (31), Santiago de Chile (17), NavCanada (4)
- 2005: Cape Town (16), Amsterdam (31), Copenhagen (25)

ADS-B Programme in ERA

§ 2000

- “Measurement of 1090 MHz Extended Squitter Performance” in Langen near Frankfurt (Germany) in May 2000 – Eurocontrol, FAA and DFS

§ 2003

- VTS contract for Santiago de Chile
- ADS-B processing fully integrated into MLAT systems

§ 2004

- VTS Santiago de Chile delivered
- DSS-1090 trials in Scandinavia
- Integration with VDL-4 station
- Long-term trials in Pardubice and Prague

§ 2005

- SQB type approval by CAA
- DSS-1090 delivered to Czech Army

ADS-B Programme in ERA

§ 2003 – ERA decided to develop an ADS-B Ground Station

§ Motivation

- Growing market, customer requests
- Design based on existing MLAT Ground Station

§ Principal Requirements

- Plug-and-Play – easy installation and maintenance
- Low weight and power consumption
- Outdoor and embedded design

§ 2004 – development finished and production started

§ 2005 – production capacity of hundreds of GS / year

DSS-1090: Mode S-ES ADS-B Ground Station



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DSS-1090: The Compact Mode S-ES ADS-B Ground Station

Ground Station

§ Main features:

- Mode S Extended Squitter (DF 17 and 18, other DF optional)
- Low-cost and compact solution
- Plug-and-Play solution
- Easy outdoor installation
- Open architecture – easy extension
- High reliability (MTBF 38 500 h, MTTR 1 h)
- Low power consumption
- Long range (> 150 - 250 NM, depending on antenna)
- Multiple Asterix Cat. 21 or Cat. 10 outputs
- Remote monitoring and control
- Optional VDL Mode 4 dual-link ground station
- Suitable for upper- and lower-airspace applications

Ground Station

§ Compact design

350 x 300 x 270 mm, < 12 kg



Ground Station

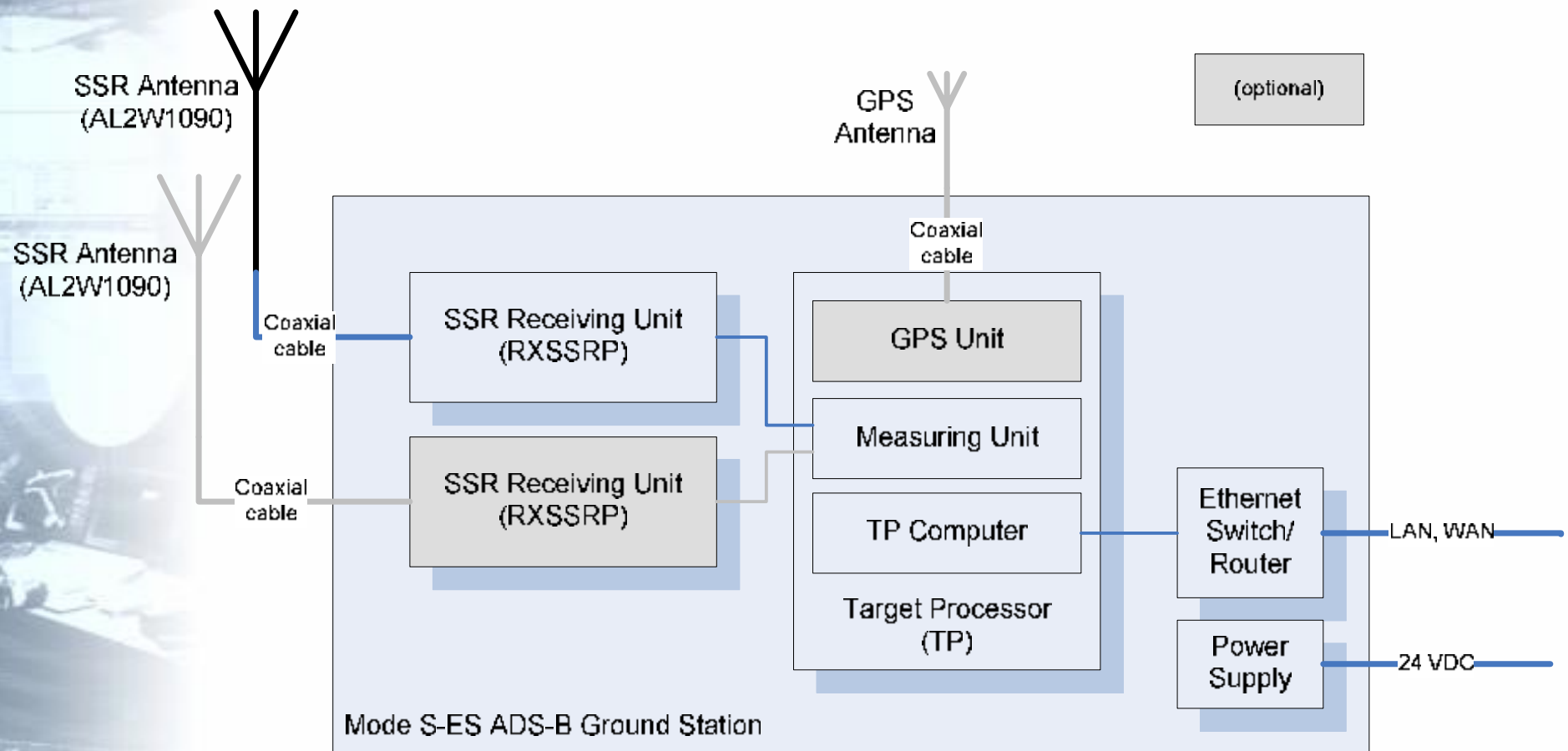
§ Main parameters:

- Temperature: - 40 to + 60 °C
- Power Supply: 24VDC (20V to 28V), other options available
- Power Consumption: < 30W (up to 250W with heating)

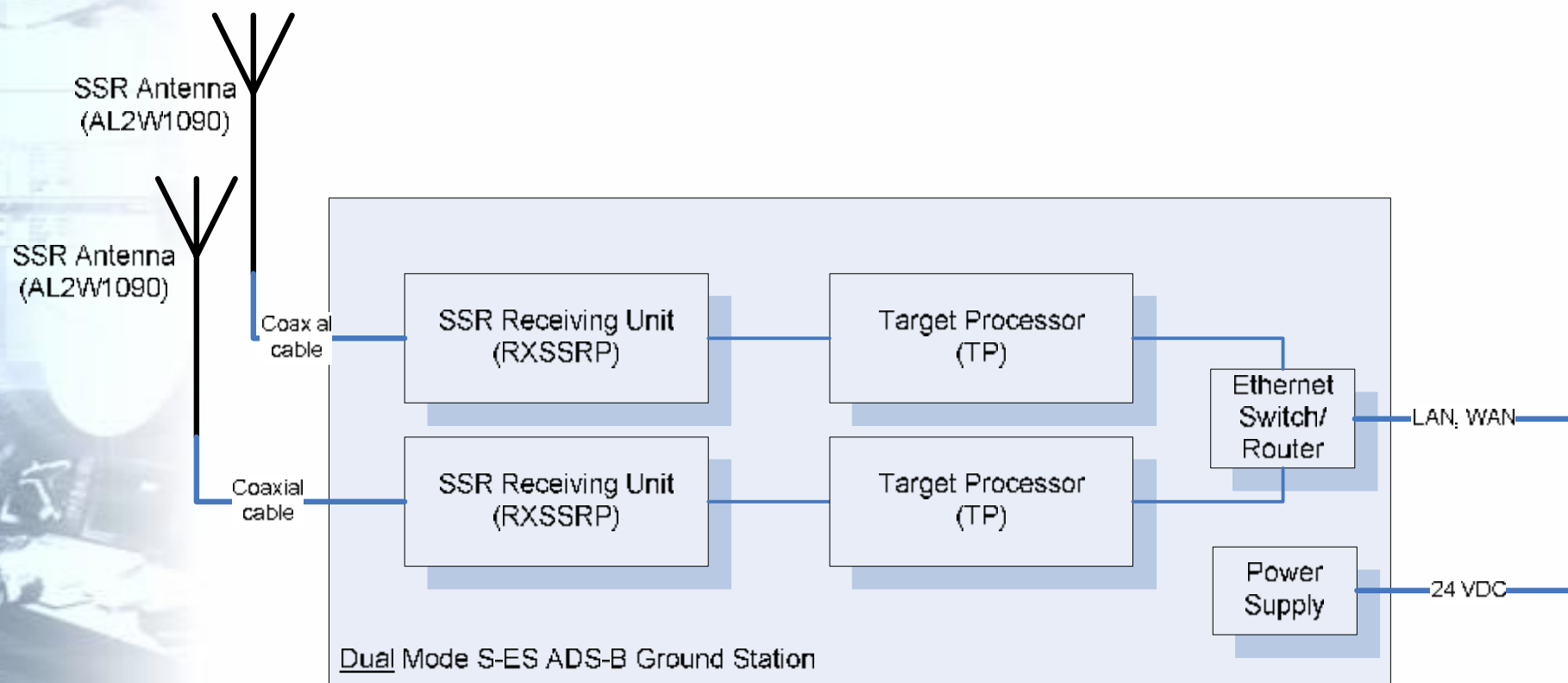
§ The ground station consists of the following parts:

- AL2W1090 Antenna (5 dB)
- SSR Signal Receiver RXSSRP (sensitivity min. -116 dBW, dynamic range min. 70 dB)
- Target Processor with Measuring Unit (PC/104)
- Power Supply
- Optional UPS, GPS receiver, Site Monitor, Management System, Dual Antenna, Dual Station, TIS-B transmitter, VDL Mode 4, MLAT, WAN

Ground Station



Dual Ground Station

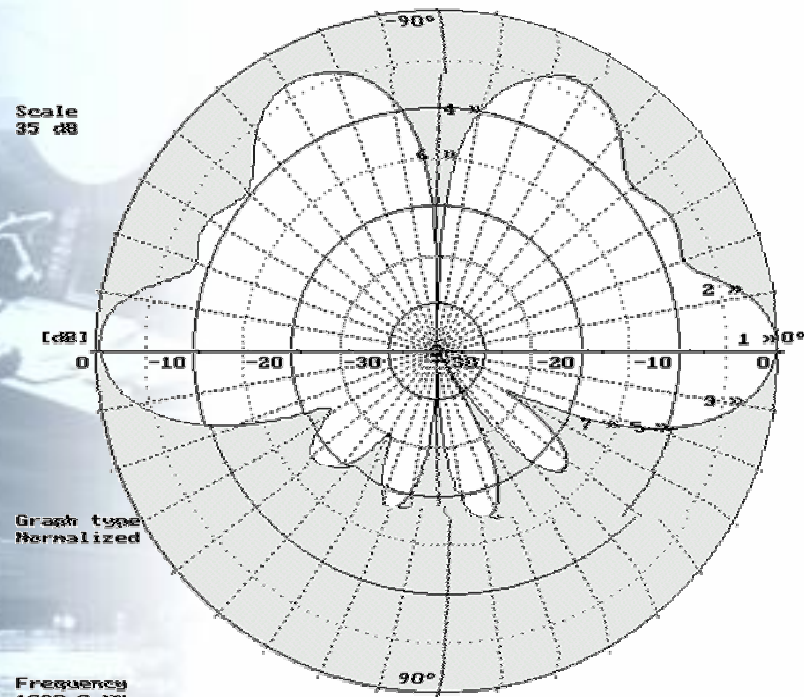


AL2W1090 Antenna

§ Narrowband omni-directional two-dipole array antenna with vertical polarization

§ Main parameters:

- Gain: 5 dB
- Length: 756 mm / 2.5 ft
- Weight: 1.8 kg / 4 lb



Vertical pattern (1090 MHz)



AL2W1090



AL2W1090 with a reflector

RXSSRP SSR Signal Receiver

§ Main parameters:

- Sensitivity $S_{0,5}$: min. -116 dBW
- Dynamic Range: min. 70 dB
- Bandwidth: 28 MHz
- Power Supply: 24V (20V to 28V)
- Power Consumption: < 4W

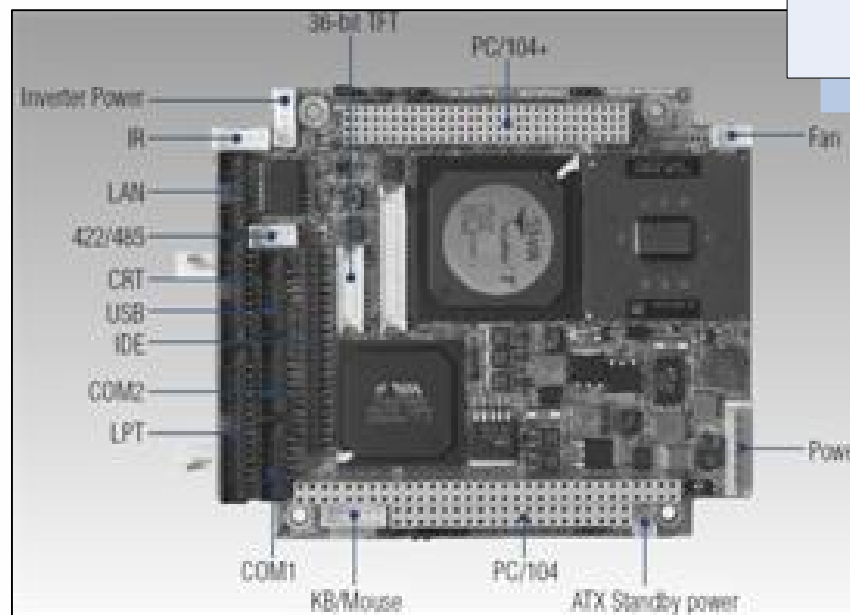
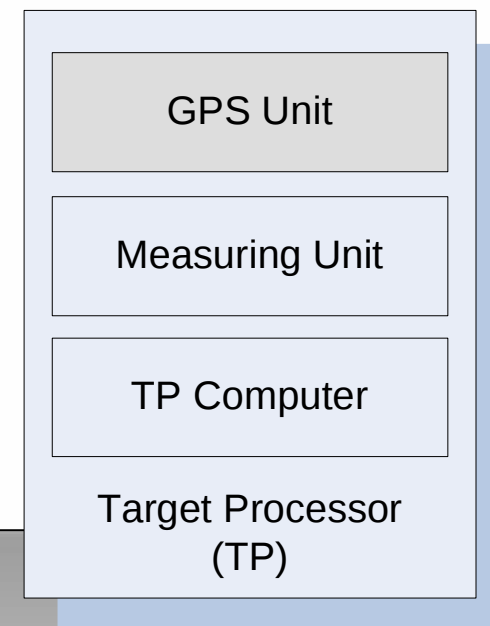


RXSSRP housed in a box

ADS-B Target Processor

§ Main parameters:

- Compact solution
- PC/104 industrial computer
- Embedded OS
- SW on Flash
- SW remotely upgradeable, including the Measuring Unit firmware
- NTP or GPS time synchronization



Target Processing

- § The Target Processor performs automatic evaluation of parameters (aircraft identification, position, altitude, ...).
- § To minimize spurious position decoding the globally unambiguous position decoding algorithm is primarily used.
- § The CPR algorithm for airborne targets is implemented according to RTCA DO-260A.
- § The CPR algorithm for surface targets is implemented in accordance with standards and recommended practices (SARP's) for Global Decoding of the ES Surface Format.
- § 3D tracker
 - Kalman filter with 4 stages: stationary, straight moving, accelerating, strongly accelerating
 - Position validation against 3D region predicted by the tracker
 - Target validated after min. 3 plots

Target Processing

§ Compliant with

- DO-260A MOPS for 1090 MHz Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services (TIS-B), RTCA, Issued 4-10-03, Prepared by SC-186, Supersedes DO-260
- DO-242A, Minimum Aviation System Performance Standards for Automatic Dependent Surveillance Broadcast (ADS-B), RTCA, Issued 6-25-02, Prepared by SC-189, Supersedes DO-242
- Surveillance and Conflict Resolution System Panel (SCRSP).
Surveillance Systems Working Group-B. WP/B/6-05 SARPs CP for Global Decoding of the ES Surface Format

§ Available data

- ICAO 24-bit Mode-S address, Identification, Type - aircraft category
- Decoded Latitude and Longitude, Barometric Altitude / GNSS height
- Velocity, Emergency/Priority Status, Target State and Status, Aircraft operational status

Options

§ Site Monitor

- Allows to independently test the end to end functional performance of the ADS-B System
- Provides system integrity verification – checks performance of the SSR antenna and information on quality of GPS data
- Based on SQB, controlled by the TP

§ Optional GPS receiver built-in the TP

- provides UTC time, GS position, and additional integrity information

§ UPS

- > 24 h backup (24 VDC), outdoor

§ Dual Antenna; Dual Station

- Improved reliability and flexibility

§ Various antenna types

- Airport application
- Long-range antennas

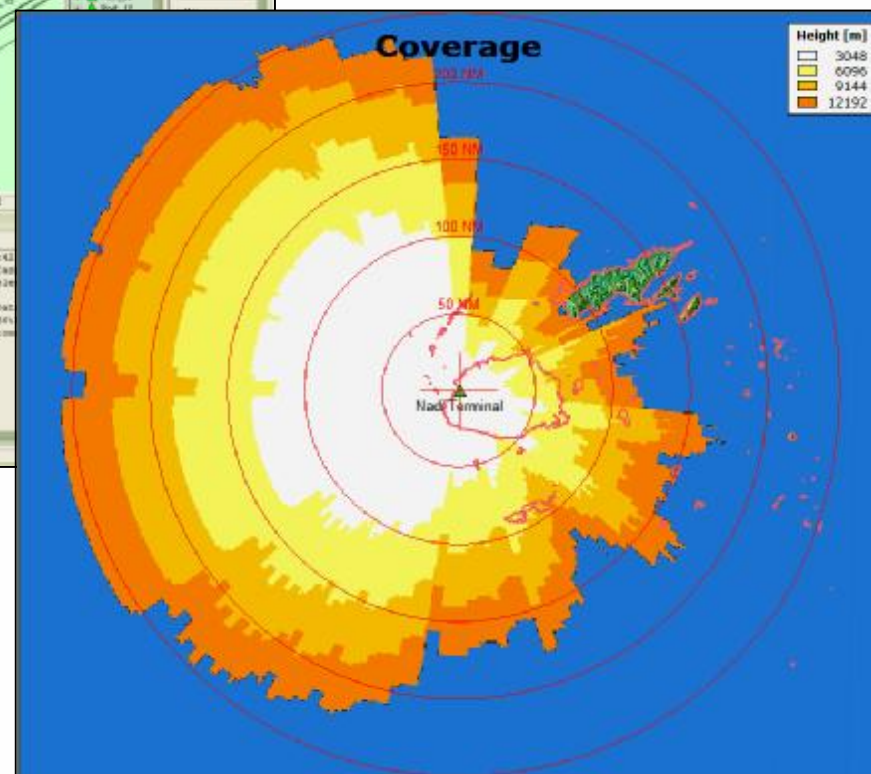
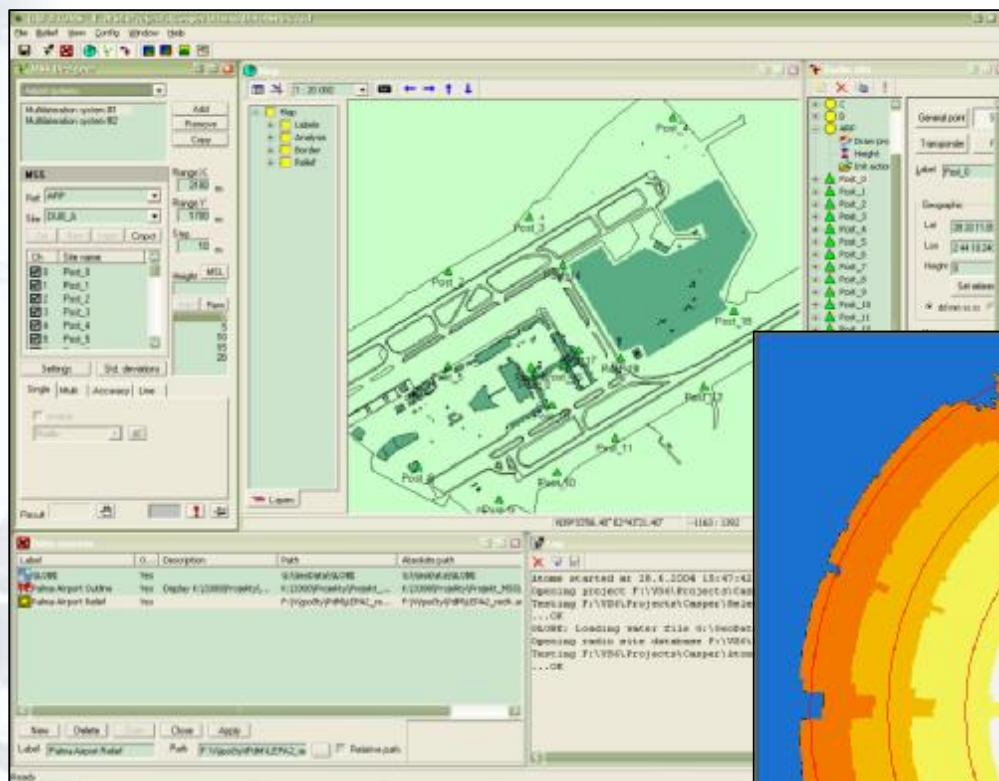


Options

- § **VDL Mode 4 dual link**
 - Joint product with a partner company
- § **TIS-B Transmitter and Mode S Interrogator (100/1600 W)**
- § **Multilateration**
 - Independent ADS-B position validation
- § **Management System (CMS)**
 - Local and remote monitoring and control
 - Remote upgrade of the software
 - Data recording and post-processing

Options

§ Site Selection Tool ATOMS

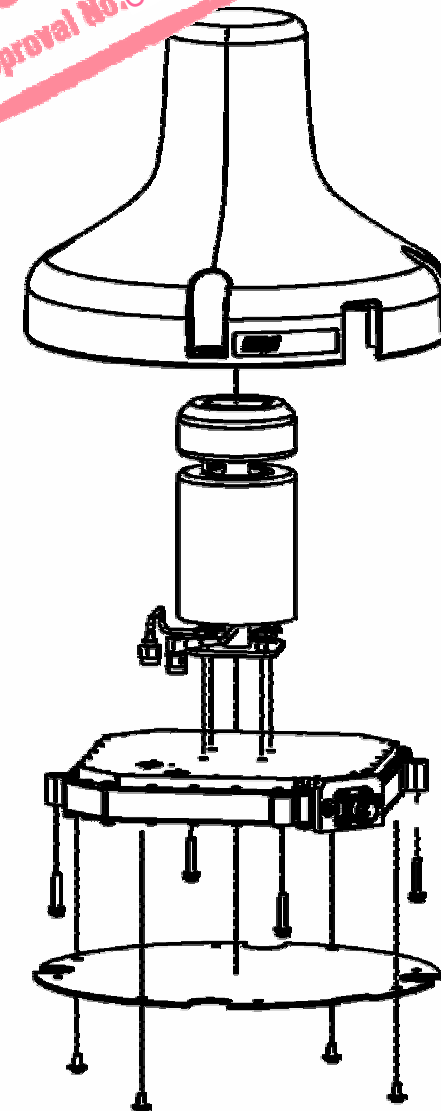
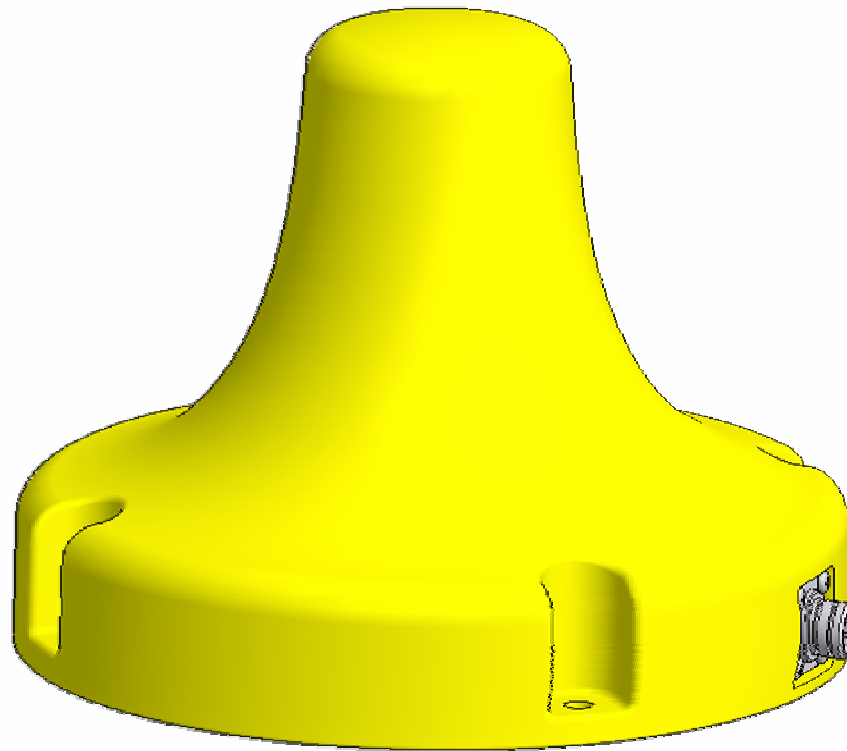


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Vehicle Location Unit SQB

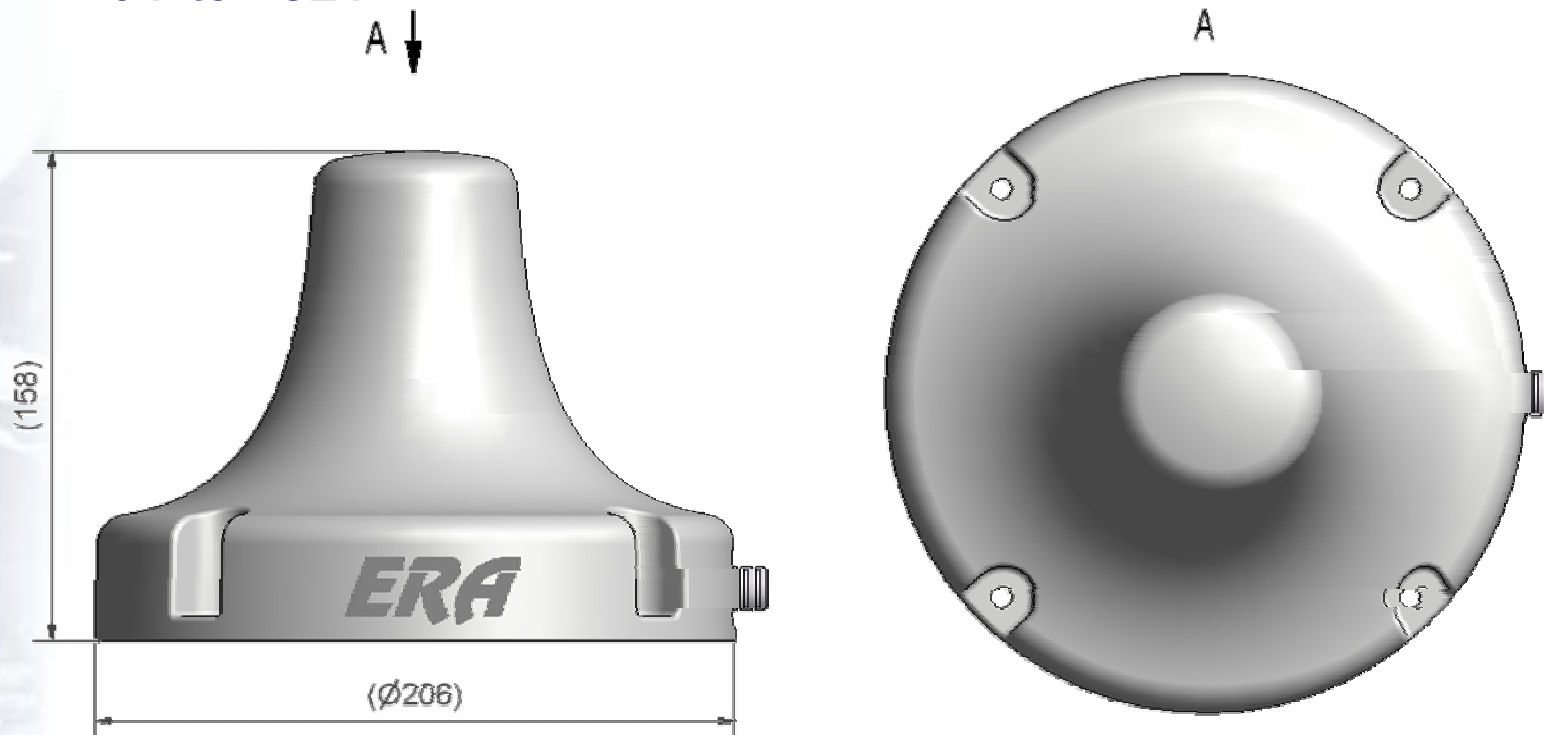
- § DF18 Mode S extended squitter (for ADS-B, for multilateration)
- § Position from built-in GPS receiver
- § Powered from the car cigarette lighter



Vehicle Location Unit SQB

§ Main parameters:

- Output power: 16 W (pulse)
- Configurable (Mode S address, callsign)
- Power consumption: < 2 W
- -40°C to +70°C
- +9V to +32V



Vehicle Location Unit SQB



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Air Situation Display

§ Main features

- § Displays targets from multiple sensors
- § Up to 10 Map windows, 2 Target tables
- § Internal target tracking
- § Powerful filtering
- § Customizable colors
- § ICAO 4444 Flight Plans

Air Situation Display

§ Main Window

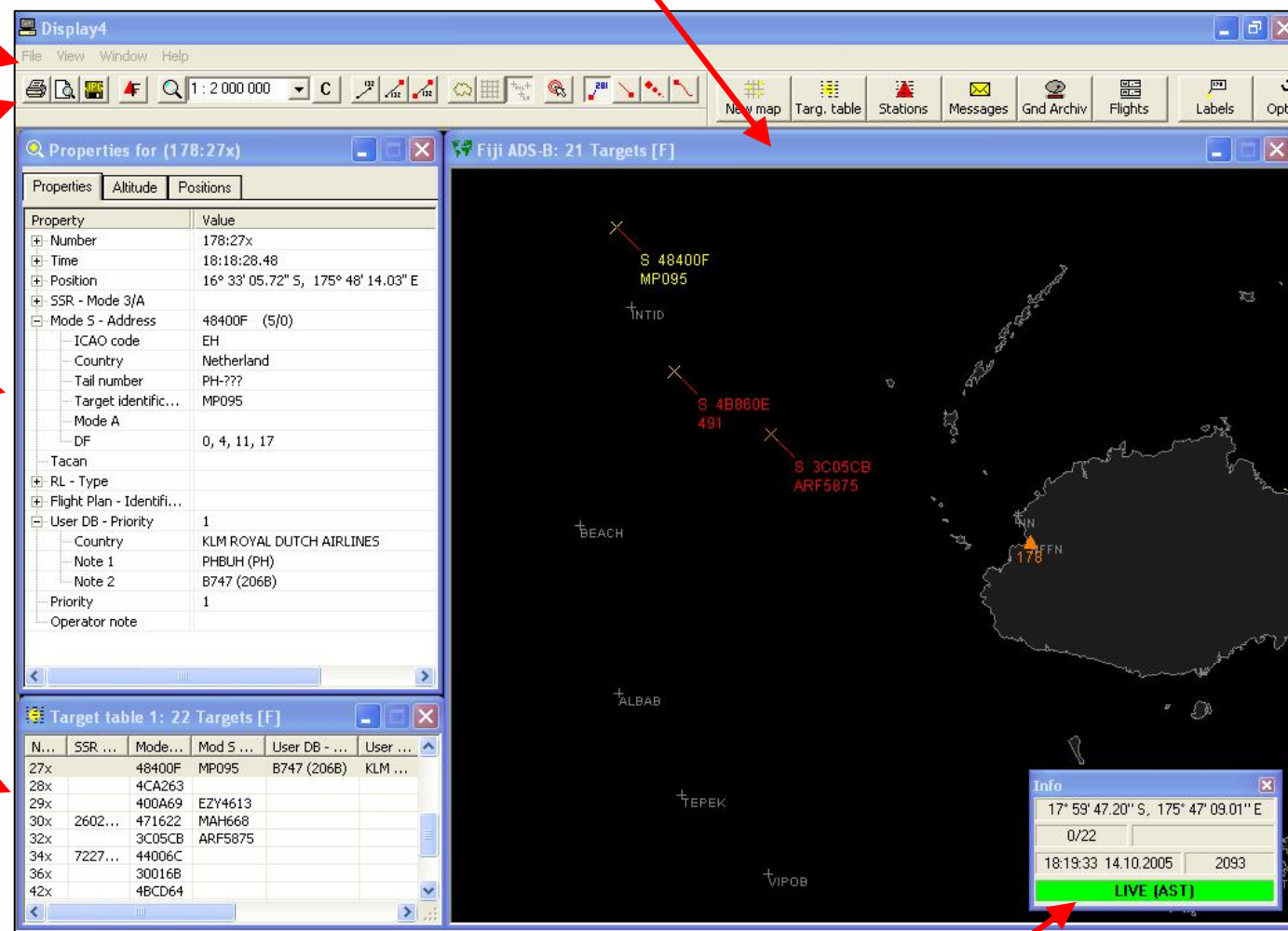
Main menu

Toolbar

Target parameters

Target table

Main map



Info window

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Management System

§ Remote and local

§ Based on standard Simple Network Management Protocol (SNMP)

Monitoring:

- Sensor state and mode, regimes of operation
- Diagnostics, Failure localization
- Integrity check
- Number of tracked targets
- Connection test

Control:

- Restart, start and stop of the system operation
- Adaptation parameters
- Configuration sets
- User profiles

Maintenance:

- Software upgrade and rollback
- Software version check

Management System



Samples

GS Installations

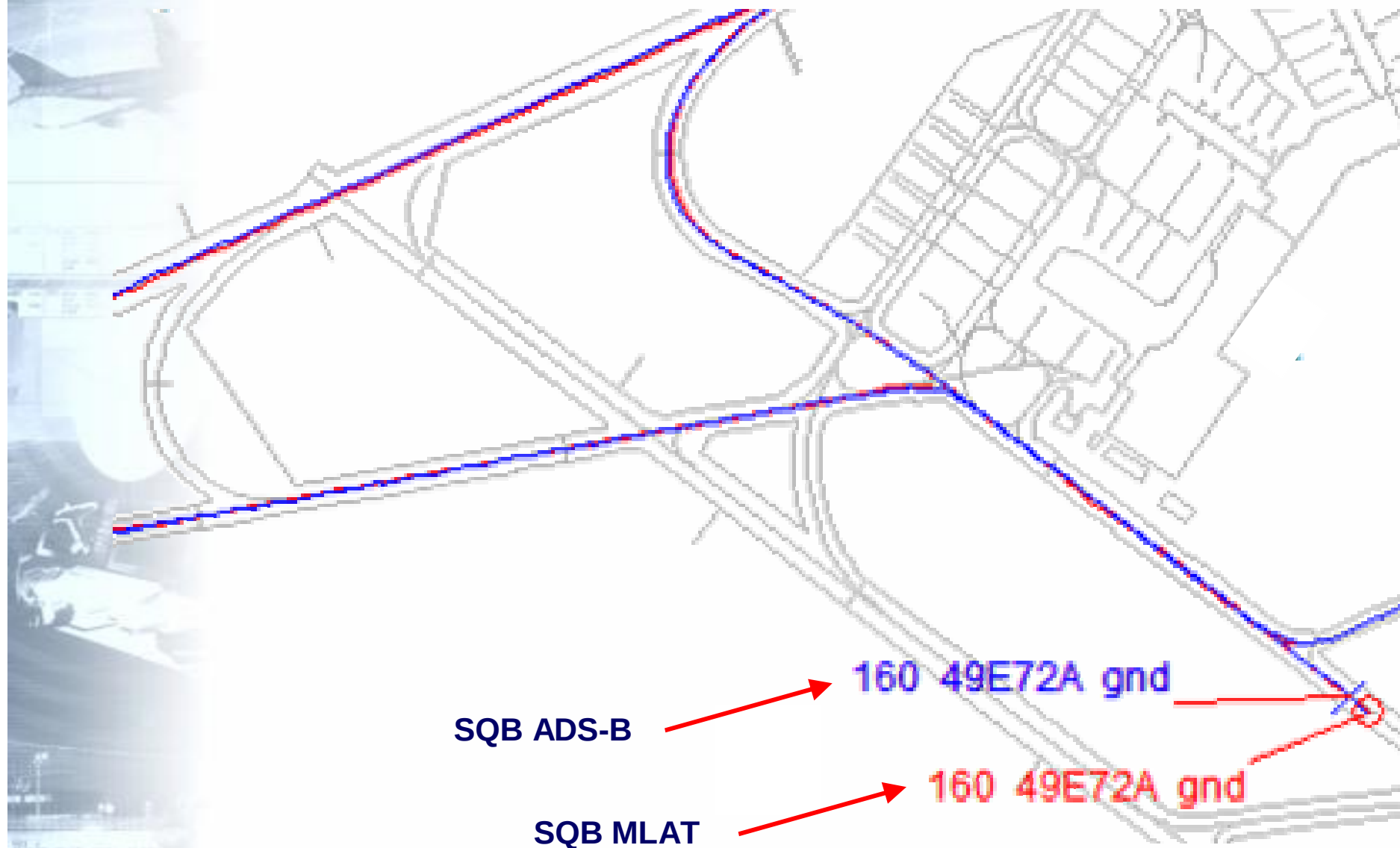


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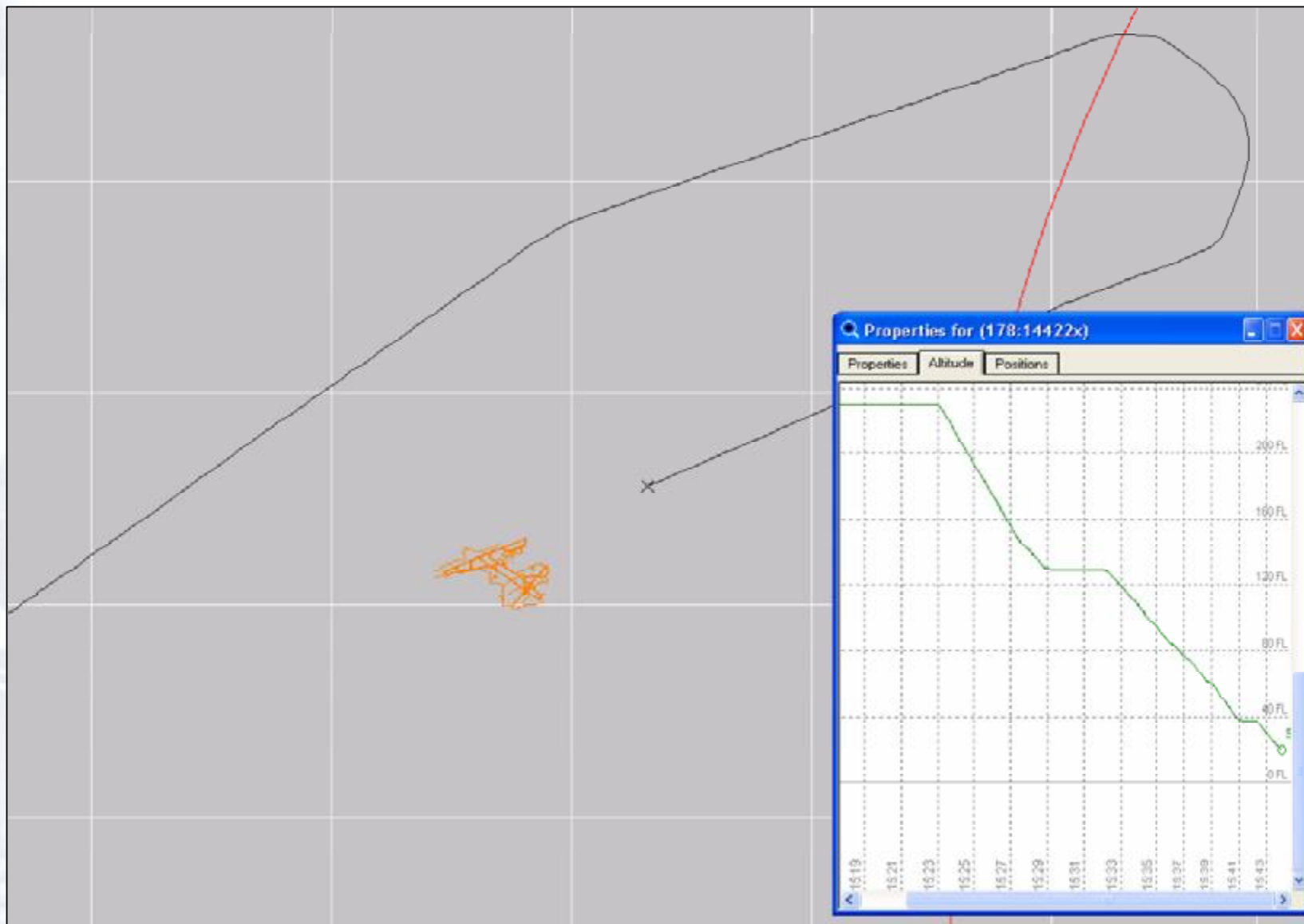
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SQB trials in Prague



ADS-B trials in Prague



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Fiji Demo

§ Components:

- GS (minimal configuration, without case, short-range antenna)
- SQB (on Airports Fiji Ltd. car)
- Air Situation Display (live and recoded data)



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Thank You for Your Attention

ERA a.s.

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Questions?

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