SURVEILLANCE SYSTEMS

Operational Improvement and Cost Savings, from Airport Surface to Airspace

Sergio Martins

Director, Air Traffic Management - Latin America

AGENDA

- Airport Surface Solutions
  - A-SMGCS *(Advanced Movement Guidance and Control System)*
    - ✓ ***SR-3*** (Surface Movement Radar)
    - ✓ **Surface Multilateration**
    - ✓ ***A3000*** (HMI Platform)
  - Surface Surveillance for A-CDM purposes
- Airspace Solutions
  - Wide Area Multilateration
  - ADS-B

A-SMGCS *(Advanced Movement Guidance and Control System)*

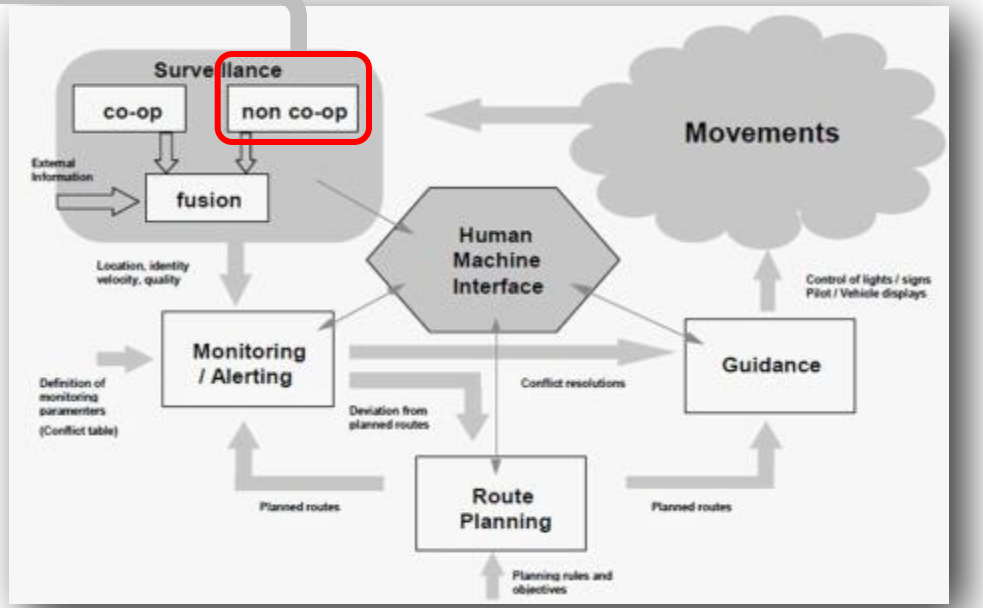
A-SMGCS

Advanced Surface Movement Guidance and Control System

(**ICAO 9830**)

SR-3

Surface Movement Radar



NON-COOPERATIVE Surveillance / NON-POSITIVE Identification - SAFETY driven component !

A-SMGCS *(Advanced Movement Guidance and Control System)*

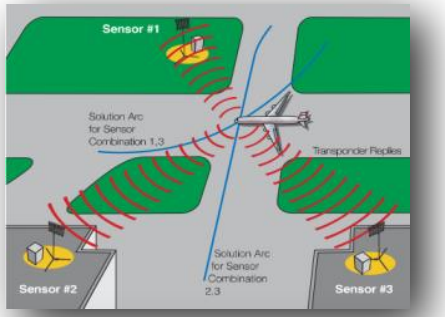
A-SMGCS

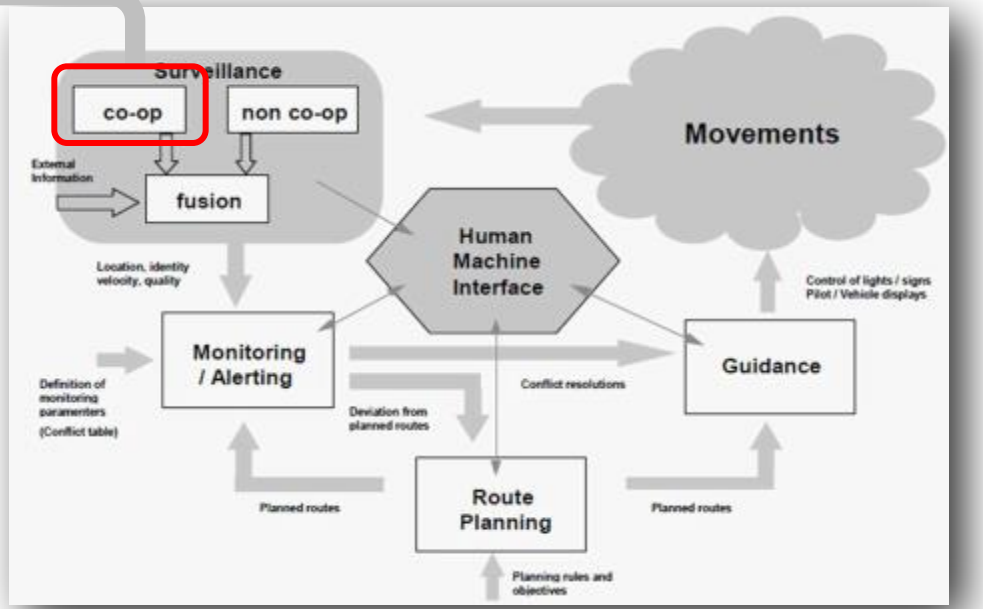
Advanced Surface Movement Guidance and Control System

(**ICAO 9830**)

MDS

Multilateration





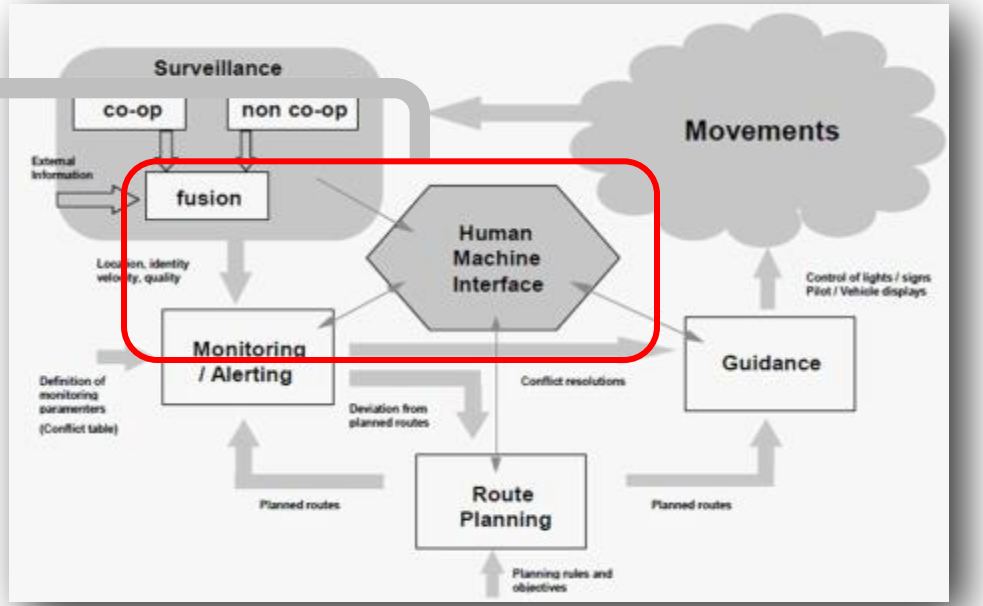
COOPERATIVE Surveillance / POSITIVE Identification - OPERATIONAL MANAGEMENT driven component !

A-SMGCS *(Advanced Movement Guidance and Control System)*

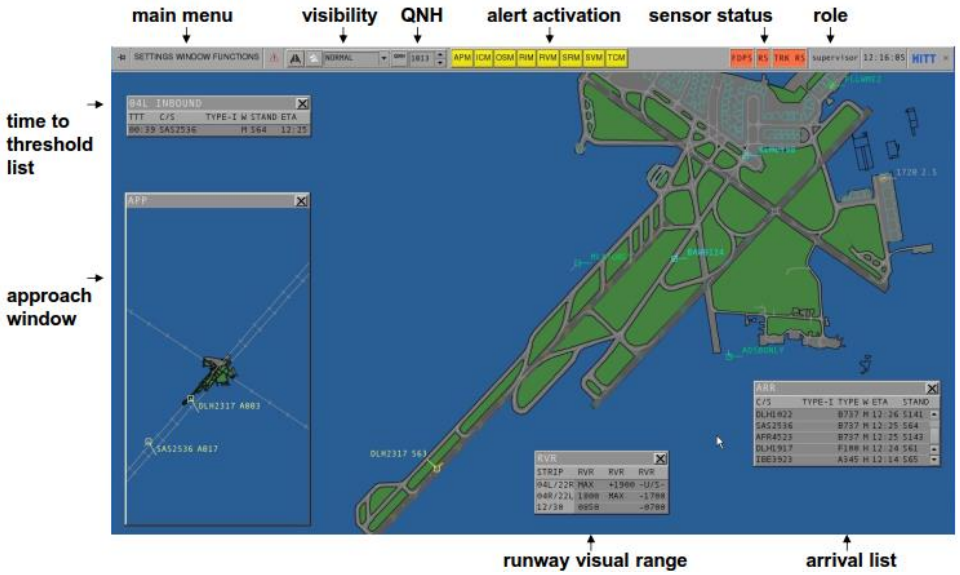
A-SMGCS

Advanced Surface Movement Guidance and Control System

(**ICAO 9830**)

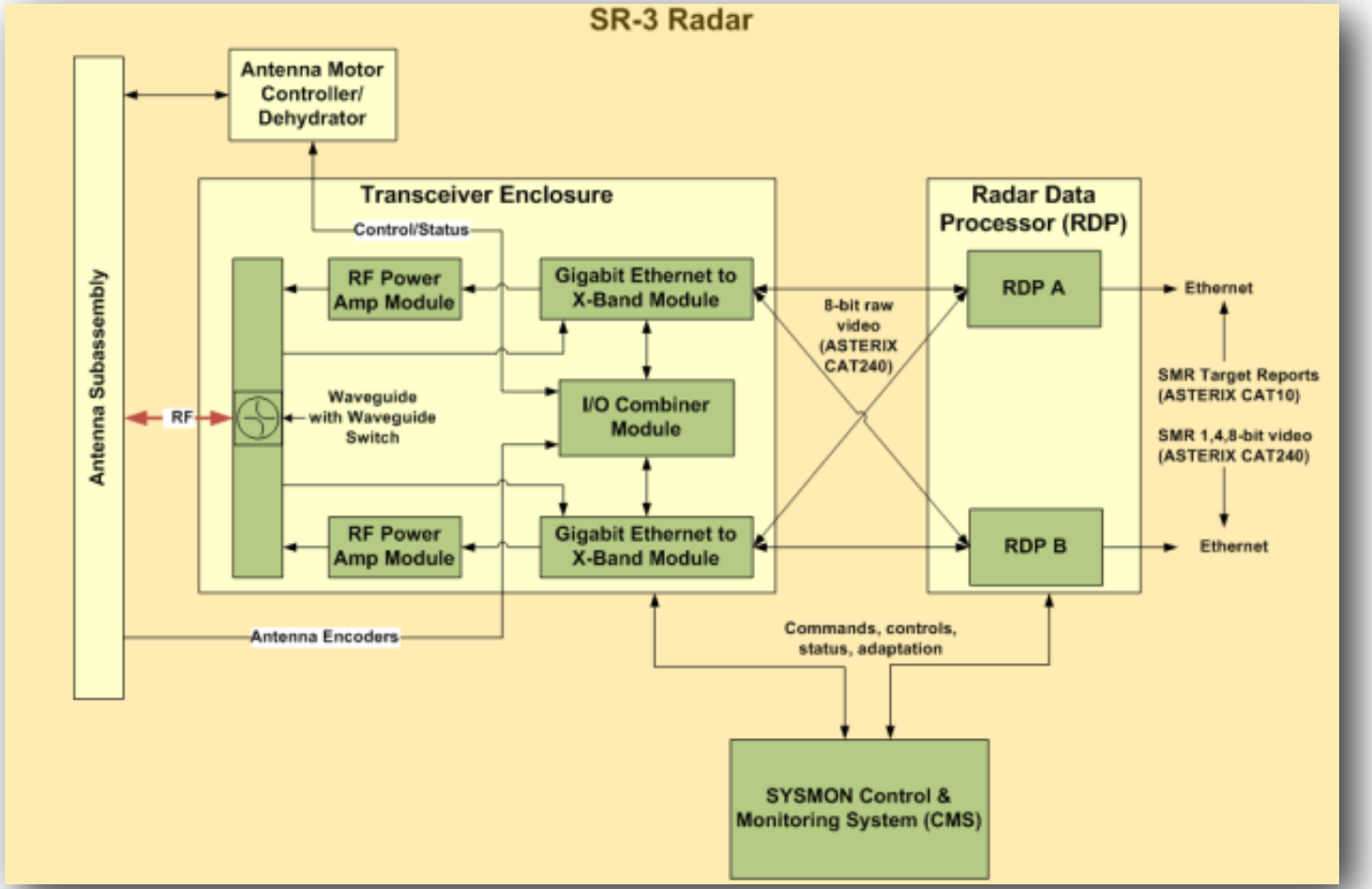


A3000



Controller Working Position - Air Traffic Controller´s HMI

SR-3 SURFACE MOVEMENT RADAR



SR-3 SURFACE MOVEMENT RADAR

Antenna Subsystem

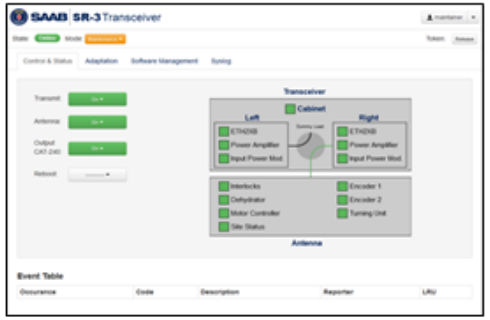
Antenna

Motor Controller

Radar Data Processor (RDP)

Transceiver Enclosure

Control & Monitoring System (CMS)



SR-3 SURFACE MOVEMENT RADAR

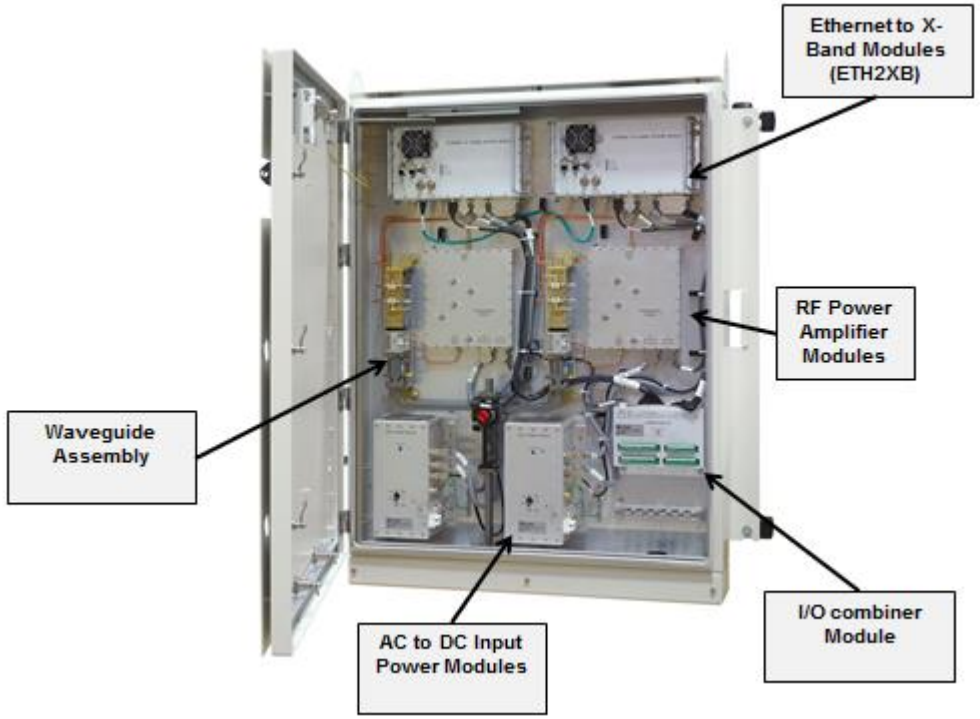
- Saab´s **third-generation** SMR system that delivers critical situational awareness and safety in **all visibility conditions**
- **SR-3** is a **backwards compatible** upgrade to Saab's existing **SMRi**, installed in **over 20 airports** in US, Saudi Arabia, Australia, India, Austria, and Israel
  - **ED-116**, **FAA-E-2942**, **DTFAWA-08-R-00027** compliant
  - Support for **indoor and outdoor** configurations
  - **Lower equipment, installation, and lifecycle cost**

SR-3 SURFACE MOVEMENT RADAR

- **Circularly polarized, slotted waveguide** antenna
- The SR-3 is **also fully compatible with multiple types of antennas**, making it ideal for replacement of legacy systems where the antenna does not need to be replaced.

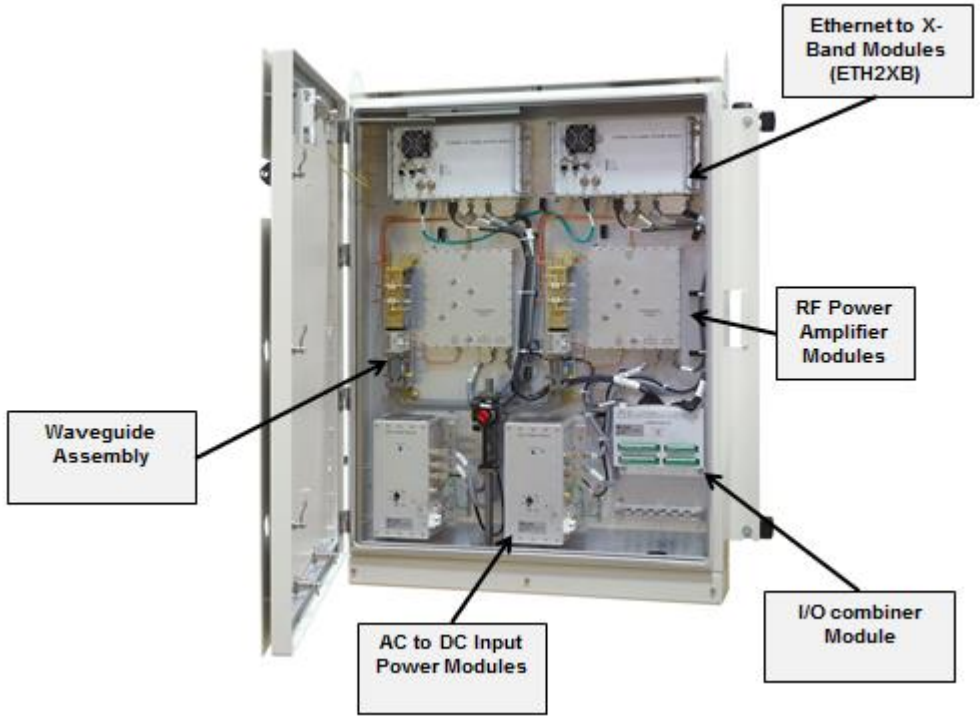
SR-3 SURFACE MOVEMENT RADAR

- State-of-the-art **fully solid state / low power consumption**, simplifies installation and **lowers lifecycle cost**
- **16-level frequency diversity** optimizes all-weather performance
- The Transceiver outputs **8-bit video in ASTERIX CAT240** format over standard Ethernet. .

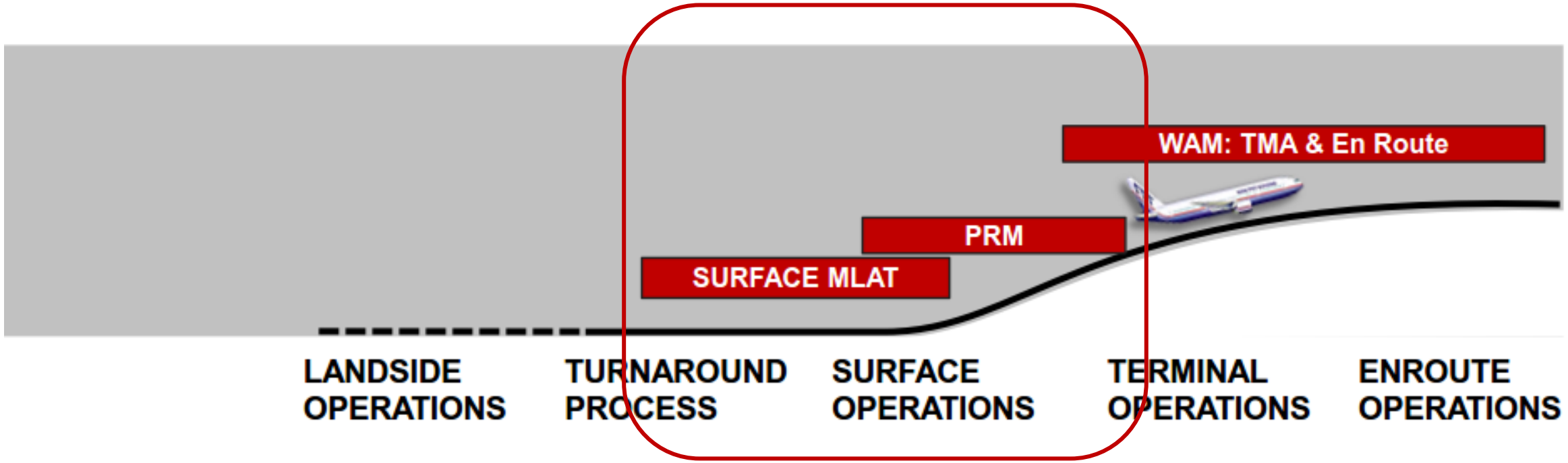


SR-3 SURFACE MOVEMENT RADAR

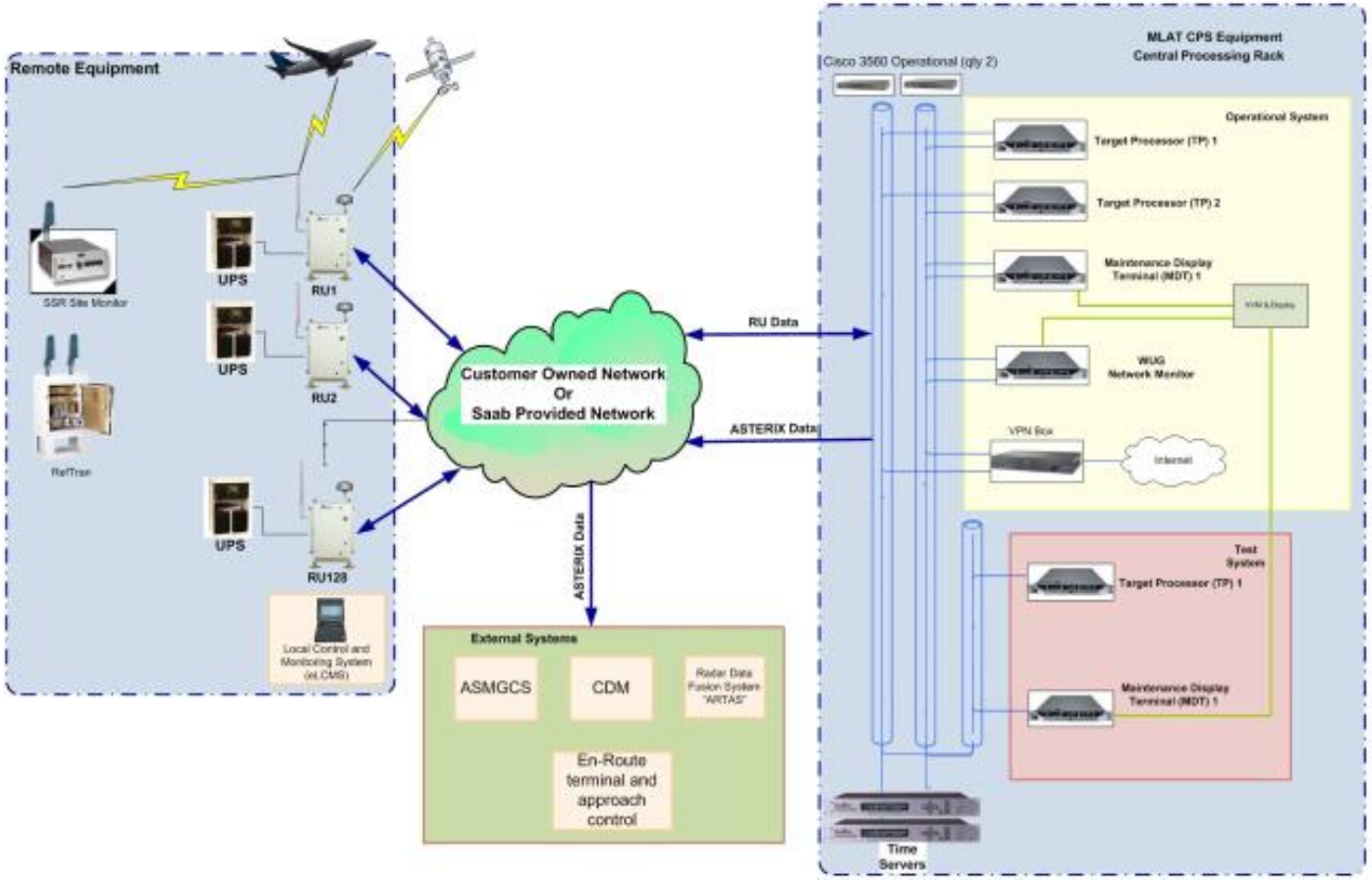
- **No shelter requirements** - easier to find a suitable site location within a **crowded airport environment**
- Allows for antenna installation **closer to the transceiver**, which improves the radar's performance by **lowering signal loss**
- **Low number of LRUs**, further reducing **maintenance and lifecycle costs**



SURFACE MULTILATERATION



SURFACE MULTILATERATION

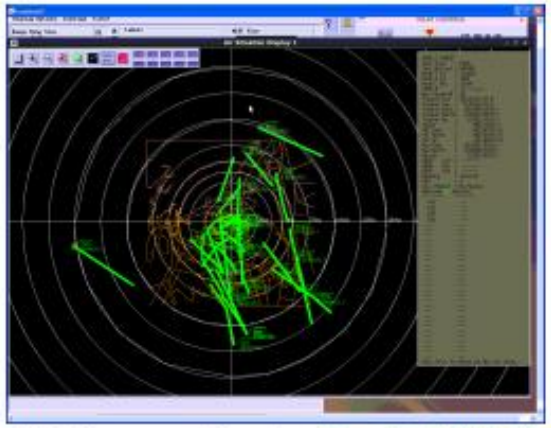


SURFACE MULTILATERATION

Remote Unit (RU)

RU Antenna

Central Processing System (CPS)



Maintenance Display Terminal (MDT)

Rack Mount Remote Unit

External RF Amplifier (ERFA)

SURFACE MULTILATERATION

- **First operational Multilateration** system used in an A-SMGCS (London Heathrow, 2003)
- **Only Multilateration system** used for ATC operations in the US (**ASDE-X** *Airport Surface Detection Equipment Mode X), at over 35* airports)
- **Multilateration & ADS-B** in one single system

SURFACE MULTILATERATION

- **Airport Surface Application**
  - A-SMGCS for ATC/safety and/or for ramp management
  - ED-117 defines recommended requirements
  - 7.5m or better accuracy
  - Runways, taxiways, aprons, gates
- Use **GPS** or **Reference transmitters** for time synchronization
- **Fully expandable system**
  - Surface > WAM or WAM > Surface

SURFACE MULTILATERATION

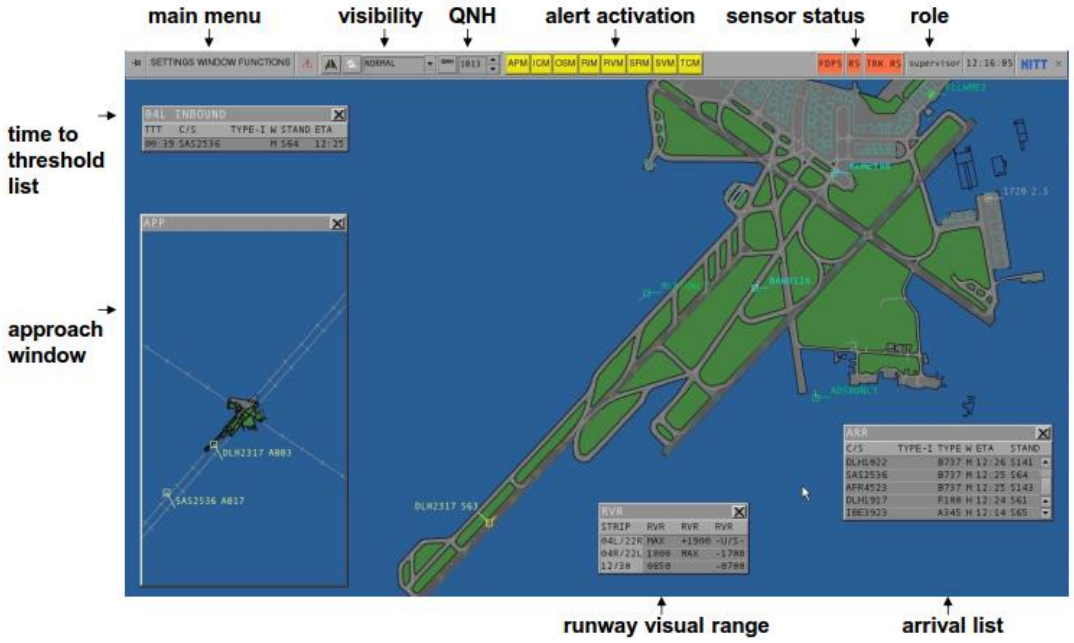
MDS (Multilateración): Over 500 million passengers per year

A FEW EXAMPLES

Atlanta:	82 million
Frankfurt:	58 million
Heathrow:	70 million
Gatwick:	34 million
Charles de Gaulle:	80 million
Hong Kong:	61 million
Dubai:	66 million

A3000 HMI PLATFORM

- A3000 is a proven, reliable, and standards compliant **A-SMGCS Level 1 and Level 2** system
- **Intuitive**, **easy to use** controller working position (CWP)
- **Over 50 different external interfaces** have been implemented over the years
- Many protocols are supported out of the box, both **proprietary and standard**



A3000 HMI PLATFORM

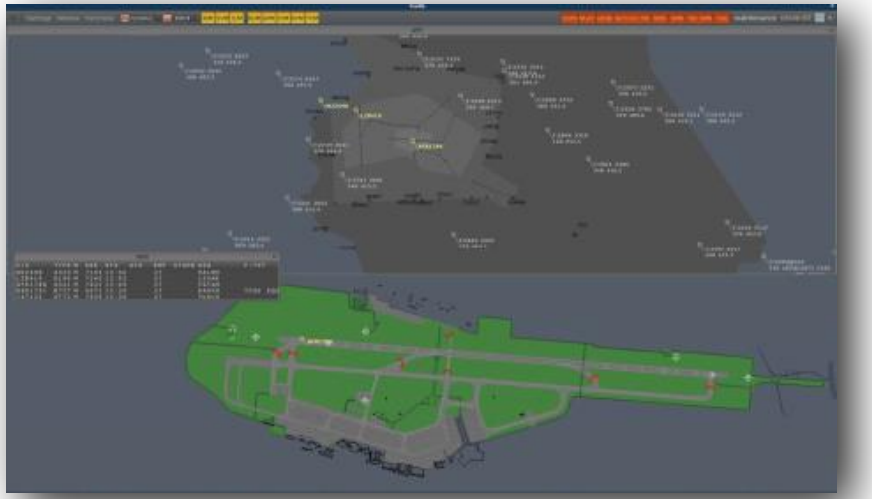
- Design practices comply with **ISO 9001:2008** and **TickIT**
- Tested in accordance with **ED-87B**
- Safety assessment in accordance with **ESSAR4**, **ESSAR6**, **EUROCONTROL SAM**
- It supports **multiple types of sensors**:
  - SMR
  - MLAT
  - ADS-B
  - Primary radar (PSR)
  - Secondary radar (SSR), including Mode S
  - Inputs from external trackers

A3000 HMI PLATFORM

- Ground traffic is shown in **main window** or different **sub-windows**
- **Each window shows**:
  - One or more background maps
  - SMR video
  - Fused Tracks
    - Track symbol
    - Track label
    - Track history dots
    - Color indicates classification:
      - Arrival
      - Departure
      - Vehicle
      - Tow
      - Overflight

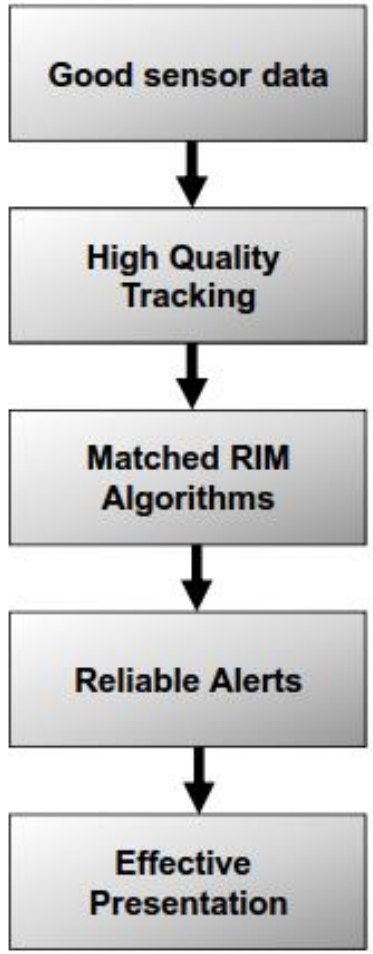
A3000 HMI PLATFORM

- **Approach traffic** is shown in:
  - One or more approach windows
  - Approach window can also be put on a separate screen
  - Approach label layout can differ from ground label layout
- **Flight data can be fused from different sources**:
  - Flight Data Processing System
  - Airport database
  - Gate management system
  - A-CDM system
- **Identification**
  - Automatic
  - Manually



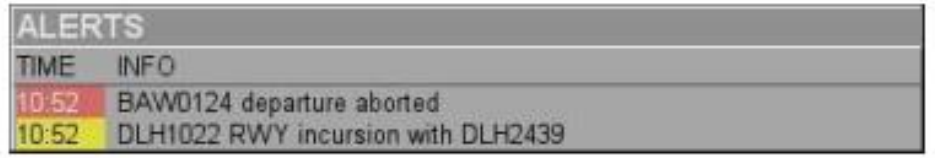
A3000 HMI PLATFORM

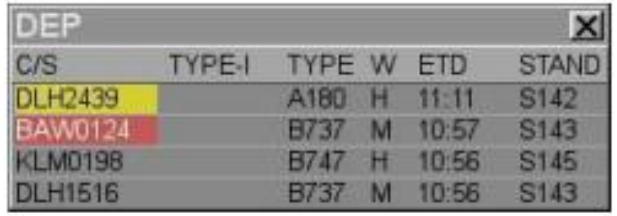
- A3000 incorporates a comprehensive, highly configurable set of surface **safety nets**
- Alerts can be adapted to the **local operational procedures**
- Different parameters sets for **normal** and **low visibility** operations
- Configurable **audible** alerts
- Alert parameters are (**Rule Based**) configurable
- Alerts can also be received from **external systems**



A3000 HMI PLATFORM

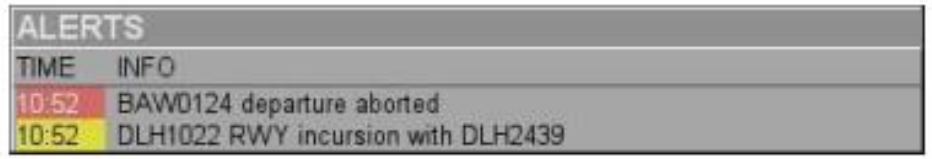
- Alerts are presented:
  - In **alarm list**
  - In **track label**
  - In **flight data lists**
  - On **electronic flight strip**
- Most alerts have a **warning state** and an **alarm state**

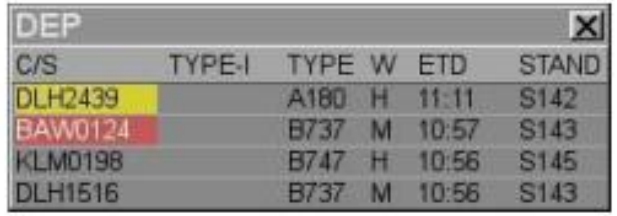




A3000 HMI PLATFORM

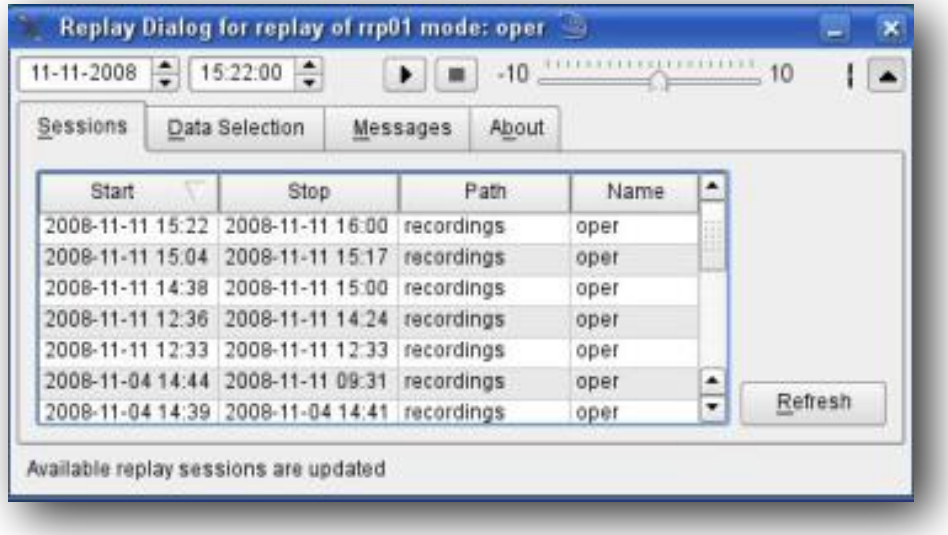
- **Runway Incursion** Monitoring (RIM)
- **Stopbar Violation** Monitoring (SVM)
- **Taxiway Collision** Monitoring (TCM)
- **Emergency Code** Monitoring (ECM)
- **Restriction Violation** Monitoring (RVM)
- **Area Penetration** Monitoring (APM)
- **Occupied Stand** Monitoring (OSM)
- **SID / Runway** Monitoring (SRM)





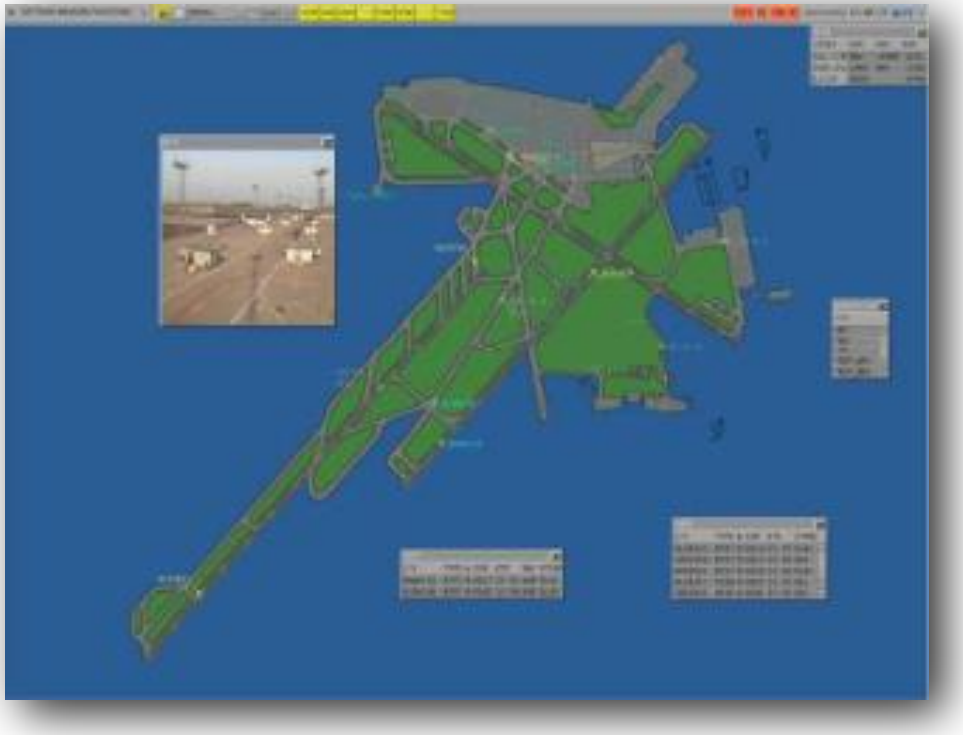
A3000 HMI PLATFORM

- **Data Recorded**: Internal data, external interfaces, voice channels
- **Workstation Syncronized Replay** (Radar Video, Flight Data, Voice)
- **Replay Commands** (Start, Freeze, Forward, Backward, Stop, etc.)
- **Cyclical Recording**



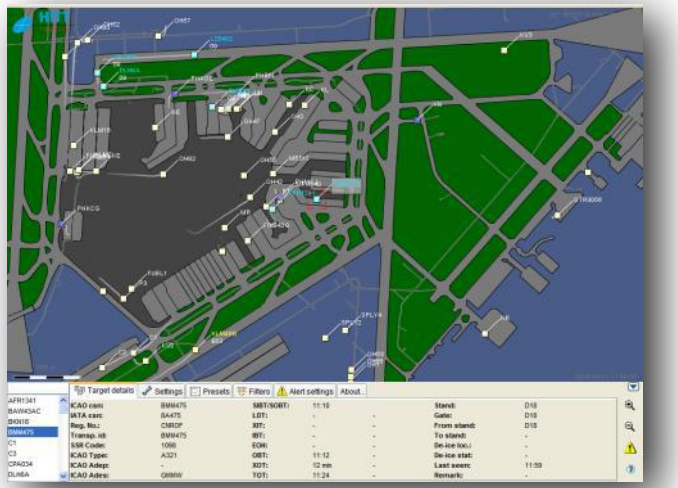
A3000 HMI PLATFORM

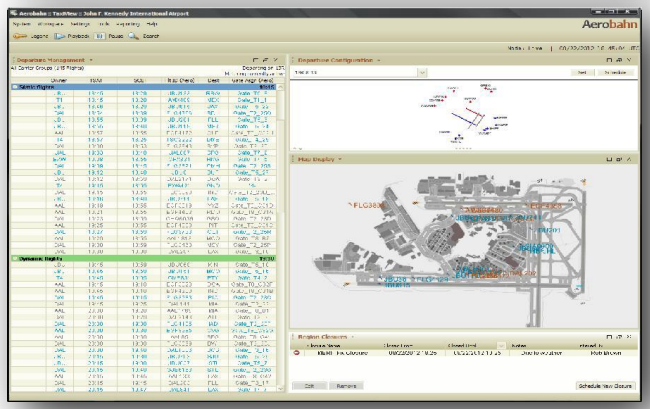
- **Display camera** image(s)
  - Integrated in Traffic Display; and/or
  - On 2nd screen (mosaic)
- **Control cameras** (PTZ)
  - Manually
  - Follow track
  - Field of view is shown
- **Integrated in Recording**
- **Synchronized Replay**



A3000 HMI PLATFORM

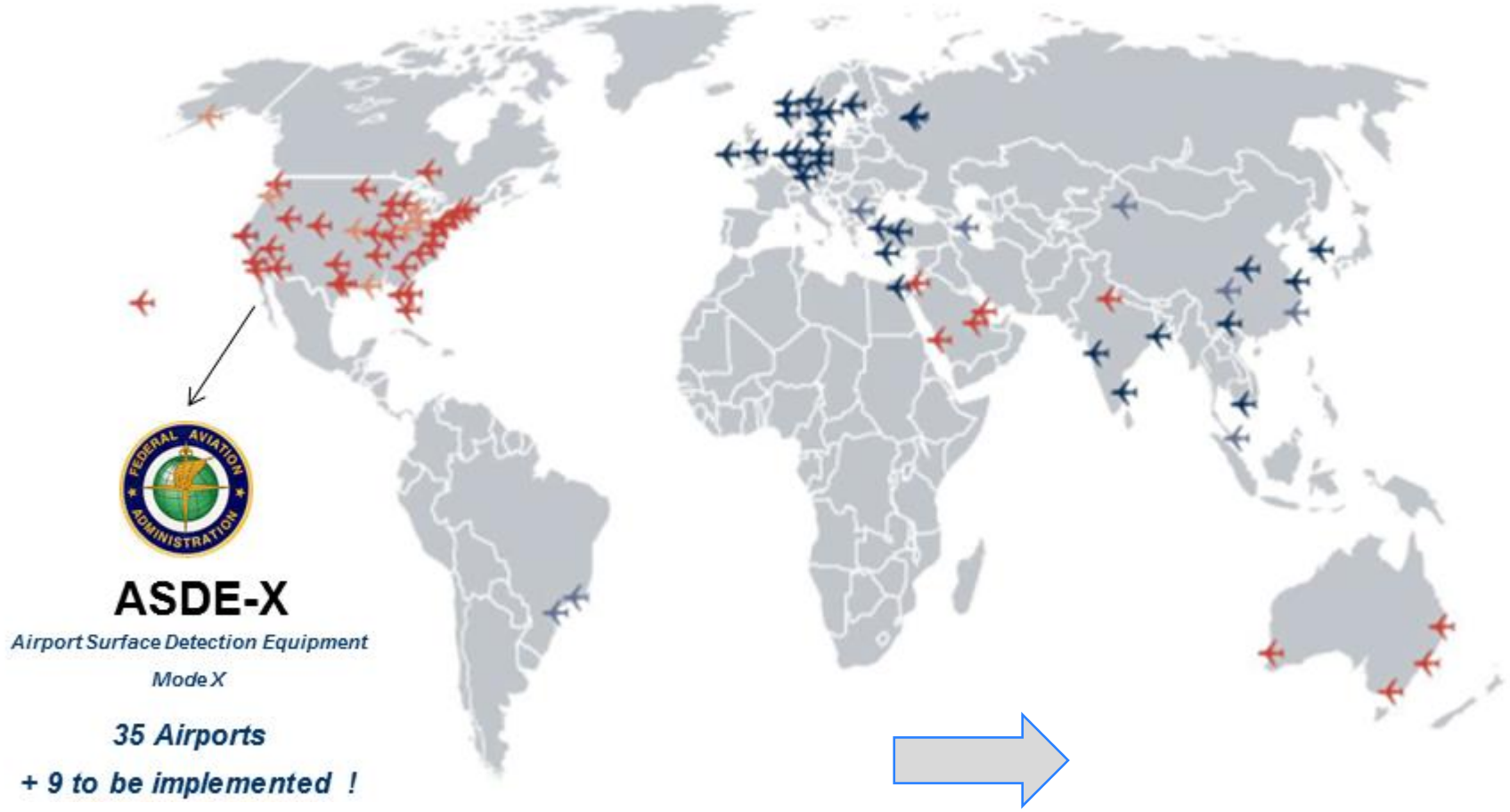
- Traffic situation is of interest for **other users at the airport**
- Examples: **airlines**, **airport**, **handling companies**, **fire department**, **security**, **VIP office**, etc.
- Can be presented:
  - On **existing office computers** (in web browser)
  - On **mobile devices** (e.g. in vehicles)





A3000 HMI PLATFORM

A3000: *Advanced Surface Movement Guidance and Control System*



ASDE-X

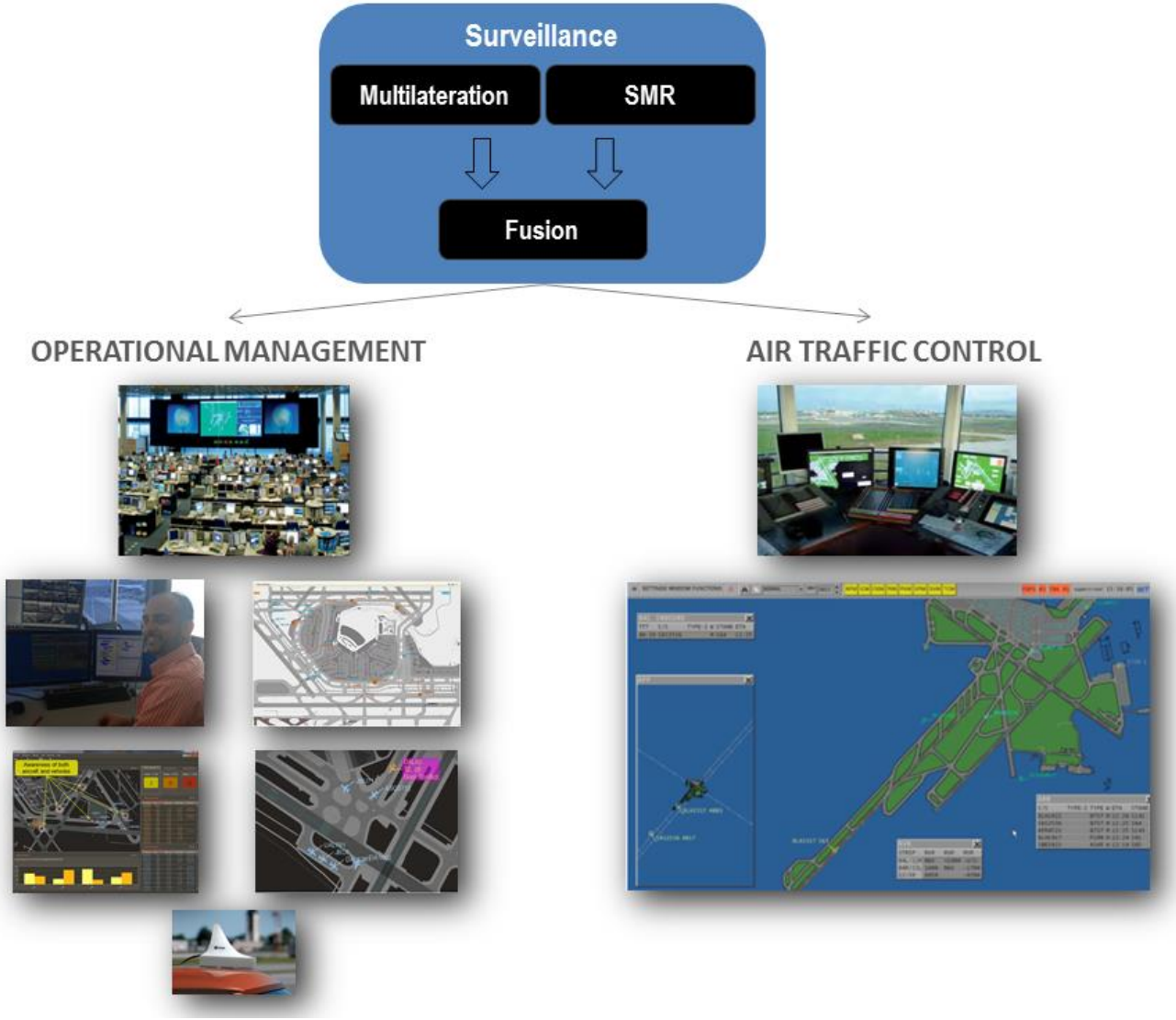
Airport Surface Detection Equipment

Mode X

35 Airports

+ 9 to be implemented !

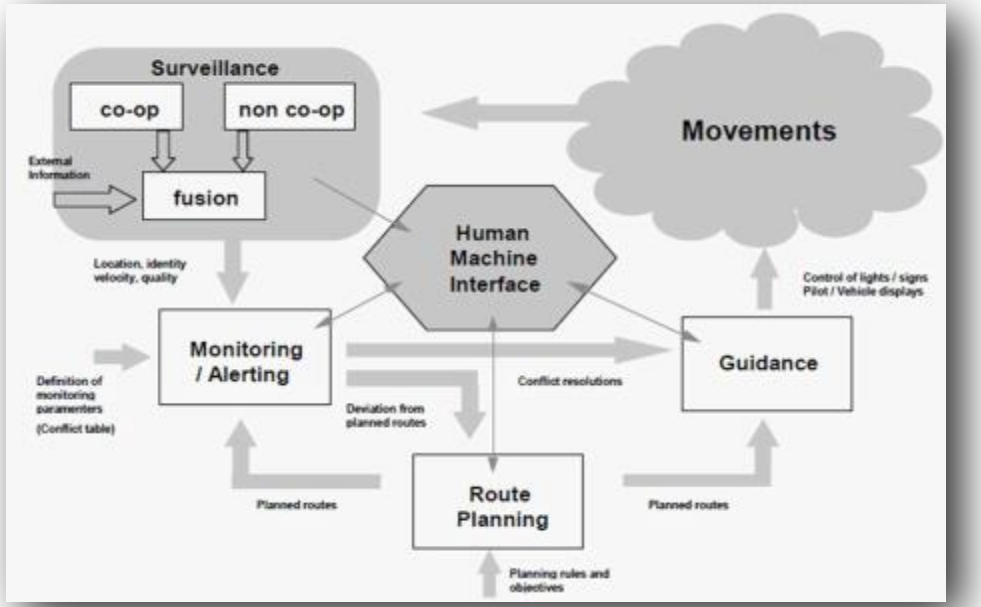
SURFACE SURVEILLANCE FOR A-CDM PURPOSES



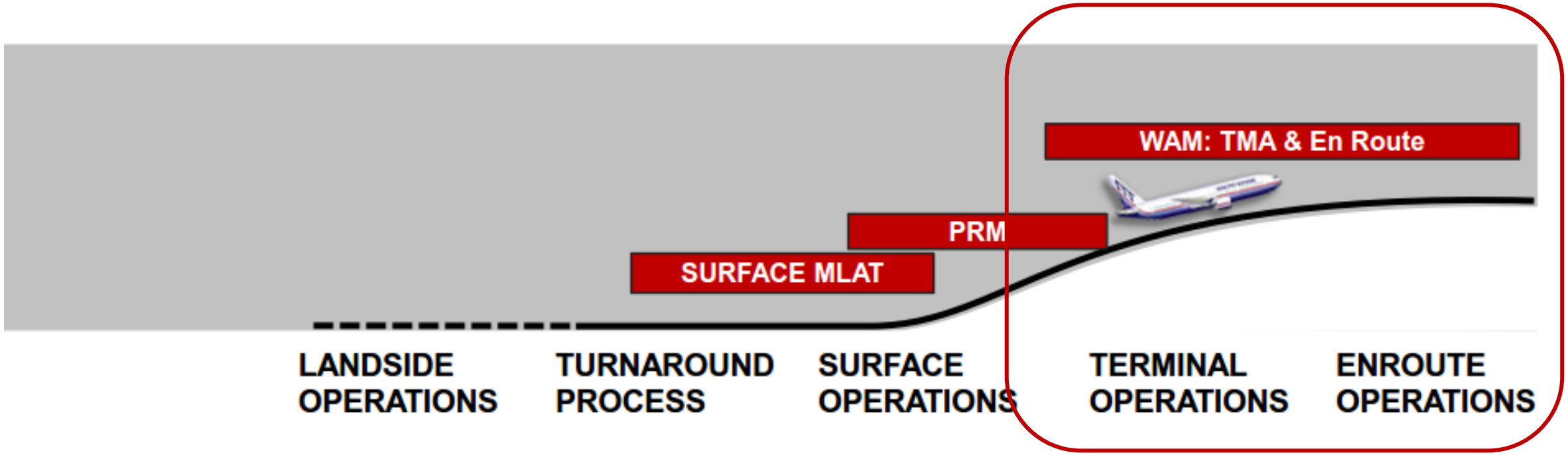
A-SMGCS

Advanced Surface Movement Guidance and Control System

(**ICAO 9830**)

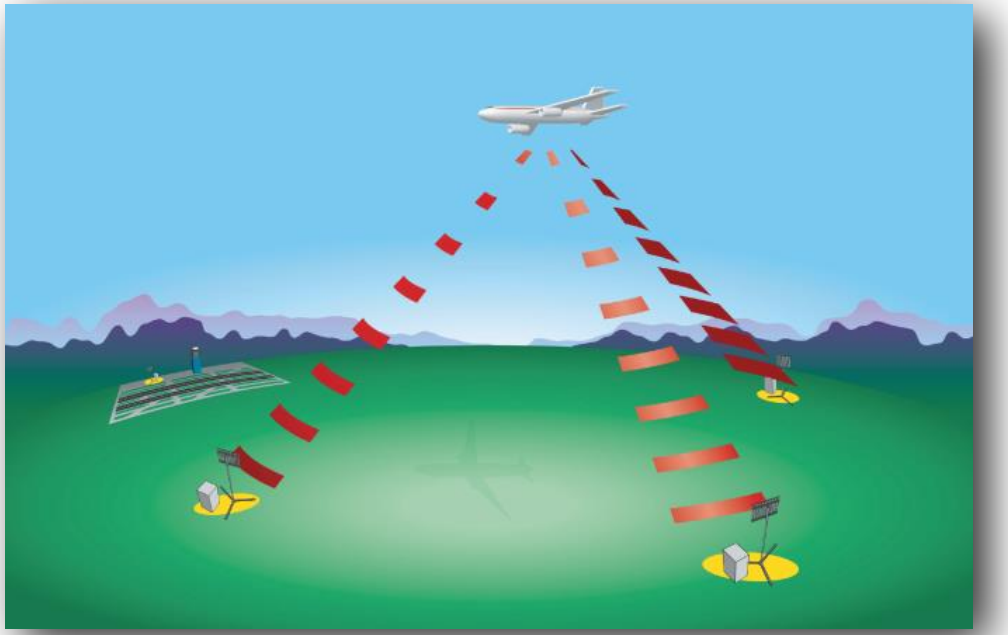


AIRSPACE SOLUTIONS - WIDE AREA MULTILATERATION



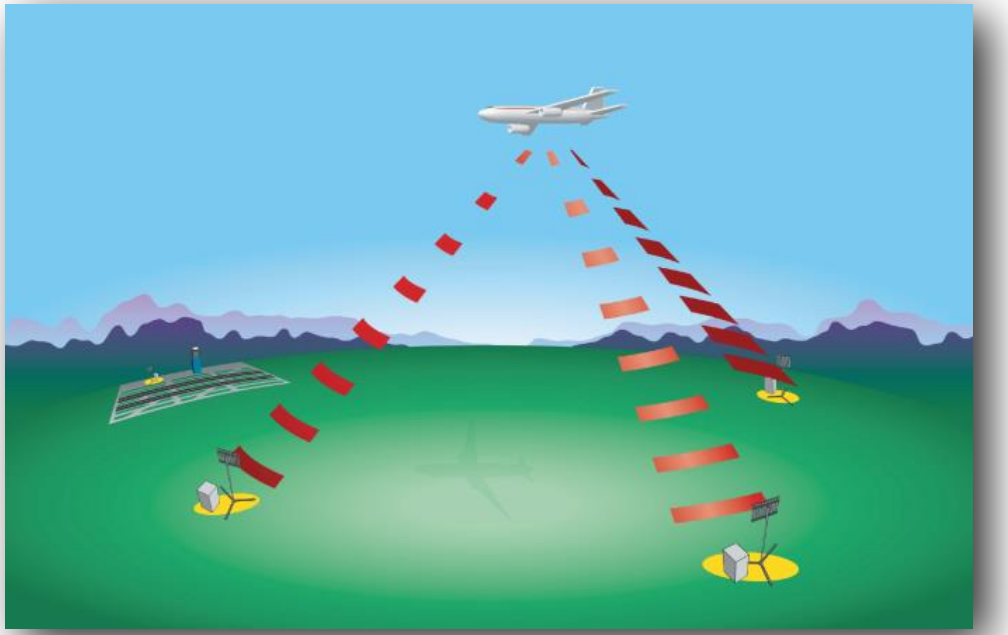
AIRSPACE SOLUTIONS - WIDE AREA MULTILATERATION

- Network of **fixed ground stations** that simultaneously provides surveillance for aircraft of varying equipage:
  - **Multilateration**
    - Mode A/C Transponder (1090 MHz)
    - Mode S Transponder (1090 MHz)
  - **ADS–B**
    - 1090 MHz Extended Squitter
- **Two surveillance systems in one**
  - **ADS-B surveillance** provided by decoding the content of messages transmitted by aircraft
  - **Multilateration surveillance** provided by measuring the time of arrival of same messages to calculate position independent of message content



AIRSPACE SOLUTIONS - WIDE AREA MULTILATERATION

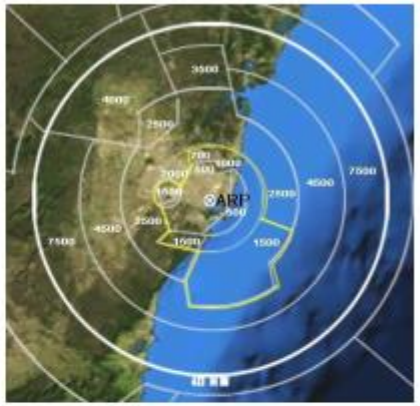
- **Higher accuracy** & **update rate** allow for **reduced separation**
- No impact on equipage – it works with existing transponders, **no need to wait for ADS-B equipage**
- **Deployment in challenging environments** (Areas where traditional Radars cannot operate !)
- **Cost effective alternative** to secondary surveillance radars

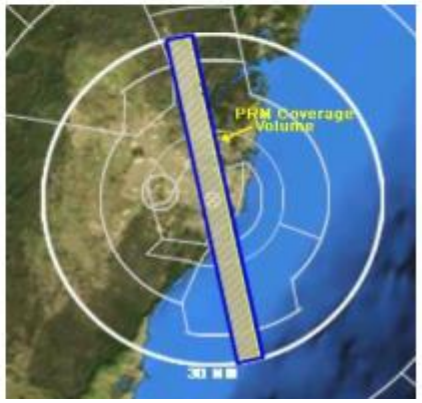


AIRSPACE SOLUTIONS - WIDE AREA MULTILATERATION

SYDNEY WAM / PRM

- Overview:
  - WAM system for surveillance of SSR and ADS-B aircraft in the Sydney TMA
  - Commissioned September 2011
  - Independent surface MLAT system for A-SMGCS
- WAM Requirements:
  - Coverage: 40 NM radius from the Sydney ARP, up to FL180
  - Accuracy: 150 m RMS
  - Update rate: four seconds
- PRM Requirements:
  - Coverage: 30 NM from Sydney ARP, 4.6 nm band along runways 16/34 (2 NM on each side of the runways). Upper limit is FL150
  - Accuracy: 50 m RMS
  - Update rate: one second
  - Improved Sydney Operations

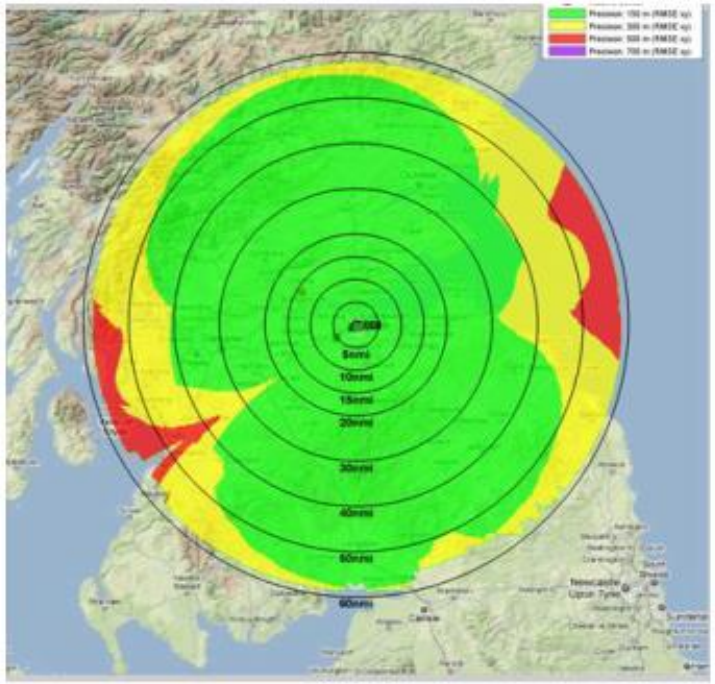


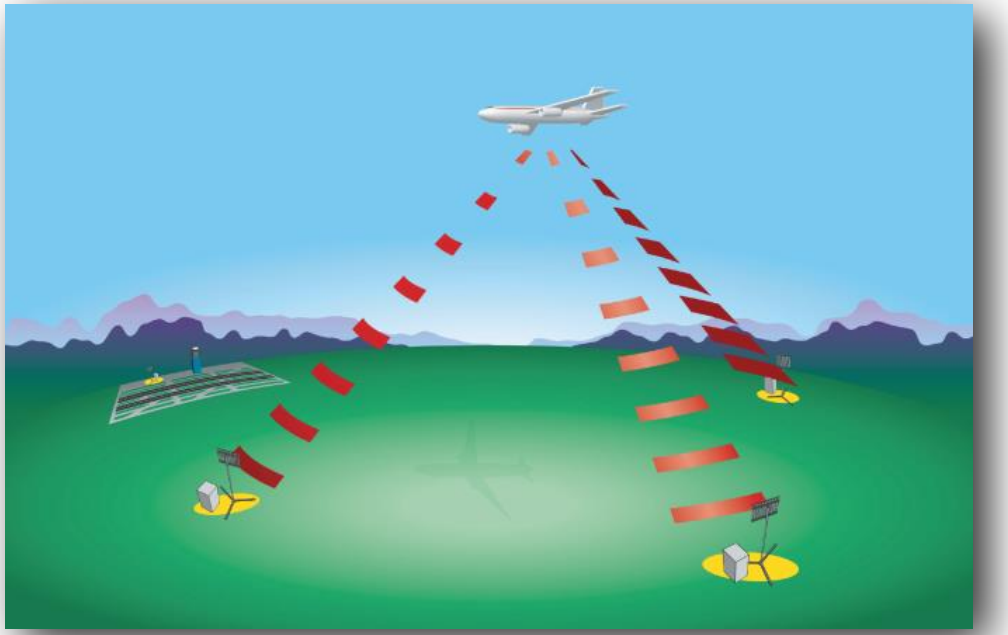


AIRSPACE SOLUTIONS - WIDE AREA MULTILATERATION

TERMINAL SURVEILLANCE

- NATS UK WAM coverage in Edinburgh, Scotland
- ED-142 driven requirements
- *A few sensors on/around the airport – only a few miles apart, looking out from constellation*
- Coverage more than 50 miles away
  - Green – 150m RMS
  - Yellow – 300m RMS
- Uses patented Range-aided Multilateration technique
- Contract award to commissioning achieved in 9 months of project execution.





AIRSPACE SOLUTIONS - WIDE AREA MULTILATERATION

SWEDEN NATIONWIDE

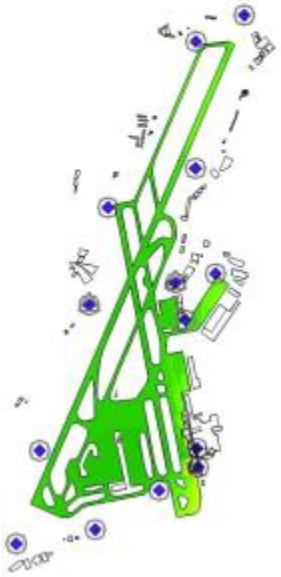
- Sweden FIR
  - 7 WAM Regions
- Continuous En-Route Coverage above FL90

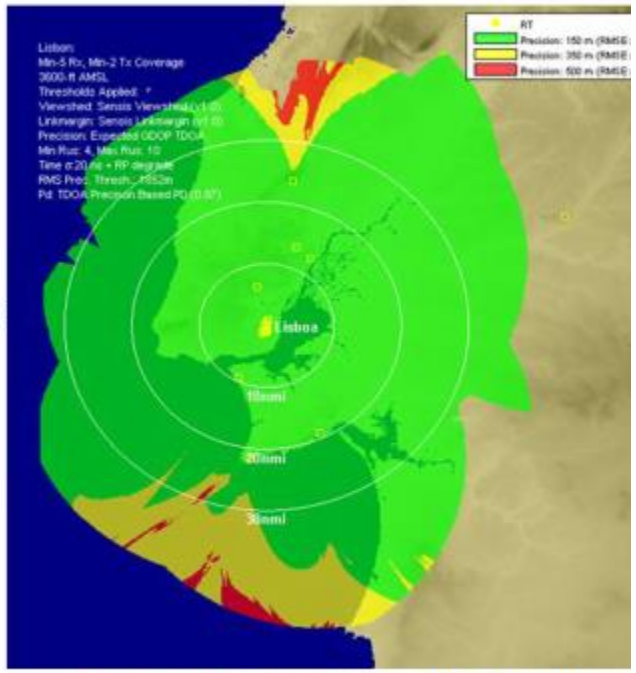
Accuracy	<FL195 150 m; ≥FL195 350 m
Update Rate	TMA/CTR: 5 sec.; En route: 8 sec.
Coverage	TMA: ≥1500 ft MSL; CTR: ≥ 200 ft AGL Enroute: FL660
Area	830 x 220 NM + 50 NM buffer zone

AIRSPACE SOLUTIONS - WIDE AREA MULTILATERATION

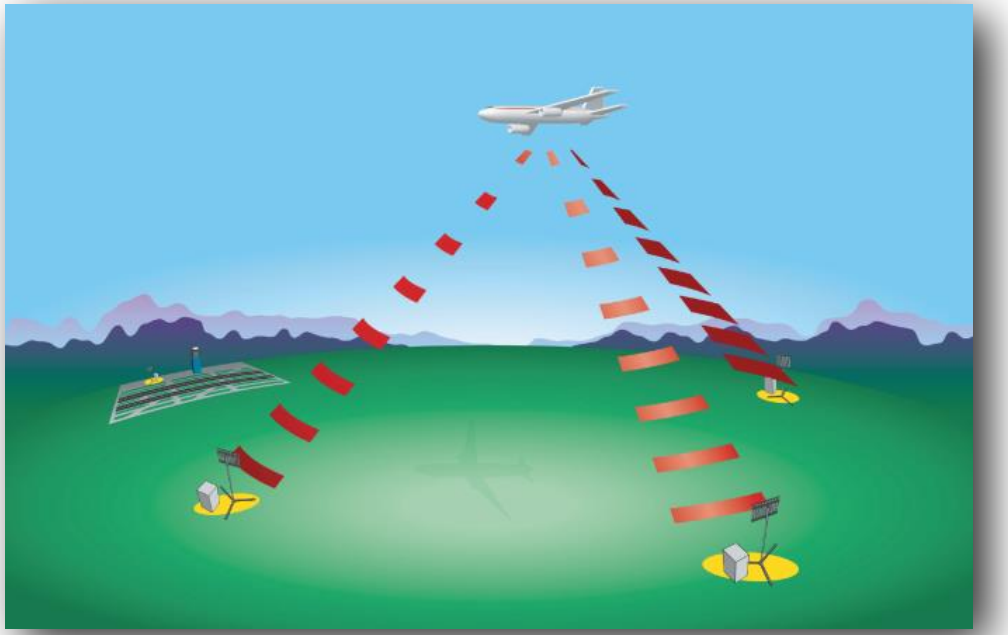
MIXED MODE

- Mixed Mode (Surface/TMA/WAM)
  - Lisbon, Portugal
  - One system – two applications
  - Airport surface
  - Low-altitude coverage TMA (below radar coverage)
  - One processing rack, one system
  - Expandable, flexible, powerful





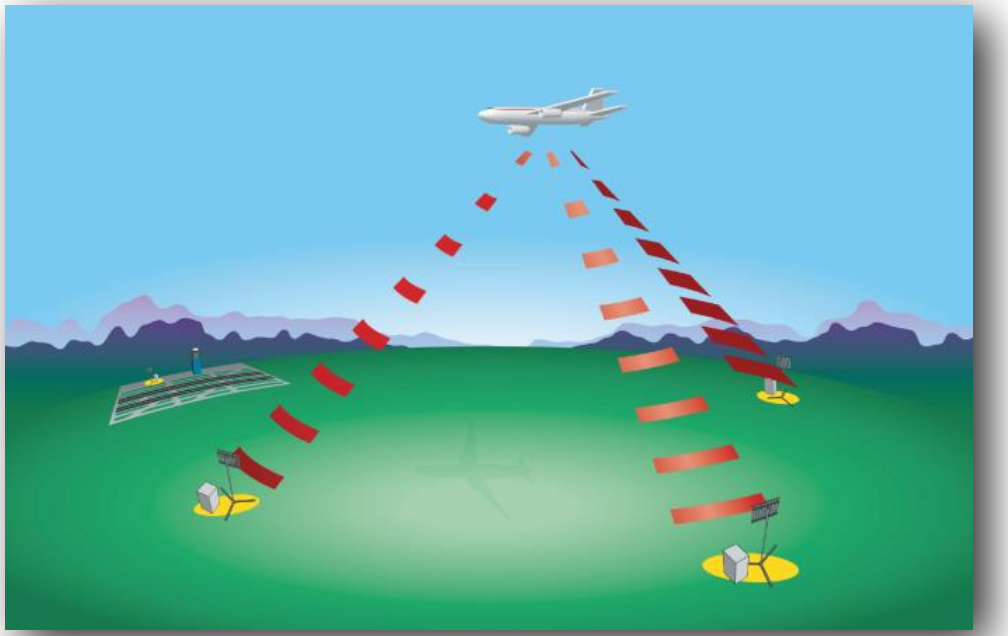
Lisbon TMA Coverage at FL036 (3,600ft)



AIRSPACE SOLUTIONS - WIDE AREA MULTILATERATION

SPECIAL APPLICATIONS

- WAM surveillance for Non-Radar Airspace in the North Sea
- Detect & track low-flying helicopters that serve the oil rigs
- Flexibility is very important
- Example systems:
  - NATS North Sea (Operational)



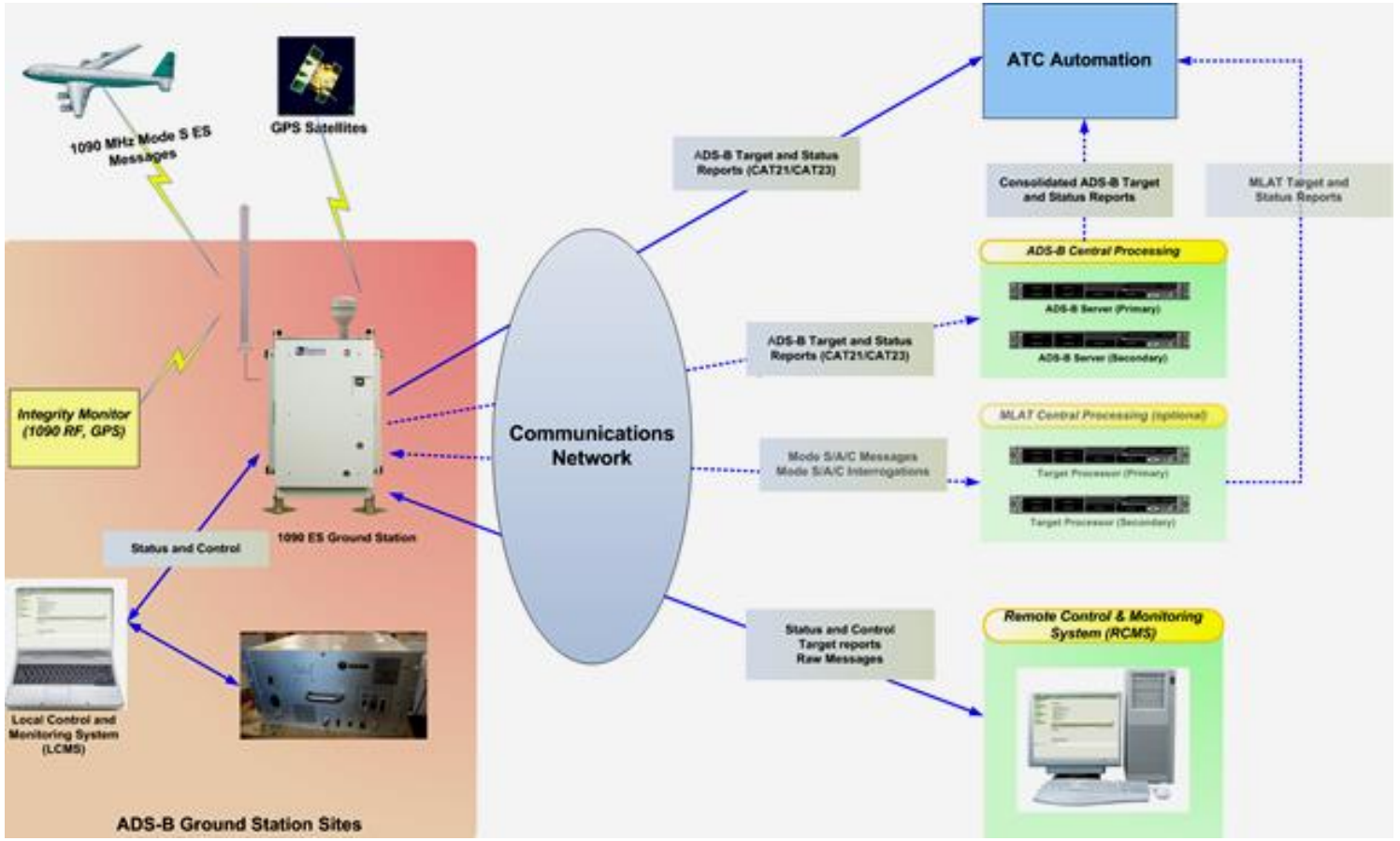
AIRSPACE SOLUTIONS - ADS-B

- On board aircraft equipment determines **GPS position and velocity** based on GPS
- Aircraft transmits **position, velocity, identity, altitude, status, intent**
- Ground stations receive and **decode ADS-B** messages and send ADS-B position reports to ATC automation
- Multiple ADS-B data links
  - **1090 MHz Extended Squitter (ES)**
  - Universal Access Transceiver (UAT), implemented in the US

AIRSPACE SOLUTIONS - ADS-B

- Flexible and Scalable
  - **Small size**, **low power** consumption GS enable deployment in many physical environments
  - **Adaptable to terrain-limited coverage**
  - **Coverage extendable** by addition of ground stations
- High Performance
  - ADS-B provides **better accuracy, higher integrity and higher update rate** than traditional radar
  - Enables **reduction in separation standards**
- Low Cost
  - **Lower acquisition cost and life cycle costs than radar**

AIRSPACE SOLUTIONS - ADS-B



AIRSPACE SOLUTIONS - ADS-B

- **ADS-B capable**
  - Processes DO-260/A/B Mode S ES messages
  - Reports ASTERIX CAT021/CAT023 messages
  - Complies with ED-129
- **MLAT capable**
  - Receives and decodes Mode S, Mode S ES and Mode A/C messages
  - Transmits Mode S/A/C interrogations
- **High resolution time stamping**
- **GPS antenna and receiver**
- **Indoor/Outdoor**
  - Weatherproof enclosure, -40C to 55C

AIRSPACE SOLUTIONS - ADS-B

- Consolidates **CAT21 reports** for one target from different ground stations into one output for automation
- Can support multiple **flavors of ASTERIX CAT21**, as well as **legacy radar formats such as CAT34/48**
- Provides ADS-B outputs to **multiple clients**
- Flexible, scalable service oriented architecture
- Supports **up to 500 simultaneous targets** and up to 128 GS