SURVEILLANCE SYSTEMS

Operational Improvement and Cost Savings, from Airport Surface to Airspace

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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)

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 )

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 )

Controller Working Position - Air Traffic Controller’s HMI
SR-3 SURFACE MOVEMENT RADAR
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Antenna Subsystem
- Antenna
- Motor Controller

Transceiver Enclosure

Radar Data Processor (RDP)

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

- LANDSIDE OPERATIONS
- TURNAROUND PROCESS
- SURFACE OPERATIONS
- TERMINAL OPERATIONS
- ENROUTE OPERATIONS

- WAM: TMA & En Route
- PRM
- SURFACE MLAT
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 (Multilateralación): 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 Synchronized 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: 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
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• 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

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