

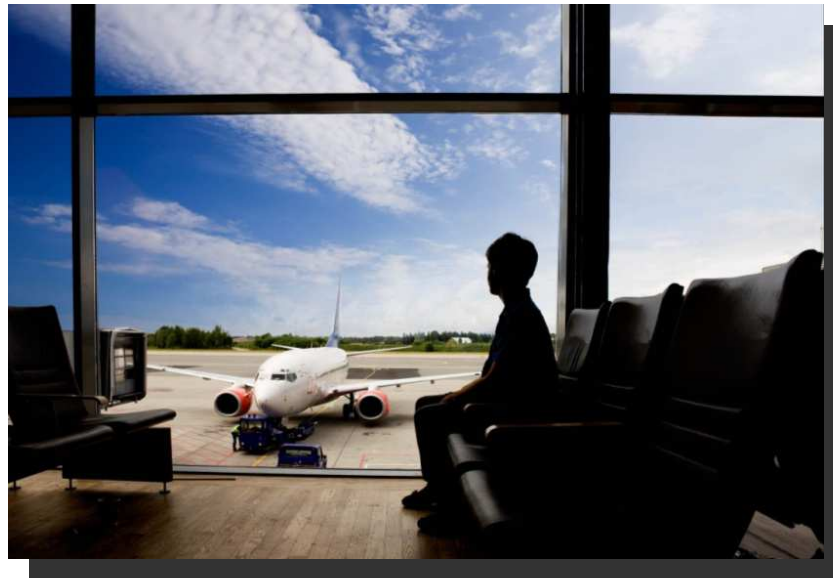
# Air Traffic Management and ADS-B

*Michael Sahlberg, April 2013*



# What I'll talk about

- ▶ Saab's role in world-wide air traffic management
- ▶ Our product suite
- ▶ And, of course, a detailed look at Saab's ADS-B, including
  - Saab 1090 Extended Squitter ADS-B Ground Surveillance System
  - Deployments for Nav Canada and Avinor



# WORLD-CLASS TECHNOLOGY

## *More than 75 years*



**1941**

First B17 delivered



**1948**

Tunnan – first flight



**1979**



**1990**

First laser simulator BT46



**1993**

First Gripen delivered



**2002**

First contract for NLAW



**2005**

Contract for Neuron



**2006**

Saab 2000 ERIEYE™ AEW&C



**2008**

Gripen Demo – first flight



**1937**

Saab is founded

**1990**

Saab Automobile independent company

**2000**

Saab acquires Celsius

**2005**

Saab acquires Grintek

**2006**

Saab acquires EMW

**1646**

Bofors Jämbruk is founded



**1894**

Alfred Nobel acquire Bofors



**1948**

First order for Carl Gustaf



**1998**

StriC in operation



**1950-**

Development of fighter radar



**1970-**

Development of GIRAFFE



**1980-**

Development of ARTHUR



**1990-**

Sea Giraffe AMB is launched



# THE FUTURE OF AIR TRAFFIC MANAGEMENT



DOUBLED **CAPACITY**



INCREASED **SAFETY & SECURITY**



REDUCED **COSTS**



REDUCED **ENVIRONMENTAL FOOTPRINT**



ATC



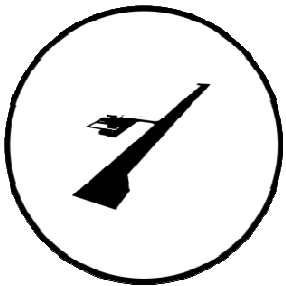
AIRPORT



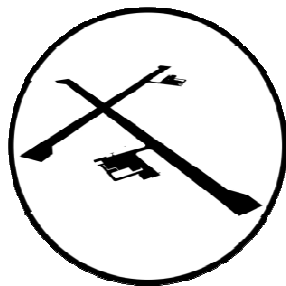
AIRLINE



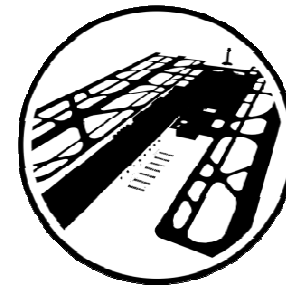
# FOR ALL STAKEHOLDERS AT AIRPORTS OF ALL SIZES



SMALL



MEDIUM



LARGE

# Saab ATM

- ▶ Saab Sensis leads Saab's global air traffic management
- ▶ Employees in United States, Europe and Australia



# Saab ATM

- ▶ We are the unmatched leaders in global ATM
- ▶ We helped pioneer many of the modern ATM systems in use across the world today
- ▶ We're respected for innovation, agility, and our commitment to engineering excellence.
- ▶ Improving security, safety and efficiency at more than 250 locations in 40 countries.



# Sensis and HITT

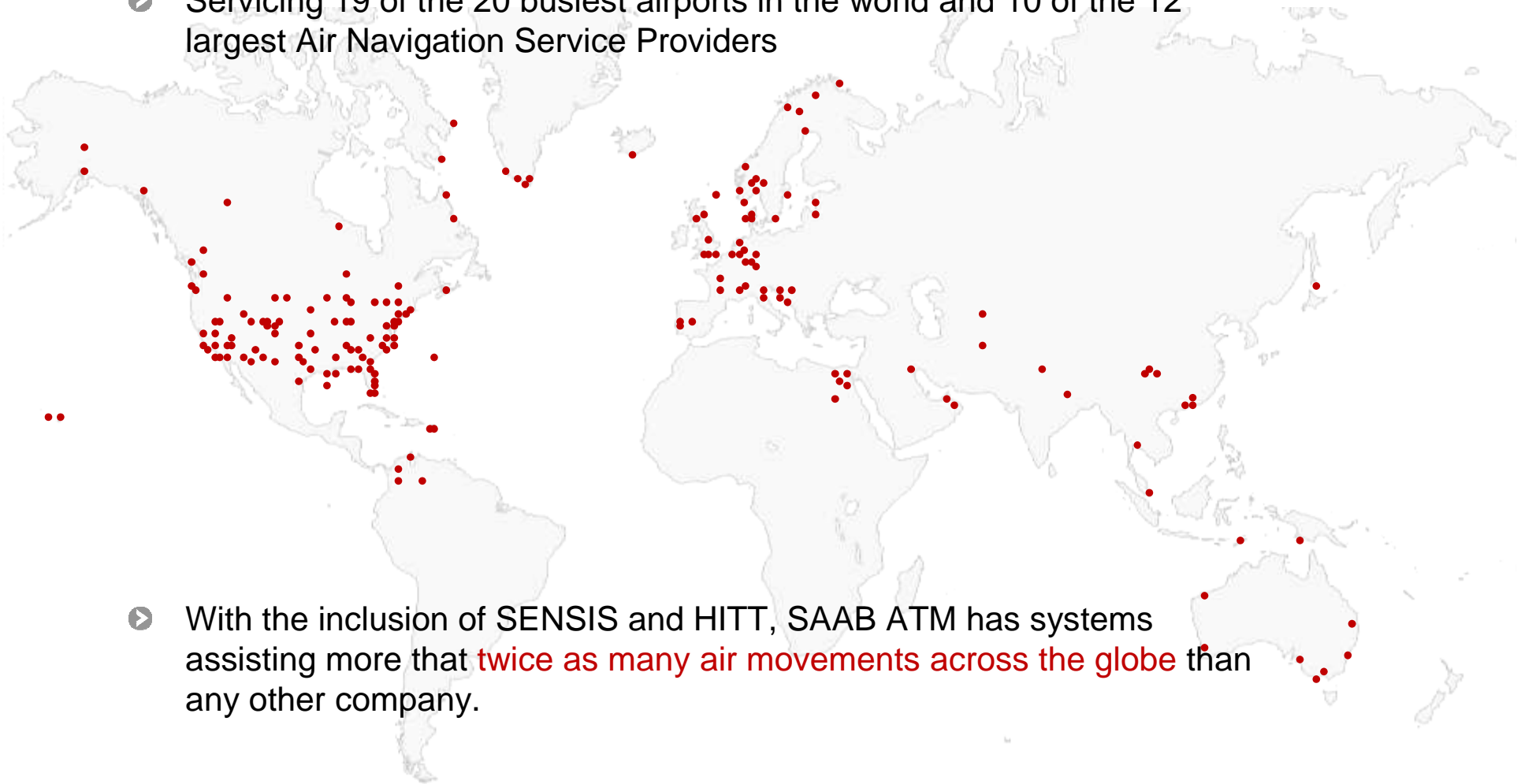
- ▶ Building on its own air traffic management capabilities, Saab acquired Sensis in 2011 and HITT in 2012
- ▶ Sensis, founded in 1985, specializes in advanced air traffic management and defense radar and security systems. **Sensis pioneered the development and implementation of ADS-B**, fielding the first operational transceivers for both Mode S Extended Squitter (1092 ES) and UAT datalinks.
- ▶ HITT brings considerable expertise in air and vessel traffic management systems and has a well-established presence in Europe, India and China; and a growing presence in South America.





# Saab ATM

- ▶ Products and services in more than 250 locations across the globe
- ▶ Servicing 19 of the 20 busiest airports in the world and 10 of the 12 largest Air Navigation Service Providers



- ▶ With the inclusion of SENSIS and HITT, SAAB ATM has systems assisting more that **twice as many air movements across the globe** than any other company.

# AIR TRAFFIC MANAGEMENT LEADERS

**AIRPORT SURFACE SAFETY**

**WIDE AREA SURVEILLANCE**

**AIRLINE AND AIRPORT  
AUTOMATION**

**TOWER AUTOMATION**

**ADVANCED DEVELOPMENT**

## RWSL & A-SMGCS & MLAT



- Additional runway safety
- Aircraft and vehicle movements
- All weather operations
- Direct-to-pilot warnings

# AIR TRAFFIC MANAGEMENT LEADERS

AIRPORT SURFACE SAFETY

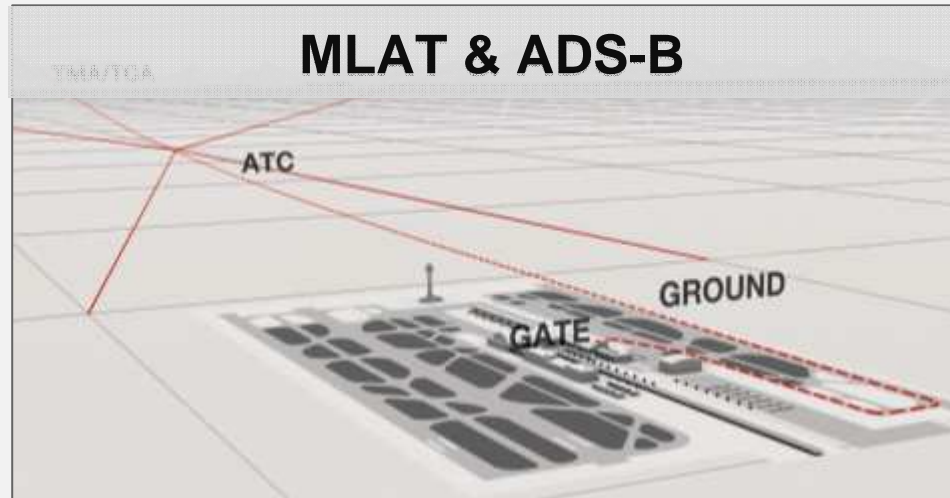
WIDE AREA SURVEILLANCE

AIRLINE AND AIRPORT  
AUTOMATION

TOWER AUTOMATION

ADVANCED DEVELOPMENT

## MLAT & ADS-B



- Multi-level surveillance
- Precise location of traffic
- Conflict detection and alert
- Lower costs

# AIR TRAFFIC MANAGEMENT LEADERS

AIRPORT SURFACE SAFETY

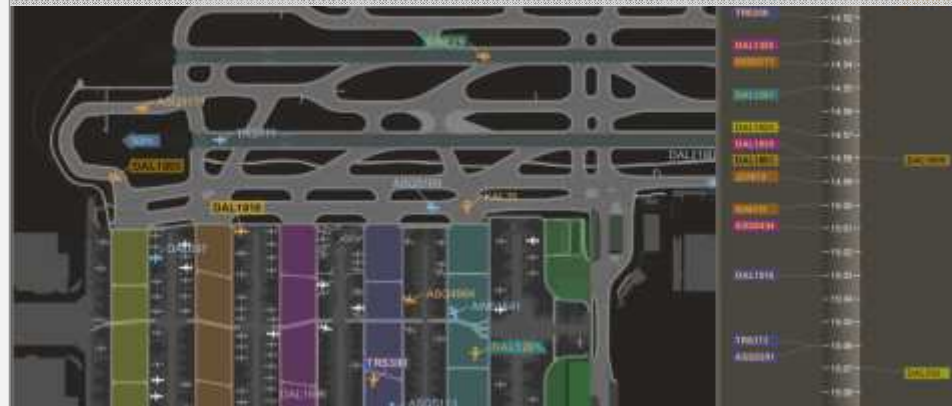
WIDE AREA SURVEILLANCE

AIRLINE AND AIRPORT  
AUTOMATION

TOWER AUTOMATION

ADVANCED DEVELOPMENT

## AEROBAHN



- Enables resource optimization
- Reduce emissions
- Facilitates planning
- Decrease delays and heighten performance

# AIR TRAFFIC MANAGEMENT LEADERS

AIRPORT SURFACE SAFETY

WIDE AREA SURVEILLANCE

AIRLINE AND AIRPORT  
AUTOMATION

TOWER AUTOMATION

ADVANCED DEVELOPMENT

## r-TWR & INTAS & i-TWR



- E-strips and other advanced systems
- Improved workflow
- Sustaining profitable airports
- Efficient and safe



# AIR TRAFFIC MANAGEMENT LEADERS

**AIRPORT SURFACE SAFETY**

**WIDE AREA SURVEILLANCE**

**AIRLINE AND AIRPORT  
AUTOMATION**

**TOWER AUTOMATION**

**ADVANCED DEVELOPMENT**



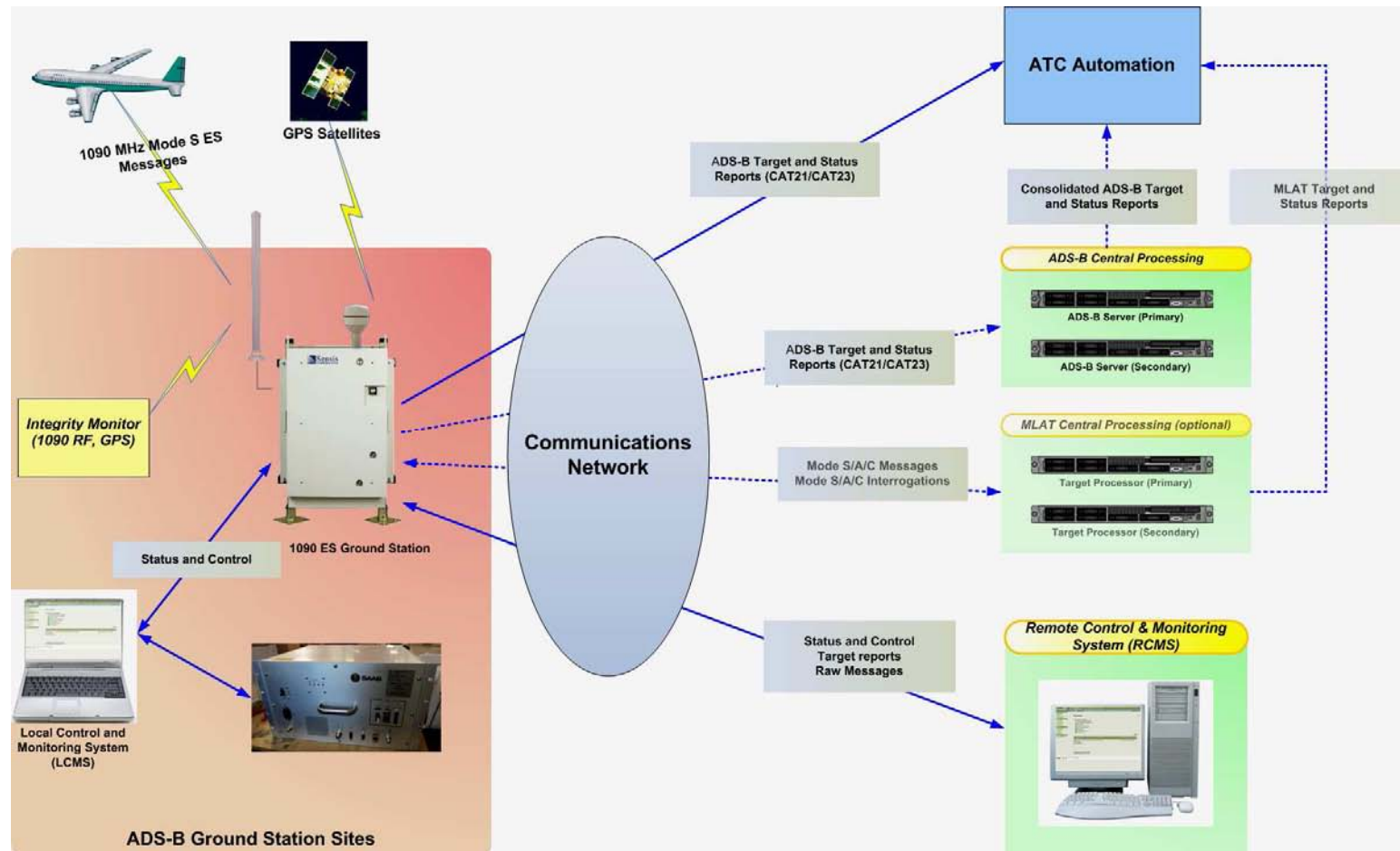
- **Decision support tools**
- **Trajectory based flight management**
- **Advanced analysis and problem-solving**
- **Research to Reality**

# ▶ Saab 1090 Extended Squitter (ES) ADS-B Ground Surveillance System (GSS)





# Ground Surveillance System (GSS) Architecture



***GSS consists of ground stations, Remote Control & Monitoring, optional ADS-B Central Processing and optional MLAT Processing***

# RU6 – MLAT and 1090 ES ADS-B Ground Station

- ▶ 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
  - 19" rack mountable
- ▶ Low power consumption



# ADS-B Central Processor (ADS-B Server)

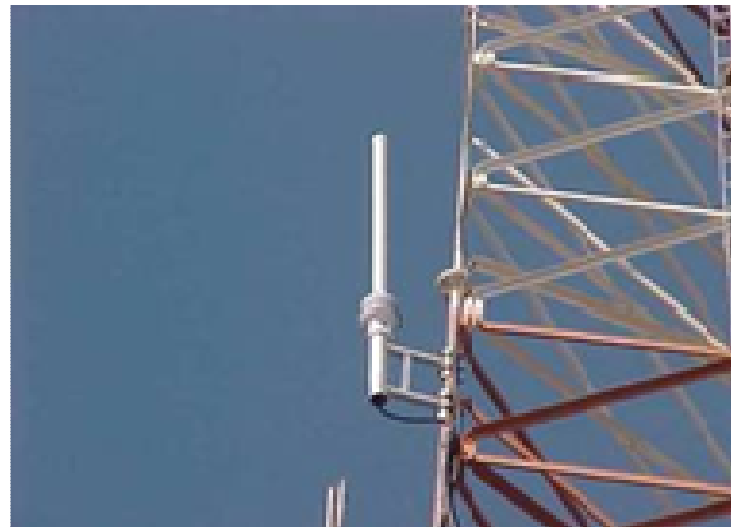
- Consolidates CAT21 reports for one target from different ground stations into one output for automation
- Can support validation of ADS-B data through a variety of techniques (TDOA, comparison to radar, etc.)
- Can support multiple flavors of ASTERIX CAT21, as well as legacy radar formats such as CAT34/48
- Provides ADS-B outputs to multiple clients
- Evaluates equipment status to determine system status
- Web based control and monitoring interface (like eLCMS for the GS)
- Flexible, scalable service oriented architecture
- Fully redundant
- Supports up to 500 simultaneous targets and up to 128 GS

# Ground Station Antennas



► Variety of antennas for short range, medium range and long range applications:

- 3 dB AS177
- 9 dB dB-5100A
- 12 dB dB-540



# 1090 ES Ground Station Specs (1/2)

Parameter	Specification
Message Processing	Complies with <b><i>EUROCAE ED-129</i></b> and <b><i>DO-260B</i></b>
Report Formats	Target Reports: Cat021 Ed 1.4 Status Reports: Cat023 Ed 1.2
ASTERIX CAT021 Data Items Inclusion	Per ED-129. Non-mandatory data items are configurable.
Reporting Modes	Periodic, Data Driven, Throttled
Target Filters	Filters by 24 bit ICAO address, NUCp, NIC
Capacity/Latency	3000 ES messages/sec, 500 ASTERIX reports/sec < 500 ms latency

# 1090 ES Ground Station Specs (2/2)

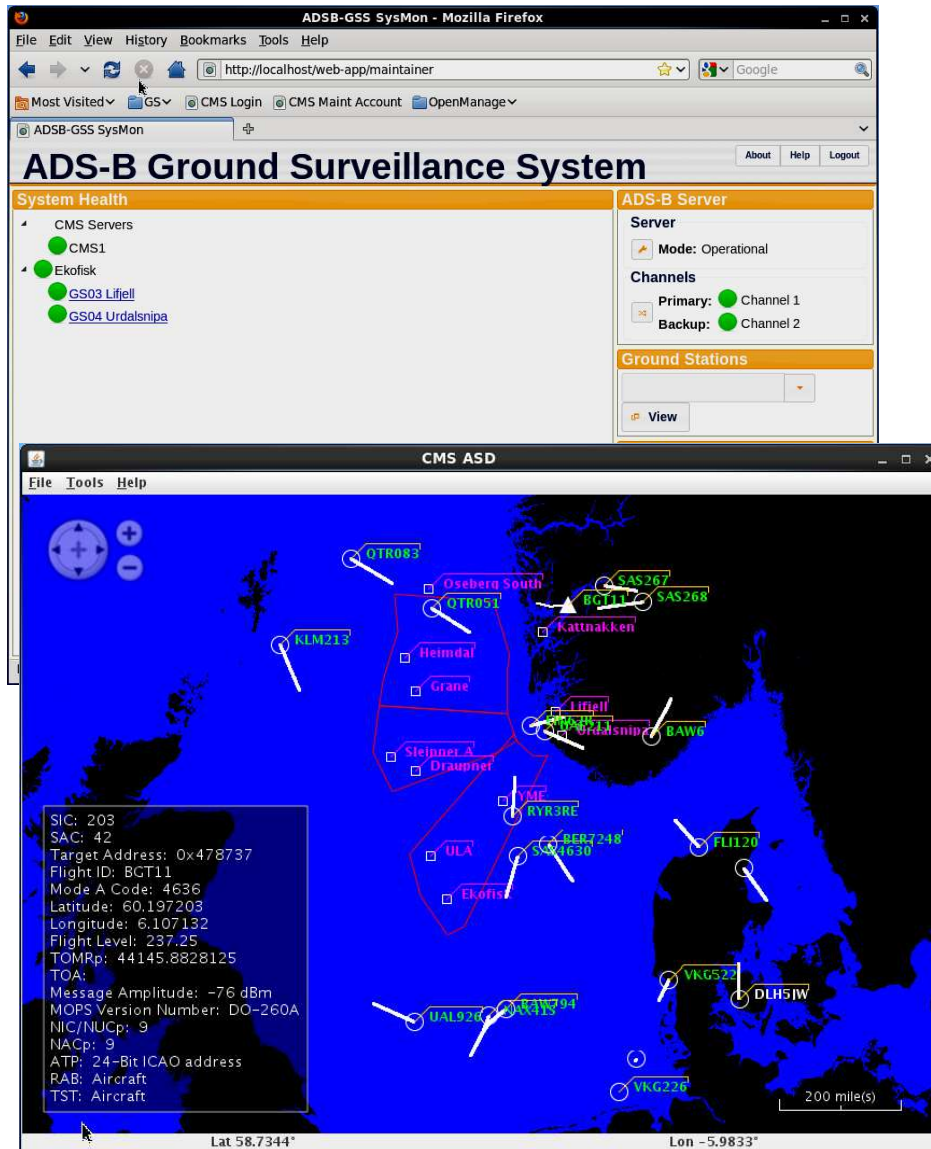
Parameter	Specification
<b>Control &amp; Monitoring</b>	SNMP v2, embedded web based interface
<b>Interfaces</b>	IP based, local and remote network interfaces
<b>Modes &amp; States</b>	Operational/Maintenance Mode Primary/Secondary State (for redundancy support)
<b>MLAT Support</b>	Compatible with Saab Sensis Multistatic Dependent Surveillance (MDS) surface and wide area multilateration system
<b>Software Assurance</b>	ED-129, Assurance Level (AL) 4

# Local Control & Monitoring System (LCMS)

- ▶ Saab ADS-B Ground station incorporates embedded web server (eLCMS) for control & monitoring
- ▶ User connects to eLCMS with standard web browser, no special software is required
- ▶ User can view LRU status, view statistics, configure GS and upload new software versions

The screenshot displays the eLCMS web interface. At the top, it shows 'eLCMS: Connected' and 'GS04-Urdalsnipa'. A yellow warning banner states: 'The Control Mode is Operational, switch to Maintenance/Reprocessing before making changes.' The main content area is titled 'ADS-B Commands' and features a dropdown menu set to 'Operational'. Below this are several buttons: 'Save Config', 'Load Config', 'Reset Statistics', 'Switch Image', 'Soft Reset', and 'Hard Reset', each with a corresponding description of its function. A footer at the bottom left identifies the system as 'eLCMS' and notes it is designed and developed by 'Saab Sensis Corporation'.

# Remote Control & Monitoring System (RCMS)



- ▶ Control & monitoring of multiple ground stations
  - GS LRU status and statistics
  - GS commands and configuration parameters
  - Code and file upload
- ▶ Data recording: ASTERIX CAT21/23 and raw Mode S messages (if enabled at the GS)
- ▶ Air Situation Display
- ▶ Security and access control



# ADS-B Integrity Monitoring



Saab Sensis VeeLo

Dimensions (HxWxD)	235 x 146 x 205 mm
Weight	0.77 kg
Power Supply	9 to 32 Volts DC, ~1.5 watts
Transmit Power	20 W (peak)
Temperature	-30 to 55 °C
Relative Humidity	5 to 95%
Wind	Up to 160 kph

- Saab VeeLo NG can be used as an ADS-B Site Monitor
- Provides end-to-end RF Test Target and GPS integrity monitoring
- Generates DO-260A compliant ADS-B position with HPL
- Adaptable Mode S address
- GS monitors reception of ADS-B site monitor message and verify correct position
- GS generates CAT21 target report flagged as site monitor, with FOM derived from HPL

# ADS-B Implementation Considerations

## ► Interfaces to Automation

- Eurocontrol ASTERIX standards for ADS-B reports
- Typical: Category 21 for target reports, Category 23 for ground station status
- Specialized formats possible for legacy automation (e.g. CD2, CAT34/48)
- Needs to be supported by the ATC Processing and Display system: data fusion, handling of accuracy/integrity indicators, handling of identification (Flight ID vs. Mode A), display symbology, etc.

## ► Standards Compliance

- ADS-B Mandate in 2016 for Europe and 2020 for United States
- **Ground Station:** EUROCAE ED-126 (RTCA DO-303)/ED-129
- **Software:** EUROCAE ED-109/ED-153
- **Avionics:** RTCA DO-260/A/B, EUROCAE ED-102A

## ► Ensure that continuous compliance to revised specifications is supported by surveillance supplier

# ADS-B Safety Considerations

## ➤ ADS-B accuracy and equipage

- Risk: non-equipped targets or inaccurate or low quality ADS-B positions
- Mitigation: airspace segregation for ADS-B equipped targets, implementation of ADS-B “White List”, filtering of low integrity ADS-B reports

## ➤ GPS Integrity

- Risk: Poor ADS-B accuracy due to constellation or no ADS-B due to GPS outage
- Mitigation: incorporate GPS integrity monitors at each ground station location. Discard ADS-B reports in case of low GPS integrity

## ➤ Duplicate ICAO 24-bit Mode S address

- Risk: Safety critical situation if transponder identifications are duplicated
- Mitigation: detect, track and identify duplicated addresses

# Deployment Example:

## ➤ ADS-B for NAV CANADA

- 12 redundant ground stations deployed around Hudson Bay, North Eastern Canada and Greenland



# ADS-B for NAV CANADA

## ► Problem:

- Hudson Bay covers an area of over 250,000 sq. nmi
- Little surveillance coverage over the Bay
- Aircraft traversing the area require procedural separation (80 nmi – 10 minutes)
- Longer flights, increased fuel consumption, traffic limitations

## ► Solution:

- ADS-B surveillance of airspace over Bay
- Reduced separation to 5 nmi and preferred altitude for qualified aircraft
- Enhanced safety



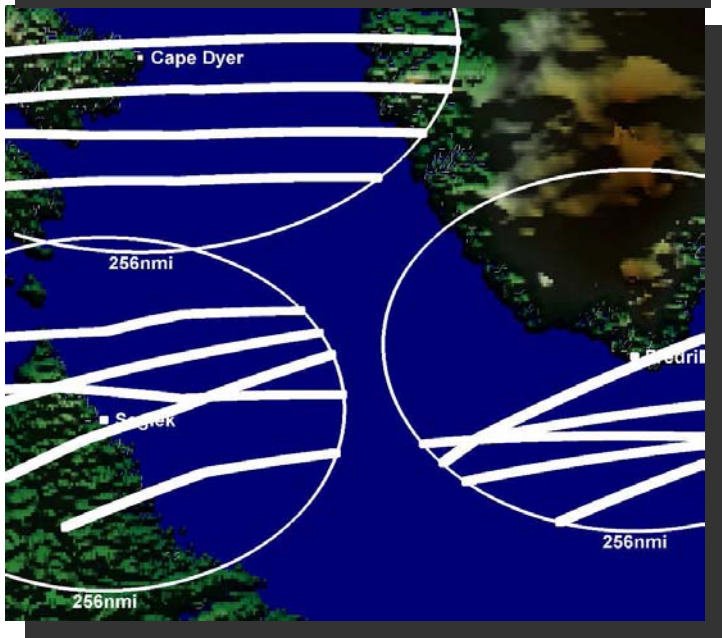
# ADS-B for NAV CANADA



**ADS-B GS are installed in challenging environment**

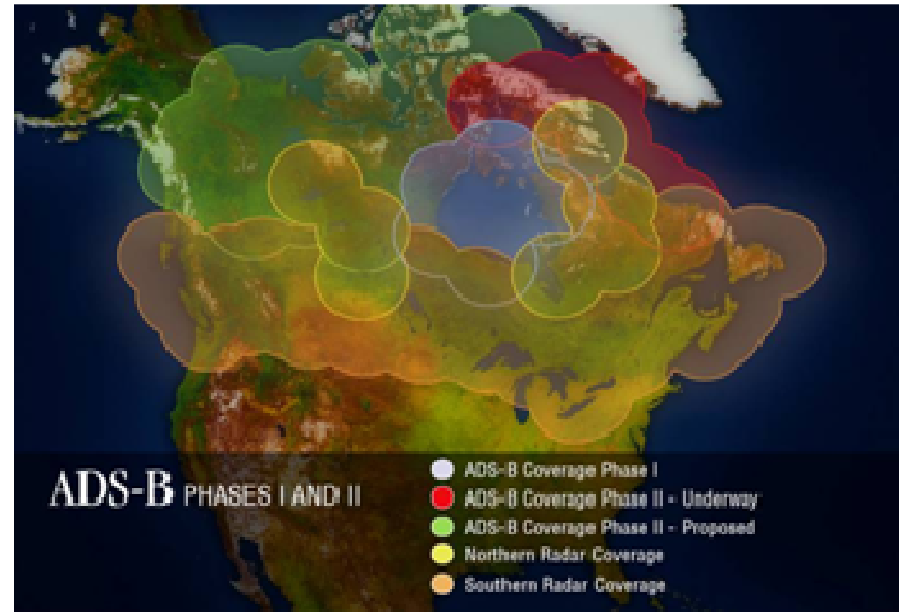


**ADS-B GS provide a >250 nm range**



# ADS-B for NAV CANADA

- Hudson Bay currently operational for 5 nm separation of qualified aircraft since January 2009
- 30 Airlines with Over 800 ADS-B Eligible Aircraft are currently operating in Hudson Bay Airspace
- 50-60% ADS-B equipage
- NAV CANADA estimates that ADS-B will save 195M CAD and will reduce carbon emissions by 436,000 metric tonnes by 2016
- Saab Sensis/NAV CANADA awarded the “Jane’s Environment Award” at the 2010 ATC Global Exhibition and Conference



*ADS-B Deployment will proceed in multiple phases throughout Canada. Goal is to provide full coverage of Canadian airspace through a combination of ADS-B, WAM and radar*

# Deployment Example:

- ▶ **ADS-B for Avinor Ekofisk/Balder**
- ▶ **North Sea west of Norway**



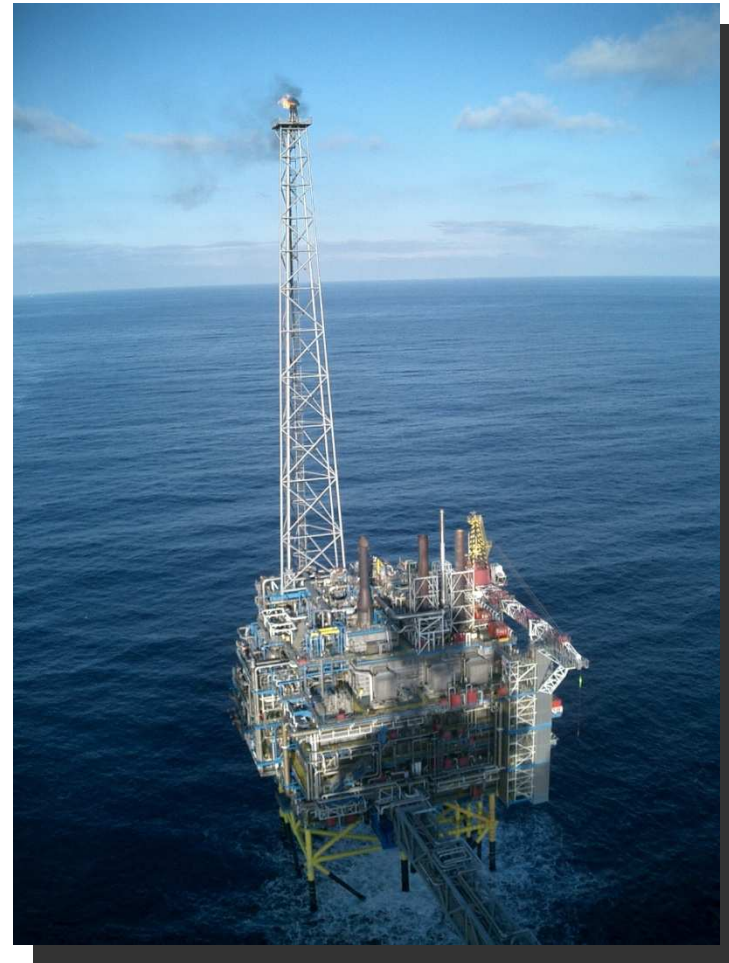


# Program Description

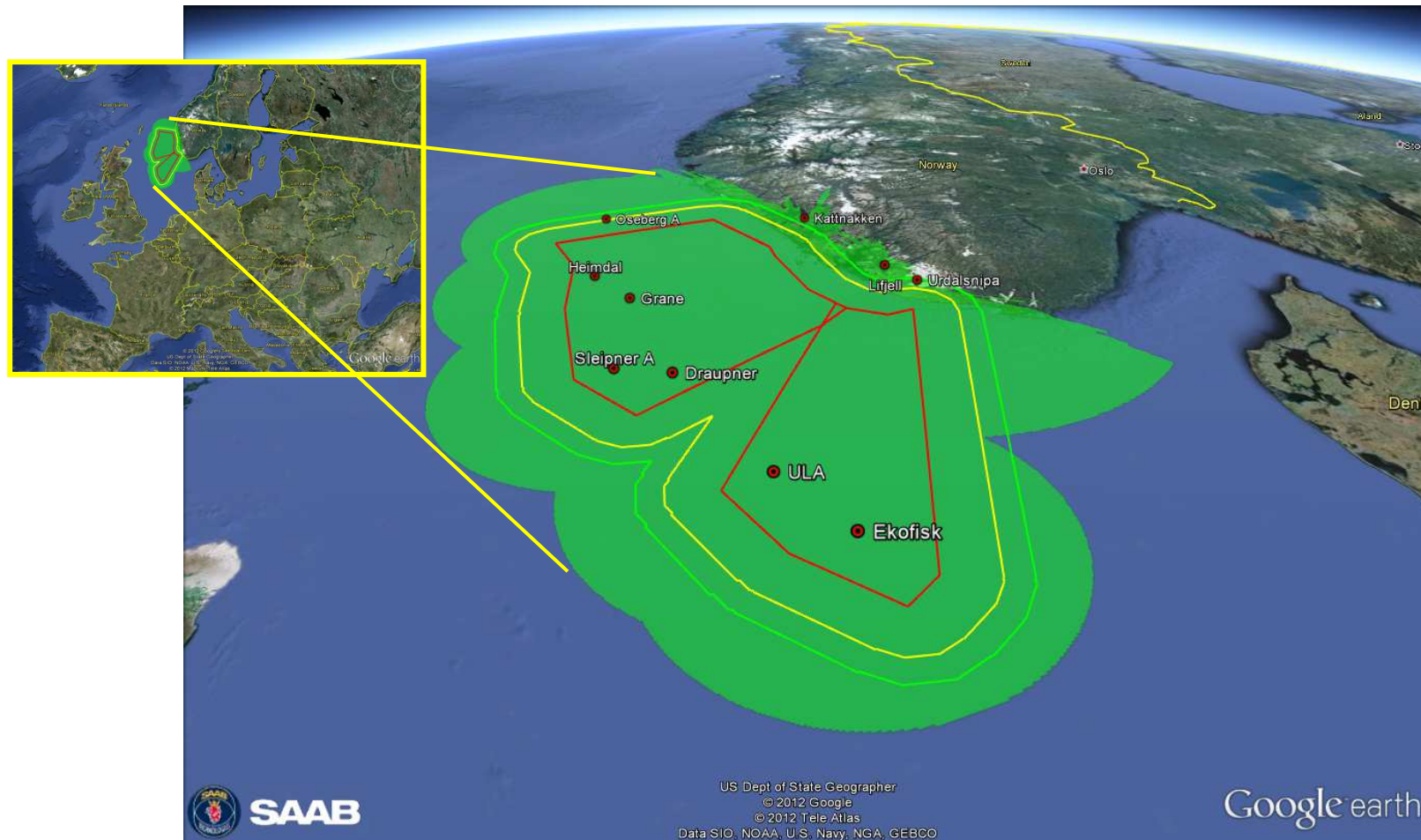
- ▶ Customer: Avinor
- ▶ Purpose:
  - Deploy an ADS-B surveillance system to provide all weather surveillance of helicopters over oil platforms in the North Sea
  - Upgrade Ekofisk ADS area from Class G uncontrolled to Class D controlled airspace
  - Provide accurate location data for search and rescue operations
- ▶ Challenges
  - Harsh North Sea environment
  - 160,000 helicopter movements annually
  - Low-altitude coverage requirements
  - Confined equipment spaces
  - Limited site accessibility

# Solution and Benefits

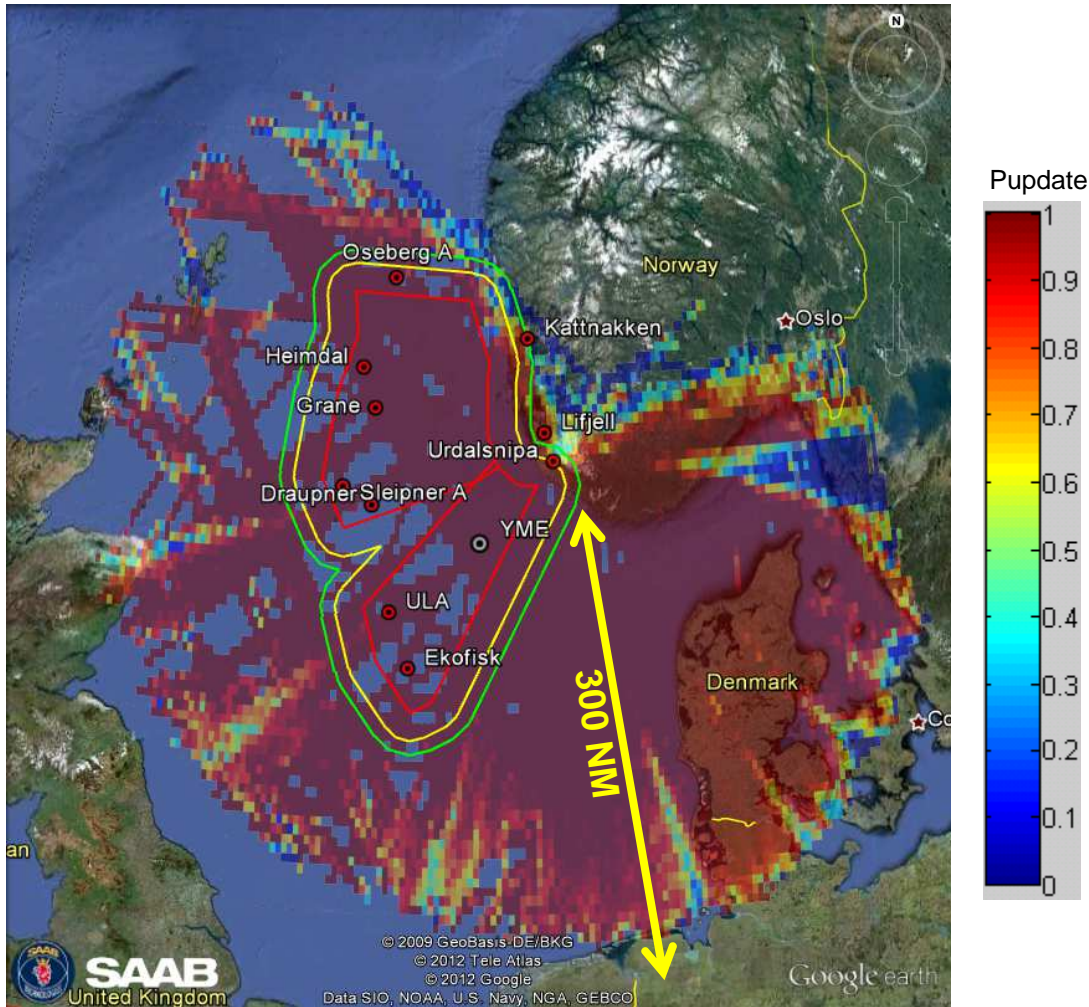
- ▶ Solution: ADS-B GSS with 11 GS, 2 ADS-B Servers and 2 CMS Servers
- ▶ Benefits
  - Highly accurate surveillance enhances safety of flights by providing greater situational awareness as well as critical data for search and rescue
  - Upgraded to support ATC services with a minimum separation of five nautical miles
  - use the same hardware as existing MLAT systems, = lower logistics costs



# Avinor ADS-B Coverage at 1500 Ft AMSL



# Actual Ground Station Performance



**Actual ADS-B GS range exceeds 250 NM!**

# ADS-B Deployment Challenges

## ➤ Availability of infrastructure

- Cost of available bandwidth
- Reliability of comms & power
- Space constraints
- Remote locations
- Maintenance difficulties

## ➤ Site Acquisition

- Often commercial sites required
- Cost, time to get access

## ➤ Environment and weather



*Site selection is critical for successful ADS-B deployment*

# Saab ADS-B Experience



- ▶ Saab has deployed over 1000 MLAT and ADS-B Ground Stations throughout the world
- ▶ Saab (Sensis) has been an ADS-B technology leader by participating in ADS-B trials and early deployments
- ▶ Saab is an active participant of key RTCA, Eurocontrol and EUROCAE ADS-B working groups and is helping shape the ADS-B standards

# Summary

- ▶ Saab has a long and rich experience with ADS-B technologies
- ▶ Saab MLAT and ADS-B equipment has been deployed for ATC applications throughout the world, in a variety of operational and physical environments
- ▶ Saab equipment is very reliable and has performed flawlessly in all environments
- ▶ The Saab ADS-B Ground System complies with the latest ADS-B standards, ED-129 and DO-260B
- ▶ The Saab Ground Station can provide both ADS-B and MLAT services simultaneously
- ▶ Saab is committed to the ADS-B technology and will continue to update its product line as the standards evolve

# THANK YOU

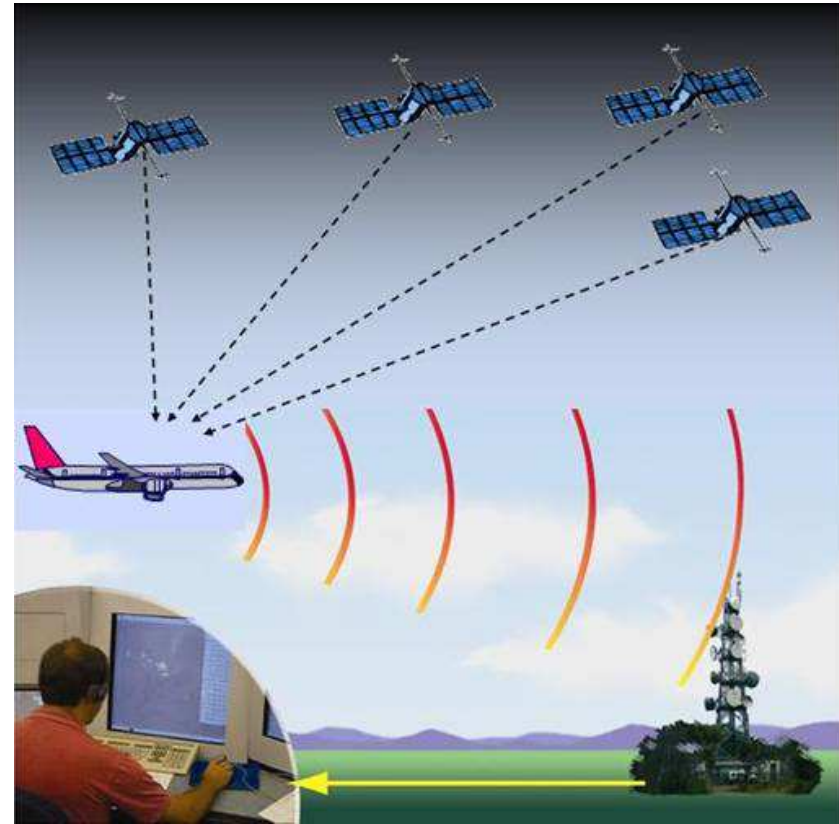
Saab ADS-B technology: proven, rugged and reliable.  
Lower initial cost and lifecycle cost.  
Deployed in challenging environments.



**Back up slides follow**

# What is ADS-B Surveillance?

- ▶ 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



# Benefits of ADS-B

## ► Flexible and Scalable

- Small size, low power consumption GS enable deployment in many physical environments
- Adaptable to terrain-limited coverage
- Coverage is extended with 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
- Enables many air-to-ground and air-to-air applications

## ► Low Cost

- Lower acquisition cost and life cycle costs than radar



***ADS-B has many qualities that SSR cannot match***