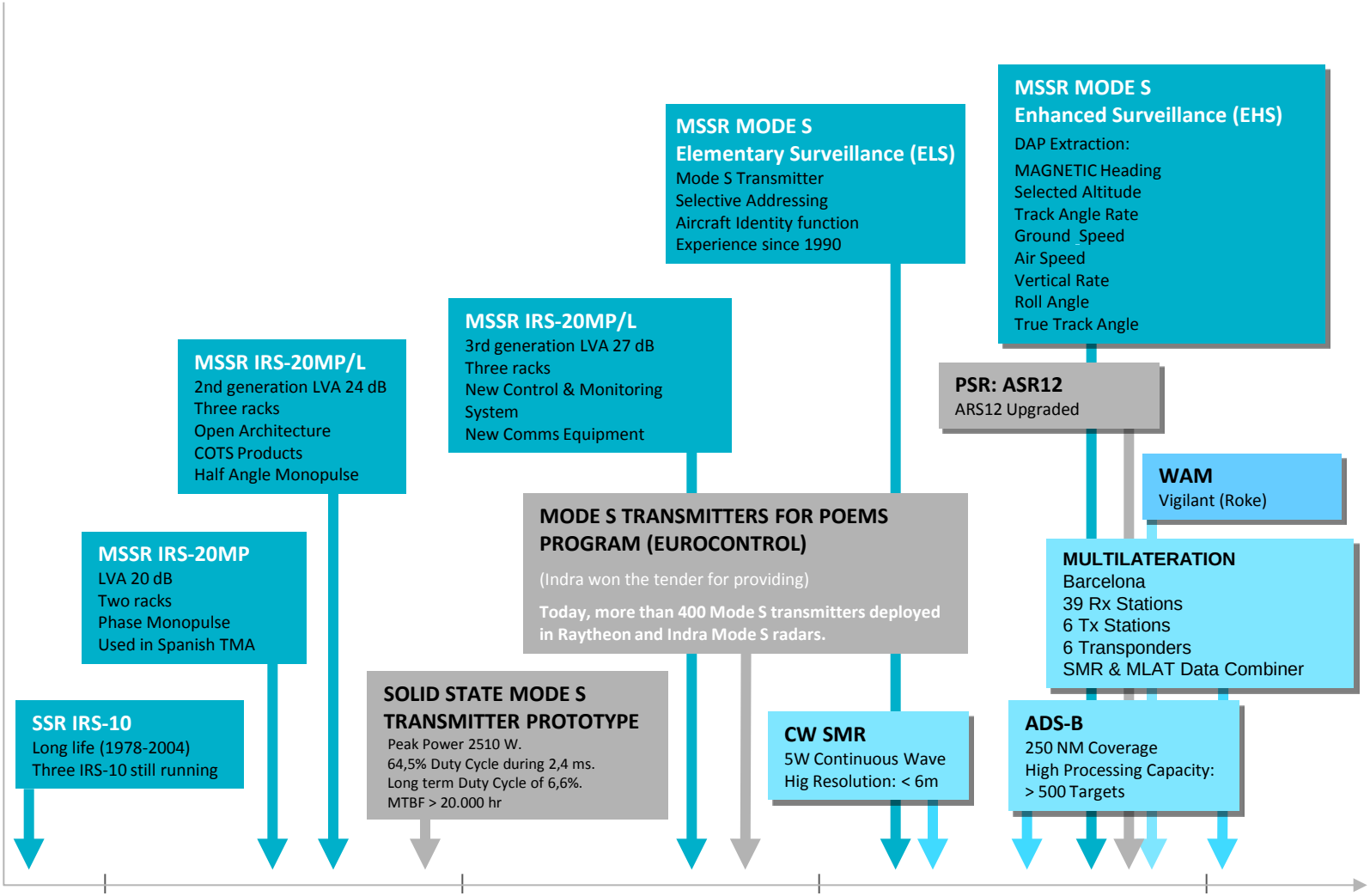
INDRA

SURVEILLANCE: ADS-B/MLAT

April 2015

SURVEILLANCE KNOW-HOW



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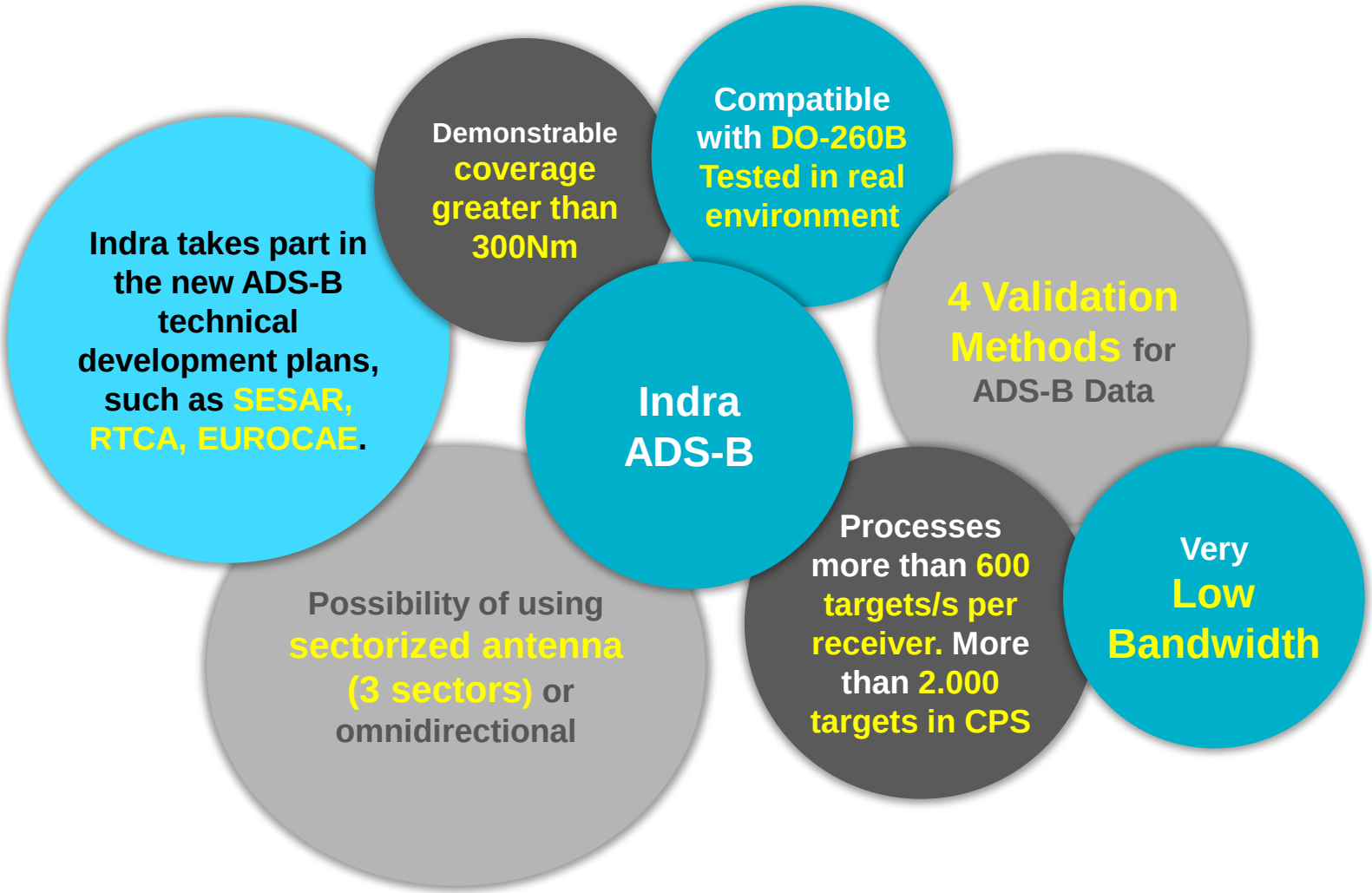
HIGHLIGHTS


Indra takes part in the new ADS-B technical development plans, such as SESAR, RTCA, EUROCAE.
Demonstrable coverage greater than 300Nm
Compatible with DO-260B Tested in real environment
Indra ADS-B
4 Validation Methods for ADS-B Data
Possibility of using sectorized antenna (3 sectors) or omnidirectional
Processes more than 600 targets/s per receiver. More than 2.000 targets in CPS
Very Low Bandwidth

HIGHLIGHTS

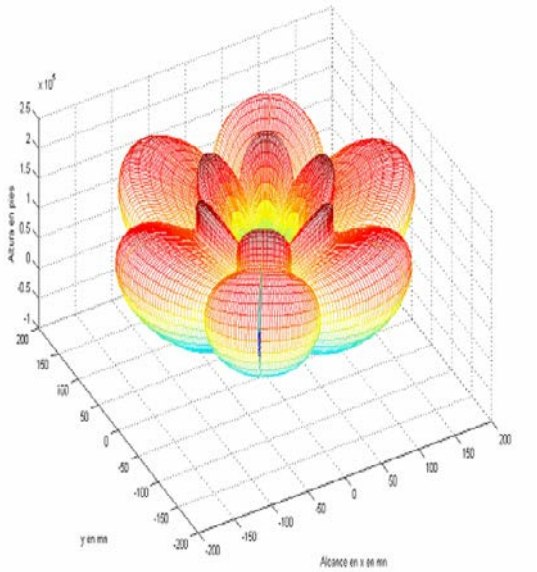
Indra is participating in the definition of ADS-B:

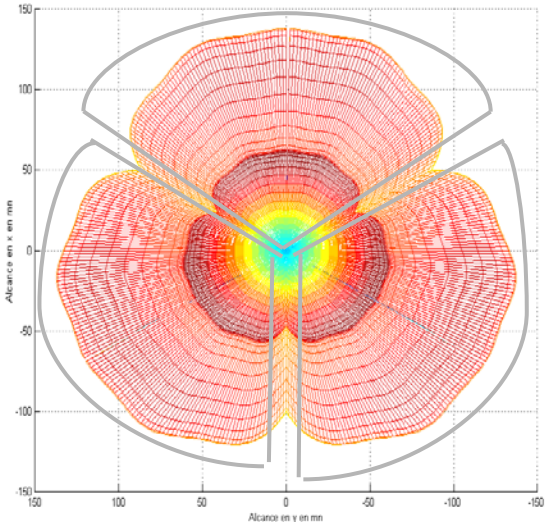
- Indra takes part in the new ADS-B technical development plans, such as SESAR, RTCA, EUROCAE.
- EUROCAE: Development of new ADS-B standards
- RTCA: Development of Technical specifications for new data links.
- SESAR
  - Definition & development of new ADS-B functionalities
    - Integrity validation (TDOA, angle of arrival,..)
    - Automatic bandwidth optimization techniques
    - ADS-B for APT

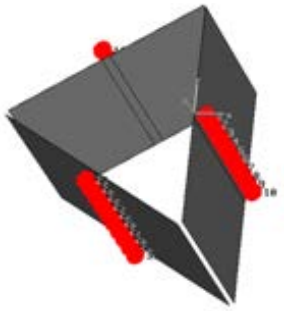
VALIDATION OF ADS-B DATA

Indra ADS-B System provides 4 validation methods:

1. Angle of arrival validation: The **sectorized antenna** of Indra's ADS-B System allows the determination of the direction or sector of arrival of the received messages, **this direction is correlated with the angle of arrival obtained from the position reported by the aircraft.**

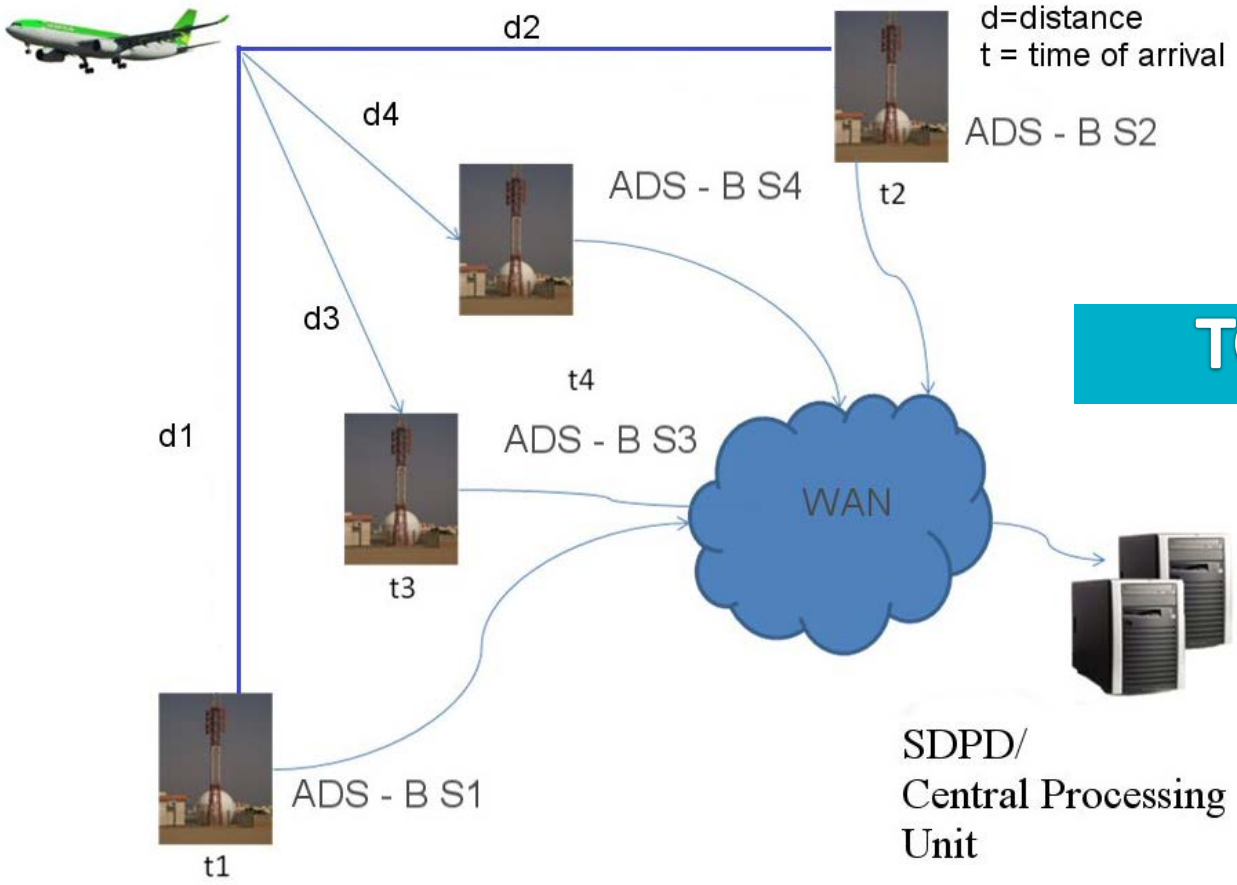






VALIDATION OF ADS-B DATA

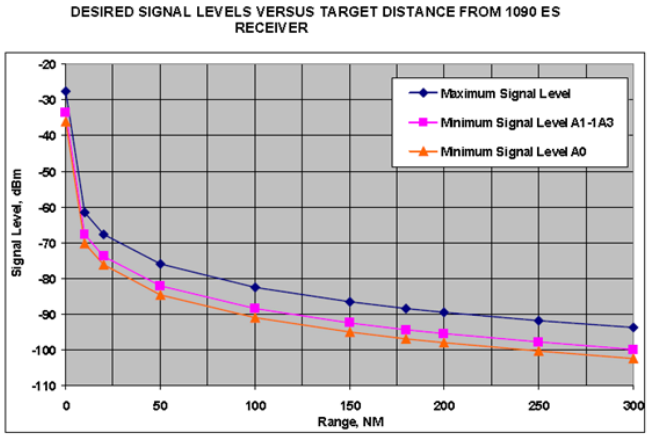
2. Time of arrival (TOA) validation: The principle of this validation method lies in the correlation between of Time of Arrival of Extended Squitters and the reported distance from multiple receivers.



TOA Validation

VALIDATION OF ADS-B DATA

3. Power measure versus range: Depending on the type of transponder of the target and other parameters such as the antenna gain, height, distance, **Indra ADS-B system will expect to receive ES messages from a target that will be inside a range of power values.**



4. Target velocity against the ADS-B received target position change: Actual and historic position and velocity information of the same target are also used to cross-check the credibility of both data items.

These validation methods have been developed and tested in SESAR program.

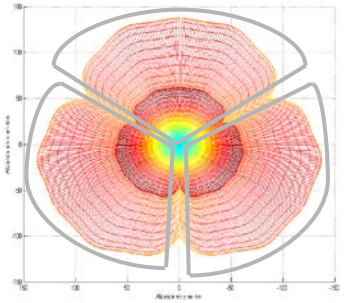
MULTICHANNEL RECEIVER

Indra ADS-B System is equipped with **3 independent processing channels**. This feature enable the use of 3-sector receiver antennas, which introduce less noise and, therefore, **increase the maximum range** and Signal/Noise level of the inputs and reduce interferences.

Sectorized antennas are easy to install since they do not need to be sited at the top of towers and admit other elements located in parallel.

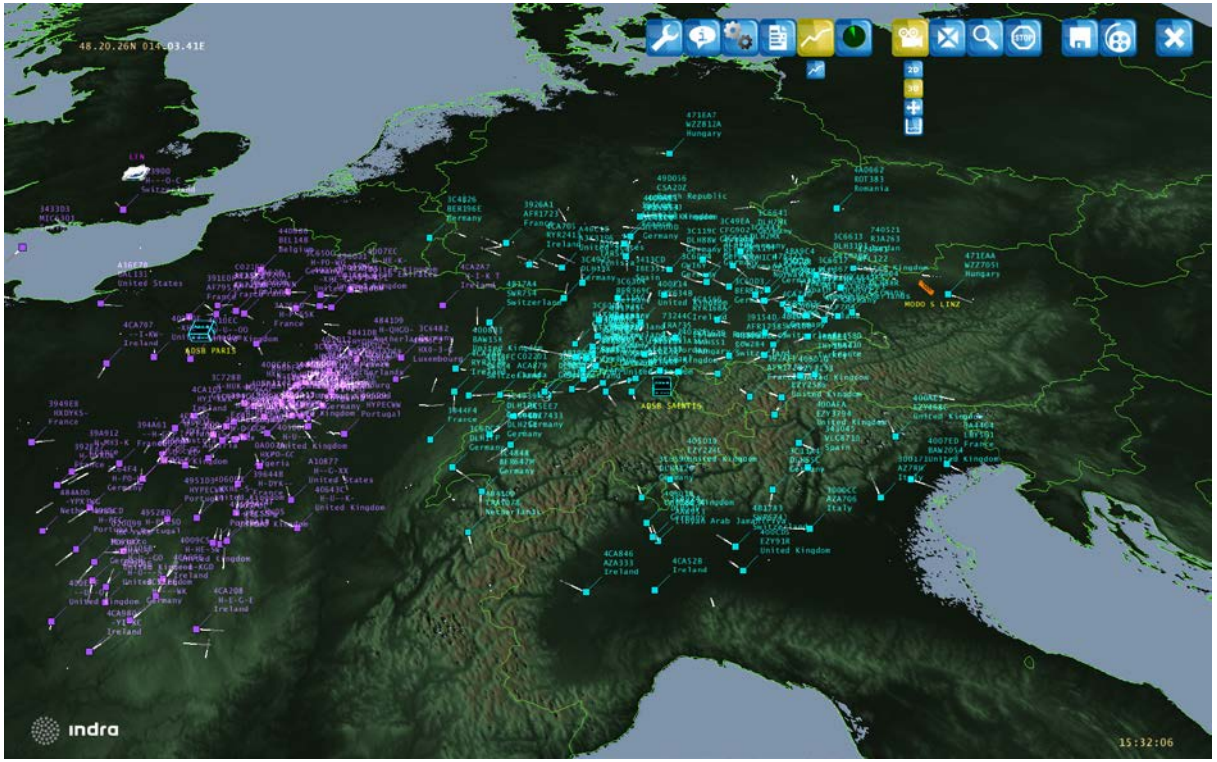
On the other hand, **omnidirectional antennas** shall be installed with no other obstacles in parallel, which could be impossible on many occasions (i.e: Installation of ADS-B in a tower where existing radar is already installed at the top.)

Indra ADS-B System has a maximum range beyond 300NM. This maximum range has been tested in real environment.



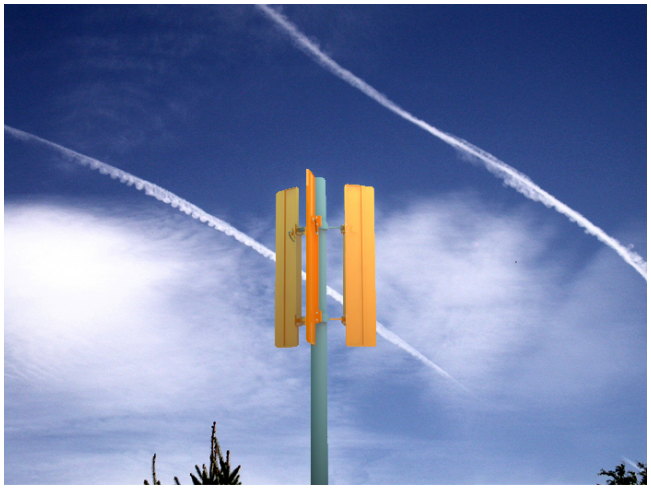
EUROCONTROL
USED FOR DO-260B CERTIFICATION

INDRA INDRA ADS-B SYSTEM IS USED BY EUROCONTROL TO CERTIFY THE DO-260B TRANSPONDERS; THEREFORE, THE DECODING OF THE DO-260B IS FULLY TESTED IN REAL ENVIRONMENT.



ANTENNAS

- The Antenna Subsystem is composed of:
  - Three Sectorized antennas or
  - One Omni-directional antenna
  - RF Filters
  - Mast head box with LNA (Optional)



- Antenna columns are directional. Each column covers a minimum of 120º. This increases the range and reduces the noise received at each channel.

- Antenna Gain Options:
  - 12 dB for Long Range
  - 9 dB for Medium- Long Range
  - 5 dB Medium Range
  - 2 dB Airport Surveillance

- Options & Upgrades: Solar Panel , Diesel Generator and batteries for Outdoor.

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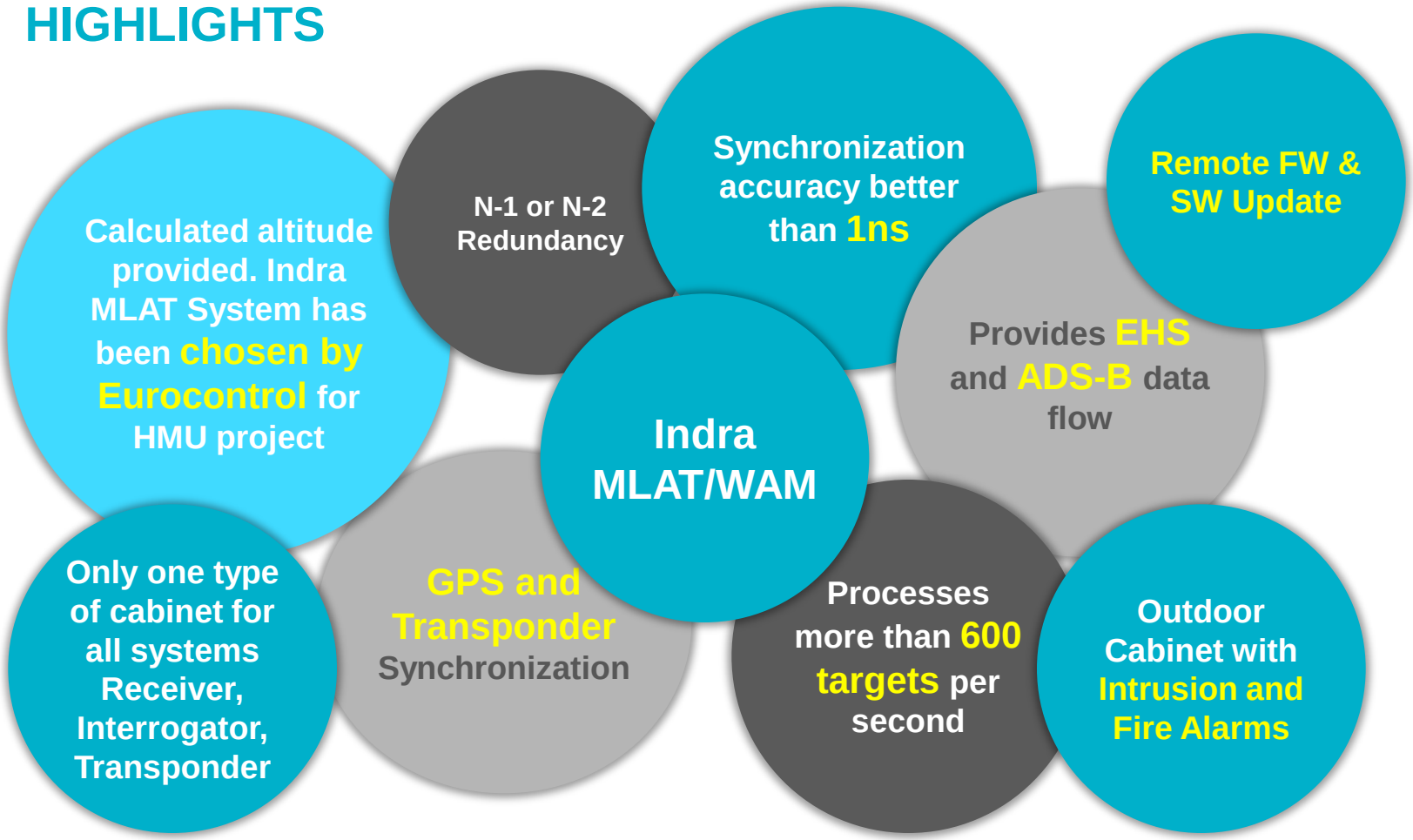
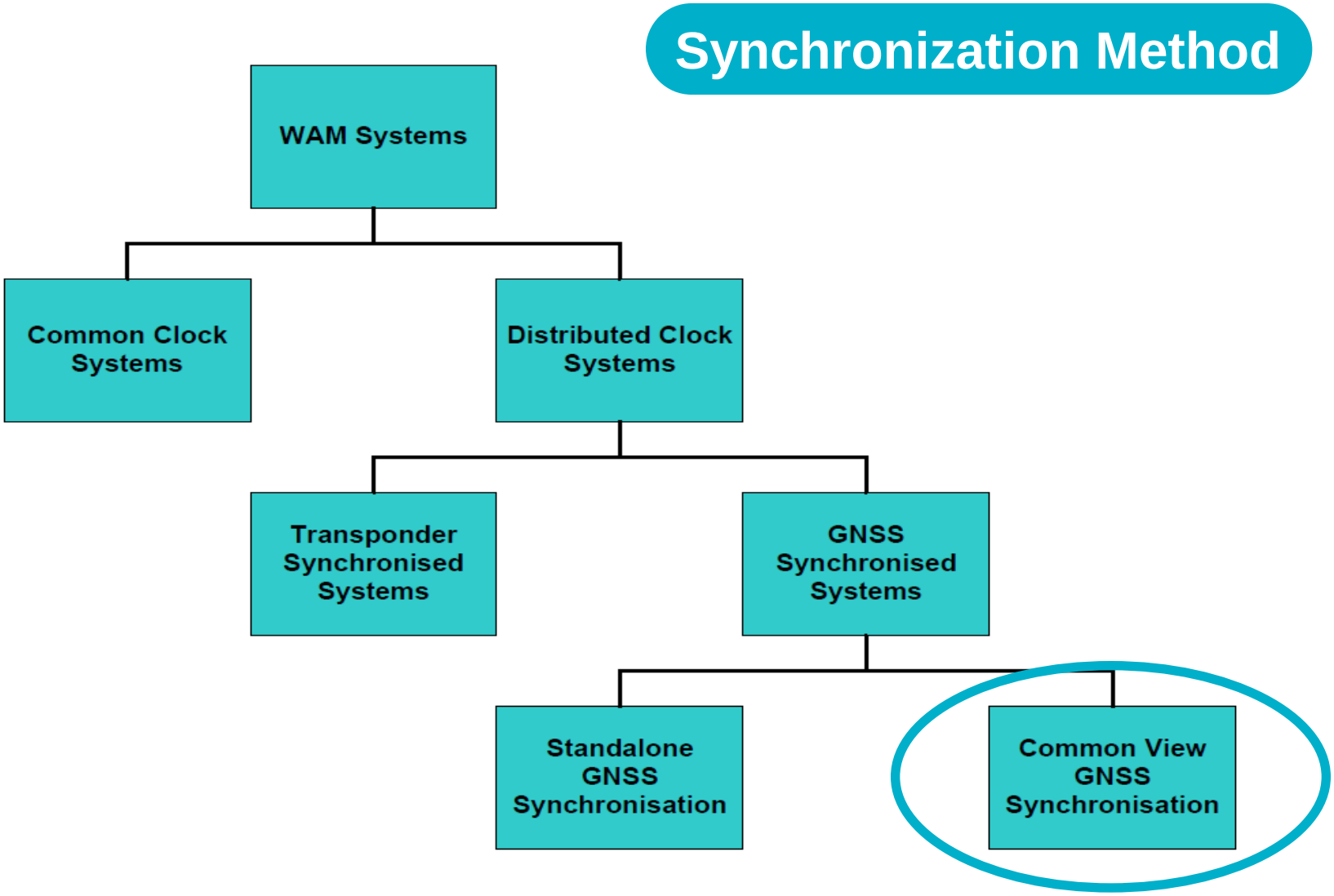
HIGHLIGHTS



Accuracy	**3m for MLAT 20- 30m for WAM**
Synchronization	**By GPS (GNSS) and Reference Transponder**
Target Capacity	**≥ 600 aircraft**. Software is not dependant from HW. Easy to upgrade.
Output	Asterix Cat. 20, 19, 10, 247 (**MLAT, WAM**) and Asterix Cat. 21, 23 (**ADS-B**)

INDRA MLAT/WAM FEATURES



WHY GNSS COMMON VIEW?

- **Common View GNSS Benefits**
  - **Accuracy**: **Better than 3 meters** for MLAT systems.
  - **Easy deployment**: No reference transmitter in common view required.

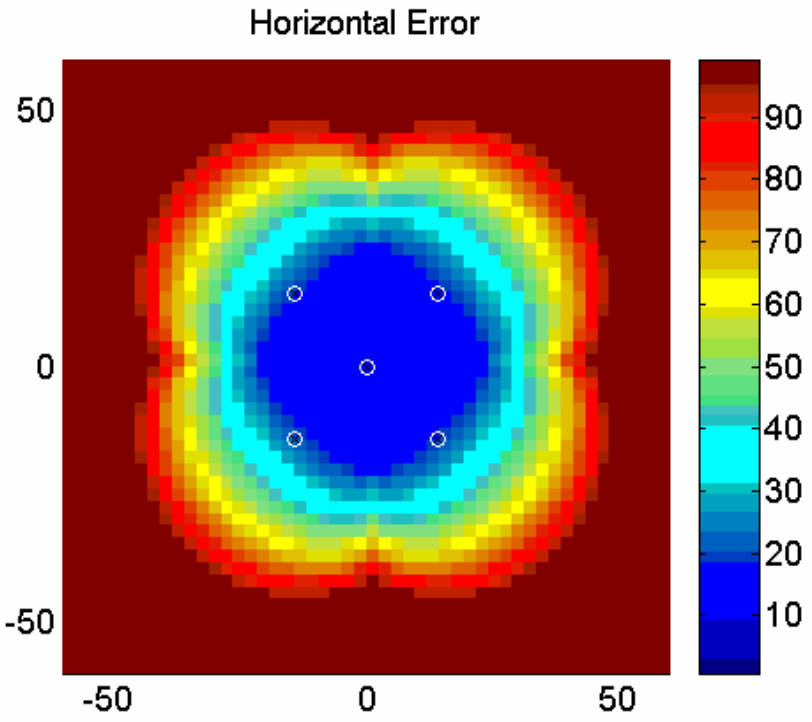
Synchronization accuracy better than 1ns

- **Indra MLAT is the most accurate system on the market:**
  - The other synchronization methods achieve accuracies between 5 and 20 ns.
  - **Indra GNSS Common View synchronization is better than 1ns.**

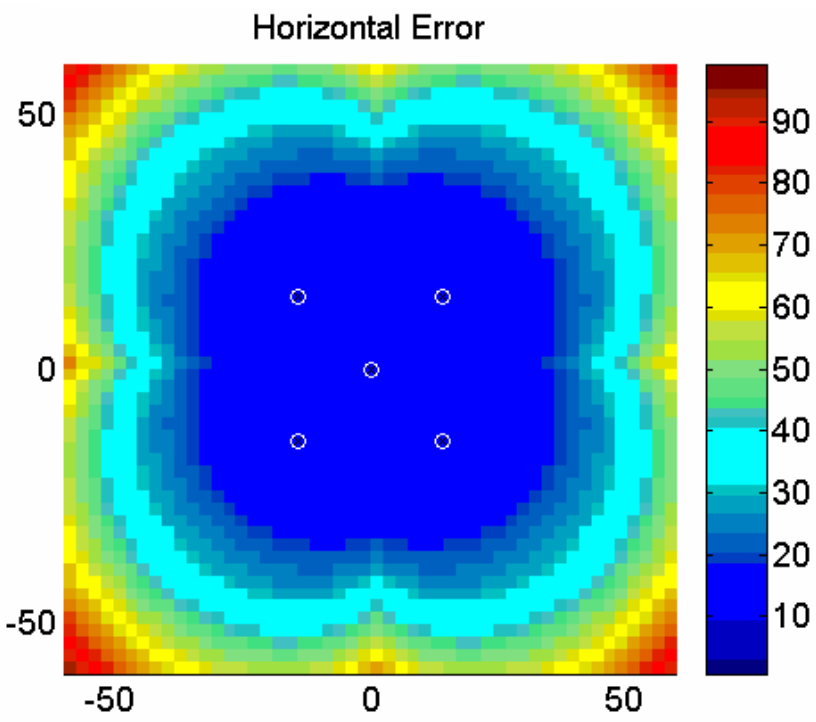
WHY GNSS COMMON VIEW? *

Effect of synchronization error

Horizontal accuracy in a system with Synchronization Accuracy of **10ns**



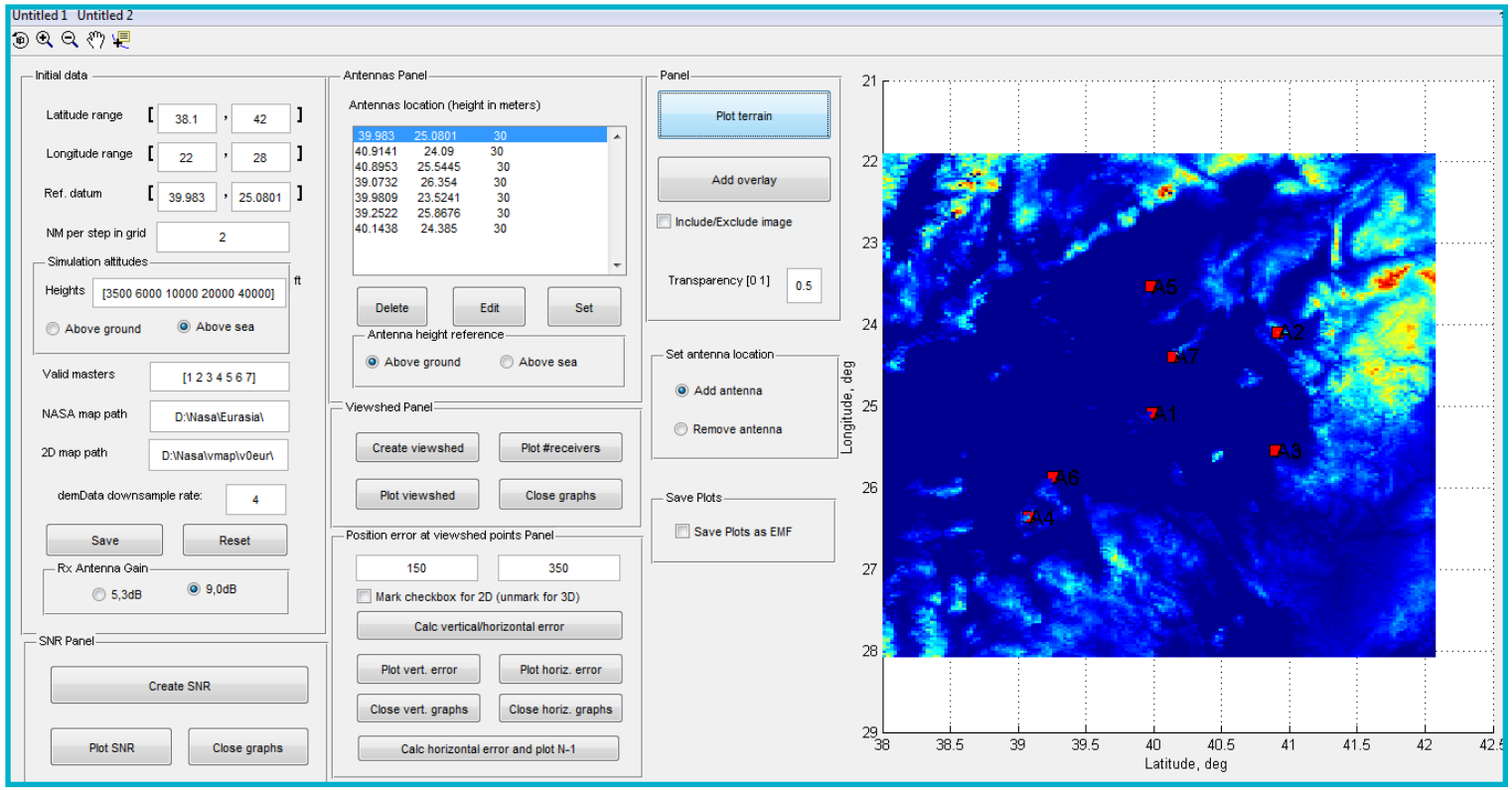
Indra Horizontal accuracy in a system with Synchronization Accuracy of **1ns**



PROPRIETARY COVERAGE & DEPLOYMENT SIMULATION TOOL

- Viewshed and SNR Calculation
- Multilateration and coverage analysis. (Including N-1 Redundancy)
- Terrain analysis using NASA maps.

Site List (By Customer):
Having a **list of possible locations** for the remote stations **with available power and communications** will **reduce significantly the costs** of the overall WAM system. Indra will pick the most convenient sites from the list in order to achieve an optimal performance and accuracy.



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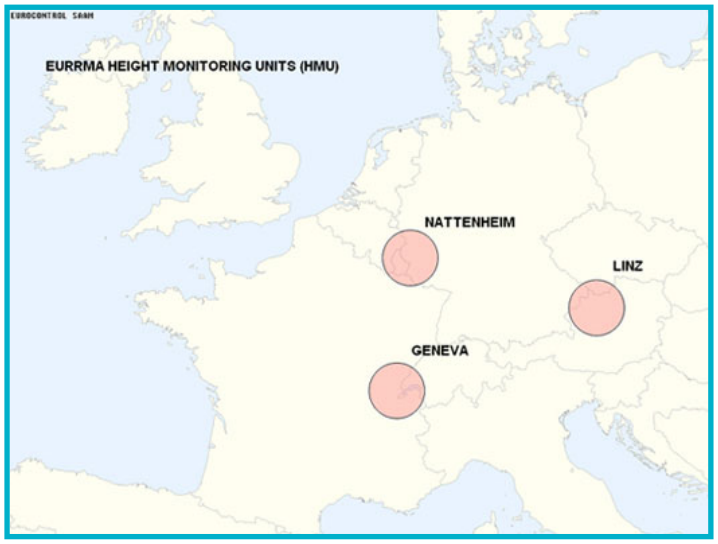
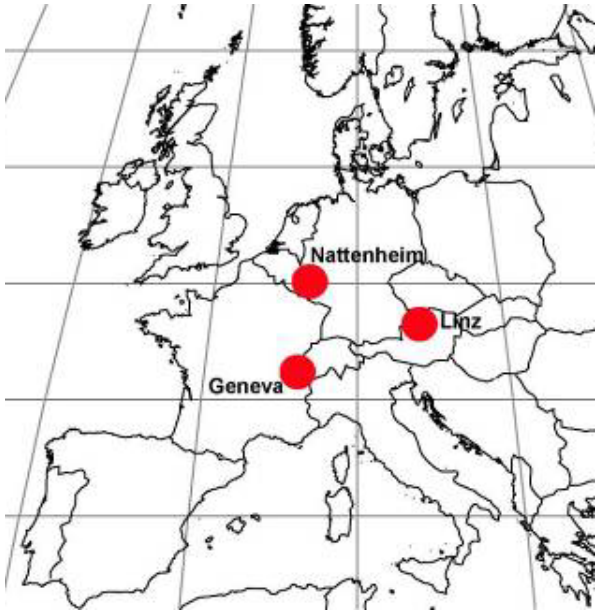
EXPERIENCE WAM/MLAT + ADS-B

Country	Units	Customer
Barcelona (Spain)	36 (MLAT/WAM + ADS-B)	AENA
Vilnius (Lithuania)	11 (MLAT/WAM + ADS-B)	ORO NAVIGACIJA
Bogota (Colombia)	26 (MLAT/WAM + ADS-B)	ACC
Geneva (Switzerland)	5 (WAM+ ADS-B)	EUROCONTROL
Nattenheim (Germany)	5 (WAM+ ADS-B)	EUROCONTROL
Linz (Austria)	5 (WAM+ ADS-B)	EUROCONTROL
Latacunga (Ecuador)	5+2 (WAM+ ADS-B)	DGAC
Loja (Ecuador)	9 +3 (WAM+ ADS-B)	DGAC
Southampton (UK)	7 (WAM+ ADS-B)	BAA
Barranquilla (Colombia)	7 (MLAT + ADS-B)	ACC
Oslo (Norway)	1 ADS-B	NAVIA
Chile (2014)	2 ADS-B	CAA CHILE
Morocco I	6 (3x2) ADS-B	ONDA
Peru	2 (1x2) ADS-B	CORPAC
Colombia ADS-B Country Wide	20 (10x2) ADS-B	ACC
Libia (Tripoli and Benghazi)	4 (2x2)	LCAA
Mongolia I	5 (5x1) ADS-B	MCAA
Georgia (2014)	6 (3x2) ADS-B	SAKAERONAVIGATSIA
France	1 (1X1) ADS-B	EUROCONTROL
Switzerland	2 (1x2) ADS-B	RUAG
Tegucigalpa (Honduras) (2014)	2ADS-B	COCESNA
Turkey	2 (1X2) ADS-B	DHMI
Pakistan	1 ADS-B	PCAA
Colombia (Río Negro)	1 ADS-B	ACC
Morocco II (2014)	10 (5X2) ADS-B	MCAA
Mongolia II (2014)	10 (5X2) ADS-B	MCAA

WAM CENTER EUROPE (GERMANY, SWITZERLAND AND AUSTRIA) I

Eurocontrol WAM Deployment



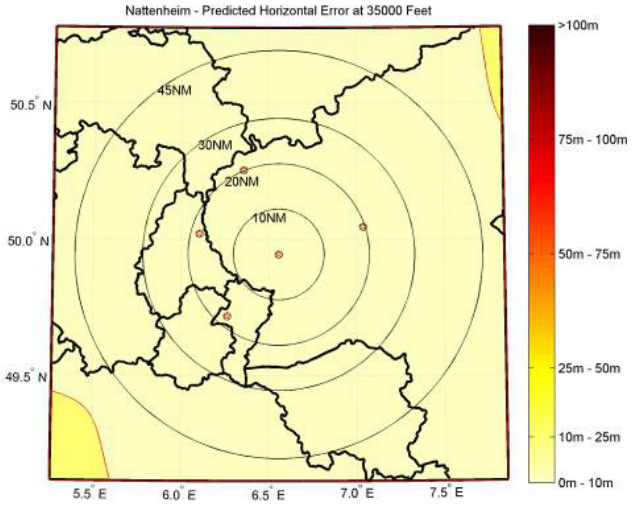


- **Three (3) Wide Area Multilateration Systems (WAM) for Eurocontrol:**
  - **Range of 90NM x 90NM (Each System)**
  - **Located in Germany, Austria and Switzerland.**
  - **Accuracy of 20 meters**
  - **Fifteen (15) receivers installed and operating**

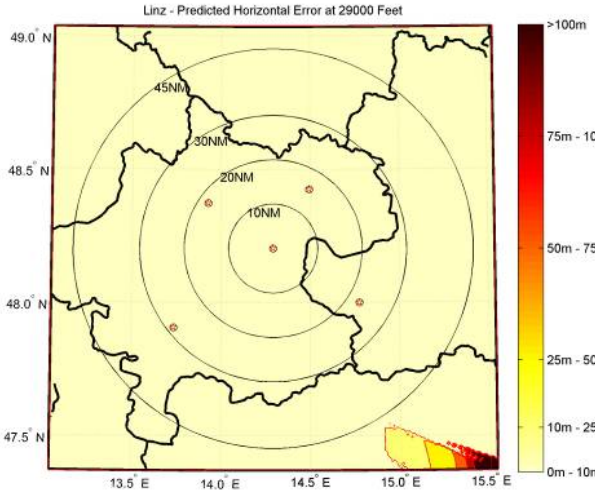
EUROCONTROL

WAM CENTER EUROPE (GERMANY, SWITZERLAND AND AUSTRIA) II

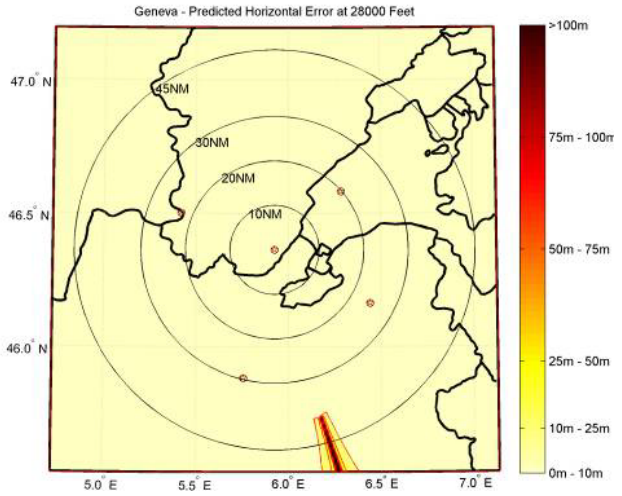
Deployments & Accuracy



Nattenheim



Linz



Geneva

“The supplied system meets the technical standards established in WAM EUROCAE (ED-142) and, with regards to accuracy, greatly exceeds those standards.”

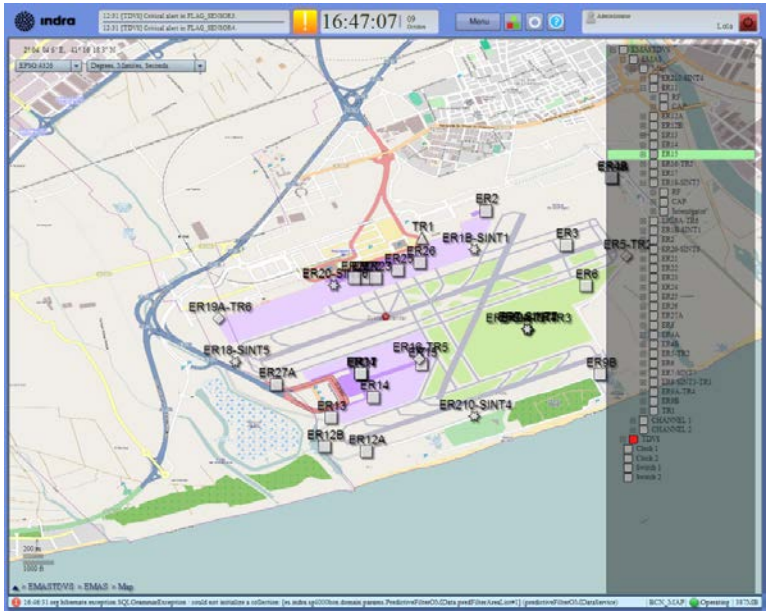
Mr. Andrew Lewis
Manager EUR RMA
EUROCONTROL RMA and Height Monitoring
96 Rue de la Fusée, 1130, Brussels

MLAT/WAM BARCELONA

Barcelona Deployment

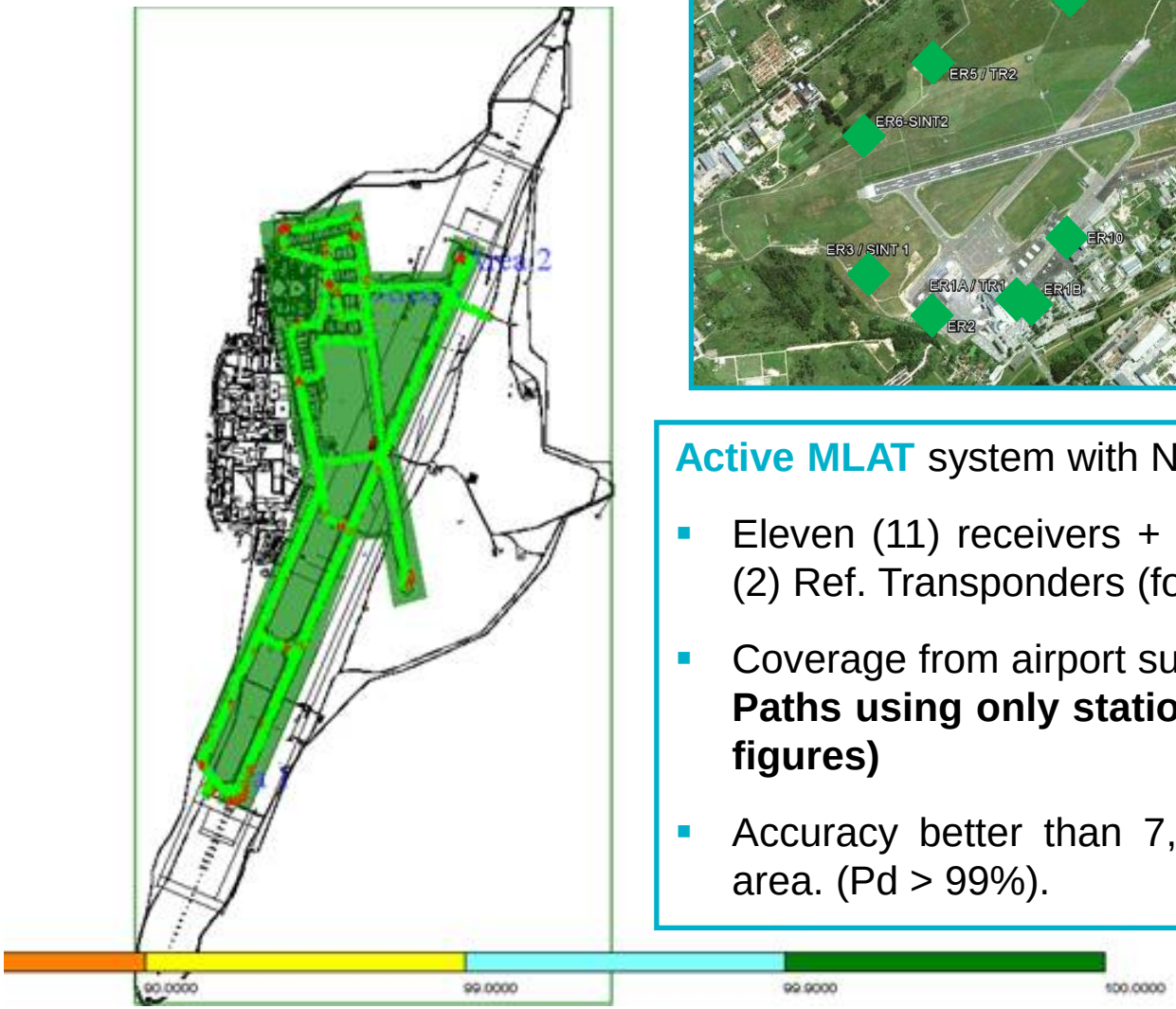
Active MLAT system with N-2 redundancy.

- Receiving Stations → 36 Units
- Reference transponder → 6 Units
- Central Processor →1 Unit



- FAT passed on 2010
- SAT by 3Q 2011
- In-Service from 1Q 2012

MLAT/WAM VILNIUS



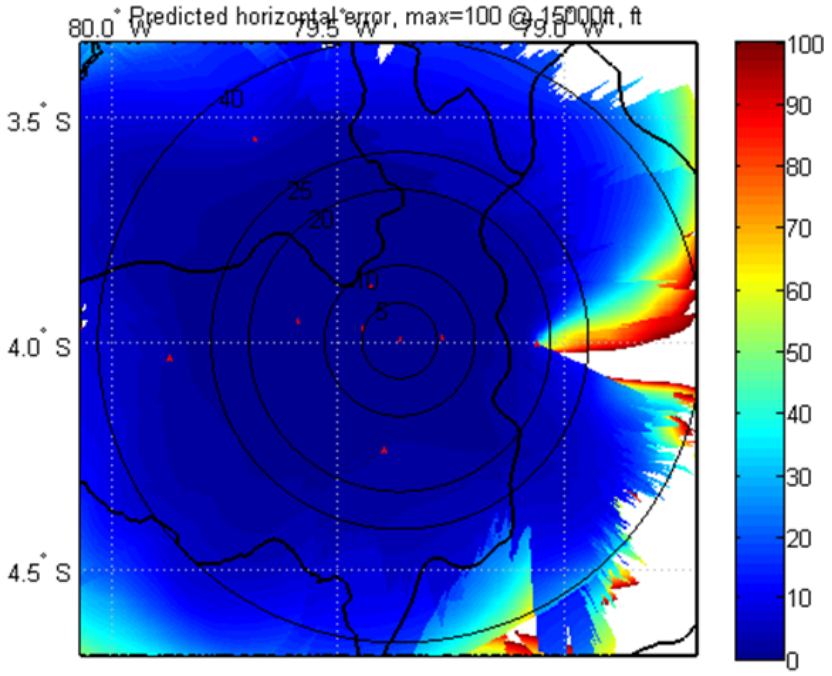
Active MLAT system with N-1 redundancy.

- Eleven (11) receivers + two (2) interrogators + two (2) Ref. Transponders (for redundancy).
- Coverage from airport surface up to **10Nm on Glide Paths using only stations inside the airport (see figures)**
- Accuracy better than 7,5 meters in all movement area. (Pd > 99%).

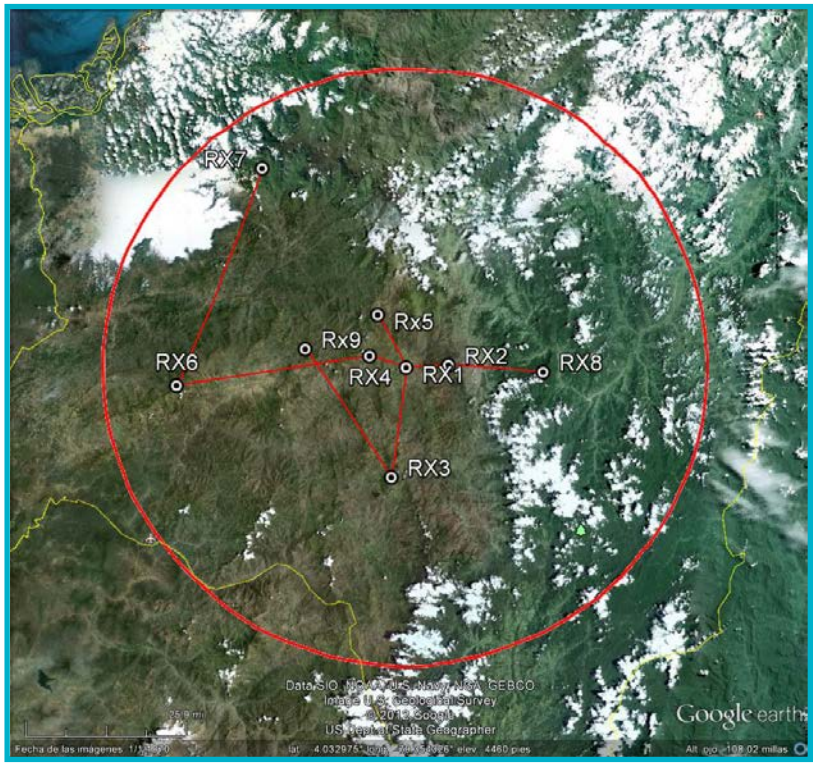
LOJA WAM PROJECT (ECUADOR)

WAM System in LOJA

- Active WAM system with N-1 redundancy
- Nine (9)receivers + three (3) Interrogators
- Covers more than 100x100NM
- RX installed in harsh climatic environment
- Accuracy performance exceed ED-142



Loja WAM Deployment

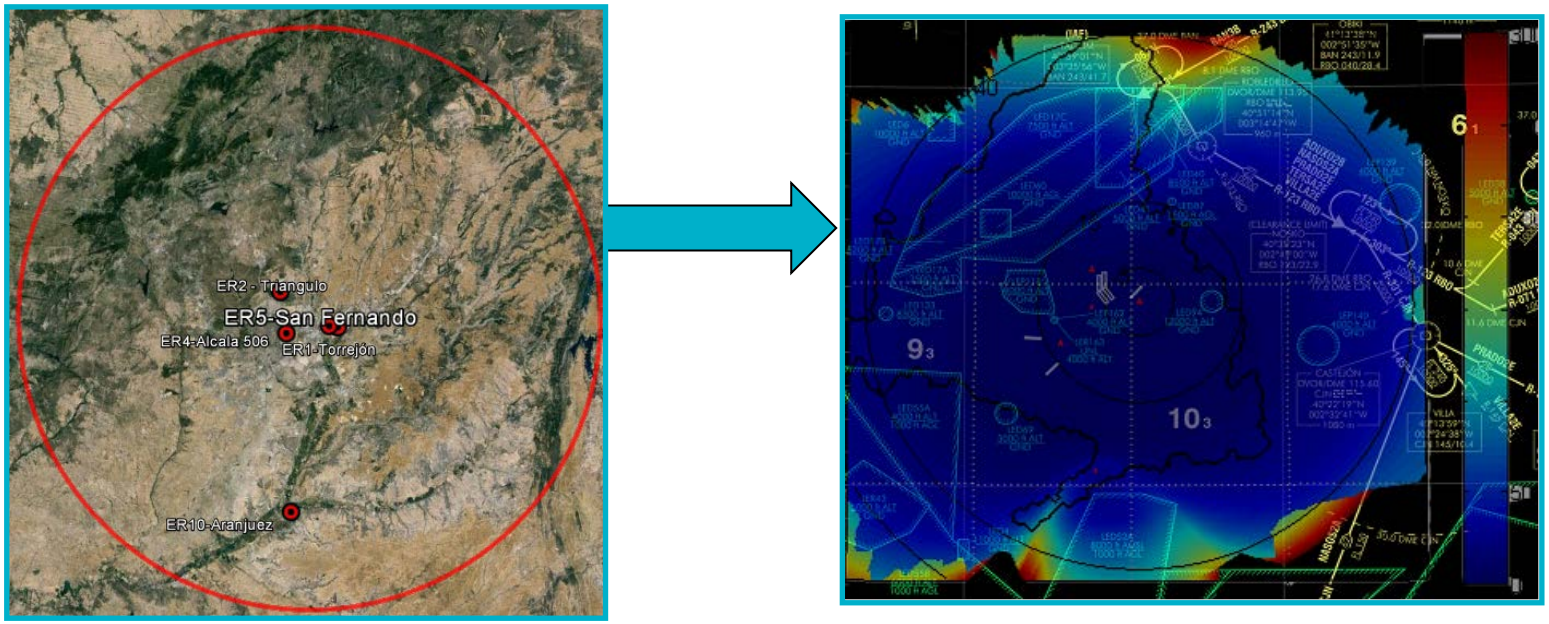


← Loja WAM Accuracy

OPERATING WAM MOCK-UP AT INDRA FACILITIES

WAM System with 5 receiver stations.

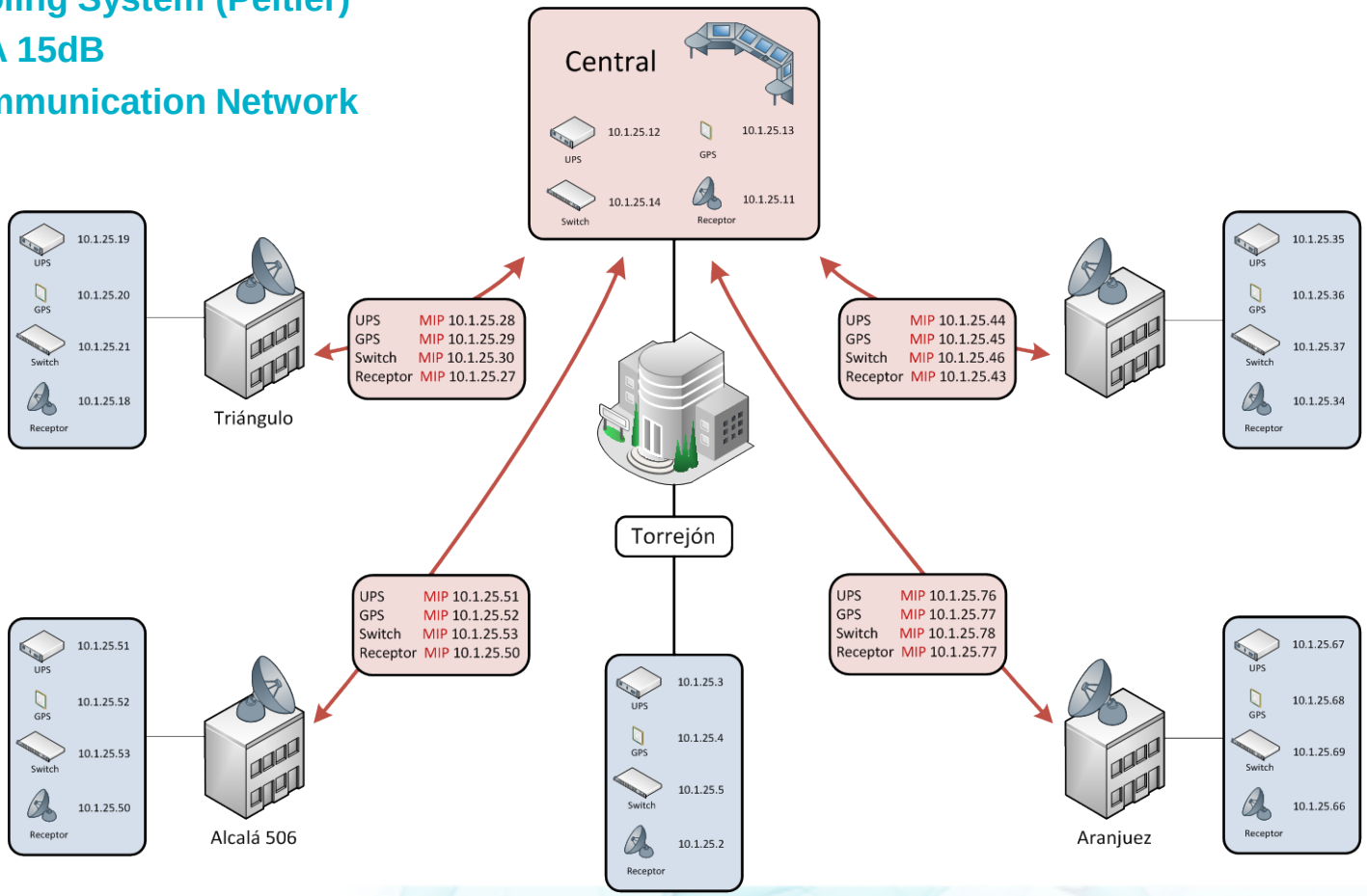
- MLAT Coverage around 40NM. * ADS-B Coverage Around 150NM
- Indra is the only company with an operative WAM mock-up installed at their own facilities.
- Receiver Locations:
  - Indra TT1 Building at Torrejón (Central Processor and RX1)
  - Indra Building Triangulo (RX2)
  - Indra Building at Calle Alcalá 506 (RX3)
  - Indra Building at Aranjuez (RX4)
  - Indra Building at San Fernando (RX5)



OPER ATING WAM MOCK-UP AT INDRA FACILITIES

Equipment: Five (5) Receiver Stations

- 5.5dBi Antennas (70cm height) with GPS antenna
- Outdoor Cabinet Water and Dust Resistant (100cmx68cmx55cm)
- Cooling System (Peltier)
- LNA 15dB
- Communication Network



Thank you

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