Performance-focused surveillance

February 2021

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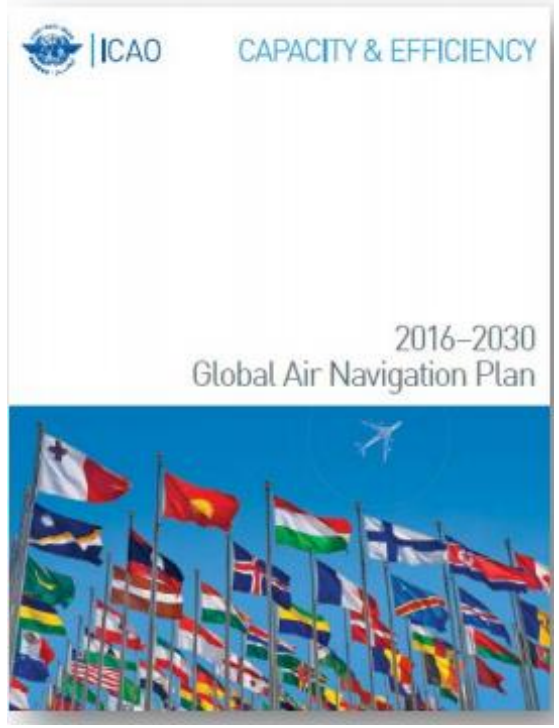
ICAO VISION

Performance-based approach (ICAO)

In addition to the fundamental aviation principles of safety, security and economic and environmental sustainability, there are several consequential performance requirements that the air navigation system must meet to fulfil the ever-growing expectations of society in general and, in particular, the aviation community. The air navigation system's required level of performance involves difficult decisions and strong commitments. **Based on what we know about the future and its opportunities and challenges, the air navigation system should provide for certain performance ambition**



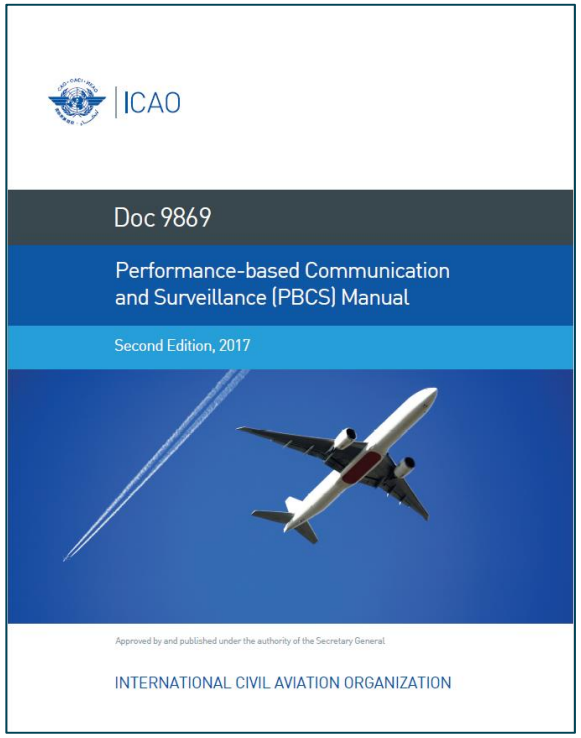
ICAO VISION

Performance-based approach (ICAO)

To prioritize future investment and to improve system efficiency, adoption of a performance-based approach in the spirit of ICAO document 9883 is required, in which a carefully chosen set of performance indicators is used that also allows for monitoring of current operations.

A performance-based approach is results-oriented, helping decision makers set priorities and determine appropriate trade-offs that support optimum resource allocation while maintaining an acceptable level of safety performance and promoting transparency and accountability among stakeholders.

Currently ICAO is developing PBCS concept also (Doc 9869 Performance-based Communication and Surveillance (PBCS) Manual), which will be deploy in parallel with PBN in order to achieve Performance Based Operations.



EUROPEAN VISION

CNS as Service approach (SESAR)

The development of ATM, with the use of virtualisation and innovative concepts of operations, will support the move towards a service-oriented architecture, in which **CNS service providers and ANSPs, as consumers of these services, may be different entities**.

.....

This approach will create business opportunities for those providing affordable services, with a strong incentive for service providers
to compete **resulting in cost-efficient services**

....

EUROPEAN VISION

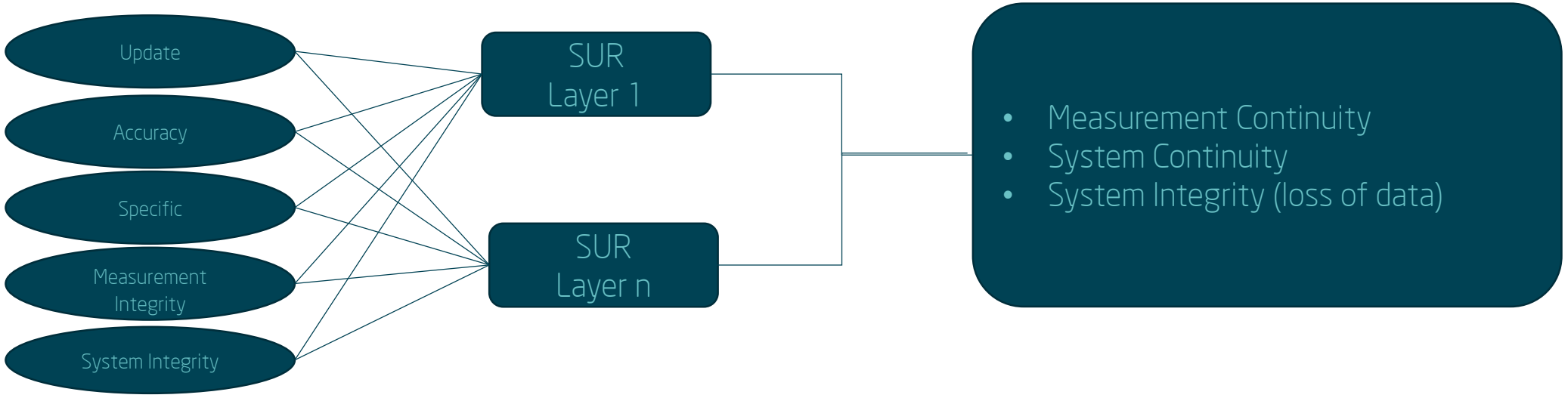
CNS as Service approach. EUROCAE: Logical Surveillance Layers

Sustainabilty Premise

Any logical Surveillance Layer has to fulfil de nominal Performance, Measurement Integrity and (misleading data) System Integrity requirements on its own

Continuity of Service

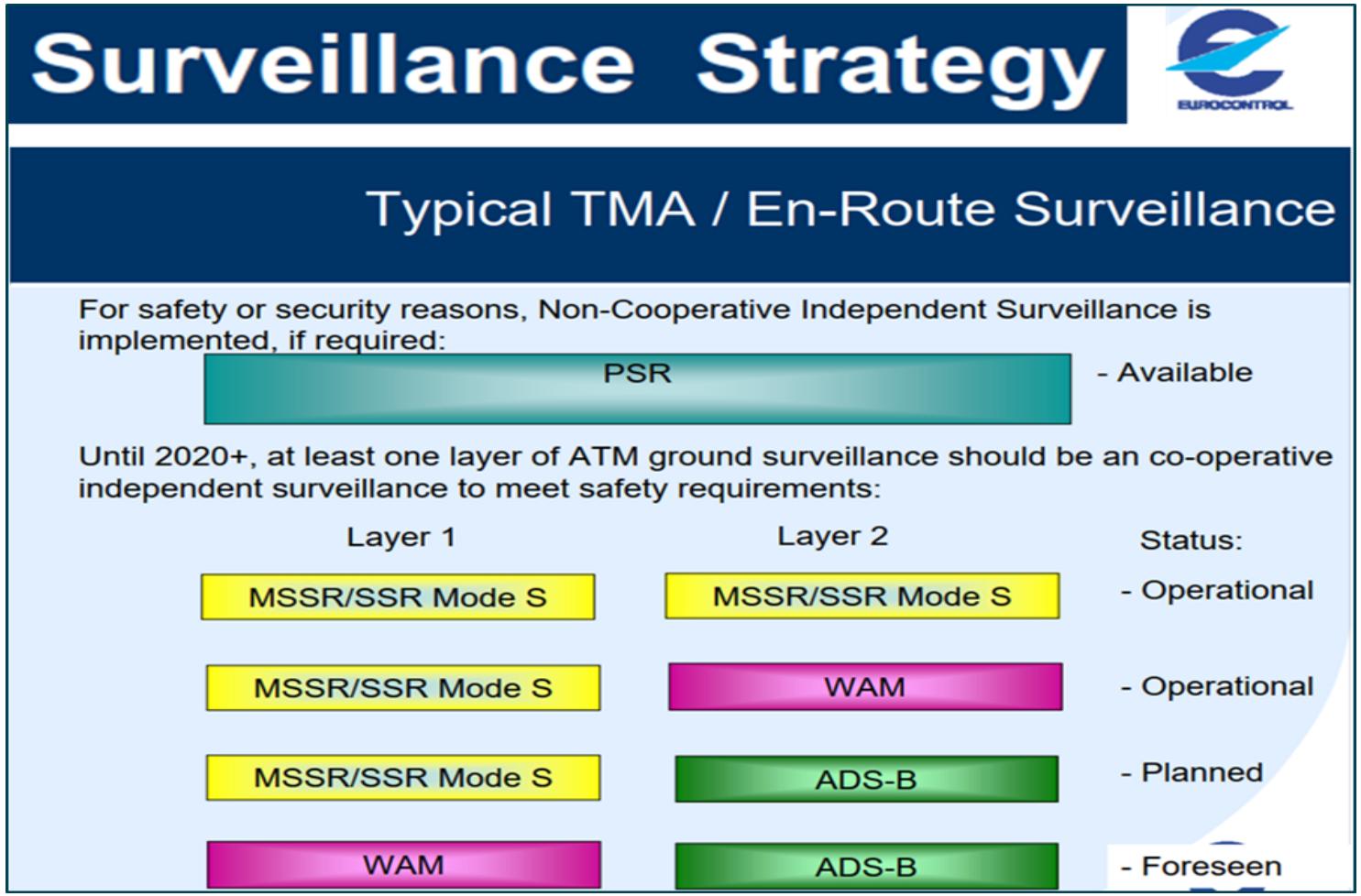
The Measurement/System Continuity and (loss of data) System Integrity requirements are shareable across the surveillance Layers



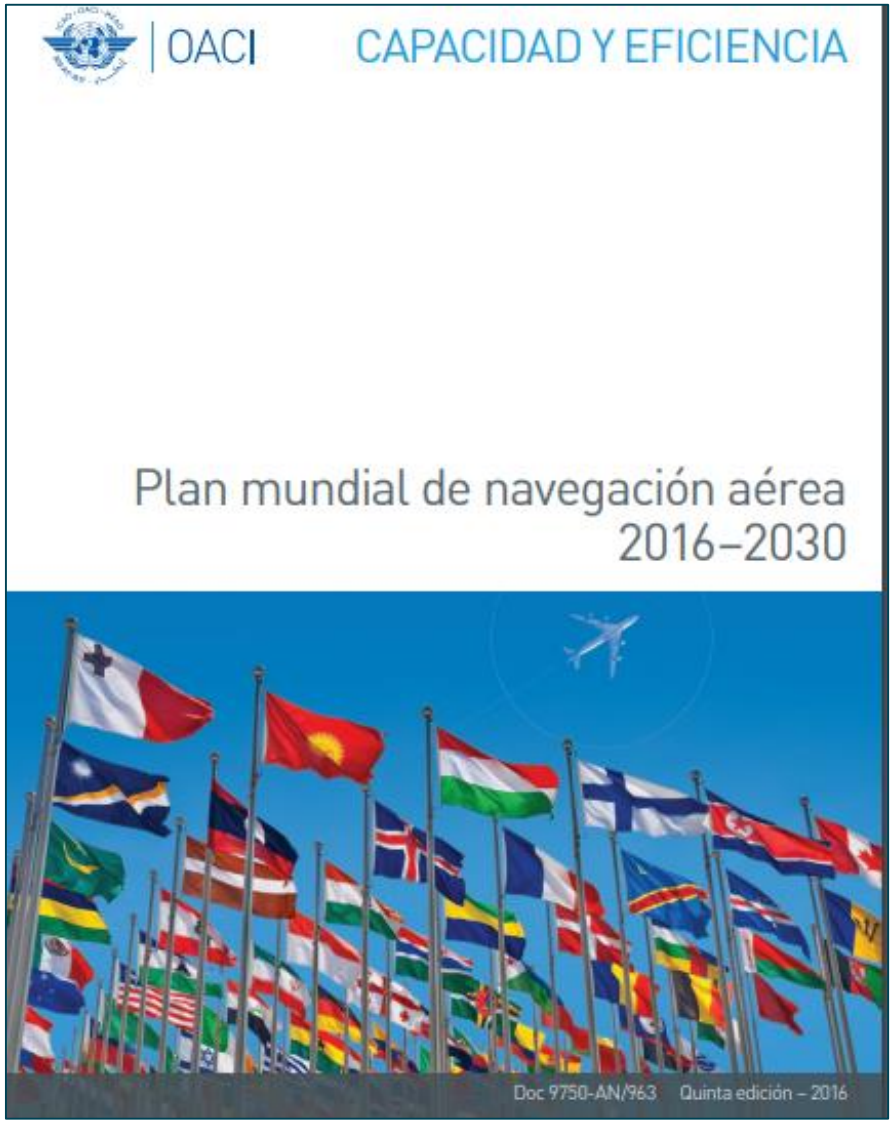
GEN-SUR SPR : Safety and Performance Requirements Standars for a Generic Surveillance System (EUROCAE)

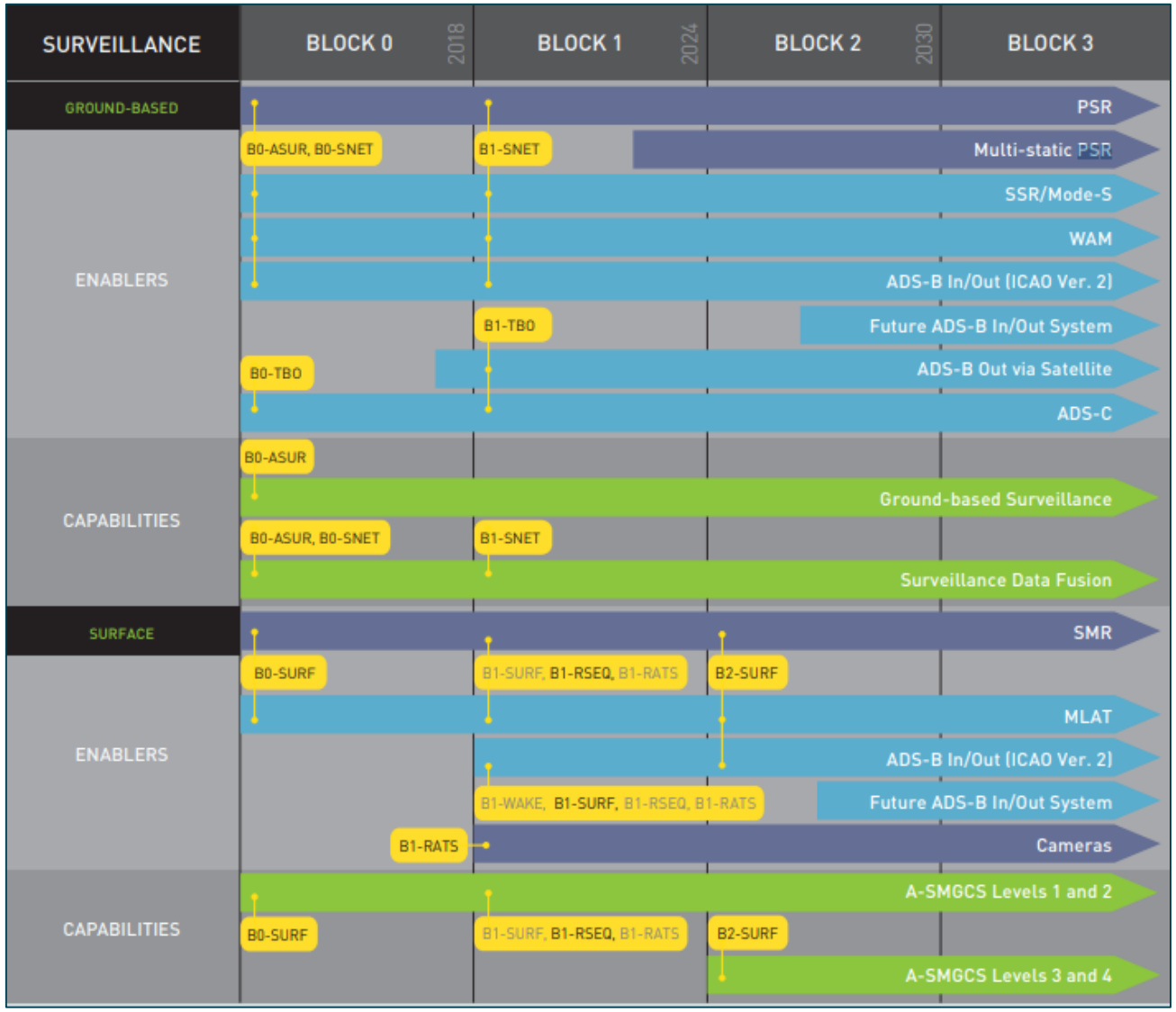
EUROPEAN VISION

Eurocontrol : Logical Surveillance Layers



Infrastructure Roadmap





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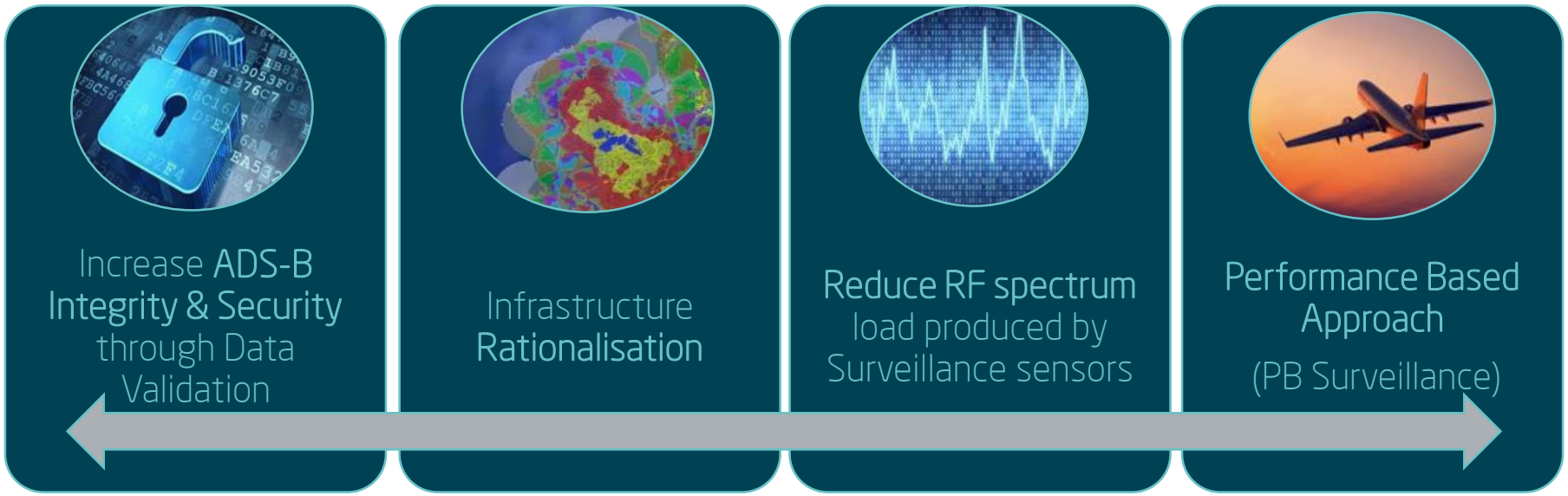
INDRA- SESAR PJ14 Technical goal

Surveillance goals is moving towards a **PBS concept** based on **ADS-B** and supplemented by a **MON** (Minimum Operating Network) including **Mode S Radar, MLAT** and primary surveillance.



INDRA VISION

Safety

- No Cooperative Surveillance for TMA
- Double layer C S : ICS +DCS
- Performance Monitoring

Efficiency

- Minimal infrastructure
- New Maintenance Policies
- ¿Surveillance as service?

INDRA VISION

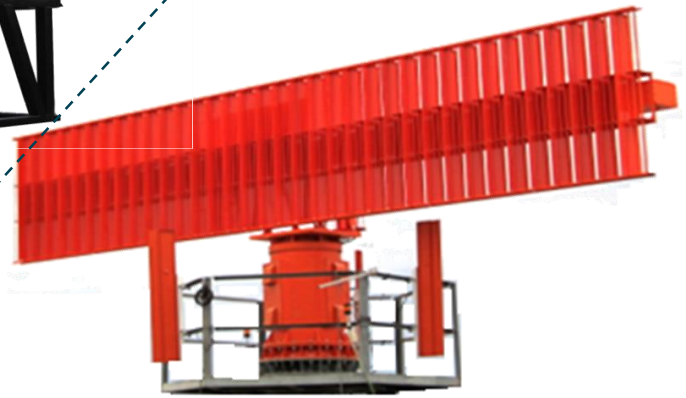
a) Regarding the Safety:
   1. The No Cooperative Independent Surveillance is a convenient safety net for TMA (at least)
   2. At least one layer of ATM ground surveillance should be Cooperative Independent Surveillance
   3. The Performance of the Surveillance Service is in the base of the safety of the ATC service

b) Regarding the efficiency:
   1. The architecture of the Surveillance System should be optimized
   2. The service cost should be minimum
      a) Remote Maintenance Activities
      b) New maintenance policies: CBM, Predictive Maintenance

INDRA SOLUTIONS FOR ATM SURVEILLANCE

COMPLETE AND UPDATED PORTFOLIO OF PRODUCTS

- PSR (L-Band and S-Band)
- MSSR mode S - Composite
- WAM //MLAT //ADS-B - Composite
- Drone detection
- Video Surveillance



VIDEO

PSR
2D & 3D Primary
Surveillance

MSSR

WLAM

ADS-B

No Cooperative Surveillance

Cooperative Surveillance

PERFORMANCE ORIENTED DESIGN

- Perfect alignment with incoming updates. Key Indicators:
  - **UPDATE** rate
  - **ACCURACY**
  - **FALSE** target
  - **INTEGRITY** and Continuity
  - **EFFICIENCY** and resources optimization
- Extensive **experience. Multiple Inputs**
  - Large portfolio
  - Worldwide presence
- Face **future** needs and expansion

ATM PRIMARY SURVEILLANCE RADARS

EN-ROUTE, APPROACH & TMA APPLICATION

1

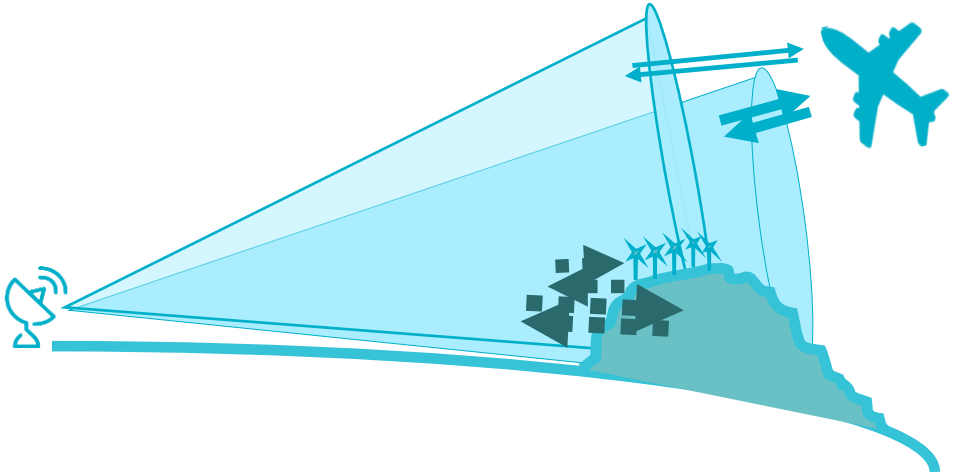
INDRA SOLUTION FOR PRIMARY RADARS

Indra Solutions

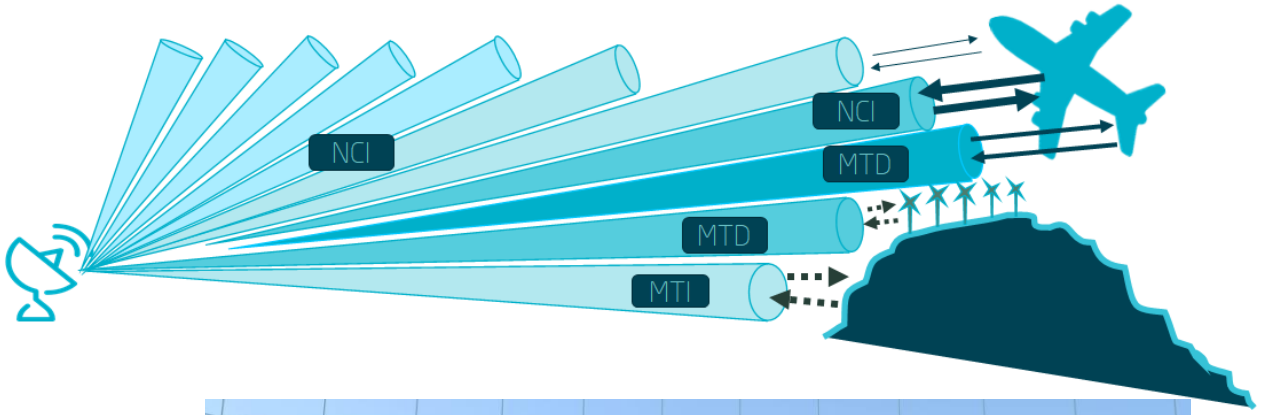
- TMA Application → S Band System & PSR3D L Band System
- Approach Application→ S Band System & PSR3D L Band System
- En-Route Application→ PSR3D L Band System

INDRA SOLUTION FOR PRIMARY RADARS

Radar PSR2D



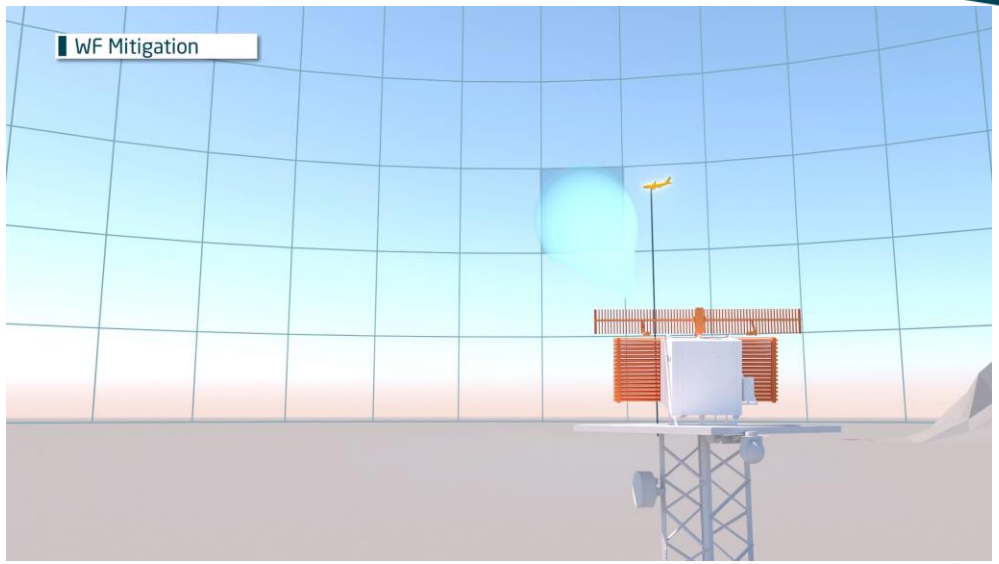
Radar PSR3D



Challenge for a Non-Cooperative Radar:
Distinguish between a Target Echo and Clutter Echo

PSR2D: Targets echoes always received together with clutter echoes

PSR3D: Electronic Vertical Exploration
Targets and Clutter are received from different pencil beams



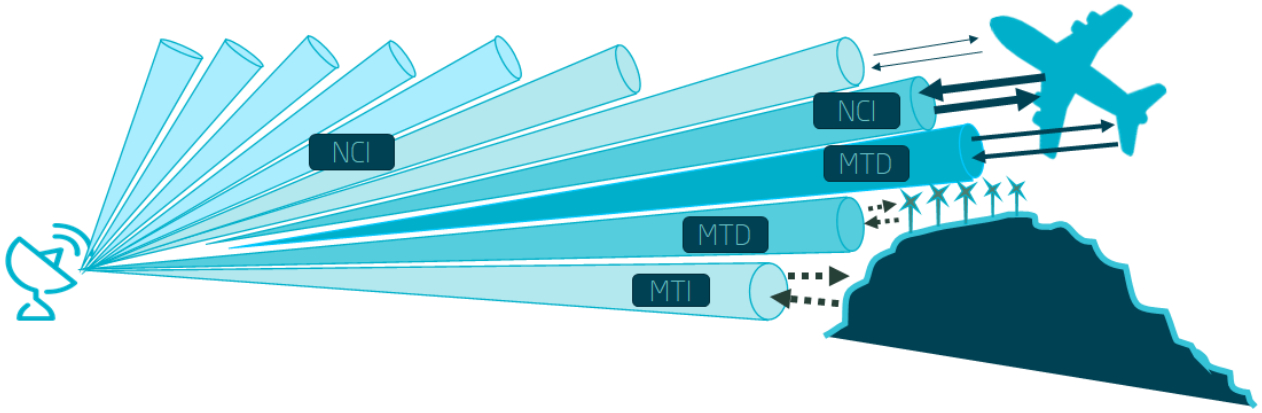
INDRA SOLUTION FOR PRIMARY RADAR

Expectations from a Non-Cooperative Surveillance System?

- Good Detection of probability
- Good Accuracy for Target Detection
- Low False alarm Rate
- Weather Information with high refresh rate (updated in the order of seconds)

Typical Non-Cooperative Surveillance System Problems?

- Difficult adaptation to hard sites environment
- Installation infrastructure necessary
- System Maintainability and Availability



INDRA SOLUTION FOR PRIMARY RADAR

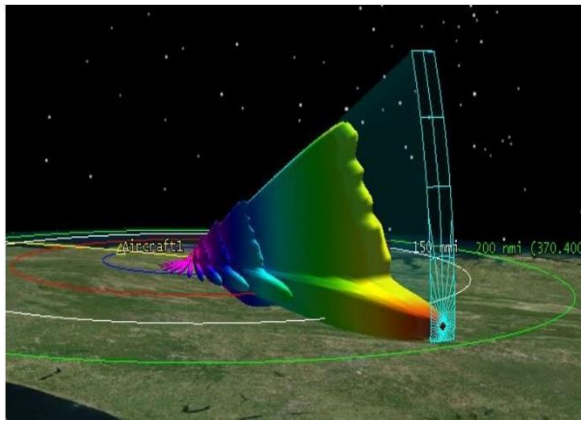
Probability of Detection & Accuracy

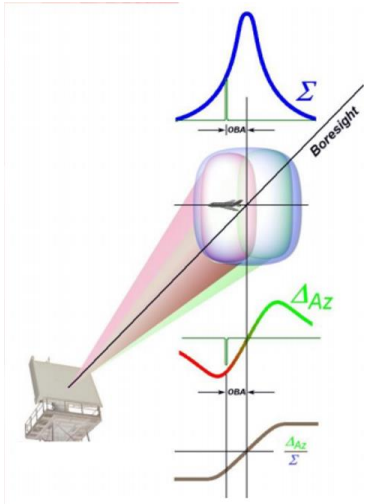
- Improved detection algorithms:
  - PSR S-Band 2D Radar:
    - Latest Adaptive Doppler Filtering
    - Adaptive A-STC
    - Synchronous clutter map
    - Concurrent beam processing avoiding blind areas (no mechanical switching)
  - PSR L-Band 3D Radar:
    - Each pencil Beam with different configuration:
      - Latest Doppler Filtering
      - NCI Algorithms
    - Accurate Non-cooperative altitude target report

INDRA SOLUTION FOR PRIMARY RADAR

Probability of Detection & Accuracy

- PSR S-Band 2D Radar
  - High PRF: 14 hits per beam, increasing detection accuracy
- PSR L-Band 3D Radar
  - Improved Detection accuracy with Monopulse Techniques
- Drone Detection Capabilities in a PSR3D System
  - Thanks to electronic elevation exploration with pencil beams
  - Clutter & Target (Drone) echoes in different beams

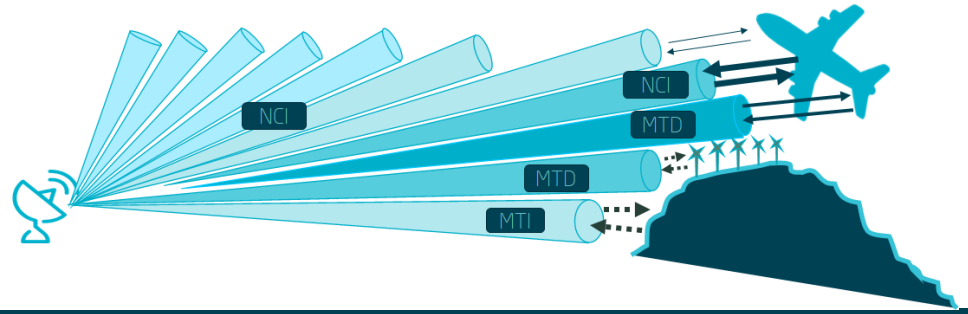




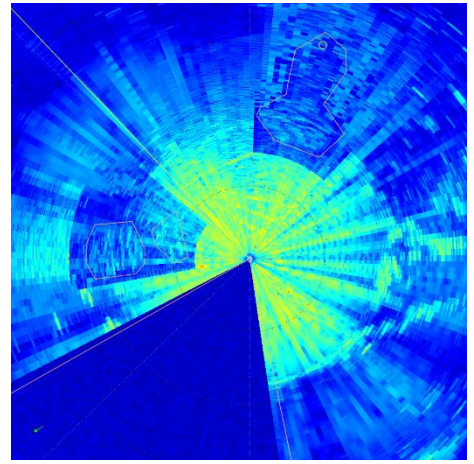
INDRA SOLUTION FOR PRIMARY RADAR

False Target Rate and Detection Improvement in clutter enviroments

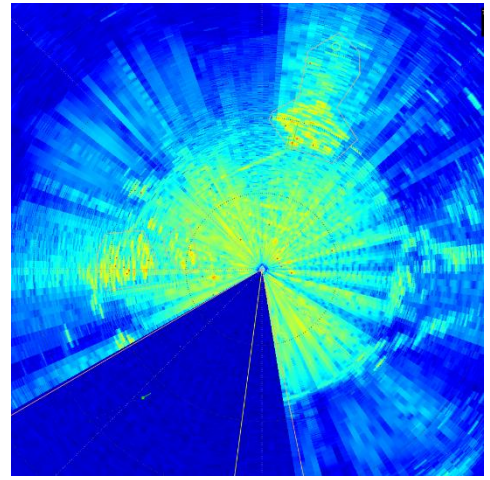
- Advanced Tracking algorithms
- PSR S-Band 2D Radar
  - Synchronous clutter map
  - Synthetic Null Generation
- PSR L-Band 3D Radar
  - Inherent clutter mitigation due to vertical coverage exploration.
  - Enhanced Synthetic Null Generation, better clutter rejection



Processing **ON**.



Processing **OFF.**

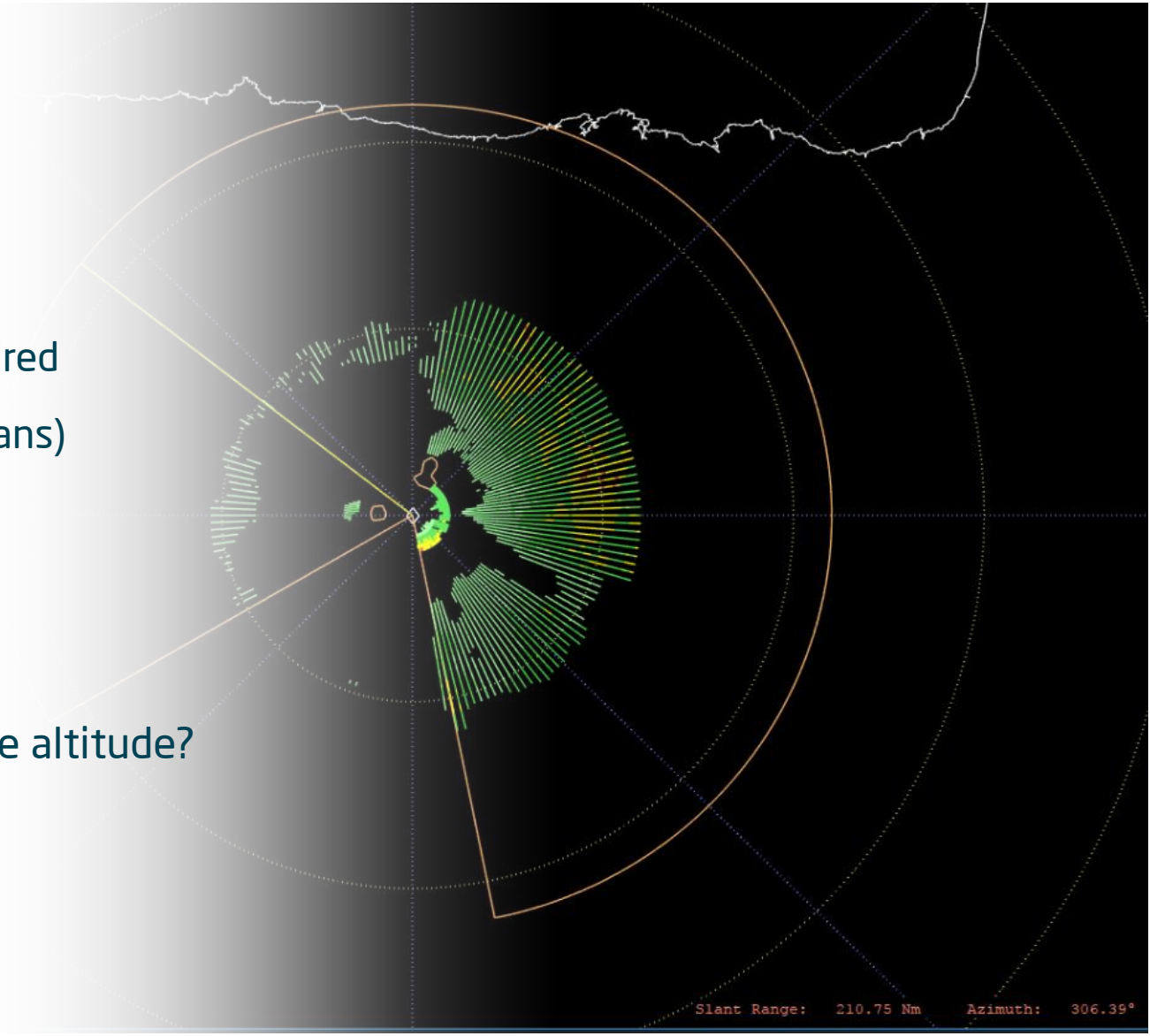


INDRA SOLUTION FOR PRIMARY RADAR

Weather Detection

- Calibrated 6 Levels Weather Channel according to NWS
- Integrated in the Systems: No additional package required
- Configurable update interval (From 1 picture each 6 scans)

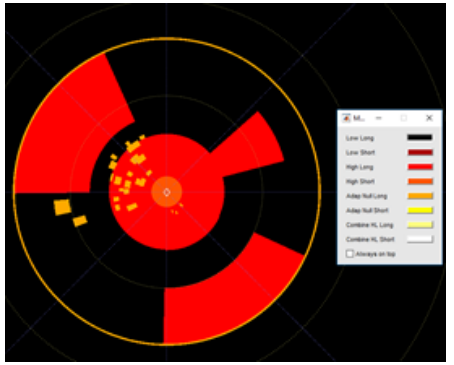
- Indra PSR3D L-Band
  - Estimation of weather Altitude
  - Helps controller decision: Change route / change altitude?



INDRA SOLUTION FOR PRIMARY RADAR

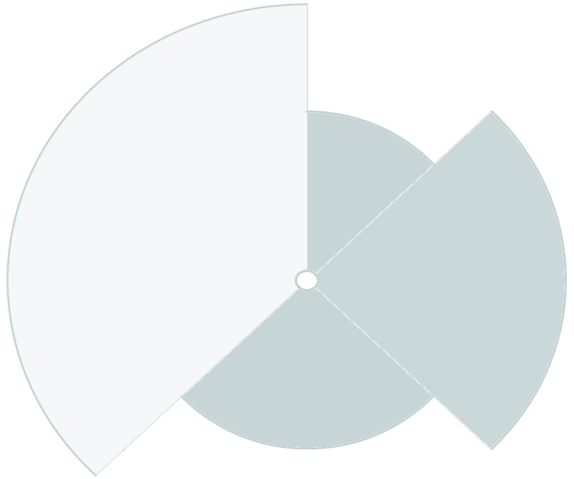
PSR Radar Challenges: Site Adaptation

- Typical Difficulties in a Primary Radars are the correct parameters adaptation to optimize system performances



- Graphical Adaptation Tools: User-friendly and easy for operator

- PSR L-Band 3D Radar
  - Different configurations for different aims
  - Adaptable to the environment in azimuth Sectors including tilt
  - Flexible adaptation and optimization for every site



INDRA SOLUTION FOR PRIMARY RADAR

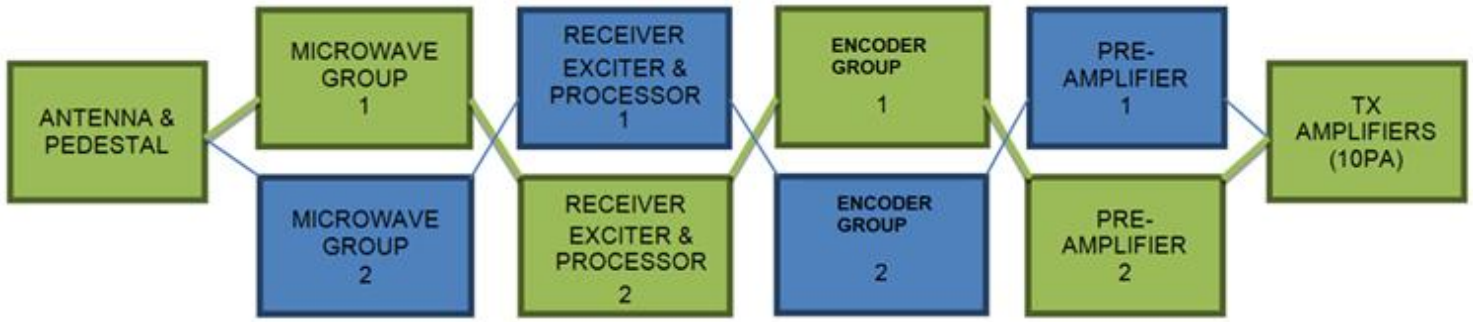
PSR Radar Challenges: Installation Infrastructure

- PSR L-Band 3D Radar Phase Array Antenna
  - 5.5 x 2.2 meters.
  - Instead of “traditional” 13 x 8 meters.
  - Easier installation.
  - No radome required.
  - Tower costs reduction.

INDRA SOLUTION FOR PRIMARY RADAR

PSR Radar Challenges: Reliable & Maintainable Concept

- The most redundant system on the market.
- Independent channel operation in Main/Standby
- Full performances achieved with only one channel operating
- Built-in Signal & Target Injection system: Available Advanced Remote Maintenance
- New redundancy concept and combining groups from both channels.
  - Cross-redundancy philosophy: Elements are not associated to channels, but to Main/Stand-by;



ATM SURVEILLANCE RADARS

- MSSR mode S

MSSR – INDRA SOLUTION

- **MODERN** AND UPDATED SYSTEM
  - Digital Rx
  - Modernized HMI
  - Powerful processors

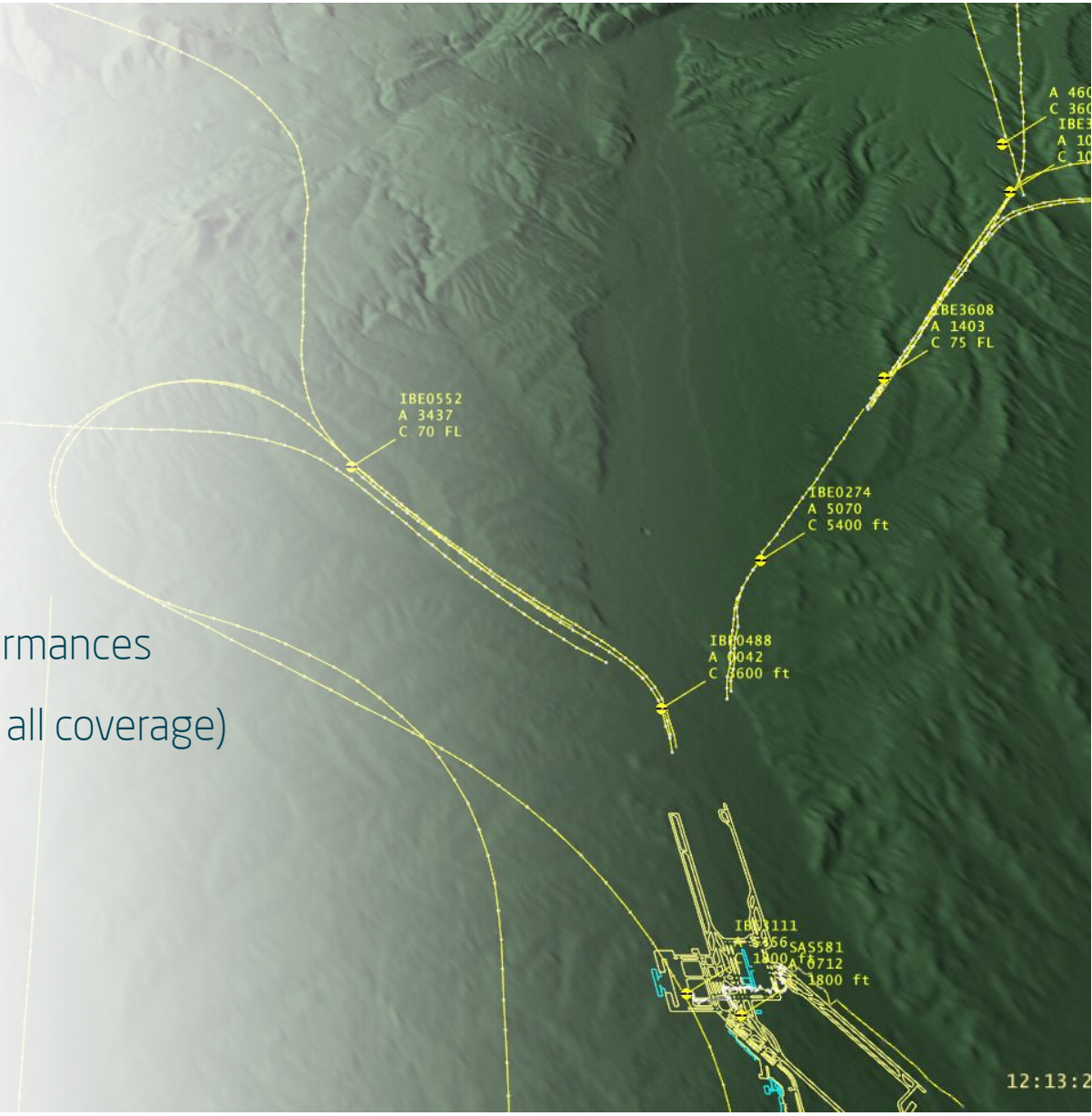
- **INTEGRATED** BUT INDEPENDENT **ADS-B**
  - Redundant surveillance layers (Radar & ADS-B)
  - Improved performances (SMART integration)

- VIDEO

MSSR - UPDATE RATES

- HOW?
  - Use of powerful processors
  - Video and real-time processing
  - Adaptive scheduling for optimization

- WHY?
  - Up to 15rpm while maintaining rest of performances
  - Absence of limitations (mode S enhanced in all coverage)
  - Maintaining coverage volume (256NM)
  - Super-Early acquisition and reporting
  - Reduced cone of silence

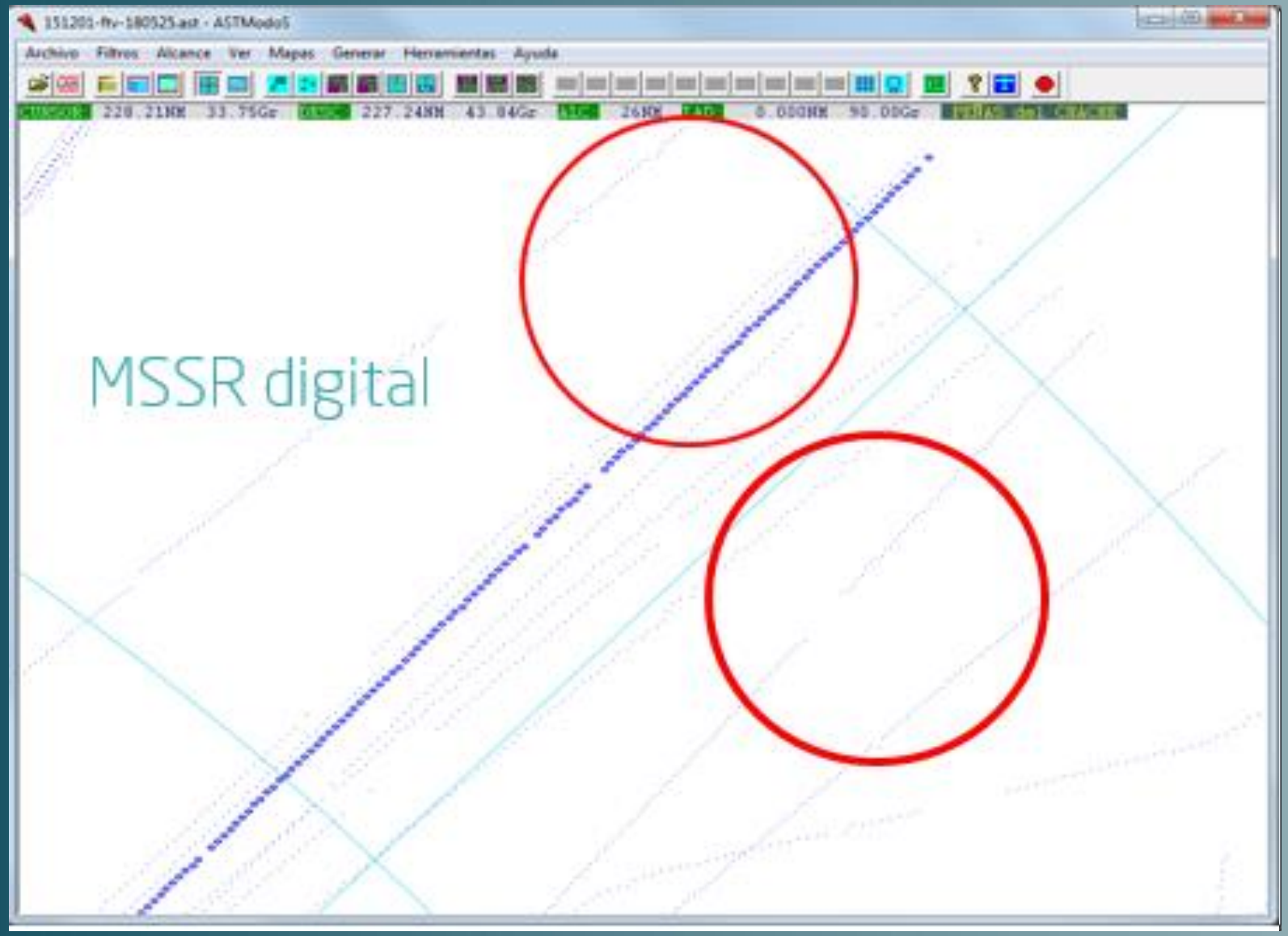


MSSR - ACCURACY & PD FIGURES

- HOW?
  - Complete digital chains using pioneering technology
  - Monopulse receiver and processor improvement
  - Extremely high sensitivity
  - Redundant amplification chains for extended range

- WHY?
  - Pd & Azimuth performances in all coverage (range, low altitudes)
  - Improved tracking algorithms (ADS-B integration)
  - Reduced cone of silence

MSSR - ACCURACY & PD FIGURES



MSSR - FALSE TARGETS REMOVAL

- HOW?
  - Powerful false target removal algorithms
  - Definable, Flexible, adaptable to environment
  - Fit with ADS-B data to improve performances

- WHY?
  - Perfect false rate
  - In all coverage (range, low altitudes)
  - Even in hard or complex environments

MSSR – DATA INTEGRITY & SERVICE CONTINUITY

- Integrated but independent **ADS-B**
  - Redundancy on surveillance layers
  - Performance improvement (SMART ADS-B integration)
  - In whole coverage (250NM)

- Integrated **test and supervision unit**
  - Remote and automatized maintenance
  - Maintenance cost reduction

- Powerfull BITE algorithms **detecting any malfunction** on system
- **Redundancy** in all the elements
- Reliability and quality

MSSR – TRANSPORTABLE SYSTEMS

- **FAST** DEPLOYMENT AND **HIGH QUALITY** SERVICE PROVISION
  - TRANSITIONS//BACK-UP//CONTINGENCY//EMERGENCY
  - PEAK OR TRAFFIC CHANGE

MSSR – EFFICIENCY AND RESOURCE OPTIMIZATION

- HOW?
  - Power & heat
  - Optimization of RF link usage
  - Integration of ADS-B

- WHY?
  - Reduction of **RF Link congestion**
    - Minimal All-Call interrogations/replies
    - Passive acquisition of targets
    - Optimization of selective replies required
    - Optimal output power usage
  - **Simplifying** infrastructure and **costs**

ATM

SURVEILLANCE OVERVIEW

ADS-B & Multilateration

(Multilateration, WAM & ADS-B)

INDRA MWA SOLUTION

Benefits of the MWA system

- Flexible and adaptable solutions to the particular needs of each area or areas of interest
- High accuracy and update rate, configurable for each Operative Service Volume
- Passive cooperation or low interrogation rate -> reduction of the radiofrequency spectrum pollution
- Possible to get a double surveillance layer with only one deployment (cooperative dependent and independent)
- Complementary with any other surveillance system, including space based systems

INDRA MWA SOLUTION

Benefits of the MWA system

- MWA systems can cover the whole cycle of the aircrafts, from the Airport Surface (MLAT), to the TMA and En-route Air Traffic Control (WAM/ADS-B), focused in cooperative aircrafts with passive or active systems, using the same hardware solution. Three different Solutions with common advantages:
  - MLAT: Surveillance System for Airports
    - Fit for complex and congested airports with high accuracy and update rate
  - WAM: Surveillance for Approach (PRM included), TMA and En-route, with high performances and adaptability
    - Better behavior in difficult environments than radar. Flexibility to expand coverage and suitable for difficult environments
  - ADS-B: Surveillance for Surface, Approach, TMA and En-route with high performances and adaptability
    - Easy deployment and cost effective alternative or complementary to secondary radars
    - ADS-B Server to get a single ADS-B dataflow for every ADS-B Service

INDRA MWA SOLUTION

Benefits of the Indra MWA system

Multi purpose MLAT-WAM-ADSB Ground station

Common HW for multilateration (Wide or extended Area) or ADS-B deployments.

- Baseline common HW shared for all purposes (ADS-B stand alone, MLAT, WAM)
- HW configurable for different applications (Rx only, Rx – Tx, Rx – Rt, Rx – Tx - Tr)

INDRA MWA SOLUTION

Benefits of the Indra MWA system

Central Processing Station

- Possibility to configure different simultaneous services for each defined Operational Service Volume
  - MLAT services
  - WAM services
  - ADS-B services

INDRA MWA SOLUTION

Benefits of the Indra MWA system

Overdetermined GNSS synchronization system

- System can operate using different satellite constellations (GPS, GLONASS, GALILEO, BEIDOU and QZSS) in isolation or combining some of them, ensuring a correct operation in case of failure or degradation of any of them
- No Line of Sight restrictions between receivers, so they can be deployed easily. Specially useful in WAM deployments, allowing an easier and more efficient deployment of the receivers
- Improves the precision. Indra synchronization technology offers the highest accuracy on the market, with synchronization errors around 1 ns (1-sigma)

Second method of synchronization using reference transponder synchronization with centralized correction

GPS	Galileo	GLONASS	BeiDou	QZSS
X				
	X			
		X		
			X	
X	X			
X		X		
X			X	
X	X			X
X		X		X
X			X	X
X				X

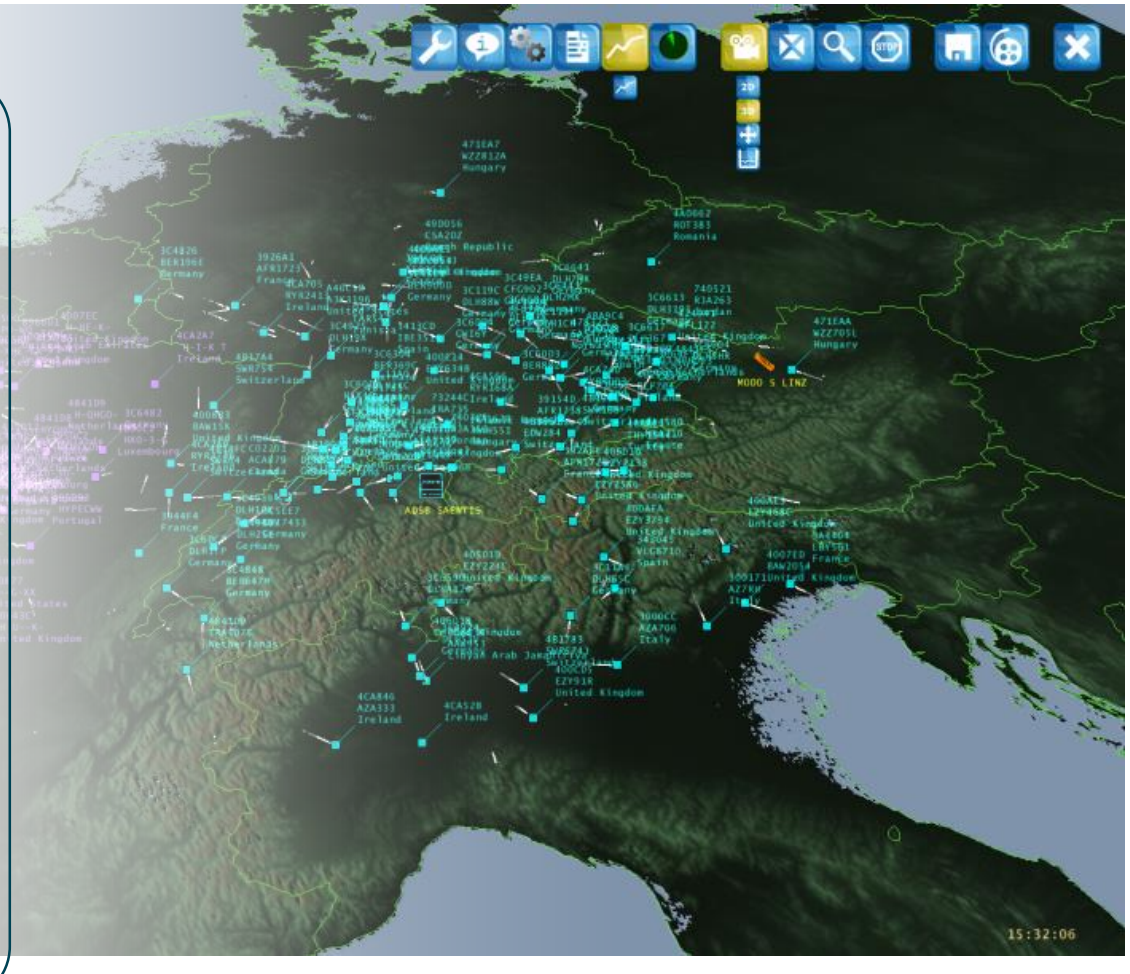
INDRA MWA SOLUTION

Benefits of the Indra MWA system

Dynamic adaptation for ADS-B & WAM simultaneous use

Dynamic adaptation of the receivers for the simultaneous use as ADS-B or WAM. Double triggering detection level optimizing commutations and processing load while maintaining the performances of the ADS-B coverage (no range reduction)

- Increases system performances for dual use stations (WAM+ADS-B service).



INDRA MWA SOLUTION

Benefits of the Indra MWA system

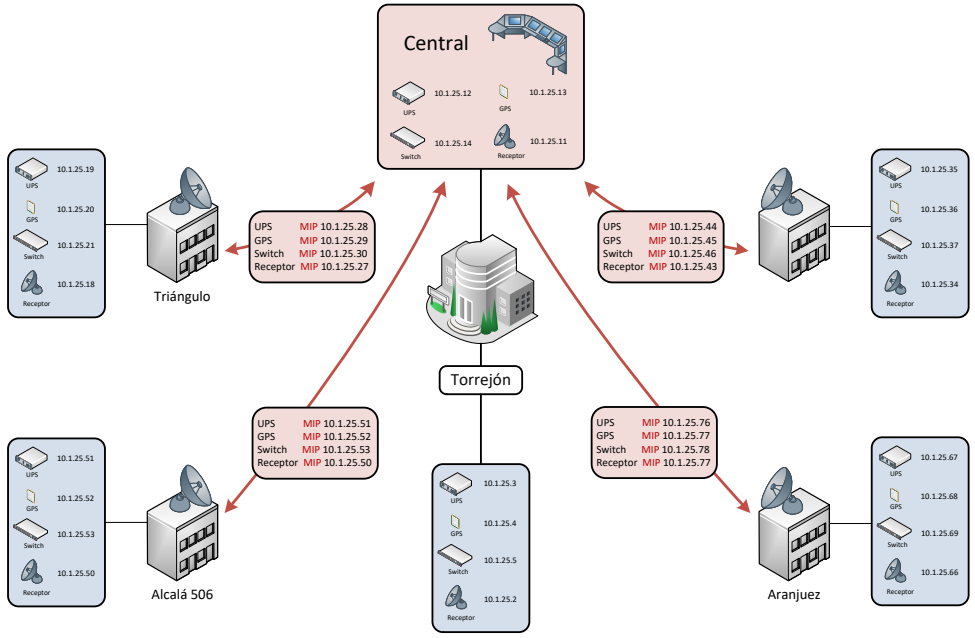
Adaptive ICD for narrow link communications

System adapts output characteristics for narrowband links, ensuring a minimum quality of service of the data and avoiding unexpected loss of data.

Use of non dedicated communications and wireless link

System internal communications can make use of non dedicated networks ensuring a minimum quality of service. Reduction of deployment costs making use of customer´s existing infrastructure.

Wireless communication systems can be used for deployment in Airport environments, reducing Civil Works to a minimum.



INDRA MWA SOLUTION

Benefits of the Indra MWA system

Composite Surveillance

In line with ECTRL roadmaps, Indra is leading developments in SESAR & EUROCAE for Composite surveillance. System make correct data of ADS-B information in both WLAM & ADS-B channels.

- Operation in passive or quasi passive mode by validation of ADS-B information.
- ADS-B validation and marking of correct and incorrect data. This info can be used downstream for different purposes (whitelist, blacklist, identification of jamming-spoofing, tracker settings, increase coverage limits.....). Quality of validated ADS-B targets is normally better than WAM info in the borders of the coverage.
- Provides a solution to ICAO mandates to reduce Transponder load.
- Verifies ADS-B data integrity.

INDRA MWA SOLUTION

Benefits of the Indra MWA system

Secured ADS-B

Indra is leading developments in SESAR & EUROCAE for Secured surveillance. Making use of Composite surveillance and other features, system detects and reports different kind of threats at target and at sensor level. Reporting is through ASTERIX CAT025 and/or CAT021.

- Identification of jamming signals at sensor level.
- Identification of spoofing targets (false or modified targets).
- Provides to the customer methods for threat detection & reporting.

Performance Assurance of Surveillance Systems

PASS

Regulatory Framework

Regulatory Framework

ICAO Aeronautical Surveillance Manual (ICAO Doc. 9924)

4.3 OTHER PERFORMANCE-RELATED ISSUES

4.3.1 Definition of surveillance system performance should be independent of technology as much as possible. Such an approach allows more efficient system design based on the operational environment and with available surveillance techniques.

4.3.2 For traceability, the surveillance system performance should be defined for a given supported application. When a surveillance system is used to support a number of different applications, the most stringent requirements must be used. Examples of surveillance system performance required for supporting some common applications are shown in Appendix A.

4.3.3 It should be verified that a surveillance system meets the requirements prior to being put into operational service. The environment in which the system operates can change over time. For example, the coverage may be impacted by new obstructions, or traffic density may increase. Also, some components may degrade over time. It is therefore important to put measures in place to ensure continued compliance to performance requirements. Examples of such measures are:

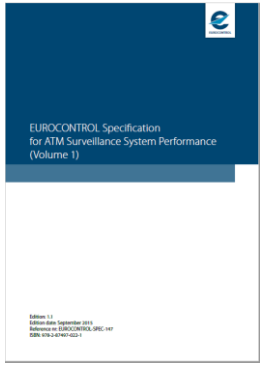
a) periodically verifying the performance of the system. The initial verification testing can be used as a baseline to compare against; or

b) ensuring that the surveillance system has sufficient built-in tests and external monitoring features to continuously demonstrate that the performance requirements are being met.

It is recommended that periodic testing be conducted to safeguard against undetected changes to the environment.

Regulatory Framework

EUROCONTROL Specification for ATM Surveillance System Performance (Volume I) - CONFORMITY ASSESSMENT



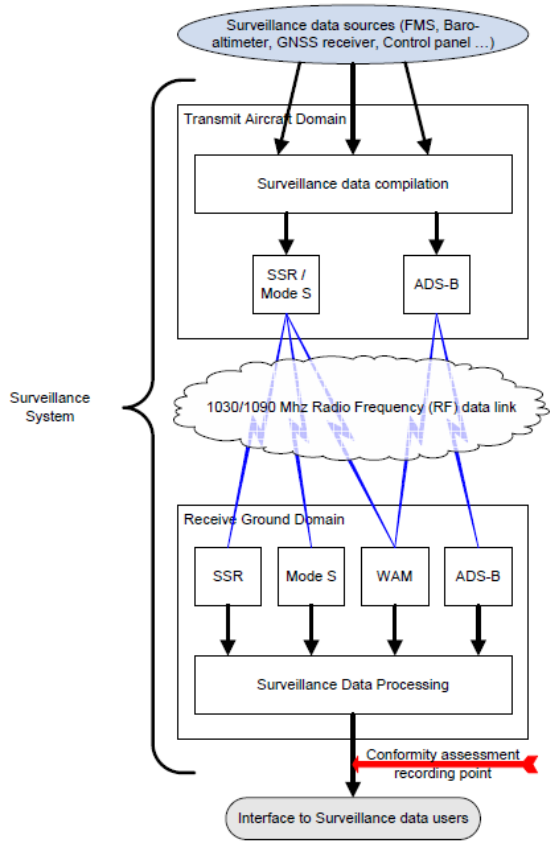


Figure 13: Current Air-Ground Surveillance systems implementation based on 1030/1090 MHz data link

4 CONFORMITY ASSESSMENT

4.1 Generalities

4.1.1 Conformity assessment approaches

The conformity assessment of surveillance systems can be undertaken on the basis of one or more of the five following approaches and in accordance with its associated priority:

- Opportunity traffic (priority 1),
- Flight trials (priority 2),
- Proof offered through system design files or by system design assurance (priority 3),
- Test transponder (priority 3),
- Injected test target (priority 3).

The priorities have been allocated on the basis of the operational relevance of each approach. The approach based on opportunity traffic has priority 1 as it is fully representative of the operational traffic and of the operational environment. The remaining 3 approaches are rather partially representative of the operational traffic and operational environment and have the lowest priority.

4.1.4 Conformity assessment periodicity

The assessment shall be made periodically on each ground surveillance system and after each system or environment modification that may have an impact on its performance characteristics.

The periodicity of the conformity assessment is to be defined depending on the system design and the type of technology used.

When assessing the surveillance system performance on the basis of opportunity traffic, the system is only evaluated where there are flights. If airspace design modifications are to be implemented, a study will have to be undertaken to check that the system will still meet the required performance with the new traffic and specific flight trials may be needed.

Performance Assessment - SW Tool

Performance Assessment

SW Tool – SASS-C/VERIF

- SASS-C is a Software Tool developed by EUROCONTROL to assess the performance of surveillance systems. → VERIF SW tool.
- Performance Analysis based on Opportunity Traffic.
- Essential for the correct certification of data quality.
  - Commissioning - Adaptation to the environment.
  - Performance Optimization Process.
  - Analysis and Study of specific cases/areas.
  - Stability/Service Period - Assurance and early/preventive detection of possible degradations in data quality.

Performance Assessment

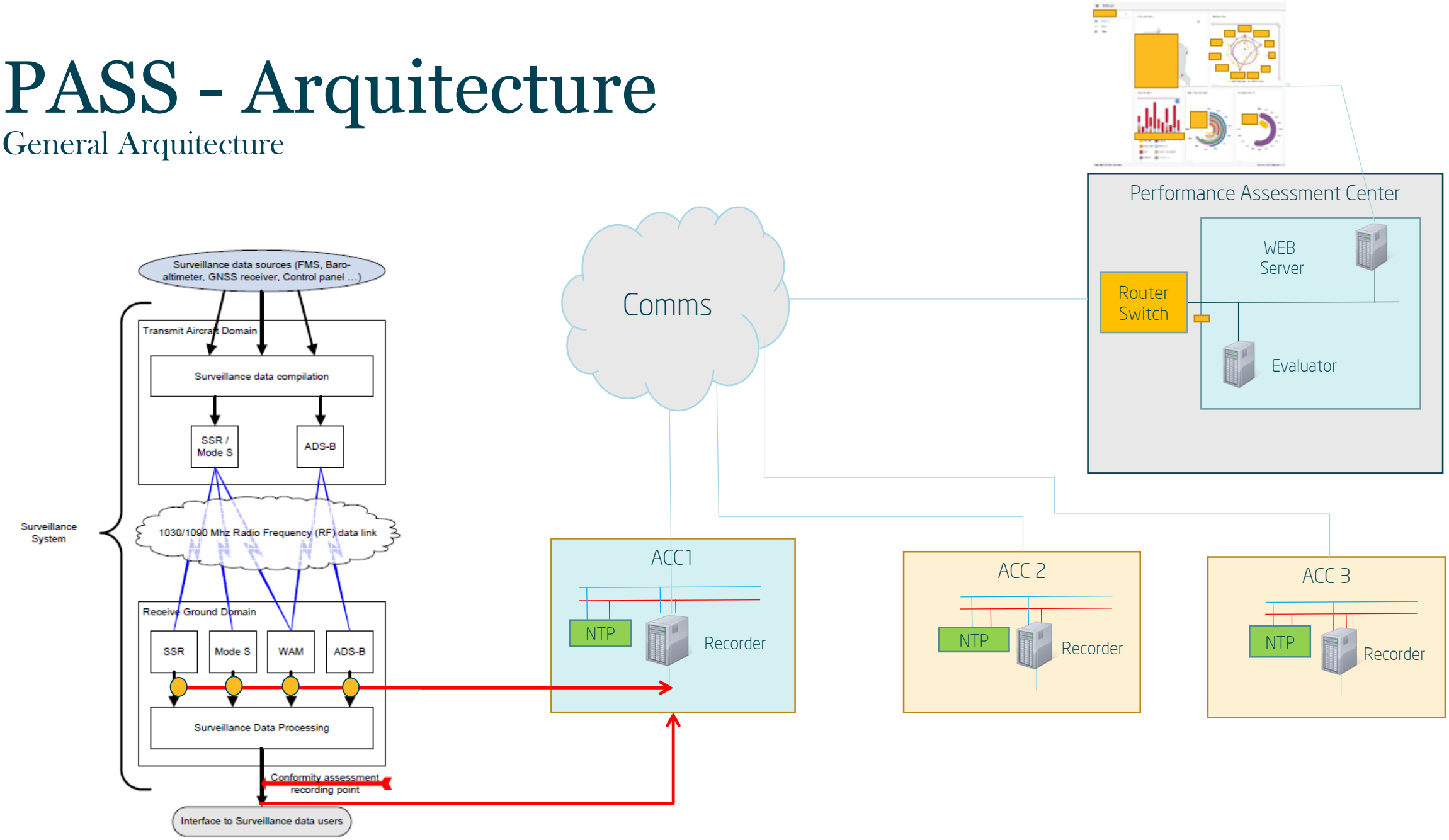
SW Tool – SASS-C/VERIF

- Multiradar Recordings - **Performance Requirements for Individual Surveillance Sensors:**
  - Target Statistics, Probability of Detection (targets and codes), False rate (targets and codes), Accuracy, etc → Meet the KPIs required for the service.
- **Performance requirements for Air Traffic Management (ATM) surveillance system** supporting the service and horizontal separation application required for each specific volume.
  - ESASSP - EUROCONTROL Specification for ATM Surveillance System Performance

PASS - Performance Assurance of Surveillance System

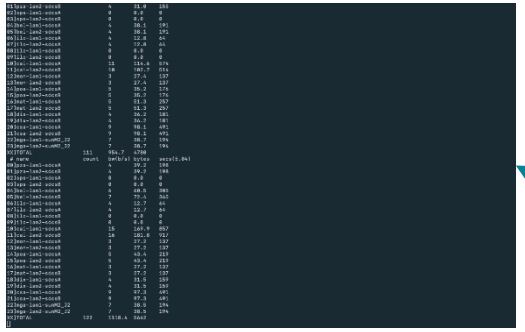
PASS - Arquitecture

General Arquitecture



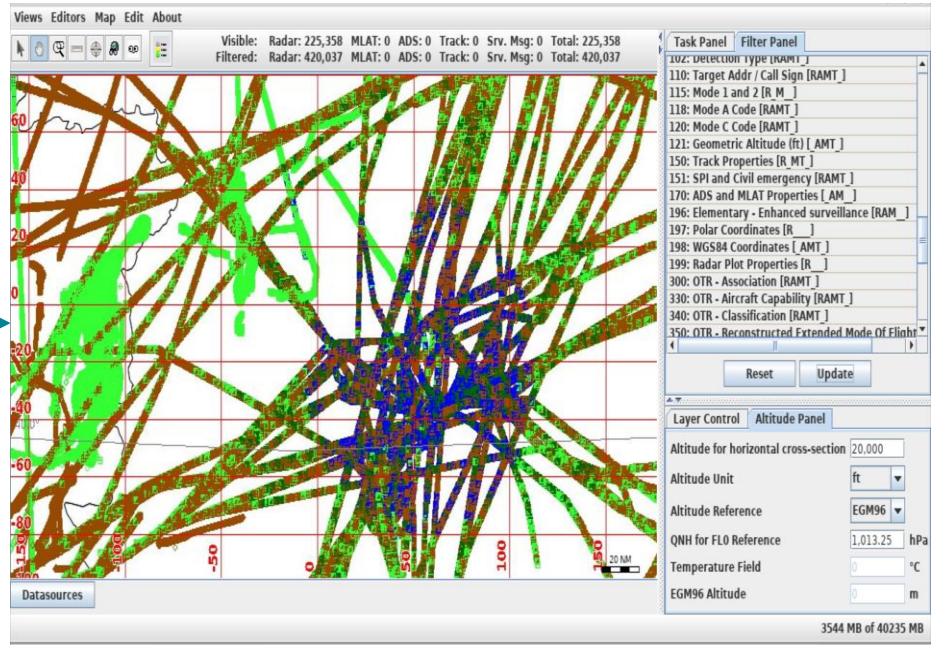
PASS Service

Processes Involved in PASS



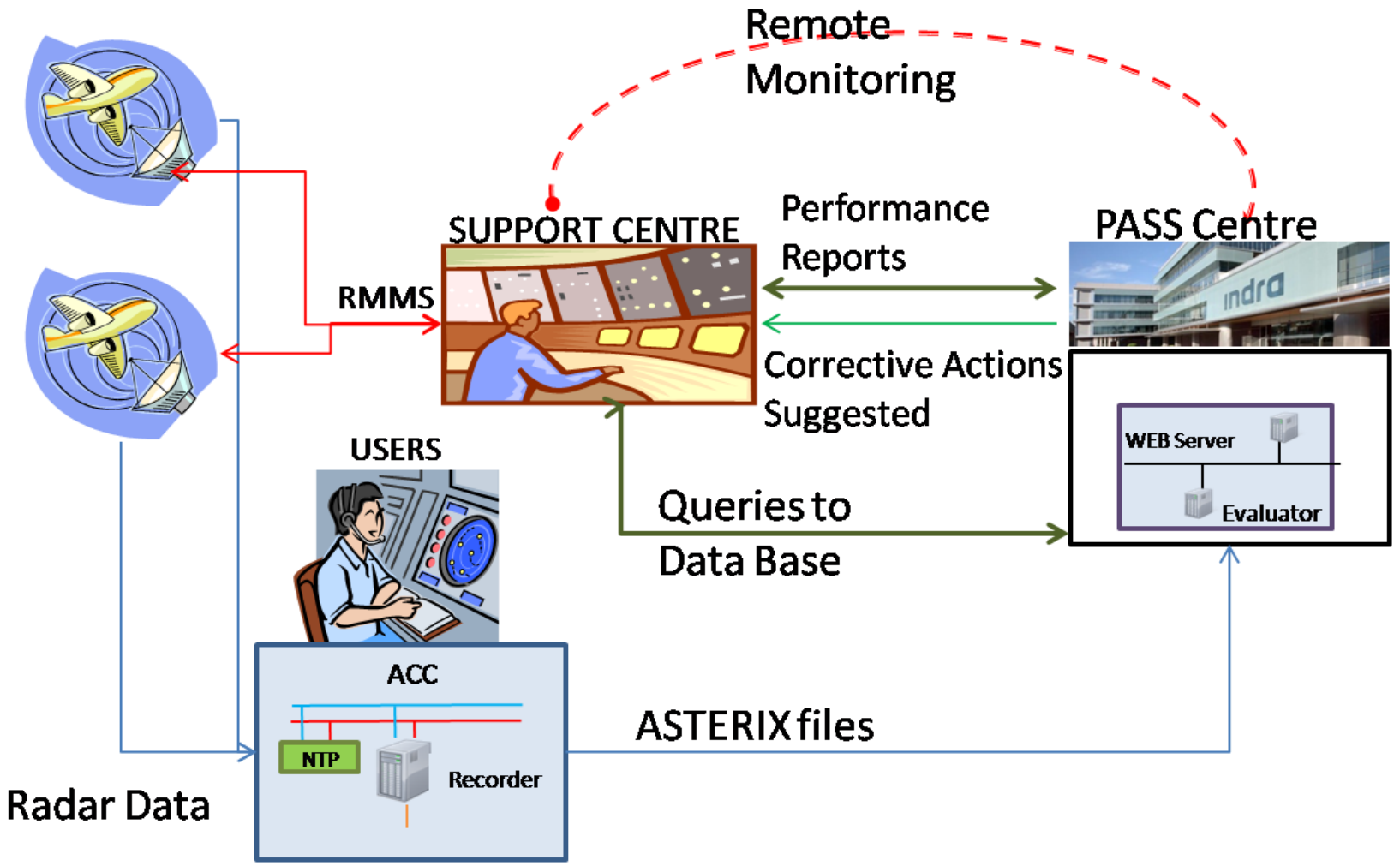
PASS Processes

- **Automatic Recording of Multi-radar data**
- **Automatic Recordings Evaluation - VERIF**
- **Data available in WEB App**



PASS Service

Workflow



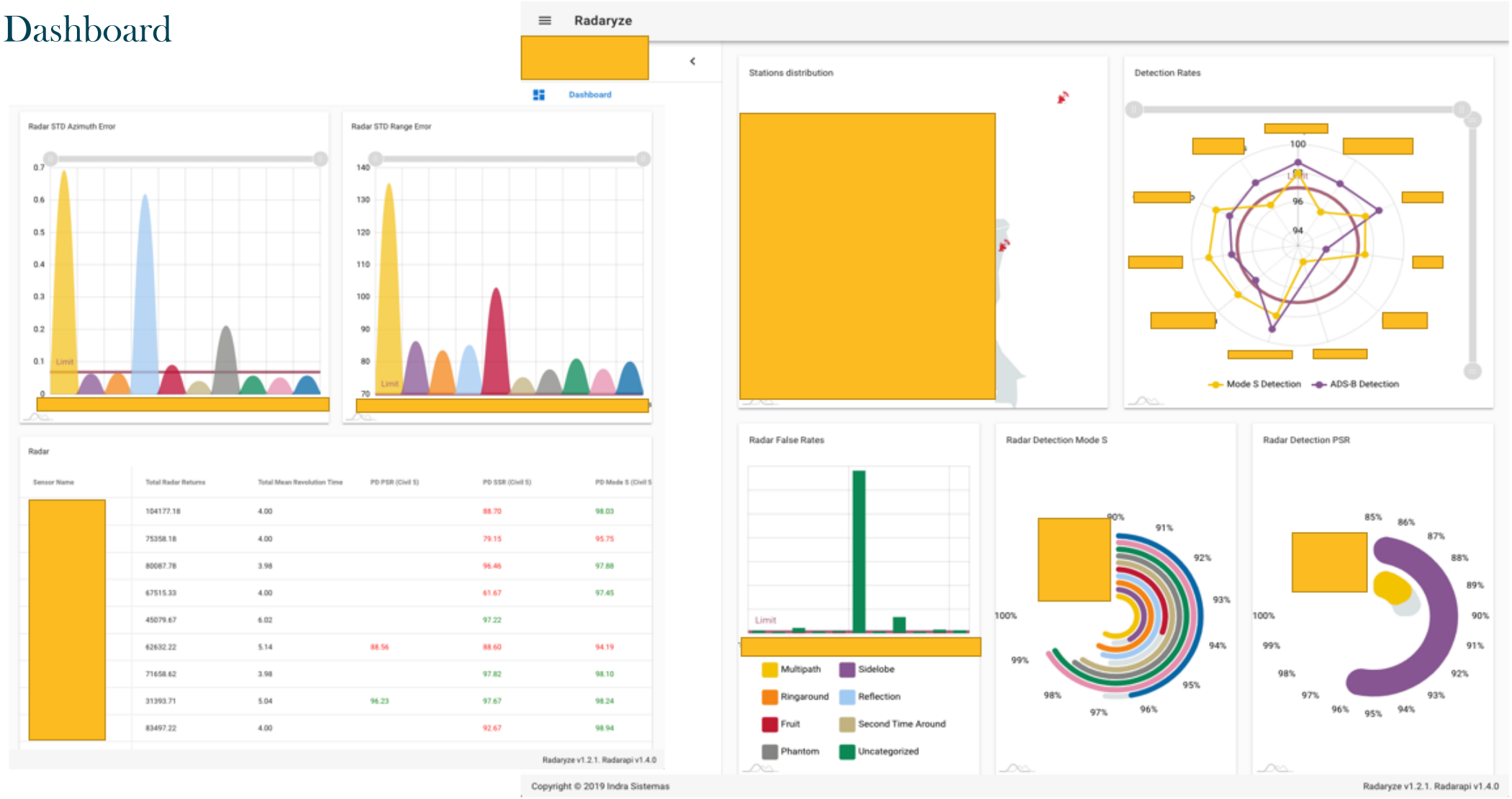
PASS Service

Service Main Features

- Highly specialized and continuous technical assistance.
- Meetings for monitoring and analysis of system performance.
- Generation of periodic system performance reports.
- Early detection of degradations.
- Identification of the source of degradations.
- Proposals for corrective actions.
- Identification and analysis of trends → Predictive Maintenance

PASS Service

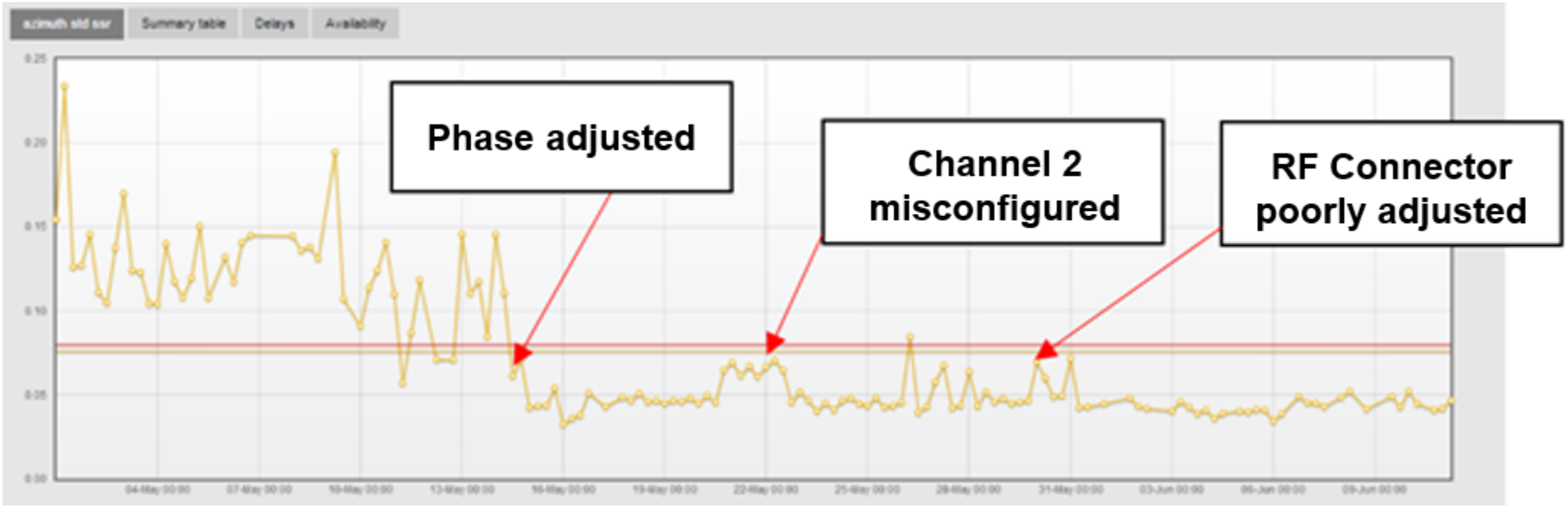
Dashboard



PASS Service

Real-Time Performance Example - Actions

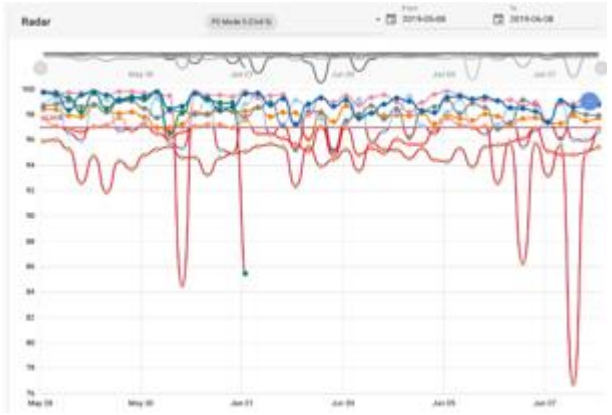
- Example of the monitoring of the performance evolution for the azimuth radar accuracy.
- Some corrective actions have been taken and the results are clearly visible in the trend.



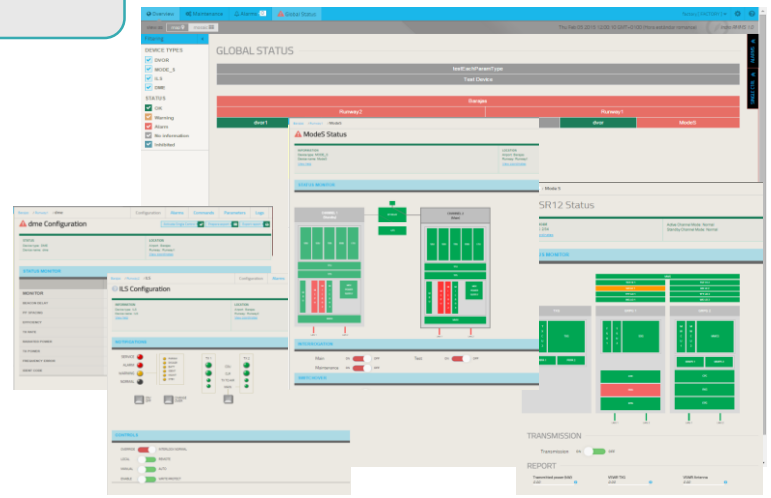
PASS Service

Main Advantages/Benefits

OPERATIONAL PERFORMANCE UNDER CONTROL



RMMS STATUS INFORMATION
+
PERFORMANCE DATA (PASS)



- EARLY DETECTION OF DEGRADATIONS
- CONDITION-BASED MAINTENANCE
- SYSTEMS ALWAYS OPTIMIZED TO THE CHANGES OF THE ENVIRONMENT
- CONTINUOUS EVIDENCE OF SYSTEMS PERFORMANCE
- IMPROVEMENT IN THE SAFETY OF OPERATIONS

Remote Management and Monitoring System RMMS

Basic Functions

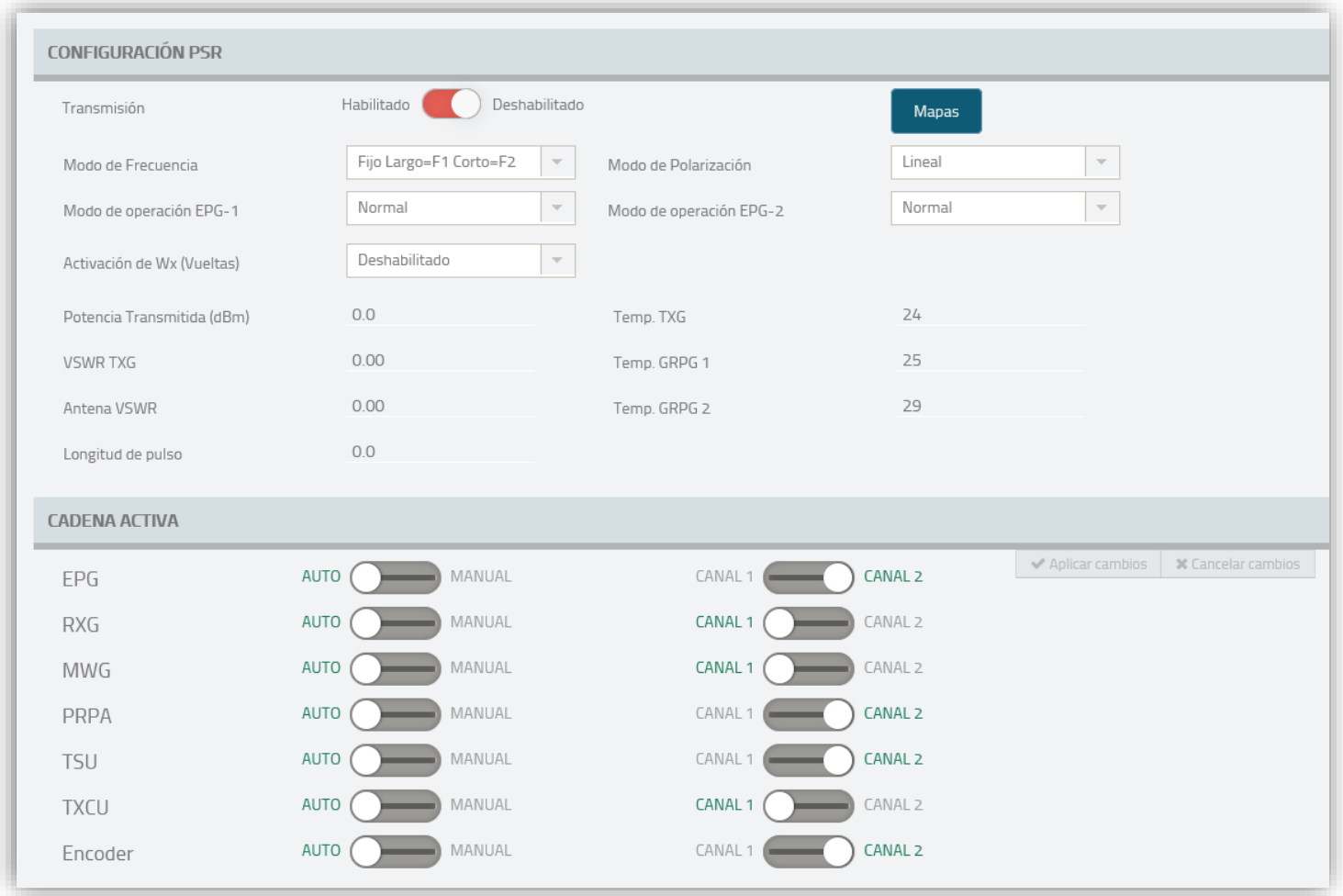
Supervision

- HMI adapted to every device:
  - Detailed status Information
  - Alarm Presentation
  - Operative Configuration presentation

Basic Functions

Control

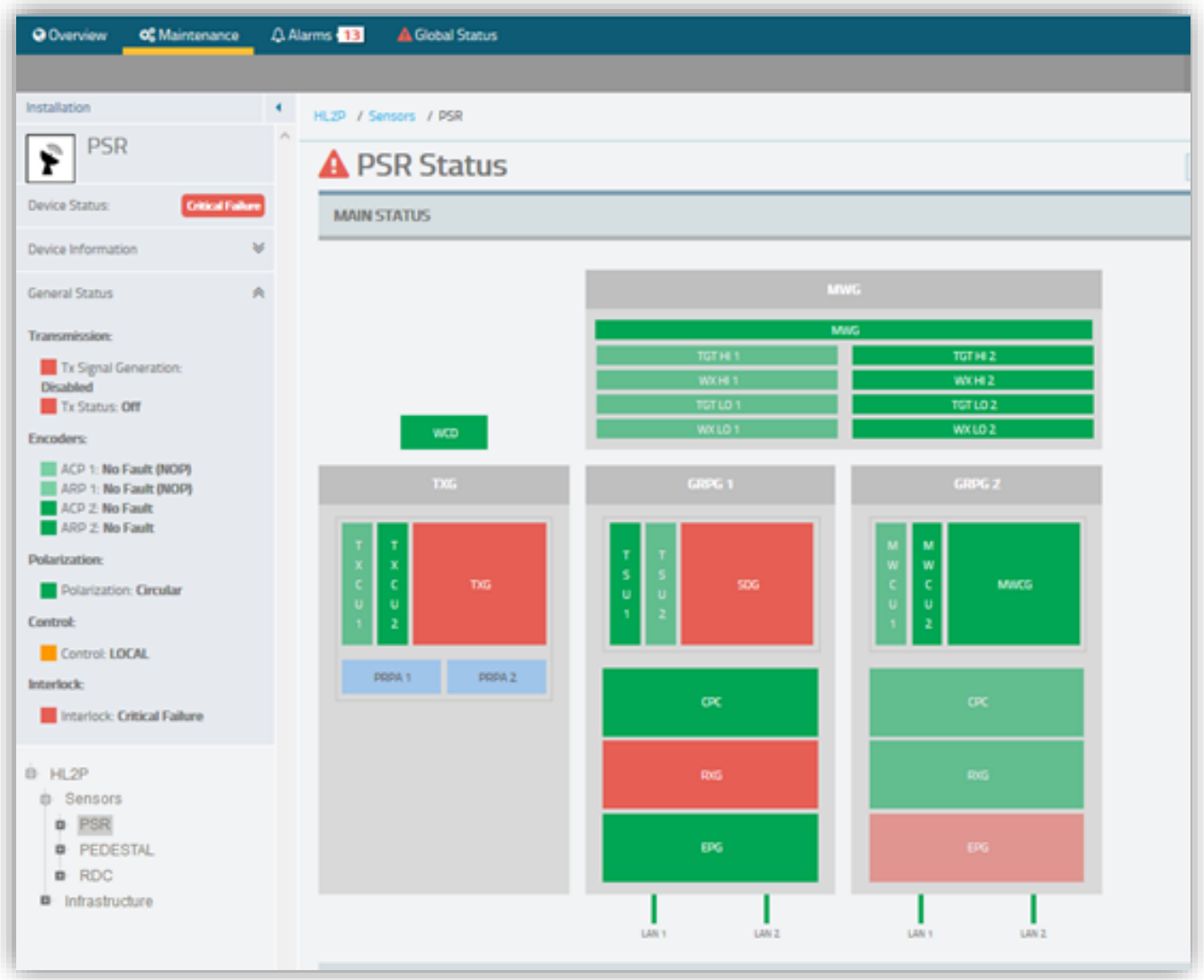
- Change selection and parameter adjustment of the supervised elements.
- Automatic Switchover (or manual) that allows the system to recover from a system failure.
- Independent single control for each device: A single user could only operate over a device at a time.
- Different user level access according to different roles.



Basic Functions

Maintenance

- Configuration back-ups management .
- Failure Management
  - Detection
  - Isolation
  - Correction
- Test
  - Automatic
  - User driven

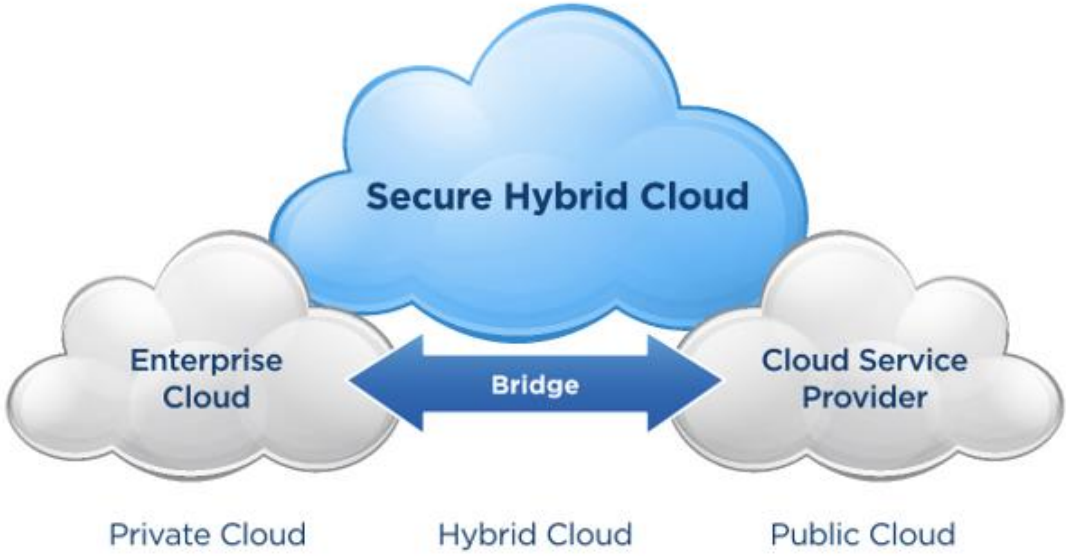


Current Control and Monitoring Constraints

- Site access limitations
  - Far locations
  - Permissions
  - NOTAM's
- Communications
  - Bandwidth
  - Reliability
  - Data consistency
- Hardware and Software
  - Difficult to update
  - Monolithic
  - Obsolescence
  - Not scalable
- User related
  - Fixed position
  - One management system per device
  - Training costs

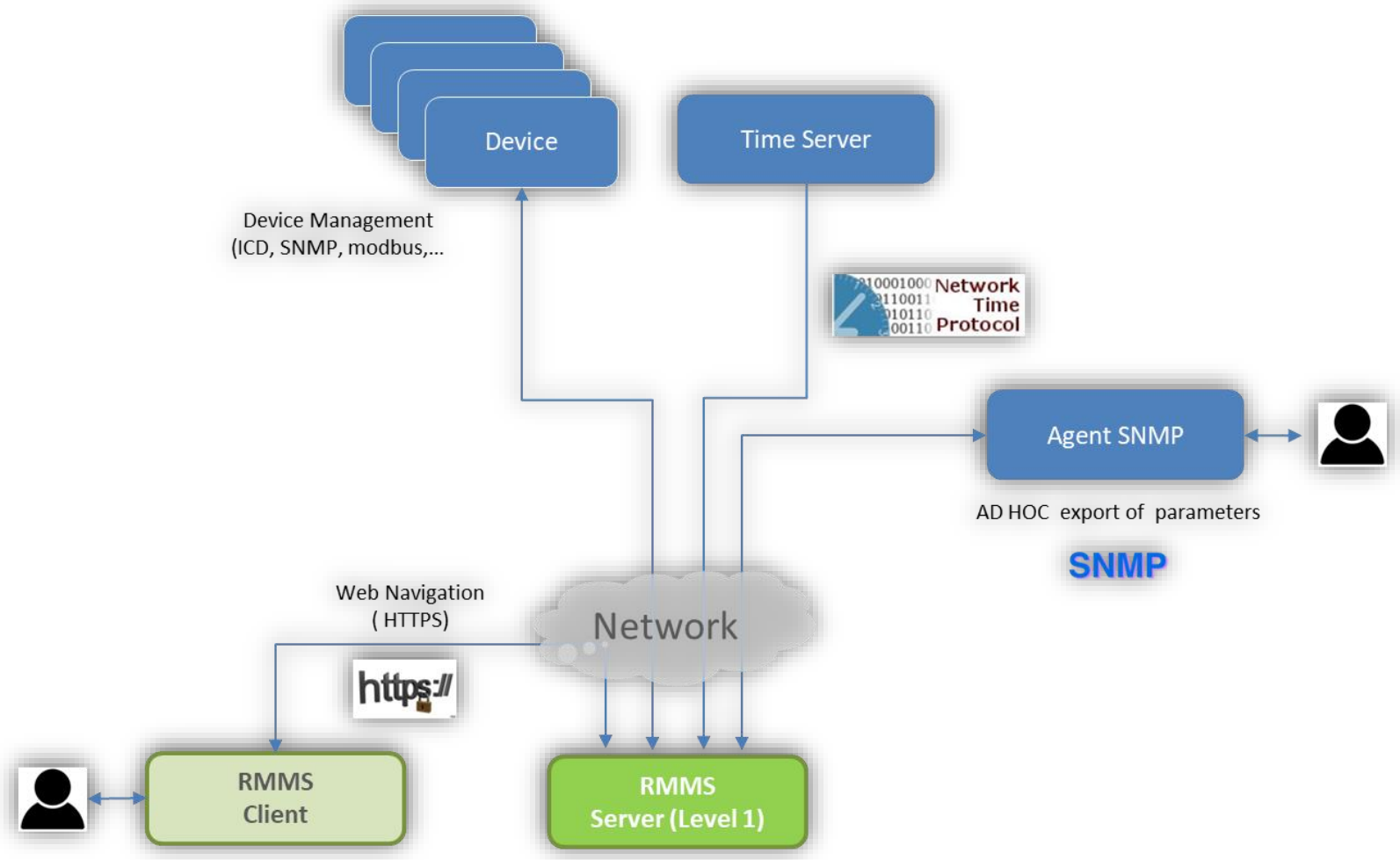
RMMS Architecture

- HW Architecture: Modular, flexible, scalable & distributed
  - Software not linked to an specific hardware
  - Different redundancy levels
  - Connection oriented communications. Integrity
  - High availability
  - Quick deployment. User transparent
- User oriented, not to fixed position.
  - User can be located anywhere
  - Access from any kind of device
  - Unlimited simultaneous users



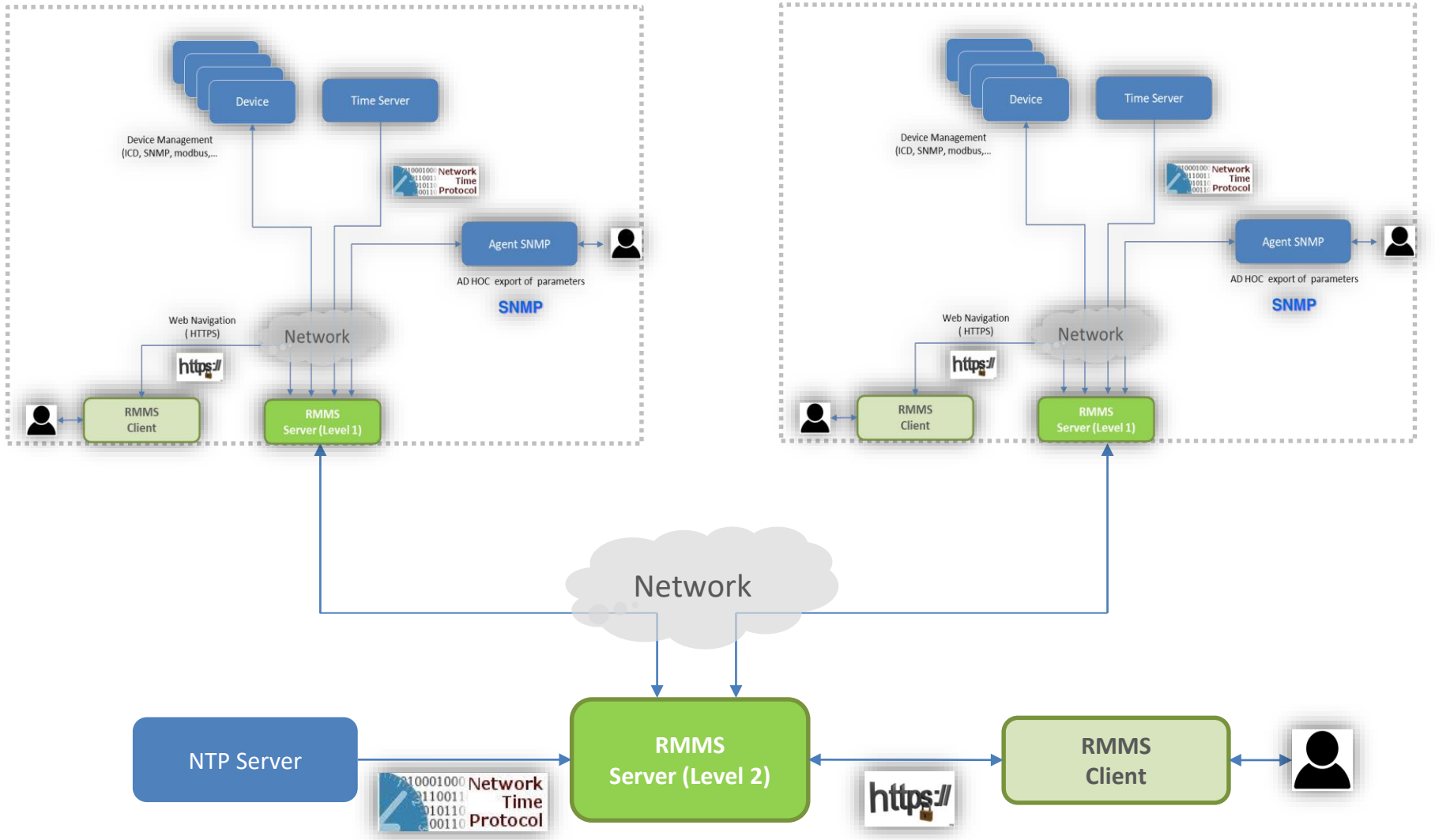
RMMS- Multi level

- Site (local or remote)



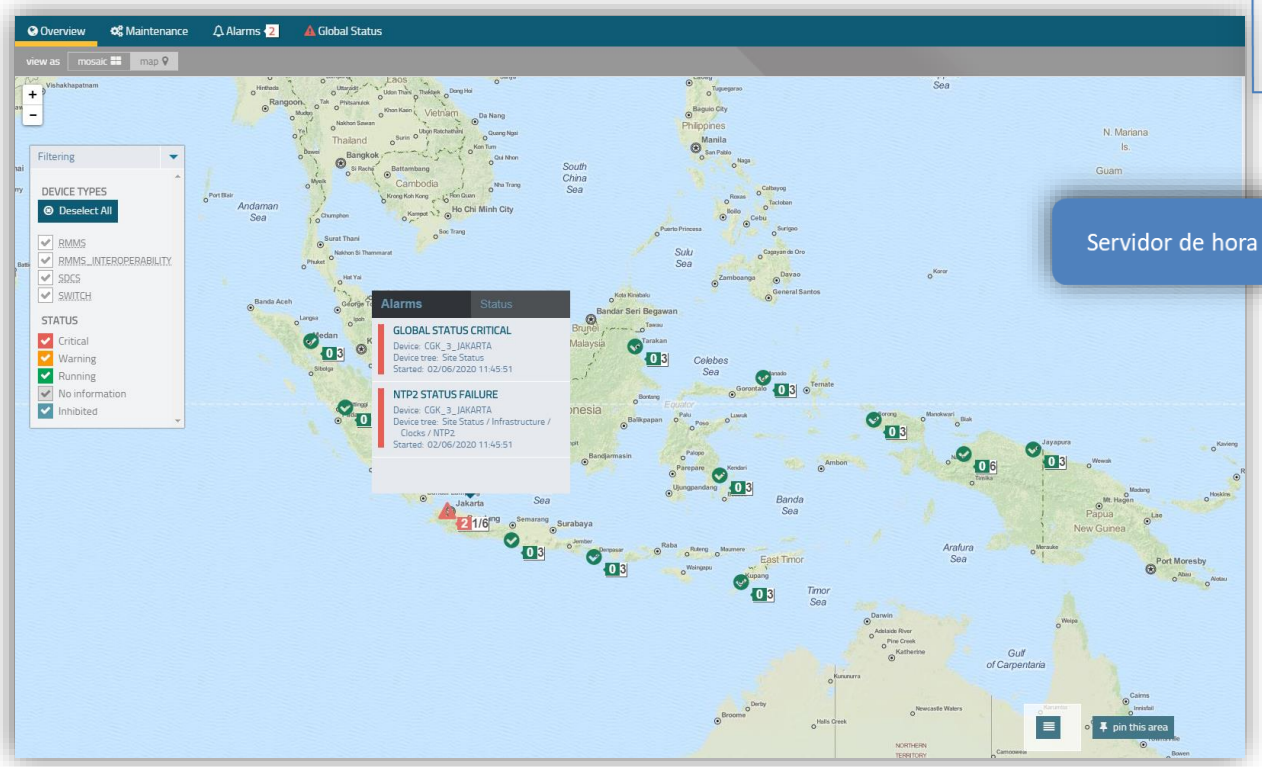
RMMS- Multi level

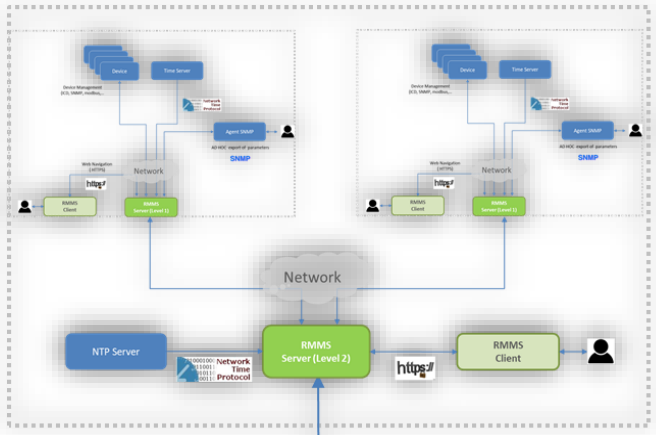
- Region

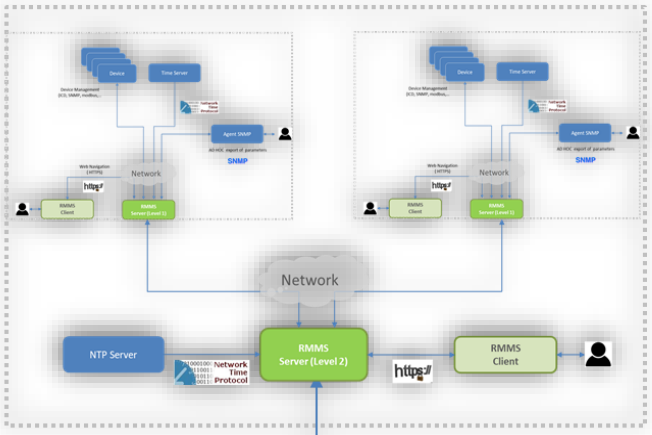


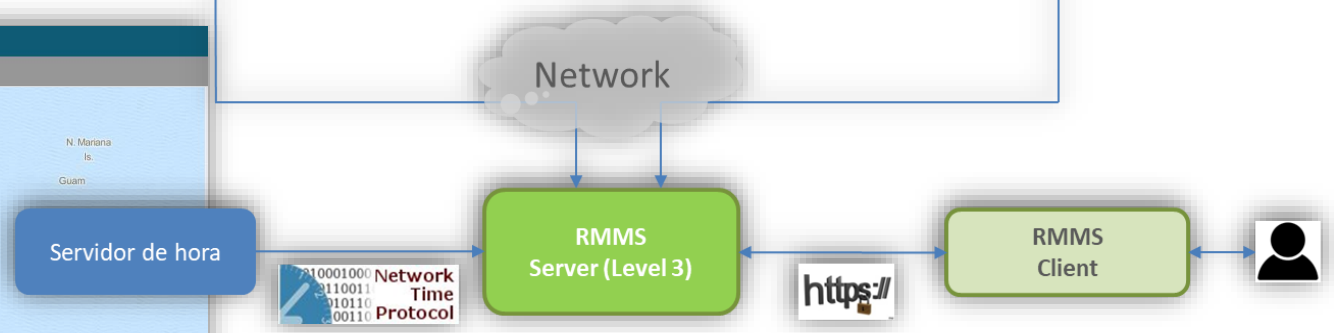
RMMS- Multi level

- Complete network (Service)









Advanced Features - Troubleshooting

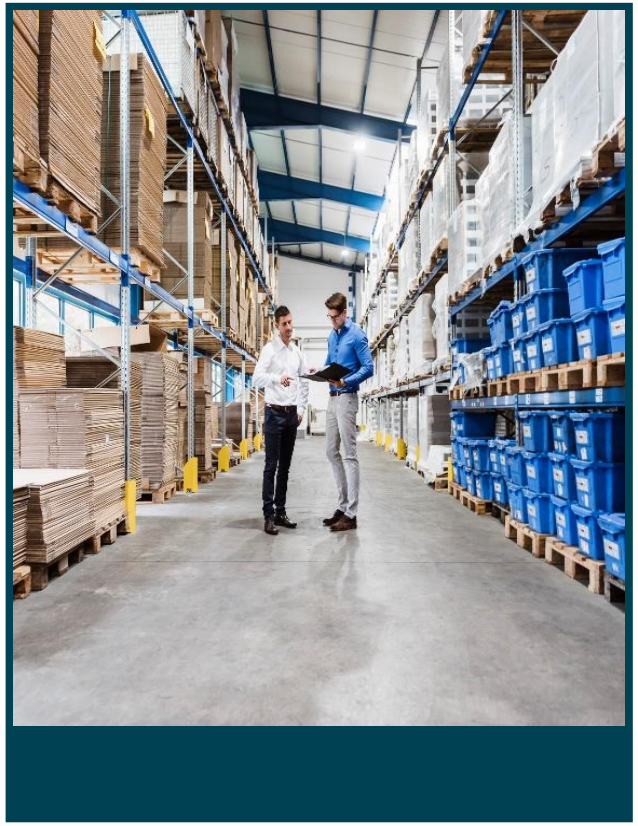
- Troubleshooting integrated for each surveillance device.
  - Procedures linked to each alarm
  - Guides the operator through the steps to correct the failure when possible
  - Can be performed from remote locations

- Interactive
  - Automatic measures
  - Logging actions and steps
  - Shortcuts to corrective maintenance tasks

- Benefits
  - Reduction of failure reparation times

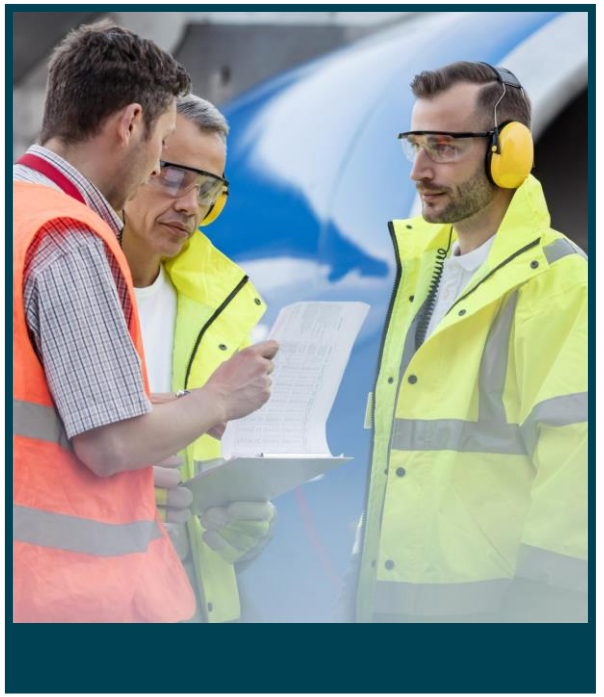
Advanced Features – Configuration control

- Hardware/Firmware/Software Configuration
  - LRU Level
  - Part Number / Serial Number / Versions
  - Traceability of deployed modules in every station
  - Reporting and search of modules
  - Distributed repository
  - Module replacement procedures
  - Spares availability / location



Advanced Features – Interactive Maintenance

- Preventive Maintenances- Interactive/Automatic
  - Configurable Schedule
  - Deadline warnings according to maintenance plan
  - Leads the operator through the necessary steps
  - Recording of the step results, user notes and the measured values
  - Can be performed from remote locations
- Corrective Maintenances- Manual
  - Step-by-step user help
  - Results report
  - Can be performed from remote locations if possible



Advanced Features – Predictive Maintenance

- Benefits of Predictive and CBM Maintenance
  - Increases the availability of the assets
  - Reduced maintenance and out of service times
  - Real-Time warnings and early alert systems
  - Machine learning algorithm for identification of failure patterns
  - Helps with the costs planning and maintenance budgets

Advanced Features – Big Data

- Extract value from stored data
- Business Intelligence
- Trend analisys
- Key Performance Indicators (KPI)
  - MTBF
  - MTTR
  - Availability-Downtime
  - PMP – Planned Maintenance percentage
  - PMC – Planned Maintenance compliance


indra
At the core