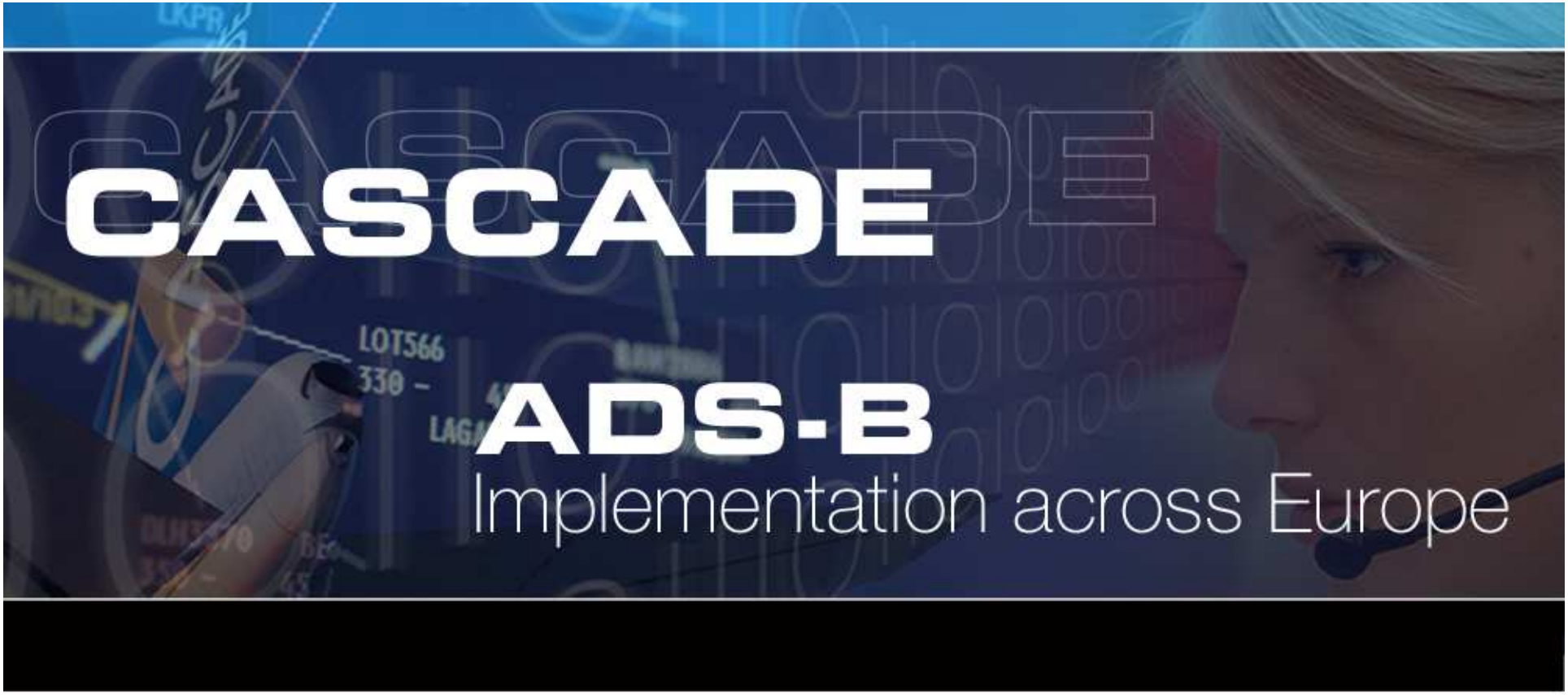


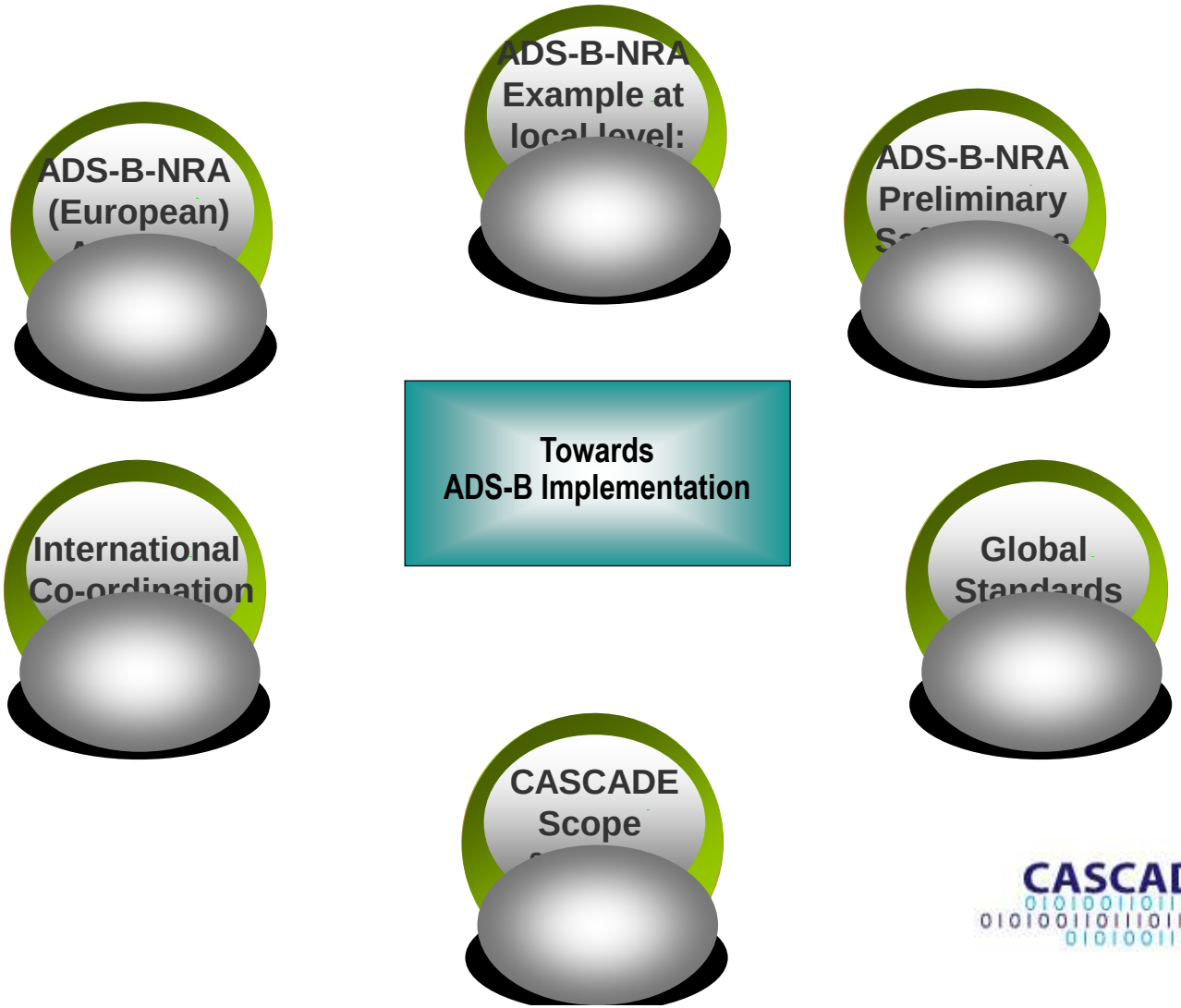
ADS-B-NRA : an example of continuum between CND and ANSP

SASI - Support to ANSPs for SMS Implementation

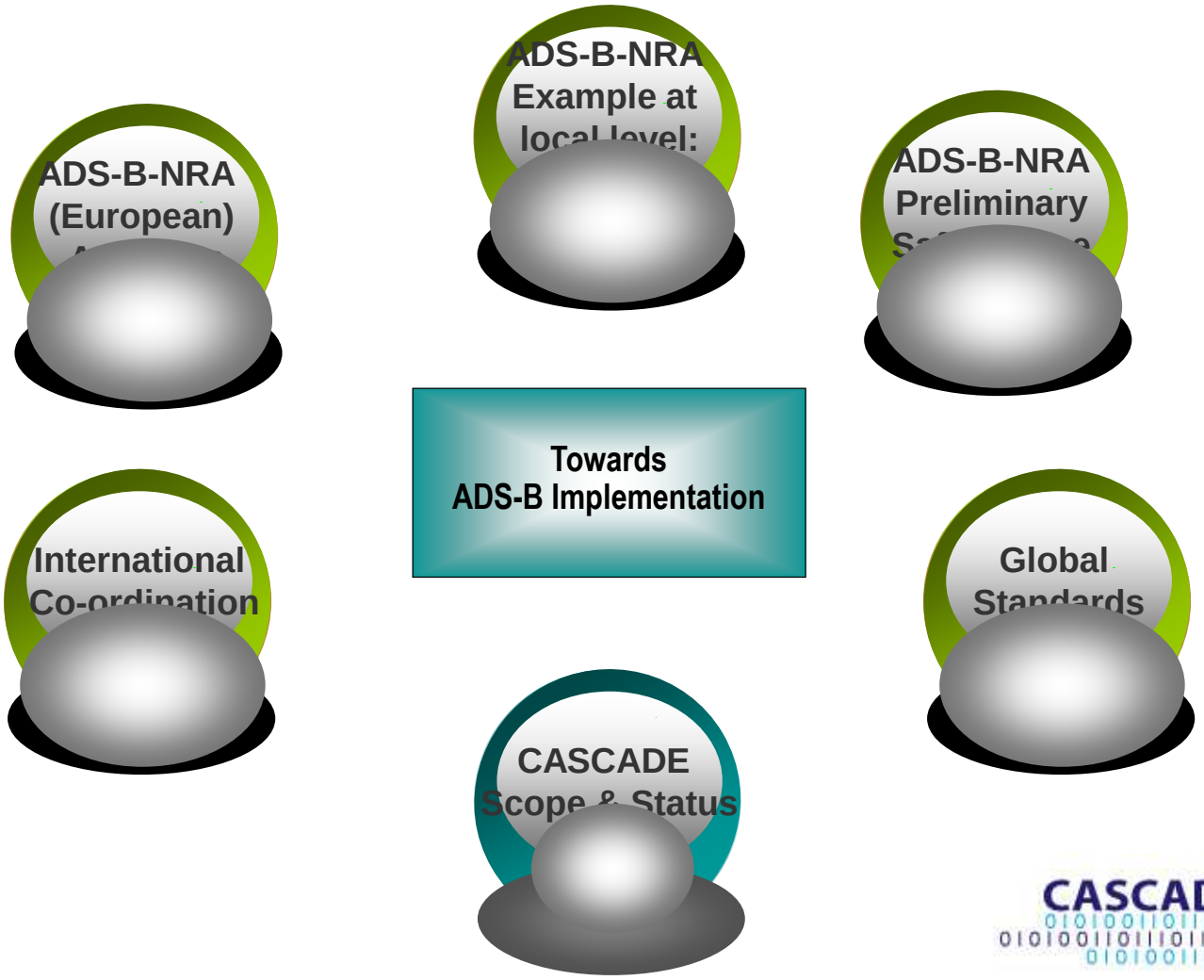
Eurocontrol Brussels June 2009

Gilles Caligaris – Mesut Gurbuz

Overview


ADS-B-NRA (European)
ADS-B-NRA Example at local level:
ADS-B-NRA Preliminary
Towards ADS-B Implementation
International Co-ordination
Global Standards
CASCADE Scope

Overview


ADS-B-NRA (European)
ADS-B-NRA Example at local level:
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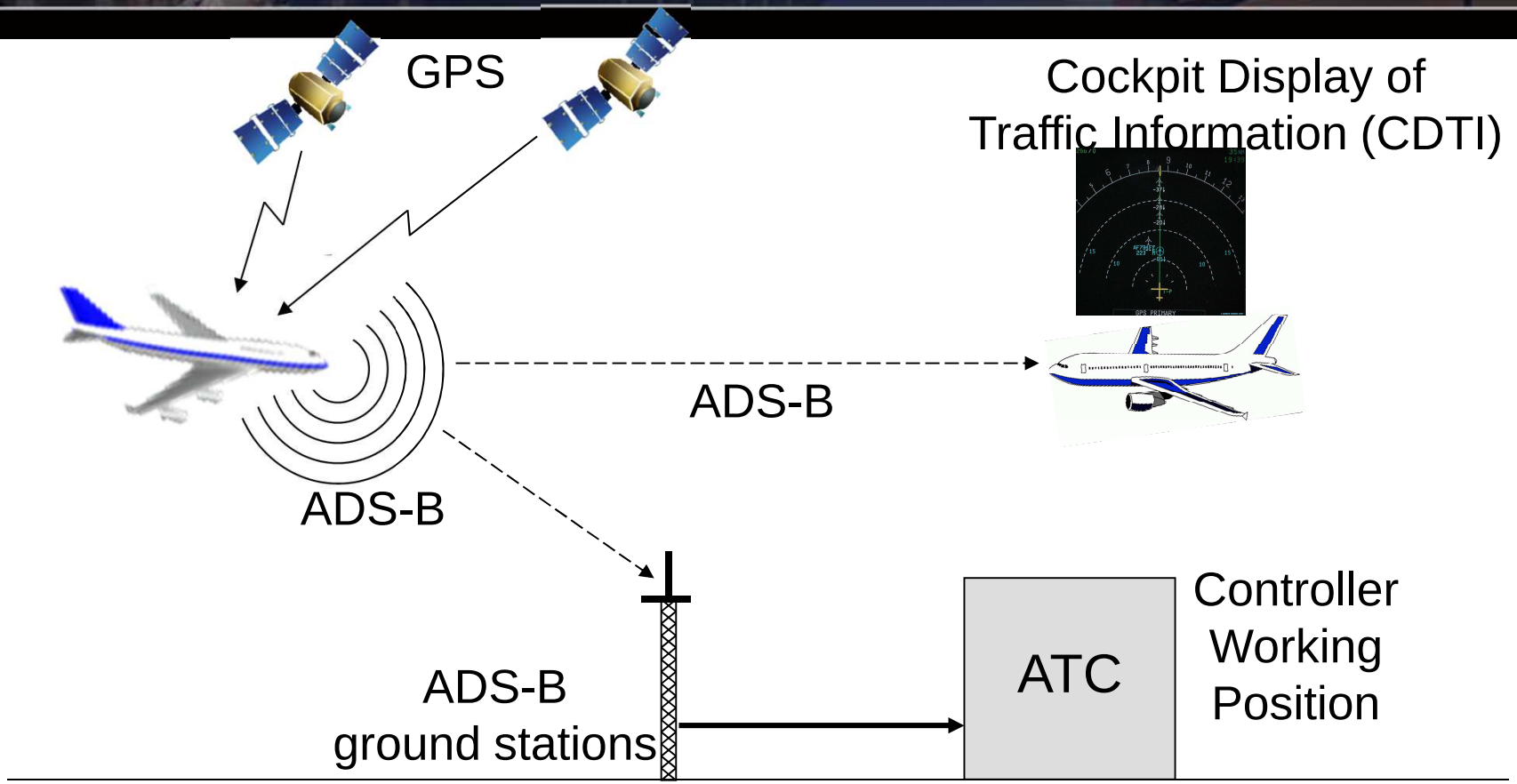
Global Standards
CASCADE Scope & Status

ADS-B overview



ADS-B capabilities

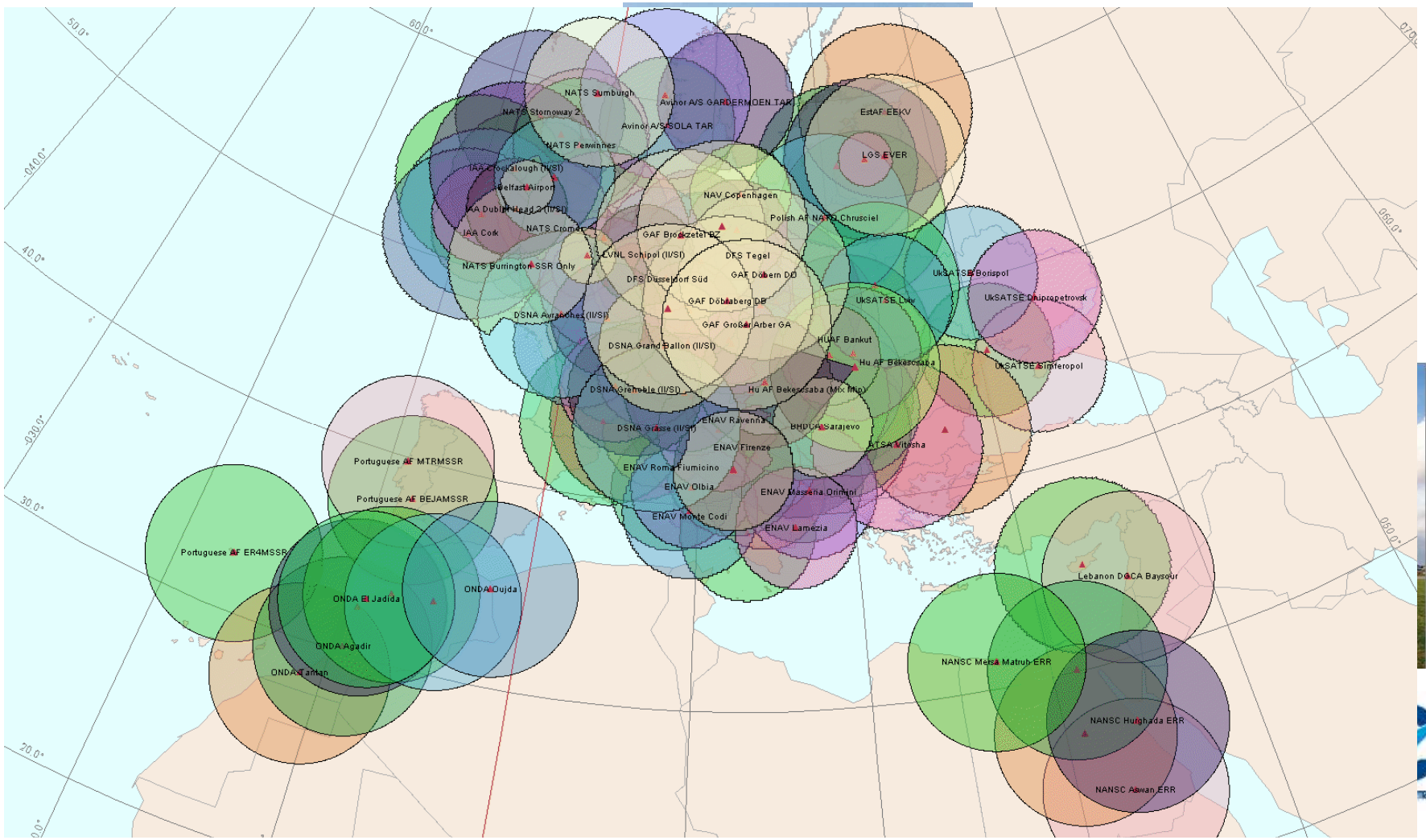
ADS-B OUT

Function allowing an aircraft or a surface vehicle to automatically and periodically broadcast information, including Identification, position, etc.

ADS-B IN

Function allowing an aircraft or a surface vehicle to receive, process and display ADS-B information to pilots (or vehicle drivers) on a CDTI

ADS-B in the Surveillance Environment Europe



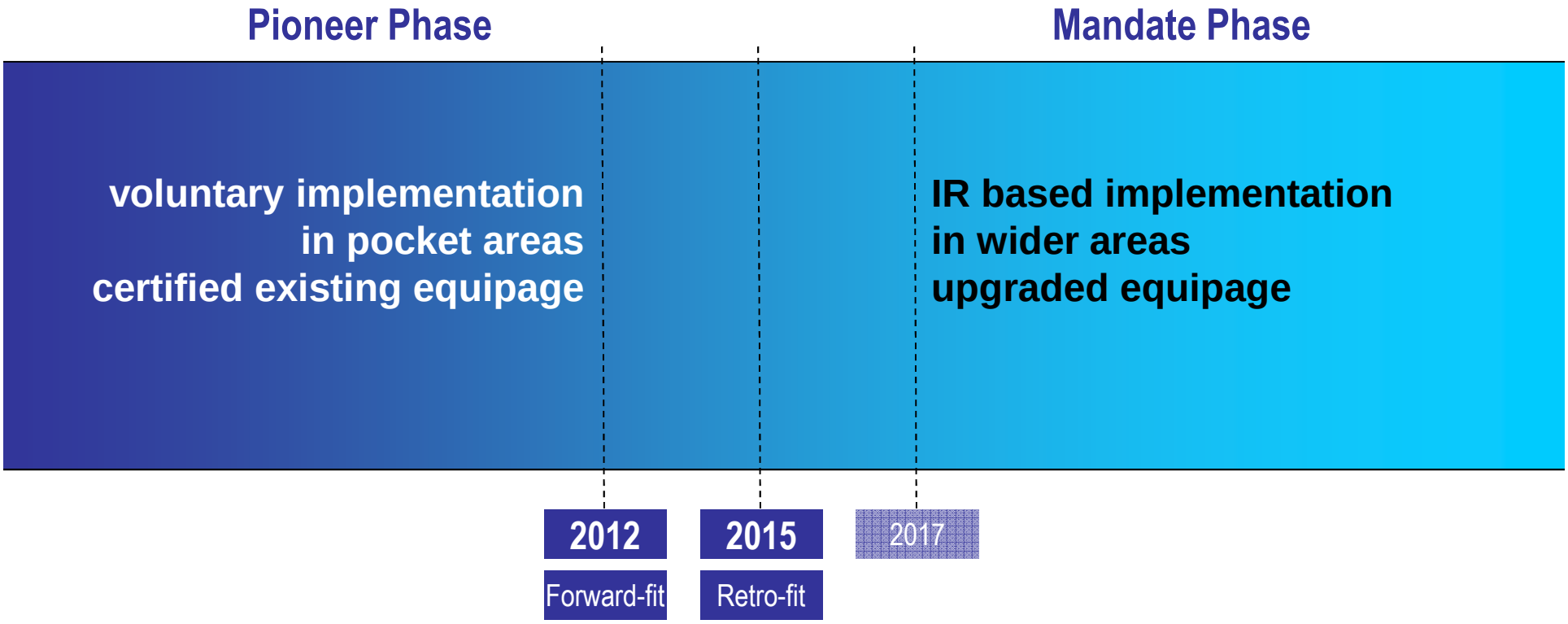
Surveillance Performance Interoperability - Implementing Rule Draft

1.01.2012 for "new" aircraft

5.02.2015 for retrofit

- Mode S (Elementary) all aircraft flying IFR/GAT
- Mode S (Enhanced and ADS-B Out) > 5700 kg MTOM OR >250 kts TAS

European Implementing Rule ADS-B



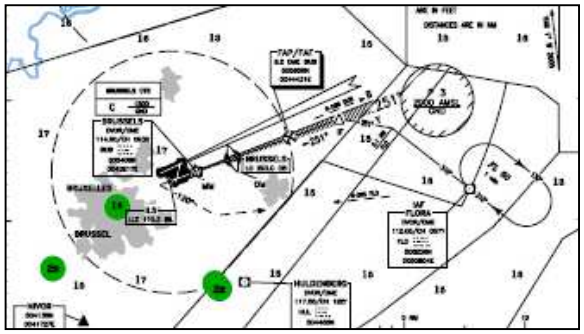
Single European Sky
Surveillance Performance x Interoperability
Implementing Rule

SPI IR

ADS-B is Happening

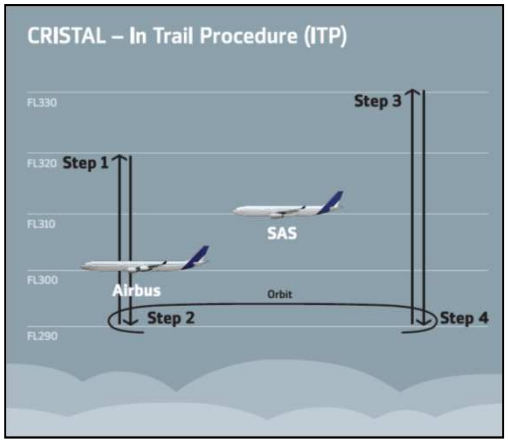
Why ADS-B?

In a non-radar environment



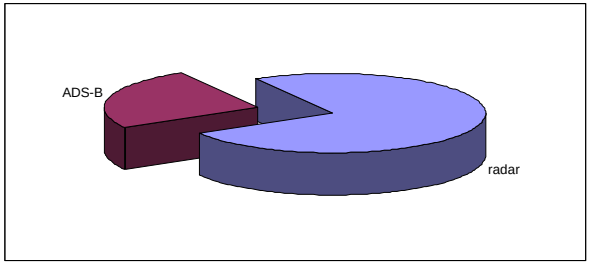
2 mins saved per flight

In Trail Procedure



Fuel: - 0.5 %

In a radar environment

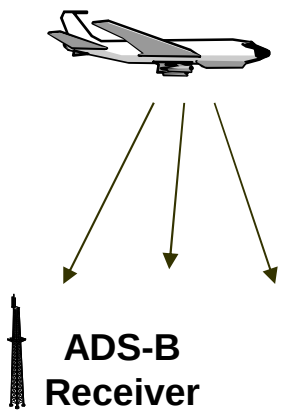


Route Charges: - 0.5 %

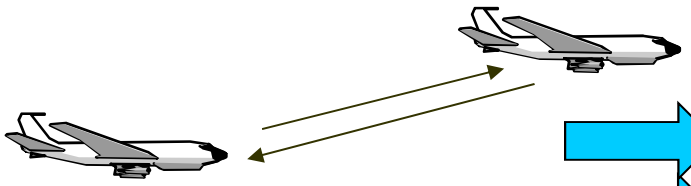
Cascade Programme Scope

- Ground Surveillance Applications (ADS-B-out)
  - In a non-radar environment
  - In a radar environment
  - On the airport surface

2008/9



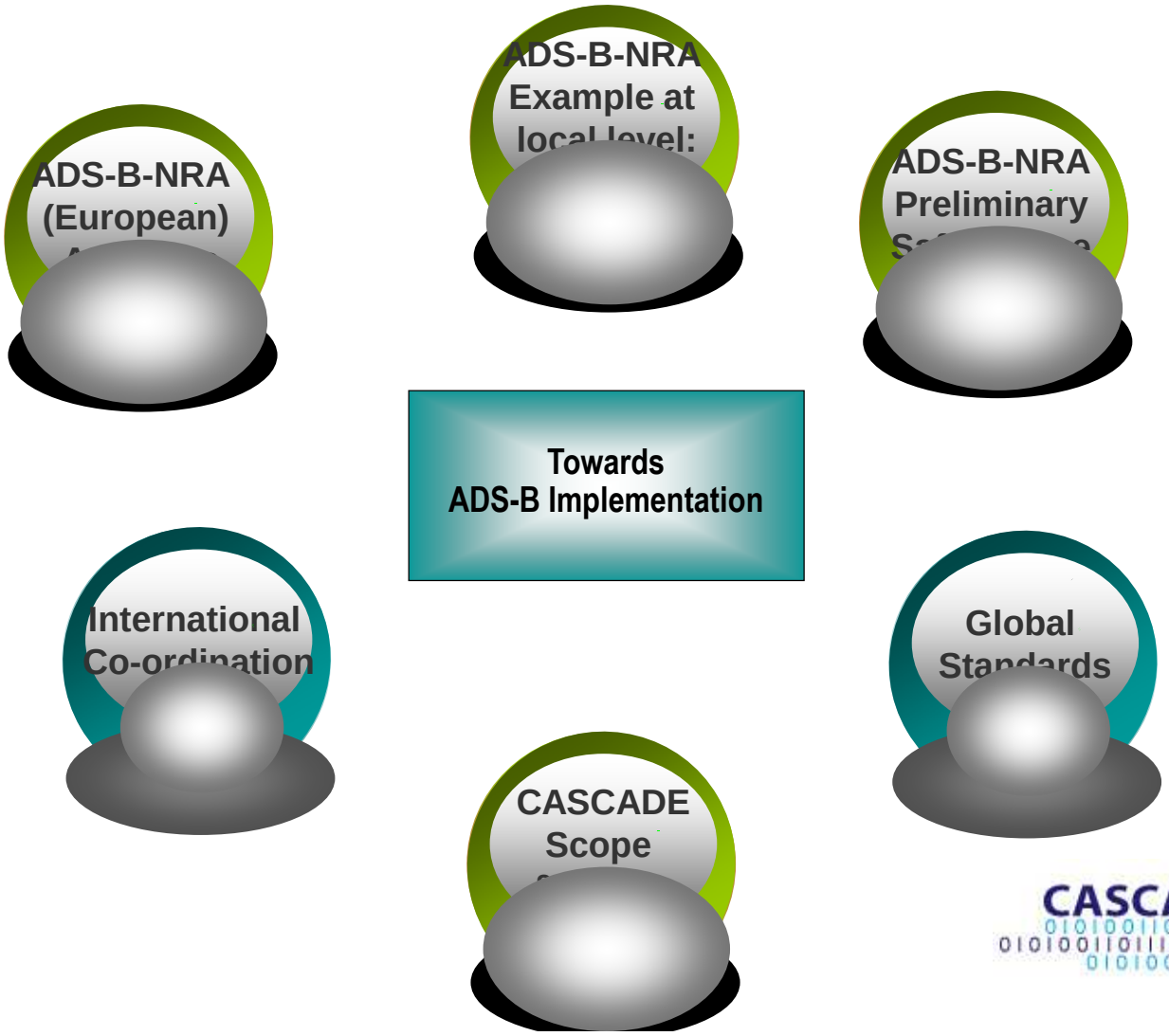
- Airborne Surveillance Applications (ADS-B-in)
  - Situational awareness on the surface
  - Airborne situational awareness
  - Visual separation on approach
  - In Trail Procedure



2011

Traffic Situational Awareness “only”

Overview


ADS-B-NRA (European)
ADS-B-NRA Example at
ADS-B-NRA Preliminary
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International Co-ordination
Global Standards
CASCADE Scope

Requirements Focus Group (RFG)
Scope, Objective & Key Stakeholders

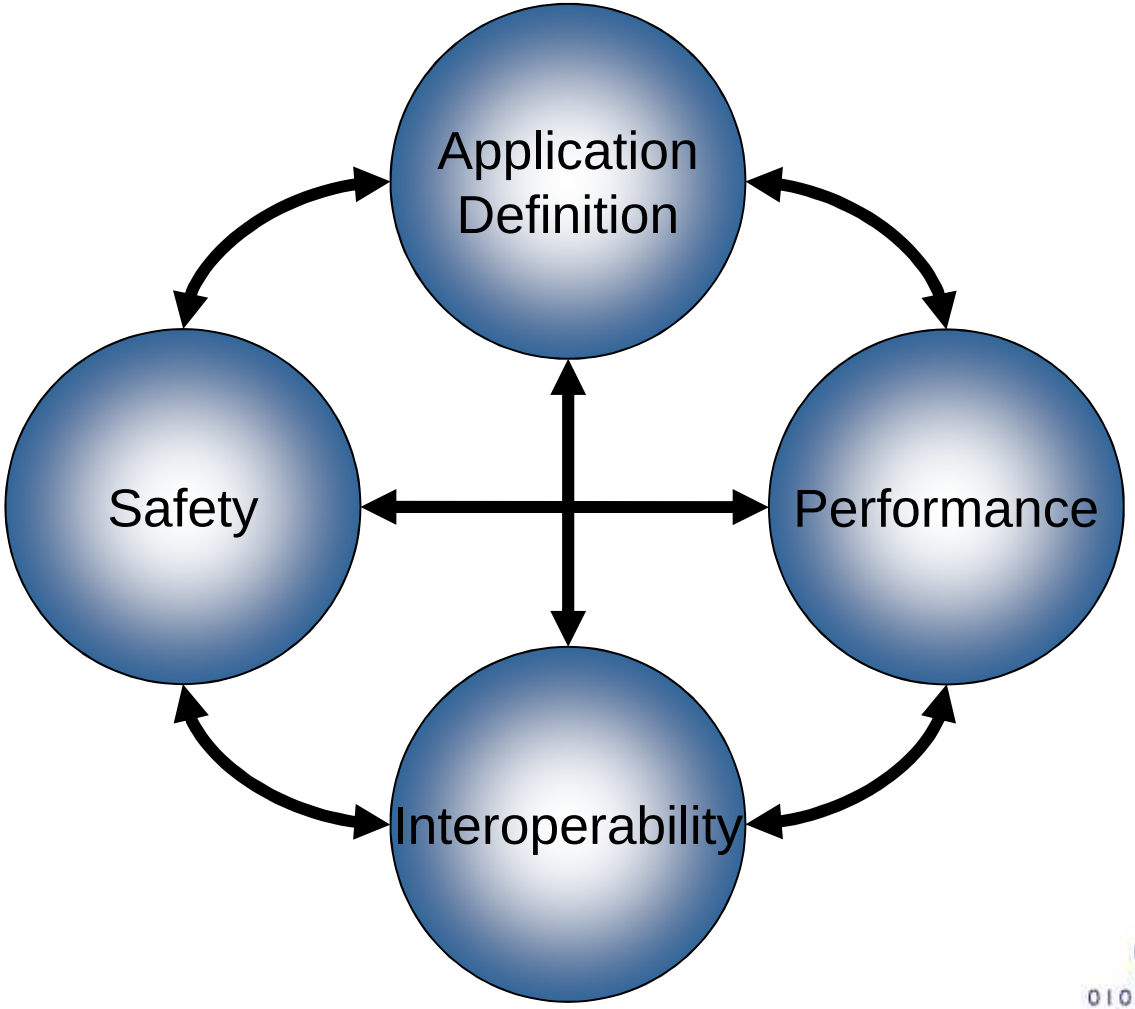
Package I
Ground & Airborne Surveillance Applications

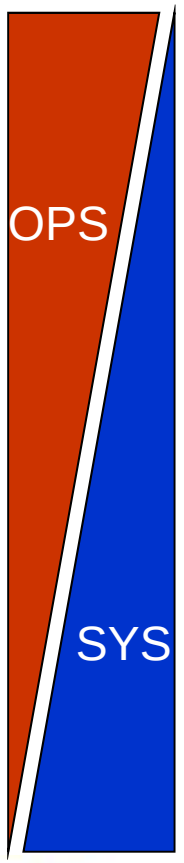
Development of International Industry Standards

Safety, Performance & Interoperability Requirements

EUROCAE WG51, RTCA SC-186
EUROCONTROL CASCADE, FAA SBS

Requirements Focus Group (RFG)
Requirements Determination Process

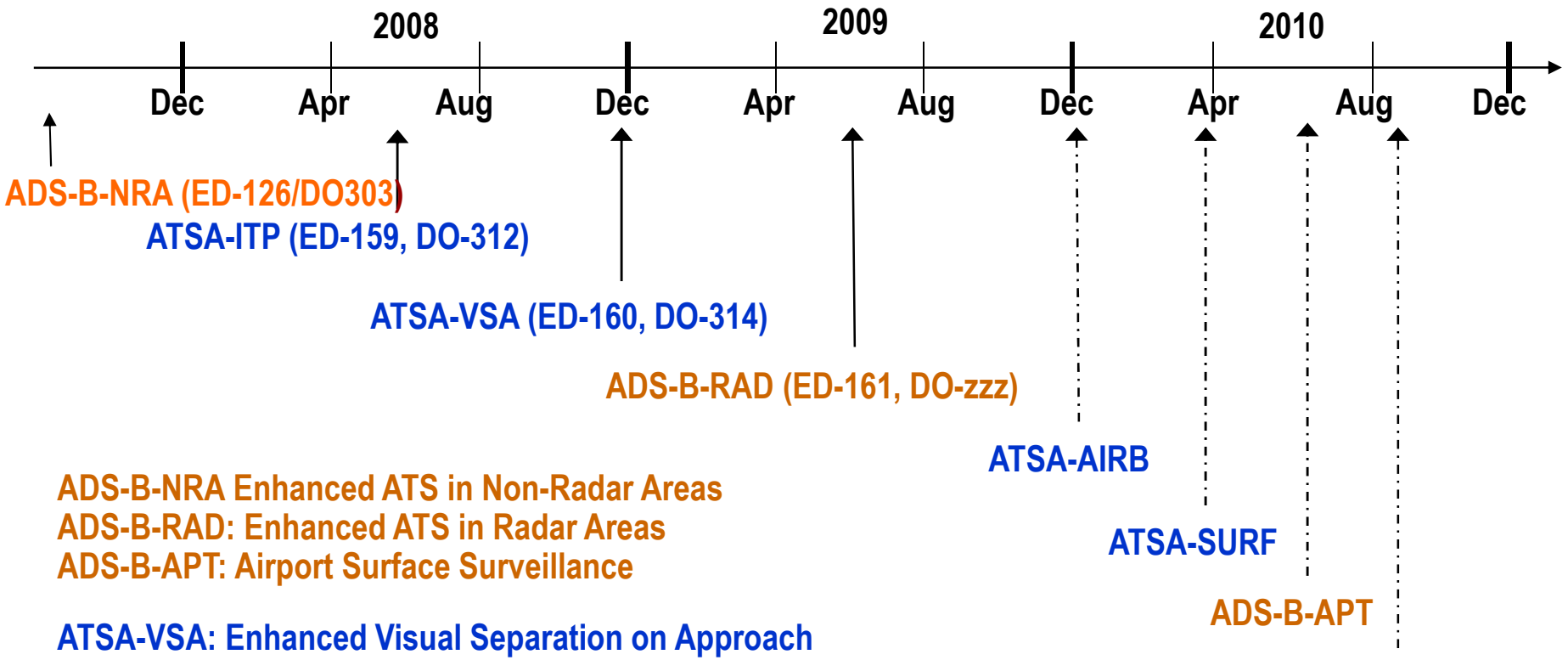




CASCADE

EUROCONTROL

High-level RFG Planning



ADS-B-NRA Enhanced ATS in Non-Radar Areas
ADS-B-RAD: Enhanced ATS in Radar Areas
ADS-B-APT: Airport Surface Surveillance

ATSA-VSA: Enhanced Visual Separation on Approach
ATSA-ITP: In-trail Procedure in Oceanic Airspace
ATSA-AIRB: Enhanced Traffic Situational Awareness During Flight Operations
ATSA-SURF: Enhanced Traffic Situational Awareness on the Airport Surface

CASCADE

EUROCONTROL

RFG SPR-INTEROP Development Approach

- **Key aspects:**
  - Top-down & end-to-end
  - Pragmatic: bottom-up constraints
  - Balanced expertise mix
  - Design independence: freedom to aircraft integrators, feeds into system MOPS
  - Harmonised EUROPE/US safety approach
  - Interoperability
  - In coordination with ICAO
- **Is there an alternative ?**

ADS-B Programmes International Co-ordination

Air Services Australia

FAA

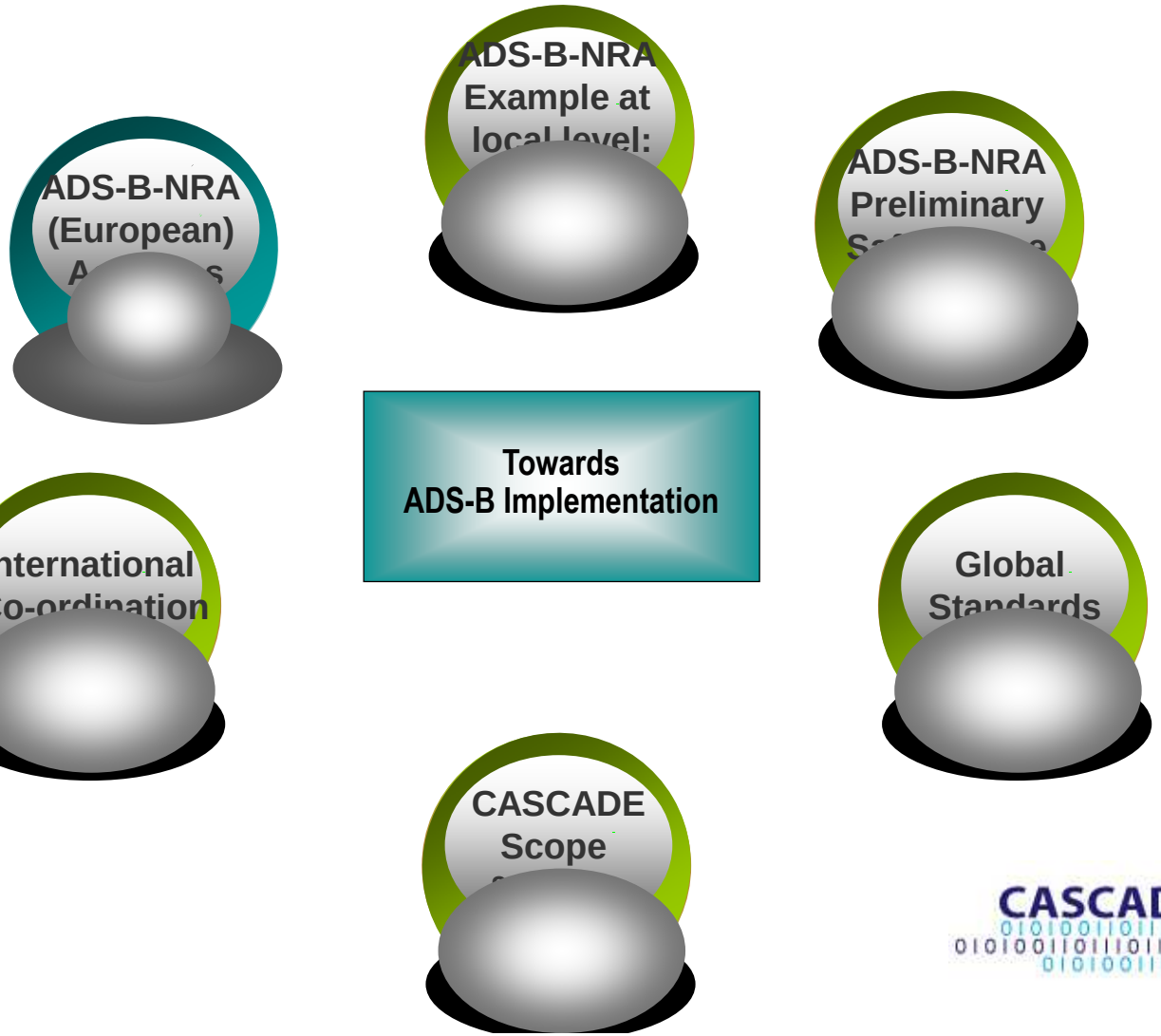
Nav Canada

EUROCONTROL

Joint ADS-B Harmonisation Statement

- Standards
- Certification
- Implementation

Overview


ADS-B-NRA Example at local level:
ADS-B-NRA (European)
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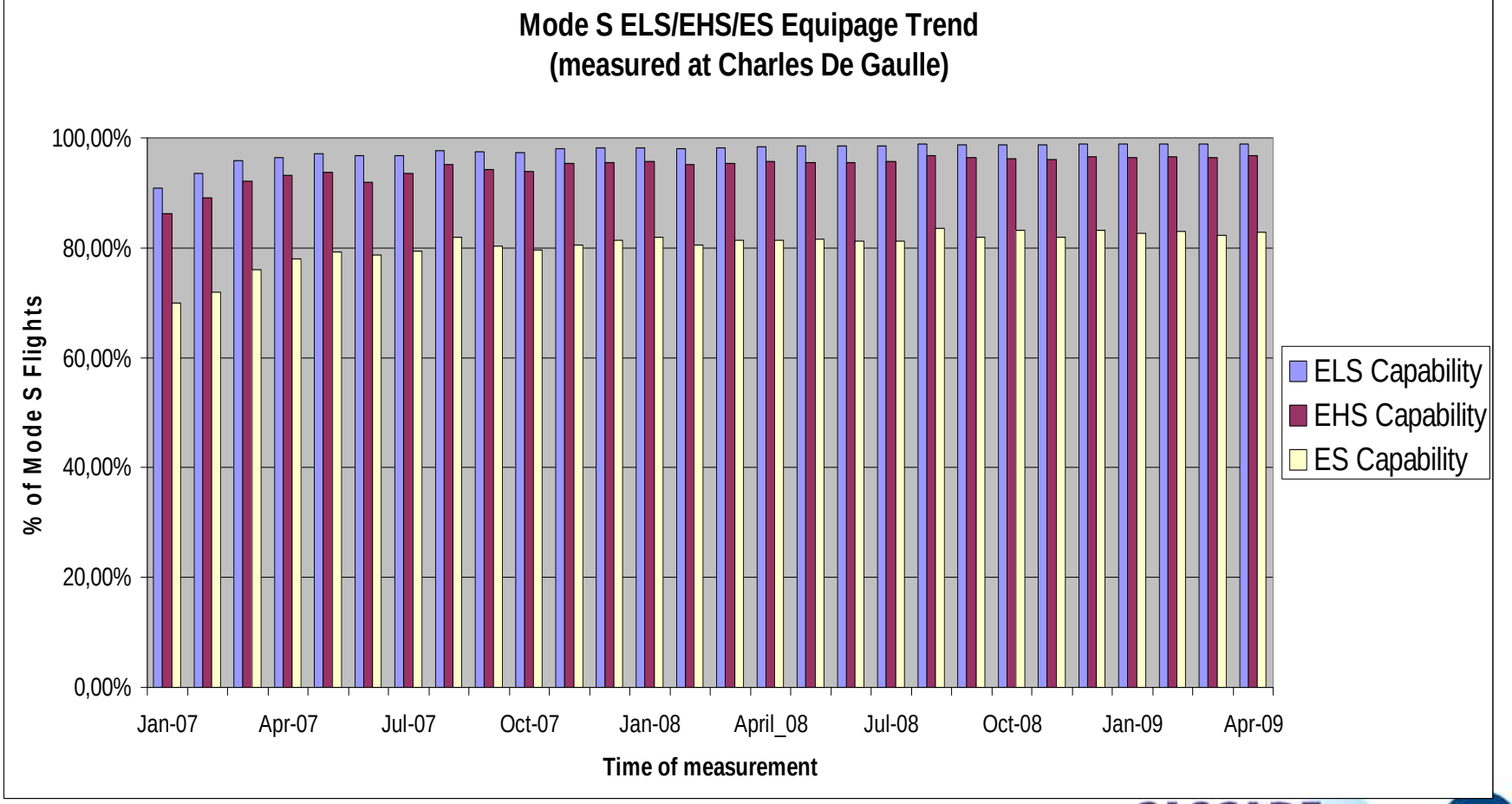
CASCADE Scope

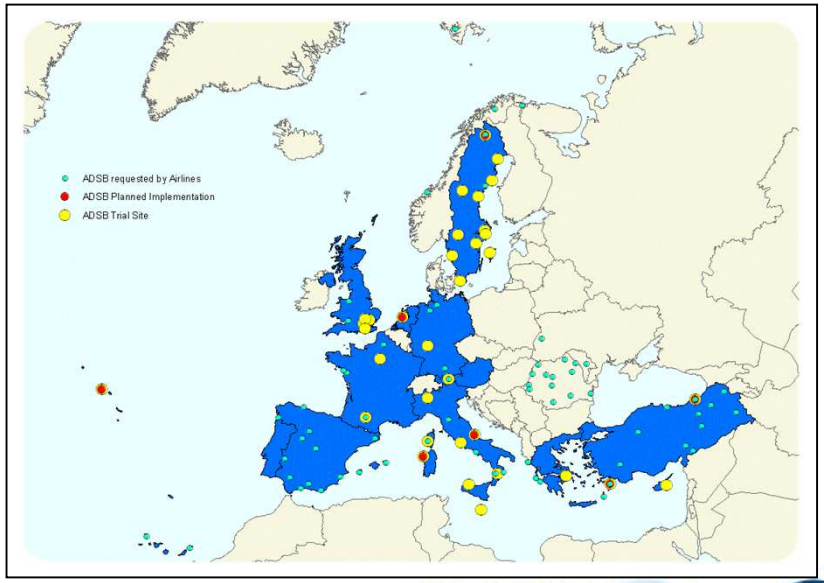
ADS-B declared capability



ADS-B-NRA Pioneer Airlines & Trials leading to implementation

Pioneer airline project

"CRISTAL": Pre-operational Evaluations with ANSPs"

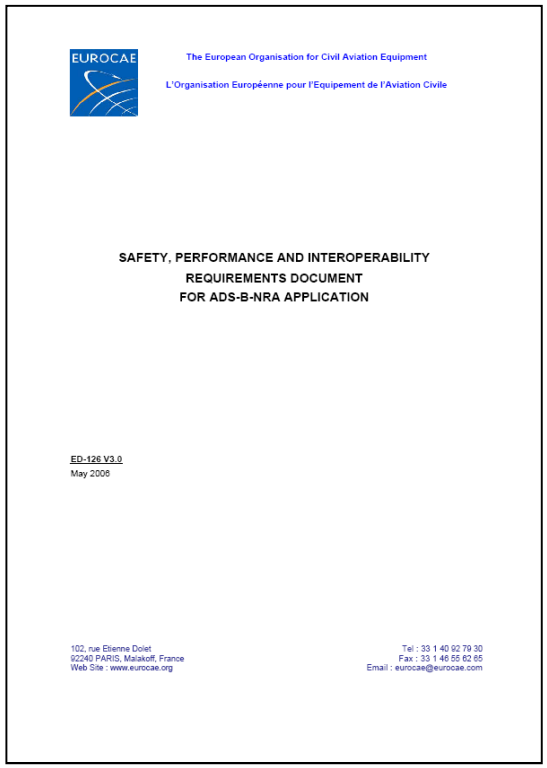


CASCADE

EUROCONTROL

Pioneer Airline Certification basis

- Safety, performance & interoperability requirements (SPR/INTEROP) for the ADS-B-NRA application



The European Organisation for Civil Aviation Equipment

L'Organisation Européenne pour l'Equipement de l'Aviation Civile

SAFETY, PERFORMANCE AND INTEROPERABILITY REQUIREMENTS DOCUMENT FOR ADS-B-NRA APPLICATION

ED-126 V3.0

May 2006

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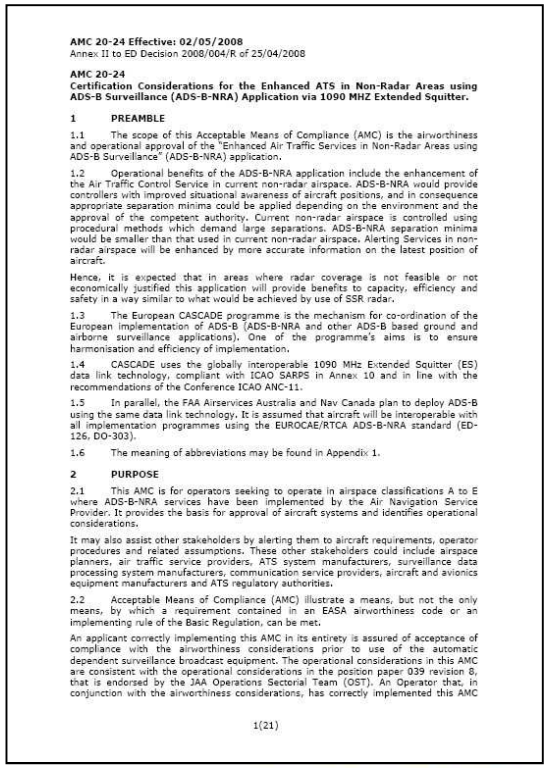
92240 PARIS, Malakoff, France
Web Site : www.eurocae.org

Tel : 33 1 40 92 79 30
Fax : 33 1 46 55 62 65
Email : eurocae@eurocae.com

- EASA Airworthiness Approval Acceptable Means of Compliance AMC 20-24



AMC 20-24 Effective: 02/05/2008
Annex II to ED Decision 2008/004/R of 25/04/2008

AMC 20-24
Certification Considerations for the Enhanced ATS in Non-Radar Areas using ADS-B Surveillance (ADS-B-NRA) Application via 1090 MHZ Extended Squitter.

1 PREAMBLE

1.1 The scope of this Acceptable Means of Compliance (AMC) is the airworthiness and operational approval of the "Enhanced Air Traffic Services in Non-Radar Areas using ADS-B Surveillance" (ADS-B-NRA) application.

1.2 Operational benefits of the ADS-B-NRA application include the enhancement of the Air Traffic Control Service in current non-radar airspace. ADS-B-NRA would provide controllers with improved situational awareness of aircraft positions, and in consequence appropriate separation minima could be applied depending on the environment and the approval of the competent authority. Current non-radar airspace is controlled using procedural methods which demand large separations. ADS-B-NRA separation minima would be smaller than that used in current non-radar airspace. Alerting Services in non-radar airspace will be enhanced by more accurate information on the latest position of aircraft.

Hence, it is expected that in areas where radar coverage is not feasible or not economically justified this application will provide benefits to capacity, efficiency and safety in a way similar to what would be achieved by use of SSR radar.

1.3 The European CASCADE programme is the mechanism for co-ordination of the European implementation of ADS-B (ADS-B-NRA and other ADS-B based ground and airborne surveillance applications). One of the programme's aims is to ensure harmonisation and efficiency of implementation.

1.4 CASCADE uses the globally interoperable 1090 MHz Extended Squitter (ES) data link technology, compliant with ICAO SARPS in Annex 10 and in line with the recommendations of the Conference ICAO ANC-11.

1.5 In parallel, the FAA Airservices Australia and Nav Canada plan to deploy ADS-B using the same data link technology. It is assumed that aircraft will be interoperable with all implementation programmes using the EUROCAE/RTCA ADS-B-NRA standard (ED-126, DO-303).

1.6 The meaning of abbreviations may be found in Appendix 1.

2 PURPOSE

2.1 This AMC is for operators seeking to operate in airspace classifications A to E where ADS-B-NRA services have been implemented by the Air Navigation Service Provider. It provides the basis for approval of aircraft systems and identifies operational considerations.

It may also assist other stakeholders by alerting them to aircraft requirements, operator procedures and related assumptions. These other stakeholders could include airspace planners, air traffic service providers, ATS system manufacturers, surveillance data processing system manufacturers, communication service providers, aircraft and avionics equipment manufacturers and ATS regulatory authorities.

2.2 Acceptable Means of Compliance (AMC) illustrate a means, but not the only means, by which a requirement contained in an EASA airworthiness code or an implementing rule of the Basic Regulation, can be met.

An applicant correctly implementing this AMC in its entirety is assured of acceptance of compliance with the airworthiness considerations prior to use of the automatic dependent surveillance broadcast equipment. The operational considerations in this AMC are consistent with the operational considerations in the position paper 039 revision 8, that is endorsed by the JAA Operations Sectorial Team (OST). An Operator that, in conjunction with the airworthiness considerations, has correctly implemented this AMC

1(21)

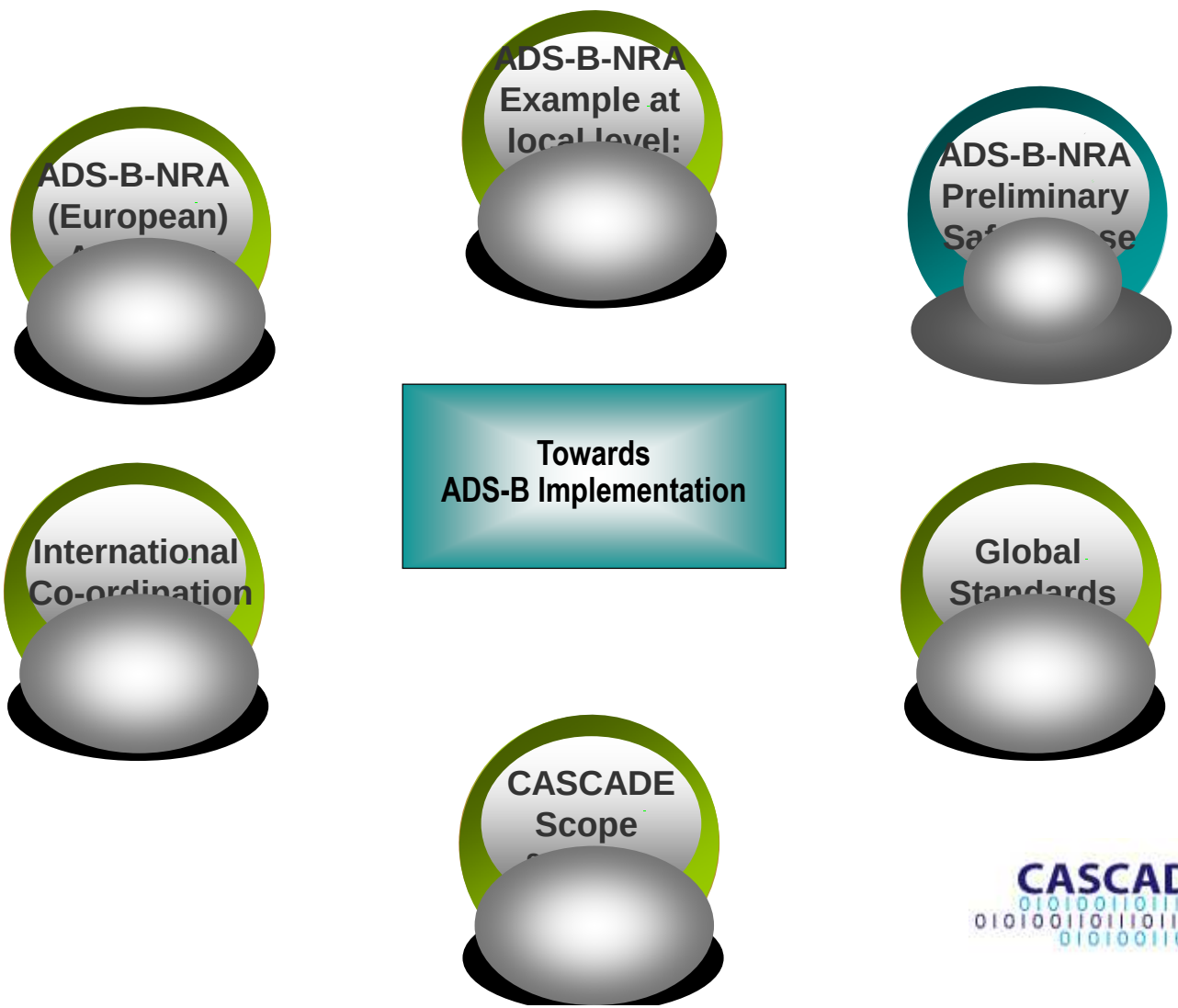
CASCADE

EUROCONTROL

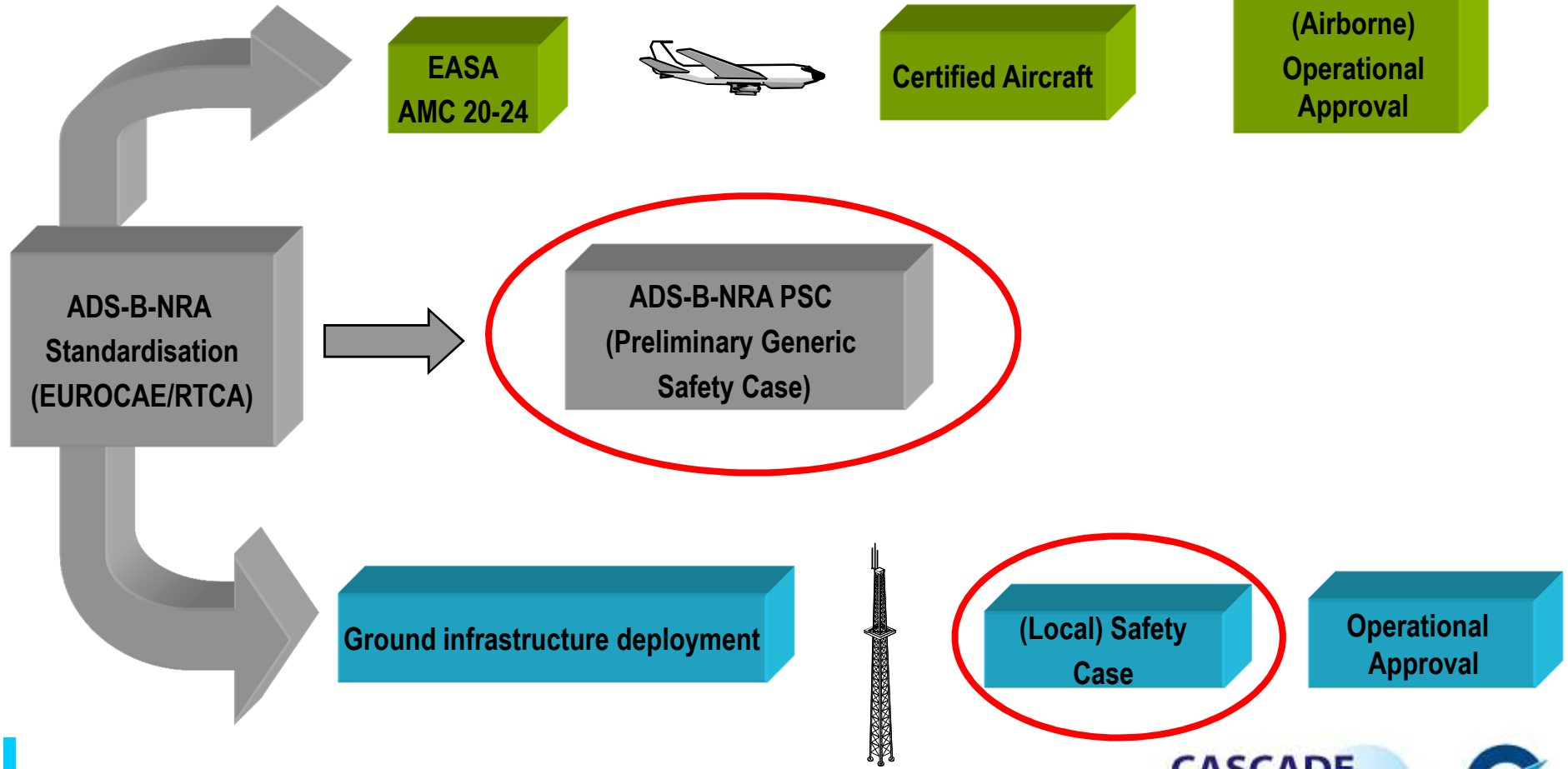
Pioneers and Certification

	"Applicant"	Ac type
TC	Airbus	A380 A330/A340 A320 family
	Boeing	B737-600/700/800/900 B757, B767 B747-400 B777
	ATR	ATR72
	Dassault	Falcon 2000
STC	Aeroconseil	A321
	ATI	A3ST
	Air France	B777, B747
	British Airways	A320family, B777, B747

Overview


ADS-B-NRA (European)
ADS-B-NRA Example at local level:
ADS-B-NRA Preliminary
Towards ADS-B Implementation
International Co-ordination
Global Standards
CASCADE Scope

Safety case: on the path towards ADS-B-NRA operation



WHICH BENEFITS ?

PRELIMINARY SAFETY CASE (PSC)

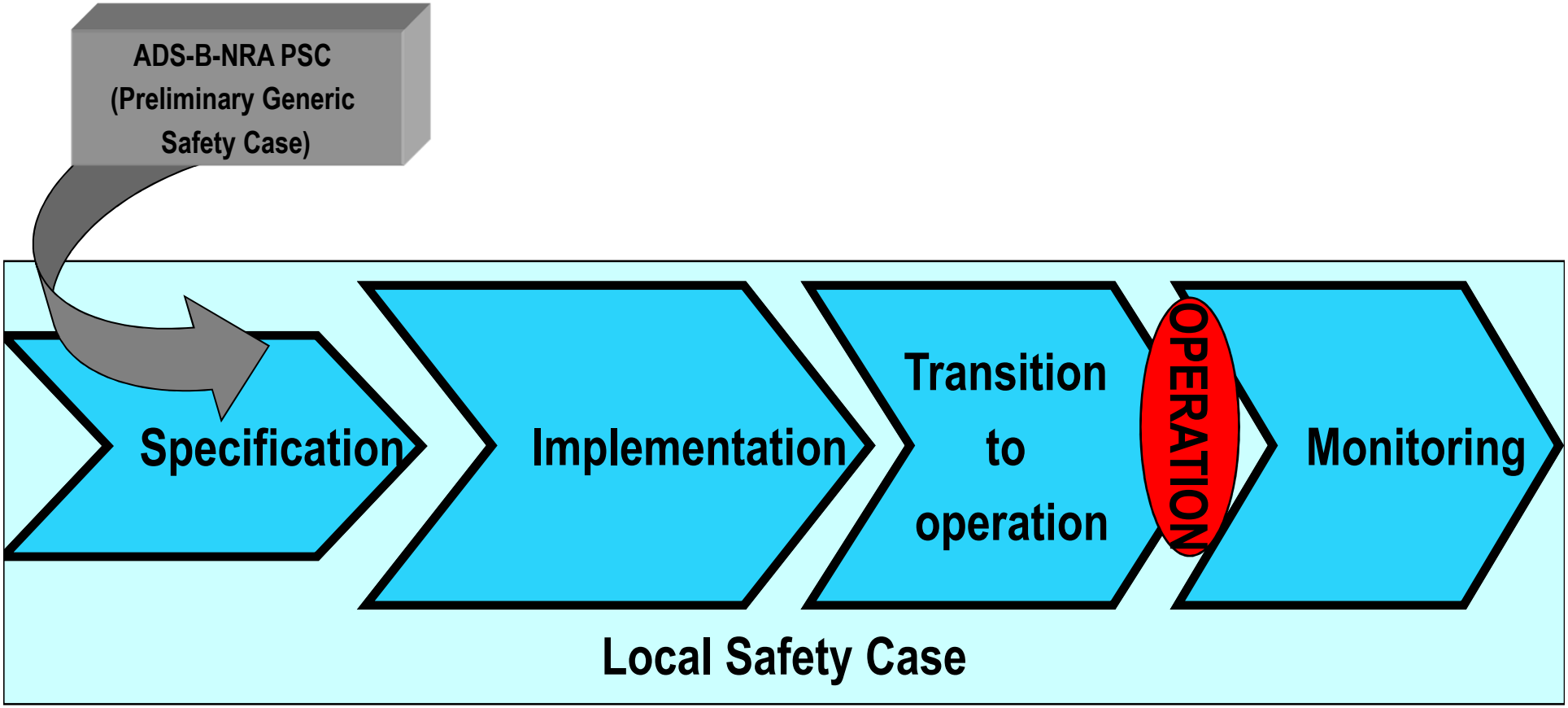
- A key input to Local Safety Case and Operation Approval
- A reusable structure for Local Safety Case
- Document & Support available

WHICH BENEFITS ?

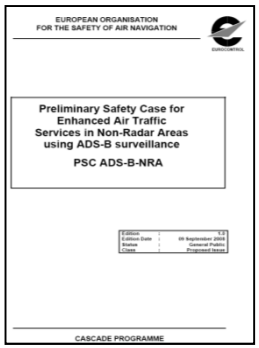
PRELIMINARY SAFETY CASE (PSC)

- **A key input to Local Safety Case and Operation Approval**
- **A reusable structure for Local Safety Case**
- **Document & Support available**

Key input to the local safety case



Key input to regulatory bodies



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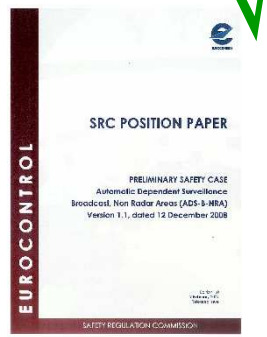
Preliminary Safety Case

SRC Safety Regulatory Review



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Local Safety Case

National Regulatory Approval

WHICH BENEFITS ?

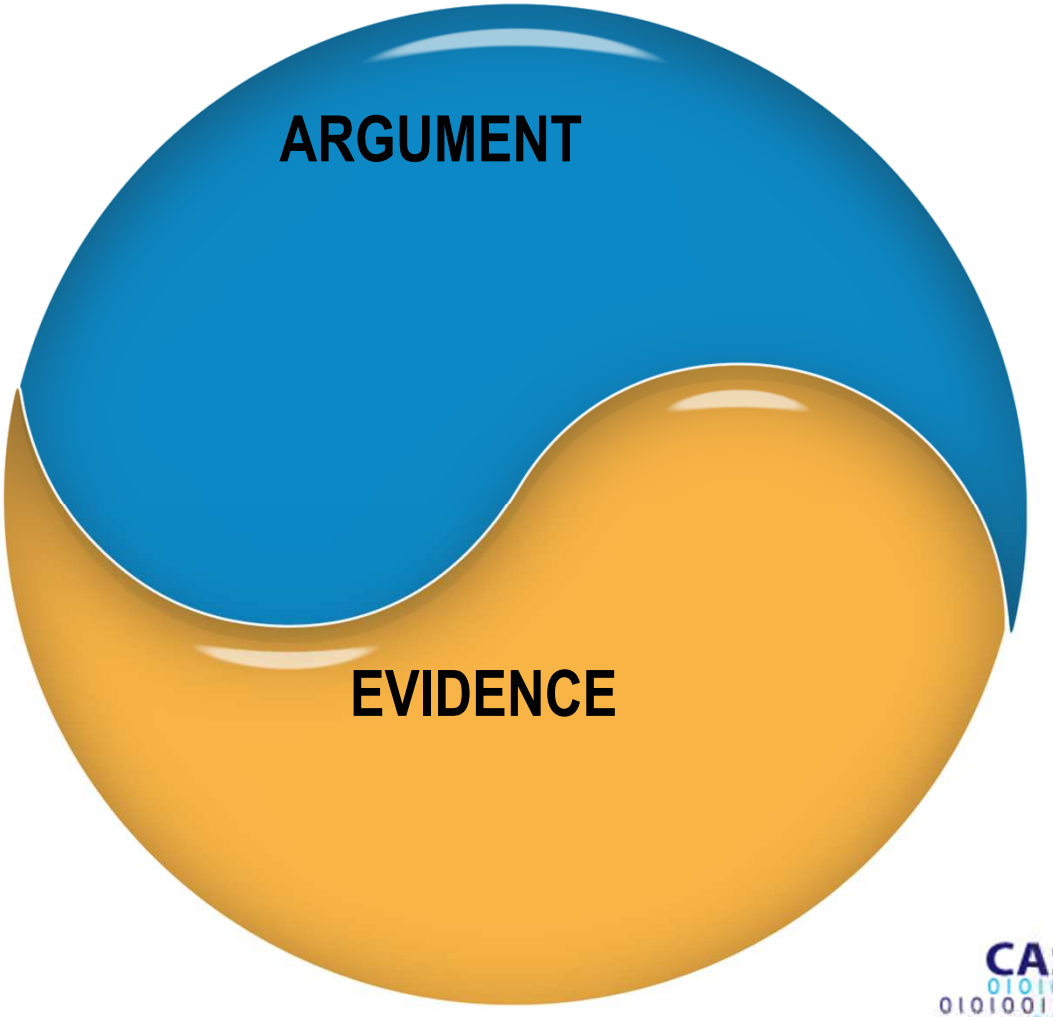
PRELIMINARY SAFETY CASE (PSC)

A key input to Local Safety Case and Operation Approval

A reusable structure for Local Safety Case

Document & Support available

Argument/Evidence structure reusable for Local Safety Case



Guidance to Local Safety Case included

- Local safety case can largely refer/re-use the PSC when it is directly applicable

- Guidance material highlights where the development of local argument/evidence is needed

Guidance to Local Safety Case included (example)

5.5.1 Safety Requirements relating to Operational ADS-B-NRA Procedures

As already mentioned in section 4.3.1 the ATS procedures to be used for ADS-B-NRA are similar to those, used in reference radar service. Table 7 below lists the related safety requirements to be applied:

Actor	ADS-B-NRA procedural Safety Requirement
ATCo	**SAF001.** Controller shall apply PANS ATM Doc4444 [Ref.2] procedures to perform ADS-B-NRA application.
Flight Crew	**SAF002.** Flight crew shall apply PANS-OPS Doc 8168 [Ref.8] procedures to perform ADS-B-NRA application.

Table 7: Safety Requirements on ATS Procedures for ADS-B-NRA

GM014. Guidance material to be considered for local implementation: "Guidance for the Provision of Air Traffic Services Using ADS-B in Non Radar Areas" ([Ref.11] and "The NRA Flight Crew Manual" [Ref.10].

GM015. Any divergence in terms of procedure at local implementation level will have to be addressed under argument 1.3 (section 3.4.3).

Concerning the conditions on which separation minima can be applied by the controller, the related safety requirements are presented hereafter:

SAF003. Separation minima of 5NM shall be only applied by controller to aircraft being eligible for ADS-B-NRA in en-route.

Note: see aircraft eligibility conditions in section 5.5.3.3.

SAF004. Separation minima of 3NM shall be only applied by controller to aircraft being eligible for ADS-B-NRA in TMA.

Note: see aircraft eligibility conditions in section5.5.3.3.

See GM001 for ICAO provision with respect to separation minima applicability.

5.5.2 Safety Requirements relating to Data Items

This section provides safety requirements relating to data items provided and used by the different elements of the ADS-B-NRA system.

5.5.2.1 Safety Requirements on Operational Surveillance Data Items

Concerning the operational surveillance data items required at the ATCo interface (i.e. at point of measurement G2 in Figure 1), the list of related

WHICH BENEFITS ?

PRELIMINARY SAFETY CASE (PSC)

A key input to Local Safety Case and Operation Approval

A reusable structure for Local Safety Case

Document & Support available

Safety | Regulation | Strategy & Planning | ATM Performance | Air Traffic Control | Air Navigation Charges | Training | Airports

Security | Civil / Military | Research & Development | Managing the Traffic | Society & Economics | Capacity | Traffic & Delay | Environment

EUROCONTROL > cascade > CASCADE Home

CASCADE

- CASCADE Home
- ADS-B for Aircraft Operators
- ADS-B for ANSPs

The CASCADE Programme

The CASCADE programme co-ordinates the European implementation of ADS-B (Automatic Dependent Surveillance Broadcast), a surveillance technique that relies on aircraft broadcasting their identity, position and other aircraft information. This signal can be captured on the ground for surveillance purposes (ADS-B-out) or onboard other aircraft for air traffic situational awareness (ADS-B-in) and airborne separation assistance. ADS-B-out is expected to reach initial operational capability status in 2009. ADS-B-in for air traffic situational awareness in 2013. In order to meet the surveillance requirements of different environments, ADS-B-out can be used as a sole means of surveillance or in combination with radar or multi-lateration.

This website gives you an overview of the CASCADE programme, its applications, validation activities and implementation plans. You can also find dedicated information for Aircraft Operators and ANSPs and documents, FAQs and contacts.

- Overview
- Validation
- Documents
- FAQ
- Contacts
- ADS-B for Aircraft Operators
- ADS-B for ANSPs

EASA has published the Acceptable Means of Compliance for ADS-B in a non-radar environment

→ EASA has published the Acceptable Means of Compliance for ADS-B in a non-radar environment. The document is applicable since 02 May 2008. A number of aircraft have already obtained their airworthiness approval.

Aena Spain has confirmed that it intends to join the CASCADE pre-operational validation work with one or more airports.

→ Aena Spain has confirmed that it intends to join the CASCADE pre-operational validation work with one or more airports. The involvement will start with a cost benefit analysis, hopefully leading up to the installation of one or more ADS-B stations and pre-operational trials.

ADS-B-NRA Safety Case

→ "Preliminary Safety Case for Enhanced Air Traffic Services in Non-Radar Areas using ADS-B Surveillance" version 1.0 has now been published to provide the basis for Eurocontrol regulatory approval and to be an input for ANSPs to produce their own local Safety Case for the ADS-B-NRA application. It includes substantial guidance to local ADS-B-NRA implementers. This PSC is at the moment under Safety Regulation Commision (SRC) review.

Preliminary Safety Case for Enhanced Air Traffic Services in Non-Radar Areas using ADS-B Surveillance (1.0)

Available on the CASCADE WEB Page

CASCADE support to Local Safety Case

- to ANSP, in developing their Local Safety Case

- Coordination is already taking place with DHMI on the ADS-B-NRA Trabzon Local Safety Case

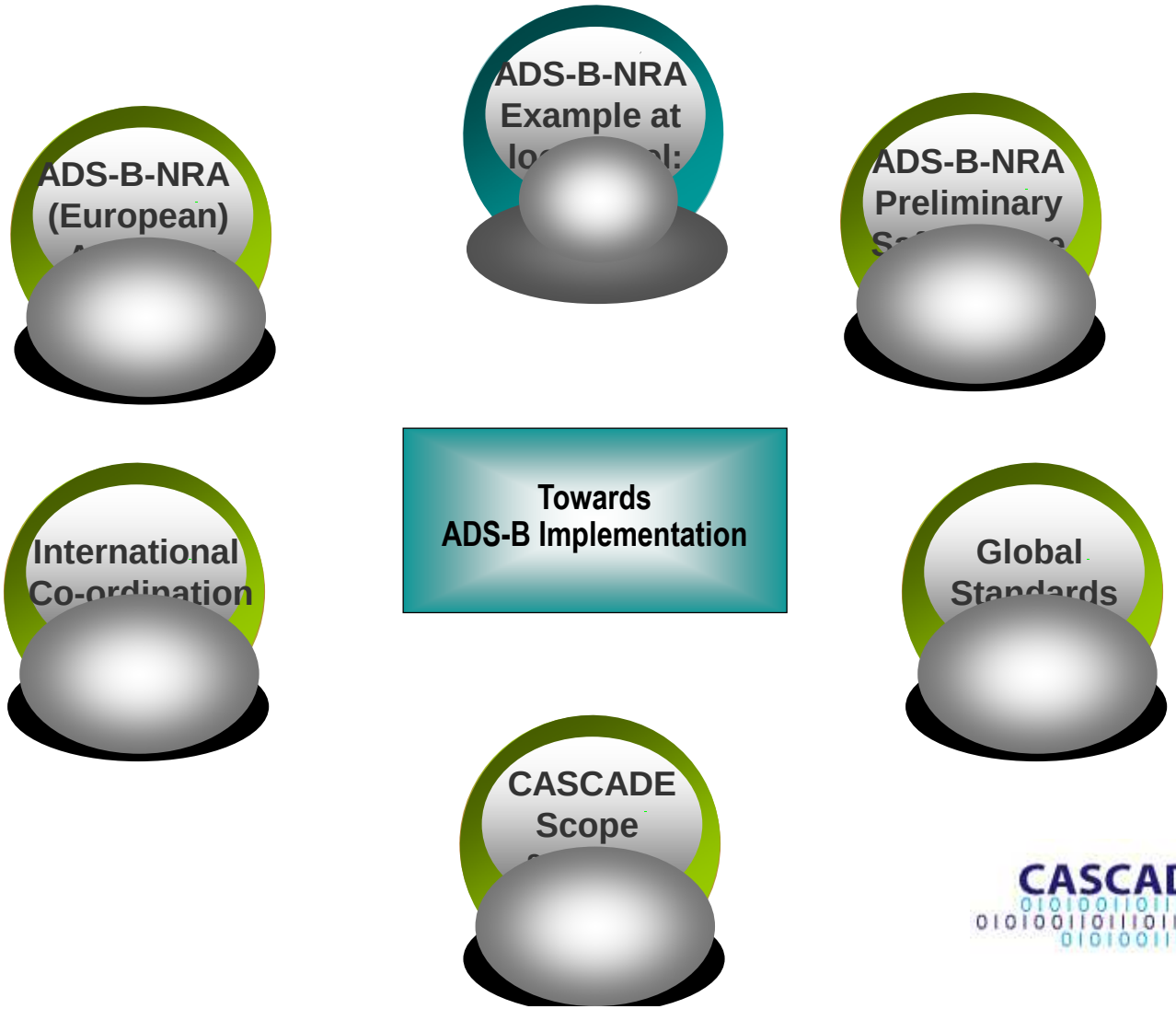
SUMMARY OF THE BENEFITS

A key input to Local Safety Case and Operation Approval

A reusable structure for Local Safety Case

Document & Support available

Overview


ADS-B-NRA (European)
ADS-B-NRA Example at
ADS-B-NRA Preliminary
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Global Standards
CASCADE Scope

BACKGROUND

BACKGROUND

- Non-radar APP/DEP + Aerodrome Control
- Daily traffic average : 40 Flights; Peak traffic 8 Flights/Hr. (2007 figures)
  - 90% of traffic delivered by 4 airlines (Turkish, Pegasus, Sunexpress, Onur)
  - 30% Traffic increase expected by 2010
- Constraints:
  - Frequency congestion due to procedural control
  - Controller workload due to communication tasks
  - Lack of surveillance. Controllers unaware of hazardous situations
  - Mountainous terrain.

CASCADE

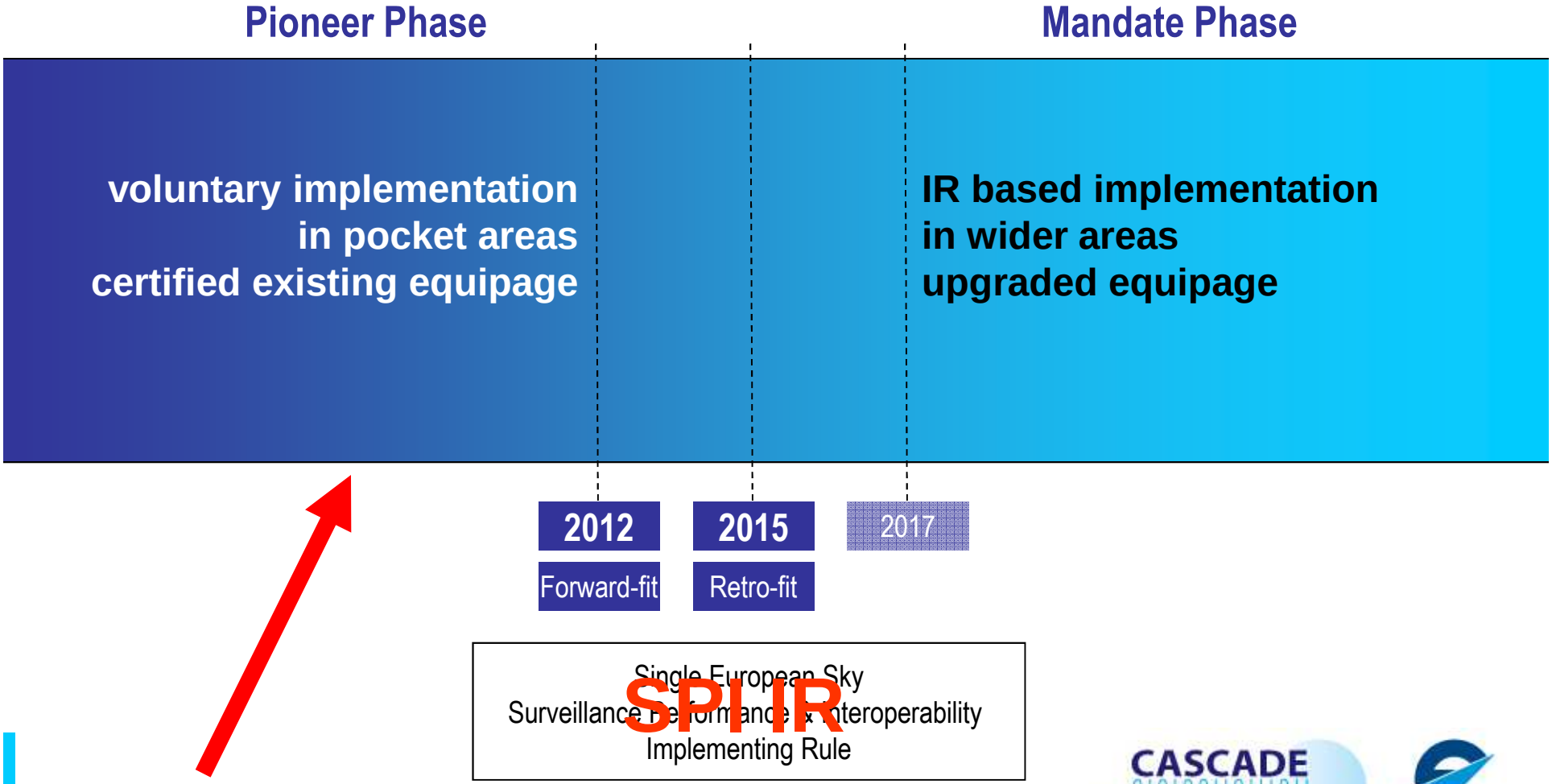
EUROCONTROL

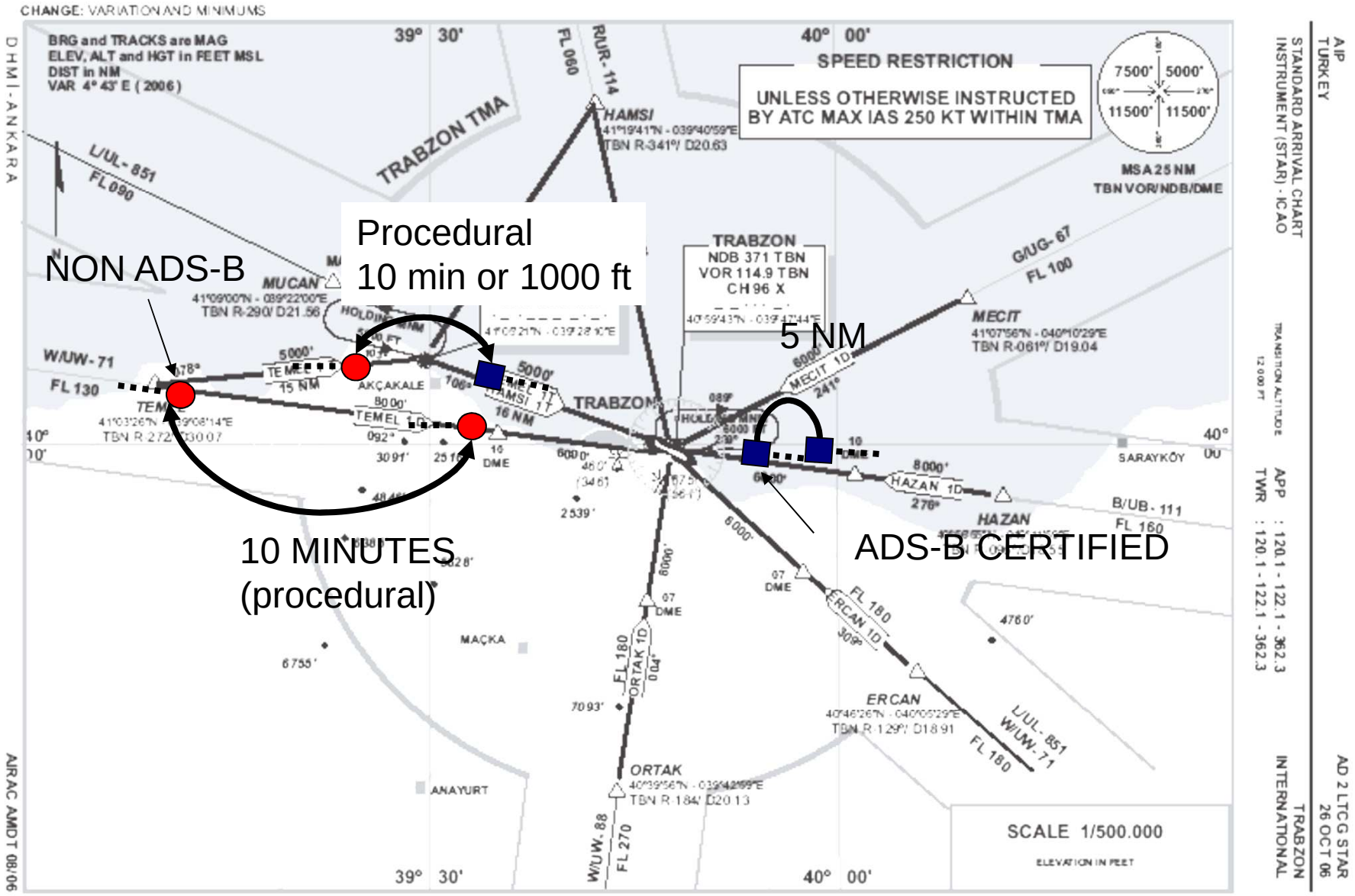
ADS-B Expected Benefits

- Safety
  - Improved Controller Situation Awareness
  - Enabler for safety nets like STCA and MSAW
  - Reduced Controller Workload
  - Improved quality of information for Alerting Services.

- Capacity and Efficiency
  - Reduced Communications
  - Increase sector capacity
  - More efficient traffic flow

European Implementing Rule ADS-B

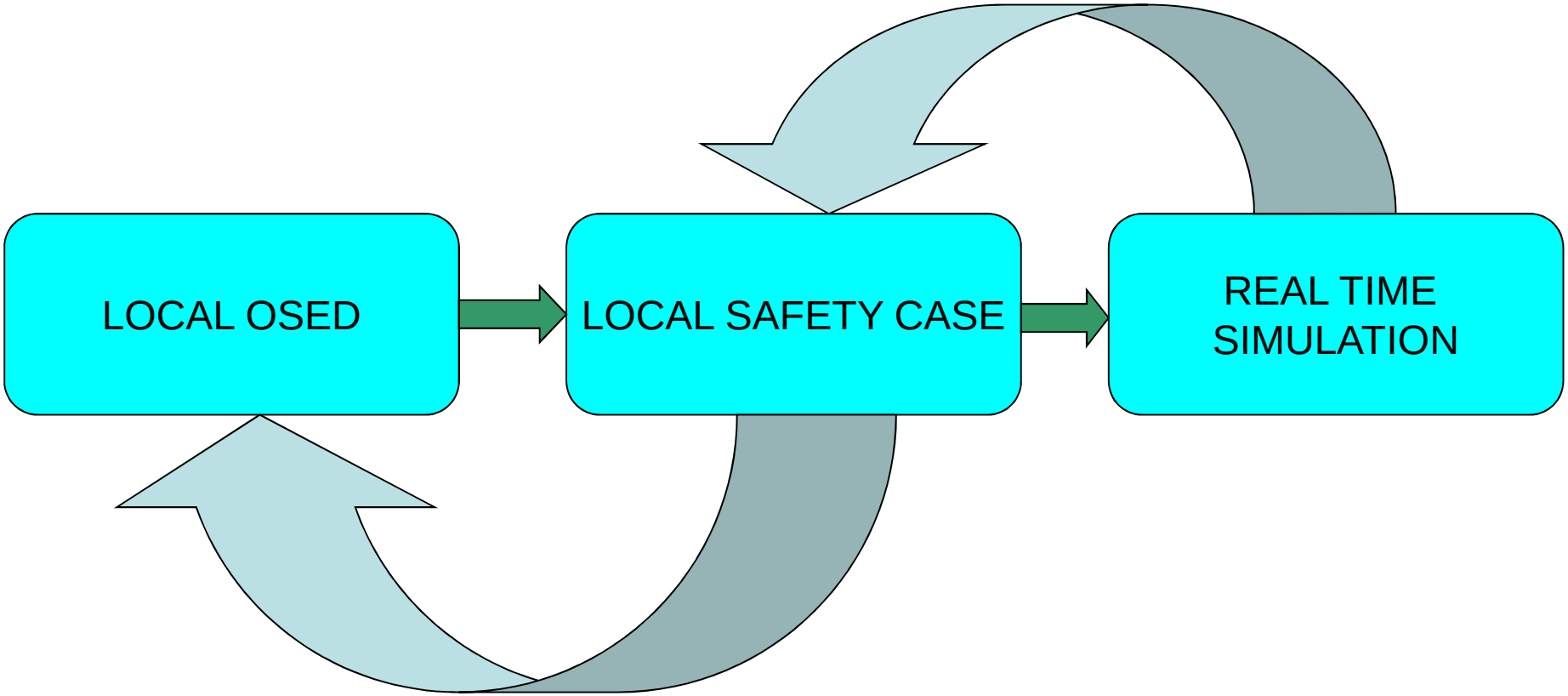



CHANGE: VARIATION AND MINIMUMS
BRG and TRACKS are MAG
ELEV, ALT and HGT in FEET MSL
DIST in NM
VAR 4° 43' E (2006)
SPEED RESTRICTION
UNLESS OTHERWISE INSTRUCTED
BY ATC MAX IAS 250 KT WITHIN TMA
7500' 5000'
11500' 11500'
MSA 25 NM
TBN VOR/NDB/DME
TRABZON TMA
L/UL- 851
FL 090
HAMSI
41°19'41"N - 039°40'59"E
TBN R-341°/ D20.63
TRABZON
NDB 371 TBN
VOR 114.9 TBN
CH 96 X
MECIT
41°07'56"N - 040°10'29"E
TBN R-061°/ D19.04
G/UG- 67
FL 100
MUCAN
41°09'00"N - 039°22'00"E
TBN R-290°/ D21.56
W/UW- 71
FL 130
TEMEL
41°03'26"N - 039°08'14"E
TBN R-272°/ D30.07
AKÇAKALE
TRABZON
HAZAN
HAZAN 1D
B/UB- 111
FL 160
SARAYKÖY
ERCAN
40°46'26"N - 040°05'29"E
TBN R-129°/ D18.91
ERCAN 1D
FL 180
L/UL- 851
W/UW- 71
ORTAK
40°39'56"N - 039°42'59"E
TBN R-184°/ D20.13
ORTAK 1D
W/UW- 88
FL 270
MAÇKA
ANAYURT
SARAYKÖY
SCALE 1/500.000
ELEVATION IN FEET
39° 30'
40° 00'
Procedural
10 min or 1000 ft
NON ADS-B
5 NM
10 MINUTES
(procedural)
ADS-B CERTIFIED
DHMI-ANKARA
AIRAC AMDT 08/06
AIP
TURKEY
STANDARD ARRIVAL CHART
INSTRUMENT (STAR) - ICAO
TRANSITION ALTITUDE
12 000 FT
APP : 120.1 - 122.1 - 362.3
TWR : 120.1 - 122.1 - 362.3
TRABZON
INTERNATIONAL
AD 2 LTCG STAR
26 OCT 06

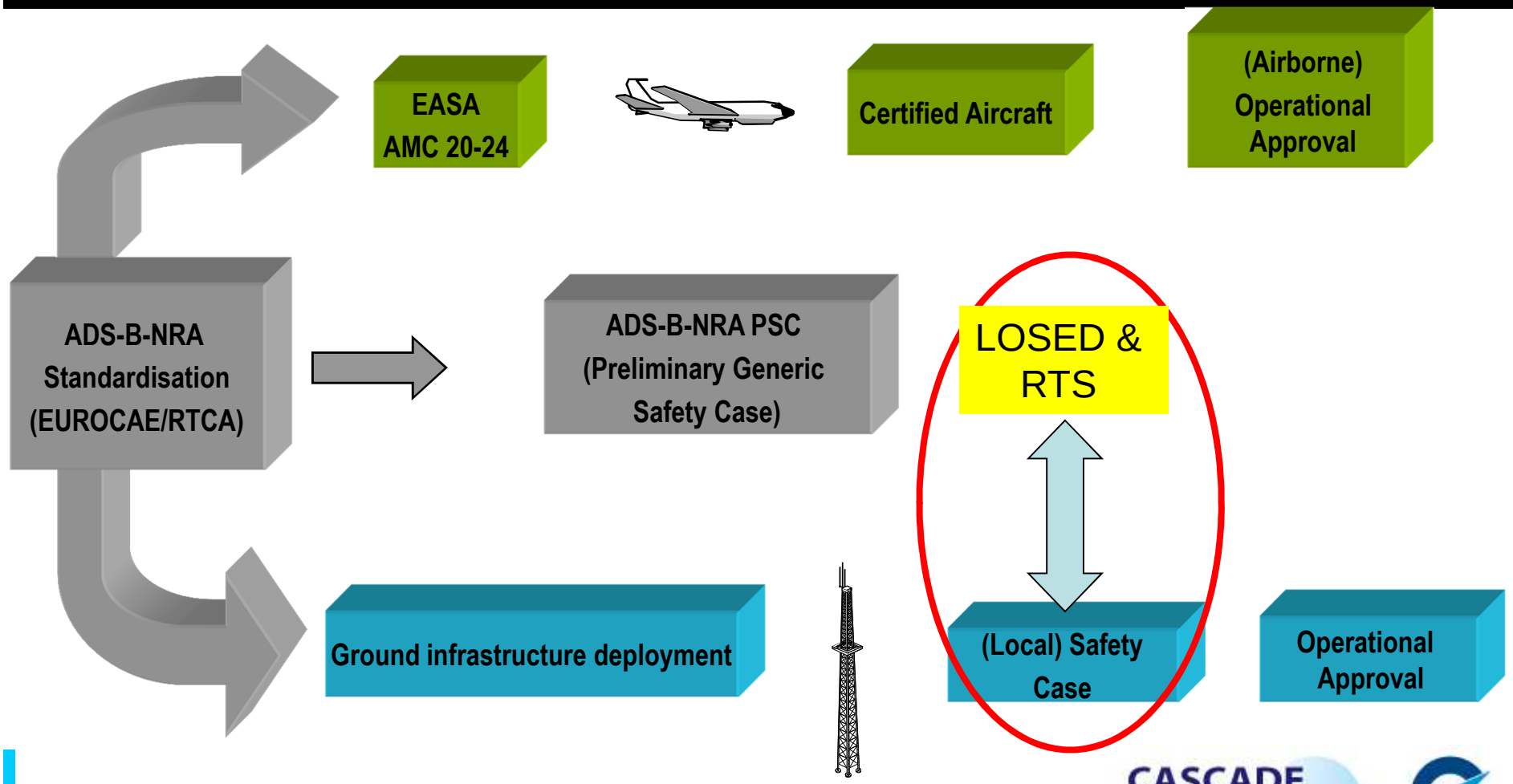
ADS-B-NRA

- Video…….

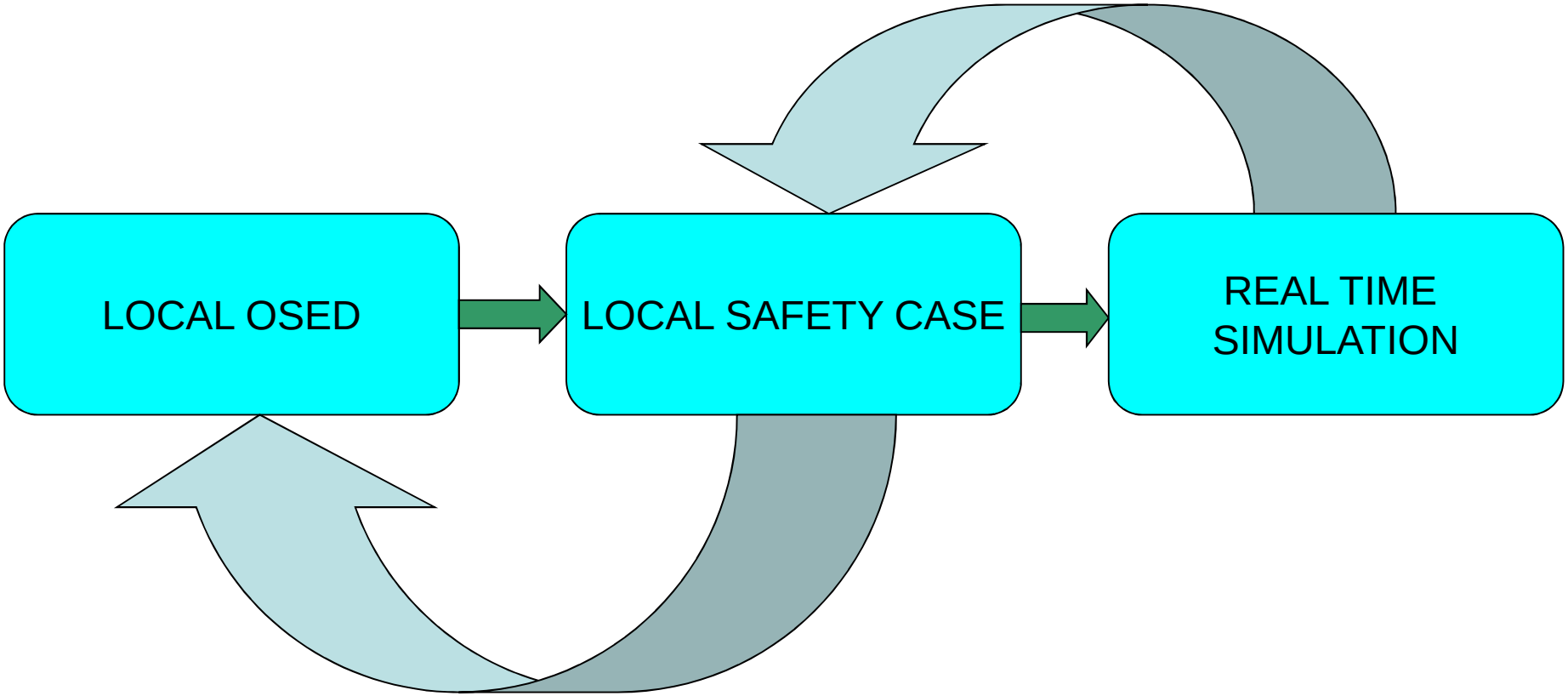
WORK FLOW



Safety case: on the path towards ADS-B-NRA operation



WORK FLOW



REAL TIME SIMULATION

- Majority (13) of Trabzon Controllers participated at request of DHMI
  - 2 Simulation Sessions of 2 weeks each
  - 3 Days Training including revision of vectoring
  - 7 Days Measured Runs – R/W 11 & R/W 29
  - 36 “exercises”
    - 6 Baseline (Procedural Service)
    - 6 100% ADS-B Equipped
    - 24 50% ADS-B Equipped

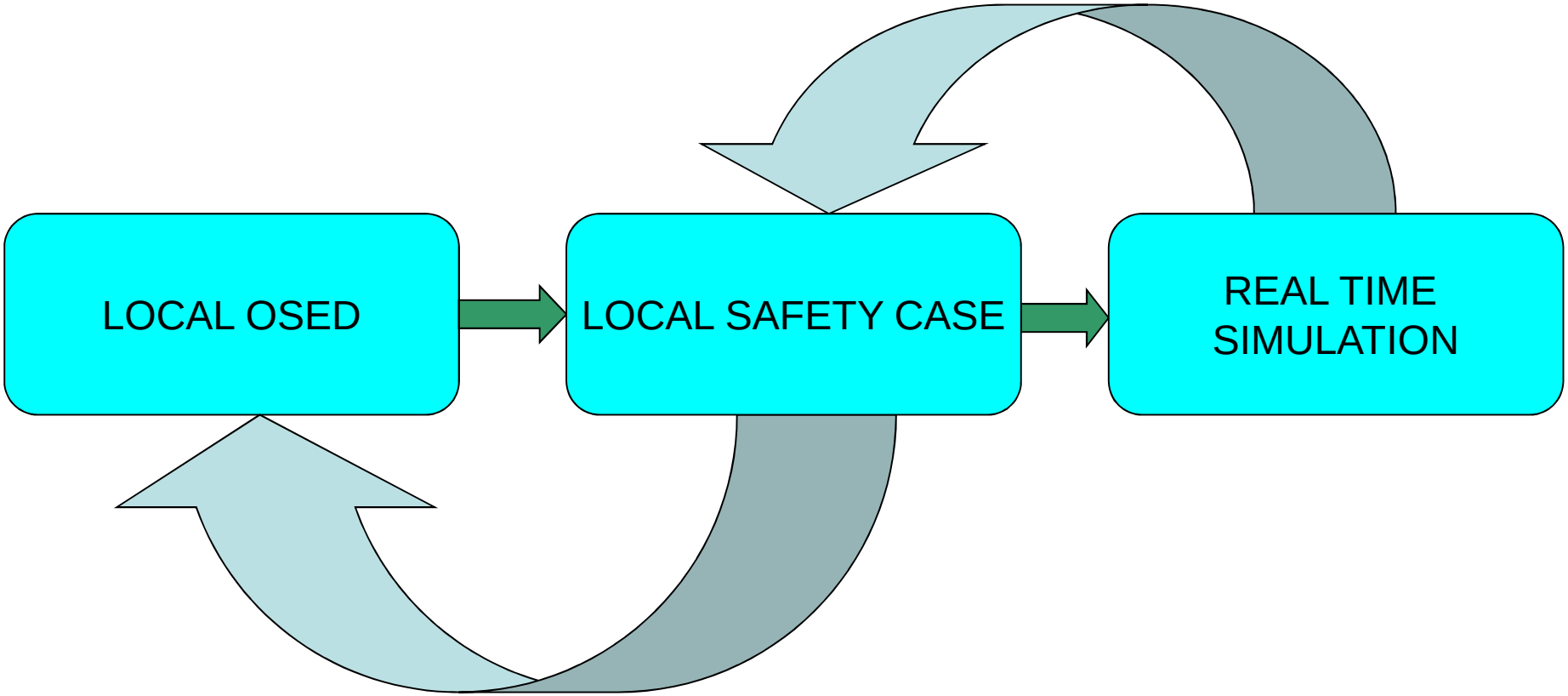
CAPACITY AND EFFICIENCY

Procedural traffic patterns

ADS-B traffic patterns

ADS-B versus Procedural – Shorter Approach Route PGT2427

WORK FLOW



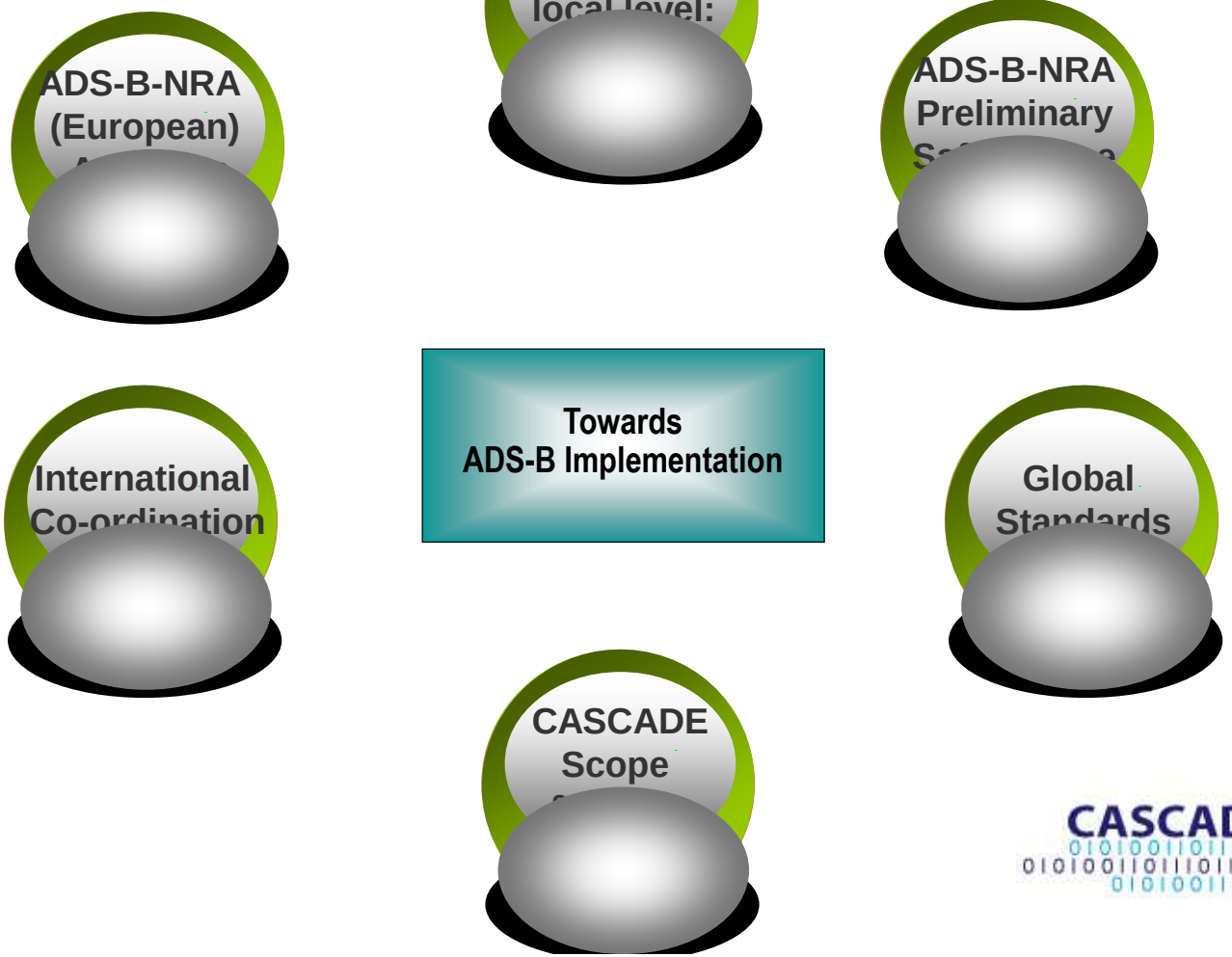
RTS Safety activities

- POST EXERCISE QUESTIONAIRES
- LOSS OF SEPARATION ASSESSMENT
- HAZARD IDENTIFICATION WORKSHOPS

RESULTS

- Mountainous terrain in the south can create new hazards when aircraft are vectored perpendicular towards the mountains, waiting for a final turn
  - During frequency occupation by procedurally controlled aircraft
  - During communication loss
  - Not a typical ADS-B issue, but a surveillance issue.
- Overall workload with partial equipage still lower than procedural control
  - Some peaks during separation of ADS-B and procedural aircraft.
- ATC Procedures and use of controller resources acceptable from controller point of view.
- Clear procedures need to be established, especially for R/W 29.
- Overall handling partial equipage was acceptable to the controllers.

Overview


ADS-B-NRA Example at local level:
ADS-B-NRA (European)
ADS-B-NRA Preliminary
Towards ADS-B Implementation
International Co-ordination
Global Standards
CASCADE Scope

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