

SIP/2009-WP/22

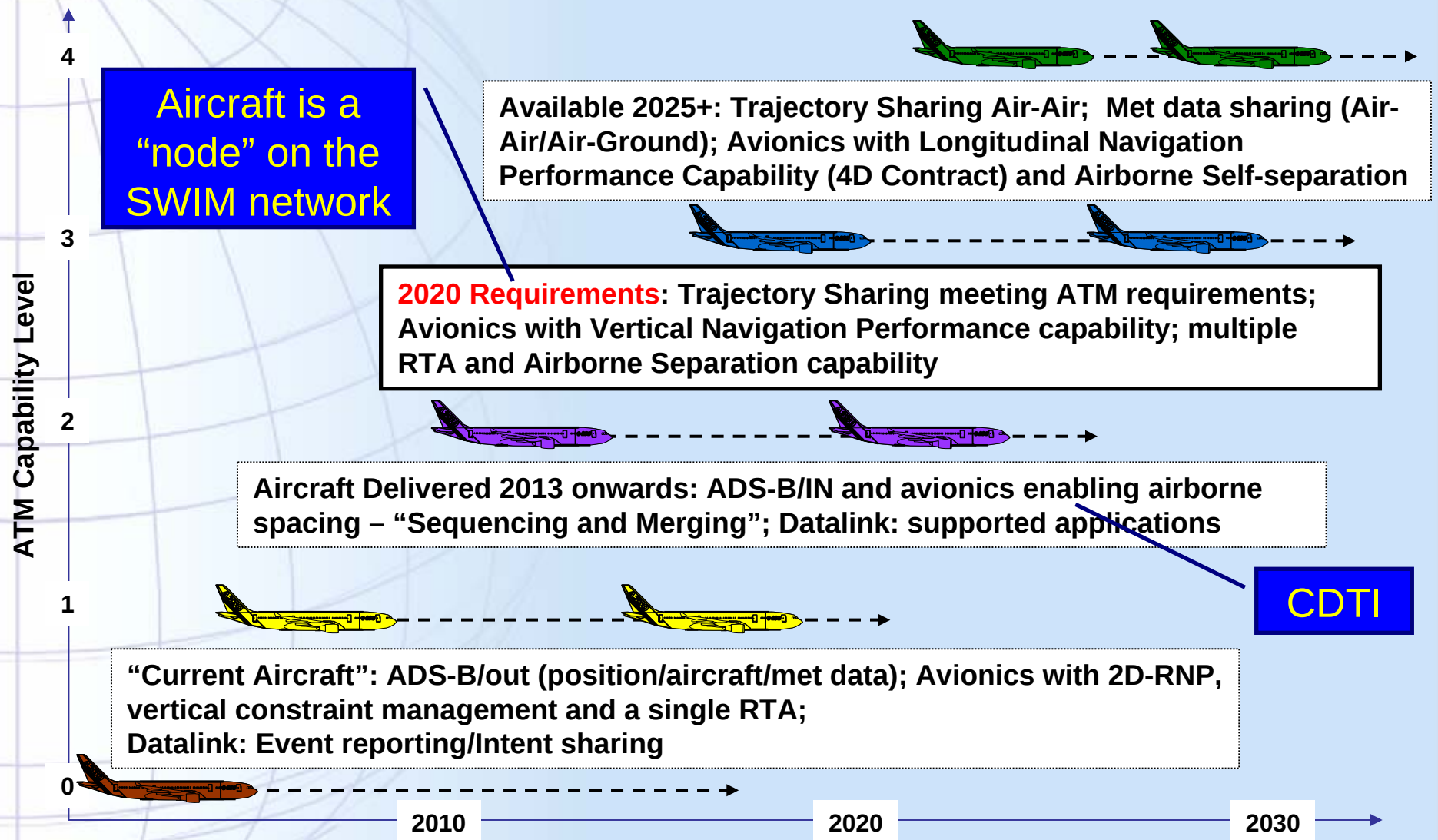
**Emerging
Technologies**

Global Air Navigation System Performance Based Air Navigation Emerging Technologies

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**Workshop on the Development of Business Case for
the Implementation of CNS/ATM Systems
(Antigua and Barbuda, 28 September –
2 October 2009)**

ATM Capability Levels



User Vision on ATM 2020+ (amongst others)

- The future ATM Network will be 4D trajectory based
 - Collaborative Planning resulting trajectories reflecting user intentions
 - Once agreed A/C flies FMS trajectories, negotiated, updated in real-time
- The system is based on System Wide Information Management and Collaborative Decision Making meaning:
 - All actors have access to all relevant information
 - Decisions driven by common situational awareness
 - CDM introduce airports and airspace users in ATM decision process
- Uncertainty in ATC ground based trajectory prediction is reduced by:
 - A/C derived information or 4D-trajectories sourced by AOC or by the onboard aircraft systems
 - ATM Network shall make full use of the ATM capabilities of modern aircraft

NextGen & SESAR

- SESAR and NextGen both based on full 4D Trajectory Based Operations
- TBO entails the systematic sharing of aircraft trajectory data between various participants in the ATM process from planning and execution phases
- All ATM decision making and tactical operations based on most recent data available.
- A reference trajectory integrating applicable ATM/Airports agreed before flight and executed with the required precision in all 4 dimensions.
- Trajectories are shared and updated from the source(s) best suited to the prevailing operational circumstances.

A Trajectory Based Environment

- Trajectory based operations
 - A new approach to airspace design and flexible airspace management
- Business Trajectory ownership
 - User involvement in decision making processes
 - Users determine how constraints shall be applied whenever possible
- Trajectory management
 - An agreed 4D trajectory for each flight – as close as possible to the user preferred trajectory which may include cruise climb - route structures only deployed when/where essential for capacity reasons.
 - Authorised by controllers using new separation modes or executed by the flight crew using airborne separation modes
 - Executed with an agreed precision
 - Trajectory revisions respect the concept of ownership
 - 4D trajectories are the principle language for information sharing

NextGen Goal

Achieve a Next Generation Air Transportation System that meets the nations's future air transportation safety, security, mobility, efficiency, and environmental needs

SESAR Goal

To achieve a performance-based European ATM System, built in partnership, to best support the ever increasing societal and States' (including military) expectations for air transport with respect to the growing mobility of both citizens & goods and all the other aviation activities, in a safe, secure & environmentally sustainable & cost-effective manner

Summary of Key Characteristics for NextGen and SESAR

- Shift to increase User Focus
 - User preferences and business models
- Distributed and Collaborative Decision-Making
 - Distributed, but optimize on Network Plan
- Implement Just Safety Culture/Safety Management
- Take advantage of Automation; Tailor automation to assist humans
 - Human role will shift to ATM, with less emphasis on tactical control
- Reduce Impact of Weather
 - Equivalent Visional Ops for NextGen
 - 80% equivalence for SESAR
 - Common weather picture and improved decision support
- Migrate to digital and satellite-based technologies



NextGen & SESAR Objectives are Similar

- Expand Capacity
- Global Aviation Harmonization
- Ensure Safety (with increasing capacity)
- Protect the Environment
- Improve Service for Aviation Customers

NextGen Construct differs from SESAR

- Institutional
 - U.S. Government is ANSP (won't change any time soon)
 - FAA funding is not cost-based
 - FAA includes regulation and service provision
- Different stakeholder balance
 - Major lobbies for GA and business users, single military presence
- Scope:
 - NextGen curb-to-curb, security, ...
- Industry involvement different
 - NextGen is more government owned and driven
 - Industry participation is through the NGATS Institute to avoid competitive issues

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graph TD; A[Current Development work in ICAO On CNS] --- B[ACP  
* Use of IPS  
• Future Communications Infrastructure (FCI)]; A --- C[NSP  
* Evolution of GNSS (including new elements like GALILEO)]; A --- D[ASP  
* Multilateration  
* Airborne Surveillance Applications]; A --- E[RF Spectrum]; B --- E; C --- E; D --- E;
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Current Development
work in ICAO
On
CNS

RF Spectrum

ACP
* Use of IPS
• Future Communications Infrastructure (FCI)

NSP
* Evolution of GNSS (including new elements like GALILEO)

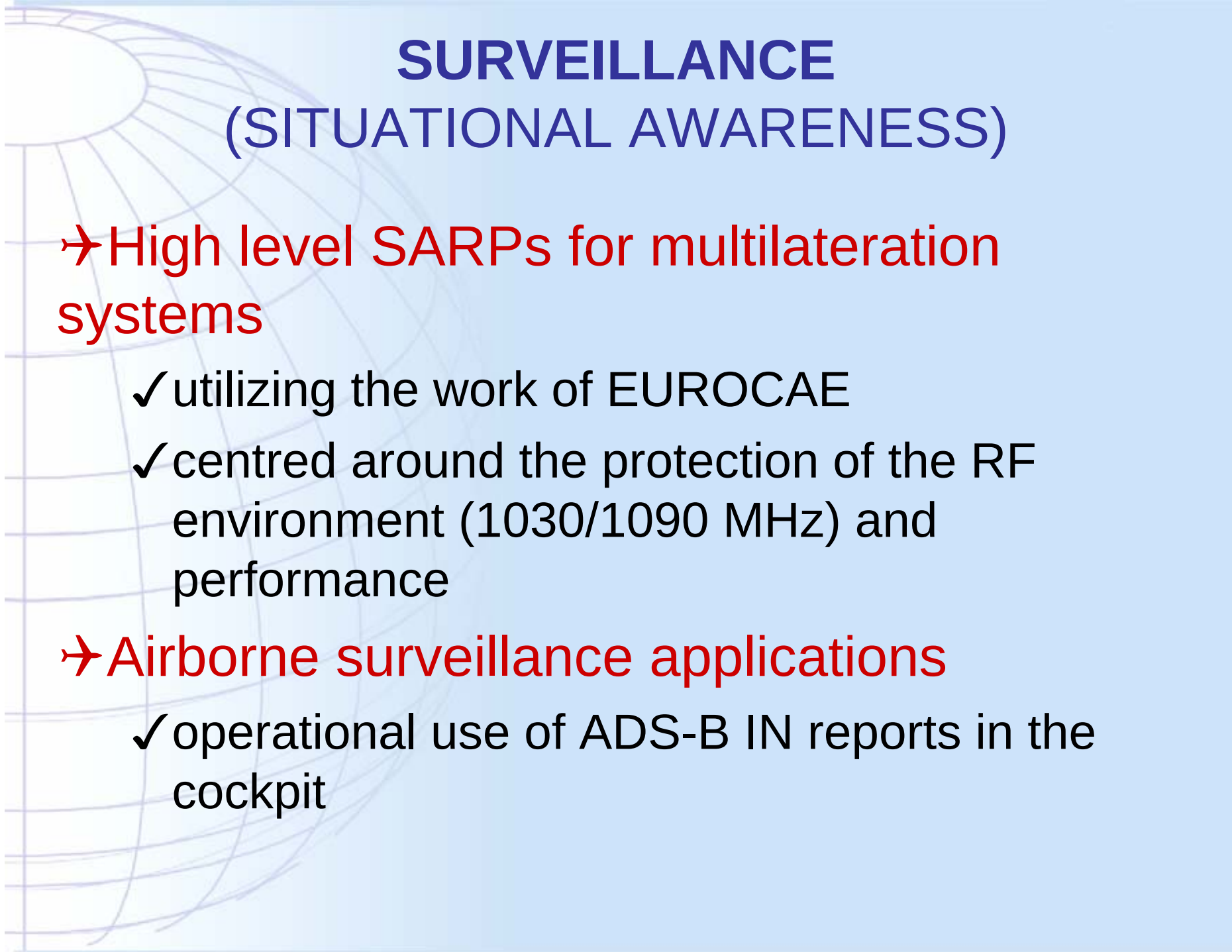
ASP
* Multilateration
* Airborne Surveillance Applications

RADIO FREQUENCY SPECTRUM

→ Develop ICAO Policy for WRC-2011

- ✓ Development of ICAO policy and other provisions to ensure the availability of sufficient spectrum for current/future CNS systems as well as for their protection against electromagnetic interference.
- ✓ Update the ICAO RF Handbook accordingly

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SURVEILLANCE

(SITUATIONAL AWARENESS)

→ High level SARPs for multilateration systems

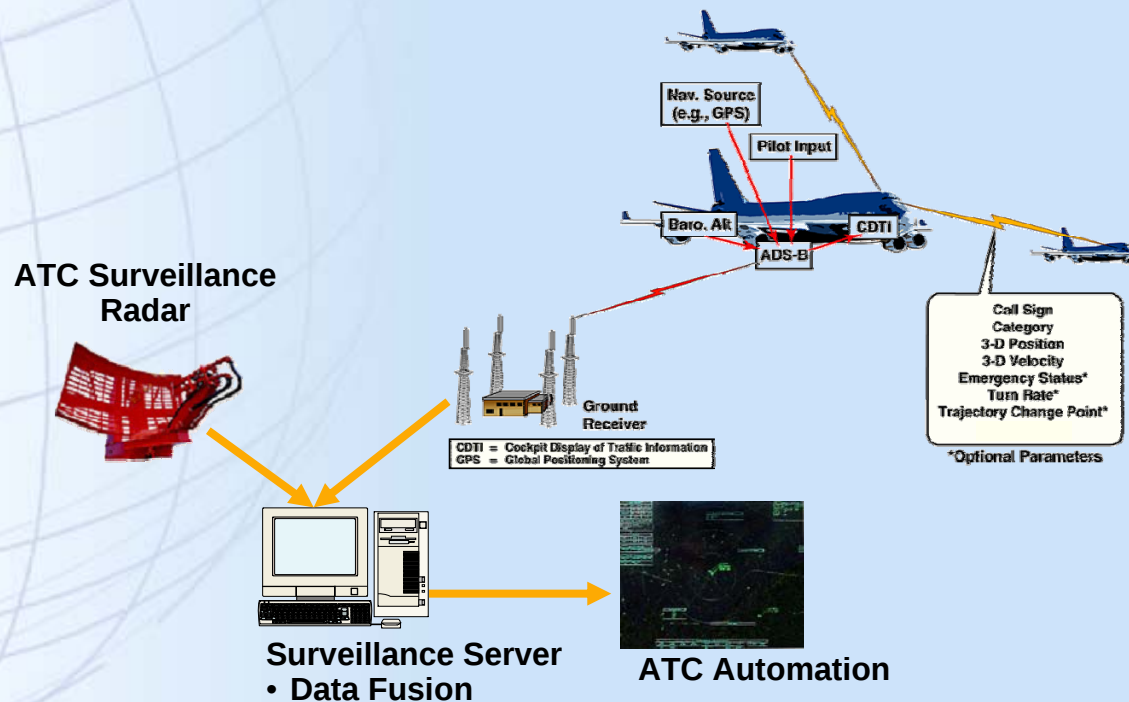
- ✓ utilizing the work of EUROCAE
- ✓ centred around the protection of the RF environment (1030/1090 MHz) and performance

→ Airborne surveillance applications

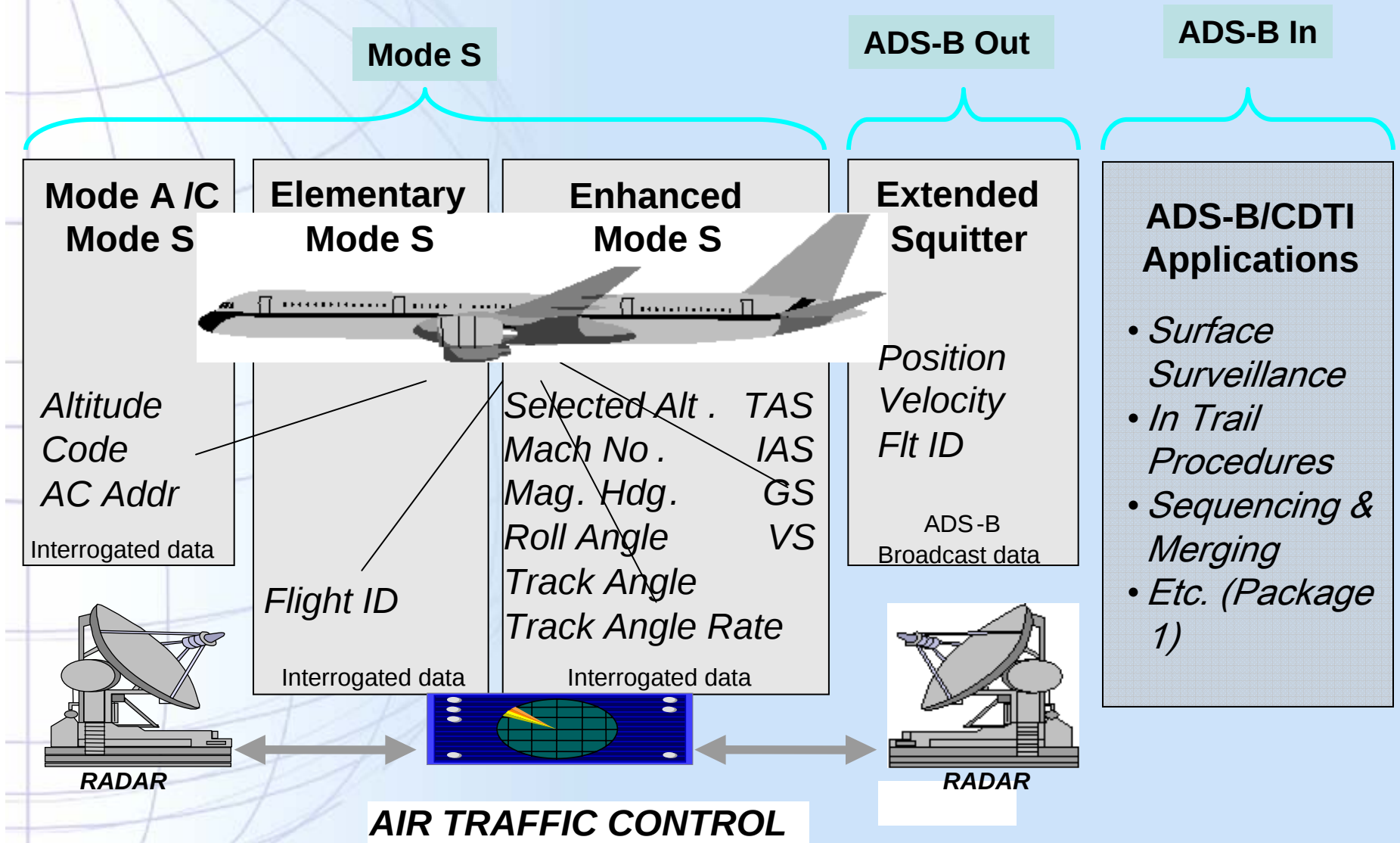
- ✓ operational use of ADS-B IN reports in the cockpit

Surveillance Evolution

- ADS-B proposed for two categories of applications
 - Ground surveillance using ADS-B-out
 - Airborne surveillance using ADS-B-In and CDTI



ADS-B Equipage



ASAS Self Separation

Nextgen and SESAR both plan to migrate Separation method from ATC as done today, progressing to airborne self-separation

- **NextGen (EN-0032) Self Separation timeline 2022**
- **SESAR timeline is IWP3; post 2020**

Airborne Separation Assistance System (ASAS)

- “Application” is an industry-selected term
 - Each application considered here is a procedure supported by ADS-B surveillance on the flight deck
- Application categories under current consideration:
 - Situational awareness enhancement
 - In-Trail Procedures in procedural airspace (ITP)
 - Enhanced Visual Separation on approach (VSA)
 - Enhanced Visual Acquisition
 - Traffic Situation Awareness – airborne and on airport surface
 - Spacing from other aircraft
 - Sequencing & Merging – ASAS version
 - Merging and Spacing – UPS/FAA version
 - Separation assurance from other aircraft
 - Flight crews accept responsibility for separation from other aircraft
- Display Integrated in Forward Field of View (FFOV) is generally preferable for CDTI applications although some situational awareness and spacing applications could be on non-FFOV display.

NAVIGATION

- Evolution of existing GNSS (GPS & GLONASS)
 - - dual frequency SBAS
 - - multi-frequency GPS & GLONASS
 - CAT II / III GBAS
- * New GNSS elements such as GALILEO
- Implementation strategy
 - - involving ground and satellite-based systems

Planned GNSS

- Global Constellations
 - GPS (US)
 - GLONASS (Russia)
 - Galileo (EU)
 - Compass (China)
- Regional Constellations
 - QZSS (Japan)
 - IRNSS (India)
- Satellite-Based Augmentations
 - WAAS (US)
 - MSAS (Japan)
 - EGNOS (EU)
 - GAGAN (India)

All Segment – GPS Modernization

Satellites

Legacy (Block IIA/IIR)

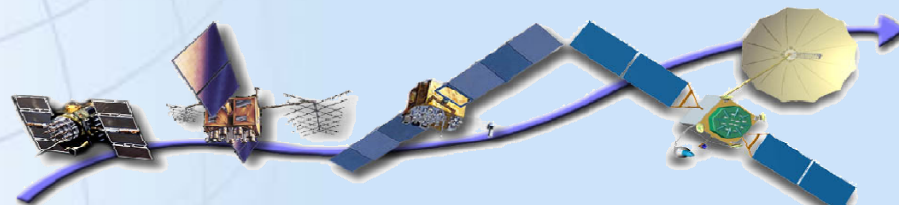
- Basic GPS
- C/A civil signal (L1C/A)
- Std Pos. Service
- Precise Pos. Service
 - L1 & L2 P(Y) nav

Modernized (Block IIR-M)

- 2nd civil signal (L2C)
- M-Code signals (L1M, L2M)

Modernized (Block IIF)

- 3rd civil signal (L5)



GPS III (Block C)

- Increased accuracy
- Increased signal strength
- Signal integrity
- Search and Rescue
- Common Galileo OS/GPS (L1C)

Third Civil Signal (L5)

- Designed to meet demanding requirements for aviation safety
 - Uses highly protected Aeronautical Radionavigation Service (ARNS) band
- Wider bandwidth improves resistance to interference
- Signal Structure for enhanced performance
- Higher power than other GPS signals
- Increasing interoperability
 - Galileo E5a, GLONASS, Compass, QZSS, WAAS & other SBAS
- Demonstration signal in 2008
- 24 satellites by 2018



COMMUNICATIONS

- * **Introduction of Internet Protocol Suite (IPS)**
 - For G-G and A-G communications
 - Based on already available industry standards
 - Cost effective, proven and widely available
- * **Future Communications Infrastructure (FCI)**
 - various candidate technologies and frequency bands are being investigated

A wireframe globe graphic is positioned on the left side of the slide, showing a grid of latitude and longitude lines. The globe is partially cut off by the left edge of the frame.

ICAO

Future Communications Study (FCS) Overview

The Results - Technology shortlist

NASA – ITT	Common Recommendations		Eurocontrol
Continental • INMARSAT Swift Broadband • Custom Satellite • Link 16	• P-34 • Wideband CDMA • L-band Datalink [(x)DL3]	• P-34 • Wideband CDMA • L-band Datalink [(x)DL3]	Continental • [(x)DL4]
Oceanic	• INMARSAT Swift Broadband • Custom Satellite	• INMARSAT Swift Broadband • Custom Satellite	Oceanic
Airport	• IEEE 802.16e	• IEEE 802.16e	• ADL Airport

A wireframe globe graphic is positioned on the left side of the slide. It features a grid of latitude and longitude lines, with a white circular area at the top representing the North Pole. The globe is rendered in a light blue color that blends into the background.

Thank You