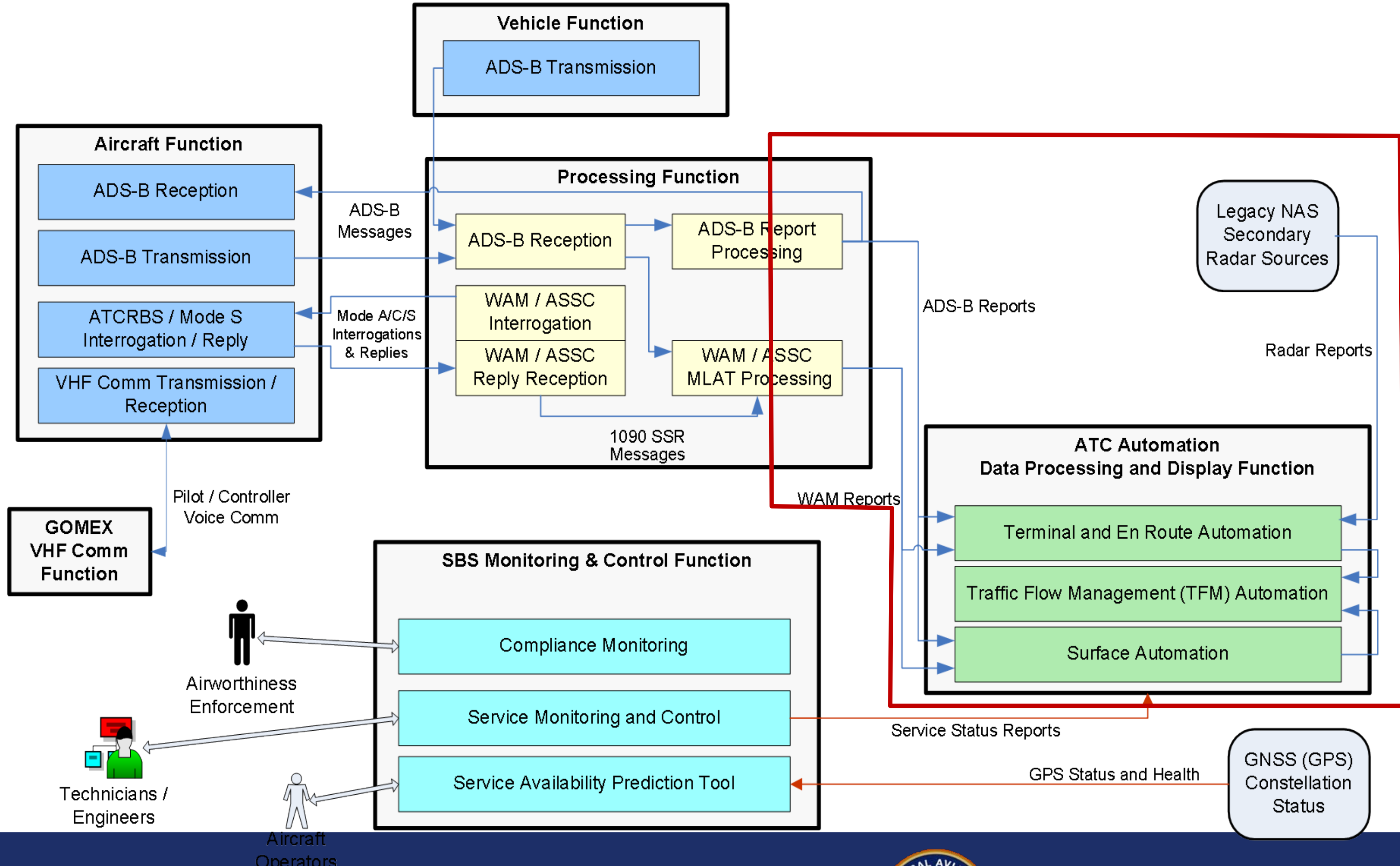
Detailed Overview of Surveillance Chain Integration

Objectives

- Surveillance Chain Overview
- ASTERIX
- Fusion
- ADS-B Validation
- Security
- Conclusion

FAA Surveillance Functional Architecture



ASTERIX

ASTERIX Acronym

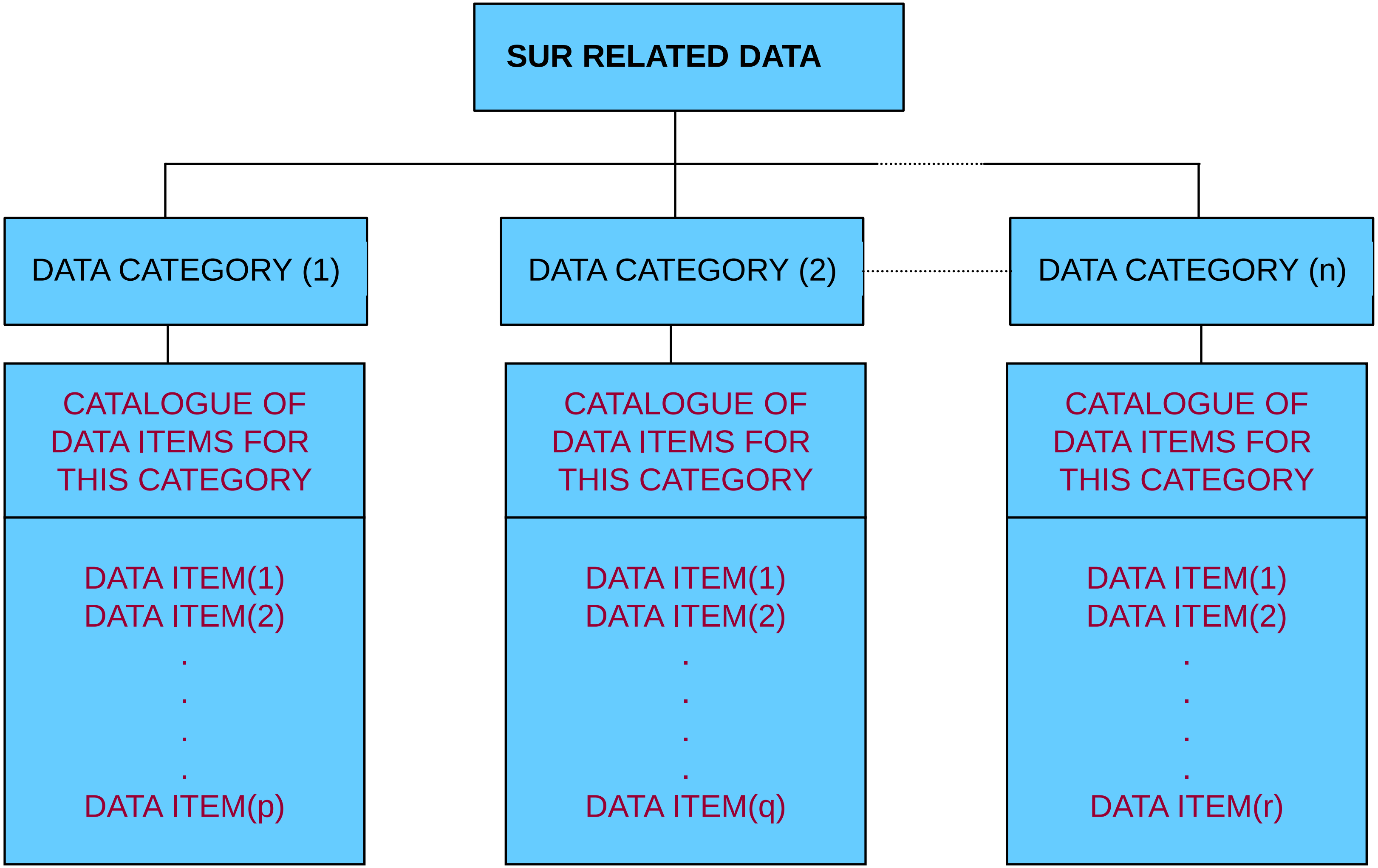
- **A**ll purpose
- **ST**ructured
- **E**urocontrol
- **suRveillance**
- **I**nformation
- **eXchange**

http://www.eurocontrol.int/asterix/

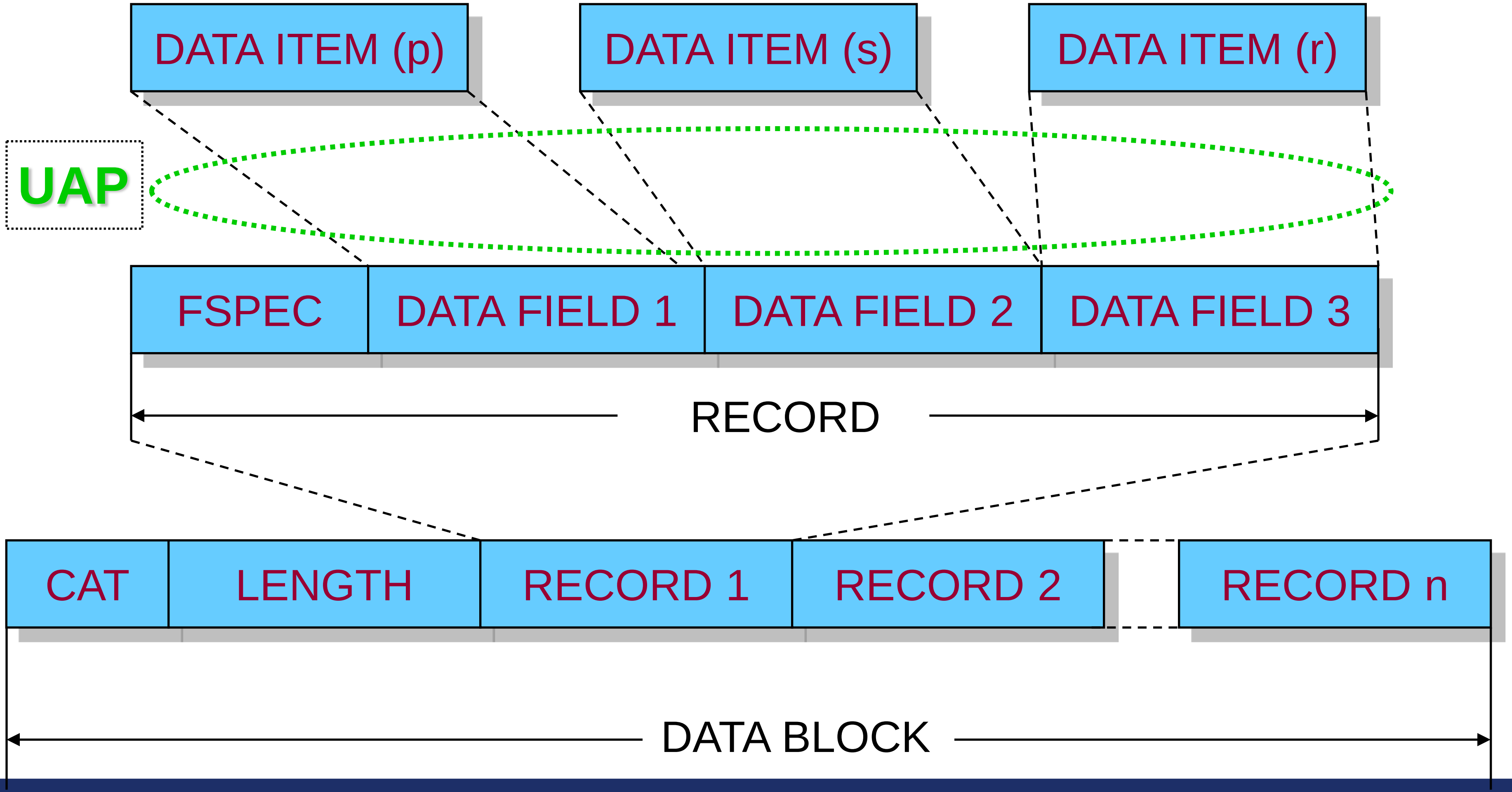
The Need for a Common Format

- Harmonization
- Suppliers offering systems to customers with proprietary interfaces.
- Evaluations of competing suppliers equipment on common tool-set
- Facilitating the shared use of surveillance data across National boundaries
- Surveillance Standard

Organization of the Data



General Message Structure



Relevant ASTERIX CATegories

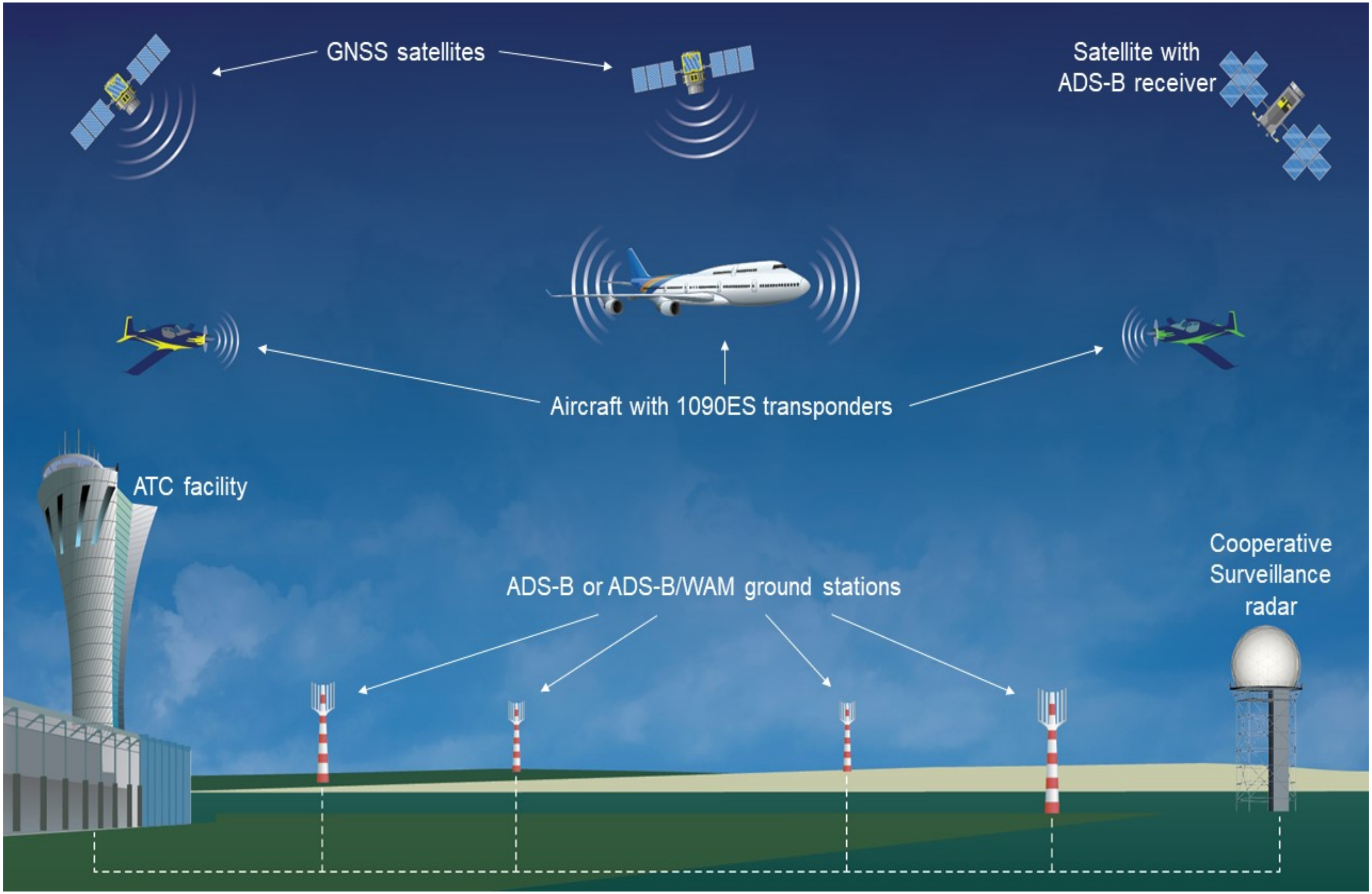
CAT	Description	Data Source
CAT010	Transmission of Multisensor Surface Movement Data	Multilateration Target Processor
CAT019	MLAT System Status Messages	Multilateration Ground Station
CAT020	MLAT Messages	Multilateration Ground Station
CAT021	ADS-B Messages	ADS-B Ground Station
CAT023	CNS/ATM Ground Station Service Messages (modified in the USA for 1090ES & UAT by the FAA)	ADS-B Ground Station
CAT024	ADS-C Messages	ADS-C Ground Station
CAT033	ADS-B Target Reports for Ground Stations (defined for 1090ES & UAT by the FAA)	ADS-B Avionics
CAT048	Radar Target Reports	PSR, SSR, MSSR or Mode S Radar
CAT062	Specification of message structure for transmission of System Track Data to the User	Automation tracker output

Asterix Cat021 Versions

- **ANSPs should be cognizant of the ASTERIX version being implemented in the automation system.**

- **As ADS-B progresses, the ASTERIX Cat021 data versions are modified in order to properly process the information received.**
  - v0.23 for DO-260/ED-102
  - v1.0 or later for DO-260/ED-102 and DO-260A
  - v2.1 or later for DO-260/ED-102, DO-260A, and DO-260B/ED-102A
  - vX.X will allow for processing of DO-260C/ED-102A

Fusion


GNSS satellites
Satellite with
ADS-B receiver
Aircraft with 1090ES transponders
ATC facility
ADS-B or ADS-B/WAM ground stations
Cooperative
Surveillance
radar

Fusion

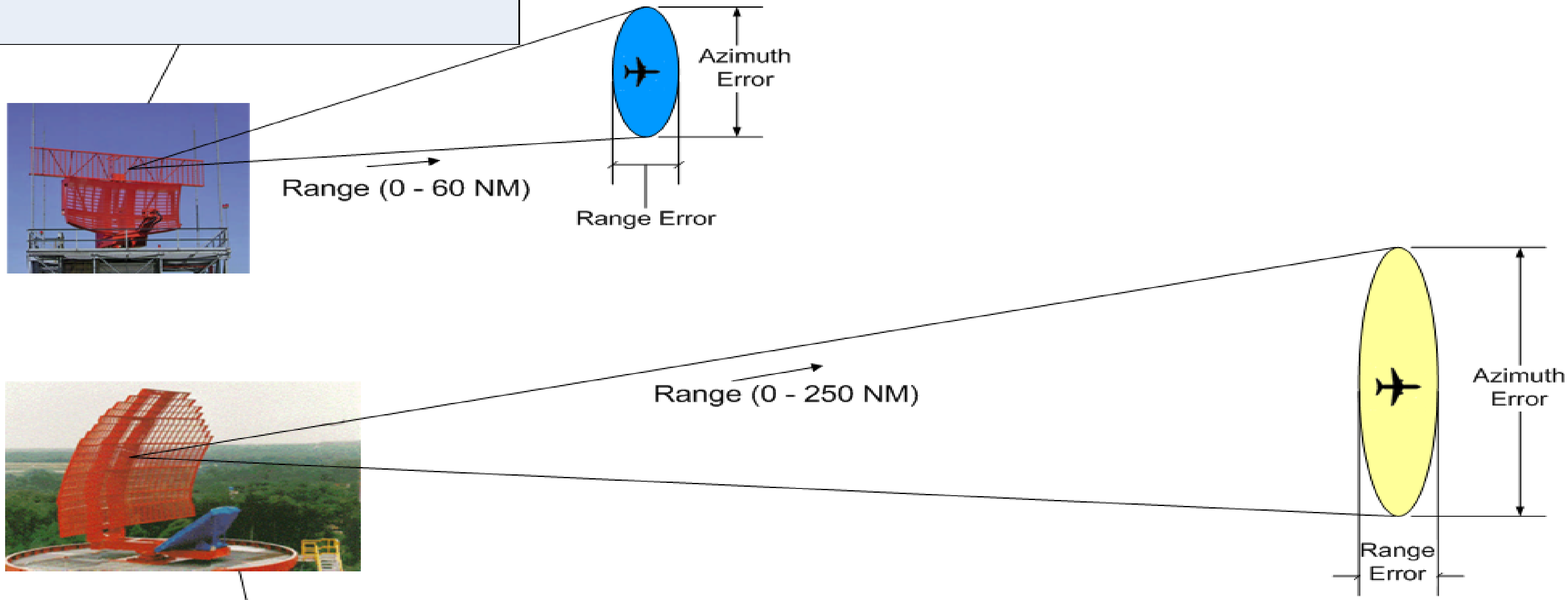
- Definition of Fusion for Aircraft Tracking
  - Fusion: A system that is capable of receiving surveillance reports from multiple sensors (Radar, ADS-B, WAM), possibly of different types, and of combining those surveillance reports into a single track for each aircraft that will generally provide more rapid track initiation and higher update rates, and potentially more accurate position and velocity estimates than could be achieved with any of the individual sensors.

Fusion Considerations in the FAA

- The FAA approved of advancing Fusion technologies with ADS-B to take advantage of potential benefits related to fusion:
  - Synchronization of track updates on an operational display regardless of surveillance source update rates for improved separation awareness.
  - Potential improvement to target position and velocity accuracy that could lead to reduced separation.
  - Provides increased reliability and redundancy for area with multiple sensor coverage.
  - Simpler integration of new surveillance sources, such as multilateration, into automation or other tracking processes.
  - Provides opportunities for computer-human interface improvements and decreased clutter on the display which will also improve situational awareness.
  - Eliminates significant jumps in target position as compared with mosaic displays.
  - Improves Safety Function performance for Minimum Safe Altitude Warning (MSAW), conflict alert, etc.

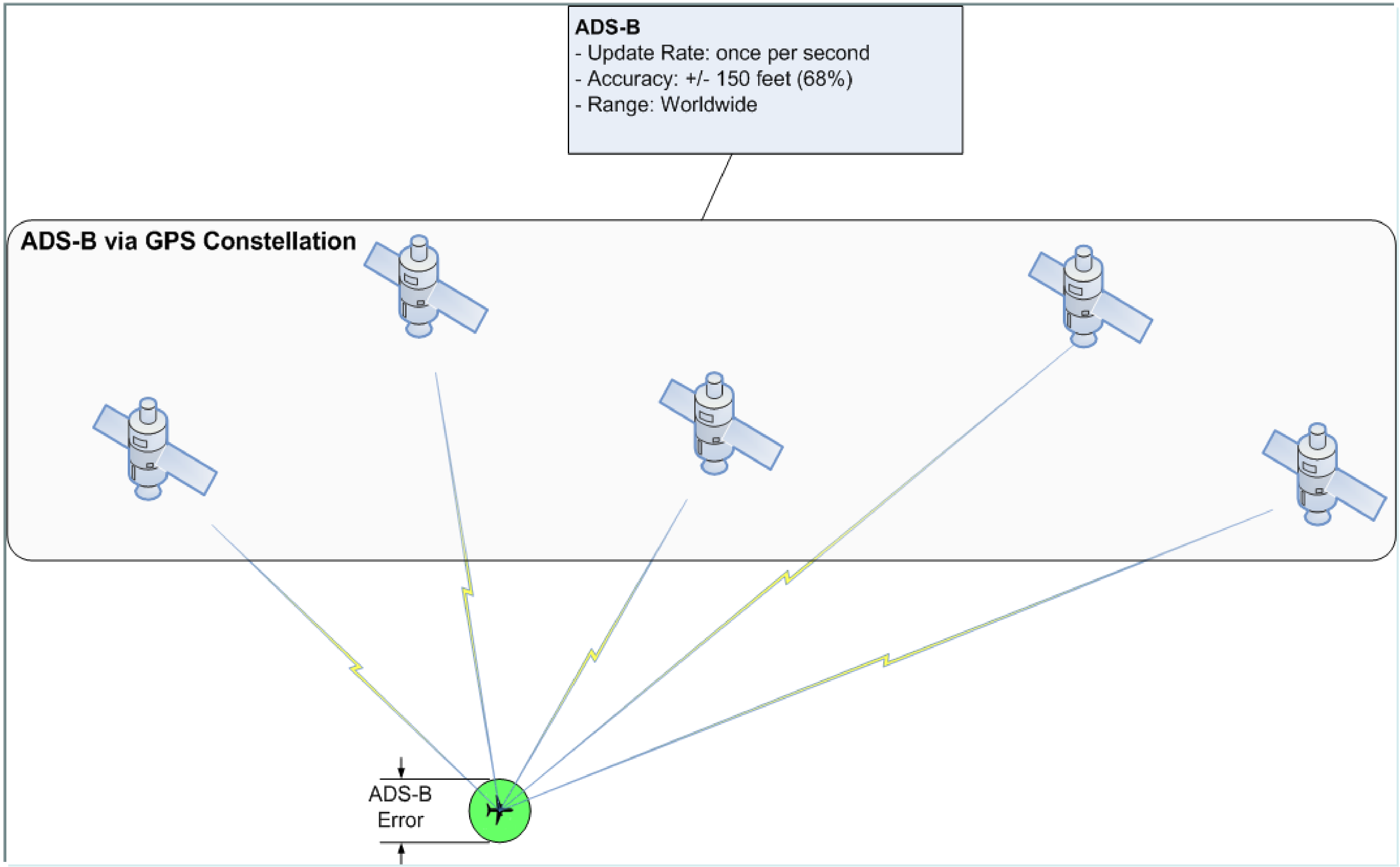
Sensor Characteristics for Fusion

ASR-9/Mode S
- Update Rate: 4.61 seconds
- Range Accuracy: +/- 180 feet (68%)
- Azimuth Accuracy: +/- 637 feet (68%) at 60NM
- Range: 60NM

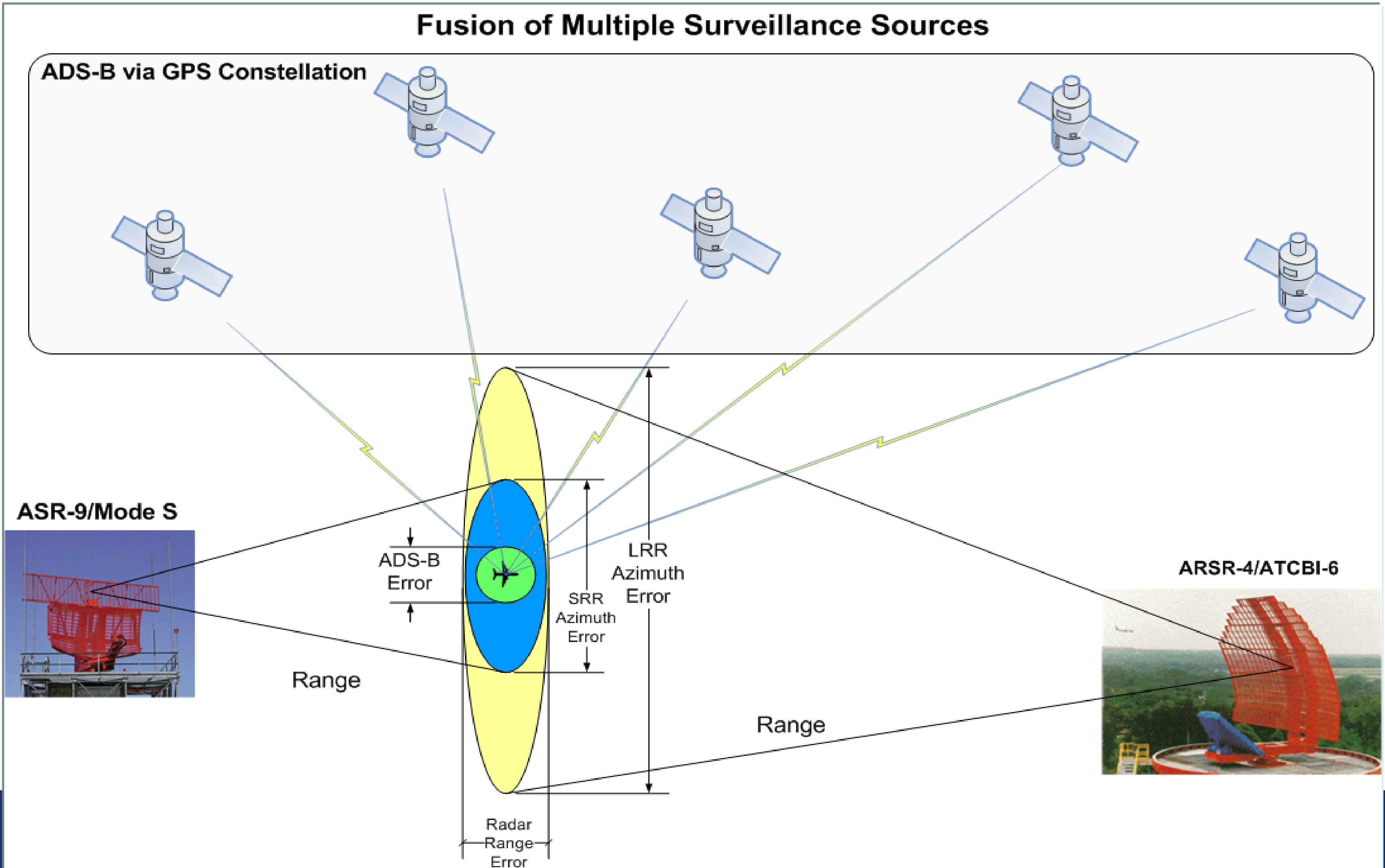


ARSR-4/ATCBI-6
- Update Rate: 12 seconds
- Range Accuracy: +/- 180 feet (68%)
- Azimuth Accuracy: +/- 2652 feet (68%) at 250NM
- Range: 250NM

Sensor Characteristics for Fusion



Comparison of Different Sensors



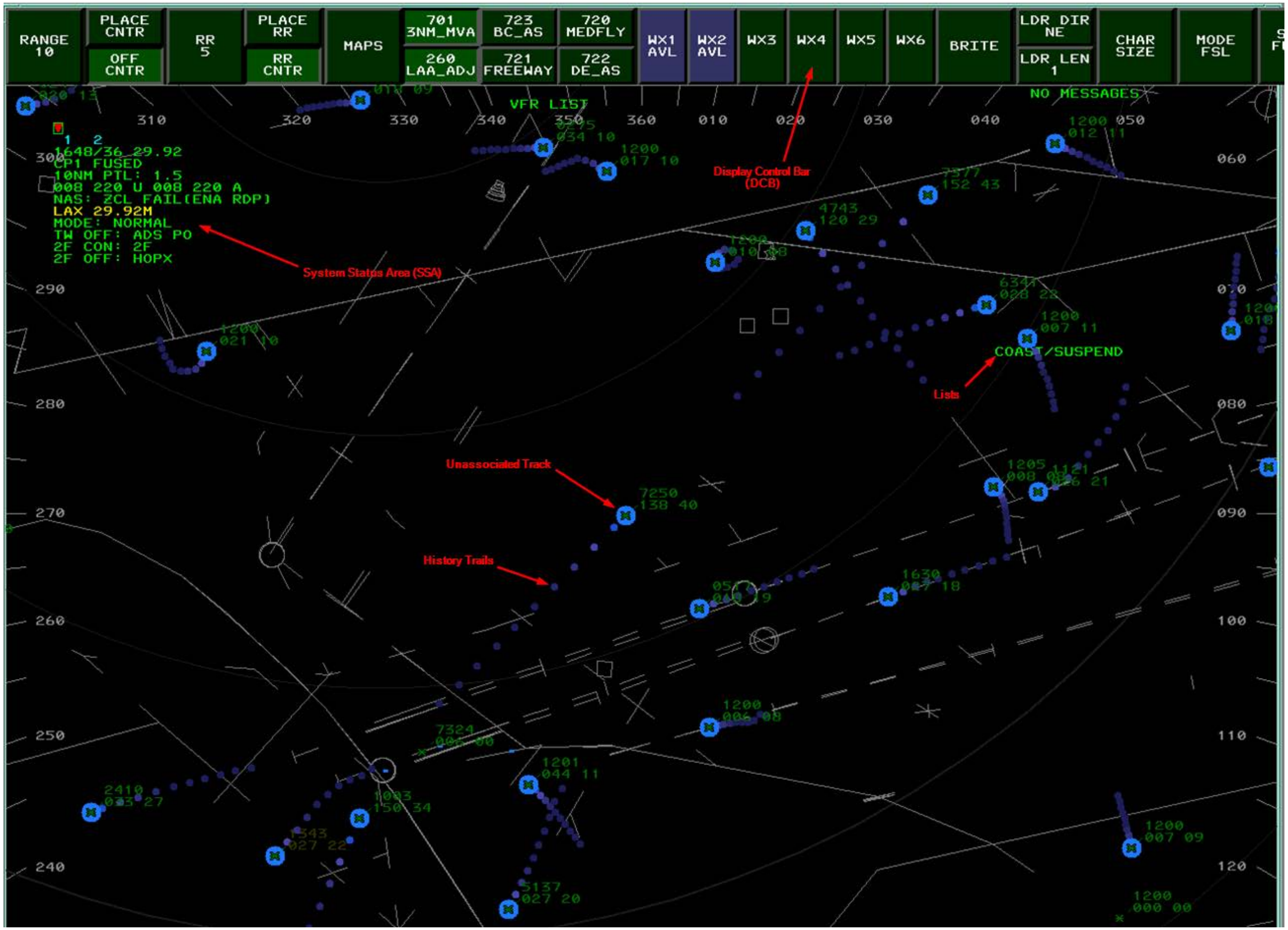
ADS-B Validation

- **Due to ADS-B's reliance on other aircraft systems, there is a need to ensure proper validation of the ADS-B information beyond the minimum performance threshold/requirements.**
- **The precision of information such as NIC/NUCp, NACp, etc. rely on the number of GNSS satellites within the aircrafts view.**
- **Validation of ADS-B information provides level of assurance that aircraft with "bad avionic" will not be visible to the controller.**
  - Comparison with Secondary Surveillance Radars
  - TDOA
  - Ranging

Fusion Benefits

- Fusion provides better update rates than single sensor and accuracy consistent with the best sensor source
- Fusion provides improvements to Tracker Continuity in a multi-sensor environment
- Fusion provides a smoother track on ATC displays and reduce rerouting or deviations

STARS Fused Display Mode



Track Initiation

- **On every ADS report that**
  - Contains position information

    AND
  - Is not associated to an existing track

- **"Quick initiation" on Mode S and WAM, based on presence of ICAO 24-bit address**

Track Continuation

- Association based on ICAO 24-bit address

  - Mode S: otherwise with low probability

  - ADS: always (ICAO 24-bit address is the only field that doesn't alternate)

- Blunder detection (ADS <-> Radar)

Security

FAA Security Inquiries

- Jamming (Denial of Service Attacks)
- Spoofing (False Target Attacks)
- Vulnerability associated with guided unmanned aircraft systems
- Ground Infrastructure
- Summary

GPS Outages and Signal Jamming (Denial of Service)

- Mitigation Approaches: Procedures, Radar, Monitoring, and Independent Position Validation:
  - Procedures: implement increases in separation to deal with equipment outages
  - Radar:
    - The FAA will maintain certain secondary radars as a back-up system throughout en route and high density terminal airspace
    - At this time, the FAA is evaluating areas where redundant cooperative coverage is no longer required as part of a radar divestiture effort. This may lead to removing complete radar sites where full redundancy is no longer required.
  - Monitoring: The FAA has an active monitoring process that generates a monthly report of system validation performance that is calculated from all of the flights for that month to verify that each automation feed remains in tolerance. Any anomalies are investigated and resolved.
  - Independent Position Validation: *See spoofing slide*

Spoofing (False Target Attacks)

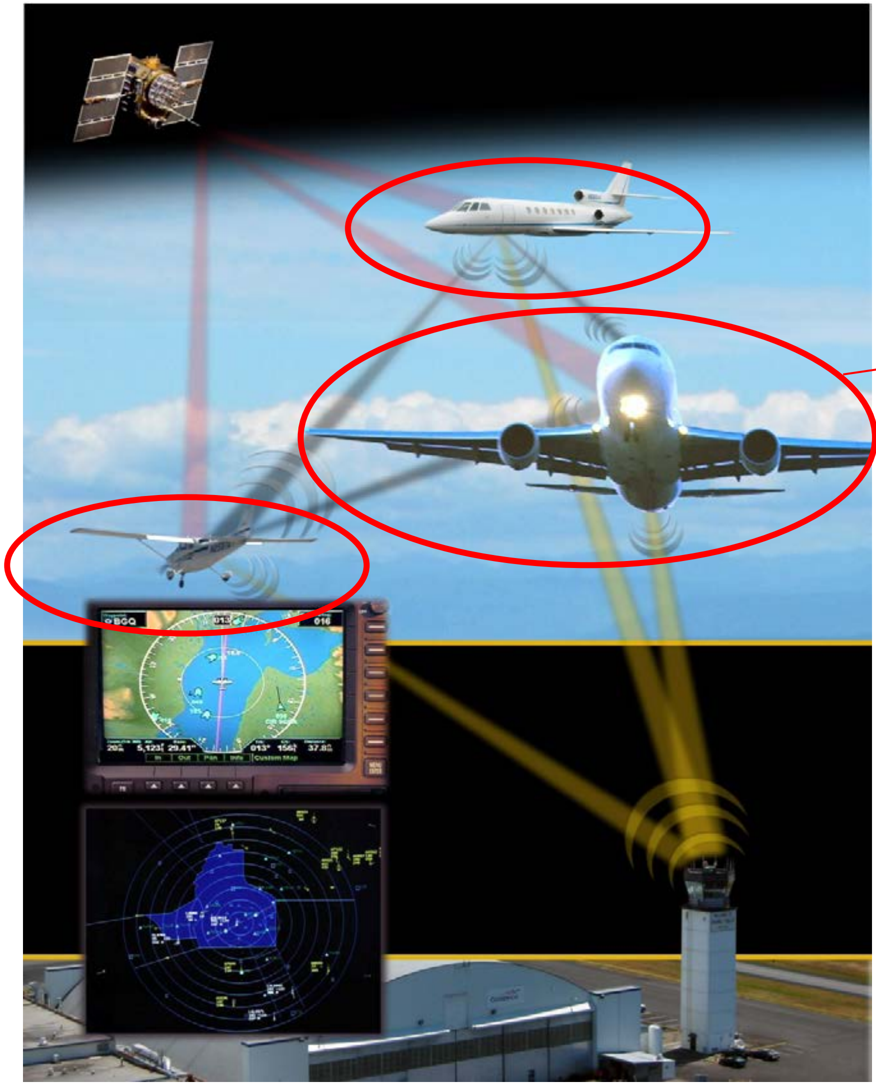
Mitigation Approach: Multiple, independent aircraft position determination strategies to determine when an ADS-B signal is being broadcast from one location while sending out inaccurate location information.

Independent position validation is accomplished using multiple techniques:

1. Primary method employed is TDOA, where radios overlap in coverage.
2. Consistency with radar track, if present. This is applicable for detecting malperforming avionics
3. Passive ranging to a ground based radio station on Universal Access Transceiver (UAT) and active ranging on 1090 through Mode S protocols.
4. Kinematic techniques to correlate time, position and velocity tracking.
5. GeoSpatial techniques to correlate reported 3D position relative to available receivers and radars.

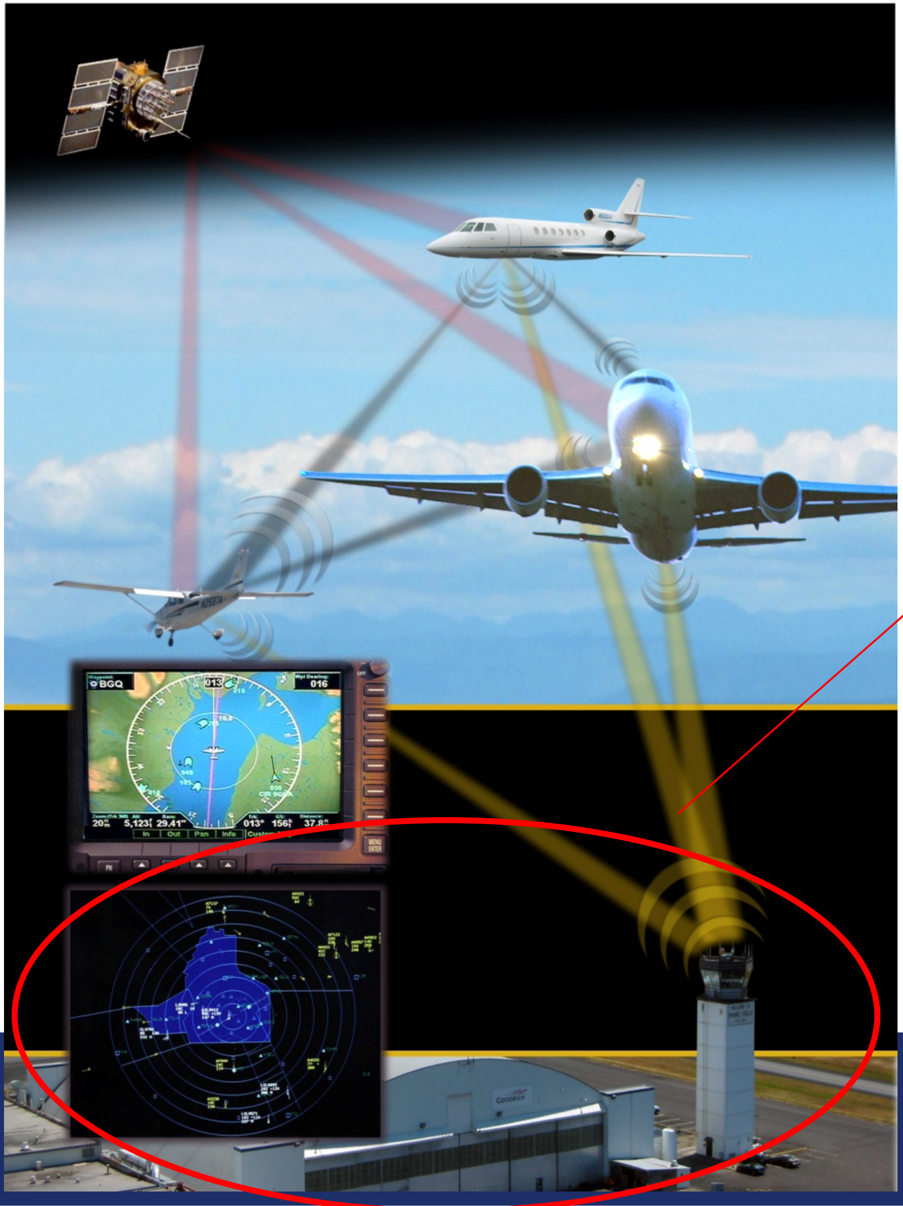
- This validation capability has already been implemented and tested.
- Targets that are determined to be “invalid” (not in agreement with the independent position estimate) are automatically filtered from the automation system and not used for tracking or display to Air Traffic Control (ATC).
- Targets that are “Valid” or “Unknown” are accepted for tracking and display. The “Unknown” condition is a short term state until the validation process makes a determination of the target’s position to the independent source.

Aircraft Vulnerabilities



- Approach: Completed a comparative security assessment of the air-to-ground link to ensure vulnerability is not increased through the use of ADS-B.
- Conclusions:
  - While ADS-B transmissions provide a greater degree of accuracy with respect to the aircraft's present position over previous technology, many additional factors are involved in the coordination and execution of an attack, severely limiting the likelihood of success.
  - A subsequent review of the findings from an independently prepared DOT/MITRE report determined that while this vulnerability is technically feasible, the potential for a realization of this threat is small.
  - The potential threat for scenarios using ADS-B data for targeting is not greater but rather, in general, is less than alternate means.

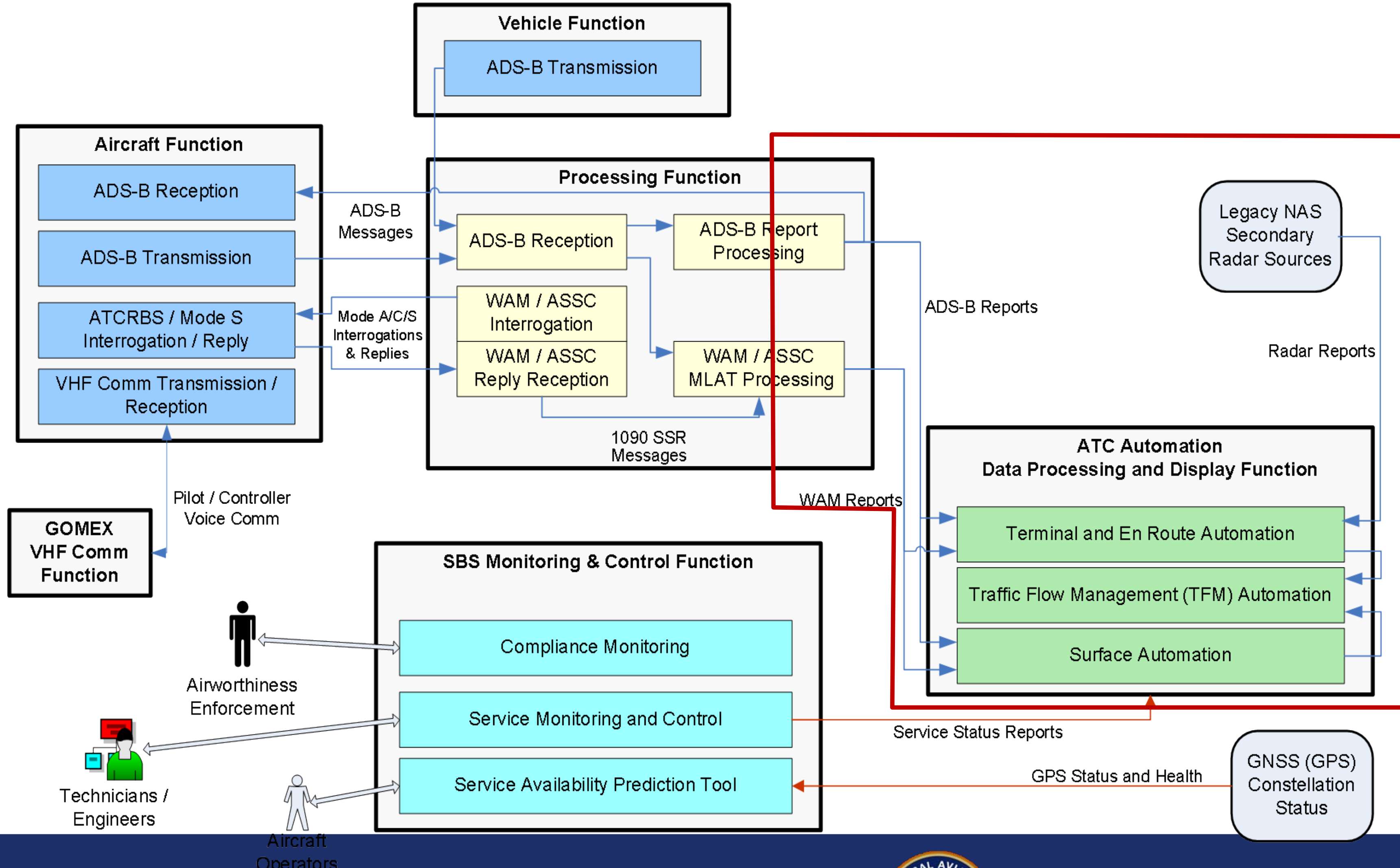
Ground Infrastructure



Mitigation Approach: Security Authorization (SA) process

- RF signals cannot be used to gain access to the ADS-B system
- Contractor owned-systems must reach and maintain FAA's Federal Information Security Management Act (FISMA) compliance, via contract requirements, with the procedures and standards established by the FAA's Information Systems Security (ISS) Accreditation Program.
- Throughout the program's system engineering process these security requirements are implemented and FAA's security analysts ensure that security compliance is achieved via the SA process.
- The SA ensures compliance with all federal mandates and security guidance (OMB, NIST, NSA, DoD, DHS, DOT, and FAA Orders), certifies and authorizes a system for operation within the FAA, documents the system security posture, and assures risks have been mitigated to an acceptable level commensurate with potential magnitude of harm.

FAA Surveillance Functional Architecture



Conclusion

- **ASTERIX categories for ADS-B and WAM**
  - The importance of having a common format for the shared use of surveillance data across boundaries.
- **Fusion**
  - Provides improvements to tracker continuity resulting in smoother tracks on ATC displays.
  - Need to validate ADS-B information received.
- **Security**
  - Illustrates the need for redundancy and independent backup capabilities.