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Implementing the FAA ADS-B Link Decision

- A Near Term Strategic Plan-

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Strategic Plan workgroup members from:

- Aircraft Owners and Pilots Association
- Cargo Airline Association
- FAA Capstone
- UPSAT
- FAA AFS-400
- FAA AND-500
- MITRE Corporation
- Calibre

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Executive Summary

The FAA Safe Flight 21 program office has developed and matured air-to-ground, air-to-air and uplink capabilities associated with Automatic Dependant Surveillance-Broadcast (ADS-B) enabling air traffic control services, graphical depictions of traffic, weather, and airspace constraint information consistent with the ADS-B link decision. This strategic plan identifies key sites for implementation, and provides standards for organizations seeking to proliferate ADS-B and Safe Flight 21 applications. The plan is 'open' in nature and is not intended to limit the proliferation or the expansion of ADS-B into the National Airspace System (NAS), but to rather promote such activities.

This strategy defines the following:

Who: The FAA's Safe Flight 21 office, in conjunction with regional offices is primarily responsible for implementing this phase of the ADS-B link decision.

What: Coordinating the deployment of ground infrastructure to ensure the availability of benefits (see Table 1) to National Airspace System (NAS) users.

When: The FAA's ADS-B Link Decision requires the near term implementation of infrastructure by the end of FY 2005.

Where: There will be approximately 130 ADS-B sites, primarily utilizing established FAA sites by the end of FY 2005.

How: The FAA, having overall responsibility for safe and efficient aeronautical operations within the NAS, is primarily responsible for infrastructure deployment. Appropriate locations for deployment will be established using partnerships with user groups, states, counties, municipalities, colleges / universities, and/ or other organizations within the FAA. These partnerships should not preclude non-FAA funded implementation of ground-based infrastructure. Avionics equipage is voluntary and may be funded by aircraft owners. The use of financial incentives may be pursued to accelerate equipage.

Why: This strategy is a key element to implementing the FAA's ADS-B link decision, which includes the use of ADS-B for air traffic services. Deploying uplink services (FIS-B and TIS-B) encourages aircraft to begin equipping with ADS-B technologies for future NAS use. Meanwhile, these capabilities provide near-term benefits at many locations for all users equipped with ADS-B. These benefits are documented in the Safe Flight 21 cost/benefit analysis.

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Near Term Strategic Plan

Purpose

To outline the strategy and identify key steps towards implementing the FAA's near term ADS-B link decision.

Need for this Plan

On July 1, 2002, FAA published the ADS-B link decision. This decision supports industry requested "Operational Enhancements" identified through RTCA (Safe Flight 21) as critical to NAS modernization. However, the decision does not include an implementation strategy.

Concurrent with development of the decision, several geographic pockets of ADS-B have been implemented or are now being planned. While they reflect strong support and enthusiasm for ADS-B based data link applications, they lack cohesiveness and focused direction leading toward nationwide implementation of the ADS-B data link capabilities. The strategic plan contained herein is intended to focus the government and industry activities in near term efforts to accelerate the implementation of Safe Flight 21 enhancements, including ADS-B and other data link based capabilities, throughout the NAS. This strategy will initially support the implementation of these services in several geographic "pockets" as the first step of a NAS-wide system.

Risk of not implementing

Delayed implementation of the link decision foregoes increases in safety, limits efficiency gains, and delays capacity benefits derived from ADS-B. Furthermore, it risks the proliferation of incompatible equipment, which unnecessarily increases costs, delays benefits accrual, and complicates the task of coordinating a worldwide aviation strategy. With this implementation strategy, the FAA reduces risks associated with global ADS-B design uncertainty and creates strong industry support by the airlines and general aviation.

Background

In 1997, responding to industry requests, the FAA's Alaskan Region launched Capstone. Simultaneously, RTCA and the FAA established Safe Flight 21 to develop, mature and implement nine (9) operational enhancements that maximize satellite navigation (GPS), multi function displays and broadcast data link. These related activities led to the February 2000 approval to use ADS-B for enhanced visual acquisition and the January 2001 approval to use ADS-B for radar-like services for ADS-B equipped aircraft operating in non-radar airspace.

Current Status

- In November 2002, the RTCA published an FAA Government Industry Concept of Operations, which highlights the need to develop the method to provide pilots and controllers with substantially increased information. This CONOPS, while not technology specific, highlights the future and long term need for pilots operating in the future airspace system to have full access to traffic, weather and

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airspace constraint information. Additionally, the International Civil Aviation Organization (ICAO) Operations Panel is writing an *ADS-B Concept of Use* while the Air Traffic Management Concept Panel is writing an operational concept that includes ADS-B.

- In February 2003, UPS Airlines will begin equipping 40 percent of their aircraft with 1090 mhz Extended Squitter (ES) ADS-B equipment. They have committed to equip 107 Boeing 757/767 aircraft with ADS-B.
- By the end of 2004, there will be up to 450 ADS- B aircraft equipped with Universal Access Transceivers (UAT) avionics, certified to FAA Technical Standard Orders published in November 2003.
- Beginning in 2001, operational approval to use ADS-B for five (5) mile air traffic control separation minima was granted. Efforts are now underway to establish terminal separation services to three (3) miles by March 2004.

As part of the technology maturation, RTCA and the joint FAA/Eurocontrol Technical Link Assessment Team (TLAT) evaluated the alternative ADS-B links. Based in part on the work of the TLAT, FAA, on July 1, 2002 selected the UAT and 1090 ES as the ADS-B link architecture for use in the NAS.

Customer needs/benefits with services enabled.

The ADS-B Link Decision has a direct impact on nearly every user of the National Airspace System. Air traffic controllers, pilots, dispatchers, airline operations centers, traffic management staff, and airways facilities are all stakeholders in this implementation strategy. The following table outlines potential benefits to each group of users.

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Customers Services	Flight Crew	ATC Service Providers	Operator/ School	Dispatch Staff	Airway Facilities	Security Restrictions	Individual Airports	FAA Goals
Graphical Weather and Airspace Constraints (FIS-B)	✓		✓			✓		
RTCA Free Flight	✓	✓	✓	✓				✓
Increased all weather airport capacity	✓	✓	✓				✓	✓
Improved Fleet Recovery		✓	✓					
Improved ground services and gate utilization			✓					
Real time operator sfc. management			✓					
Enhanced surveillance (better accuracy and increased update rates)	✓	✓				✓		
More affordable surveillance in non-radar airspace	✓	✓					✓	
New surveillance in radar unfriendly terrain	✓	✓					✓	
Improved tower controller sit. awareness		✓						
Enhanced departure/arrival throughput	✓	✓						
Flight Following	✓	✓	✓	✓				
Enhanced Search and Rescue/ELT functionality	✓		✓	✓				
Easily Scaleable Infrastructure		✓			✓		✓	✓
Reduced required maintenance					✓			
Increased Situational Awareness	✓	✓						
Reduced airspace restriction size	✓					✓		
Decreased restricted airspace violations	✓		✓			✓		
Radar derived traffic to flight deck *(Traffic Information Services-Broadcast)	✓							
Increased safety	✓		✓					✓

Table 1

*NOTE: These capabilities enable first equipped to receive immediate benefits.

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Timeframes Quoted from the Link Decision (July 2002)

- **Near-Term: 2002-2005**
 - Prior to deployment of ADS-B national ground infrastructure
 - Some “pockets” of ground infrastructure may exist or may be deployed.
 - Principal efficiency benefits are expected to be pairwise air-to-air, except in “pockets”.
 - Air carrier and general aviation begin to equip.
- **Mid-Term: 2006-2010**
 - Ground Infrastructure being deployed throughout the NAS to provide 1090 ES and UAT capability
 - ADS-B surveillance data is being used by ATC as ground infrastructure is deployed
 - Ground uplinks TIS-B (on 1090 MHz Extended Squitter and UAT) and FIS-B (on UAT) where ground infrastructure is deployed
 - Commercial aircraft fleet completes ADS-B equipage
 - Requirements for longer-range air-to-air (>40 nmi.) applications may be validated for operation in the long-term
- **Long-Term: Post 2010**
 - Air carrier fleets achieve the intended ADS-B benefits in the terminal and enroute airspace
 - Equipped GA aircraft are receiving TIS-B and FIS-B services throughout the NAS
 - GA fleet continues to equip with ADS-B

Use of “Pockets of Implementation” supporting the near term. There are pockets of implementation now (SEE FIG 1 next page). As pockets of implementation expand, ground based transceivers should be used to provide near term capabilities. These pockets will generate equipage of both air carrier and general aviation aircraft in advance of the broad rollout of ground infrastructure as identified in the FAA ADS-B link decision.

When establishing such pockets, the site selection for these GBT’s should be optimized to ensure maximum low altitude airspace coverage, and therefore their locations may not necessarily be on an airport.

The mid term timeframe identified in the ADS-B link decision includes the deployment of an ADS-B national ground infrastructure. Pockets implemented in the near term will be consistent with, and become part of the national ground infrastructure deployment.

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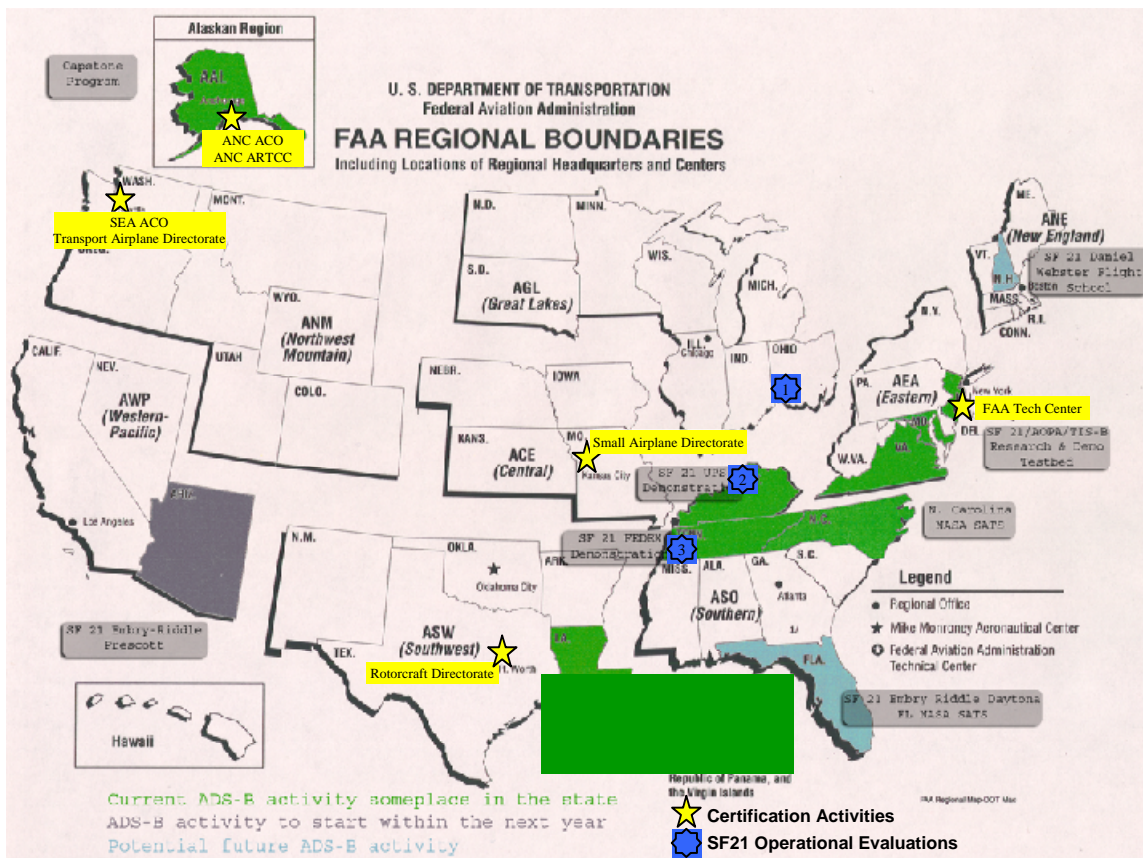


Figure 1 Map of NAS ADS-B Pockets of Implementation Planned or Envisioned

Locations considered for initial “pockets of implementation”.

The following geographic locations are the prime sites where pockets of implementation should be completed and/or aggressively pursued.

- **Alaskan Region – Capstone.** Phase I operations include 190+ equipped aircraft operating in daily revenue service. 11 GBT sites are installed, providing FIS-B and ADS-B for radar-like services and operator flight following. Phase I is in the process of being “hardened” to national standards. Phase II will include up to 200 additional aircraft and 14 additional GBT sites.
- **Louisville, KY and Memphis, TN.** These two Ohio River Valley locations are currently using ADS-B to evaluate benefits of terminal area surveillance enhancements, which enable visual approach throughput in marginal weather conditions. The two locations should, in the near term, be developed to support publicly available TIS-B and FIS-B capabilities.
- **Atlantic City, NJ.** The ADS-B test bed at the FAA’s Aeronautical Center should, in the near term, be developed to support publicly available TIS-B and FIS-B capabilities.
- **Prescott/Phoenix, AZ supporting Embry Riddle Aeronautical University.** The FAA will provide TIS-B and FIS-B uplink capabilities to support Embry Riddle

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Aeronautical University equipage of ADS-B avionics. They operate throughout much of the state of Arizona, and the placement of infrastructure will support these operations. Many other users in the geographic coverage area will also benefit from this pocket of implementation.

- **Daytona Beach and East/Central, FL supporting Embry Riddle Aeronautical University.** Embry Riddle Aeronautical University (ERAU) has decided to equip over 100 training aircraft at their two main campuses with ADS-B avionics. The decision to implement was primarily driven by safety considerations, specifically a reduction of near mid-air collisions (NMAC) in ERAU flight training areas. ERAU also plans to use ADS-B for fleet tracking and management as well as reception of FIS-B.
- **Washington DC area (currently Frederick, MD).** Two GBT installations should be matured, and brought into RTCA Minimum Operational Performance Standards compliance, including the use of UAT frequency 978 MHz. They will continue to support FIS-B (including Temporary Flight Restriction) and TIS-B uplink services in the near term and are available to enhance the security of general aviation operations in the Washington, DC metropolitan area.
- **Gulf of Mexico.** Planning continues to mature for providing both high- and low-altitude operators with safety and efficiency enhancing capabilities. The local operating community has expressed strong interest in implementing ADS-B separation services as well as uplink capabilities of FIS-B and TIS-B.
- **North Carolina and Upper Great Plains SATSLAB**
North Carolina and Upper Great Plains Small Aircraft Transportation Systems Laboratory (SATSLab) is conducting a demonstration of advanced avionics and ADS-B link technologies, with a focus on improving aviation service to small airports. Initial focus is within the state of North Carolina, in which they will equip and demonstrate service to eight airports using up to 40 ADS-B equipped aircraft.
- **Maryland SATSLAB**
Maryland SATSLab plans to implement textual and graphical FIS-B products throughout the state on the ADS-B link, including weather and NAS status information.
- **Any State or locally supported airport initiatives.** Funding for such installations could be via AIP funding, or non-FAA sources.

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- **All Terminal Mode S Radar Sites now providing TIS.** Figure 2 shows currently available TIS capability at 125 sites. To ensure a smooth transition to ADS-B, each current TIS site should be supplemented with 1090 ES and UAT ADS-B GBT's to ensure no loss of currently existing TIS services while ensuring availability of updated TIS-B and FIS-B capability.

MODE-S SITE LOCATIONS

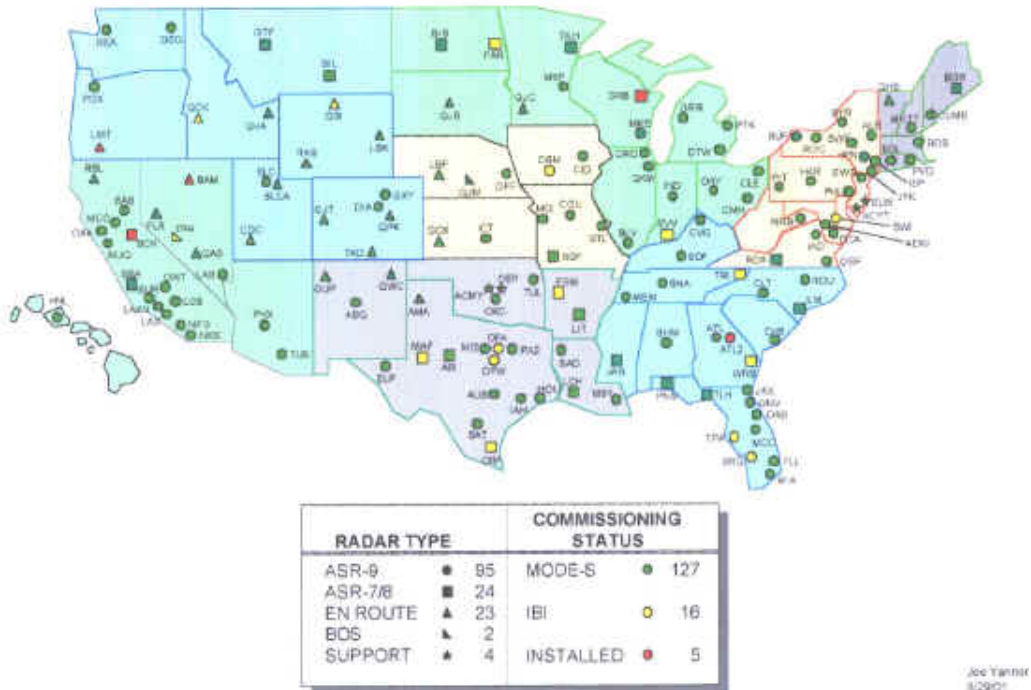


Figure 2

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Avionics and Ground System Architecture

Aircraft Avionics Description (see Figure 3)

- ADS-B Control Head on panel (enabling 4096 codes, privacy features, IDENT and standby functionality). Note that this may also be a Mode A/C or Mode S transponder (stand alone) during the interim pending surveillance/flight data processing upgrades.
- Either UAT or 1090 ES ADS-B data link radio (or both as appropriate)
- Optional graphical display, depending on services desired

Note: The performance standards for UAT avionics are complete. All ADS-B applications currently envisioned for use in the NAS can be implemented with the existing UAT avionics standards. The performance standards for 1090 avionics are nearly complete.

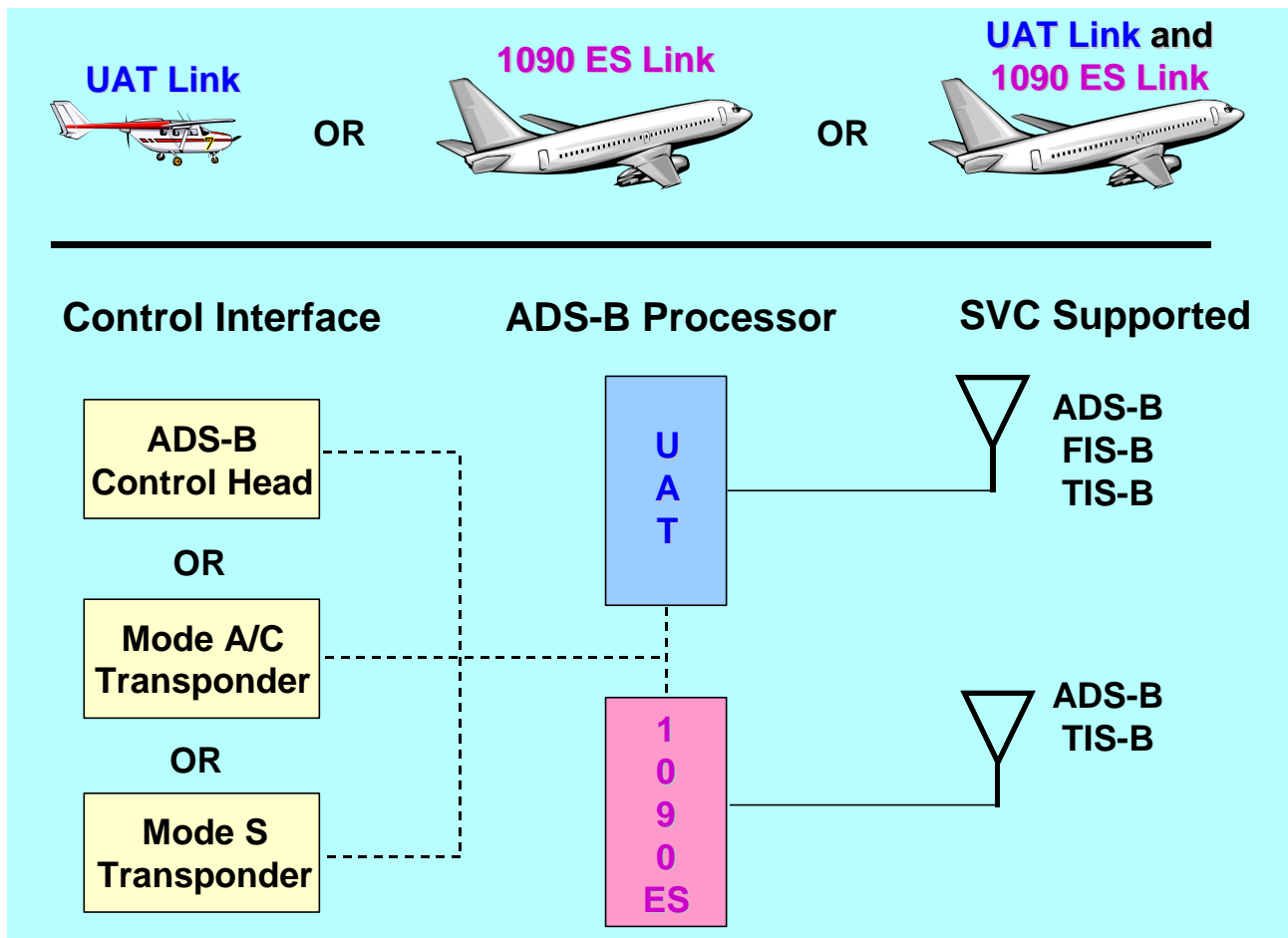


Figure 3 Airborne Avionics Architecture

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Ground Architecture Vision

Options exist for ADS-B ground system architecture as a function of location. While ADS-B bundled into ASDE-X may be required for large terminal areas, only a simple GBT is required to support “core” (ADS-B, FIS-B, & TIS-B) capability elsewhere.

NOTE: Given the availability of existing “real estate” at airports or other existing FAA properties in the area, various considerations may lead to a balanced decision when selecting a GBT location.

The UAT Ground Broadcast Transceiver (GBT) national specifications are nearly complete. They support ADS-B based surveillance applications as well as data link broadcast services. However, it is recognized that a 1090 GBT needs development, as do automation standards for broadcast services and terminal /en route air traffic control automation systems. The establishment of ADS-B pockets is driving rapid standards establishment. ADS-B deployment lends itself to a “building block” concept such that ADS-B implementation should proceed with the elements already available for use. This will provide near term services, and serve as a risk reduction strategy towards successful NAS-wide implementation. As final standards are developed, the existing infrastructure will be upgraded to the national specifications. The key elements of the ground infrastructure are described below and further detailed in figure 4.

Both UAT and 1090 GBTs will be capable of ADS-B and TIS-B. Additionally, the UAT system will be used to support FIS-B. In the end state, these stations will be capable of the “cross link” functionality as described in the ADS-B link decision. In the end state, all GBT's will incorporate both 1090 and UAT capability.

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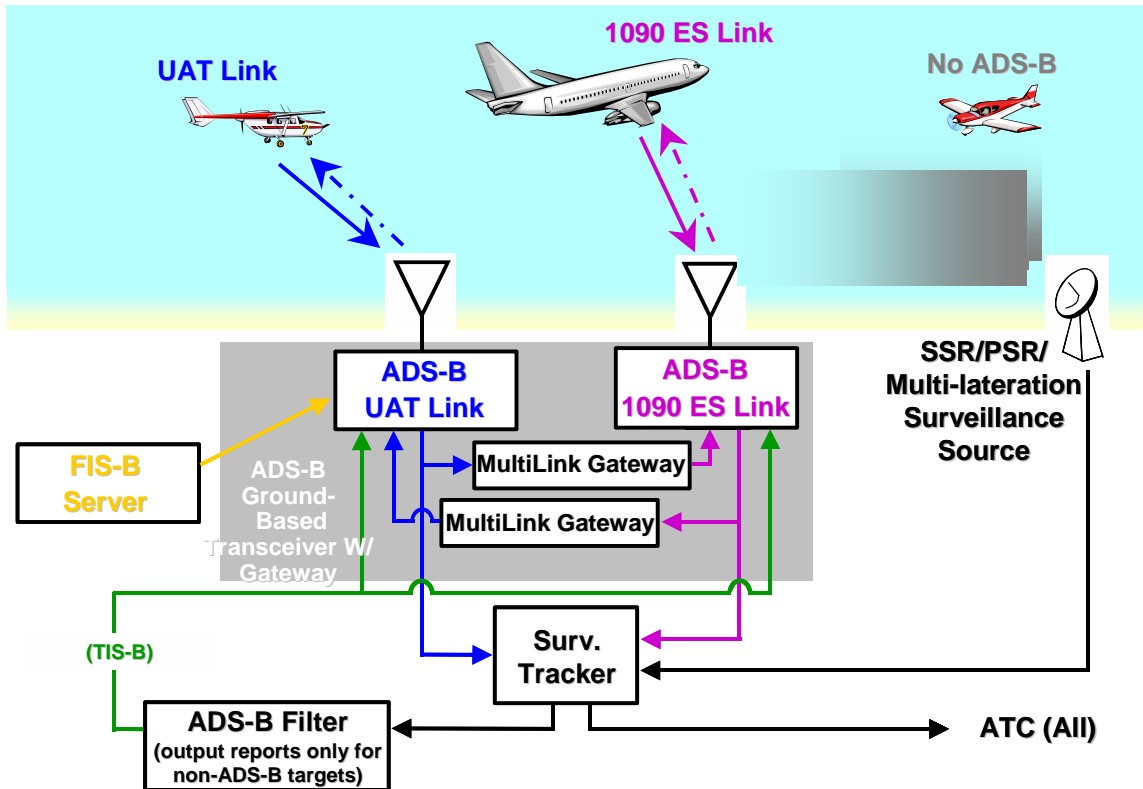


Figure 4 Ground Architecture

Leadership

Regulatory Authorizations/Approvals

Leading the way in regulatory authorizations and approvals, while anticipating future NAS evolution, and to provide an incentive for self-equipage, regulatory recognition of ADS-B technology should be pursued in the near-term. This would include regulatory recognition of ADS-B in lieu of transponder equipment in airspace where an AT capability for ADS-B exists.

Focused Leadership and Management

A combination of User and FAA Regional/HQ leadership is key to ADS-B “pockets” of deployment. The users establish requirements, regional offices manage certification/approval and are the point of delivery for services, while HQ provides policy guidance and financial management (both F&E and O&M). Recognizing the requirements for ADS-B as well as up-linking both TIS-B and FIS-B, FAA HQ should consider establishing an “Office of Broadcast Services” to establish requirements for a core list of products and development of corresponding standards.

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Conclusion

To achieve the vision of the government/industry NAS ConOps; to successfully implement ADS-B as identified in the FAA's ADS-B Link Decision; to meet current known surveillance related deficiencies; and to maintain worldwide leadership in aviation - focused steps towards the near-term implementation of ADS-B, as specified above, have already begun and must be pursued aggressively.

Beyond the Link Decision, it must be recognized that a surveillance system based on ADS-B is far more cost effective, and enables more capabilities (bundled FIS-B and TIS-B) than today's radar surveillance systems. The cost savings alone would warrant the transitions - for example, one terminal radar with sixty nautical mile surveillance radius costs as much as a network of at least 20 GBT's, each providing surveillance service up to 120 nautical miles, while providing equal or improved performance.