

Bird Strike Mitigation for Aviation

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**Joint University Program
November 5-6, 2015
MIT, Cambridge, MA**

Acknowledgement

- **This work is funded and supported by the FAA, Aviation Research Division, Airport Technology R&D Branch (ANG), Ryan King.**

Outline

- **Background**
 - » **Bird Strikes in Aviation**
 - » **Previous FAA efforts**
- **Ohio University Research Items**
 - » **Overall Approach**
 - » **Bird Radar Detections**
 - » **Target Output Requirements**
 - » **Target Classification & Risk Assessment**
 - » **TIS-B/FIS-B Considerations**
 - » **TIS-B Target Report Formatting/Distribution**
 - » **Applicability of Target Report**
 - » **Plans**

Background: Bird Strikes in Aviation

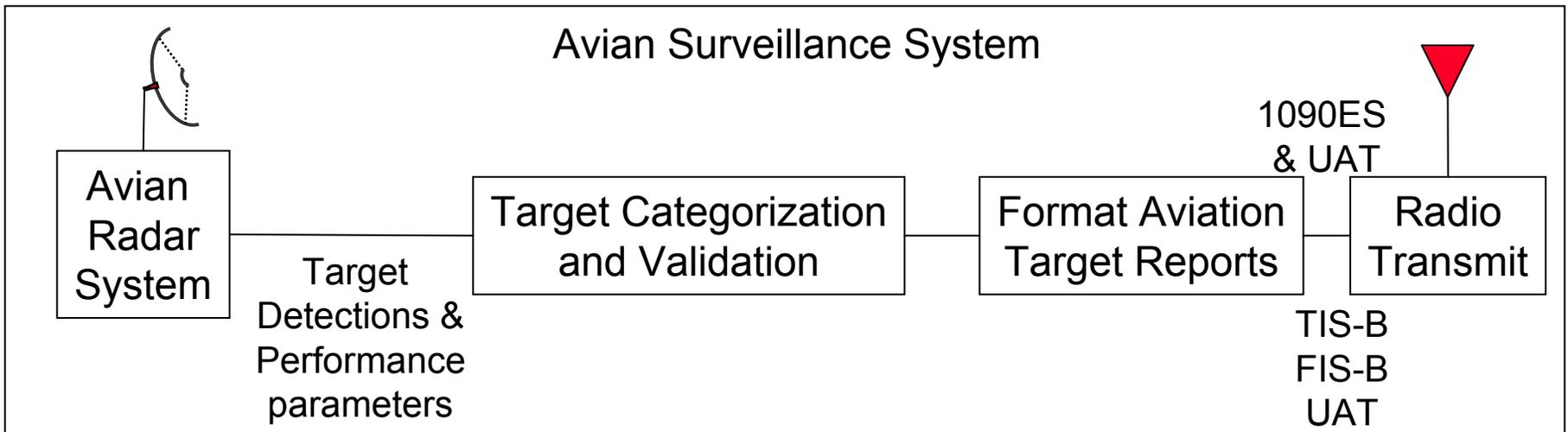
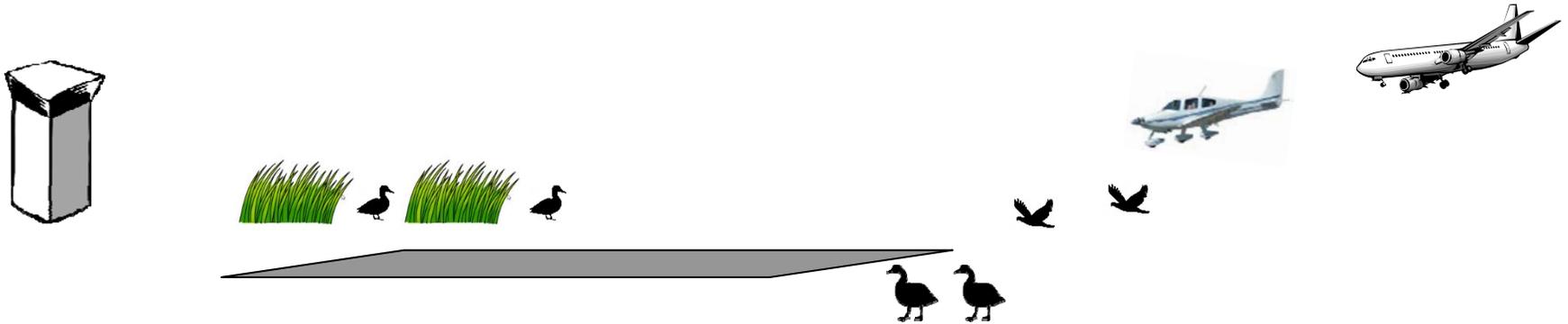
- **Occur when a bird collides with an aircraft; usually cause little damage, but can be devastating (ex. American Airlines Flight 1549 Hudson River incident).**
- **Roughly 10,000 strikes are reported annually; estimates suggest that as few as half of total strikes are reported.**
- **Less than 8% of strikes occur above 3,000 feet and 61% occur at less than 100 feet (according to FAA Wildlife Hazard Management Manual).**
- **FAA estimates \$400 million in damages annually are attributed to bird strikes in the United States alone, and over \$1.2 billion in damages occur annually worldwide.**

Ref: http://www.faa.gov/airports/airport_safety/wildlife/media/wildlife-strike-report-1990-2013-usda-faa.pdf

Ohio University Research Plans: Overview

- **Goal: Reduce bird strikes for aviation**
- **Considering a “stand-alone” Avian Surveillance System**
- **Investigate utilizing Ground-based Radar Detection and Information/signal transmission to A/C tower and A/C in/around airport**
 - » **Implement specialized avian ground-based radar on the airport property**
 - **Produce target detections and performance parameters**
 - » **Target categorize and validation**
 - » **Create target reports**
- **Transmit Interface to NAS via aviation data links**
 - » **Aircraft: ADS-B equipped and non-ADS-B equipped via 1090ES and UAT**
 - » **ATC tower: via ADS-B**

Ohio University Research Plans: Overview



Ohio University Research Plans: Bird Detection

- **Utilization of ground based radar on the airport property to detect bird activity and pass data out a data bus. Commercially available avian radar systems:**
 - » **SRC, BSTAR™ Avian Surveillance and Warning System, at DFW**
 - » **Accipiter Avian Radars**
 - » **DeTect, Merlin, Avian Radar Systems**
 - » **Etc.**
- **Investigating Avian Radar Performance and Output Parameters**
 - » **Requirements and current avian radar capabilities**
 - » **Information request for Avian Radar Performance and Output Parameters**
- **Goal here: Establish a common interface standard to produce target detections and detection performance parameter data so that targets can be appropriately categorized and validated.**

Avian Target Detection Outputs (Requirements)

- **Identify Avian Radar Output Requirements**
 - » **RCS**
 - » **Target mass (i.e., bird body mass)**
 - » **Target classification**
 - **Single detection**
 - **Volume detection**
 - **Target type**
 - **Target ID (number)**
 - » **Location similar reporting as ADS-B Target¹**
 - **Latitude, Longitude (referenced to WGS-84)**
 - **Height (i.e., pressure altitude)**
 - **Position Quality Indicator (both accuracy and integrity)**
 - » **Velocity¹ (i.e., ground referenced to WGS-84)**
 - » **Other...**

Ref 1: DO-318 Safety, Performance and Interoperability Requirements Document for Enhanced Air Traffic Services in Radar-Controlled Areas Using ADS-B Surveillance (ADS-B-RAD), pdf pg. 82-85/582.

Avian Radar Info Requested (7/3/2015)

- **Information on the SRC, BSTAR Avian Surveillance and Warning System, Accipiter Avian Radars, and DeTect, Merlin, Avian Radar Systems:**
 1. **Performance Specifications that, for example, include minimum radar cross section, range, number of targets supported, target update rates, azimuth, and elevation resolutions/performance, range performance, etc.**
 2. **Interface Control Documents that, for example, discuss output target detections/reports on data busses (data format and content, message structures, etc.), bus hardware and software communication protocols, etc.**
 3. **Test reports on any performance and test assessments of the avian radar systems.**
 4. **Any design documents such as Final Design Reviews, delivery documentation, etc for the avian radar systems.**

Avian Radar Info (Status)

- **Reached out to three Avian Radar Manufactures:**
 - » **SRC, BSTAR™ Avian Surveillance and Warning System**
 - **Initial telecon: Oct 13, 2015.**
 - **NDA in process**
 - » **Accipiter Avian Radars**
 - **Initial email exchanges. Telecon TBD**
 - » **DeTect, Merlin Avian Radar System**
 - **Working to firm up telecon.**
- **Plan to report findings at next JUP meeting.**

Ohio University Research Plans: Target Categorization & Risk Assessment

- **Considering:**
 - » Avian target detections requirements
 - » Avian radar output capabilities
- **Investigate best place to do Target Categorization and Risk Assessment:**
 - » Within avian radar systems
 - » Separate processor (external to radar)
 - » Interface and parameter production requirements
- **Investigate consideration of external parameters:**
 - » Actual A/C flight path (from ADS-B IN functionality)
 - » Weather
 - » Etc.

Ohio University Research Plan: Target Report Formatting

- Take categorized and validated target detections and create Target Reports
- Format Target Reports in aviation format, suitable for distribution
- Investigate Automatic Dependence Surveillance-Broadcast (ADS-B) integration:
 - » Traffic Information Service - Broadcast (TIS-B)
 - » Flight Information Service - Broadcast (FIS-B)
 - » Universal Access Transceiver (UAT)
- Considering existing RTCA standards to facilitate integration within the National Airspace System (NAS).

Related RTCA Documents for Avian Messages

1. **DO-242A Minimum Aviation System Performance Standards for Automatic Dependent Surveillance Broadcast (ADS-B)**
2. **DO-338 Minimum Aviation System Performance Standards (MASPS) for ADS-B Traffic Surveillance Systems and Applications (ATSSA)**
3. **DO-318 Safety, Performance and Interoperability Requirements Document for Enhanced Air Traffic Services in Radar-Controlled Areas Using ADS-B Surveillance (ADS-B-RAD)**
4. **DO-348 Safety, Performance and Interoperability Requirements Document for Traffic Situation Awareness with Alerts (TSAA)**
5. **DO-319 Safety, Performance and Interoperability Requirements Document for Enhanced Traffic Situational Awareness During Flight Operations (ATSA-AIRB)**

6. **DO-286B Minimum Aviation System Performance Standards (MASPS) for Traffic Information Service - Broadcast (TIS-B)**
7. **DO-260B with Corrigendum 1 - Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance - Broadcast (ADS-B) and Traffic Information Services - Broadcast (TIS-B)**
8. **DO-282B with Corrigendum 1, Minimum Operational Performance Standards for Universal Access Transceiver (UAT) Automatic Dependent Surveillance – Broadcast**
9. **DO-323 Safety, Performance and Interoperability Requirements Document for Enhanced Traffic Situational Awareness on the Airport Surface with Indications and Alerts (SURF IA)**
10. **DO-323 Supplement - Supplement to DO-323: Safety, Performance and Interoperability Requirements Document for Enhanced Traffic Situational Awareness on the Airport Surface with Indications and Alerts (SURF IA)**

ADS-B Report Design Formats

Three Report Types are defined for ADS-B
Outputs to applications:

1. Surveillance State Vector Report (SV, §3.4.3)
2. Mode-Status Report (MS, §3.4.4)
3. Various On-Conditional Reports (SC, §3.4.5)
 - » Air Referenced Velocity Report (ARV, §3.4.6)
 - » **Target State Report (TS §3.4.7)**
 - » Trajectory Change Report (TC+0 or TC+N, §3.4.8)
 - » Other On-Condition Reports (future)

Ref: DO-242A Minimum Aviation System Performance Standards for Automatic Dependent
Surveillance Broadcast (ADS-B), pg 124/475

To TIS-B or FIS-B Avian Targets?

- **Typical TIS-B:**
 - » **Broadcast data collected from ground-based radar**
 - » **Broadcast to participating users for cockpit display of traffic information**
- **Typical FIS-B:**
 - » **Broadcast data collected from external sensors**
 - » **Weather text, weather graphics,**
 - » **NOTAMS (notice to airmen)**
 - » **ATIS (Automatic Terminal Information Service)**
 - » **Periodic broadcast requirements**

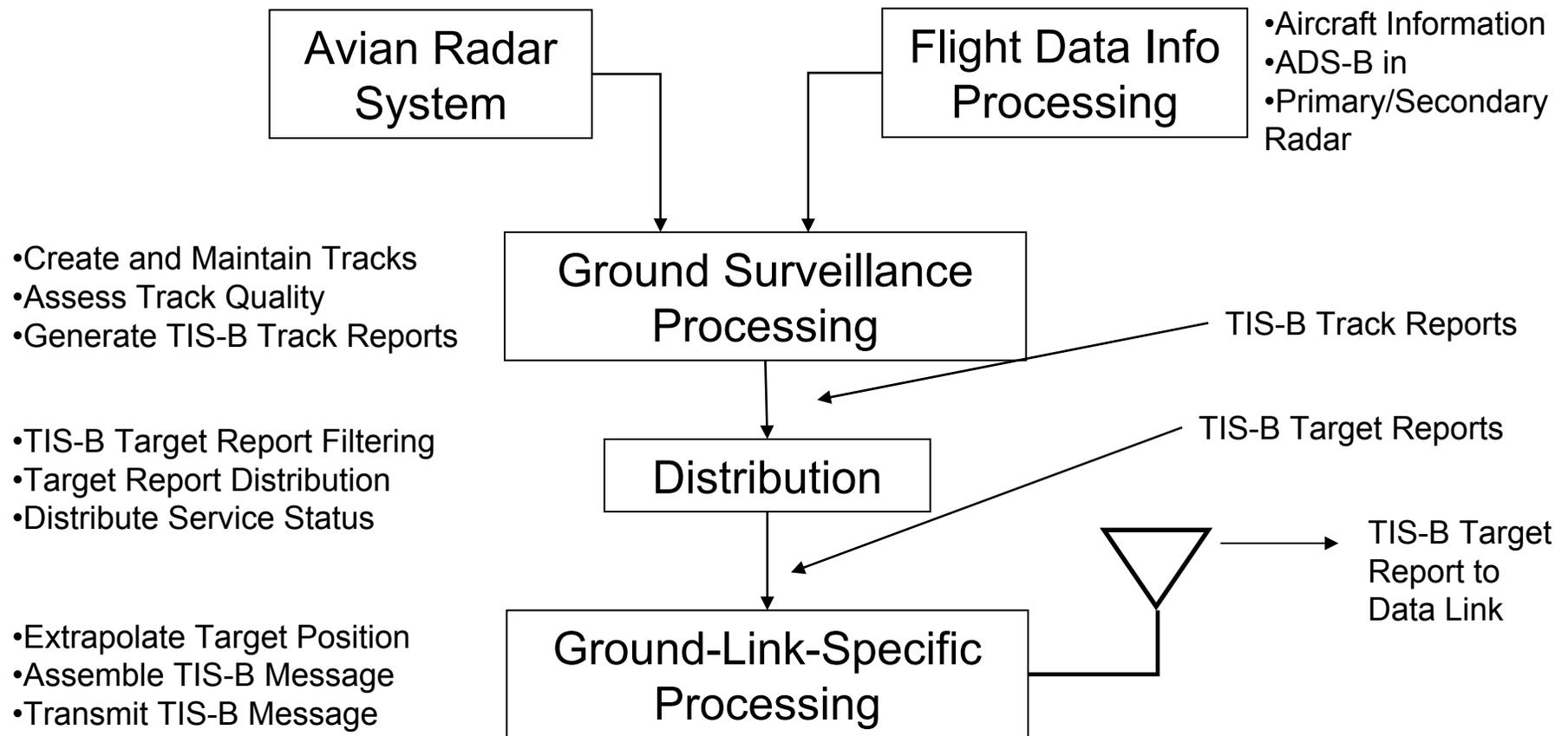
Ref: DO-242A Minimum Aviation System Performance Standards for Automatic Dependent Surveillance Broadcast (ADS-B), pg 124/475.

TIS-B Service

- **Provides ADS-B active users with:**
 - » **Low-latency stream of position reports of non-ADS-B users.**
- **Available to support Service Volumes:**
 - » **Non-ADS-B ground sensors**
 - » **FAA Surveillance and Broadcast Services (SBS) System Ground System radio stations**
- **TIS-B Client: receive avian report (i.e., aircraft or ATC tower)**
- **TIS-B Target: avian target**
- **TIS-B messages can contain higher-priority (i.e., time-sensitive/real-time, etc) traffic information than FIS-B service**

Ref: DO-338 Minimum Aviation System Performance Standards (MASPS) for ADS-B Traffic Surveillance Systems and Applications (ATSSA), pdf, pg 80/294.

TIS-B Avian Block Diagram



Ref: RTCA, DO286B Minimum Aviation System Performance Standards (MASPS) for TIS-B, Table 3.3, pg. 5

TIS-B Track Report Definition

Element	Contents	Bit #	Req. for Airborne Tgts?	Req. for Surface Tgts?	Ref. Section	Info Needed From Radar
ID	Target Address	24	Yes	Yes	3.1.1.3.1.1	TBD
	Address Qualifier	1	Yes	Yes	3.1.1.3.1.1	TBD
	Call Sign	8(char)	Yes	Yes	3.1.1.3.1.1	TBD
	Target Category	5	Yes	Yes	3.1.1.3.1.1	TBD
TOM	Time of Measurement		Yes	Yes	3.1.1.3.1.2	TBD
SV	State Vector		Yes	Yes	3.1.1.3.2	TBD
Target	Nav. Acc. Category for Position	4	Yes	Yes	3.1.1.3.1.3	TBD
Quality	Nav. Acc. Category for Velocity	3	Yes	Yes	3.1.1.3.1.3	TBD
	Navigation Integrity Category	4	Yes	Yes	3.1.1.3.1.3	TBD
	Surveillance Integrity Level	2	Yes	Yes	3.1.1.3.1.3	TBD
	Transmit Quality Level	4	Yes	Yes	3.1.1.3.1.3	TBD
	Status	Emergency/Priority Status	3	Yes	Yes	3.1.1.3.1.4
Operational	IDENT switch active	1	Yes	No	3.1.1.3.1.5	TBD
Mode	Receiving ATC service	1	Yes	No	3.1.1.3.1.5	TBD
Data	True/Magnetic Heading	1	Yes	Yes	3.1.1.3.1.6	TBD
Reference	Vertical Rate Type (Baro/Geo)	1	Yes	No	3.1.1.3.1.6	TBD
	Reserved	3	No	No		TBD
	Air/Ground State	2	Yes	Yes	3.1.1.3.1.6	TBD
Version	TIS-B Version Number	3	Yes	Yes	3.1.1.3.1.7	TBD

Ref: RTCA, DO286B Minimum Aviation System Performance Standards (MASPS) for TIS-B, Table 3.3, pg. 30.

TIS-B Target State Vector Definition

Element	Contents	Bit #	Req. for Airborne Tgts?	Req. for Surface Tgts?	Ref. Section	Info Needed From Radar
Geometric Position	Latitude (WGS-84)		Yes	Yes	3.1.1.3.2.1	TBD
	Longitude (WGS-84)		Yes	Yes	3.1.1.3.2.1	TBD
	Horizontal Position Valid	1	Yes	Yes	3.1.1.3.2.1	TBD
	Geometric Altitude		Yes	No	3.1.1.3.2.1	TBD
	Geometric Altitude Valid	1	Yes	No	3.1.1.3.2.1	TBD
Estimated Horizontal Velocity	North Velocity While Airborne		Yes	No	3.1.1.3.2.2	TBD
	East Velocity While Airborne		Yes	No	3.1.1.3.2.2	TBD
	Airborne Horizontal Velocity Valid	1	Yes	No	3.1.1.3.2.2	TBD
	Ground Speed While on Surface		No	Yes	3.1.1.3.2.2	TBD
	Ground Speed Valid	1	No	Yes	3.1.1.3.2.2	TBD
Estimated Heading	Heading While on Surface	6 bits (deg)	No	Yes	3.1.1.3.2.3	TBD
	Heading Valid	1	No	Yes	3.1.1.3.2.3	TBD
Baro Altitude	Pressure Altitude		Yes	No	3.1.1.3.2.4	TBD
	Pressure Altitude Valid	1	Yes	No	3.1.1.3.2.4	TBD
Estimated Vertical Rate	Vertical Rate Type (Baro/Geo)		Yes	No	3.1.1.3.2.5	TBD
	Vertical Rate Valid	1	Yes	No	3.1.1.3.2.5	TBD

Ref: RTCA, DO286B Minimum Aviation System Performance Standards (MASPS) for TIS-B, Table 3.3, pg. 33.

Avian Targets as TSAAs

- Investigating reporting Avian Targets as Traffic Situational Awareness Alerts (TSAA) with ADS-B IN, to provide:
 - » Alerts to flight crew to mid-air and near mid-air collisions
 - » Voice annunciations to flight to draw attention²
 - » Adds visual cues to Traffic Displays²
 - » Aids in visual acquisition and avoidance of traffic in both Visual Meteorological Conditions and Instrumented Meteorological Conditions; applicable under Visual Flight Rules (VFR) and Instrument Flight Rules (IFR)¹
 - » TIS-B information to flight crew with indications of nearby avian activity to support see-and-avoid²
 - » The alert is intended for airborne conflicts.¹
- Supported at an update 2 sec (requires additional verification)¹
 - » Alerts specified at 2 sec, but max rate is 1 Hz for 1090 and UAT for airport Surface Detection Equipment, Model X (ASDE-X) tracks.

Ref 1: DO-338 Minimum Aviation System Performance Standards (MASPS) for ADS-B Traffic Surveillance Systems and Applications (ATSSA), pdf pg 28/294, and pg 82/294.

Ref 2: DO-348 Safety, Performance and Interoperability Requirements Document for Traffic Situation Awareness with Alerts (TSAA), pdf pg 67-68/226.

Table 2-2: Required Information Elements to Support Selected ADS-B Applications

Information Element ↓	Situational Awareness (EVAcq/AIRB)	Visual Separation on Approach (VSA)	Airport Surface (APT, SURF)	Extended Situational Awareness (ITP)	Traffic Situation Awareness W/Alerts (TSAA)	Spacing (FIM-S)	Delegated Separation (FIM-DS)	Self Separation	ATS Surveillance ADS-B OUT
Identification									
Call Sign (Flight ID)	• ⁽¹⁾	•	•	•	TBD	•	TBD	TBD	•
Address	•	•	•	•	TBD	•	TBD	TBD	•
Emitter Category					TBD		TBD	TBD	•
Mode A Code					TBD		TBD	TBD	•
State Vector									
Horizontal Position	•	•	•	•	TBD	•	TBD	TBD	•
Vertical Position	•	•	• ⁽²⁾	•	TBD	•	TBD	TBD	•
Horizontal Velocity	•	•		•	TBD	•	TBD	TBD	•
Vertical Velocity					TBD		TBD	TBD	•
Surface Heading			•		TBD		TBD	TBD	•
Ground Speed			•		TBD		TBD	TBD	•
NIC		•		•	TBD	•	TBD	TBD	•
Mode Status									
Emergency/Priority Status					TBD		TBD	TBD	•
Capability Codes	•	•	•		TBD	•	TBD	TBD	•
Operational Modes	•	•	•	•	TBD	•	TBD	TBD	•
NAC _P	•	•	•	•	TBD	•	TBD	TBD	•
NAC _V	•	•	•	•	TBD	•	TBD	TBD	•
SIL		•		•	TBD	•	TBD	TBD	•
SDA	•	•	•	•	TBD	•	TBD	TBD	•
Length / Width Code									•
ARV							TBD	TBD	
Intent Data ⁽³⁾							TBD	TBD	

• = Data required for a target to be qualified for the application

Notes:

1. Flight ID is required for AIRB, but not for EVAcq.
2. SURF application also covers airborne targets on approach to and on departure from an airport.
3. Only refers to whether the application requires intent data, not the method in which it is delivered to the aircraft.

Ref: DO-338 Minimum Aviation System Performance Standards (MASPS) for ADS-B Traffic Surveillance Systems and Applications (ATSSA), pdf, pg 35/294.

To TIS-B or FIS-B Avian Targets? (Revisited)

- **Past presentation (including this one, so far) focuses on overall approach using TIS-B for real-time Traffic Situational Awareness Alerts (TSAA).**
- **Discussions with Wildlife Surveillance Concept (WisC) FAA personnel¹ emphasised:**
 - » **1) Use of TIS-B TSAA will be very valuable.**
 - » **2) FIS-B could be used to collect avian activity for non-critical activities**

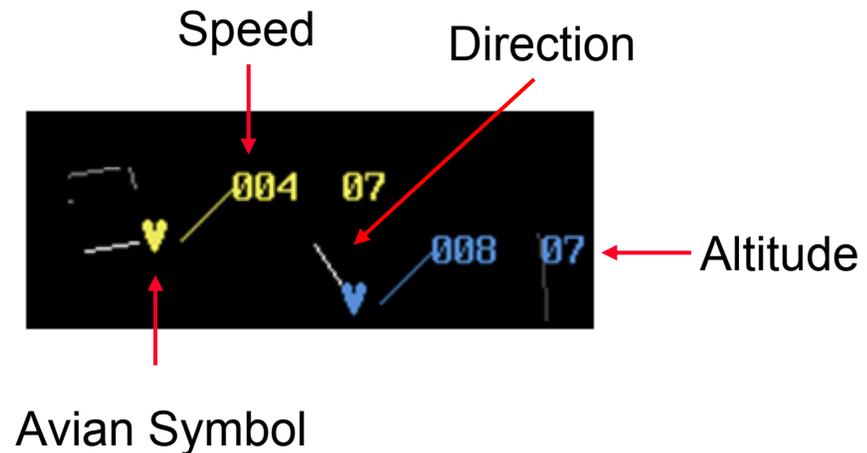
1. Phonecon w/ Anton Koros (FAA ANG-C54), Mark Hale (CSSI), Ryan King (FAA ANG-E261), Oct 19, 2015

FIS-B Avian Information

- **Avian activities could be collected and formatted on a FIS-B for advisory purposes:**
 - » **More specific/detailed avian advisory than is currently broadcast on ADAS (Automated Weather Observing System (AWOS) Data Acquisition System (ADAS)).**
 - » **Could be used to collect historical data on avian activity at a particular airport (some of which is done manually today).**
 - » **FIS-B data could be used to illustrate avian regions of activity (i.e., similar to broadcast weather text and graphics information).**

Possible Avian Display Symbology

- **FAA investigated three different potential display formats for avian reports:**
 1. **Text**
 2. **Target, for display on the Standard Terminal Automation Replacement System (STARS)**
 3. **Suppevisor.**



- Yellow: Medium priority (i.e., advisory)
- Blue: Low priority

Ref: Anton Koros, ANG-C43, Wildlife Surveillance Concept (WiSC), Socialization Briefing, ANG-C5 Brief, June 25, 2015

Ohio University Research Plans: Applicability of Target Report

- **Continue to discuss Avian TIS-B Target Reports with Wildlife Surveillance Concept (WiSC), personnel performed by Concept Development & Validation – Technical Center Branch (FAA ANG-C43).**
- **Plan more detailed discussions prior next JUP meeting at WJHTC on January 20, 2016.**

Ohio University Research Plans: Conclusion/Report to FAA

- **Plan to provide Quarterly Updates to the FAA via the JUP, over the next quarter, with plans to concentrate on:**
 - » **Continuing to evaluate overall approach**
 - » **Avian Radar output requirements and capabilities**
 - » **TIS-B data link formats**
 - » **FIS-B data link formats**

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Comments/Questions/Suggestions???

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Supplemental Slides

Background: Previous FAA efforts

- **Currently, avian activity is manually delivered to pilots from radar operators at the Air Traffic Control centers of each airport via voice communications.**
- **Guidance on Wildlife Strike Reports**
 - » **Number and kind of strike (among other details) are required to be reported when known. These figures are public, and an estimated 39% of strikes at certificated airports from 2004-2008 were reported. However, report percentages have been increasing year-to-year (1990-2013) and currently this data is under review.**
- **Airport Cooperative Research Program (ACRP) Reports**
 - » **FAA has funded three reports to aid airports with wildlife hazard mitigation.**
- **Wildlife Hazard Awareness campaigns**
 - » **Awareness is raised by FAA posters, public wildlife strike information (bird strike database)**
 - » **Advisory Circulars**

Ref: https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=14393

Automatic Dependence Surveillance -Broadcast (ADS-B)

- **Aircraft, some ground platforms, and ground equipment share position, velocity, ID, and other information (aircraft type, intent, among themselves at approximately a 1 Hz rate.**
- **ADS-B equipment can also receive similar info from nearby aircraft.**
- **Ground Based Transceivers (GBTs) can also used these transmission for surveillance**
- **Two different data links have been adopted for use in U.S. with ADS-B: 1090 MHz Extended Squitter (1090ES)**
 - » **intended for aircraft that primarily operate at >18,000 ft.**
- **Augments existing surveillance systems (primary and secondary) radar**
- **Universal Access Transceiver (UAT)**
 - » **intended for aircraft that primarily operate at <18,000 ft.**
 - » **Note: UAT also supports Flight Information Services – Broadcast (FIS-B)**

<http://www.faa.gov/ATpubs/AIM/Chap4/aim0405.html#4-5-8>

Traffic Information Service-Broadcast (TIS-B)

- **Broadcasts information to the cockpit (TIS client) via Mode S (1090ES) data link or Universal Access Transceiver (UAT)**
- **Similar to VFR radar traffic information normally received over voice radio**
 - » Provides a situational awareness display to the pilot for up to 8 “intruder” aircraft within 7 nmi horizontal distance (time of potential contact <34 s):
 - estimated position, altitude, altitude trend, and ground track
 - +3,500 and -3,000 ft vertically of the TIS client
 - » Provides data updates every 5 sec (commensurate with ground radar update rate)
- **Both TIS client, and possible intruder aircraft:**
 - » **Have to be TIS equipped (minimum of transponder (Mode A, C or S)).**
 - » **Within range of the ground TIS, Mode S radar (< 55 nmi)**
- **TIS-Broadcast (TIS-B) provides ADS-B equipped aircraft with data on non-ADS-B equipped aircraft**

Targets as Traffic Situational Awareness Alerts (TSAA) (Additional Information)

The intended function of TSAA is to provide timely alerts of qualified airborne traffic in the vicinity in order to increase flight crew traffic situation awareness. TSAA is intended to reduce the risk of a near mid-air or mid-air collision by aiding in visual acquisition as part of the flight crew's existing see-and-avoid responsibility. This application is intended for use by the general aviation community.

TSAA provides alerts using voice annunciations and visual attention-getting cues to direct attention out the window, assisting the flight crew with visual acquisition in suitable meteorological conditions. Indications of Nearby Airborne Traffic are also provided on a Traffic Display (if available). The application functions under both Visual Flight Rules (VFR) and Instrument Flight Rules (IFR). TSAA alerts and indications are for detected airborne conflicts and relevant nearby traffic status, respectively. When a Traffic Display is available, it builds on the Enhanced Visual Acquisition (EVAcq) or Basic Airborne Situational Awareness (AIRB) application. TSAA is also capable of providing alerts when a Traffic Display is not installed.

Nearby Airborne Traffic indications assist the flight crew in prioritizing activities and are expected to occur for normal traffic situations. The caution level alerts act as attention-getting mechanisms that may reduce the effort required to scan the Traffic Display (if available). They may also reduce the effort required to locate the Target Aircraft while still permitting the flight crew to determine the severity of a conflict and the appropriate action.

Universal Access Transceiver (UAT)

- **Frequency: 978 MHz**
- **Vertical Polarization**
- **Designed to be a multi-purpose data link for surveillance related applications**
 - » **Nominal channeling signal rate: ~1Mbps**
- **Can support:**
 - » **Automatic Dependence Surveillance-Broadcast (ADS-B),**
 - » **Flight Information Service-Broadcast (FIS-B),**
 - » **Traffic Information Service-Broadcast (TIS-B),**
 - » **Potentially other applications**
- **“Uplink” from ground contains:**
 - » **176ms of 1000 ms UAT Frame=1 UTC second**
 - » **weather**
 - » **flight information**
 - » **advisories**
 - » **etc.**
- **“Downlink” from Aircraft:**
 - » **800ms of 1000 ms UAT Frame=1 UTC second**
 - » **ADS-B information**

Ref: RTCA, MOPS for UAT ADS-B, DO-282A, SC-186, July 29, 2004

Background: FAA Circular (2010)

- **Provides Guidelines for Implementation On-airport property avian radar systems for:**
 - » airport authorities
 - » radar manufacturers
- **Gives Overview of Avian Radar fundamentals**
 - » Object -> radar -> A/D -> broadcast -> processor -> data delivery (screen/radio/etc)
- **System Selection considerations**
 - » Radar systems operate in X-Band (8-12 GHz), S-Band (2-4 GHz), or L-Band (\approx 1GHz), each having its own advantages.
 - » Physical capabilities of the radar systems
 - » Requirements of individual airports (topology, clutter, location, native wildlife, etc)
- **Provides Guidance for Data Storage and Management (for manufacturers and airport authorities)**
 - » Must be capable of recording at least one hour of raw digital data (in a B-scan and/or scan-converted format) to support reprocessing.
 - » Avian radar systems must be capable of recording at least 24 hours of plot and track data, or regenerating plot and track data from the raw digital data. The ability to store and view any screen captures of plot and track displays is also required.

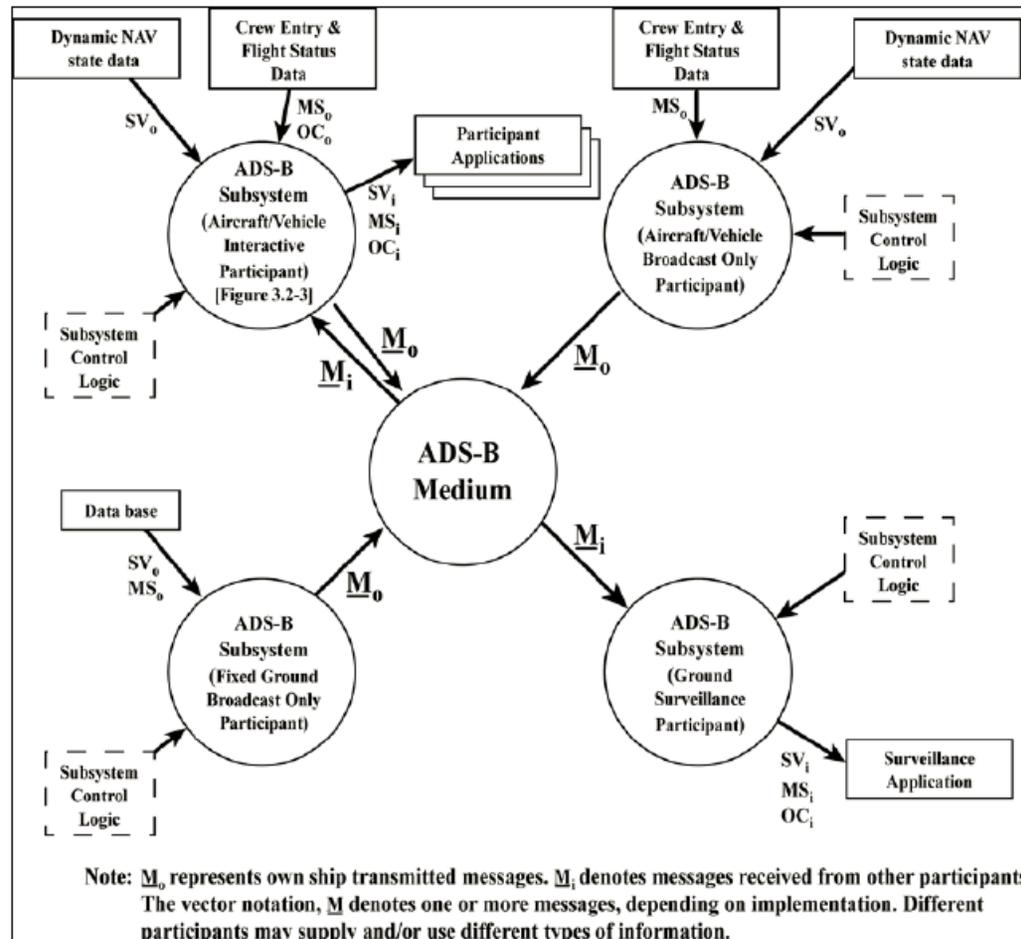
Ref: http://www.faa.gov/documentLibrary/media/Advisory_Circular/150_5220_25.pdf

Background: FAA Circular (cont.)

- **Key minimum performance specifications:**
 - » **Standard Avian Target (SAT) = 0.5kg (1.1 lb) with Radar-Cross-Section (RCS) of -16dBm² @ 300 ft in moderate clutter environments (flat airport, no rain)**
 - » **Be able to detect a 1 SAT object from 0.3-1 nmi up to an elevation of 1,000 feet**
 - » **Be able to detect a 2 SAT object up to 3 nmi up to an elevation of 3,000 ft**
 - » **Have the capability to simultaneously detect and track a minimum of 1,000 individual targets**
 - » **Have a resolution which allows differentiation between two 1 SAT objects with a 165-ft distance between them in range or azimuth**
 - » **Provide coverage of the airspace defined by the flight path of the primary runway of the airport up to 3 nmi from the sensor location and elevated up to 3,000 feet, beyond which bird strike occurrences significantly drop**
 - » **Have the capability of detecting 1 SAT up to 1 nmi with a confidence level of 90% in moderate clutter environments, and up to 3 nautical miles with a confidence of 75%**
 - » **Time interval between updates and detection time for new targets must not exceed 5 sec apiece**

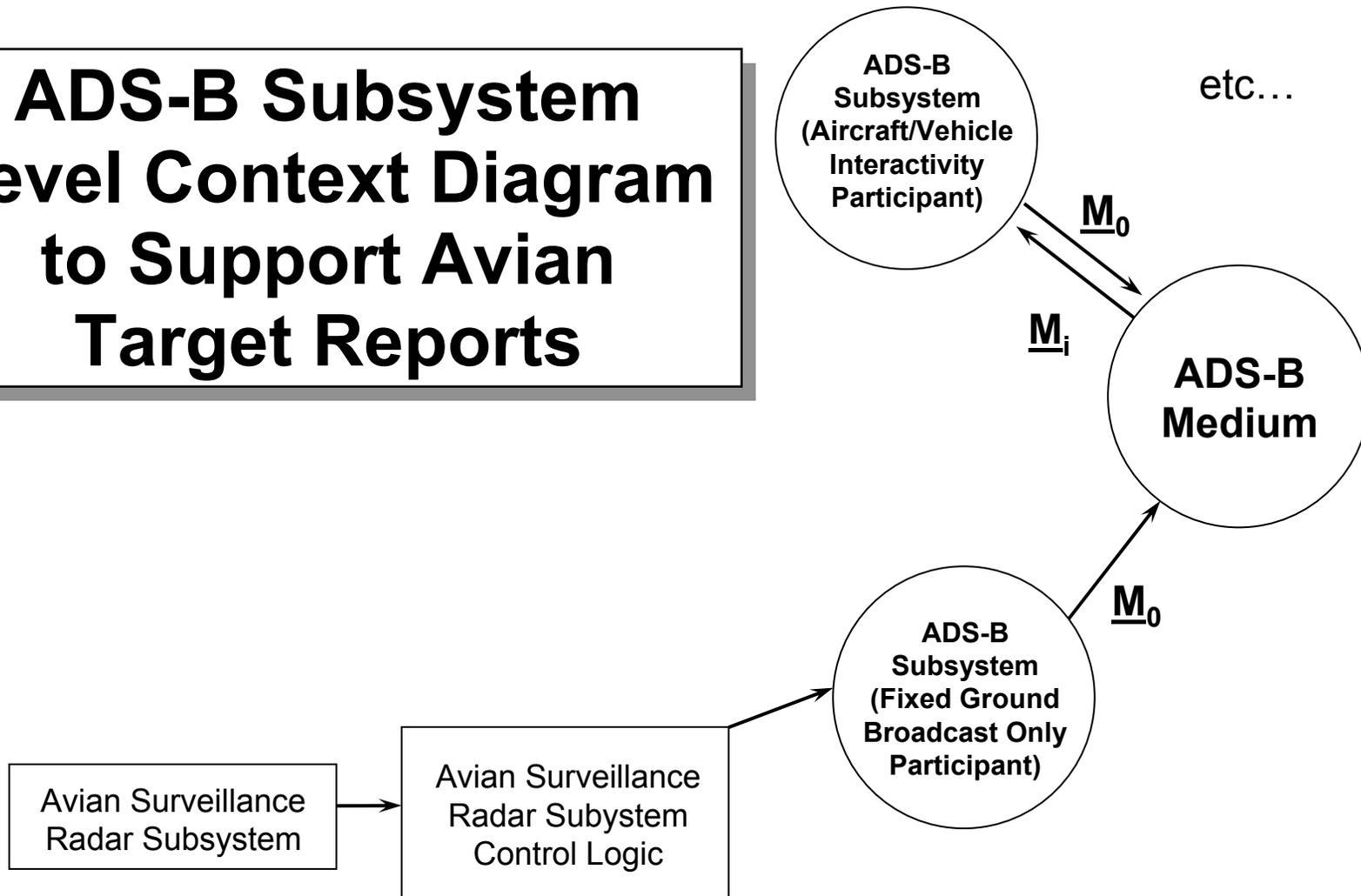
Ref: http://www.faa.gov/documentLibrary/media/Advisory_Circular/150_5220_25.pdf

ADS-B Subsystem Level Context Diagram



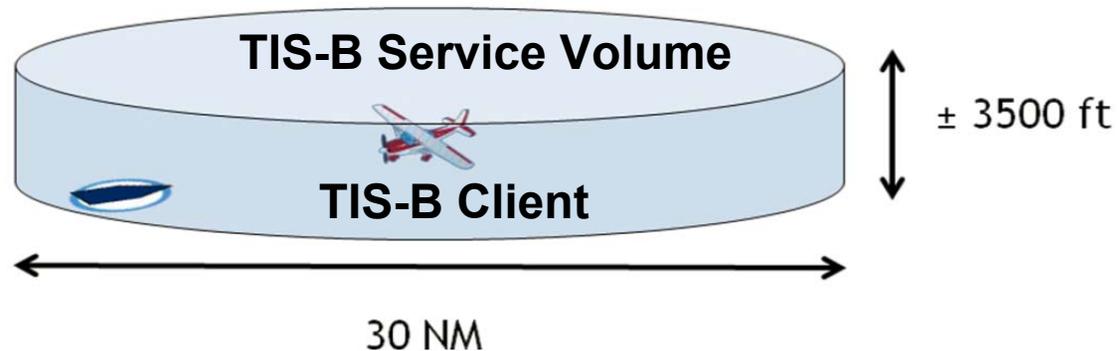
Ref: DO-242A Minimum Aviation System Performance Standards for Automatic Dependent Surveillance Broadcast (ADS-B), pg 91/475.

ADS-B Subsystem Level Context Diagram to Support Avian Target Reports



Ref: DO-242A Minimum Aviation System Performance Standards for Automatic Dependent Surveillance Broadcast (ADS-B), pdf, pg 91/475.

Avian Target Service Volume



- **TIS-B Service Volume is TIS-B Client centric**
- **Investigate defining the Avian Service Volume based on:**
 - » **Avian radar location and performance.**
 - **For example: 0-3nm, 100-3000 ft above ground level (AGL) from airport reference point (ARP).**
 - » **TIS-B Client location (with reduced service volume for Avian TIS-B Targets).**

Ref: DO-338 Minimum Aviation System Performance Standards (MASPS) for ADS-B Traffic Surveillance Systems and Applications (ATSSA), pdf, pg 81/294.