

# Surveillance and Broadcast Services

## Operational Evaluation of Mixed Surveillance Separation in Alaska

By: SBS Separation Standards Working Group  
presented by Mike Castle, JHU/APL

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Federal Aviation  
Administration



# Overview

- **Introduction**
- **Analytical Modeling of Separation**
- **ZAN ARTCC Perspective**
- **Validation Flight Test**
- **Safety Risk Methodology**
- **Summary**

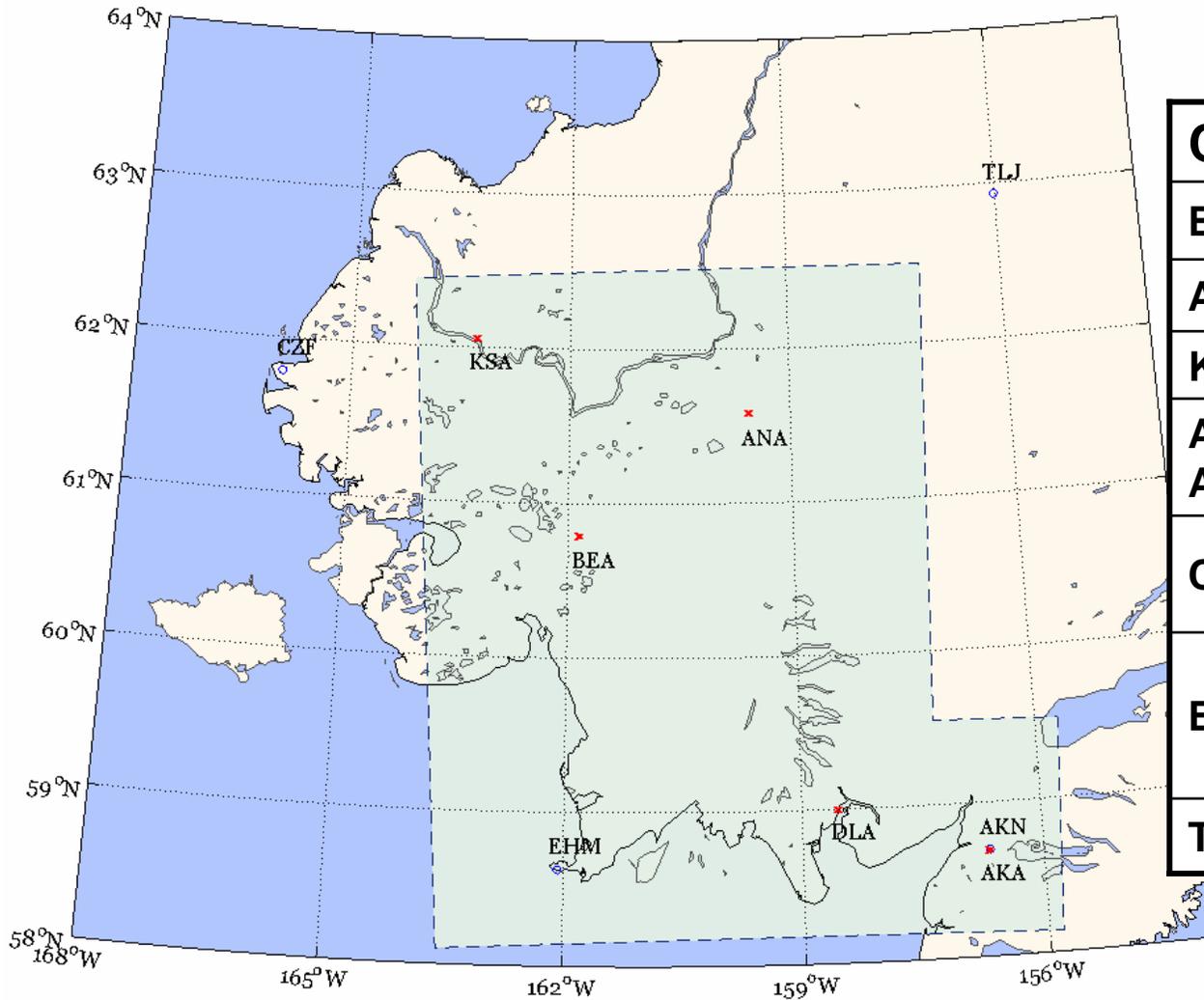


# Operational Evaluation

- **In the Bethel, AK region, ZAN ARTCC had been providing 5 NM separation to pairs of aircraft equipped with certified ADS-B avionics, beginning in 2005**
- **Separation services were discontinued Mar. 24, 2006**
  - Possibility that ADS-B to radar separation was being applied
- **Milestones created from FAA-industry group**
  - Begin Operational Evaluation of 5 NM ADS-B to radar separation on July 15, 2006
  - Expand coverage to Dillingham/King Salmon on August 10



# ADS-B to Radar Service Area



Code	Sensor
BEA	Bethel GBT
ANA	Aniak GBT
KSA	St. Mary's GBT
AKN / AKA	King Salmon radar / GBT
CZF	Cape Romanzof Radar
EHM	Cape Newenham Radar
TLJ	Tatalina Radar

# Separation Standards in AK

- **SBS created Separation Standards WG**
  - Engaged in activities to approve onset of OpEval
  - Tasked with monitoring and assessment of OpEval
  - Developed a final report that integrates a variety of approaches to the OpEval safety assessment
- **5 NM ADS-B to Radar separation in AK:**
  - In service area only
  - Used only Garmin GDL-90 (UAT) avionics (WAAS)
  - Only with current MEARTS implementation (had demonstrated experience ingesting ADS-B data)



# Safety Assessment Approaches

- **Targets of Opportunity**
  - See paper by Sleight at I-CNS 2007
- **Analytical Model of Separation**
  - Mitre extending ICAO Close Approach Prob. Model
- **ZAN ARTCC Assessment**
  - ATC reports, problems, issues, etc...
- **FAA Safety Risk Management**
  - Hazard identification and mitigation process
- **Validation Flight Test**



# Analytical Modeling

- **Used comparative assessment with radar. ADS-B had to demonstrate equivalent or better performance in:**
  - Accuracy of ADS-B position data
  - Update rate of position data
  - Separation error performance, defined as true separation less the indicated separation based on surveillance data
  - ADS-B surveillance risk, as measured by Close Approach Probability (CAP)

# Close Approach Probability

- 1<sup>st</sup> two columns in table show ADS-B data quality as inputs to CAP model (NACp and NIC, resp.)
- Last two columns show what the separation is for two aircraft nominally separated by 5 NM @ 2E-12 CAP

95% Accuracy	Containment Radius	ADS-B to ADS-B Sep.	ADS-B to SWSSR Sep.
0.5 NM	1 NM	2.5 NM	4.1 NM
0.3 NM	2 NM	2.9 NM	4.5 NM
0.5 NM	2 NM	3.5 NM	4.6 NM
1 NM	2 NM	4.9 NM	5.1 NM

# ZAN Perspective on OpEval

- **A Panel met weekly during OpEval to discuss ZAN air traffic, automation, and maintenance responses**
  - Review of ATC & AF highlights/problem reports
  - Review of Targets of Opp. Data
- **ZAN reported positively of experience**
  - Increase in efficiency for IFR operations
  - 5 NM separation v. procedural
  - Increase in SVFR operations in Bethel

# Example Anomaly from ZAN – Ownship Conflict Alerts

- **16 anomalies described as “ownship conflict alerts”**
- **Condition is specific to the introduction of ADS-B into a process that had been radar-only**
- **MEARTS maintains sets of sensor tracks from each sensor on any given target**
- **For a radar target, this means at least two: one from the secondary radar, and one from primary radar.**
  - Normally, radar targets cannot create an ownship conflict alert because there is no altitude information with the primary
  - After integrating ADS-B, this conflict alert occurred
  - In MEARTS, primary radar data associates with altitude data from the ADS-B report, which enables the proper set of data for the conflict alert logic to function.
- **While not an ADS-B anomaly, ADS-B was a contributing factor**



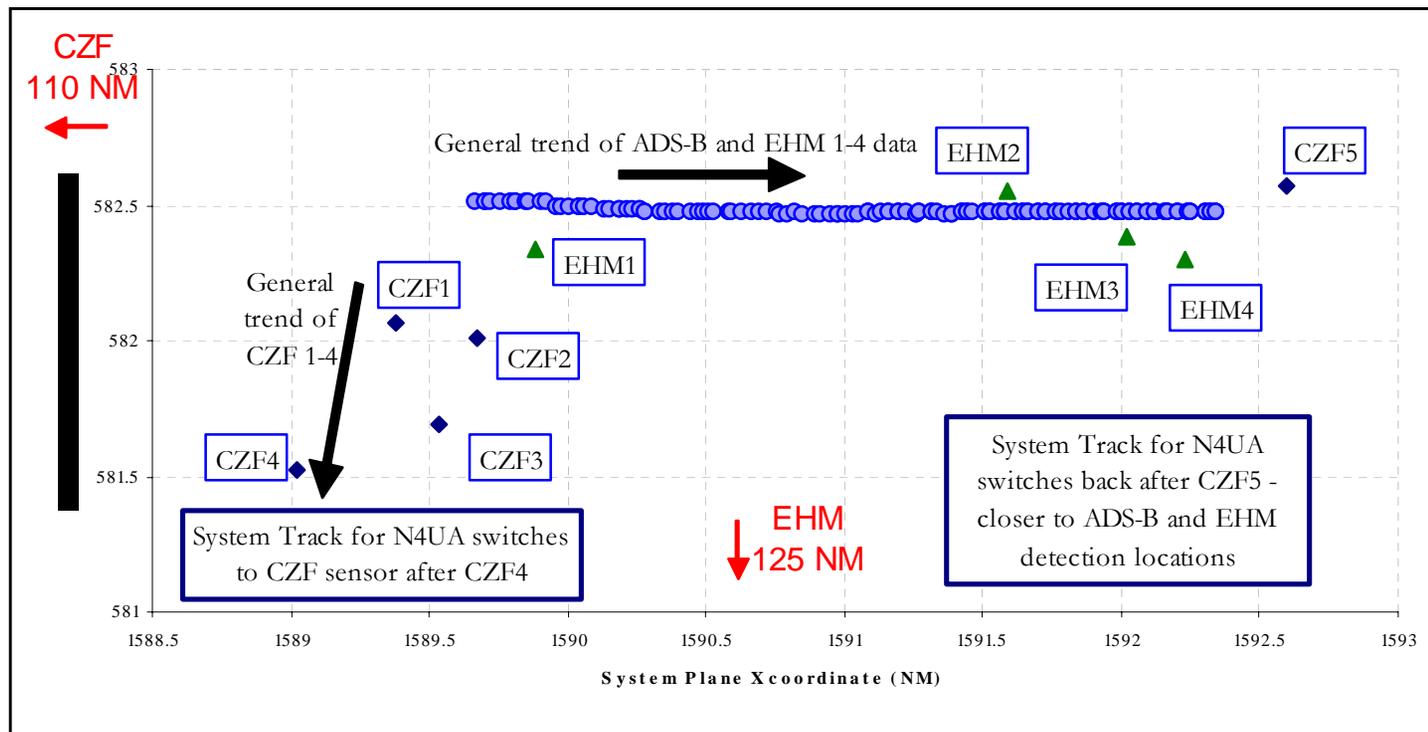
# Validation Flight Test - Overall

- **Flight Testing was conducted July 10-12 to validate the mixed equipage separation**
- **Overall Observations:**
  - There was consistent transmission of ADS-B Messages
  - There was adequate GPS coverage that maintained a high integrity for the position information.
  - The distribution of the observed quality parameters during the flight test was consistent with a similar analysis of the targets of opportunity in the Bethel area.
  - There were smooth ATC display transitions observed for ADS-B targets converting to radar targets, validating MEARTS processing and the apportioning of service volumes around the Bethel area.
  - There was good reception of ADS-B messages - the ATC display showed continuous tracks for the test aircraft in most cases
  - The display of ADS-B-to-radar targets in the sort box was smooth and seamless



# Validation Flight Test – Coasting Anomaly

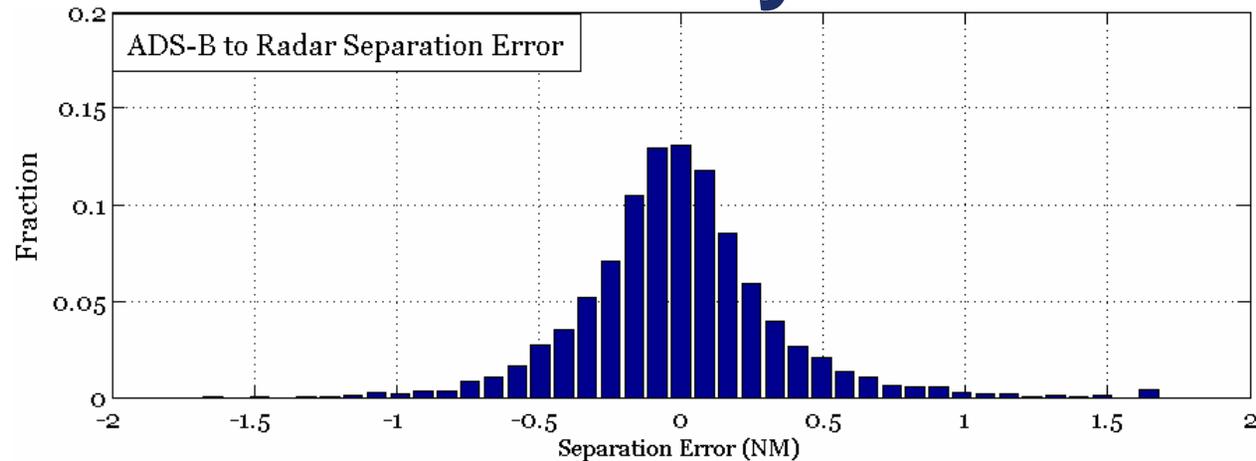
- ADS-B Coasted from the display during 2<sup>nd</sup> Leg of test
- Bad CZF data corrupted the system track for ~1.5 minutes



## Radar Tracking

MM:SS	Hit
28:22	CZF1
28:34	CZF2
28:39	EHM1
28:46	CZF3
28:51	EHM2
28:58	CZF4
29:39	EHM3
29:51	EHM4
29:58	CZF5

# Validation Flight Test - Separation Error Analysis



Statistic All Val. in NM	ADS-B to Radar Sep. Errors		Radar to Radar Separation	
	TOO	Fl. Test	TOO	Fl. Test
<b>Count</b>	<b>125,332</b>	<b>4,896</b>	<b>21,948</b>	<b>1,567</b>
<b>2.5%</b>	<b>-0.70</b>	<b>-0.67</b>	<b>-0.88</b>	<b>-0.80</b>
<b>Mean</b>	<b>-0.01</b>	<b>-0.01</b>	<b>-0.03</b>	<b>0.01</b>
<b>Std. Dev.</b>	<b>0.35</b>	<b>0.38</b>	<b>0.43</b>	<b>0.49</b>
<b>97.5%</b>	<b>0.69</b>	<b>0.77</b>	<b>0.82</b>	<b>0.96</b>

# Safety Analyses

- **Performed 3 sets of analyses**
  - Safety Risk Management Document
    - Identify unique hazards associated with the mixed ADS-B to radar environment in Alaska
  - Test Safety Analysis
    - Conducted for the validation flight test and operational evaluation – identified events and provided mitigation procedures if the event occurred
  - Avionics Level Safety Analysis
    - FAA-Industry panel identified 3 hazards to GDL-90 avionics
    - Panel determined that the GDL-90 was properly certified and is acceptable for use in the OpEval

# Summary of Report

- **Technical assessment concluded that 5 NM separation is supported on a MEARTS display w/ one target displayed w/ radar data and the other displayed w/ ADS-B data**
- **Recommendations:**
  - Operationally apply 5 NM separation services throughout the Alaska Flight Information Region (FIR) limited to the current MEARTS/GDL-90 avionics and UAT GBT equipment using the appropriate AMS, SMS, and systems engineering processes.
  - Provide ongoing monitoring of the UAT ADS-B services in Alaska to ensure the performance level of the service is maintained and that safety is not compromised.
  - Analyze, determine the level of, and correct various radar deficiencies in the Alaska radar environment beginning with the Cape Newenham and Cape Romanzof radars



# Membership of Separation Standards WG during OpEval Report

Member	Org.	Member	Org.
Brian Bagstad	FAA	Gerry McCartor	FAA
Michael Castle	JHU/APL	Gary Miller	FAA
C. Daskalakis	Volpe NTSC	Robert Novia	FAA
Paul Lipski	FAA	Robert Pomrink	Regulus Group
Clyde Jones	FAA	Dave Rudolf	STI
Stan Jones	Mitre	Randall Sleight	JHU/APL
Jason Kahara	Regulus Group	S. Thompson	MIT-LL
J. Marksteiner	FAA	P. Zelechowski	FAA
Sheila Mariano	FAA		

