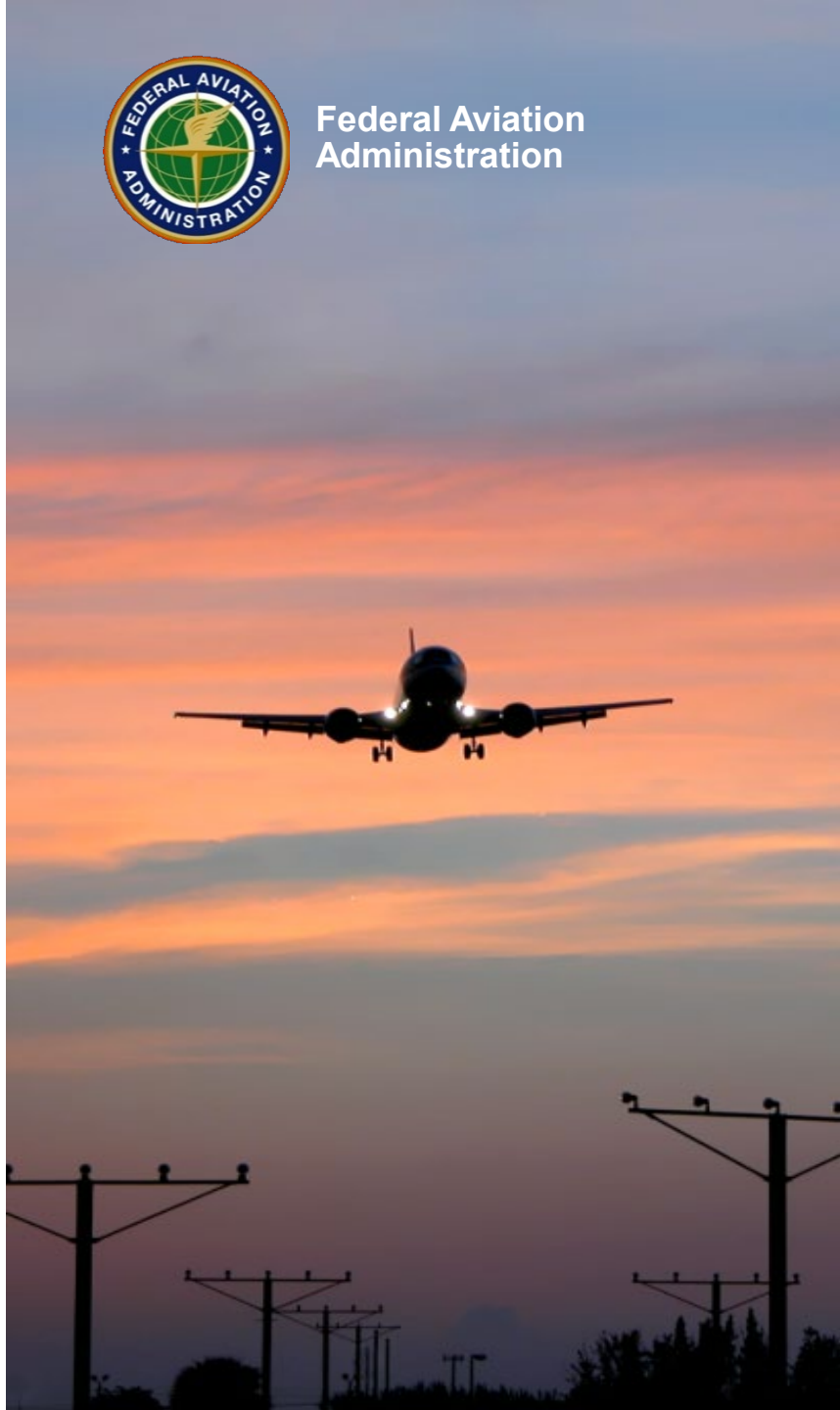
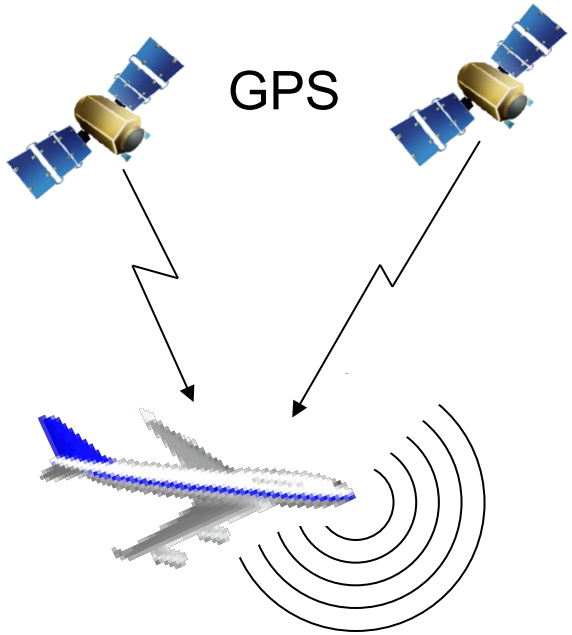
Introduction to ADS-B-In

Federal Aviation Administration



Last updated: June 2026

ADS-B Overview



ADS-B Out

(required by U.S. mandate, see 14 CFR 91.225)

Aircraft Surveillance Applications

ADS-B-In

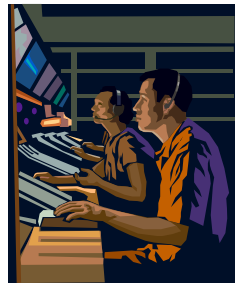
Cockpit Display of Traffic Information (CDTI)

Air Traffic Services Surveillance Capabilities

ADS-B Receiver Station

(*can be on a satellite in space*)

ATC

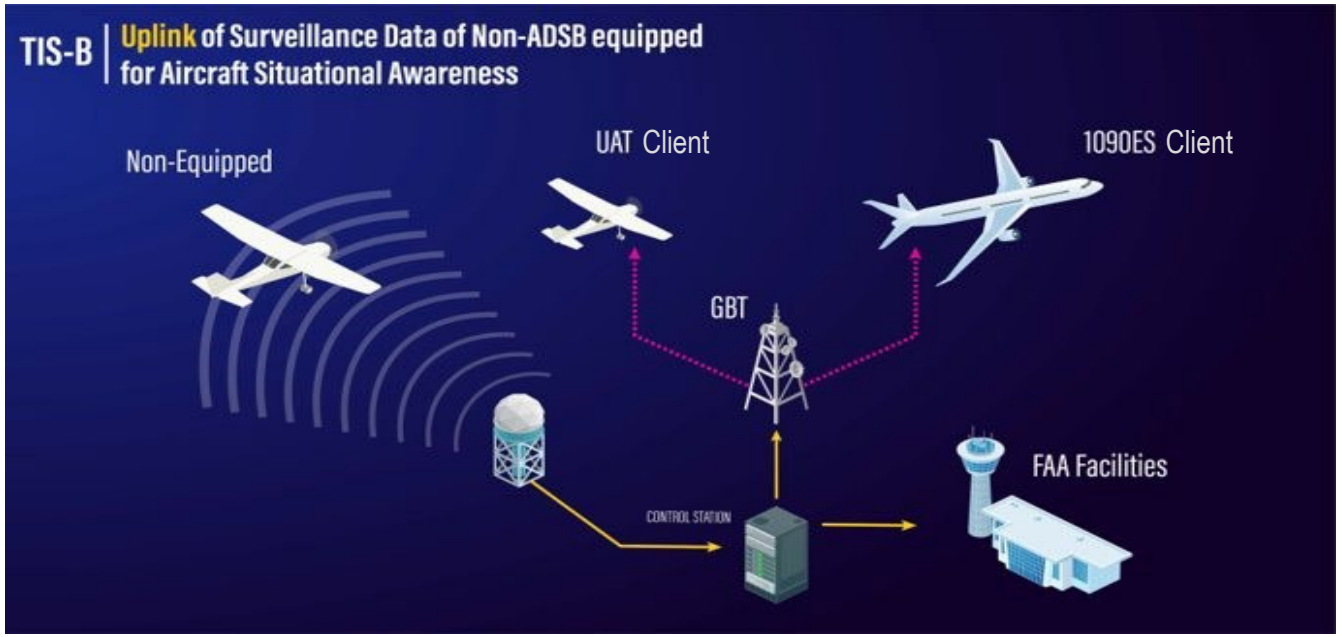


Controller Working Position

ADS-B high altitude coverage can exceed 250 nautical miles

ADS-B Overview

Traffic Information Services – Broadcast (TIS-B)



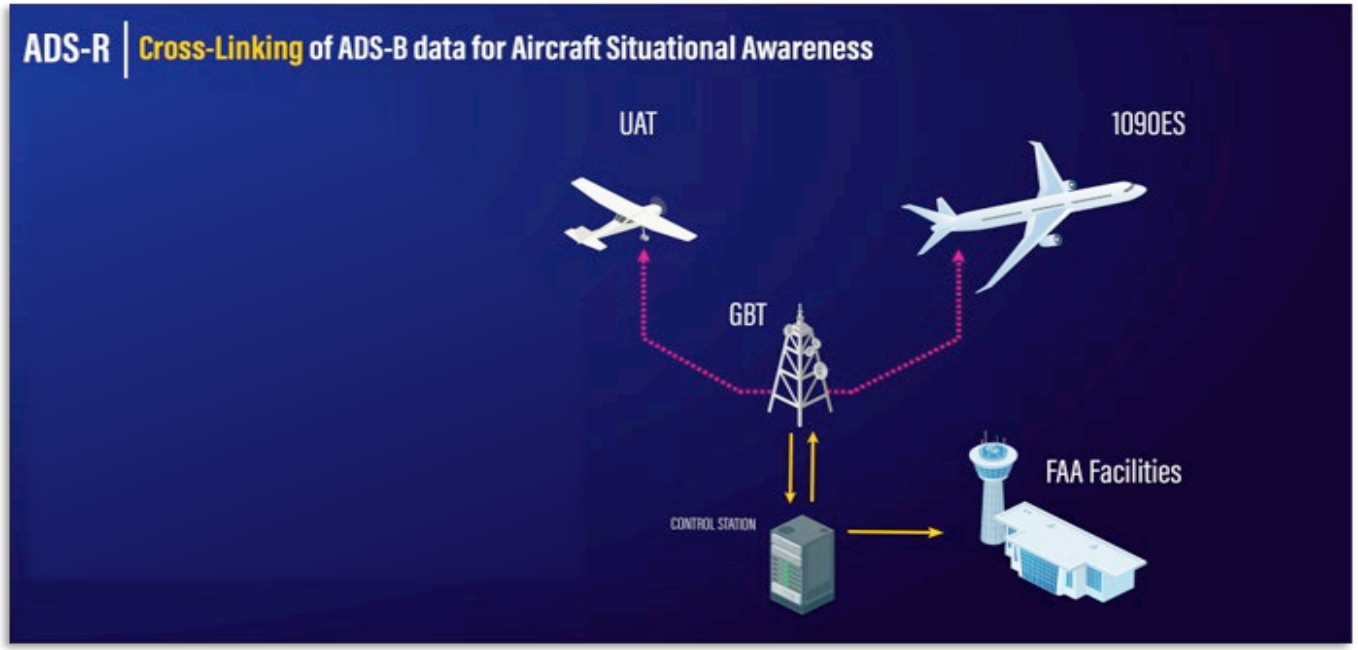
- **Client-based service providing ADS-B Out/In equipped aircraft with traffic information about "non-equipped" aircraft**
  - Clients must have ADS-B Out V2 or V3 with NIC & NACp>4 and SDA & SIL>0
- **TIS-B targets must be equipped with a transponder and be within radar coverage**

"Non-Equipped" in diagram means ONE of below:

- Aircraft without ADS-B Out [original design]
- Aircraft with ADS-B Out not meeting quality indicator requirements for TSO-certified traffic display (AIRB/ATAS)
- Aircraft with ADS-B Out using an old link version (1090ES V0-1 sent to UAT Clients OR UAT V1 sent to 1090ES Clients)

ADS-B Overview

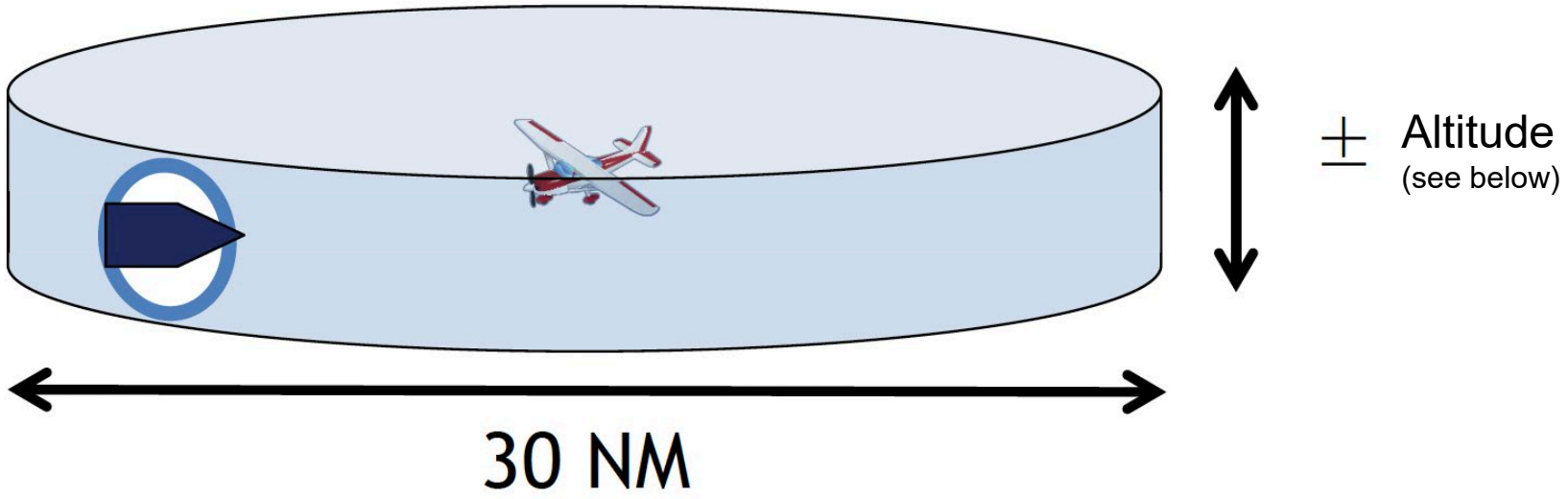
Automatic Dependent Surveillance – Rebroadcast (ADS-R)



- Client-based service relaying ADS-B information transmitted by an aircraft broadcasting on one link to aircraft equipped with ADS-B In on the other link
- Clients must have ADS-B Out V2 or V3 with NIC & NACp>4 and SDA & SIL>0
- Clients indicating in their ADS-B Out message that they are equipped with “Dual In” capability do not receive ADS-R (since they don’t need it)

ADS-B Overview

TIS-B/ADS-R “Hockey Puck”



- **TIS-B/ADS-R transmit traffic information customized to the receiving (Client) aircraft’s location**
- **Within coverage of an ADS-B ground station, Client aircraft will receive:**
  - TIS-B targets* within a 15-mile radius and +/- 3500 feet of Client’s barometric altitude
  - ADS-R targets within a 15-mile radius and +/- 5000 feet of Client’s barometric altitude

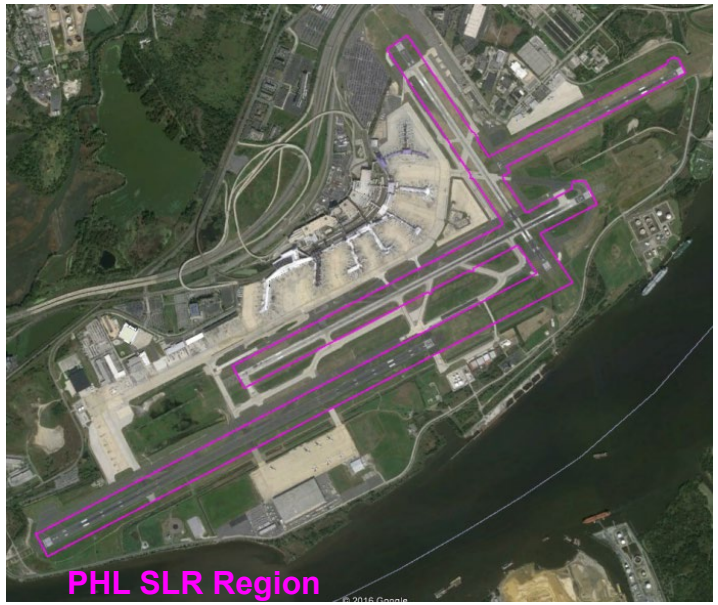
**** TIS-B targets must be within FAA radar coverage and provide valid Mode C replies to be processed***

ADS-B Overview

Automatic Dependent Surveillance – Same Link Rebroadcast (ADS-SLR)

Background

- Airport structures can block reception of direct aircraft-to-aircraft or vehicle ADS-B messages on an airport surface, impacting an application like SURF
- In addition, multipath interference with direct aircraft-to-aircraft ADS-B messages may impact aircraft reception of ADS-B messages on the surface



What It Is & How It Works

- Client-based service available only in FAA Surface Service Volumes (i.e., at airports with ASDE-X or ASSC) for aircraft with ADS-B Out V2 or V3
- ADS-SLR is only available within defined SLR regions on the surface movement area – generally, rectangles drawn around airport runways
- ADS-SLR is a variation on ADS-R that rebroadcasts ADS-B information transmitted by one aircraft broadcasting on a link to other aircraft equipped with ADS-B-In on same link

Exception: If a Client is receiving on both links (Dual In), then ADS-SLR will send all rebroadcasts to that Client on UAT (regardless of transmit link)

ADS-B Quality Indicators

Minimum to Display ADS-B Traffic to ATC

Minimum requirements of 14 CFR 91.227 (US ADS-B Mandate) are shown in green shading

NIC Encoding		NACp Encoding		Other Encodings					
Val	Radius of Containment (Rc)	Val	95% Horizontal Accuracy Bound (Estim Position Uncertainty)	Val	NACv - Horizontal Velocity Error	Val	SIL - Probability of Exceeding NIC Rc[1]	Val	SDA - System Design Assurance (per flt hr)
0	Unknown	0	≥ 18.52 km (≥ 10 nm)	0	Unknown or ≥ 10 m/s	0	Unknown or > 1 x 10^{-3}	0	Unknown or > 1 x 10^{-3}
1	< 20 nm (37.04 km)	1	< 18.52 km (10 nm)	1	< 10 m/s	1	≤ 1 x 10^{-3}	1	≤ 1 x 10^{-3}
2	< 8 nm (14.816 km)	2	< 7.408 km (4 nm)	2	<3 m/s	2	≤ 1 x 10^{-5}	2	≤ 1 x 10^{-5}
3	< 4 nm (7.408 km)	3	< 3.704 km (2 nm)	3	< 1 m/s	3	≤ 1 x 10^{-7}	3	≤ 1 x 10^{-7}
4	< 2 nm (3.704 km)	4	< 1852 m (1 nm)	4	< 0.3 m/s				
5	< 1 nm (1852 m)	5	< 926 m (0.5 nm)						
6[2]	< 0.6 nm (1111.2 m)	-	-						
	< 0.5 nm (926 m)	6	< 555.6 m (0.3 nm)						
	< 0.3 nm (555.6 m)	-	-						
7	< 0.2 nm (370.4 m)	7	< 185.2 m (0.1 nm)						
8	< 0.1 nm (185.2 m)	8	< 92.6 m (0.05 nm)						
9	< 75 m	9	< 30 m						
10	< 25 m	10	< 10 m						
11	< 7.5 nm	11	< 3 m						

[1] Per hour or per sample determined by the SIL Supplement Code: 0=per hour, 1=per sample

[2] Rc for this NIC value is dependent on the NIC Supplement Codes A and B; see RTCA DO-260B / EUROCAE ED-102A or subsequent revisions

Different ATC applications may require different values of the above ADS-B quality indicators (e.g., 3 nm separation requires higher values of NIC and NACp than shown above)

ADS-B-In Operator Classes

1) Aircraft <u>without</u> an Airborne Collision Avoidance System

- Most of the 300,000 aircraft registered in the US
- Very few aircraft without ACAS have onboard weather radar

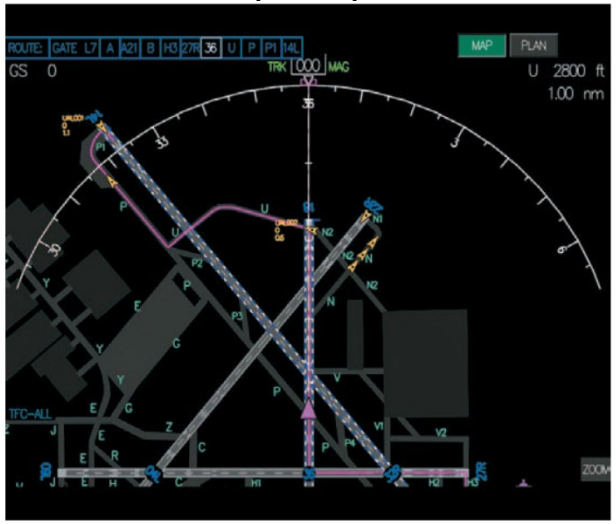
2) Aircraft with an Airborne Collision Avoidance System (aka TCAS)

- Turbine-powered aircraft of a certain weight or passenger capability are required to be equipped – see 14 CFR 121.356, 14 CFR 125.224, 14 CFR 129.18, and 14 CFR 135.180
- Many turbine-powered business aircraft also are equipped (voluntary)
- Most ACAS-equipped aircraft also have some form of onboard weather radar
- Air Carrier operations require a dispatcher – see 14 CFR 121 Subpart U

- **Views of what is meant by "ADS-B-In" vary based on the above**
- **ADS-B-In can provide a traffic display for aircraft without such capability (1), but ADS-B-In, if installed on an aircraft with ACAS (2), should have a traffic display that integrates ADS-B-In and ACAS information**
- **ADS-B-In systems receiving UAT (978 MHz) provide Flight Information Services-Broadcast (FIS-B) – while FIS-B information can share a display with traffic information, FIS-B not covered in detail by this briefing**

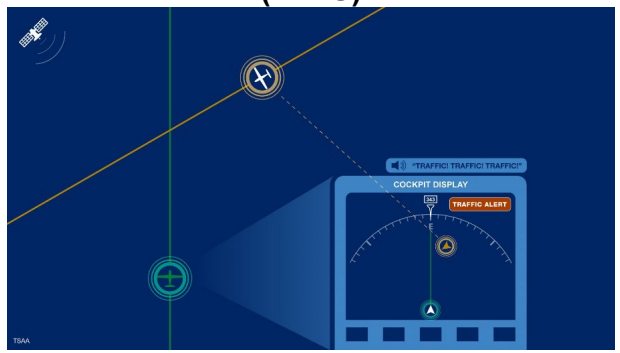
FAA TSO-C195c – ADS-B Aircraft Surveillance Applications

Surface Traffic Situational Awareness (SURF)



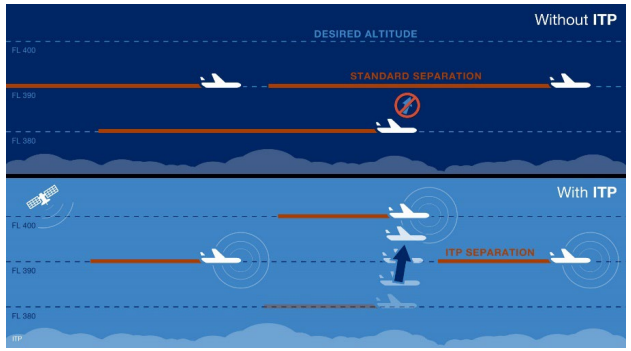
Airborne Traffic Situational Awareness (AIRB)

ADS-B Traffic Advisory System (ATAS)

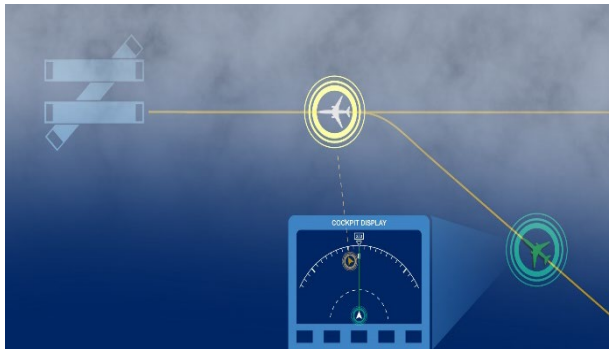


Mandatory unless equipment is interfaced with TAS or ACAS

In-Trail Procedure (ITP)

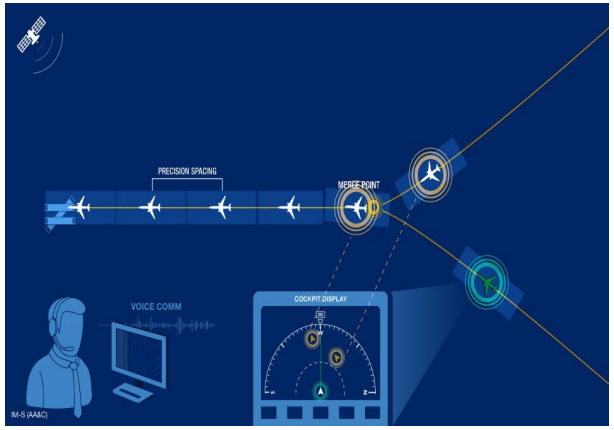


Cockpit Display of Traffic Information-Assisted Visual Separation (CAVS)



Interval Management (IM)

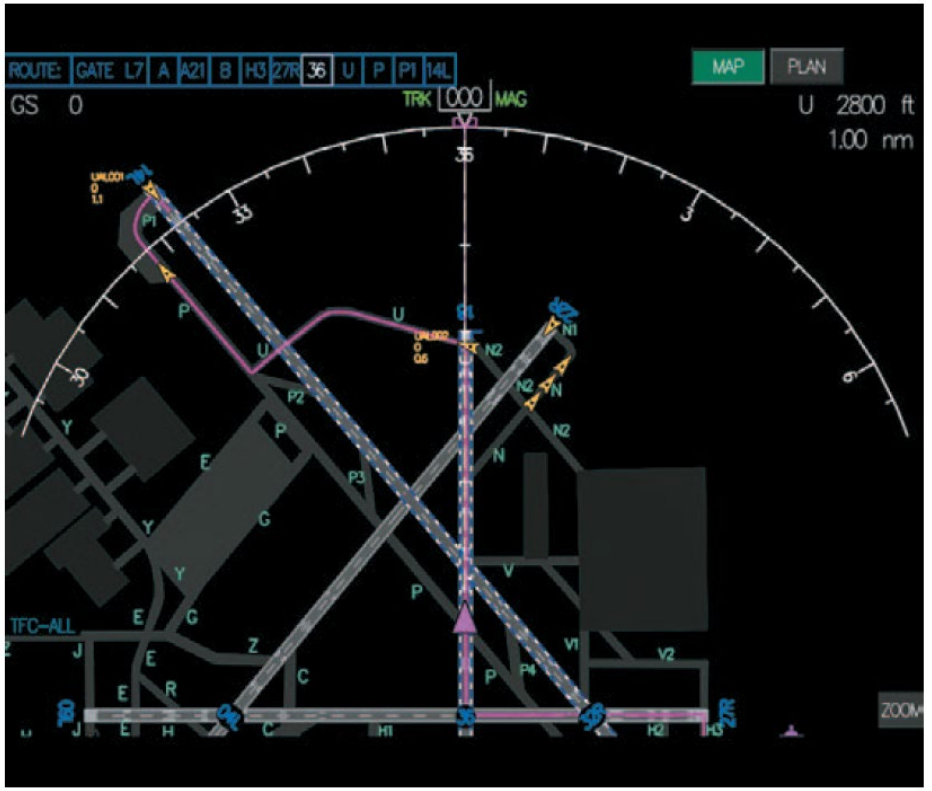
[IM is a family of operations; only one shown]



Capabilities in red box require operational approval from State Regulator before use

SURF – Basic Surface Situation Awareness

- **SURF provides the flight crew with improved situational awareness of surrounding traffic and ground vehicles**
  - Operating on the airport surface
  - During final approach and landing
  - During takeoff
- **CDTI display of traffic on an airport moving map**
- **Supplements out-the-window scans during operations on runways and taxiways**
- **Benefits:**
  - Improved safety (e.g. taxiway intersections)
  - Improved efficiency (e.g., during low-visibility operations)
  - Decreased workload (e.g., reduction in pilot-controller communications)



AIRB – Basic Airborne Situation Awareness

- **AIRB provides the flight crew with a picture of surrounding traffic on a Cockpit Display of Traffic Information (CDTI) during flight operations**

- **It can be used:**
  - Anytime during airborne operations (departure, cruise, and arrival and approach)
  - On board all types of aircraft (large commercial jets to GA aircraft)
  - In all classes of airspace
  - In both IMC and VMC under IFR and VFR

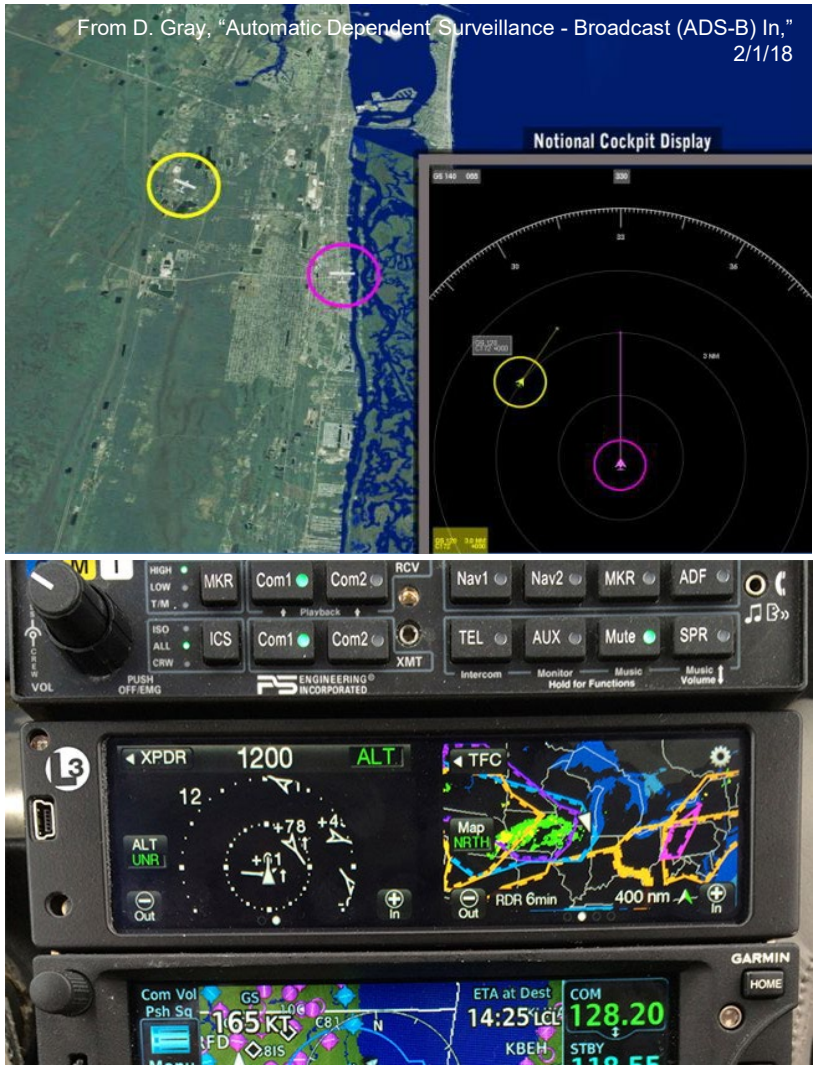
- **No new pilot or controller procedures**

- **Benefits: Can improve safety and efficiency of operations** (per FAA and Eurocontrol operational trials)

ATAS – ADS-B Traffic Advisory System

- **ATAS provides GA pilots with situational awareness and alerts about conflicting traffic**
  - Supplements pilot's see-and-avoid responsibility
- **Uses ADS-B to provide traffic alerting benefits to GA without TCAS**
- **Avionics support out-the-window visual acquisition of traffic using a traffic display with:**
  - Voice annunciations
  - Visual cues
  - Additional symbols to supplement the plan-view
- **Benefits: Reduce the number of air-to-air encounters and collisions**

Mandatory in TSO-C195c, unless equipment is interfaced with a TAS or TCAS/ACAS



https://www.planeandpilotmag.com/article/lynx-ngt-9000-l-3-atp/#.WrptRXnrtoI

ADS-B Quality Indicators

Minimum to Display Airborne ADS-B Traffic to Pilots (AIRB/ATAS)

Note: No requirements for NIC or SIL

Minimum requirements of 14 CFR 91.227 (US ADS-B Mandate) are shown in green shading

NIC Encoding		NACp Encoding		Other Encodings					
Val	Radius of Containment (Rc)	Val	95% Horizontal Accuracy Bound (Estim Position Uncertainty)	Val	NACv - Horizontal Velocity Error	Val	SIL - Probability of Exceeding NIC Rc[1]	Val	SDA - System Design Assurance (per flt hr)
0	Unknown	0	≥ 18.52 km (≥ 10 nm)	0	Unknown or ≥ 10 m/s	0	Unknown or > 1 x 10^{-3}	0	Unknown or > 1 x 10^{-3}
1	< 20 nm (37.04 km)	1	< 18.52 km (10 nm)	1	< 10 m/s	1	≤ 1 x 10^{-3}	1	≤ 1 x 10^{-3}
2	< 8 nm (14.816 km)	2	< 7.408 km (4 nm)	2	<3 m/s	2	≤ 1 x 10^{-5}	2	≤ 1 x 10^{-5}
3	< 4 nm (7.408 km)	3	< 3.704 km (2 nm)	3	< 1 m/s	3	≤ 1 x 10^{-7}	3	≤ 1 x 10^{-7}
4	< 2 nm (3.704 km)	4	< 1852 m (1 nm)	4	< 0.3 m/s				
5	< 1 nm (1852 m)	5	< 926 m (0.5 nm)						
6[2]	< 0.6 nm (1111.2 m)	-	-						
	< 0.5 nm (926 m)	6	< 555.6 m (0.3 nm)						
	< 0.3 nm (555.6 m)	-	-						
7	< 0.2 nm (370.4 m)	7	< 185.2 m (0.1 nm)						
8	< 0.1 nm (185.2 m)	8	< 92.6 m (0.05 nm)						
9	< 75 m	9	< 30 m						
10	< 25 m	10	< 10 m						
11	< 7.5 nm	11	< 3 m						

[1] Per hour or per sample determined by the SIL Supplement Code: 0=per hour, 1=per sample

[2] Rc for this NIC value is dependent on the NIC Supplement Codes A and B; see RTCA DO-260B / EUROCAE ED-102A or subsequent revisions

Different aircraft surveillance applications require other combinations of the above quality indicators

ADS-B Quality Indicators

Minimum to Display Surface ADS-B Traffic to Pilots

Note: No requirements for NIC or SIL

Minimum requirements of 14 CFR 91.227 (US ADS-B Mandate) are shown in green shading

NIC Encoding		NACp Encoding		Other Encodings					
Val	Radius of Containment (Rc)	Val	95% Horizontal Accuracy Bound (Estim Position Uncertainty)	Val	NACv - Horizontal Velocity Error	Val	SIL - Probability of Exceeding NIC Rc[1]	Val	SDA - System Design Assurance (per flt hr)
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1	< 20 nm (37.04 km)	1	< 18.52 km (10 nm)	1	< 10 m/s	1	≤ 1×10^{-3}	1	≤ 1×10^{-3}
2	< 8 nm (14.816 km)	2	< 7.408 km (4 nm)	2	<3 m/s	2	≤ 1×10^{-5}	2	≤ 1×10^{-5}
3	< 4 nm (7.408 km)	3	< 3.704 km (2 nm)	3	< 1 m/s	3	≤ 1×10^{-7}	3	≤ 1×10^{-7}
4	< 2 nm (3.704 km)	4	< 1852 m (1 nm)	4	< 0.3 m/s				
5	< 1 nm (1852 m)	5	< 926 m (0.5 nm)						
6[2]	< 0.6 nm (1111.2 m)	-	-						
	< 0.5 nm (926 m)	6	< 555.6 m (0.3 nm)						
	< 0.3 nm (555.6 m)	-	-						
7	< 0.2 nm (370.4 m)	7	< 185.2 m (0.1 nm)	When ownship is airborne (AIRB)					
8	< 0.1 nm (185.2 m)	8	< 92.6 m (0.05 nm)						
9	< 75 m	9	< 30 m	When ownship is on surface (SURF)					
10	< 25 m	10	< 10 m						
11	< 7.5 nm	11	< 3 m						

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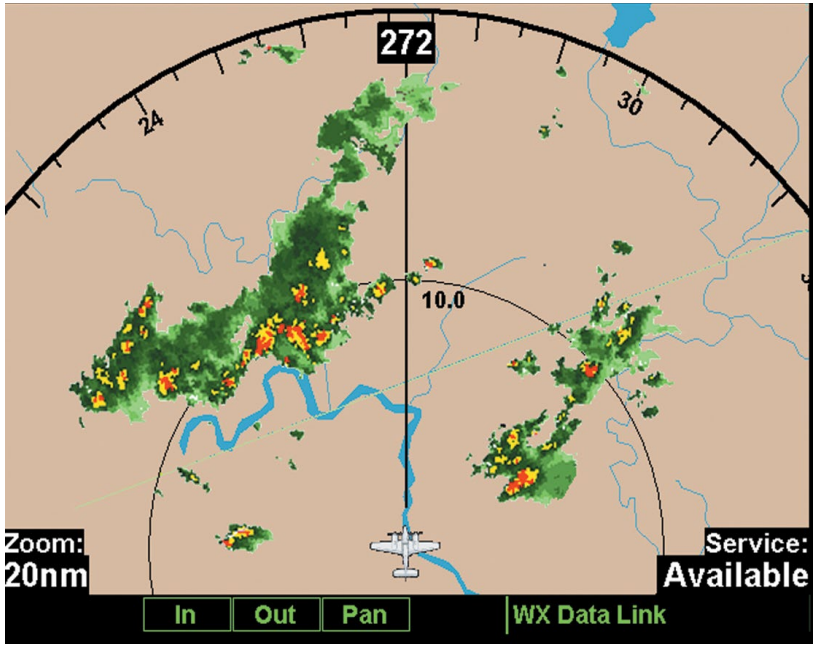
Different aircraft surveillance applications require other combinations of the above quality indicators

ADS-B-In for Most GA Pilots

Traffic Display (AIRB/SURF) improves safety of GA operations, supporting pilot “See and Avoid” (further improved by ATAS alerting)

Note: TIS-B provides information from secondary surveillance sensors for traffic not equipped with ADS-B Out

FIS-B transmits graphical and textual products such as NWS products, NOTAMs, temporary flight restrictions (TFRs), and special use airspace



Note: FIS-B is available only on ADS-B In systems capable of receiving UAT (978 MHz)

Both traffic display information and FIS-B information may appear on the same physical display; in many GA aircraft, such information will appear on an iPad or equivalent tablet device

A representative GA pilot’s guide can be found at https://static.garmincdn.com/pumac/190-01122-03_0C_Web.pdf

How does FAA know who has ADS-B-In?

1) ADS-B Out message provides an "indication of whether an ADS-B In capability is installed" – typically set at installation [See 14 CFR 91.227(d)(13)]

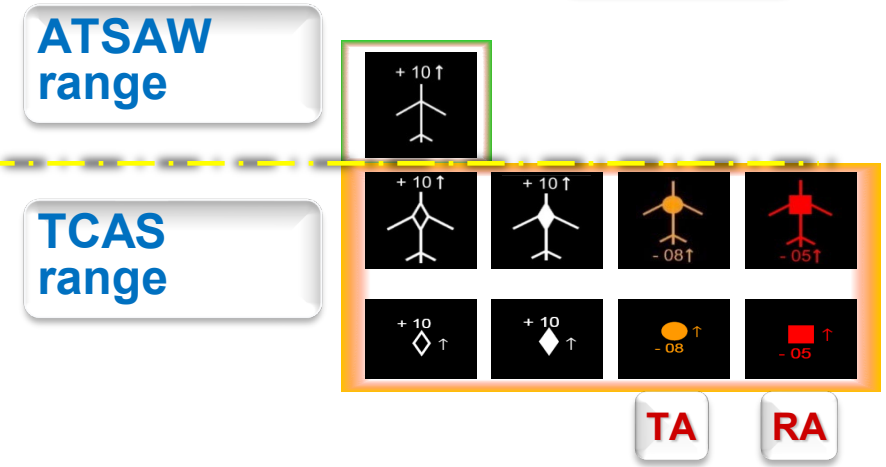
2) ICAO Flight Plan (2012 format), Item 10, allows operator to indicate whether their aircraft has an ADS-B Out capability, and if so, whether it also has an ADS-B-In capability
[See FAA Advisory Circular 90-114B, Change 1, section 4.4]

- **Both methods allow binary indication of ADS-B-In capability; a method has been developed to allow use of ICAO Flight Plan (2012 format), Item 18, to indicate certain ADS-B-In capabilities (CAS and IM, for example) to ATC, but the ERAM changes to support ADS-B-In "Capability Indicators" were deployed in June 2024**

- **As of 1-Jun-2026, ADS-B-In equipage based on (1) was:**
  - GA/air taxi: Just over 67%, or approximately 143,000 aircraft
  - Airline: Just under 19%, or approximately 1,400 aircraft

- **Remainder of briefing will generally focus on ADS-B-In capabilities envisioned for use by Airline aircraft (and high-end business aircraft whose operations are more heavily regulated by the FAA)**

Airline ADS-B-In Cockpit Interface



TA: Traffic Advisory
RA: Resolution Advisory
ATSAW: Airborne Traffic Situation Awareness

See https://www.slideshare.net/slideshow/sp08b_airbus_ads-b-in-atsaw-presentation-pdf/270029587 for further information on the Airbus ATSAW system and pilot interface

Some Aircraft Surveillance Applications Require FAA Approval

- **In-Trail Procedure (ITP)**
  - See FAA AC 90-114C, Appendix A for guidance
- **CDTI-Assisted Visual Separation (CAVS)**
  - See FAA AC 90-114C, Appendix B for guidance
- **Interval Management (IM)**
  - See FAA AC 90-114C, Appendix F for guidance
- **CDTI-Assisted Separation on Approach (CAS-A) [uses CAVS avionics]**
  - See FAA AC 90-114C, Appendix G for guidance
- **FAA AC 90-114C can be found at**
  https://drs.faa.gov/browse/excelExternalWindow/DRSDOCID1280218468202501161353 25.0001

Note that these applications require TCAS/ACAS validation of received ADS-B position reports.
See DO-317C/ED-194B for details.

ITP – Oceanic In-Trail Procedures

- **ITP enables a leading or following same-track aircraft to perform a climb or descent to a requested flight level through intermediate flight levels**
  - Climb or descent through intermediate flight levels might be disallowed when using current separation minima
- **ITP avionics helps the flight crew in determining whether the ITP criteria is met relative to one or two Reference Aircraft at intermediate flight levels**
- **Benefits: Improved fuel efficiency from greater time at optimal altitudes and improved ability to reach less turbulent altitudes when needed**

See https://www.faa.gov/sites/faa.gov/files/air_traffic/technology/adsb/quicklinks/ADS-B_ITP_Operational_Flight_Eval_Final_Data%20Report_(SBS-184)_nonCompliant.pdf

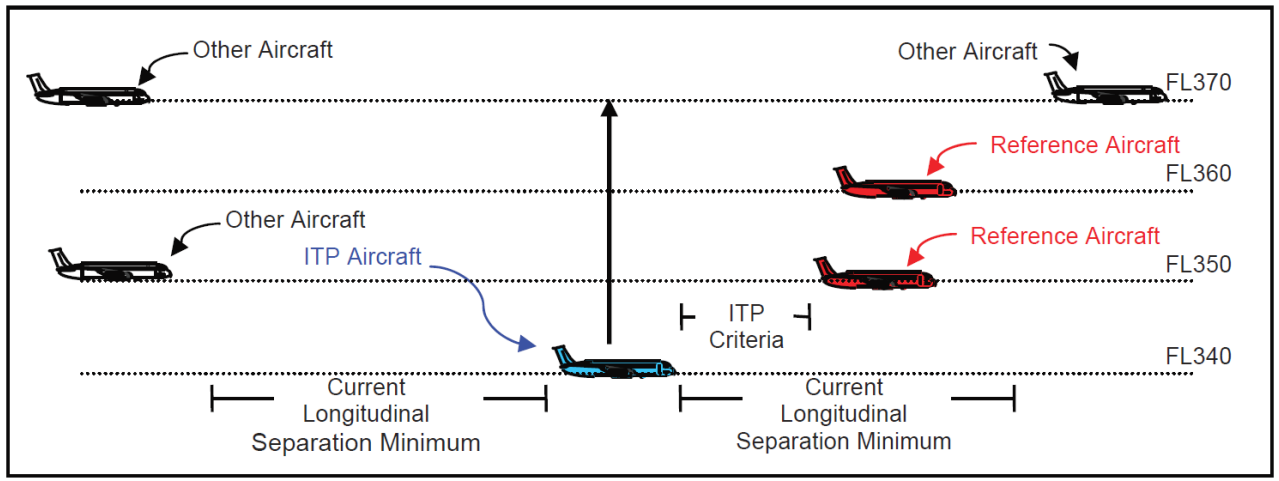


Figure A.2: SPR for In-Trail Procedures in Oceanic Airspace, DO-312

ADS-B Quality Indicators

Minimum to Use ADS-B Traffic for ITP

Minimum requirements of 14 CFR 91.227 (US ADS-B Mandate) are shown in green shading

NIC Encoding		NACp Encoding		Other Encodings					
Val	Radius of Containment (Rc)	Val	95% Horizontal Accuracy Bound (Estim Position Uncertainty)	Val	NACv - Horizontal Velocity Error	Val	SIL - Probability of Exceeding NIC Rc[1]	Val	SDA - System Design Assurance (per flt hr)
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2	< 8 nm (14.816 km)	2	< 7.408 km (4 nm)	2	<3 m/s	2	≤ 1 x 10^{-5}	2	≤ 1 x 10^{-5}
3	< 4 nm (7.408 km)	3	< 3.704 km (2 nm)	3	< 1 m/s	3	≤ 1 x 10^{-7}	3	≤ 1 x 10^{-7}
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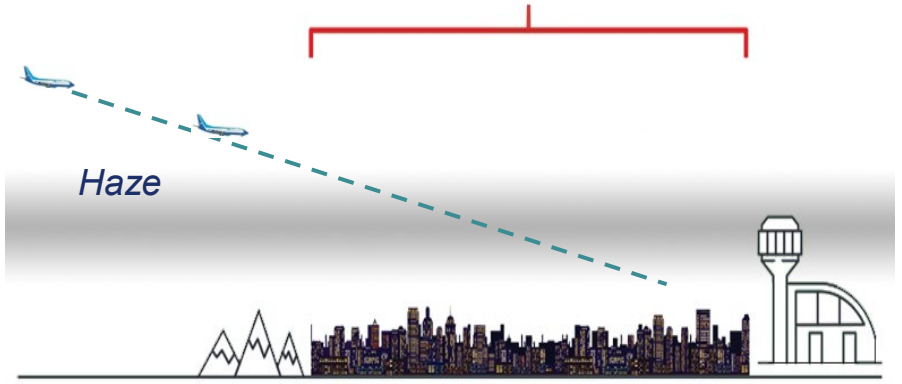
Different aircraft surveillance applications require other combinations of the above quality indicators

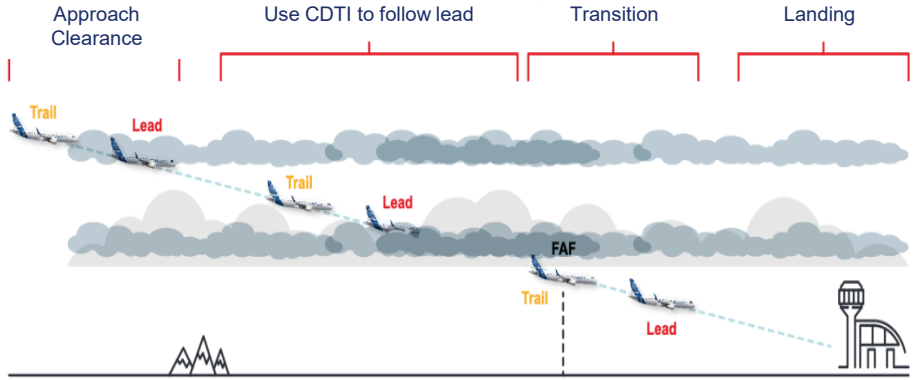
CAVS and CAS-A

CDTI Assisted Visual Separation (CAVS)



- Conducted in Visual Meteorological Conditions (VMC)
- Initiated when traffic is first visually acquired and visual separation is requested by ATC
- **Pilot may maintain visual separation using only CAVS avionics even if visual contact is lost in VMC**
- Can be used anywhere appropriate conditions exist (no ATC awareness required)
- Operational Approval from FAA Flight Standards is required

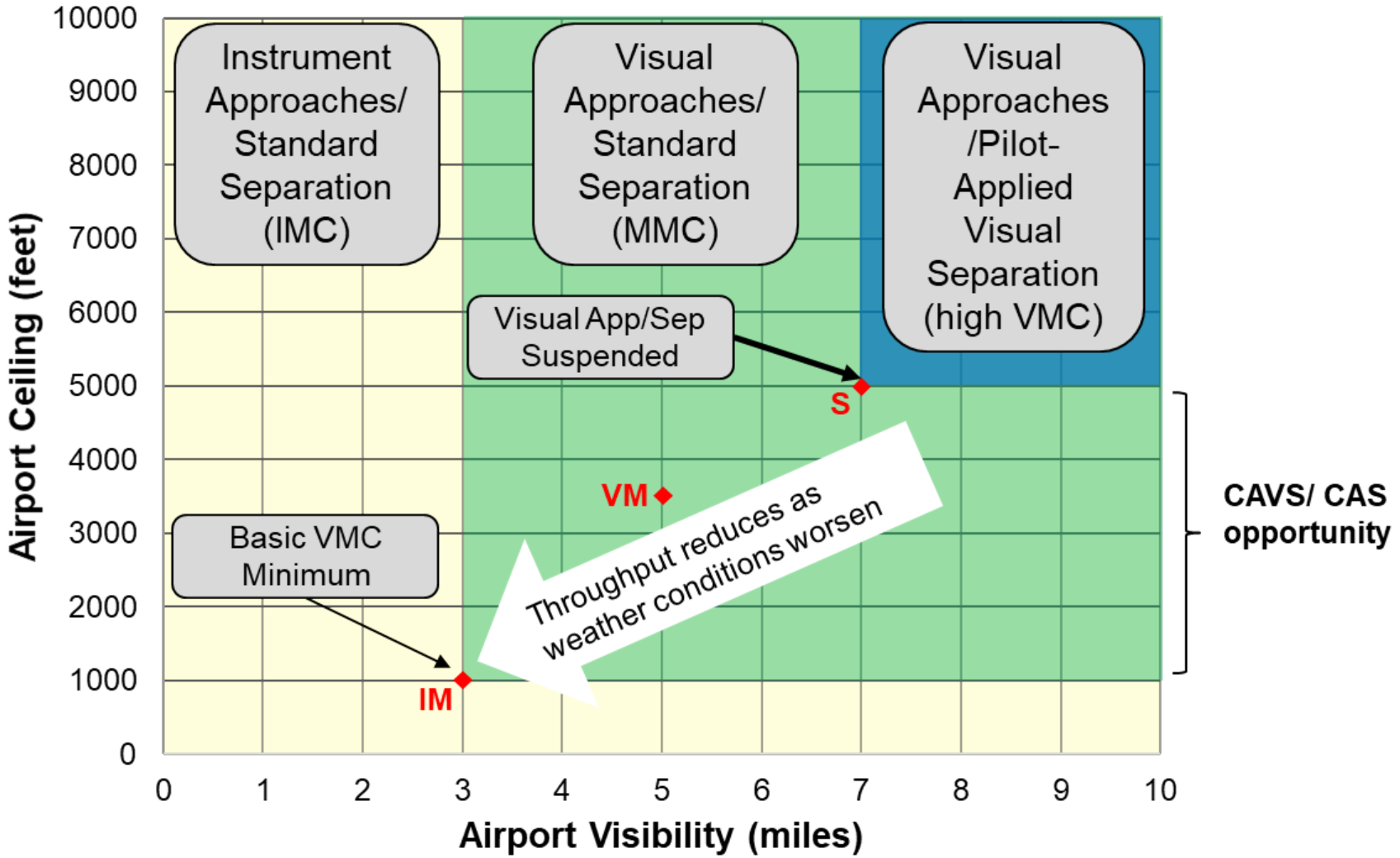
CDTI Assisted Separation on Approach (CAS-A)



- Conducted in Instrument Meteorological Conditions (IMC) or VMC
- CAS-A can be initiated **without** first acquiring traffic-to-follow out-the-window (controller provides traffic identification to flight crew)
- **Extends use of pilot-applied visual separation into Marginal Meteorological Conditions (MMC, see next slide) using only CAVS avionics (resulting in increased arrival rates)**
- Can be used only when/where ATC initiates operation
- Operational Approval from FAA Flight Standards is required

See https://www.faa.gov/about/office_org/headquarters_offices/ato/airs-cavs-cas-op-eval-final-report *for a report on results of recent CAVS/CAS-A operational evaluations*

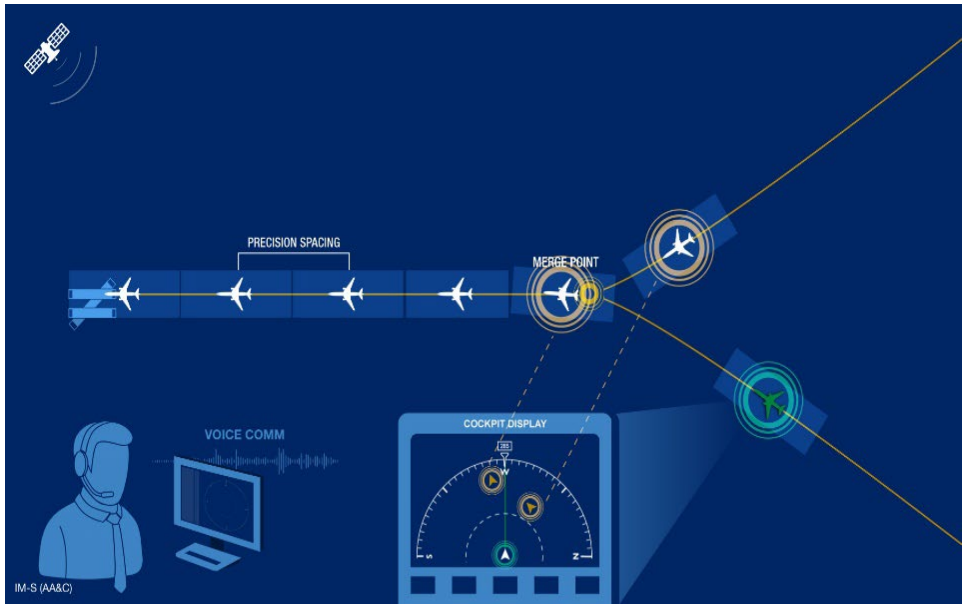
Marginal Meteorological Conditions (MMC) and Approach Throughput



Ceiling and Visibility values for suspension of visual separation are notional - in reality, these values vary by airport and runway configuration

Interval Management (IM)

- Interval Management (IM) consists of a set of ground and flight-deck capabilities used in combination by air traffic controllers and flight crews to more efficiently achieve a precise interval between aircraft in a stream of traffic
- Reducing the variance in inter-aircraft spacing will result in more efficient use of runway capacity while also enabling aircraft to remain on their Performance-based Navigation (PBN) procedures more frequently, reducing costly and inefficient vectoring
- IM functionality requires ADS-B Out and ADS-B-In equipage



Operational Concept

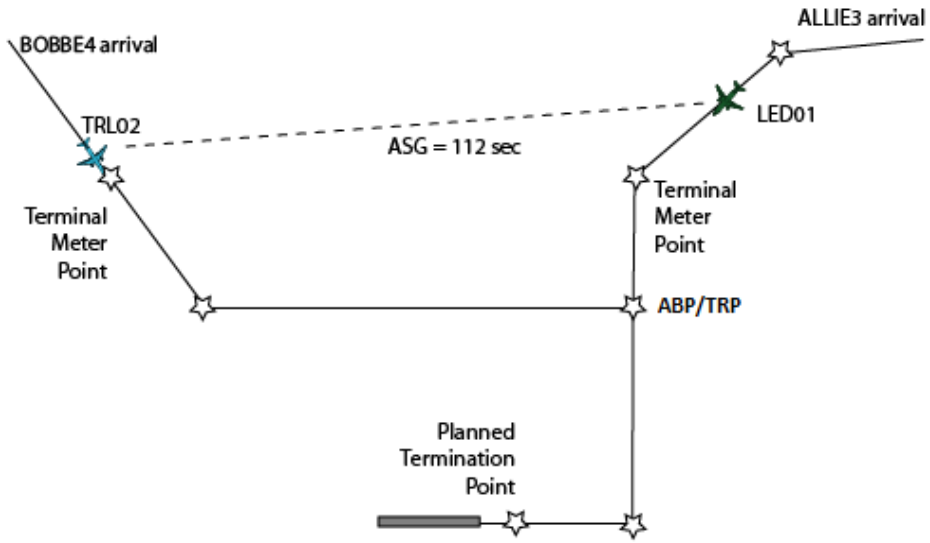
- Controller instructs flight crew to achieve/maintain an assigned spacing goal (time or distance) relative to another aircraft
- Flight crew uses IM avionics to manage aircraft speed to achieve instructed ATC objective

See https://www.faa.gov/sites/faa.gov/files/AIRS I-IM Op Eval Final Report_Consolidated for Website_final.pdf *for a report on results of a recent Initial IM operational evaluation*

Interval Management (IM) per DO-361/ED-236

IM Arrival and Approach (Same Runway)

- En route through terminal: to a single runway during metering operations
- Ground automation schedules IM-capable aircraft closer than it would otherwise
- IM operations can start before aircraft are on common routes, though IM and Target routes must be common after ABP/TRP waypoint
- Ground automation sets up feasible IM operations
- Aircraft are on RNAV routes with altitude and speed constraints (4D trajectory)



IM Cruise

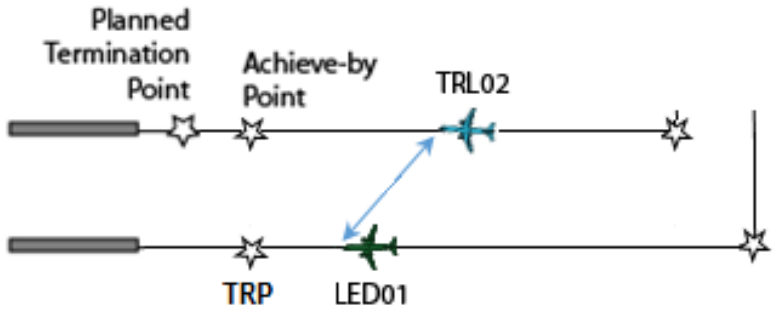
– Used in en route airspace during Miles in Trail (MIT) operations

– Reduce number of speed or vector instructions controllers need to issue to aircraft to meet MIT restrictions

Additional Capabilities per DO-361A/ED-236A (1 of 2)

Dependent Staggered Approaches (DSA)

Increase arrival throughput for dependent parallel runway operations by allowing an IM Aircraft to manage its spacing relative to the aircraft landing on parallel runway

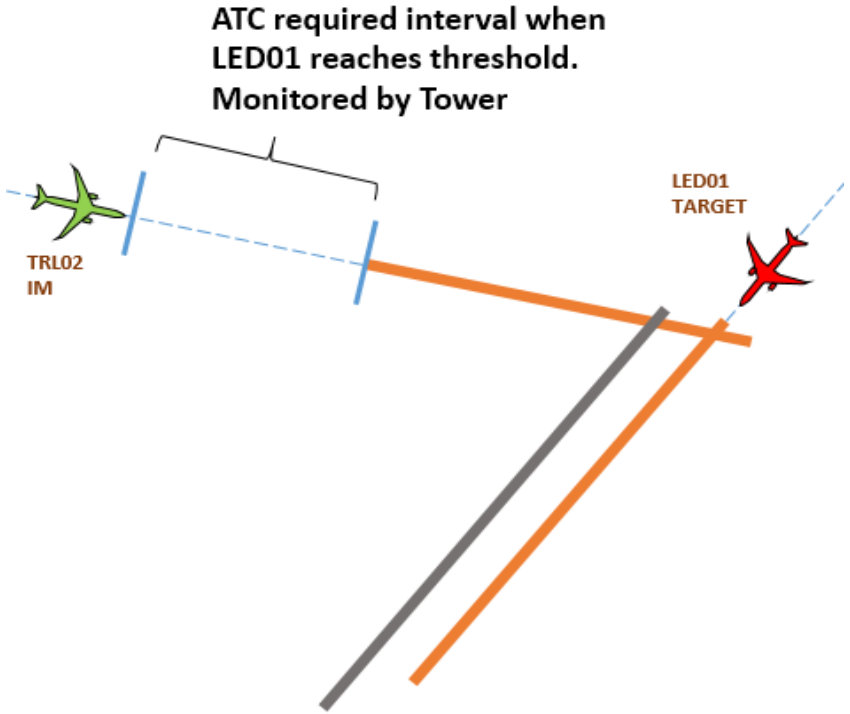


Diagonal Separation Standards
CSPR: FAAO 7110.308C
Non-CSPR: FAAO 7110.65W, §5-9-6

Longitudinal Separation Standard
CSPR: FAAO 7110.65W, §5-5-4

Dependent Converging/Crossing Runways (DCCR)

Enable certain ATC facilities to consider lowering weather minima (i.e. ceiling and visibility to which the operation can be conducted) and/or increase operations to secondary runway

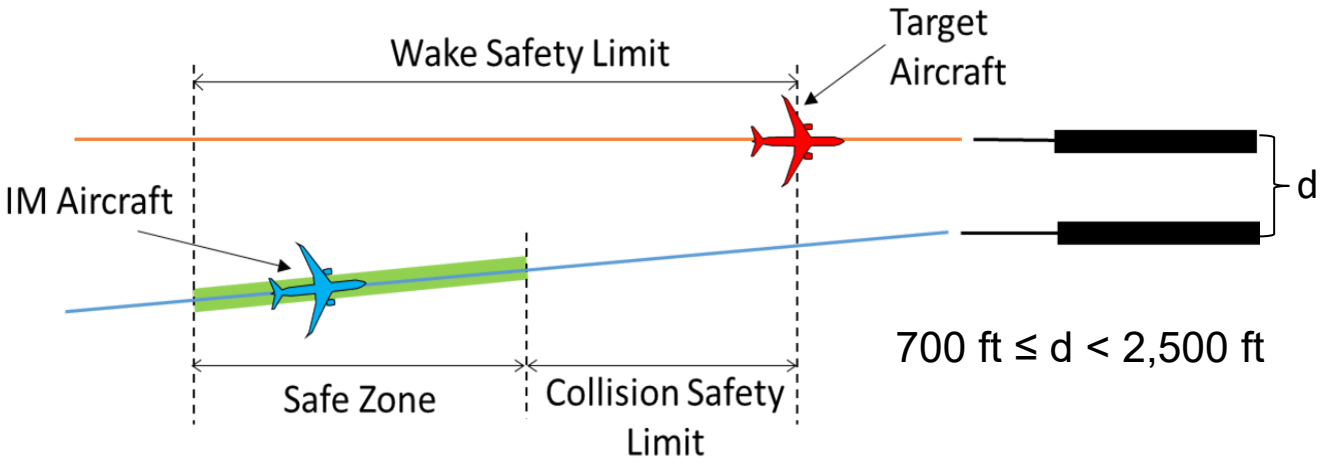


Additional Capabilities per DO-361A/ED-236A (2 of 2)

Paired Approach (PA)

Increase capacity of closely-spaced parallel runways when visual separation cannot be conducted
(i.e., runways closer than 2,500 feet and as close as 700 feet)

IM Assigned Spacing Goal calculated to keep the IM Aircraft in Safe Zone



Characteristics

- Requires a new Paired Approach Separation Standard
- Avionics functionality similar to DSA
- Controllers will require additional display/automation features to monitor conformance with Safety Limit

ADS-B Quality Indicators

Minimum to Use ADS-B traffic for CAVS/IM

Minimum requirements of 14 CFR 91.227 (US ADS-B Mandate) are shown in green shading

NIC Encoding		NACp Encoding		Other Encodings					
Val	Radius of Containment (Rc)	Val	95% Horizontal Accuracy Bound (Estim Position Uncertainty)	Val	NACv - Horizontal Velocity Error	Val	SIL - Probability of Exceeding NIC Rc[1]	Val	SDA - System Design Assurance (per flt hr)
0	Unknown	0	≥ 18.52 km (≥ 10 nm)	0	Unknown or ≥ 10 m/s	0	Unknown or > 1 x 10^{-3}	0	Unknown or > 1 x 10^{-3}
1	< 20 nm (37.04 km)	1	< 18.52 km (10 nm)	1	< 10 m/s	1	≤ 1 x 10^{-3}	1	≤ 1 x 10^{-3}
2	< 8 nm (14.816 km)	2	< 7.408 km (4 nm)	2	<3 m/s	2	≤ 1 x 10^{-5}	2	≤ 1 x 10^{-5}
3	< 4 nm (7.408 km)	3	< 3.704 km (2 nm)	3	< 1 m/s	3	≤ 1 x 10^{-7}	3	≤ 1 x 10^{-7}
4	< 2 nm (3.704 km)	4	< 1852 m (1 nm)	4	< 0.3 m/s				
5	< 1 nm (1852 m)	5	< 926 m (0.5 nm)						
6[2]	< 0.6 nm (1111.2 m)	-	-						
	< 0.5 nm (926 m)	6	< 555.6 m (0.3 nm)						
	< 0.3 nm (555.6 m)	-	-						
7	< 0.2 nm (370.4 m)	7	< 185.2 m (0.1 nm)						
8	< 0.1 nm (185.2 m)	8	< 92.6 m (0.05 nm)						
9	< 75 m	9	< 30 m						
10	< 25 m	10	< 10 m						
11	< 7.5 nm	11	< 3 m						

If designated traffic < 2.05 nm from IM ownship, NIC ≥ 7 required

CAVS Surveillance Alert is active if designated traffic < 0.42 nm horizontal range from ownship when NIC ≥ 7 and NACp ≥ 8; otherwise, Alert is active if designated traffic < 1.4 nm horizontal range from ownship

[1] Per hour or per sample determined by the SIL Supplement Code: 0=per hour, 1=per sample

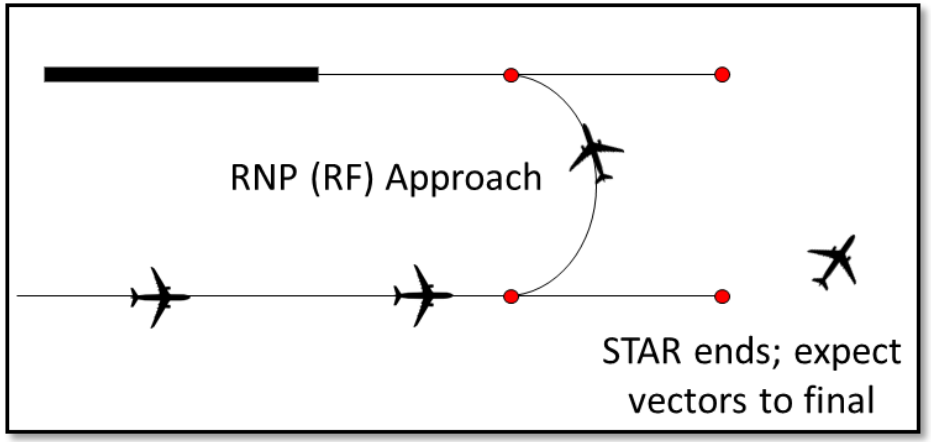
[2] Rc for this NIC value is dependent on the NIC Supplement Codes A and B; see RTCA DO-260B / EUROCAE ED-102A or subsequent revisions

Different aircraft surveillance applications require other combinations of the above quality indicators

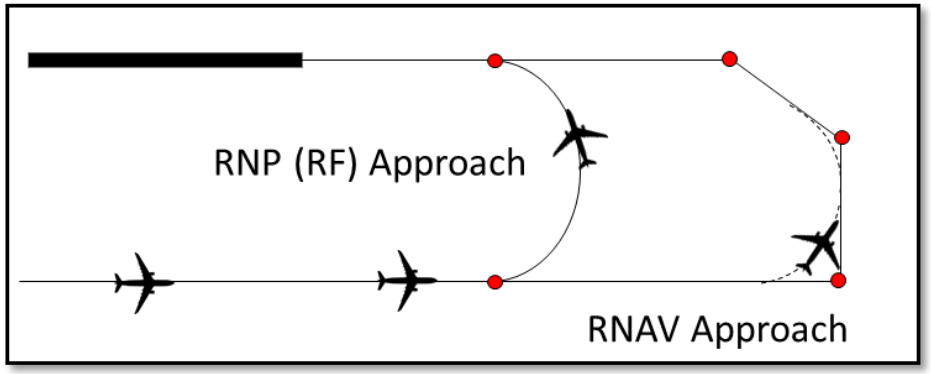
PBN Requirements for IM (1 of 2)

- **IM Operations should be conducted on fully-defined procedures**
  - e.g., RNAV STARs that connect to instrument approach procedures
- **Final Approach Spacing relies on a defined approach procedure or runway (to derive a course)**
- **Planned routes may be communicated as a sequence of waypoints**
  - Including direct-to a waypoint from present position
  - Treated like TF legs with fly-by turns

Non-connected Approaches

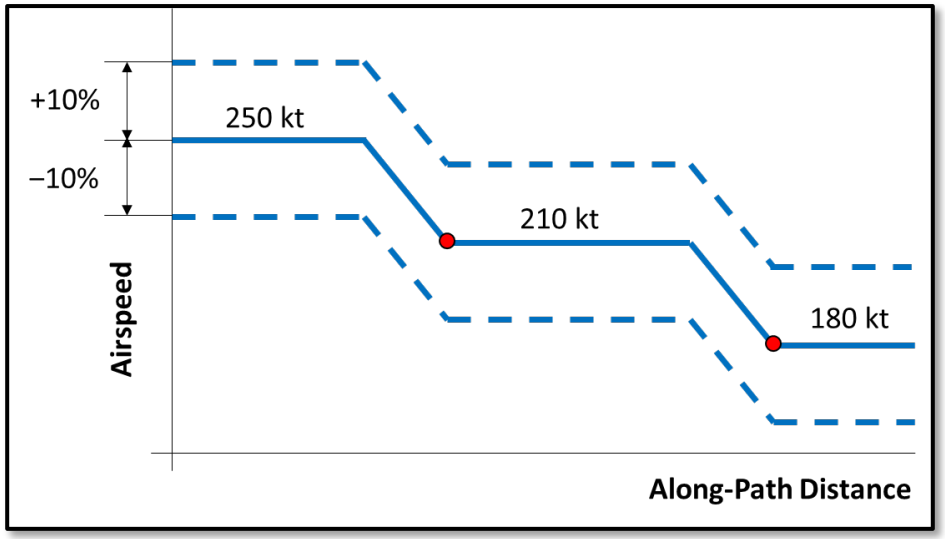


Fully-Defined Paths



PBN Requirements for IM (2 of 2)

- In an environment with no air/ground trajectory information exchange, speed constraints should be used to define a nominal speed profile
- Procedural altitude constraints should be achievable given a 10%* window around the nominal speed profile



Note: A separate briefing is available on IM Speed Limiting as defined in the FIM MOPS

***Per the FIM MOPS, "Airspeed Profile Limit must be configurable at installation with a default value of 10%"**

ADS-B-In Aviation Rulemaking Committee (ARC) Priority Capabilities (2011)

ARC recommended FAA focus funding on accelerating development of equipment standards, certification guidance, operational approval guidance, ATC automation, and any policy adjustments to enable operational implementation of capabilities listed below, in priority order [with targeted completion date]:

1. ***CDTI-Assisted Visual Separation (CAVS)*** **[FY12]**
2. ***Flight-deck-based Interval Management–Spacing (FIM–S)*** **[FY15]** [RTCA DO-361A as amended by Chg 1]
3. **Traffic Situation Awareness with Alerts (TSAA) [FY13]** [now called ATAS]
4. **Oceanic In-Trail Procedures (ITP) [FY13]**
5. ***CDTI-Assisted Pilot Procedure (CAPP)*** **[FY16]** [use of CAVS avionics to enable new operations; now called CAS-A]
6. **Ground-based Interval Management–Spacing (GIM–S) with Wake Mitigation [FY18]**
7. **Flight-deck-based Interval Management—Defined Interval (FIM–DI) [FY19]**
   [RTCA DO-361A as amended by Change 1]
8. **FIM–DI for Closely Spaced Parallel Runway Operations (CSPO) [FY17]**
   [RTCA DO-361A as amended by Change 1]
9. **Oceanic Interval Management (IM) [FY15]** [called Pairwise Trajectory Management; NASA R&D on this was discontinued before readiness for RTCA/EUROCAE standardization]
10. **Airport Traffic Situation Awareness with Indications and Alerts (SURF–IA) [FY17]** {See DO-323}

Except for possibly SURF-IA (#10), all above capabilities are compatible with U.S. ADS-B Out Rule compliant avionics & performance requirements

Current ADS-B-In Avionics Standards

- Oceanic In-Trail Procedures (ITP) SPR
  RTCA DO-312 / EUROCAE ED-159
- Visual Separation on Approach (VSA) SPR
  RTCA DO-314 / EUROCAE ED-160
- Airborne Traffic Situational Awareness (AIRB) SPR
  RTCA DO-319 / EUROCAE ED-164
- Surface Traffic Situational Awareness (SURF) SPR
  RTCA DO-322 / EUROCAE ED-165
- Traffic Situation Awareness with Alerts (TSAA) SPR
  RTCA DO-348 / EUROCAE ED-232 [now referred to as ADS-B Traffic Advisory System (ATAS)]
- CDTI-Assisted Visual Separation (CAVS) SPR
  RTCA DO-354 / EUROCAE ED-233
- Interval Management (IM) SPR
  RTCA DO-328B / EUROCAE ED-195B
- **Aircraft Surveillance System (ASA) MOPS, RTCA DO-317C / EUROCAE ED-194B as modified by Change 1**
  - Requirements for AIRB, SURF, VSA, CAVS, ATAS, and ITP
- **Interval Management (IM) MOPS, RTCA DO-361A / EUROCAE ED-236A as modified by Change 1**

SPR = Safety, Performance, and interoperability Requirements

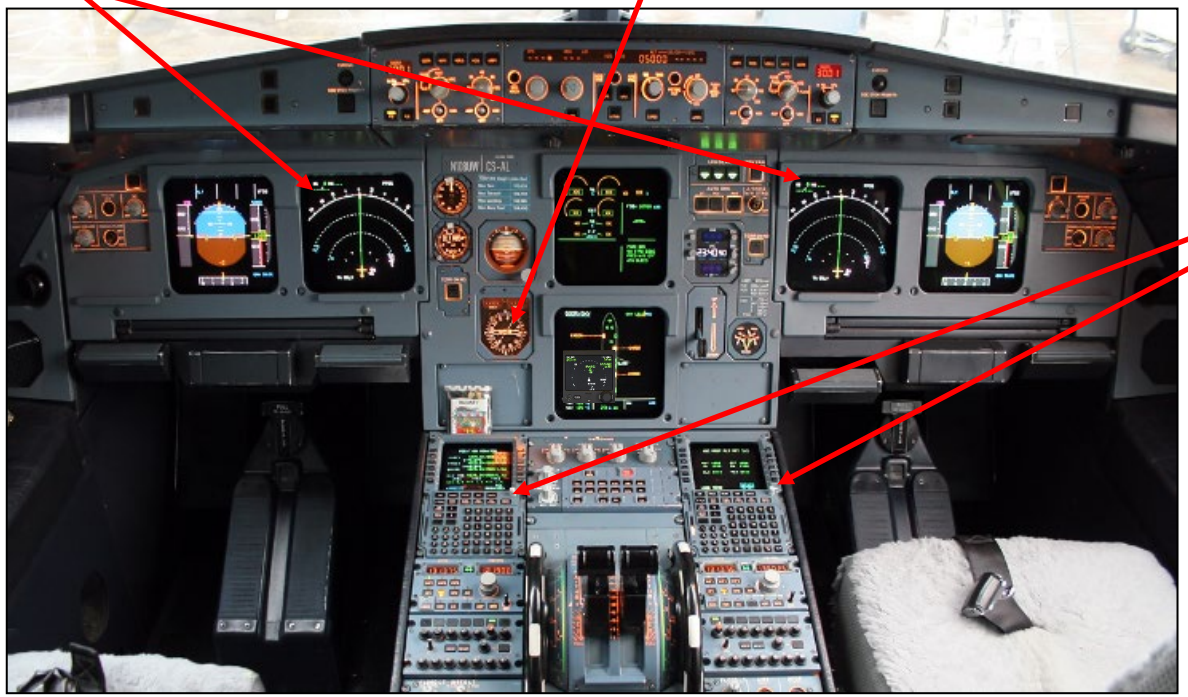
MOPS = Minimum Operational Performance Standards

ADS-B-In Retrofit Spacing (AIRS)

Navigation Display

ADS-B In Guidance Display (AGD)

Multi-Purpose Control Display Unit



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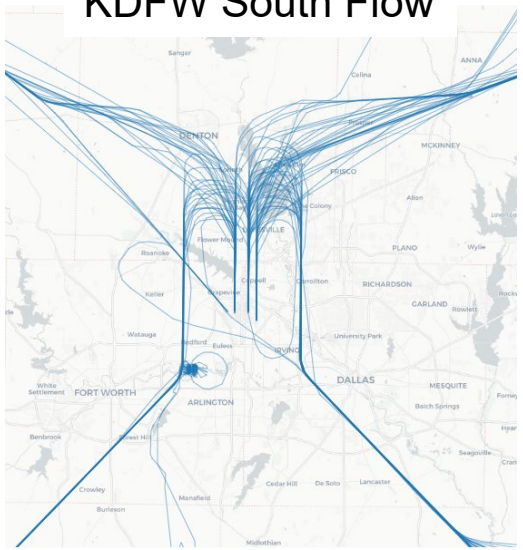
AIRS CAVS/CAS Display and Operations

KDFW South Flow



- CAVS operations are transparent to ATC, but are identified from aircraft-recorded data several months after flight operation
- CAS-A operations required controller initiation, and could be initiated in either feeder or final controller positions, depending on crew and circumstances
- Controllers entered VC or IC into STARS scratchpad to mark CAS-A operations

AIRS I-IM Display and Operations

- I-IM operations conducted with both time-based and distance-based spacing goals
- I-IM operations conducted on cruise segments and initial descent segments to ZAB/P50 boundary
- Controllers used ERAM 4th line to mark Lead / Trail aircraft and Assigned Spacing Goal

IM (airspeed) AGD

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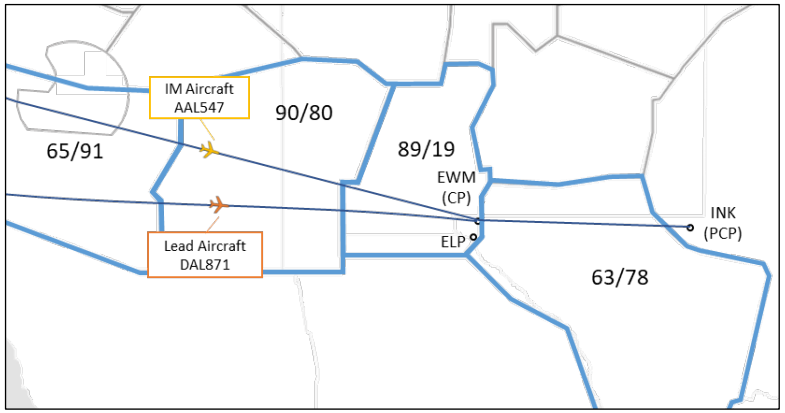
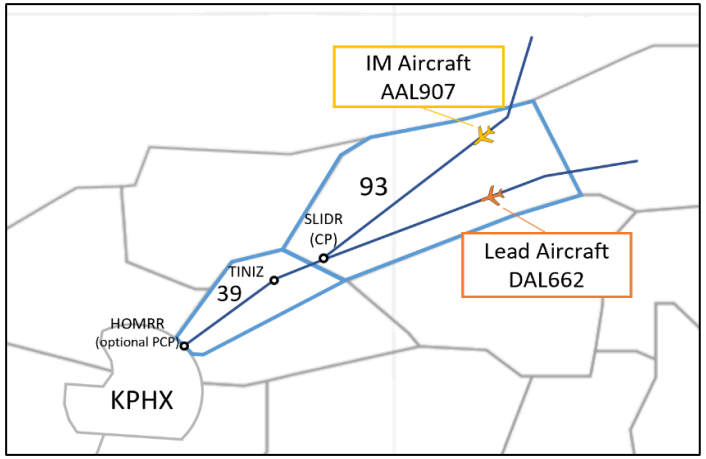
Assigned Spacing Goal (time)

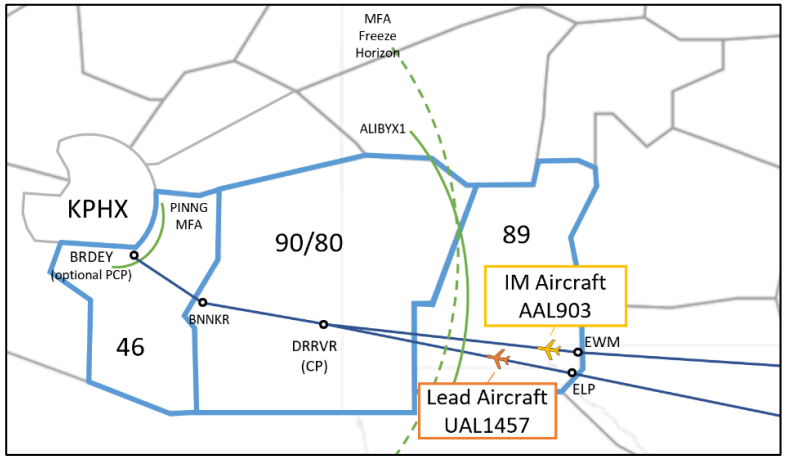
Lead aircraft ID

Avionics-computed speed guidance

Lead aircraft location, vertical sense & relative altitude







AIRS Results Summary

CAVS/CAS

- When pilots designate traffic using the ADS-B Guidance Display (AGD), they tended, on average, to achieve more consistent and smaller interarrival distances at the runway threshold
- When pilots using an AGD were combined with TRACON controllers who recognized the capable traffic and used a procedure like CAS-A, flight time and distance savings occurred in the terminal area

I-IM

- I-IM Operations resulted in smaller spacing errors than achieved with non-I-IM aircraft
- I-IM aircraft exhibited more consistent spacing that non-I-IM aircraft

See
https://www.faa.gov/about/office_org/headquarters_offices/ato/airs-cavs-cas-op-eval-final-report
https://www.faa.gov/sites/faa.gov/files/AIRS I-IM Op Eval Final Report_Consolidated for Website_final.pdf

“Airline” ADS-B-In Equipage

As of 31 December 2024

US-regulated operators only; from FAA Flight Standards Operational Approval data

Equipage Category	Total
ADS-B-In[1]	
In-Trail Procedures (ITP)	111
CDTI-Assisted Visual Separation (CAVS)	301
Interval Management – AAL A321	301
Interval Management – TSO-Compliant	0

[1] *FAA Authorized Aircraft (not all aircraft with ADS-B In equipage)*

What value did industry see in CAVS/CAS that caused interest?

- CAVS/CAS is part of a larger ADS-B-In benefits picture, of which Interval Management capability is a part
  - This picture was first laid out by the ADS-B-In Aviation Rulemaking Committee (ARC) in 2011-2012; see

    https://www.faa.gov/regulations_policies/rulemaking/committees/documents/index.cfm/document/information/documentID/762
    https://www.faa.gov/sites/faa.gov/files/air_traffic/technology/adsb/quicklinks/ADSB%20In%20ARC%20Report%20with%20transmittal%20letter.pdf
    https://www.faa.gov/sites/faa.gov/files/air_traffic/technology/adsb/quicklinks/ADS-BInARCReportOct2012.pdf
    https://www.faa.gov/sites/faa.gov/files/air_traffic/technology/adsb/quicklinks/ADS-BInARCLetterToFAA.pdf

- FAA estimated benefits for the ADS-B-In ARC, and has updated them since then; most recently for NAC Task Group 20-1 (circa 2021)

- Analysis of 2018 NAS operations estimated that airlines could have saved $192M in Aircraft Direct Operating Costs during 2018 if all aircraft had been equipped with CAVS/CAS and full Interval Management capabilities (which leverage TBO ATC automation capabilities)
  - Of these savings, approximately 27% were attributable to CAVS/CAS and the remainder to Interval Management

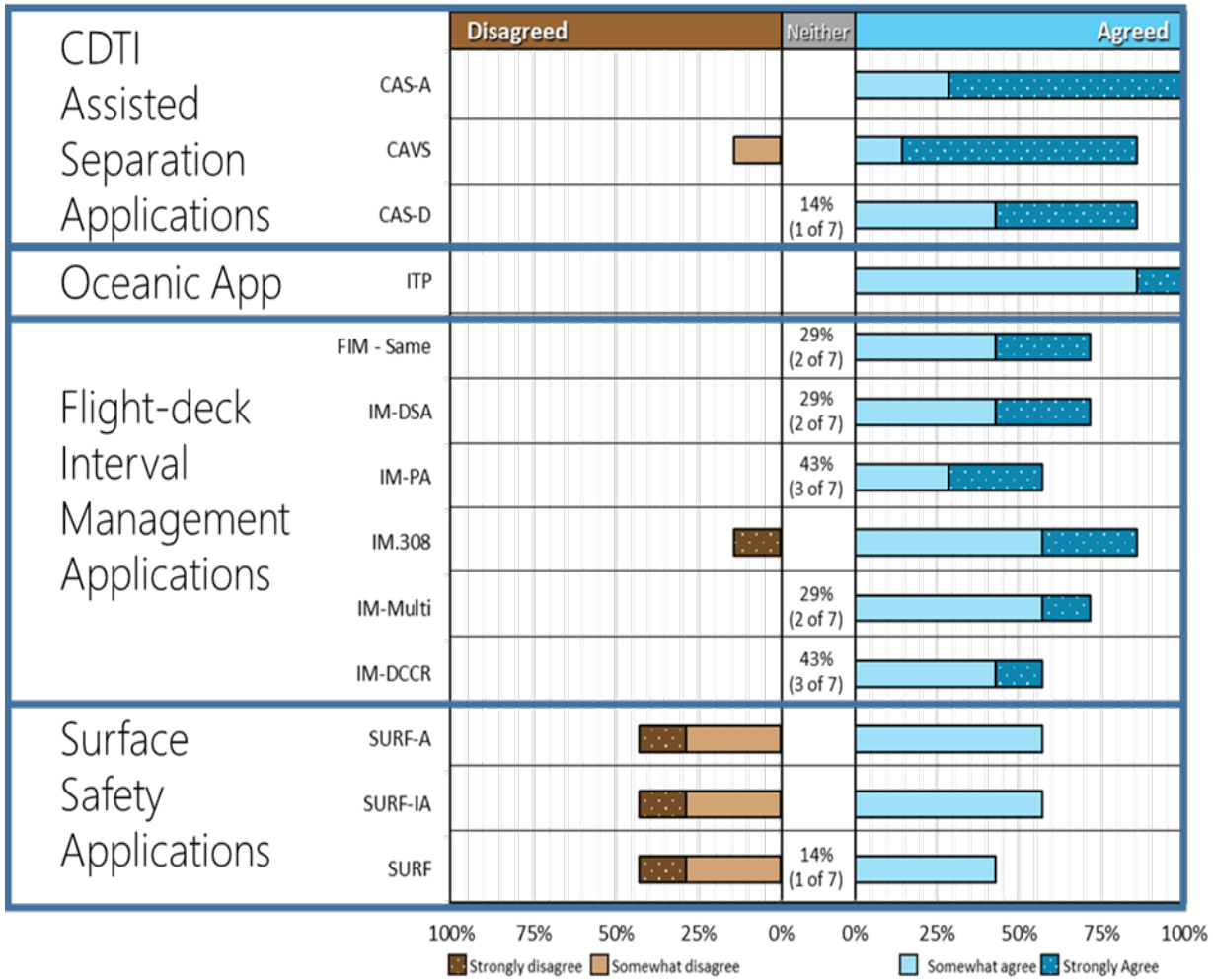
NAC Task 20-1: Selected Recommendations

- Industry most interested in:
  - Cockpit Display of Traffic Information (CDTI) Assisted Separation (CAS)
  - CAS on Departure
  - Interval Management (IM)

- Survey participants:
  - Alaska
  - American
  - Delta
  - FedEx
  - JetBlue
  - United
  - UPS

- FAA should “Formally notify Operators and OEMs when the FAA makes investment decisions or changes previously communicated investment approaches”

What ADS-B In applications are you interested in?



See https://www.faa.gov/sites/faa.gov/files/about/office_org/headquarters_offices/ang/NAC_Task_20-1_Final_Report_20210604.pdf *for the full report*

Status Assessment (June 2026)

Name	Avionics Stds	FAA Cert Guid	FAA Op Approv Guid	ATC Automation	FAA Policy adj?
CAVS	Done	Done	Done	Not needed	Done
CAS-A	Done	Done	Done	Plan awaits funding	Trial only
CAS-D	Done	Unclear if needed	No	Plan awaits funding	Not needed
ITP	Done	Done	Done	Done	Not needed
PTM	No	No	No	No plan	Possibly
IM-Same	Done	In progress	Done	No plan	Not needed for AIRS-type operations
IM-Multi	Done	In progress	Done	No plan	Unclear if needed
IM-DSA	Done	In progress	Unclear if needed beyond current	No plan	Unclear if needed
IM-.308	Done	In progress	Unclear if needed beyond current	No plan	Unclear if needed
IM-DCCR	Done	In progress	Unclear if needed beyond current	No plan	Unclear if needed
IM-PA	Done	In progress	No	No plan	No plan
RCA	No	No	No	Not needed	Unclear if needed
SURF-IA	No	No	No	Not needed	Unclear if needed
SURF	Done	Done	Done	Not needed	Not needed

Definitions (1 of 2)

1. **ADS-B In Retrofit Spacing (AIRS) Evaluation:** Operational evaluation to demonstrate the feasibility and value of ADS-B In capability using a retrofit solution. The demonstration consisted of CAVS, CAS-A, and Initial IM capabilities using certified ACSS equipment on AAL A321 aircraft (~300 aircraft).

2. **Automatic Dependent Surveillance-Broadcast-In (ADS-B-In):** Aircraft equipped with ADS-B-In can receive and display other aircraft's ADS-B Out data on an avionics display installed in the cockpit. The basic traffic display improves flight safety for aircraft without a traffic alerting or collision avoidance system. This functionality can then be enhanced to allow flight crews and ATC to leverage ADS-B In data for additional operational benefits (see items 4, 5, 6, & 7).

3. **Capability Indicator:** Provides ATC with aircraft ADS-B-In capability indication, to support operations per items 5 & 6.

4. **CDTI-Assisted Visual Separation (CAVS):** CAVS avionics functionality supports the flight crew in acquiring a lead aircraft out-the-window, when instructed by a controller to maintain pilot-applied visual separation. The Cockpit Display of Traffic Information (CDTI) is used with supporting CAVS avionics functionality to maintain awareness of the lead aircraft's position and groundspeed if the view out of the window is temporarily lost. Operators can currently conduct this operation with certified avionics and FAA Operational Specification approval. Use of this operation is transparent to ATC.

5. **CDTI-Assisted Separation (CAS):** Uses CAVS avionics functionality to enable the flight crew to acquire an ATC-identified lead aircraft without seeing traffic out the window. The flight crew can use the displayed range and ground speed on the CDTI, with supporting CAVS avionics functionality, to maintain pilot-applied separation relative to a lead aircraft. (as with pilot-applied visual separation, there is no separation minima; the controller may provide speed instructions to preserve a good approach flow)
    - **CAS on Approach (CAS-A):** ADS-B In avionics functionality used in the approach phase
    - **CAS on Departure (CAS-D):** ADS-B In avionics functionality used in the departure phase

Definitions (2 of 2)

6. **Interval Management (IM):** Uses ADS-B-In capabilities to precisely manage spacing between aircraft. IM avionics compute speed guidance to respond to unexpected behavior by the lead aircraft or wind changes, for example. IM is a component of the future Trajectory Based Operations (TBO) vision, where air traffic controllers may opt to provide IM clearances to flights to manage their spacing intervals relative to other aircraft. Flight-deck applications, like IM, can provide more precise spacing than ground-based decision support tools alone, providing greater TBO benefits. IM operations can be used in EnRoute and Terminal operations.
   - **Flight-deck Interval Management (FIM):** A reference to the flight-deck ADS-B-In application used to conduct IM operations.
   - **IM on Final:** An air traffic management IM operation that enables ATC to use IM to precisely space aircraft during the final approach phase of flight.
   - **Miles in Trail (MIT):** ATC may use IM to precisely space aircraft when receiving sectors require a distance-based spacing goal, either between aircraft departing an airport, over a fix, at an altitude, thru a sector, or on a specific route.

7. **In-Trail Procedures (ITP):** ADS-B-In avionics functionality that allows equipped aircraft to operate more often at optimal and/or less turbulent flight levels in oceanic or remote airspace. ITP uses precise ADS-B location data to allow for altitude changes that would otherwise be blocked when using procedural separation standards. ITP operations are initiated by flight crews, approved/denied by controllers, and currently occur in FAA-controlled oceanic airspace.