Virtual Radar- Emulating Long Range ARSRs with ADS-B

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Agenda

- ADS-B Overview
- Virtual Radar Concept
- Emulation
- Benefits and Possibilities
- Secondary applications
- Questions

ADS-B Overview

Technology provides both controllers and pilots with "radar-like" displays of highly accurate traffic data. The system also provides pilots access to weather services, terrain maps, and flight information services.

The FAA's Surveillance and Broadcast Services (SBS) program office was created to manage the transition the ATC from sole reliance of radar technology to the ADS-B concept that uses precise location data from the GPS network.

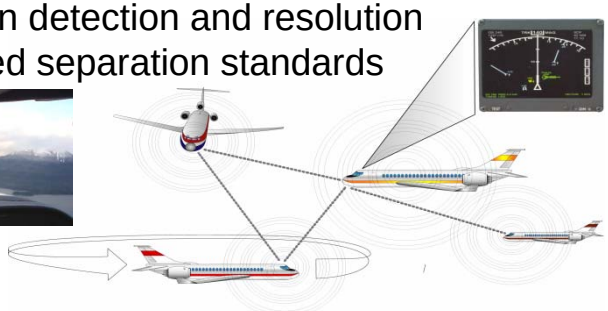
- **A**utomatic
  - No interrogation by external system and no pilot input required
- **D**ependent
  - Position and velocity vector based on own ship's navigation
- **S**urveillance –
  - Provides aircraft type, position, altitude, velocity vector, call sign (and future intent)
- **B**roadcast
  - Data transmitted for reception by airborne and ground receivers

ADS-B Applications and Benefits

Air-to-Air

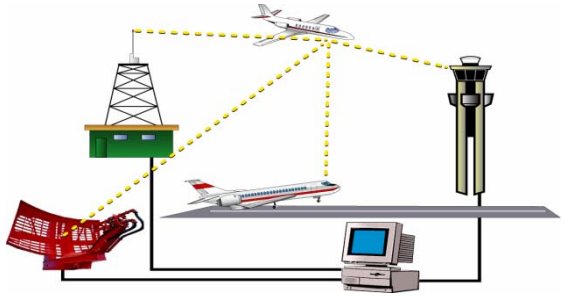
Cockpit Display of Traffic Information (CDTI) for:

- Enhanced see and avoid
- Collision detection and resolution
- Reduced separation standards



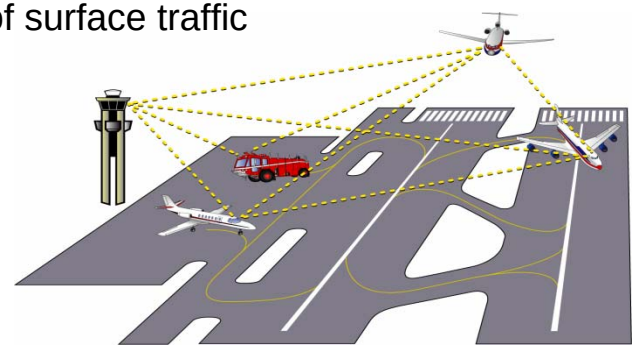
Air-to-Ground

- Enhanced surveillance
- Surveillance in non-radar airspace
- Reduced separation standards



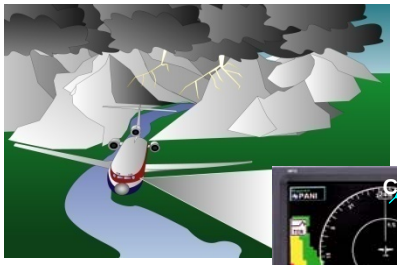
Ground-to-Ground

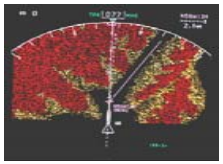
- Improved navigation on surface
- Enhanced controller awareness of surface traffic



Ground-to-Air

- Uplink of non-ADS-B equipped traffic
- Uplink of weather





Virtual Radar Concept

Virtual Radar is the emulation of the characteristics existing traditional radar so that it may be used by existing automation systems without modification.

In order to accomplish this task it must perform the following functions:

- Emulation of the physical and link level protocol currently accepted by automation equipment
  - 3 – 2400 Baud synchronous CD-2 protocol
  - CD-2 Message set
- Conversion of CAT33 ADS-B messages to CD-2
- Mapping of the Air Space from Lat-Long to Range-Azimuth
- Conversion or generation of status and control messages necessary to simulate a scanned surveillance radar

Why?

To allow the benefits of ADS-B before the automation systems can be updated to allow acceptance of native ADS-B surveillance input.

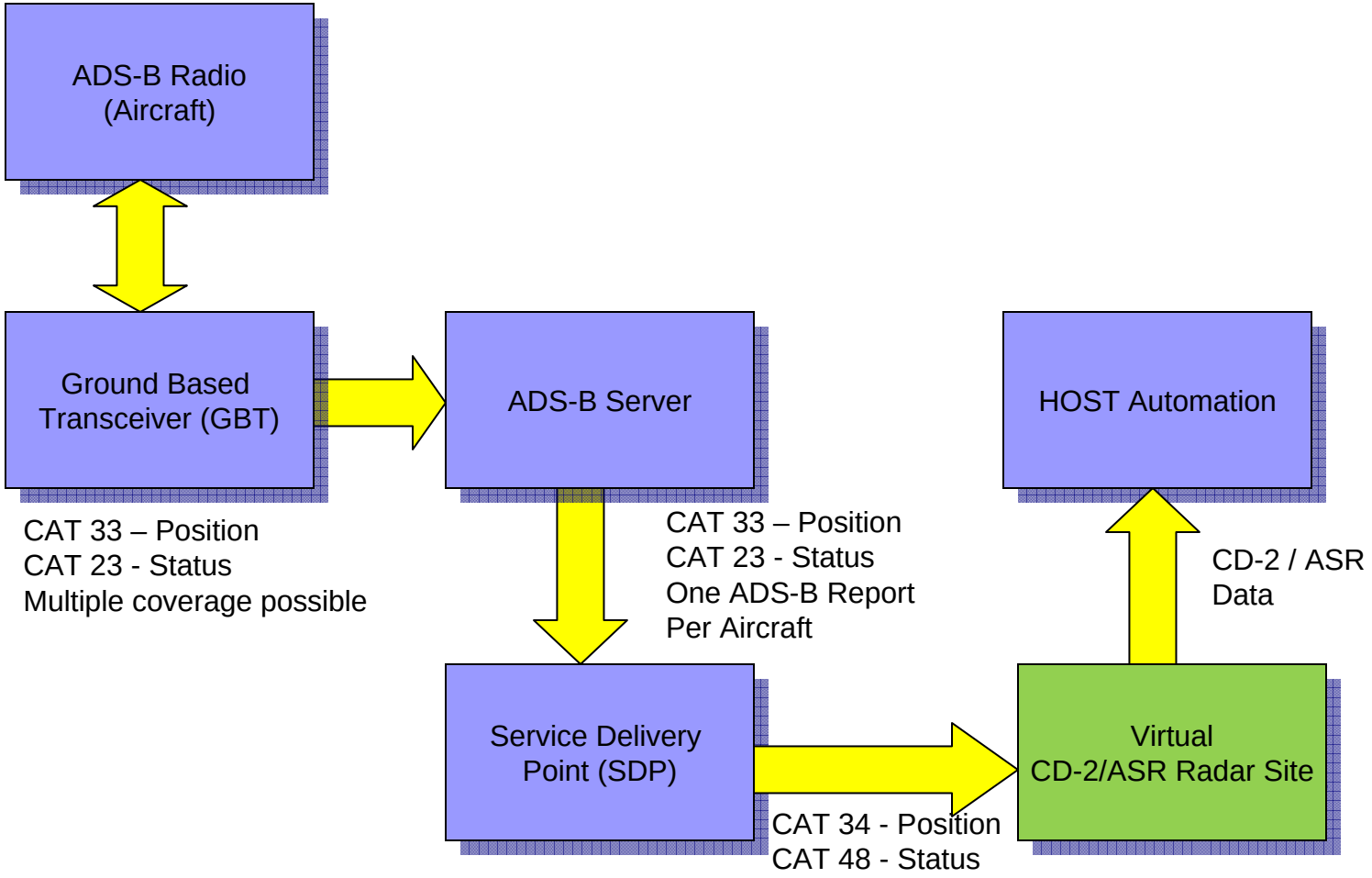
These benefits include:

- Provide coverage where none currently exist (Gulf of Mexico)
- Provide for backup of current surveillance
- Take advantage of deployed ADS-B infrastructure
- Allow transition and test environment
- More accurate time stamped data

Data Flow

- Aircraft broadcast position report including location, velocity, and vector
- Multiple ground stations receive reports and forward them to centralized ADS-B servers
- Servers process the messages:
  - Removing duplicates
  - Performing validity checks
  - Checking message quality
  - Sorting the messages into Service Volumes
- Distributing the messages to registered users
- Service Delivery Points (SDP) located at FAA facilities provide the demark between the service provider and the FAA
- Radar Data Conversion Processors at the SDPs provide the conversion to CD-2 format and protocol

Simplified Data Flow



Emulation

Virtual Radar – Functional Requirements

- Emulate Long Range ARSR Radar
  - Accept ASTERIX ADS-B (CAT033) reports and status (CAT023) reports.
  - Output Beacon, status, BRTQC, SRTQC, and RDVM messages in the CD2 format defined in NAS-IR-SBS SDP-CD2.
  - Output the prescribed report at the appropriate time, based on scan emulation of a 12 second long range radar.
  - Eliminate duplicate Reports
  - No changes to existing Automation other than Adaptation

Report Comparison Summary

Report Type	***ASTERIX Format***	***FAA CD-2 Format***
ADS-B Report	FAA CAT033	Beacon Message
Service Status Report	FAA CAT023	Status Message
Sector Crossing	Data obtained from adaptation	Beacon Real Time Quality Control (BRTQC) Message
Sector Crossing	Data obtained from adaptation	Search Real Time Quality Control (SRTQC) Message

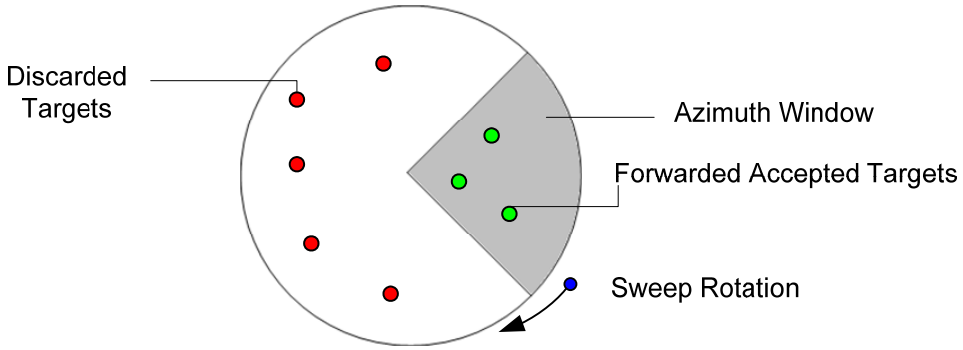
Messages are mapped from CAT33 to CD-2

Virtual Radar Emulation Modes

The Virtual Radar will operate in one of two modes:

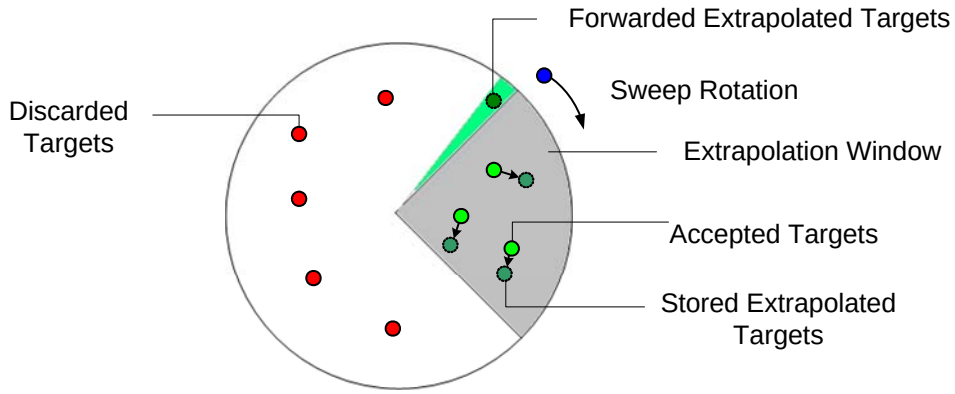
- *Non Time Registration*
  - Targets are sent out when received if they are close enough to the virtual Radar beam
- *Time Registration*
  - Targets are held and extrapolated and sent out when the beam would have hit them
- In Both cases only one beacon per target sent per emulated scan (12 sec)

Virtual Radar *Non Time Registration*



- Process and Immediately forward any beacons that appear in an adaptable wedge.
- Insure that only one target is reported during a 12 second sweep.

Virtual Radar *Time Registration*



- Time registration emulation utilizes the latest received ADS-B report and extrapolates where the aircraft will be when the emulated radar beam would encounter the target.
- Insure that only one target is reported during a 12 second sweep.

Applications and Benefits

Applications

- More efficient use of existing capacity, and opening up new flight routes in the areas, which were previously unmonitored.
- Provide accurate position data where conventional radar cannot, such as aircraft:
  - with low altitudes
  - that are on the ground
  - directly over the sensor
  - in remote areas, over mountainous terrain
  - over water

Additional Uses

- Virtual radars can be used to test configurations before new physical radars are brought online.
- Since ADSB data is more accurate then radar data, placing virtual radar over existing radar can help identify errors in adaptation or calibration.
- They can be adapted to take the place of any existing radar that is down for maintenance.
- Virtual radars can be turned on during times of day in which the sun renders conventional radars ineffective.

Challenges

- Validation and Verification Testing:
  - Existing procedures must be modified to insure certification and validation.
  - New toolsets need to be developed to generate appropriate test stimulus
  - CAT33 ADS-B simulators required to test data path and validate operation

Questions?